REMEDIAL DESIGN WORK PLAN
(RD WORK PLAN)

WEST LAKE LANDFILL SUPERFUND SITE
OPERABLE UNIT 2 (OU-2)
BRIDGETON, MISSOURI

PREPARED FOR:

BRIDGETON LANDFILL, LLC

PREPARED BY:

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PHOENIX, ARIZONA

CEC PROJECT 191-750

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1.0 INTRODUCTION

This Remedial Design Work Plan (RD Work Plan) for West Lake Landfill Superfund Site Operable Unit 2 (OU-2) has been prepared by Civil & Environmental Consultants, Inc. (CEC) (the project team). This RD Work Plan and the associated documents have been prepared by the project team on behalf of Bridgeton Landfill, LLC (the Respondent) in response to the Administrative Order on Consent (AOC) for OU-2.

This RD Work Plan and the associated documents including the Quality Assurance Project Plan (QAPP; **Appendix A**), Sampling and Analysis Plan (SAP; **Appendix B**), and Health and Safety Plan (HASP, **Appendix C**) have been prepared by the project team in accordance with the requirements of the Third Amendment to the AOC and the associated Statement of Work (SOW) which describe the requirements for completion of the remedial design (RD) phase of the implementation of the selected remedy for OU-2. A description of the various components, design criteria, and performance standards of the selected remedy are provided in this RD Work Plan. The project planning activities, additional design investigations, and progress reporting to be conducted in support of the design of the selected remedy are also described.

It should be noted that the Missouri Department of Natural Resources (MDNR) code of State regulations (CSR) cited in this RD Work Plan for the design and operation of landfills are those that were in effect at the time of the signing of the Record of Decision (ROD) in 2008. A copy of the 1998 MDNR Division 80, Chapter 3, is provided in **Attachment 1** of this RD Work Plan for convenience.

Since the 2008 OU-2 ROD was issued, several matters have developed that necessitate evaluation and consideration in the RD for OU-2. Those items include:

Subsurface Reaction (SSR)

The SSR started on the northeastern side of the South Quarry of the Formerly Active Sanitary Landfill (Bridgeton Landfill) and moved in a counterclockwise direction, past the Inactive Sanitary Landfill (ISL), and is now located in the extreme southeastern corner of the South Quarry. Based on a review of settlement and monitoring data, the SSR has remained in the southeastern corner of the South Quarry since at least winter 2015. It is unlikely that the SSR will double back towards the ISL portion of OU-2. Bridgeton Landfill, LLC will continue to manage the North and South Quarries of Bridgeton Landfill according to the obligations outlined in the MDNR permit requirements, the June 2018 Final Consent Judgement and the approved *Operation, Maintenance and Monitoring (OM&M) Plan*.

Historical aerial photographs and site drawings and plans will be reviewed to determine waste placement in the two (2) cells. Additionally, a minimum of three (3) borings will be installed to evaluate the composition of the subsurface materials between the South Quarry of Bridgeton Landfill and the ISL. This work will be performed during the design investigation.

OU-2 Remedy at Closed Demolition and Bridgeton Landfills (Timeline and Process)

As stated in the 2008 ROD for OU-2, "For areas operated under state permit, i.e., the Former Active Sanitary Landfill and the Closed Demolition Landfill, the terms of their respective permits dictate the appropriate closure and post-closure care requirements. Successful completion of these requirements would eliminate the need for further action under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at these units. Consistent with United States Environmental Protection Agency's (USEPA) policy on coordination between the Resource Conservation and Recovery Act (RCRA) and CERCLA actions, these regulated units are deferred to the state regulatory program."

Effects of OU-1 RD/RA Process on OU-2 Remedy

Because the OU-1 RD/RA is not complete, it cannot be incorporated into the OU-2 RD Work Plan at this time. However, anticipated effects on the OU-2 design effort from OU-1 include definitive demarcation between the caps and waste boundaries of OU-1 and OU-2. The design of the grades and transition between the caps, as well as managing stormwater along this boundary, will be coordinated and defined during the RD phase of both OU-2 and OU-1. Intrusive investigations near the OU-1/OU-2 boundary will be commenced after the waste boundary limits of OU-1 Area 2 are defined by the OU-1 RD effort.

Effects of OU-3 Remedial Investigation/Feasibility Study (RI/FS) Process on OU-2 Remedy

As is proposed in this RD Work Plan, the long-term groundwater monitoring program for the ISL portion of OU-2 will be coordinated with, and conducted in conjunction with, the implementation of the OU-3 Remedial Investigation/Feasibility Work Plan (OU-3 RI/FS Work Plan) groundwater monitoring activities. Long-term performance groundwater monitoring for the ISL portion of OU-2 is proposed to consist of nineteen (19) groundwater wells. The 19 wells consist of thirteen (13) existing monitoring wells (with historic water quality and water level data) and six (6) currently proposed, but not-yet-constructed OU-3 monitoring wells, for the OU-3 RI/FS. Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells.

The baseline portion of the proposed OU-2 performance groundwater monitoring program will begin following USEPA approval of both this OU-2 RD Work Plan and the OU-3

RI/FS Work Plan. At this time, it is anticipated that the OU-3 RI/FS Work Plan will be approved by the USEPA, and the proposed additional OU-3 monitoring wells will be installed, during the third and fourth quarters of 2020. Therefore, the baseline phase of the proposed OU-2 groundwater monitoring program would begin in the fourth quarter of 2020 in conjunction with the OU-3 groundwater monitoring activities. However, that date is contingent upon approval of the OU-3 RI/FS Work Plan by the USEPA. The coordination with the OU-3 groundwater investigation has been referred to in various sections of this RD Work Plan and project schedule.

1.1 PURPOSE AND SCOPE

As stated in the 2008 OU-2 ROD, the general objective of the remedial activities is to "protect public health and the environment by preventing actual or potential human exposure to the Site's contaminants and by preventing or mitigating contaminant migration." The specific Remedial Action Objectives are to:

- Prevent direct contact with landfill contents;
- Minimize infiltration and resulting contaminant leaching to groundwater;
- Control surface water runoff and erosion; and
- Control and treat landfill gas.

The requirements of other environmental regulations determined to be applicable or relevant and appropriate to the design and implementation of the remedy are identified in the ROD and incorporated in this RD Work Plan. In addition, this RD Work Plan presents preliminary design criteria upon which the RD will be based. The RD Work Plan will be used to ascertain the information necessary to perform remedial action (RA) that is compliant with the applicable or relevant and appropriate requirements (ARARs) of the MDNR regulations for sanitary landfill caps specified in Title 10, Division 80, Chapter 3 (10 CSR 80-3).

The primary purpose of the RD Work Plan is to support and allow for the appropriate RA in the future. This RD Work Plan describes the activities to be completed in conducting the additional site investigations and testing necessary to support the design of the remedy. It also includes the project planning documents required for conducting these investigations. A preliminary conceptual design of the Selected Remedy and description of the performance standards that apply to the remedy are also presented in this RD Work Plan. Specifically, the RD Work Plan will consist of the field investigations outlined below. It should be noted that documents and plans referred to that are in *italics* are anticipated deliverables during RD.

1. *Existing Conditions Summary* - topographic survey and base map preparation to provide updated topography and survey information to be used as a base map and the basis for the development of the grading plans. The updated survey will also provide a basis for evaluation of existing stormwater runoff and run-on, the locations of on-site and adjacent infrastructure and utilities at or in the immediate vicinity of the ISL.

2. *Explosive Gas Monitoring Plan* - Installation and monitoring of temporary landfill gas perimeter monitoring wells[1] to evaluate the need for and nature of potential landfill gas control measures. Findings will be reported in the *Soil Gas Summary Report*.

3. *Existing Soil Cap Evaluation Report* – to determine if the existing cover material on the ISL meets the MDNR CSR requirements, as they existed in 2008, for closure and post-closure care for sanitary landfills.

4. *Slope Stability Evaluation Report* – The Slope Stability Evaluation Plan will be submitted as a future design investigation planning document.

5. W*aste Separation Evaluation* – to determine if there is a "waste pathway" for the SSR, currently occurring in the South Quarry portion of Bridgeton Landfill, to migrate to the ISL.

6. Long-term groundwater monitoring - to establish baseline, or background, groundwater quality in the alluvial aquifer beneath the ISL; provide a basis to assess the protectiveness of the remedy relative to groundwater quality; identify any future impacts to groundwater quality during or after implementation of the remedial action for the ISL; and demonstrate that the Selected Remedy performs as required over the post-closure period. The baseline conditions will be submitted in the *Quarterly* and *Annual Monitoring Groundwater Reports*.

[1] The term "gas monitoring well" is being used throughout this document per EPA comment and at the recommendation of MDNR. Please note that such gas monitoring "wells" being installed and sampled as part of the OU-2 investigation will be installed outside of the waste boundary and will not be attached to a gas collection and control system. The "wells" will serve as what have traditionally been identified by Bridgeton Landfill as gas monitoring "probes" to monitor if landfill gas is migrating off-site.

1.2 ORGANIZATION

This RD Work Plan includes the following sections:

1.0	Introduction
2.0	Remedy Description
3.0	Design Team
4.0	Design Investigations
5.0	ARAR Requirements
6.0	Conceptual Design and Design Criteria
7.0	Progress Reports
8.0	Project Schedule for RD
9.0	References

This RD Work Plan also includes the following attachments and appendices:

Attachment 1	Copy of 1998 Rules of Department of Natural Resources Division 80, Chapter 3
Attachment 2	Photographs of Conditions at OU-2
Attachment 3	Odor Management Plan

Appendix A	Remedial Design Quality Assurance Project Plan
Appendix B	Remedial Design Sampling and Analysis Plan
Appendix C	Remedial Design Health and Safety Plan

2.0 REMEDY DESCRIPTION

The remedy will be designed to meet the performance standards, criteria and specifications set forth in the OU-2 ROD, the SOW and the AOC, unless subsequently modified in accordance with the procedures set forth in the AOC.

The performance standards, criteria and specifications will include the substantive requirements set forth in ARARs identified in Section 13.2 of the ROD.

2.1 DESCRIPTION OF THE SELECTED REMEDY

The remedy for OU-2 was developed to protect human health and the environment by providing containment in accordance with relevant and appropriate closure and post-closure care requirements for the landfilled waste materials. As stated in Section 12.2 of the ROD, the containment and post-closure care methods will prevent human receptors from contacting the waste material and control contaminant migration to air or groundwater. The major components of the Selected Remedy are as follows:

1. Installation of landfill cover meeting the Missouri regulatory closure and post-closure care requirements for sanitary landfills;

2. Use and application of groundwater monitoring and protection standards consistent with requirements for sanitary landfills;

3. Surface water runoff control;

4. Gas monitoring and control consistent with sanitary landfill requirements as necessary;

5. Institutional controls to prevent land uses that are inconsistent with a closed sanitary landfill site; and

6. Long-term surveillance and maintenance of the remedy.

The focus of the remedial design (with the exception of the institutional controls) is on the ISL portion of OU-2. Per the ROD, for areas operated under state permit (i.e., the Former Active Sanitary (Bridgeton) Landfill and the Closed Demolition Landfill) the terms of their respective permits dictate the appropriate closure and post-closure care requirements. Successful completion of these requirements would eliminate the need for further CERCLA action at these units.

Consistent with USEPA's policy on coordination between the RCRA and CERCLA actions, these regulated units are deferred to the state regulatory program.

2.2 PERFORMANCE STANDARDS FOR THE SELECTED REMEDY

The Selected Remedy will be designed to meet the performance standards and specifications set forth in the OU-2 ROD and the SOW. The performance standards for the major components of the remedy are identified below in the order listed in Section 12.2 of the ROD. Alternative standards or requirements may be approved if it can be demonstrated that the alternative design is at least equivalent in performance.

2.2.1 Landfill Cover System

The landfill cover system will be designed to meet, at a minimum, the State of Missouri closure requirements for sanitary landfills.

Rules for sanitary landfill caps in effect at the time the ROD was signed (2008) are specified in the MDNR Title 10, Division 80, Chapter 3; a copy of these rules is provided in **Attachment 1**. These rules require that the final cover shall consist of at least two (2) feet of compacted clay with a coefficient of permeability of $1x10^{-5}$ centimeters per second (cm/sec) or less and overlaid by at least one (1) foot of soil capable of sustaining vegetative growth. Pursuant to 10 CSR 80-3.010(17) A, the cover material will be capable of minimizing fire hazards, controlling infiltration of precipitation, controlling odors and blowing litter, controlling control gas venting and vectors, discouraging scavenging, and providing a pleasing appearance. Also, pursuant to 10 CSR 80-3.010(17)(C)11, the compacted clay portion of the final cover will consist of soils classified under the Unified Soil Classification System, including CH (clay of high plasticity), CL (clay of low plasticity), ML (silt), SC (clayey sand) and MH (silt of high plasticity; elastic silt).

MDNR landfill regulations contain minimum and maximum slope requirements. Specifically, these regulations require the final slope of the top of the sanitary landfill shall have a minimum slope of five percent (5%) [10 CSR 80-3.010(17)(B)(7)]. The objective of these requirements is to account for potential differential settlement. Because landfilling of the Inactive Sanitary Landfill was complete approximately 30 years ago, most compaction of the refuse has taken place and differential settlement is no longer a significant concern. The five percent (5%) minimum sloping requirement is greater than necessary and may not be-optimal in this case. Therefore, the five percent minimum slope requirement is not considered appropriate. Per Section 13.2 of the OU-2 ROD, the remedial design will incorporate a two percent (2%) minimum slope to maintain positive drainage. Additionally, MDNR 10 CSR 80-3.010(17)(B)3, requires "maximum slopes be less than 25% unless it has been demonstrated in a detailed slope stability analysis that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill. Even with such demonstration, no active, immediate, or final slope shall exceed 33 1/3%" per MDNR 10 CSR 80-3.010(17)(C)3. The slope on the western portion of the ISL has been in place for over 30 years and visually has shown to be stable and therefore an analysis of the slope will be performed as part of the RD. Additionally, MDNR 10 CSR 80-3.010(17)(C)5, requires provisions for slope stability for installation of final cover systems.

The design objectives listed above will be demonstrated by performing field tests, investigations, calculations, and evaluations as described in the *Slope Stability Evaluation Plan* that will be submitted as a future design investigation planning document. The conclusions of the field tests, investigations, calculations, and evaluations will be submitted in a future *Slope Stability Evaluation Report*.

2.2.2 Long-Term Performance Groundwater Monitoring

The objectives of the proposed OU-2 long-term performance groundwater monitoring program are to: 1) characterize the existing groundwater conditions and water quality, 2) protect groundwater from any ongoing or future impacts from the ISL, and 3) demonstrate that the Selected Remedy performs as required over the post-closure period (USEPA ROD, 2008).

The proposed groundwater monitoring program has been designed to be consistent with the requirements stated in 10 CSR 80-3.010(11). The proposed OU-2 long-term performance groundwater monitoring will consist of two phases:

- Baseline groundwater monitoring – to be conducted in accordance with 10 CSR 80-3.010 (11)(C)3, quarterly, but not to exceed eight (8) quarters of monitoring. The objective of the baseline groundwater monitoring is to establish current groundwater quality prior to implementation of the remedial action for the ISL portion of OU-2. These data will be used to calculate background (baseline) values for the detection monitoring phase.

- Detection groundwater monitoring – to begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C). Additional details regarding sampling frequency, locations and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*.

Baseline groundwater monitoring will begin, and be conducted, in conjunction with the implementation of the OU-3 RI/FS groundwater monitoring program currently under USEPA review. At this time, it is anticipated that the OU-3 RI/FS Work Plan will be approved by the USEPA in the second quarter of 2020. Installation of new monitoring wells as part of the OU-3

RI/FS is anticipated to occur during the third and fourth quarters of 2020. Therefore, groundwater sampling for the OU-2 baseline portion of the monitoring program is anticipated to begin in the fourth quarter of 2020. The actual date is contingent upon approval of the OU-3 RI/FS Work Plan by the USEPA.

The proposed OU-2 groundwater monitoring program will consist of the collection of data necessary to track the direction and gradient of groundwater flow in the area of the ISL and to monitor changes in chemical constituents and chemical concentrations in the groundwater over time after a baseline is established.

A proposed baseline monitoring well network, consisting of nineteen (19) groundwater wells that will be used to characterize existing water quality along the western, southwestern, and southeastern boundaries of the ISL, will be established. The 19 wells are shown on **Figure 1** of this RD Work Plan. These 19 monitoring wells were selected based on their geographic/spatial location to each other, their proximity to the waste boundary and property line, and their ability to monitor the various hydrogeologic zones of the alluvial aquifer. Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells.

The 19 wells consist of thirteen (13) existing monitoring wells (with existing water quality and water level data) and six (6) proposed, but not-yet-constructed, OU-3 monitoring wells. For the OU-2 groundwater monitoring program, the 19 wells will be monitored for static water level and those parameters listed in MDNR 10 CSR 80-3.010 Appendix I, which includes various general water quality parameters, metals, and organic constituents. Table 2.2 of the QAPP (**Appendix A**) provides a list of the specific parameters that will be analyzed in the groundwater samples. Groundwater quality sample data collected during the OU-2 long-term performance groundwater monitoring program will undergo a Level IV data validation process. Additional details on the analytical data verification and validation processes are provided in the QAPP (**Appendix A**). Unvalidated analytical data will be provided to the agencies as part of the monthly progress reports.

Groundwater level, water quality data, and updated potentiometric maps will be summarized and presented in the *Quarterly Groundwater Monitoring Reports*. *Annual Groundwater Monitoring Reports* will include trend analyses, tri-linear plots, and relevant maps and figures of the groundwater quality data. The groundwater monitoring reports will include the *Data Validation Report*, which will present and summarize the data verification and validation results. All laboratory data will be validated on an individual laboratory report basis within 60 days of receipt from the laboratory. Groundwater monitoring reports will be prepared and submitted to the USEPA and MDNR within 30 days after the data has been validated (or 90 days from the receipt of laboratory data).

Detection groundwater monitoring will commence upon completion of the baseline monitoring program and will be conducted in accordance with MDNR 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*. Statistical analyses (inter-well prediction limits) will be performed on the detection monitoring sample results in accordance with MDNR 10 CSR 80-3.010(11)(C)5. Groundwater quality data will be evaluated and compared against the following established Federal and State water quality standards: Code of Federal Regulations, Title 40 (40 CFR), Part 141, the primary drinking water standards, or Maximum Contaminant Levels (MCLs), and Missouri regulations 10 CSR 60-4.010 through 4.110, State primary drinking water standards.

The OU-2 groundwater monitoring program may be modified upon approval by the USEPA and MDNR. Modifications may include revising or eliminating monitoring locations, reducing monitoring frequency and/or revisions to the analytical parameters.

Details on the groundwater sampling rationale, proposed monitoring wells, sample collection procedures, sampling frequency, monitoring parameters, as well as sample documentation are provided in the SAP (**Appendix B**). Details on the Project Data Quality Objectives, analytical methods, and data verification and validation processes, are provided in the QAPP (**Appendix A**).

2.2.3 Surface Water Runoff Controls

Surface drainage diversions, controls, and structures will be designed and constructed to route stormwater runoff to the stormwater discharge points. Based on the current available topographical information and preliminary site visits of the ISL, the northwestern portion of the existing western facing slope sheet drains stormwater runoff towards the western boundary of the property where, depending upon the storm intensity, it can flow overland into the existing Earth City Levee District pond to the west of the site. Stormwater flows on the southwestern and southern slopes are collected at the toe of the slope and are discharged through an existing culvert that then discharged to the same Earth City Levee District pond to the west of the site. The stormwater drainage on the top of the landfill flows to several areas. One is a collection point on top of the landfill that is piped down the western slope to a structure that overflows into the swale along the western slope and discharges into the Earth City pond with the sheet flow from the slope itself. Stormwater for the balance of the facility drains towards the east and is collected and discharged through Outfall 003 of Bridgeton Landfill. A preliminary existing drainage area Map is included as **Figure 2**.

Stormwater drainage will be investigated further and a detailed drainage analysis will be completed as part of the RD that will include identification of existing sub watersheds and the resulting quantity/volume and nature of drainage (overland sheet flow, piped concentrated flow, and time of concentration) using applicable design storms. Since the sub-drainage areas are all less than 25 acres, with relatively short times of concentration, the Rational Method will be used for calculating the flow rates of stormwater from each sub-drainage area. Additionally, below grade existing collection and conveyance infrastructure will be evaluated for function and condition as part of the stormwater drainage evaluation. The configuration and functionality of these structures will also be evaluated relative to potential slope stability considerations.

The conceptual drainage shown on the conceptual grading plan (**Figure 3***)* indicates the continued use of both surface sheet flow as well as concentrated piped conveyance of stormwater. The proposed stormwater infrastructure will be designed using calculation methods that will provide sufficient capacity for at a minimum the 24-hour, 25-year design storm as required by 10 CSR 80-3.010(8)(B)1.F.II and III and as may be required by the Missouri Clean Water Law and corresponding rules where appropriate.

Coordination of the stormwater drainage design near the intersection with the OU-1 boundary will be ongoing with the OU-1 project team during the RD so that stormwater run-on and runoff for each operable unit can be accounted for appropriately in each of the remedy designs. This will be an ongoing feedback loop between the design teams as each design evolves. The items that need to be coordinated and shared between the design teams include: final surface grades and drainage area information; surface water controls and designs; and design and remedial action (construction) schedules. OU-1 and/or OU-2 remedial designs may need to account for interim measures for construction timelines.

The stormwater monitoring program will evolve over time and will include provisions for stormwater monitoring during the RD, RA, and ongoing operations and maintenance during closure/post closure. An initial *RD Stormwater Monitoring Plan* will be submitted and used for this RD phase of the project. The plan will include collecting stormwater samples from all ISL outfall locations on the approved stormwater plan to be developed.

The *Stormwater Monitoring Plan* for the RD work will be developed as an initial deliverable during the RD. The *Stormwater Management and Monitoring Plan* for the RA and long-term surveillance and maintenance periods will be developed and finalized as part of the RD and submitted with the 90% design documents.

2.2.4 Landfill Gas Monitoring and Control

Typically, landfill gas yields increase until the year of closure (in this context, closure is defined as the cessation of additional putrescible waste receipt). Following closure, gas yields decline at a rate dependent on various factors. Moisture content of the landfill when active as well as the relative bioavailability of carbon in disposed wastes are primary factors governing the "slope" of this declining yield curve. See USEPA *Compilation of Air Emissions Factors, Section 2.4, Municipal Solid Waste Landfills* (2008).

Because ISL has not received additional waste materials for approximately 30 years, it is anticipated that gas yields are already at low levels and will continue to decline further as bioavailable carbon sources continue to be consumed. Likewise, gas pressures will also decline. However, gas pressures may remain at levels that can promote subsurface migration. Therefore, gas migration potential, and in particular, the need to control available pressure that may drive subsurface migration requires additional definition and investigation as a component of the RD.

Characterization of landfill gas migration potential and subsurface concentrations at the western facility perimeter of the ISL will be conducted as part of the RD. MDNR 10 CSR 80-3.010(14)(C)(2)B states that decomposition gases will not be allowed to concentrate above 50% of the lower explosive limit (LEL) or 2.5% by volume for methane in the soil at the property boundary of a sanitary landfill. A preliminary assessment of landfill gas occurrence and concentrations will be conducted as described in Section 5.3 of the QAPP (**Appendix A**) and presented in the *Soil Gas Summary Report*.

Following collection of gas related information detailed within this RD Work Plan, the necessity of a landfill gas (LFG) collection system can be determined. If deemed necessary, the type, location and deployment of such a system can be determined and appropriately designed such that potential impacts to underlying waste materials is minimized. It is anticipated that through development of an Explosive Gas Monitoring Plan in accordance with 10 CSR 80-3.010(14), the need for any collection or control will be governed by detections above an established threshold (2.5% methane by volume) at the facility perimeter, followed by the applicable remedial actions set forth in 10 CSR 80-3.010(14)(C)5.

In the event that landfill gas migration occurs, or may reasonably be expected to occur, after modification of the current landfill cover (if required), at levels greater than the 2.5% threshold, then a landfill gas collection and control system will be designed following cover modification and the design will be included in the *Preliminary Remedial Design* submittal. Based on the age of the waste, absence of odor and lack of vegetative stress, it is not currently anticipated that a LFG system will be required. Furthermore, it is not anticipated that a collection and control system would impact the design of any final cover modification.

2.2.5 Institutional Controls

The RD will provide for the design and implementation of institutional controls meeting the land and resource use requirements and objectives identified in Section 12.2.2 of the OU-2 ROD. Proprietary controls will be used because they generally run with the land and are enforceable. The Missouri Environmental Covenants Act (MoECA) is the preferred instrument for institutional controls at this site.

2.2.6 Long-term Surveillance and Maintenance

The RD will provide for the long-term surveillance and maintenance of the remedy for the ISL. Plans will be developed as part of the 90% design describing the procedures for inspection and maintenance of engineering controls, access controls, and monitoring structures. Plans will also address procedures for maintenance, inspection and enforcement of institutional controls.

3.0 DESIGN TEAM

The RD will be managed by CEC. CEC will serve as the Supervising Contractor and will provide overall project management and technical direction to the project. Mr. Randal Bodnar, P.E., will serve as the Project QA Officer and Kevin Kamp, P.E. will serve as the Project Manager for the CEC team. Having been involved in the RD for OU-2 since 2008 and currently working on tasks with Bridgeton Landfill (including ongoing stormwater evaluations, leachate treatment plant design, site infrastructure design and planning, and similar tasks), CEC personnel are familiar with the various aspects of the site and with this particular project. Additionally, CEC has extensive experience designing and permitting solid waste landfills and cover systems similar to that required for OU-2.

CEC will be responsible for the following RD activities:

- Identification of the various technical requirements of the project, assignment of project tasks to the various members of the project team, development and tracking of project schedules and budgets and review and approval of project deliverables;
- The overall Quality Assurance of the project and will provide the project Quality Assurance Officer;
- Preparation of this RD Work Plan;
- Preparation of the QAPP, SAP, and the HASP included with this RD Work Plan;
- Coordination of the development of design criteria;
- Conducting the additional site investigations required to support the RD;
- Supervision of RD site surveying and base map development;
- The health and safety program utilized during performance of the design investigations;
- Installation and monitoring of landfill gas monitoring wells* to assess the potential migration beyond the outer western (property) boundary of ISL;
- Design of the environmental monitoring (groundwater, stormwater and landfill gas) program portion of the RD;
- Coordination and preparation of the Preliminary (30%) Design submittal;
- Coordination and preparation of the *Intermediate Design Report* (60%) submittal (if necessary);
- Coordination and preparation of the Pre-Final (90%) Design submittal;
- Coordination and preparation of the Final (100%) Design submittal;
- Preparation of the *Construction Quality Assurance (CQA) Plan*;
- Preparation of a construction schedule;
- Preparation of construction cost estimate;

- Coordination and preparation of the *Long-term Surveillance and Maintenance Plan*; and
- Assisting the designated project coordinator with preparation of monthly project status reports to USEPA and for scheduling and coordination of meetings and interactions with USEPA and MDNR.

Additionally, CEC will also collaborate and coordinate with the OU-1 RD and OU-3 RI/FS project teams.

Figure 4 presents an organization chart for the project team that will implement the RD, specific personnel to be involved with the RD, and the generalized lines of communication and responsibility.

4.0 DESIGN INVESTIGATIONS

Site characterization was completed as part of the OU-2 RI (Herst, 2005) and supplemental investigations completed in conjunction with the OU-2 FS (Herst, 2006); however, some additional data and information is needed as part of the RD. Site walkovers performed on November 11, 2008, May 14, 2019, and February 10, 2020, helped identify the basis for additional investigations. Photographs from the site walkovers are provided in **Attachment 2**. Field activities/investigations that will be conducted during the RD to obtain additional data are listed below. A notation is also provided to indicate which of these activities are described in this RD Work Plan and which will be addressed in future planning documents.

1. Topographic Survey and Base Map Preparation (In this Plan). During the RD, a more detailed survey will be conducted to map existing site infrastructure, features and utilities, and will include areas adjacent to the ISL. This will aid in identifying potential design considerations or constraints for the remedy. The ground survey will be combined with recent aerial flyover photography (flown in late 2019 and published in January 2020) to provide the level of detail sufficient for calculating necessary material volumes to achieve planned final grades and management of surface water. Historical surface elevations before placement of waste, and after, will also be reviewed and documented to show anticipated depth to underlying native materials. This survey will serve to update the topographic data, aid in determining and calculating existing stormwater runoff and run-on, guide review of historical documentation for the leachate sump and other on site, and adjacent, infrastructure and utilities, and provide a base map for the RD for the ISL. This information will be presented in a separate *Existing Conditions Summary*.

2. Stormwater Monitoring Plan (Future Plan)- The stormwater monitoring program will evolve over time and will include provisions for stormwater monitoring during the RD, RA, and ongoing operations and maintenance during closure/post closure. An initial *RD Stormwater Monitoring Plan* will be submitted for review and approval and used for this RD phase of the project

3. Testing of Potential Borrow Areas (Future Plan). As the RD reaches 90% completion and quantities of materials are more closely estimated, potential borrow sources will be identified. In advance of the 90% RD submittal a *Soil Borrow Area Investigation Plan* will be prepared and submitted to the USEPA to detail identification, prequalification, and quantity estimates of potential borrow sources for the construction of the OU-2 remedy. In general, this plan will describe that soil samples will be collected from potential borrow areas with laboratory testing conducted on potential sources of low-permeability final cover soils. Representative bulk soil samples will be collected from test pits in each of the

potential borrow areas to determine whether the materials is appropriate for use. A *Soil Borrow Area Investigation Report* will be provided to the regulatory agencies and will contain the potential borrow area soil sample results and usability for final cover.

4. Installation and monitoring of landfill gas monitoring wells* (In this Plan). Landfill gas monitoring wells will be installed to assess the potential for landfill gas migration and subsurface concentrations in accordance with MDNR Solid Waste Regulations (10 CSR 80- 3.010(14)(C)(2)B). These gas monitoring wells* will be installed according to the relevant regulatory requirements at a maximum spacing of 500 feet, with depths extended to the estimated base elevation of refuse (445 to 455 feet above mean sea level [amsl]). This elevation is based on two (2) borings previously advanced within the waste limits of the ISL (LR-102 and LR-101) in addition to hydrogeologic cross-sections developed as a component of the OU-3 RI/FS. The presence and concentration of landfill gases detected at the landfill property boundaries will be compared to the relevant regulatory threshold of 50% of the LEL, which is equivalent to 2.5% methane by volume. Detections above this threshold will require evaluation of appropriate gas collection and control systems. An *Explosive Gas Monitoring Plan* will be prepared to assist in the development of the landfill gas monitoring wells* and routine sampling. Gas monitoring results will be submitted to regulatory agencies in the *Soil Gas Summary Report*.

5. Evaluation of existing cover thickness (In this Plan). Cover thickness testing and geotechnical testing will be performed during the RD to optimize the existing cover. Sampling of existing cover materials will be conducted to evaluate cover thickness and assess selected geotechnical soil properties. These evaluations will provide an estimate of the volume of materials needed for construction of the final cover and the suitability of using the existing material as landfill cover. Descriptions for the cover sampling and analysis are detailed in the QAPP (**Appendix A**) and SAP (**Appendix B**) of the RD Work Plan. The results of the evaluation of existing cover thickness will be provided in the *Existing Soil Cap Evaluation Report*.

6. A slope stability analysis (Future Plan). The existing slope along the western perimeter of the ISL was established in the mid-1990's. Based on observations during site walkovers conducted by the project team and years of observations by onsite personnel, the existing slope appears stable. One of the RD tasks is to further document the stability of the existing slope. This *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

A western slope waste limit investigation that uses geophysical evaluation methods is proposed to establish the limits of waste for the western slope of the ISL. Details regarding this geophysical survey will be included in a *Western Slope Waste Limit Investigation Plan*. A *Western Slope Waste Limit Investigation Summary Report* will contain the geophysical results of the western slope waste limit investigation. This report will be submitted as part of the summary report for the slope stability analysis.

7. Waste Separation Evaluation (In this Plan). Three (3) borings will be installed to characterize the area between the ISL and the South Quarry portion of Bridgeton Landfill. Refer to **Figure 5** for preliminary boring locations. The soil borings will be used to evaluate the composition of the material between these two (2) disposal cells. The makeup of the materials between these waste disposal cells will be evaluated to assess if a continuation of waste exists between these waste cells and the thickness of waste between the two (2) cells. This will aid in determining if there is potential for migration of the SSR from the South Quarry toward or into the ISL. Historic placement of waste will also be investigated through review of aerial photos, drawings, and site files. *A Waste Separation Evaluation Report* will be submitted to the agencies detailing the findings of the waste separation evaluation and photo/file review.

8. Long-term performance groundwater monitoring (In this Plan). The RD will provide for the design and implementation of a long-term performance groundwater monitoring program with the following objectives: 1) characterize the existing groundwater conditions and water quality in the vicinity of the ISL; 2) protect groundwater from any ongoing or future impacts from the ISL; 3) identify any future impacts to groundwater from the ISL; and 4) demonstrate that the Selected Remedy performs as required over the post-closure period (USEPA ROD, 2008).

   The proposed long-term performance groundwater monitoring program was discussed above in Section 2.2.2. The OU-2 groundwater monitoring program will consist of sentinel groundwater monitoring wells located along the western, southwestern, and southeastern boundaries of the ISL. The groundwater monitoring program for OU-2 will be coordinated with, and conducted in conjunction with, the implementation of the OU-3 RI/FS groundwater monitoring activities. As described in Section 2.2.2, the proposed long-term groundwater monitoring will be performed during and after the OU-2 RA phase. The groundwater monitoring program will consist of 2 phases: baseline and detection monitoring. Baseline groundwater monitoring data will be collected from 19 selected monitoring wells during the RD investigations for comparison to groundwater monitoring data collected during and after the RA phase.

Refer to Section 8.0 of this RD Work Plan for additional details regarding the schedule for the Design Investigations outlined above.

5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section describes the ARARs or other regulations as identified in Section 13.2 of the OU-2 ROD. **Table 1** of this RD Work Plan provides a summary of the applicable regulations and the design criteria for each of the RD investigative components.

5.1 MISSOURI SOLID WASTE RULES FOR SANITARY LANDFILLS

Missouri is a USEPA-approved state for providing regulations for landfills under RCRA Subtitle D. Missouri promulgated its regulations (22 Mo Reg 1008, June 2, 1997) as the Missouri Solid Waste Rules, which became effective July 1, 1997. The Missouri Solid Waste Rules establish closure and post-closure requirements for existing sanitary landfills that close after October 9, 1991. Although not applicable to the closure of the ISL, the requirements described below are considered relevant and appropriate and therefore will be met.

The MDNR regulations require cover to be applied to minimize fire hazards, infiltration of precipitation, odors and blowing litter, control gas venting and vectors, discourage scavenging, and provide a pleasing appearance [10 CSR 80-3.010(17)(A)]. The regulations require final cover consisting of at least two (2) feet of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less overlaid by at least one (1) foot of soil capable of sustaining vegetative growth [10 CSR 80- 3.010(17)(C)(4)]. Additionally, the regulations require the compacted clay portion of the final cover to consist of soils classified under the Unified Soil Classification System as CH, CL, ML, SC or MH [per 10 CSR 80-3.010(17)(C)11]. These requirements are considered to be the design criteria for the OU-2 RD. Placement of this final soil cover addresses the requirements for minimization of fire hazards, odors, blowing litter, control of gas venting, and scavenging. Placement of materials meeting the permeability requirement also addresses the requirement for minimizing precipitation infiltration. Placement of soil and establishment of a vegetative cover meet the requirement of providing for a pleasing appearance.

The MDNR landfill regulations also contain minimum and maximum slope requirements. Specifically, these regulations require the final slope of the top of the sanitary landfill shall have a minimum slope of five percent (5%) [10 CSR 80-3.010(17)(B)(7)]. MDNR regulations also require that the "maximum slopes be less than 25% unless it has been demonstrated in a detailed slope stability analysis that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill [10 CSR 80-3.010(17)(B)3]. Even with such demonstration, no active, immediate, or final slope shall exceed 33 1/3%" per MDNR 10 CSR 80-3.010(17)(C)3. Additionally, MDNR 10 CSR 80-3.010(17)(C)5, requires provisions for slope stability for installation of final cover systems. The objective of these requirements is to promote maximum runoff without excessive erosion and to account for potential differential settlement.

Because the landfilling of the ISL was completed over 30 years ago, most compaction of the refuse has taken place and differential settlement is no longer a significant concern. The five percent (5%) minimum sloping requirement is greater than necessary and may not be optimal in this case. Therefore, the five percent (5%) minimum sloping requirement is not considered appropriate. Sloping specifications will be designed to promote drainage and reduce infiltration of precipitation while minimizing the potential for erosion. Consistent with Section 13.2 of the ROD, it is anticipated that a two percent (2%) slope would be sufficient to meet drainage requirements while resulting in a lower potential for erosion or slope failure. This approach should increase the life of the cover and overall longevity of the remedy compared to a steeper slope which would be subject to an increased erosion potential. The two percent (2%) minimum slope and 25% maximum slope (or steeper if supported by a geotechnical evaluation and slope stability analysis) will be included as design criteria in the RD. The existing western slope of the ISL exceeds the maximum slope requirement; however, as described above, based on field inspection of the landfill surface the slope appears to be stable. Additional geotechnical investigation into the stability of this existing slope will be conducted and evaluated during the RD.

The requirements for decomposition gas monitoring and control in 10 CSR 80-3.010(14) are considered relevant and appropriate and will be met. The number and locations of gas monitoring points and the frequency of measurement are described in detail in the attached QAPP and SAP. In the event landfill gas is detected at the landfill boundaries above the regulatory thresholds during the RD investigations, a landfill gas control system will be included as part of the RD.

The RD will provide for the implementation of a groundwater monitoring program. The monitoring program will be designed to meet the objectives in Section 12.2.1 of the ROD and will be consistent with the monitoring requirements and groundwater protection standards found in the Missouri Solid Waste Rules for Sanitary Landfills [10 CSR 80-3.010(11)].

The substantive MDNR landfill requirements for post-closure care and corrective action found in 10 CSR 80-2.030 are also considered relevant and appropriate. These requirements provide a useful framework for long-term surveillance and maintenance and corrective action plans and require post-closure plans describing the necessary maintenance and monitoring activities and schedules. These requirements will be used in addition to USEPA CERCLA policy and guidance and will be addressed in the development of a *Long-term Surveillance and Maintenance Plan* to be prepared as part of the RD.

5.2 NATIONAL AMBIENT AIR QUALITY STANDARDS

The National Ambient Air Quality Standards (NAAQS) apply to six (6) criteria pollutants as established under the current federal law (40 CFR 50). These standards are designed to establish maximum exposure limits that are protective of human health and the environment. Since the remedy for OU-2 may involve grading, compaction, and other soil-related activities, NAAQS for PM10 are potentially relevant and appropriate requirements during implementation of the RA.

Should the work include the potential for uncovering waste material, potential air constituents for the Site could include, but are not limited to: PM10, PM2.5, and volatile organic compounds (VOCs). Air monitoring for radionuclides would be required for intrusive work conducted in or near known or suspected areas containing radiologically impacted materials (RIM). However, the OU-1 team is planning to perform an investigation for the limits of RIM between the boundaries of the ISL, the Closed Demolition Landfill adjacent to OU-1 Area 2 as part of the OU-1 RD investigations. The OU-1 work is expected to be conducted prior to any invasive work by the OU-2 team. Therefore, it is highly unlikely that there will be a potential for OU-2 RD work to be performed in or near an area of known or suspected RIM occurrences. During the RD, it is not anticipated that there would be significant intrusive work that could potentially lead to impact on ambient air quality. The protocols currently in place for work at the Bridgeton Landfill site include equipping on-site personnel with four (4) gas meters and adhering to a Standard Operating Procedure, which is included in **Attachment 3** (Odor Management Plan), to mitigate potential odors. If field conditions warrant it, or additional unanticipated field activities require it, a plan for air monitoring will be developed on a task specific basis. This plan will include monitoring locations, sample collection equipment and methods, sampling frequency, analytical parameters (determined via RD investigations) and methods and reporting frequency at a minimum.

Potential RA work that may require air monitoring include: 1) waste excavation or relocation in OU-2 areas; and 2) earth moving or other activities that may result in emission of particulate matter. If RD determines that either of these types of work will be required, the relevant air monitoring plans will be developed during RD.

5.3 CLEAN WATER ACT

Section 402 of the Clean Water Act regulates point sources that discharge pollutants into waters of the United States. The NPDES permit program regulates these discharges, including effluent and stormwater, by requiring and issuing permits for discharges into a U.S. waters and by setting chemical-specific water quality standards for various surface water bodies. The substantive requirements for stormwater runoff are relevant and appropriate. Therefore, stormwater monitoring will begin during RD and a separate plan for stormwater monitoring during RA and post construction will be developed and provided with the Pre-Final (90%) RD report.

5.4 GROUNDWATER MONITORING AND PROTECTION

Missouri regulation 10 CSR 80-3.010(11) is relevant and applicable to the development and implementation of the long-term groundwater monitoring program for the ISL. These rules specify the requirements for: design of the monitoring well network; spacing and depth criteria for monitoring wells; parameters to be analyzed; sampling and reporting; baseline/background monitoring; detection monitoring; and the statistical methods to use for evaluating groundwater monitoring data. These rules will be used as the basis of the long-term performance groundwater monitoring program for the ISL portion of OU-2.

5.5 SAFE DRINKING WATER ACT

Title 40, CFR, Part 141 (National Primary Drinking Water Standards) are the water quality standards set by the USEPA for drinking water quality. These standards establish MCLs for specific contaminants that may have adverse health effects. Although the nearest public water supply intake is located eight (8) miles downstream of OU-2, groundwater in the vicinity of the Site is considered potentially usable for drinking water purposes. Therefore, the National Primary Drinking Water Standards MCLs are relevant and appropriate requirements for the OU-2 long-term groundwater monitoring program to use for comparison purposes only.

5.6 MISSOURI SAFE DRINKING WATER REGULATIONS

The State of Missouri has also established primary drinking water quality standards and MCLs for public water systems in 10 CSR 60-4.010 through 4.110. Pursuant to the USEPA ROD (2008), these water quality standards are also relevant and appropriate requirements for the OU-2 long-term groundwater monitoring program to use for comparison purposes only.

In addition, 10 CSR 20-7.031(5) Table A will be used for comparison purposes only of groundwater sample results to state groundwater quality standards.

5.7 MISSOURI WELL CONSTRUCTION CODE

MDNR has promulgated regulations pertaining to the location and construction of water wells. The Well Construction Code 10 CSR 23-3.010 currently prohibits the placement of a well within 1,000 feet of a sanitary landfill. These rules will provide protection against the placement of wells on or near the Site and will be incorporated as appropriate into the Institutional Controls for OU-2.

MDNR has also established regulations for the construction and replacement of new monitoring wells (10 CSR 23-3.030). All wells installed for the RD and/or RA will be in accordance with these regulations. Any wells, or standpipes, that require abandoning at the ISL will be plugged in accordance with 10 CSR 23-3.110.

MDNR 10 CSR 23-6.050 provides regulations for plugging test holes, which will apply to the sonic borings to be drilled for a slope stability evaluation, the three (3) waste separation evaluation borings, and borings drilled but not used for gas migration monitoring or recovery.

5.8 LANDFILL GAS MONITORING AND CONTROL

MDNR has regulations pertaining to the monitoring of landfill gas migration and implementation of controls. These regulations generally require placement of subsurface monitoring wells* at 500 foot intervals along the perimeter of the landfill where potential receptors may be present. Gas monitoring wells* are to be extended to the known depth of refuse. The threshold for implementation of remedial measures to control migration is 2.5% methane by volume as measured in the monitoring well* network. Relevant regulations are set forth in 10 CSR 80-3.010(14).

6.0 CONCEPTUAL DESIGN AND DESIGN CRITERIA

6.1 CONCEPTUAL DESIGN

The design team has developed conceptual grading plans for the landfill cover surface (**Figure 3**) that substantially meet the minimum slope requirements of the MDNR Solid Waste Regulations for the final closure cap for the ISL. The proposed regrading plan was developed based on general topographic elevations of the landfill surface which need to be updated to reflect current conditions. The proposed regrading plan was also developed to limit the amount of fill to be trucked on-site by locating areas within the ISL that currently have more volume than needed for the selected remedy. Excess fill from these areas may be relocated to areas with insufficient fill. It is anticipated, and conceptually shown, that regrading of the waste surface will be minimal. This goal of minimal waste disturbance will be achieved only if the existing western slope can be maintained in its current condition. If the slope stability analysis performed in the future design investigation indicates that the slope may not be stable, alternatives will be established that may include cutting back the slope. This alternative activity may require significant regrading of waste, wildlife mitigation planning, etc. Additional details regarding alternatives will be thoroughly discussed in *the Slope Stability Evaluation Plan*.

The solid waste materials in the ISL will be regraded where, and if needed, and then will be covered with a landfill cover that meets the MDNR solid waste requirements where such cover is not already in place. The final cover for OU-2, existing in place materials or regraded and constructed new, will consist of a minimum of two (2) feet of compacted soil material to a density that results in a factor of permeability for this layer of 1×10^{-5} cm/sec or less, and the existing cover will be optimized to meet these requirements. This low permeability layer in turn will be overlain by a minimum of one (1) foot of soil, not compacted, suitable to support development of grassy vegetation, again optimizing the existing cover. The cover material must be capable of minimizing fire hazards; preventing infiltration of precipitation, odors, blowing litter, and vectors; controlling gas venting; discouraging scavenging; and providing a pleasing appearance.

Figure 6 shows potential cover sampling locations by direct push soil sampling technology and Shelby Tubes. Sampling locations do not include the steep slope areas on the west side of the ISL due to access limitations for equipment. Samples immediately adjacent to the west slope of the ISL are assumed to be representative of the steep slope area. During the sampling process, elevations of the cover and solid waste layers will be recorded. After grading is completed and the low permeability layer has been placed and compacted, prior to placement of top soil, a post construction cover thickness evaluation will be performed at these same sampling points previously conducted to verify as-built and appropriate thickness.

Post RA, it is anticipated that stormwater will be collected, and continue to be managed through, a combination of sheet flow, channel flow through swales and via infrastructure (e.g., pipes, collection structures, and let down structures). The resultant discharge will be directed to the same locations to which that it currently flows towards (i.e., Earth City lagoon and Bridgeton Landfill's Outfall 003).

A preliminary assessment of landfill gas occurrence and concentrations will be conducted. Due to the overall age of the waste, it is not currently anticipated that a LFG system will be required. Furthermore, it is not anticipated that an installation of a LFG collection and control system, if needed, would impact the design of any final cover modifications.

Submittals and plans to be prepared during the RD in addition to this RD Work Plan and its attachments include the following:

- *RD Stormwater Monitoring Plan* - The *RD Stormwater Monitoring Plan* will be developed to provide consistency in the field sampling efforts, including the collection, documentation and verification of stormwater quality. Elements of the plan will include sample collection procedures, a list of parameters to be analyzed, sample documentation, sample handling, shipping, and reporting. The plan will also include a *Quality Assurance Plan* as an appendix that will include the task-specific data quality objectives, laboratory analytical methods, and data verification/validation processes.

- *Existing Soil Cap Evaluation Report* - This report will document the field investigation for the existing soil cap for the ISL.

- *Slope Stability Evaluation Plan* – This plan will present the proposed means and methods to existing slope stability of the western slope of the ISL.

- *Western Slope Waste Limit Investigation Plan* – This plan will present the proposed means and methods to identify the limits of waste on the western slope of the ISL.

- *Slope Stability Evaluation Report* – This future report will document the results of the Waste Limit Investigation, the slope stability field investigations, and the slope stability evaluations for the existing western slope of the ISL.

- *Waste Separation Evaluation Report* - A Summary Report will be prepared and submitted following the field investigation to describe the subsurface conditions observed and conclusions made from the waste separation evaluation described in Section 6.2 below.

- *Preliminary (30%) Remedial Design Report* – This submittal will provide a conceptual design for the remedy construction that incorporates all of the remedial design investigations performed to date. The remedial design will consist of plan drawings, as well as a narrative and associated design calculations. Once the EPA has completed reviewing the Preliminary Design Report (30%), the EPA will make a determination whether the Intermediate Design Report is necessary. Should the EPA determine the Intermediate Design Report is not necessary, the 60% submittal shall be limited to the draft O&M Plan and the Groundwater Monitoring Plan.

- *Intermediate (60%) Remedial Design Report* - Once the EPA has completed reviewing the *Preliminary Design Report* (30%), the EPA will make a determination whether the *Intermediate Design Report* is necessary. Should the EPA determine the Intermediate Design Report is not necessary, the 60% submittal shall be limited to the draft O&M Plan and the *Groundwater Monitoring Plan*.

- *Soil Borrow Area Investigation Plan* - This plan will detail the testing and evaluations to be performed for the soil borrow area(s) for the proposed remedy. The Soil Borrow Area investigation will be conducted after RD is 90% complete and quantity and source of the material is identified. Just prior to the submittal of the 90% RD Report, a plan, including a SAP and QAPP, for that investigation will be submitted for review and approval. The schedule would then have this investigation ongoing while the 90% design submittal is being reviewed by agencies. Following approval of the *Soil Borrow Area Investigation Plan* by the EPA, a field investigation will be performed. The results of the field investigation will be summarized in a *Soil Borrow Area Investigation Report*.

- *Intermediate (60%) Remedial Design Report* – This submittal will be dependent upon the EPA review of the Preliminary Design Report (30%). The EPA may determine that the Intermediate Design Report is not necessary and the submittal shall be limited to the draft O&M Plan and the Groundwater Monitoring Plan.

- *Pre-Final (90%) Remedial Design Report* - This submittal will address USEPA and MDNR comments on the 30% design submittal and will provide revised plan sheets, details, narrative descriptions, supporting calculations, and schedule for implementing the remedial design.

- *Final Remedial Design Report* - This submittal will address USEPA and MDNR comments on the 90% design submittal and will provide revised plan sheets, details, narrative descriptions, supporting calculations, and schedule for implementing the remedial design.

- *Long-term Surveillance and Maintenance Plan* - This plan will describe the procedures for inspection and maintenance of engineering controls, access controls, and monitoring structures. The plan will also address procedures for maintenance, inspection, and enforcement of institutional controls.

- *Groundwater Monitoring Reports* – The groundwater monitoring reports, quarterly and annual during the baseline phase, will include the Data Validation Reports. The Data Validation Reports will present and summarize the data verification and validation results. All laboratory data will be validated within 60 days of receipt from the laboratory. The *Quarterly Groundwater Monitoring Reports* will also include groundwater level and water quality data, and updated potentiometric maps. *Annual Groundwater Monitoring Reports* will include trend analyses, tri-linear plots, and relevant maps and figures of the groundwater quality data. Groundwater monitoring reports will be prepared and submitted to USEPA and MDNR within 30 days after the laboratory data has been validated (or 90 days from the receipt of the laboratory analytical data.) Additionally, statistical analyses will also be performed on the sample results in accordance with MDNR 10 CSR 80-3.010(11)(C)5 and documented in the annual reports. Unvalidated groundwater quality analytical data will be provided to the USEPA and MDNR as part of the monthly progress reports.

  No additional submittals for the long-term performance groundwater monitoring program are anticipated. The Groundwater Monitoring SAP for the baseline portion of the long-term performance groundwater monitoring program is included in **Appendix B** of this RD Work Plan. The QAPP, included as **Appendix A** of this RD Work Plan, includes the data quality objectives, laboratory analytical methods, and data verification/validation processes.

- *Explosive Gas Monitoring Plan* – This plan will submitted following installation of the initial series of gas monitoring wells* and initial data collection period. The primary intent of this plan will be to assess subsurface migration of landfill gas, evaluate the initial monitoring network and establish sampling and data evaluation protocol for future sampling events.

6.2 BASIS OF DESIGN

The design criteria to be used as a basis for the design of the Selected Remedy were identified based on the requirements of the OU-2 ROD and professional engineering judgment. Refer to **Table 1** for design constraints associated with each layer of cover design, including required thicknesses, hydraulic conductivity, vegetation considerations, slope geometry, surface water controls, benching, access roads, slope support, and other relevant design constraints for the RD.

The results of the design investigations will also be considered during the development of the design. Anticipated data sets to be generated and the types of engineering assessments to be conducted during RD include:

- *Slope Stability Evaluation*
  - The *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document and will address the existing slope geometry through a series of slope stability analyses to determine if the existing slope configuration will be stable under long-term conditions.

- *Existing Soil Cap Evaluation*
  - Sampling the thickness of existing cover materials will be completed using a direct push soil sampling machine to measure the thickness of material above the waste. The composition (e.g., soil type and USCS classification) of the cover materials will also be characterized. The results of the soil sampling will be documented in a summary report as described in Section 6.1 above.

  - The minimum thickness required per 10 CSR 80-3(17)(C)4.A is three (3) feet [two (2) feet of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less and overlaid by at least one (1) foot of soil capable of sustaining vegetative growth]. The existing landfill cap has a good stand of vegetative cover. As such, if the existing soil cap evaluation shows adequate thickness for the total soil thickness and acceptable permeability for the low permeability layer, the existing cap will be determined to be acceptable.

  - The existing cap thickness evaluation will use data from the cover material soil sampling to identify the cap thickness and areas where additional cover soil placement is required. The design will incorporate additional cap material to be placed in areas where the total thickness is less than three (3) feet and the permeability requirements are not met.

- *Waste Separation Evaluation*
  - To demonstrate a separation between the South Quarry portion of Bridgeton Landfill and the ISL, three (3) sonic borings will be installed between the two (2) units. The materials returned to the surface will be investigated for evidence and thickness of MSW.

- *Soil Borrow Area Investigation*
  - A separate submittal will be prepared to detail the investigation associated with the proposed borrow area. The borrow area investigation will evaluate the hydraulic conductivity, soil type, vegetative capability, and available volume of potential borrow sources to be used in cap construction for the ISL.

- *Baseline Groundwater Monitoring*
  - The proposed groundwater monitoring program for the ISL has been designed to be consistent with the requirements stated in 10 CSR 80-3.010(11). Nineteen (19) monitoring wells have been selected for the long-term performance groundwater monitoring program including 16 downgradient wells and 3 upgradient wells. Locations of the proposed monitoring wells are shown on **Figure 1**.

    The proposed OU-2 long-term performance groundwater monitoring will consist of two (2) phases:

    - Baseline groundwater monitoring – to be conducted in accordance with 10 CSR 80-3.010(11)(C)3, quarterly, but not to exceed eight (8) quarters of monitoring. The objective of the baseline groundwater monitoring is to establish current groundwater quality prior to closure of the ISL portion of OU-2. Baseline groundwater monitoring data will be used for comparison to groundwater monitoring data collected during and after the RD phase.

    - Detection groundwater monitoring – to begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C). Additional details regarding sampling frequency, locations and evaluation approach will be included in the *Groundwater Monitoring Report* submitted as part of the *Intermediate Design Report*.

    Section 8.0 of the RD Work Plan SAP (**Appendix B**) provides details on the procedures, methods, and considerations that will be used for collecting the groundwater quality samples.

7.0 PROGRESS REPORTS

Monthly progress reports will be prepared and submitted by the 10th day of each following month. These progress reports will include the following items:

1. A description of the actions taken during the prior month to comply with the AOC;

2. Copies of analytical and geotechnical data received by the Respondents during the prior month;

3. A description of the work planned for the next two (2) months;

4. A description of material problems encountered and any anticipated material problems, as well as actual or anticipated material delays and solutions developed and implemented to address any actual or anticipated material problems or delays; and

5. Unvalidated ground quality sample results received from Pace Analytical Services, LLC.

Progress reports will be submitted to the USEPA Remedial Project Manager (RPM) via e-mail with a copy provided to the MDNR project manager.

8.0 PROJECT SCHEDULE FOR REMEDIAL DESIGN

A listing of the various RD plans and deliverables is provided below. The anticipated schedules for submittal of these documents are shown in **Figure 8**. A notation is also provided to indicate which of these activities are described in this RD Work Plan and which will be addressed in future planning documents.

- This RD Work Plan

- Remedial Design Investigations/Evaluations

  - *RD Stormwater Monitoring Plan* separately from the RD Work Plan (Future Plan).

  - *Existing Conditions Summary* – (In this Plan) Topographic survey and base map preparation for the ISL. This information will be detailed in, and used for, the RD.

  - *Waste Separation Evaluation* (In this Plan) – The results of the waste separation boring program, along with the review of historical documents/photos, will be provided in the Waste Separation Evaluation Report.

  - *Slope Stability Evaluation* (Future Plan) – The findings of the future *Slope Stability Evaluation Plan* will be compiled and discussed in the *Slope Stability Evaluation Report* which will include a *Western Slope Waste Limit Investigation Report*.

  - *Landfill Gas Monitoring* (Future Plan) – This task will provide for the development of an *Explosive Gas Monitoring Plan*. Gas monitoring data will be provided in the monthly progress reports.

  - *Existing Soil Cap Evaluation* (This Plan) - The existing soil cap will be investigated using a direct push soil sampling machine to determine the thickness of the cap. Additionally, (minimum of ten (10)) Shelby tube samples will be collected and tested for hydraulic conductivity to verify compliance with regulatory requirements for soil permeability. An *Existing Soil Cap Evaluation Report* will be prepared to discuss the results. Field activities near the northern portion of the ISL will only commence once the limits of the OU-1 boundary are determined and established by the OU-1 RD team.

  - *Soil Borrow Area Investigation* (Future Plan) - This investigation is for the potential sources of borrow material for remedial design activities. The timing is thought to be consistent with where the progress of the design will be such that needed material types and amounts will be fairly close to what will be expected and that if this is review just prior to 90% submittal that then while the 90% is being reviewed, the borrow investigation can begin. Submittals associated with the Soil Borrow Area Investigation include a *Soil Borrow Investigation Plan* to be prepared prior to any field work and a *Soil Borrow Area Investigation Summary Report* to be prepared following any field work.

- Baseline Groundwater Monitoring (In this Plan)– Although the proposed long-term groundwater monitoring program will consist of two (2) phases, baseline and detection monitoring, the RDWP schedule (**Figure 8**) only shows the timeline for the baseline portion of the monitoring and reporting. The baseline monitoring phase of the groundwater monitoring program is projected to continue quarterly through two (2) years. The anticipated start date for the beginning of the baseline groundwater monitoring is shown on **Figure 8** to be the fourth quarter of 2020, based on current projections for the approval of the OU-3 RI/FS. However, because the proposed OU-2 groundwater monitoring program will be coordinated with, and conducted in conjunction with, the implementation of the OU-3 RI/FS groundwater monitoring program and installation of the OU-3 monitoring wells, the anticipated start date may change.

  As stated in Section 6.1, baseline groundwater level and water quality data, and updated potentiometric maps will be summarized and presented in *Quarterly Groundwater Monitoring Reports*. *Annual Groundwater Monitoring Reports* will include trend analyses, tri-linear plots, and relevant maps and figures of the groundwater quality data for the previous year. The groundwater monitoring reports will be submitted to the agencies within 90 days of the receipt of laboratory data. Each *Quarterly* and *Annual Groundwater Monitoring Report* submittal is shown on **Figure 8**.

- *Remedial Design Report* Submittals
  - *30%* - this will be the initial design and will incorporate the information from the design investigations. In accordance with the Statement of Work (SOW), the *30% Remedial Design Report* will be submitted within 60 days after the last design investigation report is completed.

  - *60%* - In accordance with the SOW, based upon review of the *Preliminary Design Report (30%)*, the EPA may determine that the *Intermediate Design Report* is not necessary and this submittal shall be limited to the draft *O&M Plan* and the *Groundwater Monitoring Plan*.

- *90%* - this plan will address the comments from the 30% design and include project specifications. This plan will also include an *Air Monitoring Plan* (if needed) and a RA *Stormwater Management and Monitoring Plan*. In accordance with the SOW, the *90% Remedial Design Report* will be submitted within 60 days after receipt of the EPA's comments on the *60% Remedial Design Report*.

- *Final Remedial Design Report* – This document will include revisions from the 90% review and also include plans and specifications needed for construction of the final cap and remedy. This will also include final versions of *Stormwater Management and Monitoring Plan* and *Air Monitoring Plan*. In accordance with the SOW, *the Final Remedial Design Report* will be submitted within 30 days after receipt of the EPA's comments on the *90% Remedial Design Report.*

- *Long-term Surveillance and Maintenance Plan*
  - This plan is not shown on the project schedule but will be prepared and submitted during RA.

- Monthly Progress Reports
  - These monthly reports will continue through all of the RD activities. The schedule will be routinely updated and also provided in the monthly progress reports.

9.0 REFERENCES

Golder Associates, Inc., 1995. *Draft Report – Inactive Sanitary Landfill Cap Investigation, West Lake Site.* August 25, 1995.

Herst & Associates, Inc., 2006. *Feasibility Study Report, West Lake Landfill Operable Unit 2, Bridgeton, Missouri, Revision 1.* June 2006.

Herst &Associates, Inc., 2005. *Remedial Investigation Report, West Lake Landfill Operable Unit 2, Bridgeton, Missouri*. September 2005.

Missouri Department of Natural Resources. 2003. *Landfill Closure Guidance, Publication 187*. July 2003.

United States Environmental Protection Agency, 2008. *Third Amendment to Administrative Settlement Agreement and Order on Consent in the Matter of Bridgeton Landfill, LLC.* Docket No. VII-94- F- 0025. October 16, 2008.

United States Environmental Protection Agency, 2008. *Record of Decision, West Lake Landfill Site, Bridgeton, Missouri, Operable Unit 2.* July 2008.

United States Environmental Protection Agency, 2008. *Compilation of Air Emissions Factors, Section 2.4, Municipal Solid Waste Landfills.* Draft update issued October 2008.

TABLE

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
SLOPE AND SLOPE STABILITY			
Slope Stability Requirement	MDNR Solid Waste Management 10 CSR 80-3.010(17)(B)3	Restricts final side slopes to 25% unless it has been demonstrated in a detailed slope stability analysis that the slopes can be constructed and maintained throughout the entire operations life and post-closure period of the landfill.	RDWP: Sections 2.2.1, 5.1 QAPP: Section 1.6 SAP: Section 2.0
Minimum Slope	MDNR Solid Waste Management 10 CSR 80-3.010(17)(B)7 and 2008 Record of Decision	Requires the final slope for the top of the sanitary landfill to have a minimum slope of 5%, which has been identified in the ROD as "not considered appropriate". Instead, per Section 13.2 of the ROD, the minimum slope for the Remedial Design will be 2%.	RDWP: Sections 2.2 and 5.1
Additional Requirements for Slopes greater than 25%	MDNR Solid Waste Management 10 CSR 80-3.010(17)(B)8	Requires a shear failure analysis where intermediate and final side slopes exceed 25%.	RDWP: Section 4.0
Maximum Slope Requirement	MDNR Solid Waste Management 10 CSR 80-3.010(17)(C)3	Prohibits final side slopes exceeding 33-1/3%	RDWP Section 2.2.1 QAPP Section 1.6 SAP: Section 2.0
Final Cover Slope Stability Requirements	MDNR Solid Waste Management 10 CSR 80-3.010(17)(C)5	Requires provisions for slope stability for installation of final cover systems.	RDWP: Sections 2.2.1 and 4.0, 5.1 QAPP: Section 1.6 SAP: Sections 2.0
Plugging of Test Holes	MDNR Well Installation Management 10 CSR 23-6.050	Specifies that test holes (for Shelby Tube samples) must be plugged from total depth to within 2 feet of ground surface with grout. This citation applies to both the Slope Stability Evaluation and Waste Separation Evaluation tasks.	RDWP: Section 5.7 QAPP: Section 1.6 SAP: Section 5.1

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
SLOPE AND SLOPE STABILITY			
Soil Sample Borings	MDNR Well Installation Test Hole Construction 10 CSR 23-6.050	Specific requirements for plugging test holes.	SAP: Section 5.7
LANDFILL COVER			
Cover Functionality	MDNR Solid Waste Management 10 CSR 80-3.010(17)(A)	Cover shall be applied to minimize fire hazards, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance.	RDWP: Sections 2.2 and 5.1
Low permeability layer	MDNR Solid Waste Management 10 CSR 80-3.010(17)(C)4.A	Final cover shall consist of 2 ft of compacted clay, silt or sandy clay with a permeability of 1×10^{-5} cm/sec or less and overlain by at least 1 ft minimum of soil capable of sustaining vegetative growth.	RDWP: Section 6.2 QAPP: Section 1.4
Compacted Clay Liner	MDNR Solid Waste Management 10 CSR 80-3.010(17)(C)11	Requires the compacted clay portion to consist of soils classified under the Unified Soil Classification System as CH, CL, ML, SC or MH.	RDWP: Sections 2.2 and 5.1 QAPP: Section 1.4

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
LANDFILL GAS CONTROL			
Design of a landfill gas system, if necessary	MDNR Solid Waste Management 10 CSR 80-3.010(14)	Identifies the specific requirements for design of a landfill gas control system. Implementation of a methane monitoring program capable of detecting decomposition gas migration to ensure that the standards of paragraph (14)(C)2 are met.	RDWP: Sections 2.2, 5.1 and 5.8
Landfill Gas Control System Assessment	MDNR Solid Waste Management 10 CSR 80-3.010(14)(B)2	Development of a Landfill Gas Monitoring Plan. Plans shall assess the need for gas control and indicate the location and design of any vents, barriers or other control measure to be provided.	RDWP Sections 2.2.4, 4.0 and 5.8 QAPP Sections 1.3, 2.3, 5.3 6.3, 7.3, 8.3, 9.3 and 10.3 SAP Section 4.0
Decision as to whether a landfill gas system is necessary	MDNR Solid Waste Management 10 CSR 80-3.010(14)(C)2.B	Landfill decomposition gases shall not exceed 50% of the LEL or 2.5% by volume of methane in soil at the property boundary.	RDWP: Sections 2.2 and 4.0 QAPP Section 2.3
Landfill Gas Migration Assessment and Continued Monitoring	MDNR Solid Waste Management 10 CSR 80-3.010(14)(C)4	Owners/operators of all sanitary landfills shall implement a methane monitoring program capable of detecting decomposition gas migration in the most likely zone(s) of migration, to ensure that the standards of paragraph (14)(C)2. of this rule are met. Methane monitoring shall be conducted at least quarterly with equipment warranted by the manufacturer to detect explosive gases under the conditions the equipment is to be used. Facilities shall submit the results of this methane monitoring to the department at least quarterly. The electronic submission of methane monitoring data is required. This submission shall be in a format and manner as prescribed by the department.	RDWP Sections 2.2 and 4.0 QAPP Sections 1.3, 2.3, 5.3 6.3, 7.3, 8.3, 9.3 and 10.3 SAP: Section 4.0
Landfill Gas Migration Response	MDNR Solid Waste Management 10 CSR 80-3.010(14)(C)5	Exceedance of methane gas levels as specified in 10 CSR 80-3.010(14)(C)4)	RDWP: Section 2.2.4 QAPP Section 2.3

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
EROSION AND SEDIMENTATION CONTROL			
Stormwater	MDNR Solid Waste Management 10 CSR 80-3.010(7)(B)	On-site drainage structures and channels shall be designed to collect at least the water volume resulting from a 24-hour, 25-year storm	RDWP: Section 2.2
STORMWATER REGULATIONS			
Stormwater	MDNR Storm water Management 10 CSR 20-6.200	Stormwater regulations and the process of application for permits for stormwater discharges and the terms and conditions for the permits. Because this project is being conducted under the CERCLA regulations, a State stormwater discharge permit is not required.	RDWP: Section 2.2.3
Surface Water Management	MDNR Solid Waste Management 10 CSR 80-3.010(8)	Requirements for the management of leachate generation, collection media, dispersion, and onsite surface water; stormwater infrastructure management.	QAPP: Section 1.5
Stormwater	Clean Water Act Section 402	National Pollutant Discharge Elimination System (NPDES) regulations for direct discharges, including stormwater run-off, to surface waters. Because this project is being conducted under the CERCLA regulations, a NPDES permit for stormwater discharge is not required.	RDWP Section 5.3

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
GROUNDWATER MONITORING			
Long-term performance groundwater monitoring	MDNR Solid Waste Management 10 CSR 80-3.010(11) Including Appendix I	Requirements for the development and implementation of a groundwater monitoring program for a sanitary landfill, including: the minimum number of downgradient wells to be used; spacing and depth criteria for monitoring wells; specific groundwater quality parameters to be monitored; and statistical methods to be used for evaluation of groundwater analytical data.	RDWP: Sections 2.2, 5.1, 5.4 and 6.2. QAPP: Sections 1.8, 2.8 SAP: Section 8.0
Long-term performance groundwater monitoring	Code of Federal Regulations Title 40 (40 CFR) Part 141	Federal primary drinking water standards (primary maximum contaminant levels [MCLs]) for public water systems.	RDWP: Sections 2.2 and 5.5 QAPP: Sections 1.8, 2.8, 8.7 and 14.2 SAP: Section 8.0
Long-term performance groundwater monitoring	MDNR Public Drinking Water Program 10 CSR 60-4.010 through 4.110	State contaminant levels (MCLs) and monitoring requirements for public water systems.	RDWP: Sections 2.2 and 5.6 QAPP: Sections 1.8, 2.8, and 14.2 SAP: Section 8.0
Long-term performance groundwater monitoring	MDNR Clean Water Commission 10 CSR 20-7.031(5) Table A	State water quality standards for groundwater.	RDWP: Section 5.6 QAPP: Sections 1.8, 2.8, and 14.2 SAP: Section 8.0
Long-term performance groundwater monitoring	MDNR Division of Geology and Land Survey 10 CSR 23-3.010 – 23-3.110	Specific requirements for design and construction of groundwater monitoring wells	RDWP: Section 5.7

Table 1
Design Basis and Design Criteria
West Lake Landfill OU-2

Parameter or Criteria	Design Basis	Design Criteria	Document Reference
SOUTH QUARRY SSR MIGRATION POTENTIAL			
Demonstration Borings	Discussions with CEC and EPA	Per previous discussions, a minimum of (3) borings will be performed and with materials returned being visually evaluated/photographed to determine if MSW materials are present.	No regulatory rules or statutes.
OTHER ARARs			
Solid Waste Disposal Area Closure, Post-Closure Care	MDNR Solid Waste Management 10 CSR 80-2.030	Solid Waste Disposal Area Closure, Post-Closure Care and Corrective Action Plans and Procedures with Associated Financial Assurance Requirements	RDWP: Section 5.1
	Code of Federal Regulations Title 40 (40 CFR) Part 50	National Primary and Secondary Ambient Air Quality Standards	RDWP: Section 5.2

Design criteria and basis are based on the Missouri Department of Natural Resources rules and regulations that were in effect as of the date of approval for the 2008 Record of Decision (Section 13.2).

FIGURES

P:\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Proposed OU2 Performance Groundwater Wells.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 5/19/2020 4:56 PM

LEGEND

— — —	OU–2 BOUNDARY
——500——	EXISTING CONTOUR MAJOR
- - - - -	EXISTING CONTOUR MINOR
XX-## (red)	PROPOSED WELLS FOR OU–2 RD WORK PLAN (EXISTING)
MW-###-XX (blue)	PROPOSED WELLS FOR OU–2 RD WORK PLAN AND OU–3 GROUNDWATER MONITORING (TO BE CONSTRUCTED)
XX-## (black)	OTHER MONITORING WELLS (EXISTING AND TO BE CONSTRUCTED)

*HAND SIGNATURE ON FILE

SCALE IN FEET

0 200 400

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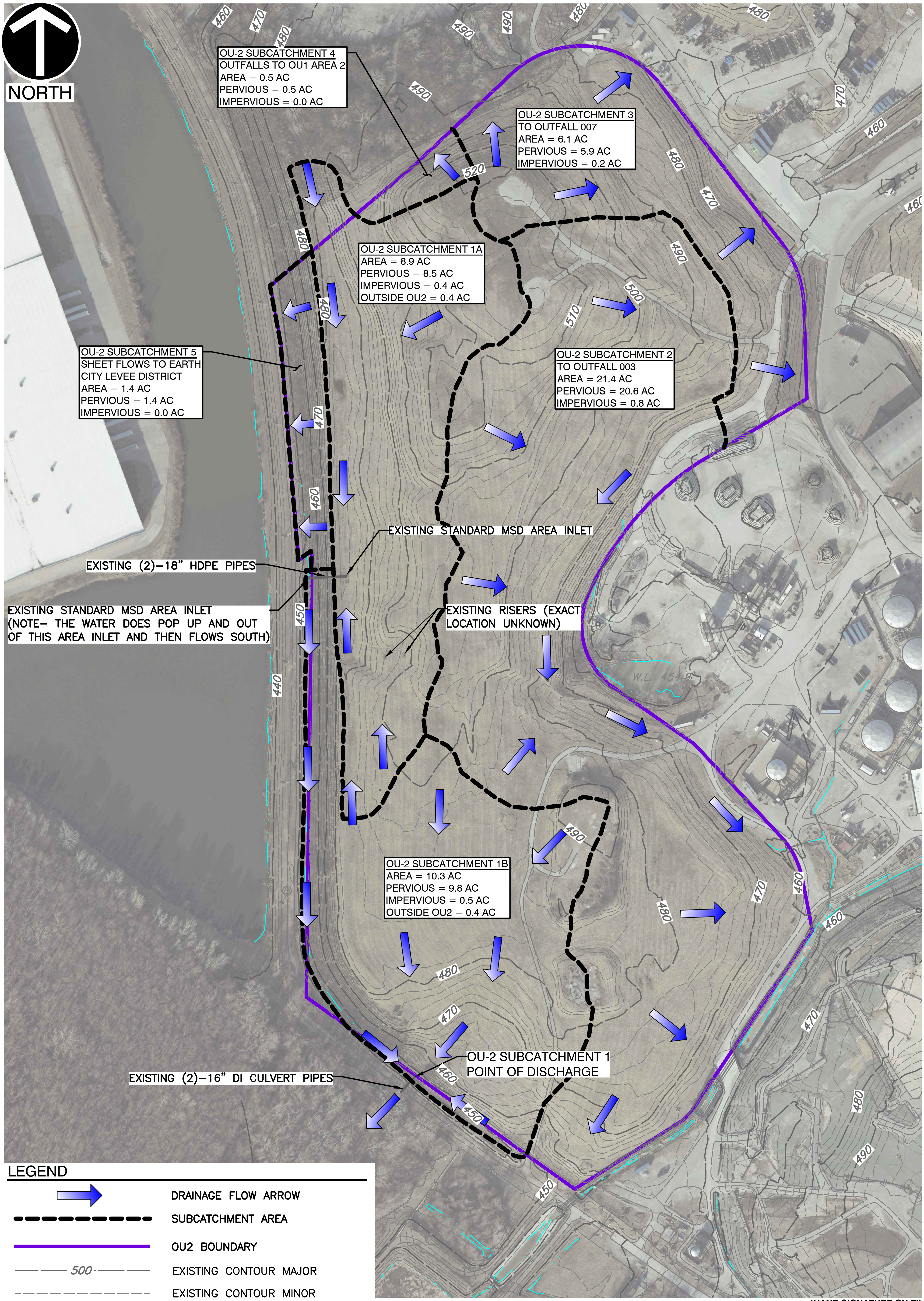
ST. LOUIS COUNTY

PROPOSED OU-2 PERFORMANCE GROUNDWATER MONITORING WELLS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	1
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Existing Drainage Area Map.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 3:24 PM



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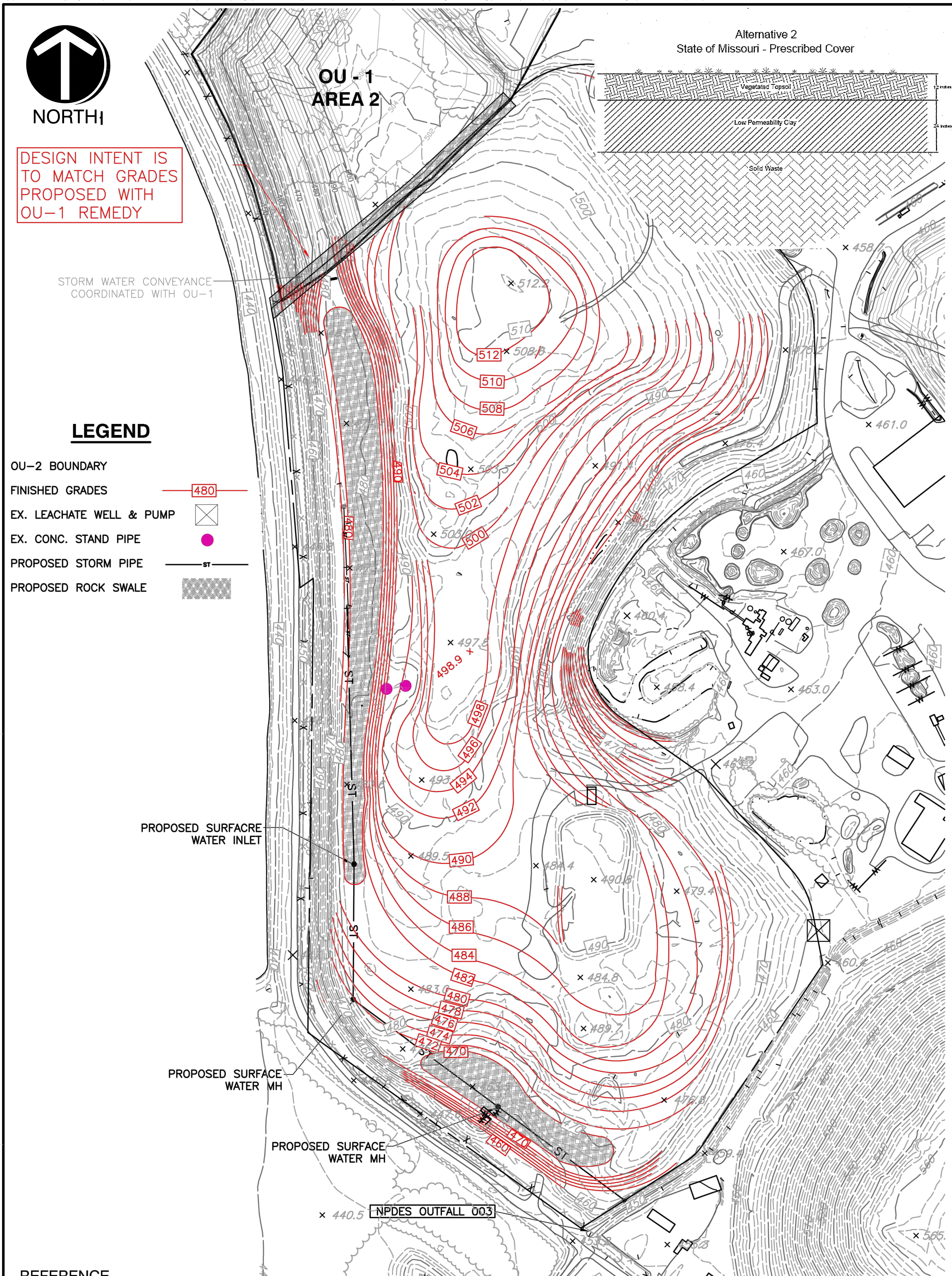
ST. LOUIS COUNTY

EXISTING DRAINAGE AREA MAP

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	2
DATE:	FEB. 2020	DWG SCALE:	1"=200'	PROJECT NO:	191-750		



REFERENCE

1. TOPOGRAPHIC SURVEY PROVIDED BY HERST & ASSOCIATES, INC., DENOTED "RAW TOPOGRAPHY MAP GENERATED BY SANBORN (JAN 20, 2005 AERIAL DATE)"

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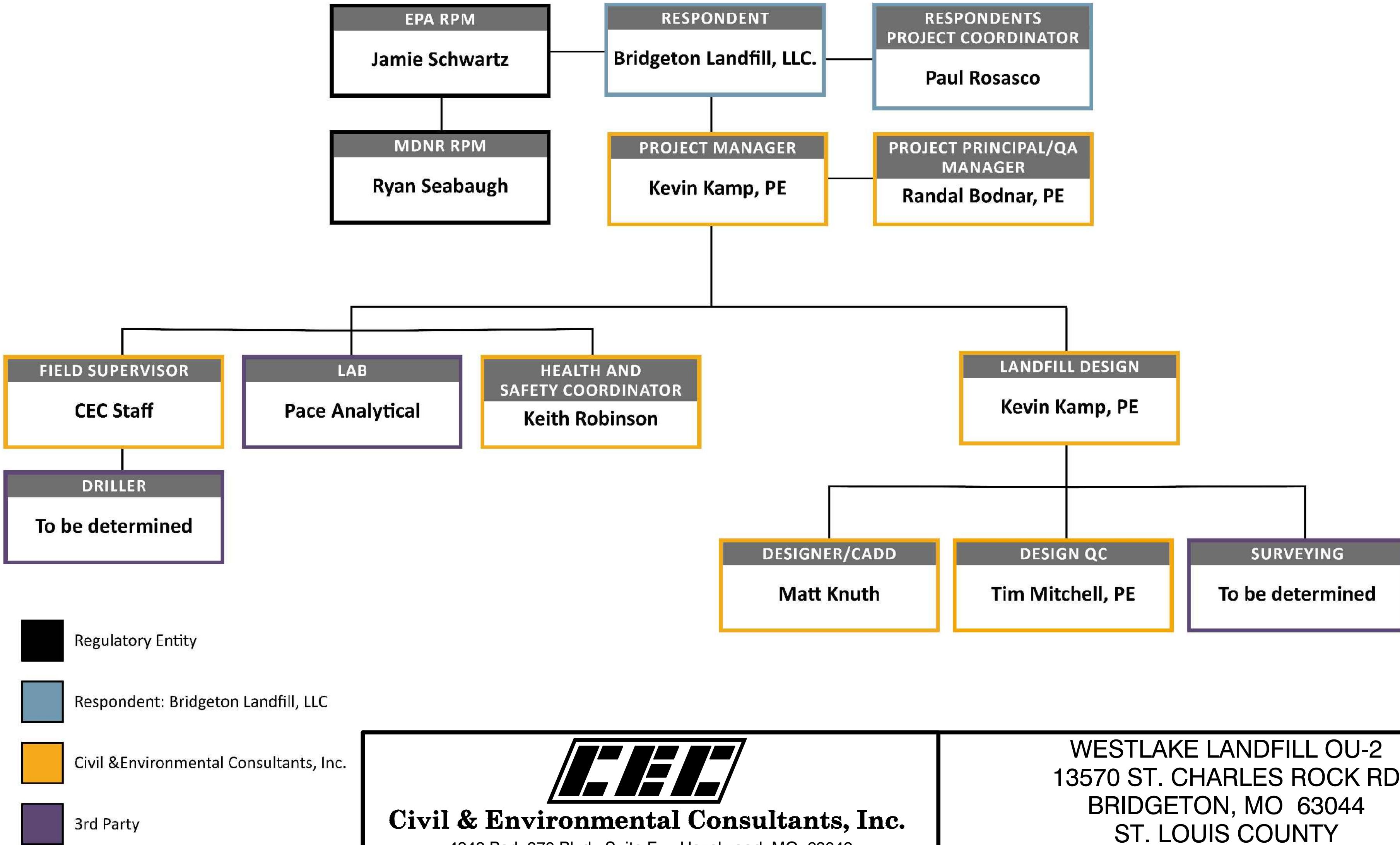
CONCEPTUAL GRADING PLAN

DRAWN BY: CAN	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.: 3
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	

*HAND SIGNATURE ON FILE



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ORGANIZATION CHART

DRAWN BY: CAN	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.: 4
DATE: MARCH 2020	DWG SCALE: N.T.S.	PROJECT NO: 191-750	

*HAND SIGNATURE ON FILE

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LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

BH-# PROPOSED WASTE SEPARATION BOREHOLES

SCALE IN FEET

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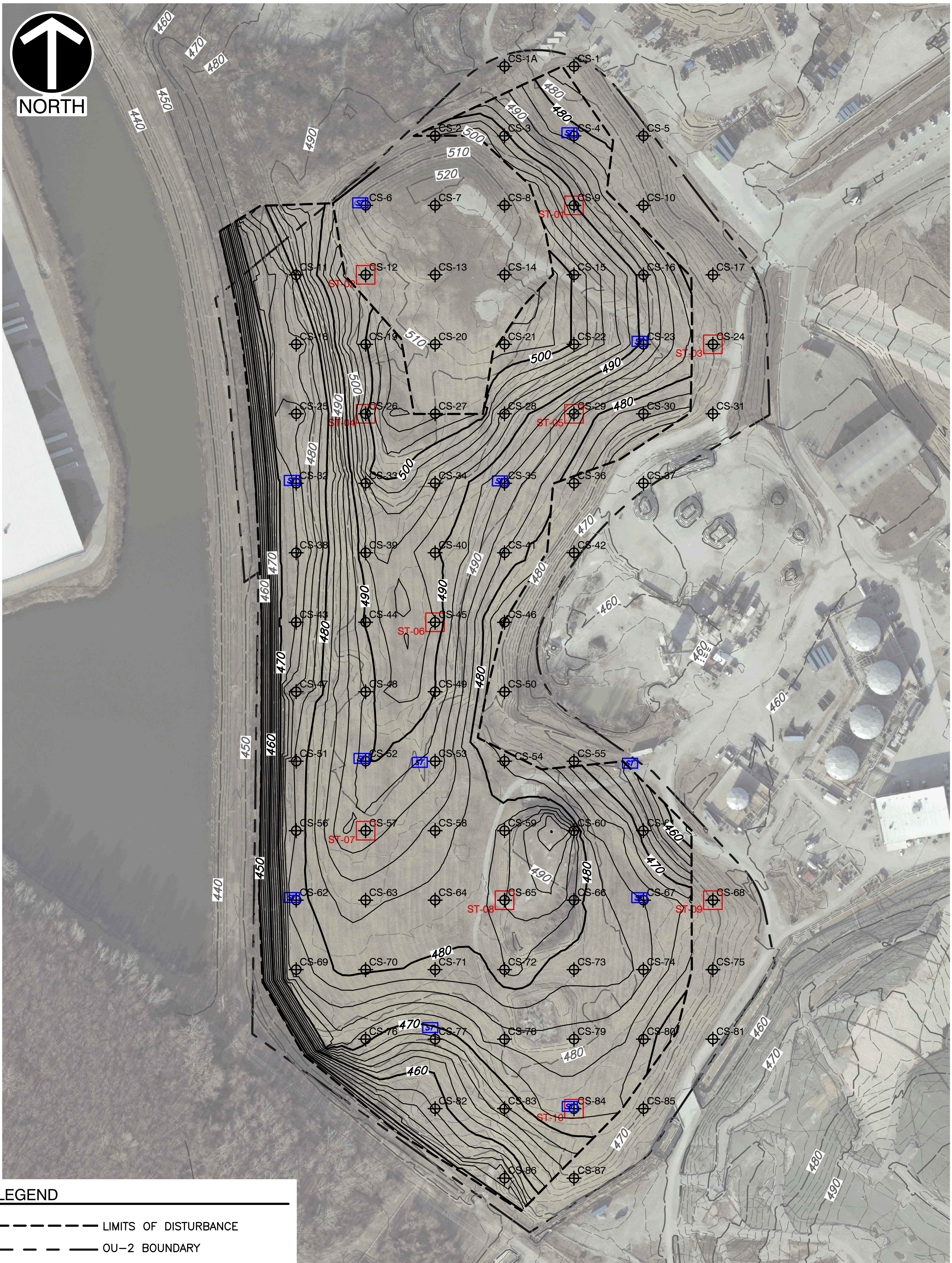
PROPOSED WASTE SEPARATION DEMONSTRATION BOREHOLES

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	5



LEGEND

- LIMITS OF DISTURBANCE
- OU-2 BOUNDARY
- 500 — TOP OF WASTE CONTOUR MAJOR
- TOP OF WASTE CONTOUR MINOR
- 500 — EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- CS-89 — SAMPLING LOCATIONS
- ST-## — SHELBY TUBE SAMPLING LOCATIONS
- ST — PREVIOUS SHELBY TUBE SAMPLING LOCATIONS

SCALE IN FEET

0 200 400

NOTE

1. ADDITIONAL CAP OR SHELBY TUBE SAMPLING LOCATIONS MAY BE UTILIZED FOR IRREGULARITIES OBSERVED DURING THE INACTIVE SANITARY LANDFILL EXISTING CAP EVALUATION

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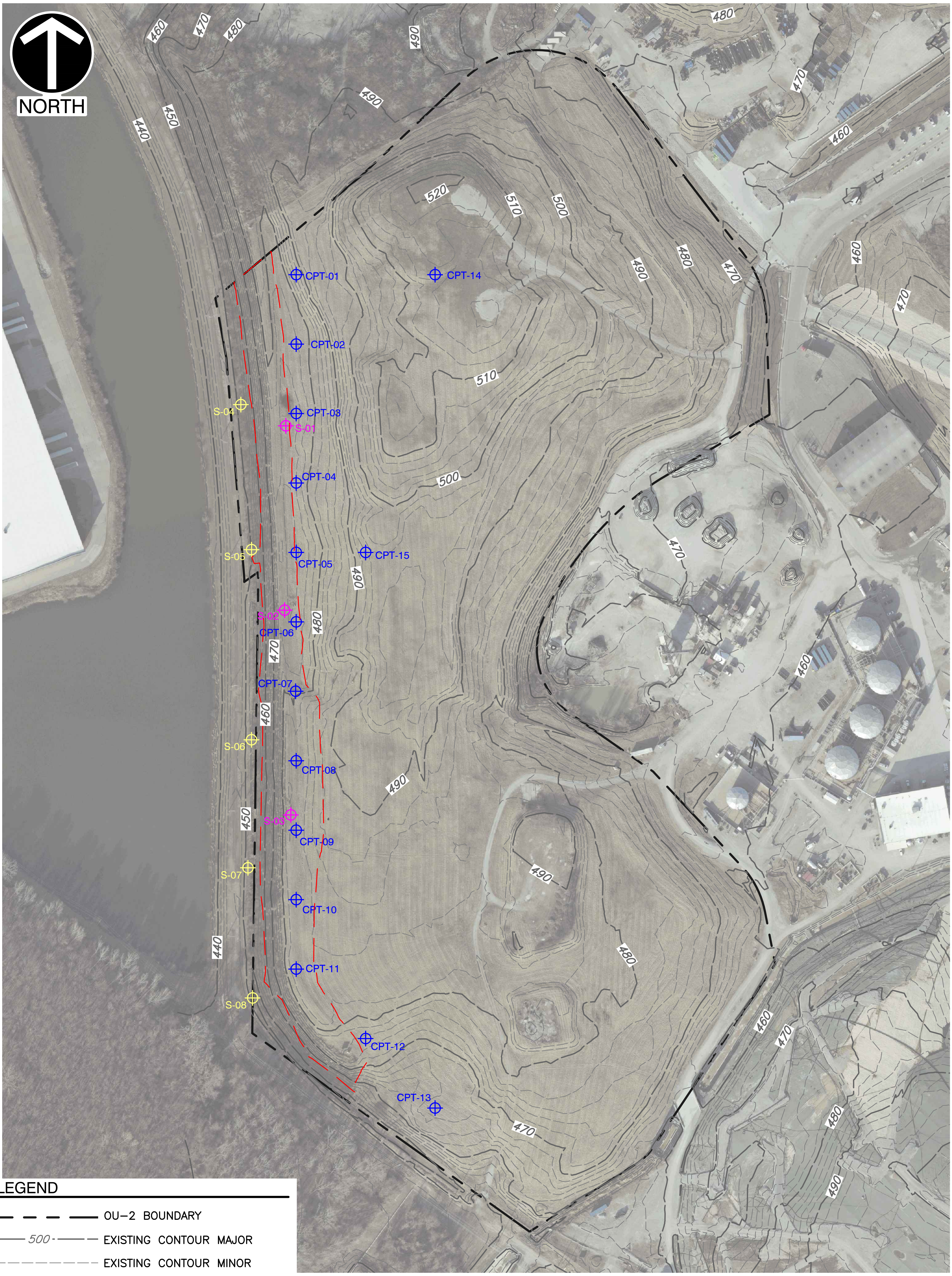
CAP SAMPLING LOCATIONS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	6
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		



LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

CPT-## PROPOSED CPT LOCATIONS

S-## PROPOSED GEOTECHNICAL EVALUATION BOREHOLE

S-## PROPOSED WASTE PROPERTIES SONIC DRILLING LOCATIONS

NOTE

1. SONIC BORING LOCATIONS IN THE WASTE MASS SHALL BE LOCATED BASED ON THE CPT RESULTS. LOCATIONS SHOWN ARE ONLY FOR DISCUSSION.

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SCALE IN FEET

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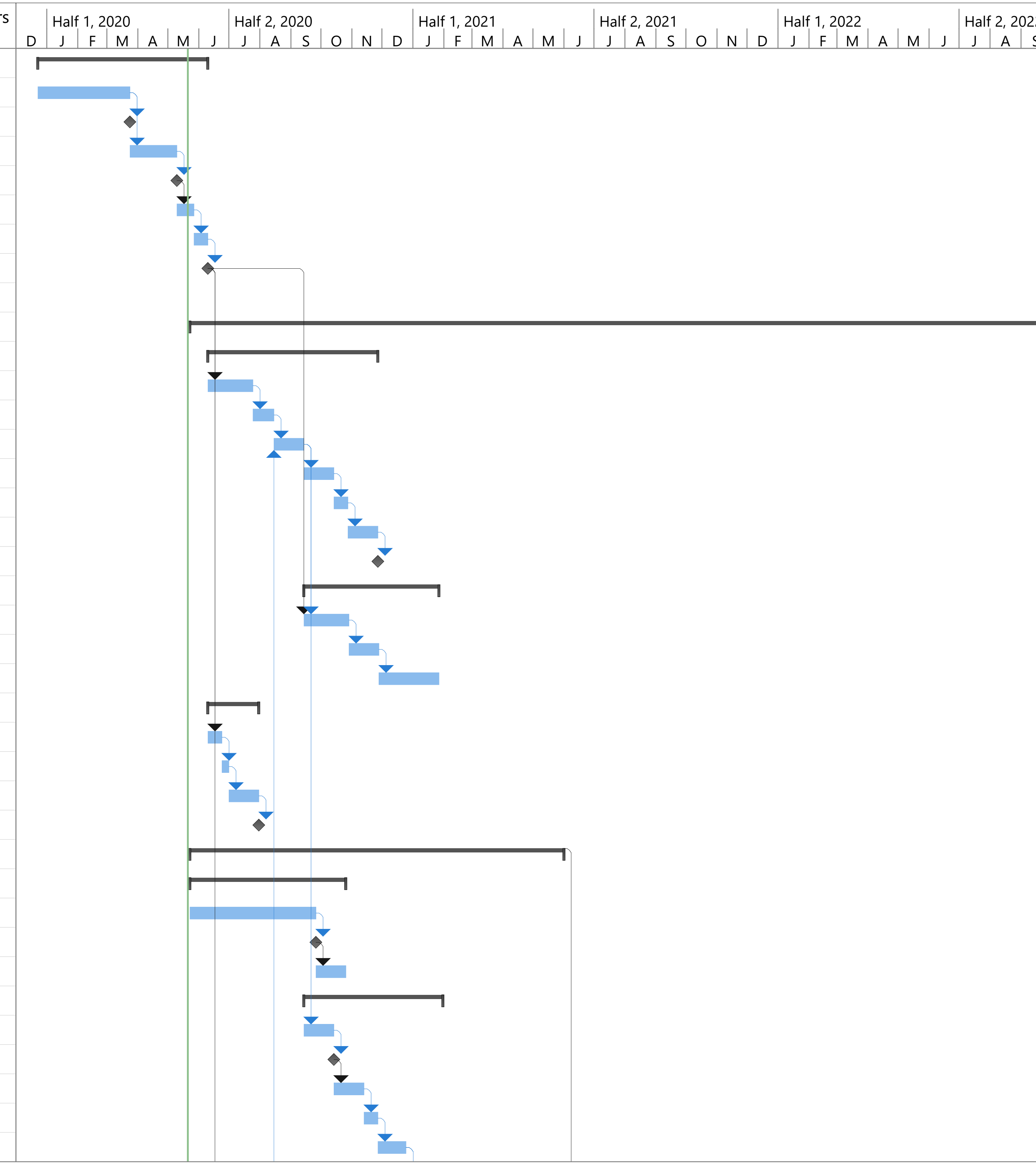
PROPOSED CPT AND SONIC DRILLING LOCATIONS

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	7

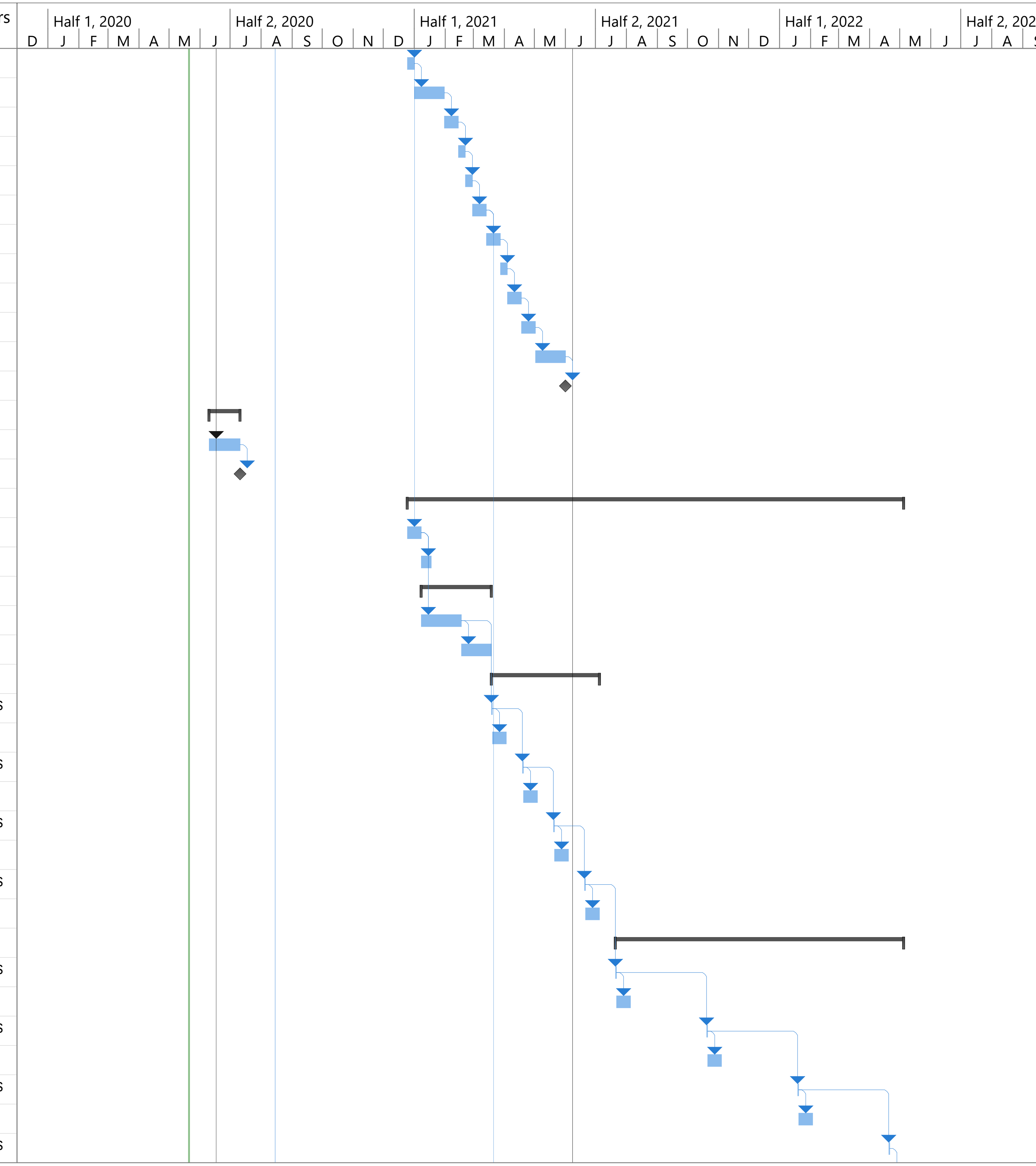
ID	Task Name	Duration	Start	Finish	Predecessors
1	Remedial Design Work Plan	170 days	Mon 12/23/19	Tue 6/9/20	
2	Prepare Response to Comments for 12/20/2019 EPA Comment Letter	92 days	Mon 12/23/19	Mon 3/23/20	
3	Submit Response to Comments	0 days	Mon 3/23/20	Mon 3/23/20	2
4	EPA Review of Draft Remedial Design Plan	47 days	Tue 3/24/20	Sat 5/9/20	2
5	EPA Conditional Approval of RDWP	0 days	Sat 5/9/20	Sat 5/9/20	4
6	Modifications per Conditional Approval	17 days	Sun 5/10/20	Tue 5/26/20	5
7	EPA Review of Conditional Approval Modifications	14 days	Wed 5/27/20	Tue 6/9/20	6
8	EPA Approval of Remedial Design Work Plan	0 days	Tue 6/9/20	Tue 6/9/20	7
9					
10	Remedial Design Investigations/Evaluations	870 days	Sat 5/23/20	Sun 10/9/22	
11	Existing Conditions Plan	170 days	Wed 6/10/20	Thu 11/26/20	
12	Coordination and Mobilization	45 days	Wed 6/10/20	Fri 7/24/20	8
13	Utility Surveying and Marking	21 days	Sat 7/25/20	Fri 8/14/20	12
14	Ground Surveying	30 days	Sat 8/15/20	Sun 9/13/20	13,81
15	Review Historical & Record Information of Existing Infrastructure	30 days	Mon 9/14/20	Tue 10/13/20	14
16	Field Verify Function & Condition of Existing Infrastructure	14 days	Wed 10/14/20	Tue 10/27/20	15
17	Prepare Existing Conditions Summary Submittal	30 days	Wed 10/28/20	Thu 11/26/20	16
18	Submit Existing Conditions Summary Submittal	0 days	Thu 11/26/20	Thu 11/26/20	17
19	RD Stormwater Monitoring Plan	135 days	Mon 9/14/20	Tue 1/26/21	
20	Develop Stormwater Sampling Plan	45 days	Mon 9/14/20	Wed 10/28/20	8,14
21	EPA Review of Plan	30 days	Thu 10/29/20	Fri 11/27/20	20
22	Coordination & Implementation	60 days	Sat 11/28/20	Tue 1/26/21	21
23	Waste Separation	51 days	Wed 6/10/20	Thu 7/30/20	
24	Coordination and Mobilization	14 days	Wed 6/10/20	Tue 6/23/20	8
25	Perform Borings and Observations	7 days	Wed 6/24/20	Tue 6/30/20	24
26	Prepare Waste Separation Evaluation Report	30 days	Wed 7/1/20	Thu 7/30/20	25
27	Submit Waste Separation Evaluation Report	0 days	Thu 7/30/20	Thu 7/30/20	26
28	Slope Stability Evaluation	374 days	Sat 5/23/20	Mon 5/31/21	
29	Slope Stability Evaluation Plan	156 days	Sat 5/23/20	Sun 10/25/20	
30	Prepare Slope Stability Evaluation Plan	126 days	Sat 5/23/20	Fri 9/25/20	
31	Submit Slope Stability Evaluation Plan	0 days	Fri 9/25/20	Fri 9/25/20	30
32	EPA Review of Slope Stability Evaluation Plan	30 days	Sat 9/26/20	Sun 10/25/20	31
33	Western Slope Waste Limit Investigation	139 days	Mon 9/14/20	Sat 1/30/21	
34	Prepare Western Slope Waste Limit Investigation Plan	30 days	Mon 9/14/20	Tue 10/13/20	14
35	Western Slope Waste Limit Investigation Plan Submission to EPA for Review and Approval	0 days	Tue 10/13/20	Tue 10/13/20	34
36	EPA Review of Western Slope Waste Limit Investigation Plan	30 days	Wed 10/14/20	Thu 11/12/20	35
37	Coordination and Mobilization	14 days	Fri 11/13/20	Thu 11/26/20	36
38	Implement Sampling and Analysis	28 days	Fri 11/27/20	Thu 12/24/20	37



Project: Remedial Design Sched
Date: Thu 5/21/20

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

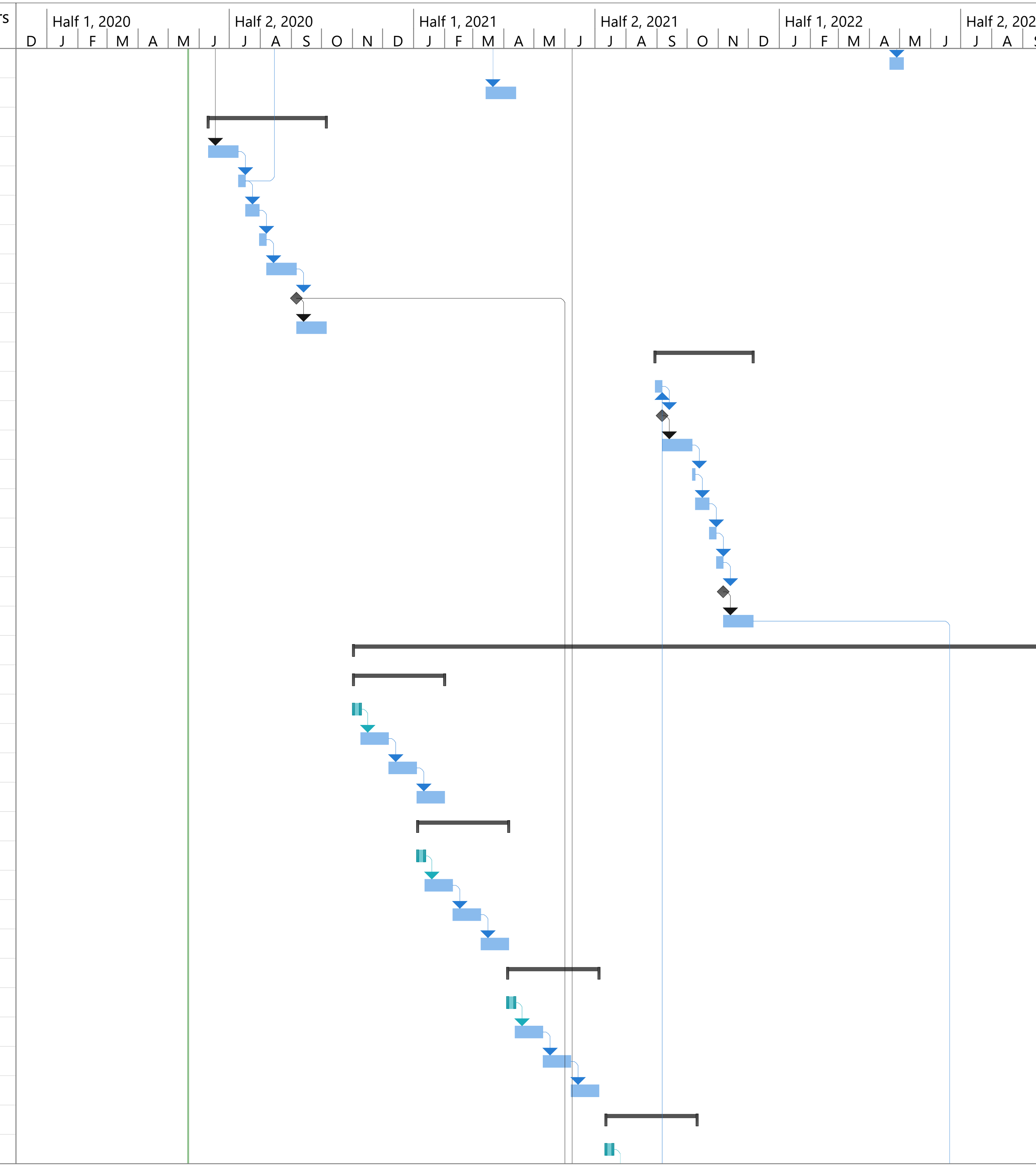
ID	Task Name	Duration	Start	Finish	Predecessors
39	Review Data	7 days	Fri 12/25/20	Thu 12/31/20	38
40	Prepare Western Slope Waste Limit Investigation Summary Report	30 days	Fri 1/1/21	Sat 1/30/21	39
41	Coordination and Mobilization	14 days	Sun 1/31/21	Sat 2/13/21	40
42	Perform CPT Soundings	7 days	Sun 2/14/21	Sat 2/20/21	41
43	Review CPT Data	7 days	Sun 2/21/21	Sat 2/27/21	42
44	Perform Borings and Subsurface Material Sampling	14 days	Sun 2/28/21	Sat 3/13/21	43
45	Laboratory Testing	14 days	Sun 3/14/21	Sat 3/27/21	44
46	Review Laboratory Data	7 days	Sun 3/28/21	Sat 4/3/21	45
47	Prepare Slope Stability Evaluation	14 days	Sun 4/4/21	Sat 4/17/21	46
48	Perform Alternative Analysis (if needed)	14 days	Sun 4/18/21	Sat 5/1/21	47
49	Prepare Slope Stability Evaluation Report	30 days	Sun 5/2/21	Mon 5/31/21	48
50	Submit Slope Stability Evaluation Report Including Western Slope Waste Limit Summary	0 days	Mon 5/31/21	Mon 5/31/21	49
51	Explosive Gas Monitoring Plan	31 days	Wed 6/10/20	Fri 7/10/20	
52	Prepare Explosive Gas Monitoring Plan	31 days	Wed 6/10/20	Fri 7/10/20	8
53	Submit Explosive Gas Monitoring Plan	0 days	Fri 7/10/20	Fri 7/10/20	52
54	Initial Landfill Gas Monitoring	496 days	Fri 12/25/20	Wed 5/4/22	
55	Install Gas Monitoring Probes	14 days	Fri 12/25/20	Thu 1/7/21	38
56	Develop and Submit Addendum to Explosive Gas Monitoring Plan (Probe Logs)	10 days	Fri 1/8/21	Sun 1/17/21	55
57	Weekly Landfill Gas Sampling Program	70 days	Fri 1/8/21	Thu 3/18/21	
58	Weekly Landfill Gas Sampling	40 days	Fri 1/8/21	Tue 2/16/21	55
59	Prepare and Submit Landfill Gas Monitoring Report (Weekly Sampling Events 1 through 4)	30 days	Wed 2/17/21	Thu 3/18/21	58
60	Monthly Landfill Gas Sampling Program	108 days	Fri 3/19/21	Sun 7/4/21	
61	Monthly Landfill Gas Sampling Event No. 1	1 day	Fri 3/19/21	Fri 3/19/21	58FS+30 days
62	Prepare and Submit Landfill Gas Monitoring Report (Monthly Sampling Event 1)	14 days	Sat 3/20/21	Fri 4/2/21	61
63	Monthly Landfill Gas Sampling Event No. 2	1 day	Mon 4/19/21	Mon 4/19/21	61FS+30 days
64	Prepare and Submit Landfill Gas Monitoring Report (Monthly Sampling Event 2)	14 days	Tue 4/20/21	Mon 5/3/21	63
65	Monthly Landfill Gas Sampling Event No.3	1 day	Thu 5/20/21	Thu 5/20/21	63FS+30 days
66	Prepare and Submit Landfill Gas Monitoring Report (Monthly Sampling Event 3)	14 days	Fri 5/21/21	Thu 6/3/21	65
67	Monthly Landfill Gas Sampling Event No. 4	1 day	Sun 6/20/21	Sun 6/20/21	65FS+30 days
68	Prepare and Submit Landfill Gas Monitoring Report (Monthly Sampling Event 4)	14 days	Mon 6/21/21	Sun 7/4/21	67
69	Quarterly Landfill Gas Sampling Program	288 days	Wed 7/21/21	Wed 5/4/22	
70	Quarterly Landfill Gas Sampling No 1	1 day	Wed 7/21/21	Wed 7/21/21	67FS+30 days
71	Submit Landfill Gas Monitoring Report (Quarterly Sampling Event 1)	14 days	Thu 7/22/21	Wed 8/4/21	70
72	Quarterly Landfill Gas Sampling No 2	1 day	Wed 10/20/21	Wed 10/20/21	70FS+90 days
73	Submit Landfill Gas Monitoring Report (Quarterly Sampling Event 2)	14 days	Thu 10/21/21	Wed 11/3/21	72
74	Quarterly Landfill Gas Sampling No. 3	1 day	Wed 1/19/22	Wed 1/19/22	72FS+90 days
75	Submit Landfill Gas Monitoring Report (Quarterly Sampling Event 3)	14 days	Thu 1/20/22	Wed 2/2/22	74
76	Quarterly Landfill Gas Sampling No. 4	1 day	Wed 4/20/22	Wed 4/20/22	74FS+90 days



Project: Remedial Design Sched
Date: Thu 5/21/20

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Name	Duration	Start	Finish	Predecessors
77	Submit Landfill Gas Monitoring Report (Quarterly Sampling Event 4)	14 days	Thu 4/21/22	Wed 5/4/22	76
78	Prepare Ambient Air Monitoring Plan (if needed)	30 days	Sun 3/14/21	Mon 4/12/21	44
79	Existing Soil Cap Evaluation	118 days	Wed 6/10/20	Mon 10/5/20	
80	Coordination and Mobilization	30 days	Wed 6/10/20	Thu 7/9/20	8
81	Cap Thickness Sampling	7 days	Fri 7/10/20	Thu 7/16/20	80
82	Lab Testing	14 days	Fri 7/17/20	Thu 7/30/20	81
83	Data Review	7 days	Fri 7/31/20	Thu 8/6/20	82
84	Prepare Existing Soil Cap Evaluation Report	30 days	Fri 8/7/20	Sat 9/5/20	83
85	Submit Existing Soil Cap Evaluation Report	0 days	Sat 9/5/20	Sat 9/5/20	84
86	EPA Review	30 days	Sun 9/6/20	Mon 10/5/20	85
87	Soil Borrow Area Investigation	98 days	Mon 8/30/21	Sun 12/5/21	
88	Prepare Soil Borrow Investigation Plan	7 days	Mon 8/30/21	Sun 9/5/21	143
89	Submit Borrow Area Investigation Plan	0 days	Sun 9/5/21	Sun 9/5/21	88
90	EPA Review	30 days	Mon 9/6/21	Tue 10/5/21	89
91	Coordination and Mobilization	3 days	Wed 10/6/21	Fri 10/8/21	90
92	Implement Sampling and Analysis	14 days	Sat 10/9/21	Fri 10/22/21	91
93	Review Data	7 days	Sat 10/23/21	Fri 10/29/21	92
94	Prepare Soil Borrow Area Investigation Summary Report	7 days	Sat 10/30/21	Fri 11/5/21	93
95	Submit Soil Borrow Area Investigation Summary Report	0 days	Fri 11/5/21	Fri 11/5/21	94
96	EPA Review	30 days	Sat 11/6/21	Sun 12/5/21	95
97	Baseline Groundwater Monitoring	707 days	Mon 11/2/20	Sun 10/9/22	
98	1st Quarter Groundwater Monitoring	91 days	Mon 11/2/20	Sun 1/31/21	
99	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 11/2/20	Sun 11/8/20	
100	Laboratory Analyses of Groundwater Samples	28 days	Mon 11/9/20	Sun 12/6/20	99
101	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 12/7/20	Sun 1/3/21	100
102	Submittal - 1st Quarter Groundwater Monitoring Report	28 days	Mon 1/4/21	Sun 1/31/21	101
103	2nd Quarter Groundwater Monitoring	91 days	Tue 1/5/21	Mon 4/5/21	
104	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Tue 1/5/21	Mon 1/11/21	
105	Laboratory Analyses of Groundwater Samples	28 days	Tue 1/12/21	Mon 2/8/21	104
106	Evaluation, Verification, and Validation of Analytical Data	28 days	Tue 2/9/21	Mon 3/8/21	105
107	Submittal - 2nd Quarter Groundwater Monitoring Report	28 days	Tue 3/9/21	Mon 4/5/21	106
108	3rd Quarter Groundwater Monitoring	91 days	Mon 4/5/21	Sun 7/4/21	
109	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 4/5/21	Sun 4/11/21	
110	Laboratory Analyses of Groundwater Samples	28 days	Mon 4/12/21	Sun 5/9/21	109
111	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 5/10/21	Sun 6/6/21	110
112	Submittal - 3rd Quarter Groundwater Monitoring Report	28 days	Mon 6/7/21	Sun 7/4/21	111
113	Annual (4th Quarter) Groundwater Monitoring	91 days	Mon 7/12/21	Sun 10/10/21	
114	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 7/12/21	Sun 7/18/21	



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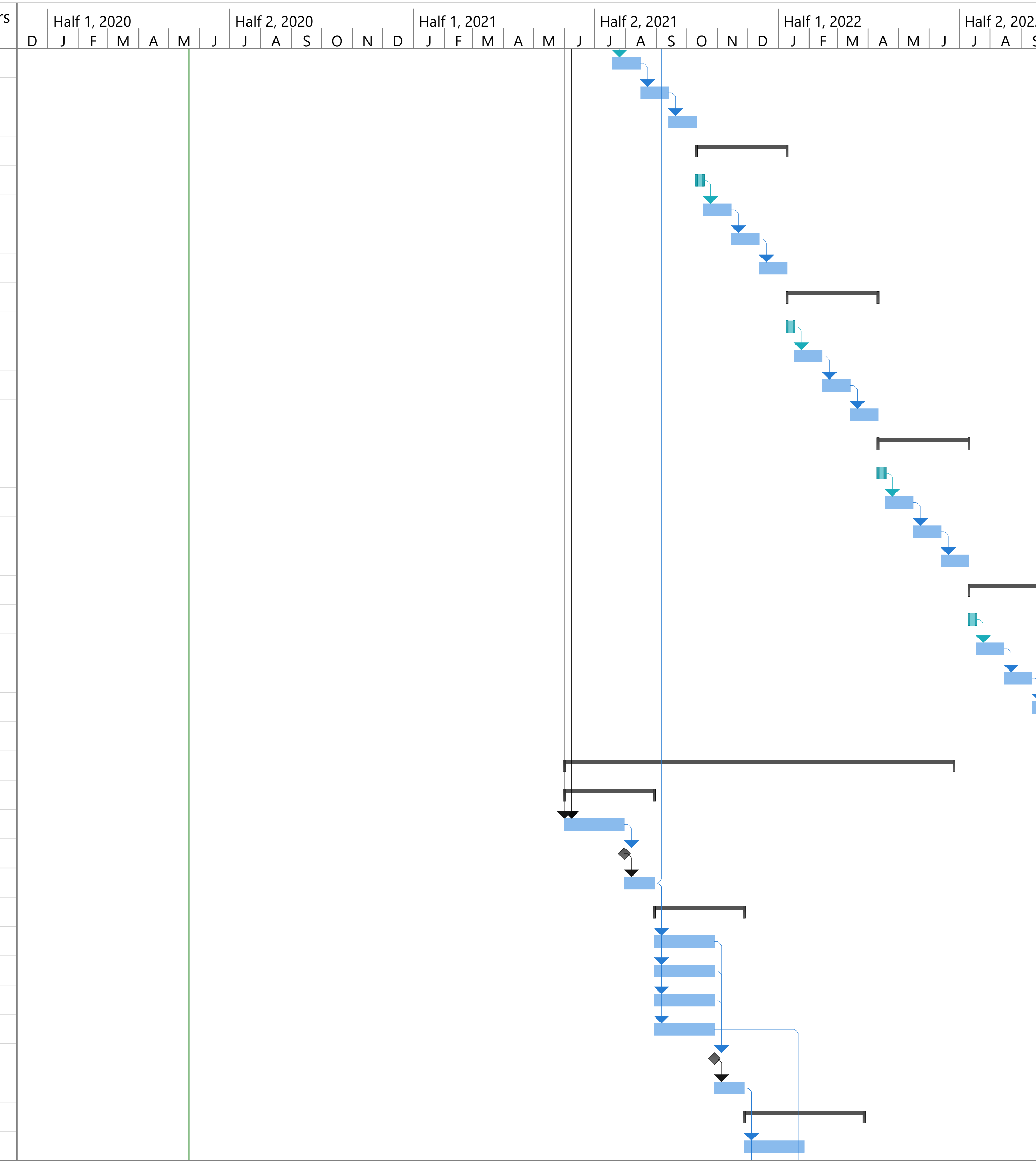
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Name	Duration	Start	Finish	Predecessors
115	Laboratory Analyses of Groundwater Samples	28 days	Mon 7/19/21	Sun 8/15/21	114
116	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 8/16/21	Sun 9/12/21	115
117	Submittal - Annual (4th Quarter) Groundwater Monitoring Report	28 days	Mon 9/13/21	Sun 10/10/21	116
118	5th Quarter Groundwater Monitoring	91 days	Mon 10/11/21	Sun 1/9/22	
119	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 10/11/21	Sun 10/17/21	
120	Laboratory Analyses of Groundwater Samples	28 days	Mon 10/18/21	Sun 11/14/21	119
121	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 11/15/21	Sun 12/12/21	120
122	Submittal - 5th Quarter Groundwater Monitoring Report	28 days	Mon 12/13/21	Sun 1/9/22	121
123	6th Quarter Groundwater Monitoring	91 days	Mon 1/10/22	Sun 4/10/22	
124	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 1/10/22	Sun 1/16/22	
125	Laboratory Analyses of Groundwater Samples	28 days	Mon 1/17/22	Sun 2/13/22	124
126	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 2/14/22	Sun 3/13/22	125
127	Submittal - 6th Quarter Groundwater Monitoring Report	28 days	Mon 3/14/22	Sun 4/10/22	126
128	7th Quarter Groundwater Monitoring	91 days	Mon 4/11/22	Sun 7/10/22	
129	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 4/11/22	Sun 4/17/22	
130	Laboratory Analyses of Groundwater Samples	28 days	Mon 4/18/22	Sun 5/15/22	129
131	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 5/16/22	Sun 6/12/22	130
132	Submittal - 7th Quarter Groundwater Monitoring Report	28 days	Mon 6/13/22	Sun 7/10/22	131
133	Annual (8th Quarter) Groundwater Monitoring	91 days	Mon 7/11/22	Sun 10/9/22	
134	Initiation of Baseline Monitoring - Groundwater Sample Collection	7 days	Mon 7/11/22	Sun 7/17/22	
135	Laboratory Analyses of Groundwater Samples	28 days	Mon 7/18/22	Sun 8/14/22	134
136	Evaluation, Verification, and Validation of Analytical Data	28 days	Mon 8/15/22	Sun 9/11/22	135
137	Submittal - Annual (8th Quarter) Groundwater Monitoring Report	28 days	Mon 9/12/22	Sun 10/9/22	136
138					
139	Remedial Design Submissions	390 days	Tue 6/1/21	Sat 6/25/22	
140	Preliminary (30%) Remedial Design Report	90 days	Tue 6/1/21	Sun 8/29/21	
141	Prepare Plan Drawings	60 days	Tue 6/1/21	Fri 7/30/21	28,85
142	Submission to EPA	0 days	Fri 7/30/21	Fri 7/30/21	141
143	EPA Review	30 days	Sat 7/31/21	Sun 8/29/21	142
144	Intermediate (60%) Remedial Design Report	90 days	Mon 8/30/21	Sat 11/27/21	
145	Respond to EPA Comments	60 days	Mon 8/30/21	Thu 10/28/21	143
146	Prepare Draft O&M Plan	60 days	Mon 8/30/21	Thu 10/28/21	143
147	Prepare Draft Groundwater Monitoring Plan	60 days	Mon 8/30/21	Thu 10/28/21	143
148	Prepare Revised Drawings, Specifications, Supporting Narratives, Calculations, and Exhibits	60 days	Mon 8/30/21	Thu 10/28/21	143
149	Submission to EPA	0 days	Thu 10/28/21	Thu 10/28/21	145,146,147
150	EPA Review	30 days	Fri 10/29/21	Sat 11/27/21	149
151	Pre-Final (90%) Remedial Design Report	120 days	Sun 11/28/21	Sun 3/27/22	
152	Respond to EPA Comments	60 days	Sun 11/28/21	Wed 1/26/22	150



Project: Remedial Design Sched
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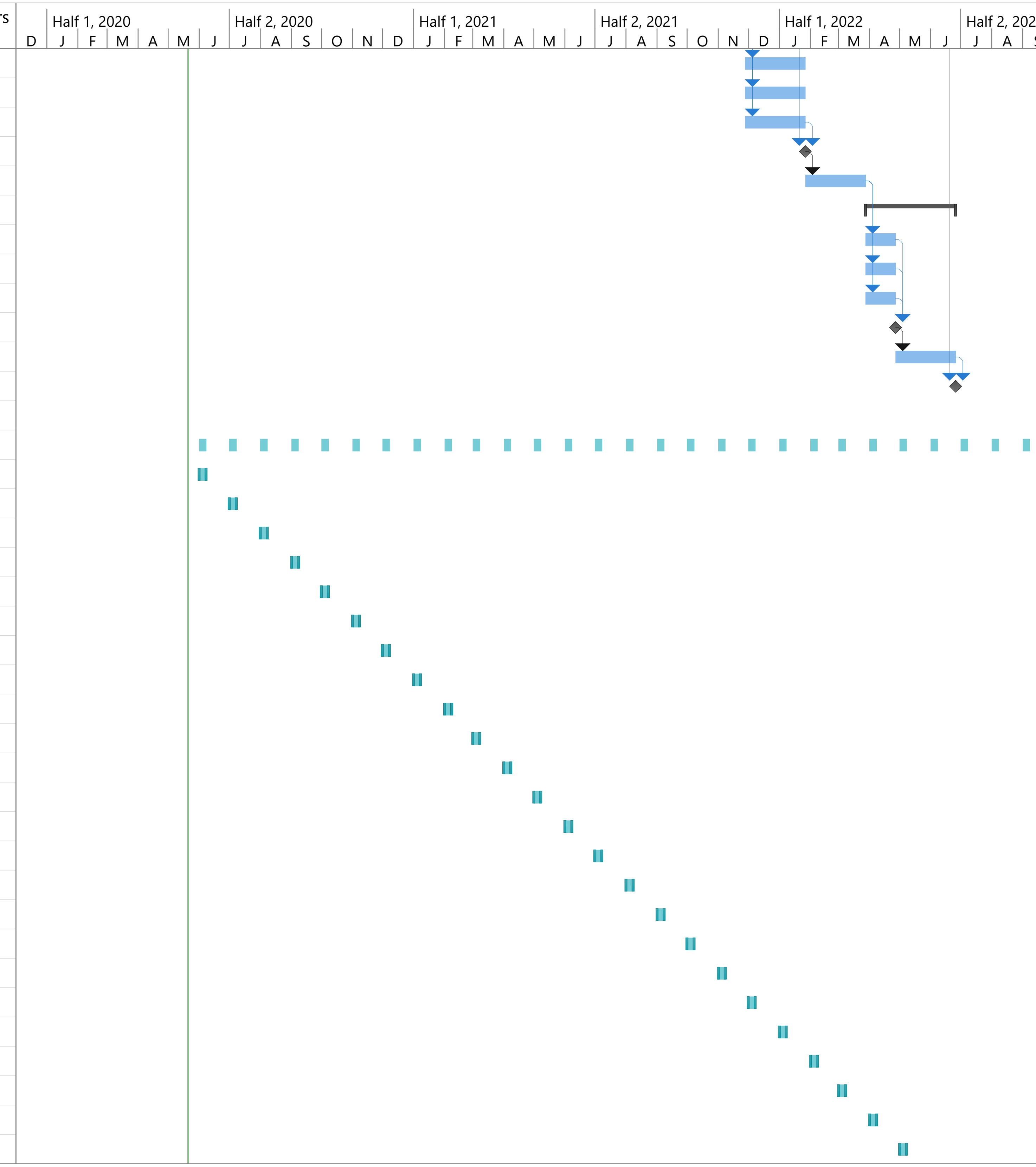
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Name	Duration	Start	Finish	Predecessors
153	Prepare Air Monitoring Plan	60 days	Sun 11/28/21	Wed 1/26/22	150
154	Prepare RA Stormwater Management and Monitoring Plan	60 days	Sun 11/28/21	Wed 1/26/22	150
155	Prepare Revised Drawings, Specifications, Supporting Narratives, Calculations, and Exhibits	60 days	Sun 11/28/21	Wed 1/26/22	150
156	Submission to EPA	0 days	Wed 1/26/22	Wed 1/26/22	155,148
157	EPA Review	60 days	Thu 1/27/22	Sun 3/27/22	156
158	Final Remedial Design Report	90 days	Mon 3/28/22	Sat 6/25/22	
159	Respond to EPA Comments	30 days	Mon 3/28/22	Tue 4/26/22	157
160	Revise Documents & Plans	30 days	Mon 3/28/22	Tue 4/26/22	157
161	Prepare Additional Drawings, Supporting Narratives, Calculations, and Exhibits	30 days	Mon 3/28/22	Tue 4/26/22	157
162	Submission to EPA	0 days	Tue 4/26/22	Tue 4/26/22	161,159,160
163	EPA Review	60 days	Wed 4/27/22	Sat 6/25/22	162
164	EPA Approval of Remedial Design	0 days	Sat 6/25/22	Sat 6/25/22	163,96
165					
166	Prepare & Submit Monthly Progress Reports	859 days	Mon 6/1/20	Fri 10/7/22	
167	Prepare & Submit Monthly Progress Reports 1	7 days	Mon 6/1/20	Sun 6/7/20	
168	Prepare & Submit Monthly Progress Reports 2	7 days	Wed 7/1/20	Tue 7/7/20	
169	Prepare & Submit Monthly Progress Reports 3	7 days	Sat 8/1/20	Fri 8/7/20	
170	Prepare & Submit Monthly Progress Reports 4	7 days	Tue 9/1/20	Mon 9/7/20	
171	Prepare & Submit Monthly Progress Reports 5	7 days	Thu 10/1/20	Wed 10/7/20	
172	Prepare & Submit Monthly Progress Reports 6	7 days	Sun 11/1/20	Sat 11/7/20	
173	Prepare & Submit Monthly Progress Reports 7	7 days	Tue 12/1/20	Mon 12/7/20	
174	Prepare & Submit Monthly Progress Reports 8	7 days	Fri 1/1/21	Thu 1/7/21	
175	Prepare & Submit Monthly Progress Reports 9	7 days	Mon 2/1/21	Sun 2/7/21	
176	Prepare & Submit Monthly Progress Reports 10	7 days	Mon 3/1/21	Sun 3/7/21	
177	Prepare & Submit Monthly Progress Reports 11	7 days	Thu 4/1/21	Wed 4/7/21	
178	Prepare & Submit Monthly Progress Reports 12	7 days	Sat 5/1/21	Fri 5/7/21	
179	Prepare & Submit Monthly Progress Reports 13	7 days	Tue 6/1/21	Mon 6/7/21	
180	Prepare & Submit Monthly Progress Reports 14	7 days	Thu 7/1/21	Wed 7/7/21	
181	Prepare & Submit Monthly Progress Reports 15	7 days	Sun 8/1/21	Sat 8/7/21	
182	Prepare & Submit Monthly Progress Reports 16	7 days	Wed 9/1/21	Tue 9/7/21	
183	Prepare & Submit Monthly Progress Reports 17	7 days	Fri 10/1/21	Thu 10/7/21	
184	Prepare & Submit Monthly Progress Reports 18	7 days	Mon 11/1/21	Sun 11/7/21	
185	Prepare & Submit Monthly Progress Reports 19	7 days	Wed 12/1/21	Tue 12/7/21	
186	Prepare & Submit Monthly Progress Reports 20	7 days	Sat 1/1/22	Fri 1/7/22	
187	Prepare & Submit Monthly Progress Reports 21	7 days	Tue 2/1/22	Mon 2/7/22	
188	Prepare & Submit Monthly Progress Reports 22	7 days	Tue 3/1/22	Mon 3/7/22	
189	Prepare & Submit Monthly Progress Reports 23	7 days	Fri 4/1/22	Thu 4/7/22	
190	Prepare & Submit Monthly Progress Reports 24	7 days	Sun 5/1/22	Sat 5/7/22	



Project: Remedial Design Sched
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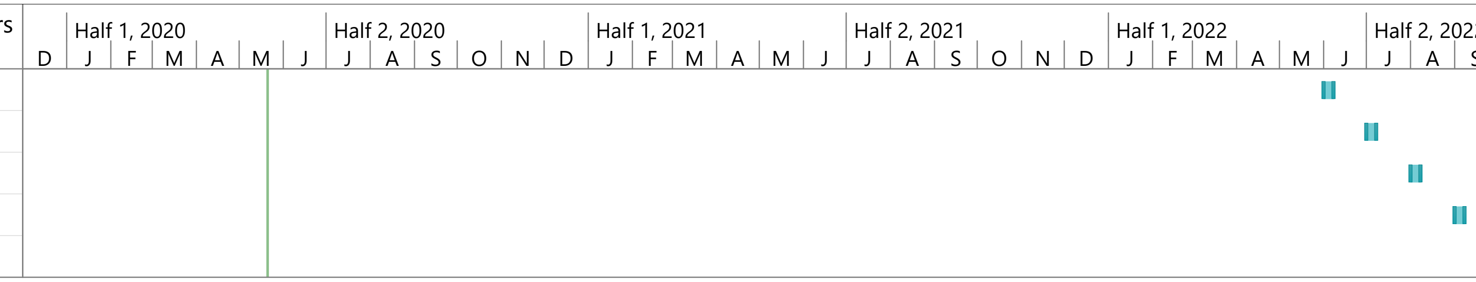
Task | Project Summary | Manual Task | Start-only | Deadline
Split | Inactive Task | Duration-only | Finish-only | Progress
Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks | Manual Progress
Summary | Inactive Summary | Manual Summary | External Milestone

ID	Task Name	Duration	Start	Finish	Predecessors
191	Prepare & Submit Monthly Progress Reports 25	7 days	Wed 6/1/22	Tue 6/7/22	
192	Prepare & Submit Monthly Progress Reports 26	7 days	Fri 7/1/22	Thu 7/7/22	
193	Prepare & Submit Monthly Progress Reports 27	7 days	Mon 8/1/22	Sun 8/7/22	
194	Prepare & Submit Monthly Progress Reports 28	7 days	Thu 9/1/22	Wed 9/7/22	
195	Prepare & Submit Monthly Progress Reports 29	7 days	Sat 10/1/22	Fri 10/7/22	



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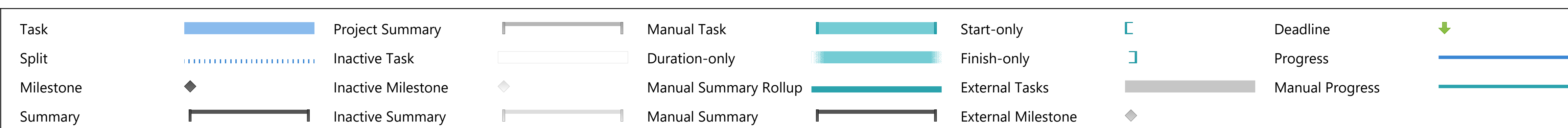

ATTACHMENT 1

Copy of 1998 Rules of Department of Natural Resources Division 80, Chapter 3

Rules of
Department of Natural Resources
Division 80—Solid Waste Management
Chapter 3—Sanitary Landfill

Title **Page**

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 80—Solid Waste Management
Chapter 3—Sanitary Landfill

10 CSR 80-3.010 Design and Operation

PURPOSE: This rule pertains to the design and operation of a sanitary landfill.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) General Provisions.

(A) This rule is intended to provide for sanitary landfill area operations that will have minimal impact on the environment. The rule sets forth requirements and the method of satisfactory compliance to ensure that the design, construction and operation of sanitary landfills will protect the public health, prevent nuisances and meet applicable environmental standards. The requirement subsections contained in this rule delineate minimum levels of performance required of any sanitary landfill operation. The satisfactory compliance subsections are presented as the authorized methods by which the objectives of the requirements can be realized. The satisfactory compliance subsections are based on the practice of sanitary landfilling municipal solid waste. If techniques other than those listed as satisfactory compliance in design or operation are used, it is the obligation of the sanitary landfill owner/operator to demonstrate to the department in advance that the techniques to be employed will satisfy the requirements. Procedures for the techniques shall be submitted to the department in writing and approved by the department in writing prior to being employed. Notwithstanding any other provision of these rules, when it is found necessary to meet objectives of the requirement subsections, the department may require changes in design or operation as the condition warrants.

(B) Owners/operators of sanitary landfills that close after October 9, 1991 and prior to October 9, 1993, and do not apply the final cover and establish vegetation on the sanitary landfill within one hundred eighty (180) days of last receipt of waste, or an alternative time frame negotiated with the department, are subject to all the requirements of this rule.

(C) Sanitary landfills not in compliance with the requirements of this chapter and of 10 CSR 80-2 are considered to be open dumps, which are prohibited by state law.

(2) Solid Waste Accepted.

(A) Requirement. Only the following solid wastes shall be accepted for disposal in a sanitary landfill: municipal waste; bulky waste; demolition and construction wastes; brush and wood wastes; cut, chipped or shredded tires as defined in 10 CSR 80-8; soil; rock; concrete; related inert solids relatively insoluble in water; and incinerator and air pollution control residues generated from facilities exempted under 10 CSR 80-2.020(9)(A)2.

(B) Satisfactory Compliance—Design. The plans shall specify the types of waste to be accepted for disposal at a sanitary landfill.

(C) Satisfactory Compliance—Operations.

1. Certain bulky solid wastes, such as automobile bodies and furniture shall be crushed on solid ground and then pushed onto the working face near the bottom of the cell. Other bulky items, such as demolition wastes, tree stumps and large timbers shall be pushed onto the working face near the bottom of the cell. Bulky waste shall be excluded from the first layer of waste placed above a composite liner to ensure that the integrity of the liner and leachate collection system has been maintained.

2. Dead animals shall be placed on the working face with other municipal solid wastes and covered immediately with solid waste or soil.

3. The disposal of special wastes which have been approved in the construction permit shall be conducted in accordance with the approved design and operating plans plus any additional procedures determined by the department as necessary to protect the environment.

4. For the disposal of special wastes not specifically approved in the construction permit, a special waste disposal request form shall be completed by the generator of the waste and the operator of the sanitary landfill prior to acceptance and disposal of the waste. The completed request shall be retained in the sanitary landfill operating record. Neither a permit modification nor prior approval is required unless deemed necessary by the department due to the characteristics of the special waste.

(3) Solid Waste Excluded.

(A) Requirement. The following are excluded from disposal:

1. Regulated quantities of hazardous waste;

2. Radioactive materials as follows:

A. The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content as defined in the Atomic Energy Act of 1954, 42 U.S.C. section 2014(e)(2)(1996);

B. Any radioactively-contaminated material used in or resulting from the cleanup of radioactively-contaminated sites;

C. Any byproduct, source or special nuclear material regulated by the Atomic Energy Act of 1954;

D. Radioactive material used in or resulting from medical processes or liquid radioactive material, unless the material has a half-life of less than thirty (30) days;

E. Naturally Occurring Radioactive Material (NORM) except with prior written approval from the Missouri Department of Natural Resources;

F. Any accelerator-produced radioisotopes, unless the material has a half-life of less than thirty (30) days;

G. Smoke detectors, electron tubes, luminous wristwatches and clocks, luminous lock illuminators, luminous automobile shift quadrants, luminous marine compasses and luminous thermostat dials and pointers in quantities greater than ten (10) items from any single source;

H. "Low-level radioactive waste" as defined in section 260.700, RSMo as radioactive waste that is not classified as high-level radioactive waste and that is class A, B, or C low-level radioactive waste as defined in 10 CFR 61.55, as that section existed on January 26, 1983. "Low-level radioactive waste" or "waste" does not include any such radioactive waste that is owned or generated by the United States Department of Energy; by the United States Navy as a result of the decommissioning of its vessels, or as a result of any research, development, testing or production of any atomic weapon; and

I. Any greater-than-class-C radioactive waste;

3. Explosives;

4. Regulated quantities of polychlorinated biphenyls (PCBs);

5. Bulk liquids;

6. Highly flammable or volatile substances;

7. Septic tank pumpings;

8. Major appliances;

9. Waste oil;

10. Lead-acid batteries;

11. Waste tires as provided by 10 CSR 80-8.020;

12. Yard waste; and

13. Infectious waste as provided by 10 CSR 80-7.010.

(B) Satisfactory Compliance—Design.

1. In consultation with the department, the applicant shall determine what wastes are to be accepted and shall identify them in the plan and the application for a construction permit. The criteria used to determine whether the waste can be accepted shall include the design of the landfill, the physical and chemical characteristics of the wastes, the quantity of the wastes, and the proposed operating procedures.

2. The plans shall specify the operating procedures for screening and removal of wastes which are excluded from disposal according to subsection (3)(A) of this rule. Operating procedures for the screening and removal of excluded wastes shall include:

A. At a minimum, random inspections of incoming loads unless the owner/operator takes other steps to ensure that incoming solid wastes do not contain wastes excluded from disposal at sanitary landfills;

B. Records of any inspections;

C. Training of facility personnel to recognize unacceptable wastes; and

D. Immediate notification of the department if a regulated hazardous waste, regulated PCB waste, or infectious waste is discovered at the facility.

(C) Satisfactory Compliance—Operations.

1. A sign with the following wording shall be displayed prominently at the site entrance. "Regulated hazardous waste, radioactive materials, polychlorinated biphenyls (PCBs), bulk liquids, highly flammable or volatile substances, septic tank pumpings, major appliances, waste oil, lead-acid batteries, waste tires as provided by 10 CSR 80-8, yard waste, explosives and regulated infectious waste are excluded from disposal."

2. The operating procedures for screening of wastes and for removal of wastes which are excluded from disposal according to subsection (3)(A) of this rule shall be implemented.

3. Bulk or noncontainerized liquid waste shall not be placed in a sanitary landfill unless—

A. The waste is household waste other than septic waste; or

B. The waste is leachate or gas condensate derived from the sanitary landfill, and the sanitary landfill is designed with a composite liner and leachate collection system as described in sections (9) and (10). The owner/operator of sanitary landfill conducting recirculation shall submit a request for departmental approval to recirculate leachate or gas condensate.

4. Containers holding liquid waste may not be placed in a sanitary landfill unless—

A. The container is a small container similar in size to that normally found in household waste; or

B. The waste is household waste.

(4) Site Selection.

(A) Requirement. Site selection and utilization shall include a study and evaluation of geologic and hydrologic conditions and soils at the proposed sanitary landfill and an evaluation of the environmental effect upon the projected use of the completed sanitary landfill. Owners/operators shall document compliance with all applicable siting restrictions and shall submit this documentation to the department by April 9, 1994, for existing sanitary landfills or prior to receiving a construction permit for sanitary landfills permitted after January 1, 1996. Any existing sanitary landfill that cannot demonstrate compliance with paragraphs (4)(B)1. through (4)(B)6. must close by October 9, 1996.

(B) Satisfactory Compliance—Design.

1. Airport safety.

A. Owners/operators of sanitary landfills operating after October 9, 1993, that are located within ten thousand feet (10,000') of any airport runway end used by turbojet aircraft or within five thousand feet (5,000') of any airport runway end used by only piston-type aircraft shall demonstrate to the department that the sanitary landfills are designed and operated so that the landfill does not pose a bird hazard to aircraft.

B. Owners/operators proposing to site new sanitary landfills and horizontal expansions of existing sanitary landfills within a five (5)-mile radius of any airport runway end used by turbojet aircraft or piston-type aircraft shall notify the affected airport and the Federal Aviation Administration (FAA).

2. Owners/operators of sanitary landfills, operating after October 9, 1993, located in one hundred (100)-year floodplains shall demonstrate to the department that the sanitary landfill will not restrict the flow of the one hundred (100)-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to public health or the environment.

3. Wetlands.

A. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills shall not be located in wetlands, unless the owner/operator can make the following demonstrations to the department:

(I) The presumption that a practicable alternative to the proposed landfill is available which does not involve wetlands is clearly rebutted;

(II) The construction and operation of the sanitary landfill will not—

(a) Cause or contribute to violations of any applicable state water quality standard;

(b) Violate any applicable toxic effluent standard or prohibition under section 307 of the federal Clean Water Act;

(c) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and

(d) Violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary;

(III) The sanitary landfill will not cause or contribute to significant degradation of wetlands. The owner/operator shall demonstrate the integrity of the sanitary landfill and its ability to protect ecological resources by addressing the following factors:

(a) Erosion, stability and migration potential of native wetland soils, muds and deposits used to support the landfill;

(b) Erosion, stability and migration potential of dredged and fill materials used to support the landfill;

(c) The volume and chemical nature of the waste disposed of in the landfill;

(d) Impacts on fish, wildlife and other aquatic resources and their habitat from potential release of solid waste from the landfill;

(e) The potential effects of contamination of the wetland and the resulting impacts on the environment; and

(f) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected;

(IV) Steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by subparagraph (4)(B)3.A. of this rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (for example, restoration of existing degraded wetlands or creation of man-made wetlands); and

(V) The requirements of paragraph (4)(B)3. may be satisfied by the owner/operator obtaining a United States Army Corps of

Engineers permit for construction in a wetland or by demonstrating that the wetland is not regulated by the United States Army Corps of Engineers, or other appropriate agency.

4. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills located in the seismic impact zone shall not be located within two hundred feet (200') of a fault that has had displacement in Holocene time unless that owner/operator demonstrates to the department that an alternative setback distance of less than two hundred feet (200') will prevent damage to the structural integrity of the landfill and will be protective of public health and the environment.

5. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills shall not be located in seismic impact zones, unless the owner/operator demonstrates to the department that all containment structures, including liners, final covers, leachate collection systems and surface water control systems, are designed to resist permanent cumulative earthquake displacements not to be greater than six inches (6"), resulting from the maximum credible Holocene time earthquake event's acceleration versus time history.

6. Owners/operators of sanitary landfills, operating after October 9, 1993, located in an unstable area shall demonstrate to the department that the sanitary landfill's design ensures that the integrity of the structural components of the sanitary landfill will not be disrupted. The owner/operator shall consider the following factors, at a minimum, when determining whether an area is unstable:

A. On-site or local rock or soil conditions that may result in failure or significant differential settling;

B. On-site or local geologic or geomorphologic features; and

C. On-site or local human-made features or events (both surface and subsurface).

7. Plans shall include:

A. A map showing initial and proposed topographies at contour intervals of five feet (5') or less. This map shall have a scale of not less than one inch (1") equal to one hundred feet (100'). If the entire site cannot be illustrated on one (1) plan sheet, an additional map with appropriate horizontal and vertical scales that allows the site to be shown on one (1) standard plan sheet is required;

B. A map showing the land use and zoning within one-fourth (1/4) mile of the sanitary landfill including location of all residences, buildings, wells, water courses, springs, lakes, rock outcroppings, caves, sinkholes and soil or rock borings. All electric, gas, water, sewer and other utility easements or lines that are located on, under or over the sanitary landfill shall be shown on the map. This map shall have a scale of not less than one inch (1") equals four hundred feet (400');

C. A description of the projected use of the closed sanitary landfill. In addition to maintenance programs and provisions, where necessary for monitoring and controlling decomposition gases and leachate, the plans shall address the following ultimate use criteria:

(I) Structures. It is not recommended practice to construct major structures within the permitted area of a closed sanitary landfill. If major structures are to be built within the permitted area of a closed sanitary landfill, prior written approval from the department is required. A professional engineer shall approve their design and construction, including provision for protection against potential hazards of solid waste decomposition gases; and

(II) Other uses. Appropriate design, construction and operating provisions for the sanitary landfill shall be specified to complement the projected future use; and

D. An evaluation of the characteristics and quantity of available on-site soil with respect to its suitability for sanitary landfilling operations. The engineering properties and quantity estimates of the on-site soil shall be discussed and shall include:

(I) Texture. Sieve and hydrometer analyses shall be performed to determine grain size distribution of representative soil samples. Texture may be determined by using the procedures described in ASTM method D422-63 or the procedures described in Appendix D of *Engineer Manual 1110-2-1906*, prepared by the United States Army Corps of Engineers;

(II) Plasticity. The liquid limit, plastic limit and plasticity index of representative soil samples shall be determined. Plasticity may be determined by using the procedures described in ASTM method D4318-84 or the procedures described in Appendix III of *Engineer Manual 1110-2-1906*, prepared by the United States Army Corps of Engineers;

(III) Hydraulic conductivity. Laboratory hydraulic conductivity tests shall be performed upon undisturbed representative soil samples using a flexible wall permeameter (ASTM D-5084). If an aquifer is found to be laterally continuous across the anticipated limit of the proposed landfill, the hydraulic conductivity of each significant continuous geologic unit must be determined. Examples of accepted field tests are *in situ* slug or pump tests which isolate the geologic unit of interest; and

(IV) Area extent and depth. The area extent and depth of soil suitable for landfill construction shall be determined. Variations in soil depth shall be clearly described.

8. If the base of the landfill liner will be in contact with groundwater, the applicant shall demonstrate to the department's satisfaction that the groundwater will not adversely impact the liner.

(C) Satisfactory Compliance—Operations.

1. The sanitary landfill shall be accessible to vehicles which the sanitary landfill is designed to serve by all-weather roads leading from the public road system; temporary roads shall be provided as needed to deliver wastes to the working face.

2. The sanitary landfill shall not be located in an area where the public roads or access roads to the sanitary landfill may be flooded preventing use of the sanitary landfill unless an alternate sanitary landfill is available.

(5) Design.

(A) Requirement. Plans, addendums, as-built drawings, or other documents which describe the design, construction, operation, or closure of a sanitary landfill or which request an operating permit modification for the sanitary landfill shall be prepared or approved by a professional engineer. These documents shall be stamped or sealed by the professional engineer and submitted to the department for review and approval.

(B) Satisfactory Compliance—Design.

1. Plans submitted as part of an application for a construction permit after the effective date of this rule shall provide for the maintenance of a one hundred foot (100')-buffer zone between the outer edge of the landfill liner and any property line(s) or any right-of-way(s) of adjoining road(s) when the property line(s) is inside the right-of-way(s) to provide room for assessment and/or remedial actions.

2. The plan shall include an operating manual describing the various tasks that shall be performed during a typical shift.

3. Owners/operators of sanitary landfills shall demonstrate how adverse geologic and hydrologic conditions may be altered or compensated for via surface water drainage diversion, underdrains, sumps, and other structural components. All alterations of the site shall be detailed in the plans.

A. Precipitation, evapotranspiration and climatological conditions shall be considered in site selection and design.

B. Engineering plans and specifications that have computer models attached to them shall list the limitations and assumptions of each model used in the application.

4. Plans shall include stability analyses for all stages of landfill construction.

A. Settlement and bearing capacity analysis shall be performed on the in-place foundation material beneath the disposal area. The effect of foundation material settlement on the liner and leachate collection system shall be evaluated.

B. Stability analysis shall be performed on all liner and leachate system components.

C. Leachate collection pipe material and drainage media shall be analyzed to demonstrate that these components possess structural strength to support maximum loads imposed by overlying waste materials and equipment.

D. Waste mass stability analysis shall be performed on the disposal area at final waste grade conditions and at intermediate slope conditions.

E. Stability analysis shall be performed on all final cover system components, including an evaluation of the effect of waste settlement on the final cover system components, side-slope liner system components, surface water management system components and gas migration system components.

(C) Satisfactory Compliance—Operations.

1. Construction and operation of the sanitary landfill shall be conducted in accordance with the engineering plans and specifications approved by the department.

2. The operating manual describing the various tasks that shall be performed during a typical shift shall be available to employees for reference and to the department upon request.

3. Phase development drawings shall be included with the application.

(6) Quality Assurance/Quality Control (qa/qc).

(A) Requirement. The construction, operation and closure of the sanitary landfill shall include quality assurance and quality control measures to ensure compliance with approved plans and all applicable federal, state and local requirements. The permittee shall be responsible for ensuring that the quality assurance/quality control supervision is conducted by a qualified professional.

(B) Satisfactory Compliance—Design.

1. Plans shall include:

A. A detailed description of the qa/qc testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;

B. A detailed procedure for the reporting and recording of qa/qc activities and testing results; and

C. Continuous visual classification of borrow soil during landfill construction by qualified qa/qc inspector(s) or certifying professional engineer.

2. All qa/qc reports shall be reviewed and approved by a professional engineer.

(C) Satisfactory Compliance—Operations.

1. At a minimum qa/qc testing shall include:

A. Testing of each lift of the soil component of the final cover and landfill liner for field density and field moisture once per every ten thousand (10,000) square feet and providing relatively uniform coverage over the landfill surface;

B. Laboratory hydraulic conductivity testing of the soil used for liner construction once for every five thousand (5,000) cubic yards of liner constructed;

C. Continuous visual classification of borrow soil during landfill construction by qualified qa/qc inspector(s) or certifying professional engineer;

D. Measuring the elevations of the final cover and the landfill liner on a maximum spacing of one hundred-foot (100') centers and at one hundred-foot (100') intervals along each line where a break in slope occurs.

(I) Landfill liner. Measuring the elevations of the top and bottom of the landfill liner.

(II) Final cover. Measuring the elevations of the top and bottom of—

(a) The compacted clay layer supporting the geomembrane liner; and

(b) The soil layer supporting vegetative growth;

E. Nondestructive testing of all seams of the geomembrane in the landfill liner and final cover;

F. Random destructive testing of the seams of the geomembrane liner in the landfill liner and final cover on an average frequency of at least one (1) every five hundred (500) linear feet of seams; and

G. Verification of the thickness of the leachate collection media by qualified qa/qc inspector(s) or certifying professional engineer on one hundred-foot (100') centers.

2. All testing shall be performed under the direction of qualified qa/qc inspectors for every major phase of construction.

3. The qa/qc plan shall provide the following components:

A. Leachate collection system. Reports prepared or approved by the professional engineer transmitting the results of the qa/qc procedures and stating that the leachate collection system was constructed according to the approved design or describing any deviations from the approved design; and

B. Liner. The liner specified by section (10) of this rule shall be constructed in accordance with the approved design specifications. The qa/qc procedures shall include:

(I) Evidence that the liner material(s) utilized meet the minimum design specifications;

(II) Evidence that field construction techniques are resulting in the minimum design specifications (for example, soil density tests);

(III) Evidence that the liner construction is proceeding as designed through regular verification using a predetermined system of horizontal and vertical survey controls; and

(IV) Oversight of the liner construction and qa/qc procedures by a professional engineer. This shall include reports prepared, or approved, by the professional engineer transmitting the results of the qa/qc procedures and stating that the liner was constructed according to design or describing any deviations from the design.

(7) Survey Control.

(A) Requirement. Benchmarks, horizontal controls and boundary markers shall be established by a land surveyor to check and mark the location and elevations of the sanitary landfill. Construction stakes marking an individual section(s) or phase(s) shall be established as necessary to ensure the construction and operation proceed in accordance with approved plans.

(B) Satisfactory Compliance—Design.

1. Boundary survey. A survey of the entire permitted acreage shall be conducted in accordance with the current Minimum Standards for Property Boundary Surveys 10 CSR 30-2.010.

2. Vertical control. The land surveyor shall establish a permanent monument as a benchmark or confirm the prior establishment of a benchmark on or adjacent to the property. The elevation shall be on the North American Vertical Datum, 1929 or similar well documented datum. If no such established datum exists within one (1) mile of the property, a project datum may be assigned to the benchmark. The benchmark shall be clearly shown on the survey plat.

3. Horizontal control. The land surveyor shall establish three (3) permanent monuments as horizontal control stations. These

stations shall form a triangle whose sides shall not be less than one thousand feet (1000'). The location of the horizontal control will be shown on the survey plat.

4. The land surveyor shall establish boundary markers designating the entire permitted acreage which shall be composed of material which will last throughout the life of the sanitary landfill.

5. Construction stakes. Stakes marking the individual section(s) or phase(s) specifically designated for the placement of solid waste are to be placed in locations and composed of material that is consistent with the operating life of the section or phase.

(C) Satisfactory Compliance—Operations.

1. All boundary markers, benchmarks, horizontal control stations and construction stakes shall be clearly marked and identified.

2. Missing or displaced benchmarks or horizontal control stations shall be replaced or reestablished by or under the supervision of a land surveyor. The registered surveyor shall prepare a plat showing the replacement or reestablishment and furnish a copy to the department.

3. Missing or displaced construction stakes shall be replaced or reestablished as necessary to ensure the operations proceed in accordance with approved plans.

4. The permanent monuments designating vertical and horizontal control stations and boundary markers designating the entire permitted acreage shall be placed prior to receiving an operating permit as required by 10 CSR 80-2.020(2)(B).

5. Construction stakes marking the active area shall be placed prior to deposition of waste in individual areas, sections or phases of the sanitary landfill as designated by the approved engineering plans.

(8) Water Quality.

(A) Requirement. The location, design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ground and surface water quality standards and requirements. Applicable standards are federal, state or local standards and requirements that are legally enforceable.

(B) Satisfactory Compliance—Design.

1. Plans shall include:

A. A report on the detailed geologic and hydrologic investigation of the site as required by 10 CSR 80-2.015.

B. Current and projected use of water resources in the potential zone of influence of the sanitary landfill;

C. Groundwater elevation and proposed separation between the lowest point of the lowest cell and the predicted maximum water table elevation;

D. Potential interrelationship of the sanitary landfill, local aquifers and surface waters based on historical records or other sources of information;

E. Proposed location and design of observation wells, sampling stations and testing program planned; and

F. Provisions for surface water runoff control to minimize infiltration and erosion of cover. All applicable permits and approvals necessary to comply with requirements of the Missouri Clean Water Law and corresponding rules shall be obtained from the department.

(I) The area of the watershed which will be affected by the sanitary landfill shall be specified.

(II) On-site drainage structures and channels shall be designed to prevent flow onto the active portion of the sanitary landfill during peak discharge from at least a twenty-five (25)-year storm. The engineering calculations and assumptions shall be included and explained in the engineering report.

(III) On-site drainage structures and channels shall be designed to collect and control at least the water volume resulting from a twenty-four (24)-hour, twenty-five (25)-year storm.

(IV) On-site drainage and channels shall be designed to empty expeditiously after storms to maintain the design capacity of the system.

(V) Contingency plans for on-site management of surface water which comes in contact with solid waste shall be specified.

(C) Satisfactory Compliance—Operations.

1. Surface water courses and runoff shall be diverted from the sanitary landfill (especially from the working face) by devices such as ditches, berms, and proper grading. The sanitary landfill shall be constructed and graded so as to promote rapid surface water runoff without excessive erosion. Regrading shall be done as required during construction and after completion to avoid ponding of precipitation and to maintain cover integrity.

2. The quantity of water coming in contact with solid waste shall be minimized by the daily operational practices. Water which comes in contact with solid waste shall be managed as leachate in accordance with the approved plans.

(9) Leachate Collection System.

(A) Requirement. A leachate collection system shall be designed, constructed, maintained and operated to collect and remove leachate from the sanitary landfill.

(B) Satisfactory Compliance—Design. The potential for leachate generation shall be evaluated in determining the design of the system. Leachate flow quantities shall be estimated and the method(s) of leachate treatment and disposal shall be outlined. Leachate storage and treatment facilities shall comply with all currently applicable requirements of the Missouri Clean Water Law and corresponding rules. Construction quality assurance/quality control (qa/qc) procedures shall be included. Where a leachate treatment system is designed to have a discharge to the waters of the state, any required discharge permit(s) shall be obtained from the department in accordance with requirements of the Missouri Clean Water Law and corresponding rules.

1. Minimum design criteria for leachate collection systems shall include the following:

A. Ponds and/or tanks of sufficient capacity to store, equalize flow to disposal systems, and allow system/operating flexibility;

B. Construction material chemically resistant to the waste managed in the sanitary landfill and the leachate expected to be generated;

C. Construction materials of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying solid wastes, cover, leachate, and by any equipment used at the sanitary landfill;

D. Design and operate systems to function without clogging through the scheduled operating life, closure and post-closure of the sanitary landfill;

E. Design and operate systems to maintain less than one foot (1') depth of leachate over the disposal area liner; and

F. Design and operate systems so that any leachate formed will flow by gravity into collection areas from which the leachate can be removed, treated, and disposed.

2. Leachate management by recirculation within the permitted fill area shall be conducted in accordance with an approved engineering method.

3. Any leachate collection system open to the atmosphere must be designed to prevent discharge during a twenty-five (25)-year, twenty-four (24)-hour storm event. Plans shall include the calculations detailing the design.

4. The applicant shall provide a method of leachate management in the application. A secondary or "backup" method of leachate disposal will be required unless the applicant can demonstrate that a secondary method will not be necessary.

(C) Satisfactory Compliance—Operations.

1. The leachate collection systems specified by subsection (9)(B) shall be properly installed and operated in accordance with the permit and the approved design and plans and maintained for the thirty (30)-year post-closure care period, or as long as the department determines necessary.

2. Leachate generated by the sanitary landfill shall be controlled on-site and not be allowed to discharge off the sanitary landfill property or discharge into the waters of the state, except in accordance with the approved plans and the Missouri Clean Water Law and corresponding rules.

(10) Liner System.

(A) Requirement. A liner shall be placed on all surfaces to minimize the migration of leachate from the sanitary landfill.

(B) Satisfactory Compliance—Design. A composite liner shall be installed at all landfills permitted after October 9, 1993, and existing landfills with uncovered surfaces, as determined by the department on a site-by-site basis, that consists of two (2) components—

1. An upper component that shall consist of a minimum thirty (30) mil thick geomembrane. Geomembrane components consisting of high density polyethylene (HDPE) shall be at least sixty (60) mil thick;

2. A lower component that shall consist of a least a two foot (2')-layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. A compacted soil liner at a minimum shall be constructed of six to eight-inch (6–8") lifts, compacted to ninety-five percent (95%) of standard Proctor density with the moisture content between optimum moisture content and four percent (4%) above the optimum moisture content, or within other ranges of density and moisture that are shown to provide for the liner to have a hydraulic conductivity no more than 1×10^{-7} cm/sec. The design shall include a detailed explanation of the construction techniques and equipment necessary to achieve ninety-five percent (95%) of the standard Proctor density under field conditions. The design also shall include qa/qc procedures to be followed during construction of the liner. The composite liner shall be protected from the adverse effects of desiccation or freeze/thaw cycles after construction, but prior to placement of waste. Traffic shall be routed so as to minimize the detrimental impact on the constructed liner prior to placement of waste. The soils used for this purpose shall meet the following minimum specifications:

A. Be classified under the Unified Soil Classification Systems as CL, CH, or SC (ASTM Test D2487-85);

B. Allow more than thirty percent (30%) passage through a No. 200 sieve (ASTM Test D1140);

C. Have a liquid limit equal to or greater than twenty (20) (ASTM Test D4318-84);

D. Have a plasticity index equal to or greater than ten (10) (ASTM Test D4318-84); and

E. Have a coefficient of permeability equal to or less than 1×10^{-7} cm/sec when compacted to ninety-five percent (95%) of standard Proctor density with the moisture content between optimum moisture content and four percent (4%) above the optimum moisture content, when tested by using (ASTM D-5084) a flexible wall permeameter or other procedures approved by the department;

3. The geomembrane component shall be installed in direct and uniform contact with the compacted soil component so as to minimize the migration of leachate through the geomembrane should a break occur; and

4. All solid waste disposal areas shall have a minimum bottom slope in any direction of flow of at lease one percent (1%).

(C) Satisfactory Compliance—Operations.

1. A test pad shall be constructed at the site and tested to verify that the proposed construction and quality control (qc) procedures are adequate to ensure that the soil component of the composite liner system will meet the requirements of (10)(B)2. of this rule.

A. Construction and qc procedures to be used during test pad construction shall be described in detail in the approved engineering report, and shall be identical to those proposed for liner construction with the following additions:

(I) At least two laboratory hydraulic conductivity tests shall be performed on undisturbed samples of the completed test pad;

(II) At least one (1) *in situ* hydraulic conductivity test shall be performed on the completed test pad; and

(III) At least two (2) test pits shall be excavated into the completed test pad to observe interlift bonding.

B. If test pad construction and testing shows that the proposed methods are not sufficient to meet the requirements of paragraph (10)(B)2. of this rule, a new test pad shall be constructed using revised procedures approved by the department.

2. For phased construction, only one test pad will be required.

3. A final report shall be submitted to the department which describes in detail the construction and qc procedures which were used to achieve satisfactory test pad performance.

A. The report must be approved by the department prior to beginning construction of any portion of the composite liner system in the disposal area.

B. The report shall serve as guidance for construction of the soil component of the composite liner system.

4. The requirement for a test pad may be waived provided—

A. The applicant can demonstrate to the department's satisfaction that construction and qc procedures identical to those described in the approved engineering report have resulted in construction of a liner which meets the requirements of paragraph (10)(B)2. of this rule; and

B. The soils proposed for liner construction meet the following minimum specifications:

(I) Have a plasticity index greater than fifteen (15) and less than thirty (30) (ASTM test D4318-84);

(II) Allow more than fifty percent (50%) passage through a number 200 serve (ASTM D1140); and

(III) Have less than ten percent (10%) by weight particle sizes greater than two (2) mm.

5. The liner specified by subsection (10)(B) of this rule shall be constructed in accordance with the approved design specifications.

(11) Groundwater Monitoring.

(A) Requirements. The owner/operator of a sanitary landfill shall implement a groundwater monitoring program capable of determining the sanitary landfill's impact on the quality of groundwater underlying the sanitary landfill.

(B) Satisfactory Compliance—Design.

1. All sanitary landfills permitted after October 9, 1993, shall be in compliance with all of the groundwater monitoring requirements of this section before an operating permit is issued. Existing sanitary landfills shall be in compliance with section (11)—

A. By October 9, 1994, if located less than one (1) mile from a drinking water intake (surface or subsurface);

B. By October 9, 1995, if located between one (1) mile and two (2) miles from a drinking water intake (surface or subsurface); or

C. By October 9, 1996, if located greater than two (2) miles from a drinking water intake (surface or subsurface).

2. The owner/operator of a sanitary landfill shall establish the potential for migration of fluid generated by the sanitary landfill into the groundwater by an evaluation of—

A. A water balance of precipitation, evapotranspiration, runoff and infiltration;

B. At a minimum, the following characteristics:

(I) Geologic materials;

(II) Description of soil and bedrock to a depth adequate to allow evaluation of water quality protection provided by the soil and bedrock;

(III) Groundwater elevation;

(IV) Proposed separation between the lowest point of the lowest cell and the maximum water table elevation;

(V) Proximity of the sanitary landfill to water supply wells or surface water;

(VI) Rate and direction of groundwater flow; and

(VII) Current and projected use of water resources in the potential zone of influence of the sanitary landfill.

3. A groundwater monitoring system shall be capable of yielding groundwater samples for analysis and shall consist of—

A. Monitoring wells (at least one (1) installed hydraulically upgradient; that is, in the direction of increasing static head from the sanitary landfill. The numbers, locations and depths shall be sufficient to yield groundwater samples that are—

(I) Representative of background water quality in the groundwater near the sanitary landfill; and

(II) Not affected by the sanitary landfill; and

B. Monitoring wells (at least three (3)) installed hydraulically downgradient; that is, in the direction of decreasing hydraulic head from the sanitary landfill. The number, locations and depths shall ensure that they detect any significant amounts of fluids generated by the sanitary landfill that migrate from the sanitary landfill to the groundwater. Monitoring wells, or clusters of monitoring wells, shall be capable at a minimum, of monitoring all saturated zones down to and including the uppermost aquifer.

4. All monitoring wells shall be constructed as per 10 CSR 23-4.

(C) Satisfactory Compliance—Operations.

1. Groundwater monitoring wells.

A. Groundwater monitoring wells shall be installed so that the number, spacing and depths of monitoring systems shall be determined based upon site-specific technical information that shall include thorough characterization of—

(I) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and

(II) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities and porosities.

B. The design and installation of groundwater monitoring well systems shall be observed, supervised, and certified by a qualified groundwater scientist and approved by the department.

C. All groundwater monitoring wells shall be operational prior to the acceptance of wastes, unless other arrangements are approved by the department.

D. The design, installation, development, and decommissioning of monitoring wells and piezometers must be performed in accordance with 10 CSR 23-4.

2. Sampling and reporting.

A. Each groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells installed in compliance with subsection (11)(B). The owner/operator must submit the sampling and analysis program to the department for approval. The program must include procedures and techniques for—

(I) Monitoring well maintenance;

(II) Monitoring well redevelopment;

(III) Monitoring well depth measurement and hydraulic levels;

(IV) Monitoring well purging and sampling utilizing dedicated equipment;

(V) Equipment calibration;

(VI) Decontamination and field blanks;

(VII) Sample and duplicate sample collection;

(VIII) Sample preservation;

(IX) Sample labeling;

(X) Sample handling;

(XI) Field measurements;

(XII) Field documentation;

(XIII) Chain of custody control;

(XIV) Sample shipment;

(XV) Analytical procedures;

(XVI) Qa/qc control—field and laboratory; and

(XVII) Statistical testing strategy per paragraph (11)(C)5. for each parameter's concentrations.

B. Each groundwater monitoring program shall include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents and other monitoring parameters in groundwater samples. Analysis shall be performed on unfiltered samples.

C. The sampling procedures and frequency shall be protective of human health and the environment.

D. Groundwater elevations shall be measured in each well immediately prior to purging, each time groundwater is sampled. The owner/operator shall determine the direction of groundwater flow each time groundwater is sampled. Groundwater elevations in wells which monitor the same solid waste disposal area shall be measured within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow direction.

3. Baseline/background monitoring.

A. The owner/operator shall establish background groundwater quality for each of the monitoring parameters or constituents required under paragraphs (11)(C)4. To establish background, a minimum of four (4) quarterly samples of statistically independent sample data shall be obtained and analyzed from all monitoring wells during a minimum of one (1) year following well installation.

B. The number of samples collected to establish background values for groundwater quality data shall satisfy the requirements of subsection (11)(C) and shall be consistent with the appropriate statistical procedures determined pursuant to paragraph (11)(C)5. The sampling procedures shall be those specified under paragraph (11)(C)4. for detection monitoring, paragraph (11)(C)6. for assessment monitoring and section (12) for corrective action.

4. Detection monitoring.

A. The owner/operator shall obtain and analyze water samples from the groundwater monitoring wells during the months of May and November of each calendar year.

B. The following parameters shall be analyzed each time a sample is obtained:

Chemical Oxygen Demand (COD in milligrams per liter (mg/l));

Chlorides (Cl, (mg/l));

Iron (Fe, (mg/l));

pH (units);

Specific Conductance (Conductivity at twenty-five degrees Celsius (25°C) in micromhos per centimeter (μmho/cm));

Total Dissolved Solids (TDS, (mg/l)); and
All parameters listed in Appendix 1 of this rule.

Additionally, the water level in each well shall be measured at the time the sample is taken.

C. The sample results, and any results of statistical analysis determining statistically significant increases for any parameter per paragraph (11)(C)5., shall be submitted to the department in one (1) report within ninety (90) days of when samples are collected.

D. In the case of all detection monitoring requirements previously listed, the department may specify an appropriate alternative frequency for repeated sampling and analysis during the active life of the sanitary landfill (including closure) and the post-closure period. The department may add additional parameters or delete parameters on a site-by-site basis through an evaluation of waste and leachate characteristics of the sanitary landfill.

E. The electronic submission of groundwater data is required. This submission shall be in the format and method as prescribed by the department.

5. The owner/operator shall specify in the operating record one (1) or more of the following statistical methods to be used in evaluating groundwater monitoring data for each monitoring constituent. The statistical test chosen shall be conducted separately for each constituent:

A. A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The procedure shall include estimation and testing of the contrasts between each downgradient well's mean and the upgradient means for each parameter;

B. An ANOVA based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The procedure shall include estimation and testing of the contrasts between each downgradient well's median and the background medians for each parameter;

C. A confidence interval procedure in which an interval for each parameter in each downgradient well is constructed around the mean/median of the particular well's data or data residuals and compared to the mean/median of pooled background well data;

D. A prediction interval procedure in which an upper prediction limit for an interval for each parameter in each well is compared to subsequently obtained values from the same well;

E. A prediction interval procedure in which an upper prediction limit for an interval for each parameter constructed on the pooled background well data or data residuals is compared to subsequently obtained values from each downgradient well;

F. A tolerance interval procedure in which an upper tolerance limit for an interval for each parameter's pooled background well data is compared to each downgradient well's concentration values;

G. A multicomparison procedure utilizing any recommended U.S. Environmental Protection Agency combinations of intra-well and inter-well procedures for each parameter;

H. A control chart approach, meeting the performance standards of part (11)(C)5.J.(III), that gives control limits for each parameter;

I. A different statistical test method that meets the performance standards of subparagraph (11)(C)5.J. of this rule. The owner/operator must submit the statistical test method to the department for approval before the use of the alternative test;

J. Any statistical method chosen under subparagraph (11)(C)5.J. of this rule shall comply with the following performance standards, as appropriate:

(I) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of the concentration data for the chemical parameters or hazardous constituents. If the distribution of the concentration data for the chemical parameters or hazardous constituents is shown by the owner/operator to be inappropriate for a normal data distribution theory test, then the data should be transformed or a distribution-free (nonparametric) theory test should be used. If the concentration data distributions for the constituents of each well differ, more than one (1) statistical method will be needed;

(II) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentration or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment-wide error rate for each testing period shall be no less than 0.05, however, the Type I error of no less than 0.01 for individual well comparisons shall be maintained. This performance standard does not apply to tolerance intervals, prediction intervals or control charts;

(III) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The selection of this method shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern;

(IV) If a confidence interval, tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, then the level of confidence for each interval, and the percentage of the population that each interval contains, shall be protective of human health and the environment. Selection of one (1) or more of these methods shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern;

(V) The statistical method shall account for data below the limit of detection with one (1) or more statistical procedures that are protective of human health and the environment. Any practical quantization limit that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility; and

(VI) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

6. Response to statistical analysis.

A. If the comparison for the upgradient wells show a statistically significant increase (or pH change) over background, the owner/operator shall submit this information to the department.

B. If the comparisons for downgradient wells show a statistically significant increase (or pH change) over background, the owner/operator shall immediately obtain two (2) additional groundwater samples from each downgradient well where a statistically significant difference was detected. One shall be analyzed by the owner; the other shall be analyzed by the department to determine whether the statistically significant difference was a result of laboratory error.

C. If the additional samples show a statistically significant increase (or pH change) over background, the owner/operator must demonstrate to the department within ninety (90) days that a source other than the sanitary landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation or natural variation. If the owner/operator cannot make this demonstration to the department, the owner/operator shall submit a plan to the department for a groundwater assessment monitoring program and implement the program as described in subparagraphs (11)(C)6.D. through J. of this rule. The plan shall specify the following:

(I) The number, location and depth of wells;

(II) Sampling and analytical methods for the monitoring parameters listed in Appendix II of this rule;

(III) Evaluation procedures, including any use of previously gathered groundwater quality information;

(IV) The rate and extent of migration of a contaminant plume in the groundwater; and

(V) The concentrations of the contaminant plume in the groundwater.

D. Within ninety (90) days of beginning an assessment monitoring program, and semiannually after that, the owner/operator shall sample and analyze the groundwater for all constituents identified in Appendix II of this rule. A minimum of one (1) sample from each downgradient well shall be collected and analyzed during the initial sampling event. A minimum of one (1) sample from each downgradient well at which Appendix II constituents were detected shall be collected and analyzed at each subsequent sampling event. For any new constituent detected during assessment monitoring (that was not detected during detection monitoring) in the downgradient wells, a minimum of four (4) statistically independent samples from each well (upgradient and downgradient) shall be collected and analyzed to establish background for the new constituents. The department may add additional parameters or delete parameters on a site-by-site basis through an evaluation of waste and leachate characteristics of the sanitary landfill.

E. The owner/operator shall establish a groundwater protection standard for each constituent specified in Appendix II of this rule and detected in the groundwater. The groundwater protection standard shall be—

(I) For constituents for which a maximum contaminant level (MCL) has been promulgated under section 1412 of the Federal Safe Drinking Water Act and found at 40 CFR part 141, the MCL for that constituent;

(II) For constituents for which MCLs have not been promulgated, the background concentration for the constituent established from wells in accordance with paragraph (11)(C)3. of this rule;

(III) For constituents for which the background level is higher than the MCL identified in part (11)(C)6.E.(I) of this rule, the background concentration; or

(IV) A level established by the department based upon a consideration of relevant factors, including: multiple contaminants in the groundwater, exposure threats to sensitive environmental receptors, and other site-specific exposure or potential exposure to groundwater.

F. After obtaining the results from the initial or subsequent sampling events required in subparagraph (11)(C)6.D. the owner/operator shall—

(I) Within fourteen (14) days, notify the department and place a notice in the operating record identifying the constituents that have been detected;

(II) Within ninety (90) days, and on at least a semiannual basis after that, resample all wells and conduct analysis for all constituents listed in Appendix I to this rule and for those constituents listed in Appendix II of this rule that are detected in response to the requirements of subparagraph (11)(C)6.D. of this rule. Record the concentrations of each constituent in the facility operating record and notify the department of the constituent concentrations. A minimum of one (1) sample from each well sampled (background and downgradient) shall be collected and analyzed during these sampling events;

(III) Establish background concentrations for any new constituents detected during subsequent monitoring events; and

(IV) Establish groundwater protection standards for all new constituents detected during subsequent monitoring events.

G. If the concentrations of all constituents listed in Appendix II to this rule are shown to be at or below background levels as established in paragraph (11)(C)3. of this rule for two (2) consecutive sampling periods, the owner/operator may reinstate detection monitoring at the sanitary landfill as specified under subparagraph (11)(C)3.C. of this rule.

H. If the concentrations of any constituents listed in Appendix II of this rule are above background values, but all concentrations are below the groundwater protection standard established under subparagraph (11)(C)6.E. of this rule using the statistical procedures in paragraph (11)(C)5. of this rule, the owner/operator shall notify the department, and the department may require the owner/operator to—

(I) Continue assessment monitoring; or

(II) Develop a corrective measures assessment, or both.

I. If one (1) or more constituents listed in Appendix II of this rule are detected at levels above the groundwater protection standard as established under subparagraph (11)(C)6.E., the owner/operator shall—

(I) Provide the department with a report assessing potential corrective measures as required under subsection (11)(A);

(II) Characterize the nature and extent of the release by installing additional monitoring wells as necessary; install at least one (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with paragraph (11)(C)6. of this rule and notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site as indicated by sampling of wells; and

(III) Continue assessment monitoring as per the groundwater quality assessment plan and as per the implementation of the corrective action program specified in section (12) of this rule.

J. The results of implementation of the assessment monitoring program shall be submitted to the department at the end of each year or an alternate time period approved by the department.

(12) Corrective Action.

(A) Assessment of Corrective Measures.

1. Within ninety (90) days of finding that any of the constituents listed in Appendix II of this rule have been detected at a statistically significant level exceeding the groundwater protection standards defined under subparagraph (11)(C)6.E. of this rule, the owner/operator shall initiate an assessment of corrective measures. This assessment shall be completed within a reasonable period of time, and a report describing the assessment of corrective measures shall be submitted to the department.

2. The owner/operator shall continue to monitor in accordance with the assessment monitoring program as specified in subparagraph (11)(C)6.F. of this rule.

3. The assessment shall include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under subsection (12)(B) of this rule, addressing at least the following:

A. The performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts and control of exposure to any residual contamination;

B. The time required to begin and complete the remedy;

C. The costs of remedy implementation; and

D. The institutional requirements such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(ies).

4. The owner/operator shall discuss the results of the corrective measures assessment, prior to the selection of remedy, in a public meeting with interested and affected parties.

(B) Selection of Remedy.

1. Based on the results of the corrective measures assessment conducted under subsection (12)(A) of this rule the owner/operator shall propose a remedy that, at a minimum, meets the standards listed in paragraph (12)(B)2. of this rule. The owner/operator shall submit to the department, within fourteen (14) days of selecting a proposed remedy, a report describing the proposed remedy and shall place a copy of the report in the operating record that describes how the proposed remedy meets the standards in paragraph (12)(B)2. of this rule.

2. Remedies shall—

A. Be protective of the public health and the environment;

B. Attain the groundwater protection standard as specified pursuant to subparagraph (11)(C)6.E. of this rule;

C. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of constituents listed in Appendix II of this rule into the environment that may pose a threat to human health or the environment; and

D. Comply with standards for management of wastes as specified in paragraph (12)(C)4.

3. In proposing a remedy that meets the standards of paragraph (12)(B)2. of this rule, the owner/operator, and, in approving a remedy, the department shall consider the following evaluation factors:

A. The long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:

(I) Magnitude of reduction of existing risks;

(II) Magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of the proposed remedy;

(III) The type and degree of long-term management required, including monitoring, operation and maintenance;

(IV) Short-term risks that might be posed to the community, workers or the environment during implementation of the remedy, including potential threats to human health and the environment associated with excavation, transportation and redisposal or containment;

(V) Time until full protection is achieved;

(VI) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, redisposal or containment;

(VII) Long-term reliability of the engineering and institutional controls; and

(VIII) Potential need for replacement of the remedy;

B. The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(I) The extent to which containment practices will reduce further releases; and

(II) The extent to which treatment technologies may be used;

C. The ease or difficulty of implementing the potential remedy(ies) based on consideration of the following types of factors:

(I) Degree of difficulty associated with constructing the remedy technology;

(II) Expected operational reliability of the proposed technologies;

(III) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(IV) Availability of necessary equipment and specialists; and

(V) Available capacity and location of needed treatment, storage and disposal services; and

D. The degree to which community concerns are addressed by the proposed remedy(ies).

4. The owner/operator shall specify as part of the proposed remedy a schedule(s) for initiating and completing remedial activities. This schedule shall require the initiation of remedial activities within a reasonable period of time taking into consideration the factors set forth in subparagraphs (12)(D)4.A. through H. of this rule. The owner/operator shall consider the following factors in determining, and the department will consider the following factors in approving, the schedule of remedial activities:

A. Extent and nature of contamination;

B. Practical capabilities of remedial technologies in achieving compliance with groundwater protection standards established under subparagraph (11)(C)6.E. of this rule and other objectives of the remedy;

C. Availability of treatment or disposal capacity for wastes managed during implementation of the remedy;

D. Desirability of utilizing technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety or ability to achieve remedial objectives;

E. Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

F. Resource value of any affected aquifer including:

(I) Current and future uses;

(II) Proximity and withdrawal rate of users;

(III) Groundwater quantity and quality;

(IV) The potential damage to wildlife, crops, vegetation and physical structures caused by exposure to the waste constituent;

(V) The hydrogeologic characteristic of the facility and surrounding land;

(VI) Groundwater removal and treatment costs; and

(VII) The cost and availability of alternative water supplies;

G. Practicable capability of the owner/operator; and

H. Other relevant factors.

5. The department may determine that remediation of a release of any constituent listed in Appendix II of this rule from a sanitary landfill is not necessary if the owner/operator demonstrates to the satisfaction of the department that—

A. The groundwater is additionally contaminated by substances that have originated from a source other than a sanitary landfill and those substances are present in concentrations such that cleanup of the release from the sanitary landfill unit would provide no significant reduction in risk to actual or potential receptors;

B. The constituent(s) is present in groundwater that—

(I) Is not a current or potential source of drinking water; and

(II) Is not hydraulically connected with waters to which the hazardous constituents are migrating or are likely to migrate in a concentration(s) that represents a statistically significant increase over background concentrations;

C. Remediation of the release(s) is technically impracticable; or

D. Remediation would result in unacceptable cross-media impacts.

6. A determination by the department pursuant to paragraph (12)(B)5. of this rule

shall not affect the authority of the state to require the owner/operator to undertake source control measures or other measures that may be necessary to eliminate or minimize further releases to the groundwater, to prevent exposure to the groundwater, or to remediate the groundwater to concentrations that are technically practicable and which significantly reduce threats to human health or the environment.

(C) Implementation of the Corrective Action Program.

1. Based on the schedule established under paragraph (12)(B)4. of this rule for initiation and completion of remedial activities the owner/operator shall—

A. Establish and implement a corrective action groundwater monitoring program that—

(I) At a minimum, meets the requirements of an assessment monitoring program under paragraph (11)(C)6. of this rule;

(II) Indicates the effectiveness of the corrective action remedy; and

(III) Demonstrates compliance with groundwater protection standard pursuant to subparagraph (11)(C)6.E. of this rule.

B. Implement the corrective action remedy selected under subsection (12)(B) of this rule; and

C. Take any interim measures necessary, any measures determined to be necessary by the department, or both, to ensure the protection of human health and the environment. Interim measures shall, to the greatest extent practicable, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to subsection (12)(B) of this rule. The following factors shall be considered by an owner/operator, and will be considered by the department, in determining whether interim measures are necessary:

(I) Time required to develop and implement a final remedy;

(II) Actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;

(III) Actual or potential contamination of drinking water supplies or sensitive ecosystems;

(IV) Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;

(V) Weather conditions that may cause hazardous constituents to migrate or be released;

(VI) Risks of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or failure of a container or handling system; and

(VII) Other situations that may pose threats to human health and the environment.

2. The department may determine, based on information developed after implementation of the remedy has begun or other information, that compliance with requirements of paragraph (12)(B)2. of this rule are not being achieved through the remedy selected. In those cases, the owner/operator shall implement other methods or techniques that will achieve compliance with the requirements, unless the department makes the determination under paragraph (12)(C)3. of this rule.

3. If the department determines that compliance with requirements under paragraph (12)(B)2. of this rule cannot be practically achieved with any currently available methods, the owner/operator shall—

A. Obtain the certification of a qualified groundwater scientist and approval from the department that compliance with the requirements under paragraph (12)(B)2. cannot be practically achieved with any currently available methods;

B. Implement alternative measures to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment;

C. Implement alternative measures for control of the sources of contamination, or for removal or decontamination of equipment, units, devices or structures that are—

(I) Technically practicable; and

(II) Consistent with the overall objective of the remedy; and

D. Submit a report to the department justifying the alternative measures. The alternative measures must be approved by the department prior to implementation.

4. All solid wastes that are managed pursuant to a remedy required under subsection (12)(C) or an interim measure required under subparagraph (12)(C)1.C. of this rule, shall be managed in a manner—

A. That is protective of the public health and the environment; and

B. That complies with all applicable state and federal requirements.

5. Remedies selected pursuant to subsection (12)(B) of this rule shall be considered complete when—

A. The owner/operator complies with the groundwater protection standards established under subparagraph (11)(C)6.E. of this rule at all points within the plume of contamination;

B. Compliance with the groundwater protection standards established under subparagraph (11)(C)6.E. of this rule has been achieved by demonstrating that concentrations of all constituents listed in Appendix II of this rule have not exceeded the groundwater protection standard(s) for a period of three (3) consecutive years using the statistical procedures and performance standards in subsection (11)(C). The department may specify an alternative length of time during which the owner/operator shall demonstrate that concentrations of all constituents listed in Appendix II of this rule have not exceeded the groundwater protection standard(s) taking into consideration—

(I) Extent and concentration of the release(s);

(II) Behavioral characteristics of the hazardous constituents in the groundwater;

(III) Accuracy of monitoring or modeling techniques, including any seasonal meteorological, or other environmental variabilities that may affect the accuracy; and

(IV) Characteristics of the groundwater; and

C. All actions required to complete the remedy have been completed.

6. Upon completion of the remedy, the owner/operator shall submit a certification to the department within fourteen (14) days after the remedy has been completed in compliance with the requirements of paragraph (12)(C)5. and shall place a copy of the certification in the facility's operating record. The certification shall be signed by the owner/operator and by a qualified groundwater scientist and approved by the department.

7. When, upon completion of the certification, the owner/operator and the department determines that the corrective action remedy has been completed in accordance with the requirements under paragraph (12)(C)5. of this rule, the owner/operator shall be released from the requirements for financial assurance for corrective action under 10 CSR 80-2.030(4)(C).

(13) Air Quality.

(A) Requirement. The design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ambient air quality and source control regulations.

(B) Satisfactory Compliance—Design. Plans shall include an effective dust control program.

(C) Satisfactory Compliance—Operations. Burning of solid waste shall be prohibited. A burning permit or exemption may be obtained from the department permitting the burning of tree trunks, tree limbs, vegetation and untreated waste lumber. In areas operating under exemption certificates authorized by Chapter 643, RSMo approval shall be obtained from the local pollution control agency. The operating procedures and location for burning practices shall be submitted to the department for review and written approval. Burning at the sanitary landfill shall be conducted in accordance with Chapter 643, RSMo, the corresponding rules, the terms conditions, or both, of the plans, permit, or both, and all local requirements.

(14) Gas Control.

(A) Requirement. Decomposition gases generated within the sanitary landfill shall be controlled on-site, as necessary, to avoid posing a hazard to the environment or to public health and the safety of occupants of adjacent property.

(B) Satisfactory Compliance—Design.

1. Plans shall contain a monitoring program capable of detecting decomposition gas migration.

A. The monitoring program must specify the type of monitoring and be based on—

(I) Soil conditions;

(II) The hydrogeologic and topographic conditions surrounding the facility; and

(III) The location of facility structures, property boundaries, and off-site features.

B. The monitoring program described in the plans must include:

(I) A written description of the monitoring system, including spacing of monitoring locations and frequency of monitoring;

(II) The results of any gas assessment that has been performed;

(III) The location of all gas monitoring wells shown on a plan sheet;

(IV) A drawing detailing the typical gas monitoring well design;

(V) The design depths and bottom elevations of the gas monitoring wells; and

(VI) Boring logs that support the design gas monitoring well depths.

C. The gas monitoring specified in the plans shall be performed at gas monitoring wells. The monitoring program shall specify how buildings on the landfill property are to be monitored. Gas monitoring wells shall be designed to monitor the unsaturated soil and rock down to an elevation equal to the bottom elevation of the landfill. Gas monitoring wells shall be placed between the landfill and off-site buildings and other features that may be harmed by landfill gas or may easily transmit gas from the landfill. Gas monitoring well locations at the property boundary shall not be more than five hundred feet (500') apart unless the permittee can show that the potential for gas migration is low.

2. Plans shall assess the need for gas control and indicate the location and design of any vents, barriers or other control measure to be provided.

A. The gas control system shall be constructed of materials that are chemically resistant to the solid wastes managed in the sanitary landfill and the gas expected to be generated. These materials shall be specified in the engineering report and the choice of materials justified.

B. The gas control system shall be constructed of materials that are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying solid wastes, cover and by any equipment used at the sanitary landfill. Overburden pressure calculations, material specifications and system installation procedures shall be included in the engineering report.

C. Maintenance and repair options shall be considered in the design and specified in the engineering report.

D. All applicable permits and approvals necessary to comply with the requirements of the Air Conservation Law and rules promulgated shall be obtained from the department.

E. The plan shall estimate the maximum anticipated rate of gas generation at the disposal area and the length of time over which it is anticipated to be generated. The method by which these calculations are arrived at shall also be included.

(C) Satisfactory Compliance—Operations.

1. Decomposition gases shall not be allowed to migrate laterally from the sanitary landfill to endanger public health and safety or to pose a hazard to the environment. They shall be controlled on-site, flared or vented to the atmosphere directly through the cover, cut-off trenches or ventilation systems in a way that they do not accumulate in explosive or toxic concentrations, especially within structures. (Information on the limits of flammability of gases is available in such references as the *Handbook of Chemistry and Physics*, 68th ed. Cleveland, Chemical Rubber Publishing Co., 1987.)

2. Decomposition gases shall not be allowed to concentrate above the following levels:

A. Twenty-five percent (25%) of the lower explosive limit (LEL) or one and one-quarter percent (1.25%) by volume for methane in buildings on the sanitary landfill property; and

B. Fifty percent (50%) of the LEL or two and one-half percent (2.5%) by volume for methane in the soil at the property boundary of the sanitary landfill.

3. For purposes of this section, lower explosive limit (LEL) means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at twenty-five degrees Celsius (25°C) and atmospheric pressure.

4. Owners/operators of all sanitary landfills shall implement a methane monitoring program capable of detecting decomposition gas migration in the most likely zone(s) of migration, to ensure that the standards of paragraph (14)(C)2. of this rule are met. Methane monitoring shall be conducted at least quarterly with equipment warranted by the manufacturer to detect explosive gases under the conditions the equipment is to be used. Facilities shall submit the results of this methane monitoring to the department at least quarterly. The electronic submission of methane monitoring data is required. This submission shall be in a format and manner as prescribed by the department.

5. If methane gas levels exceeding the limits specified in paragraph (14)(C)2. of this rule are detected, the owner/operator shall—

A. Notify the department and immediately take all necessary steps to ensure protection of public health and safety which include:

(I) When results of monitoring in on-site or off-site structures indicate levels in excess of those specified, the operator shall take appropriate action to mitigate the effects of landfill gas accumulation in those structures until a permanent remediation is completed. Actions which must be undertaken include:

(a) Notification of the fire department or other appropriate local public safety authorities;

(b) Notification of adjacent property owners and/or occupants;

(c) Ventilation of any confined spaces that may trap decomposition gases or the installation of alarm systems in any confined spaces that may trap decomposition gases; and

(d) Establishment of a temporary methane monitoring program in affected structures.

B. Within seven (7) days of detection, submit to the department a report describing the steps taken to protect public health and safety;

C. Within sixty (60) days of detection, submit to the department for approval a remediation plan designed by a professional engineer for the methane gas releases. A gas control system shall be designed to—

(I) Prevent methane accumulation in on-site and off-site buildings;

(II) Reduce methane concentrations at monitored property boundaries to below compliance levels; and

(III) Reduce methane concentrations off-site to below compliance levels;

D. Landfill gas corrective action plans shall describe the nature and extent of the problem and the proposed remedy. The plan shall be implemented upon departmental approval; and

E. The department may establish alternative schedules for demonstrating compliance with subparagraphs (14)(C)5.B. and C. of this rule.

6. The sanitary landfill shall operate in compliance with all applicable requirements of Chapter 643, RSMo and corresponding rules.

(15) Vectors.

(A) Requirements. Conditions shall be maintained that are unfavorable for the harboring, feeding and breeding of vectors.

(B) Satisfactory Compliance—Design. Plans shall include contingency programs for vector control and the operator shall be prepared at all times to implement those procedures.

(C) Satisfactory Compliance—Operations. Vector control contingency programs shall be implemented when necessary to prevent or rectify vector problems.

(16) Aesthetics.

(A) Requirement. The sanitary landfill shall be designed and operated at all times in an aesthetically acceptable manner.

(B) Satisfactory Compliance—Design. Plans shall include an effective litter control facility and operating program.

(C) Satisfactory Compliance—Operations.

1. Portable litter fences or other devices shall be used in the immediate vicinity of the working face and at other appropriate locations to control blowing litter. At the end of each operating day, or more often as required, litter shall be removed from the fences and the ground and incorporated into the cell being used. Alternatively, the litter may be containerized for disposal on the next operating day.

2. Solid wastes that are easily moved by wind shall be covered, as necessary, to prevent becoming airborne and scattered.

3. On-site vegetation should be cleared only as necessary. Natural windbreaks, such as green belts, should be maintained where they will improve the appearance and operation of the sanitary landfill.

4. Salvage operations shall be conducted in such a manner as to not detract from the appearance of the sanitary landfill. Salvaged materials shall be removed from the sanitary landfill daily or stored in aesthetically acceptable containers or enclosures.

(17) Cover.

(A) Requirement. Cover shall be applied to minimize fire hazards, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance.

(B) Satisfactory Compliance—Design. The owner/operator shall prepare a written closure plan that describes the steps necessary to close all sanitary landfill phases at any point during the active life of the sanitary landfill in accordance with the requirements of 10 CSR 80-2.030(4)(A). In addition, the final cover requirements specified in the closure and post-closure plans shall specify—

1. Cover sources, quantities and soil classification (Unified Soil Classification System or United States Department of Agriculture classification system);

2. The capability of the cover to perform the functions listed in subsection (17)(A) of this rule;

3. Surface grades and side slopes needed to promote maximum runoff, without excessive erosion, to minimize infiltration. Final side slopes shall not exceed twenty-five percent (25%) unless it has been demonstrated in a detailed slope stability analysis approved by the department that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill.

4. Procedures to establish and maintain vegetative growth to combat erosion and improve appearance of idle and completed areas. Procedures shall include seeding rate, fertilizer rate, soil conditioning rate and provisions for mulching;

5. Procedures to maintain a cover integrity, for example, regrading and recovering;

6. Methods for borrow areas to be reclaimed so as to restore aesthetic qualities and prevent excessive erosion;

7. The final slope of the top of the sanitary landfill shall have a minimum slope of five percent (5%); and

8. Shear failure analyses shall be included where intermediate or final slopes exceed twenty-five percent (25%). However, the department will waive the analysis for slopes of twenty-five percent (25%) or less, except in seismic impact zones.

(C) Satisfactory Compliance—Operations.

1. Cover shall be applied by the end of each operating day regardless of weather; sources of cover, therefore, shall be accessible on all operating days. The thickness of the compacted cover shall not be less than six inches (6"). Sanitary landfills operating twenty-four (24) hours per day shall incorporate all solid waste into one (1) or more cells at least every twenty-four (24) hours. Where a liner and leachate collection system are in place, an alternative daily cover may be approved by the department on a site-specific basis, if the owner/operator demonstrates that the alternative material controls run-on, runoff, disease vectors, fires, odors, blowing litter and scavenging without presenting a threat to human health and the environment.

2. Cover shall be increased to a total thickness of at least one foot (1') of compacted cover on filled areas of the sanitary landfill which are idle for more than sixty (60) days.

3. No active, intermediate or final slope shall exceed thirty-three and one-third percent (33 1/3%).

4. As each phase of the sanitary landfill is completed, a final cover system shall be installed at portions of—

A. Existing sanitary landfills without composite liners. This final cover shall consist of at least two feet (2') of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less and overlaid by at least one foot (1') of soil capable of sustaining vegetative growth;

B. Sanitary landfills with composite liners. This final cover shall consist of component layers, in order from top to bottom, as follows:

(I) Two feet (2') of soil capable of sustaining vegetative growth;

(II) A drainage layer;

(III) A geomembrane liner at least as thick as the geomembrane liner described in subparagraph (10)(B)1.G.;

(IV) One foot (1') of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less; and

C. The geomembrane liner shall be in intimate contact with the underlying compacted clay.

5. The installation of the final cover systems shall include provisions for slope stability.

6. The department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate to the department that the alternative design will be at least equivalent to the final cover system described in paragraph (17)(C)3. of this rule.

7. Surface grades and side slopes shall be maintained to promote runoff without excessive erosion.

8. Vegetation shall be established within one hundred eighty (180) days of application of the cover required by paragraphs (17)(C)2. and 3. of this rule. Vegetation shall be established and maintained to minimize erosion and surface water infiltration.

9. Regrading and recovering shall be performed as necessary to maintain cover slope and integrity.

10. Borrow areas shall be reclaimed in accordance with the approved plans.

11. The compacted clay portion of the final cover shall consist of soils classified under the Unified Soil Classification System as CH, CL, ML, SC or MH.

(18) Compaction.

(A) Requirement. In order to conserve sanitary landfill site capacity, thereby preserving land resources and to minimize moisture infiltration and settlement, solid waste and cover shall be compacted to the smallest practicable volume.

(B) Satisfactory Compliance—Design.

1. Arrangements shall be made and indicated in the plans where substitute equipment will be available to provide uninterrupted service during routine maintenance periods or equipment breakdowns.

2. The plans shall specify the equipment that should be available to conduct the sanitary landfill operation at the projected solid waste loading.

(C) Satisfactory Compliance—Operations.

1. Solid waste handling equipment, on any operating day shall be capable of performing and shall perform the following functions:

A. Spread the solid wastes to be compacted in layers no more than two feet (2') thick, while confining it to the smallest practicable area;

B. Compact the spread solid wastes to the smallest practicable volume; and

C. Place, spread and compact the cover as much as practicable.

2. A preventive maintenance program should be employed to maintain equipment in operating order.

3. No solid waste shall be disposed of in water where the presence of the water will prohibit the proper spreading and compaction of the solid waste or where a mosquito breeding problem would be created.

(19) Safety.

(A) Requirement. The sanitary landfill shall be designed, constructed and operated in a manner so as to protect the health and safety of personnel and others associated with and affected by the operation.

(B) Satisfactory Compliance—Design.

1. Provisions shall be included in the plans to control and limit access to the sanitary landfill in a manner that is compatible with the surrounding land use.

2. Provisions shall be included in the plans to control dust for safety purposes and to prevent a nuisance to the surrounding area.

3. The plans shall specify the facilities and methods to be provided for extinguishing fires.

(C) Satisfactory Compliance—Operation.

1. A fire extinguisher shall be provided on all solid waste handling equipment.

2. Any fires in wastes being delivered to the sanitary landfill or which occur at the working face or within equipment or personnel facilities shall be extinguished.

3. Adequate communications equipment shall be available at the sanitary landfill for emergency situations.

4. Scavenging shall be prohibited at all times to avoid injury and to prevent interference with sanitary landfill operations.

5. Access to the sanitary landfill shall be controlled and shall be by established roadways only. The sanitary landfill shall be accessible only when operating personnel are on duty. Large containers may be placed at the sanitary landfill entrance so that users can conveniently deposit solid waste after hours. The containers and the areas around them shall be maintained in a sanitary and litter-free condition.

6. Traffic signs or markers should be provided to promote an orderly traffic pattern to and from the discharge area and, if necessary, to restrict access to hazardous areas or to maintain efficient operating conditions. Drivers of manually discharging vehicles should not hinder operation of mechanically discharging vehicles. Vehicles should not be left unattended at the working face or along traffic routes. If a regular user persistently poses a safety hazard, s/he should be barred from the sanitary landfill.

7. Dust control provisions shall be utilized as necessary for safety purposes and to prevent a nuisance to the surrounding area.

(20) Records.

(A) Requirement. The owner/operator of a sanitary landfill shall maintain records and monitoring data as specified by the department and file appropriate documents with the county recorder(s) of deeds.

(B) Satisfactory Compliance—Design. Plans shall prescribe methods to be used in maintaining records and monitoring the environmental impact of the sanitary landfill. Information on recording and monitoring requirements may be obtained from the department.

(C) Satisfactory Compliance—Operations.

1. Records shall be maintained at the landfill office. Records five (5) years old or older may be stored at an alternate site if approved by the department; such stored records must be made available at the landfill upon request of department personnel. Records must cover at least the following:

A. Major operational problems, complaints or difficulties;

B. Gas monitoring results from monitoring and any remediation plans required under section (14) of this rule;

C. Any demonstration, certification, finding, monitoring, testing or analytical data required under sections (4) and (11) of this rule;

D. Vector control efforts;

E. Dust and litter control efforts;

F. Quantitative measurements of the solid waste handled and an estimate of the air space left at the facility. Every two (2) years after the date of the permit issuance and within sixty (60) days of the anniversary date of the permit issuance, the owner/operator shall submit to the department two (2) copies of a topographic map, prepared under the direction of a land surveyor or by aerial photography, showing the current horizontal and vertical boundaries of solid waste in the sanitary landfill and the boundaries of the sanitary landfill. Maps prepared by aerial photography shall meet the current National Map Accuracy Standards for Photogrammetry as indicated in United States Bureau of the Budget "Circular A-16 Exhibit C," dated October 10, 1958;

G. Description, source and volume of special wastes that are received;

H. Any sanitary landfill design documentation for recirculation of leachate or gas condensate in a landfill;

I. Closure and post-closure care plans and any monitoring, testing or analytical data as required under 10 CSR 80-2.030(4)(A);

J. Any cost estimates and financial assurance documentation required under 10 CSR 80-2.030(4)(B) and (C);

K. Inspection records and training procedures as required under 10 CSR 80-2.060 and subsection (3)(B) of this rule;

L. Records associated with fees as required under 10 CSR 80-2.080(2);

M. Records associated with corrective measures as required under section (10) of this rule; and

N. Effective January 1, 1998, on or before January 31 of each calendar year and annually thereafter each solid waste disposal area shall submit a report to the department specifying the amount of solid waste received for disposal from states other than Missouri. The landfill operator shall keep a detailed report of the origin of all waste received.

2. Upon closing of the sanitary landfill, the existence of the sanitary landfill shall be recorded with the recorder(s) of deeds in the county(ies) where the sanitary landfill is located. The owner/operator may request permission from the department to remove the notation from the deed if all wastes are removed from the facility.

A. A survey and plat meeting the requirements of the current Minimum Standards of Property Boundary Survey 10 CSR 30-2.010 and detailed description of the sanitary landfill shall be prepared by a land surveyor. The survey plat and detailed description, at a minimum, shall contain the following information:

(I) The name of the property owner as it appears on the property deed;

(II) The detailed description of the property;

(III) The general types and location of the solid wastes and the depth(s) of fill within the property; and

(IV) The location of any leachate control, gas control or water monitoring systems which shall be maintained after closure and the length of time that these systems are to be maintained.

B. The owner/operator shall obtain approval from the department of the survey plat and detailed description prior to filing with the county recorder of deeds. After receiving approval from the department and before filing with the county recorder of deeds, the detailed description shall be notarized by a lawful notary public. Filing the notarized plat or detailed description shall be accomplished within thirty (30) days of departmental approval. Two (2) copies of the notarized and properly recorded plat or detailed description showing the recorder of deeds' seal or stamp, the book and page numbers and the date of filing shall be submitted to the department within thirty (30) days of the date of filing.

C. Owners of solid waste disposal areas permitted prior to January 1, 1987, and which close after January 1, 1989, as a part of closure of the solid waste disposal area shall—

(I) Execute an easement with the department, which allows the department, its agents or its contractors to enter the premises to complete work specified in the closure plan, to monitor or maintain the solid waste disposal area or take remedial action during post-closure period; and

(II) Submit evidence to the department that a notice and covenant running with the land has been recorded with the recorder of deeds in the county where the sanitary landfill is located. The notice and covenant shall specify the following:

(a) That the property has been permitted as a sanitary landfill; and

(b) That use of the land in any manner which interferes with closure plans, and post-closure plans filed with the department, is prohibited.

AUTHORITY: section 260.225, RSMo Supp. 1997. Original rule filed Dec. 11, 1973, effective Dec. 21, 1973. Amended: Filed July 14, 1986, effective Jan. 1, 1987. Amended: Filed Jan. 5, 1987, effective June 1, 1987. Amended: Filed Jan. 29, 1988, effective Aug. 1, 1988. Amended: Filed Aug. 15, 1988, effective Dec. 29, 1988. Emergency amendment filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Amended: Filed May 3, 1993, effective Jan. 13, 1994. Amended: Filed March 17, 1992.** Emergency rescission of the 1992 amendment filed March 19, 1997, effective April 1, 1997, expired Sept. 27, 1997. Amended: Filed Oct. 10, 1996, effective July 30, 1997. Rescission of the 1992 amendment filed April 3, 1997, effective Aug. 30, 1997. Amended: Filed Dec. 15, 1997, effective Aug. 30, 1998.*

**Original authority 1972, amended 1975, 1986, 1988, 1990, 1993, 1995.*

The Missouri Supreme Court in* ***Missouri Coalition for the Environment, et al., v. Joint Committee on Administrative Rules, et al., *Case No. 78628, dated February 25, 1997, ordered the secretary of state to publish this amendment. The Missouri Department of Natural Resources subsequently filed an emergency rescission of this amendment as well as a proposed rescission of this amendment which became effective August 30, 1997. See the above authority section for filing dates.*

Op. Atty. Gen. No. 42, Frappier (3-20-74). *With respect to the Solid Waste Management Law, Senate Bill No. 387, 76th General Assembly, sections 260.200–260.245, RSMo Supp. 1978. Cities and counties are required to provide for the collection and disposal of solid wastes including industrial wastes and may contract for such collection and disposal. Service charges may be imposed if not already imposed under some other law although these charges must be billed and collected directly by the cities or counties. General revenue of the city and federal revenue sharing funds may also be expended for such purposes.*

Appendix I—Constituents for Detection Monitoring

Inorganic Constituents

Ammonia (NH_3 as N, mg/l)
Antimony (Sb, µg/l)
Arsenic (As, µg/l)
Barium (Ba, µg/l)
Beryllium (Be, µg/l)
Boron (B, µg/l)
Cadmium (Cd, µg/l)
Calcium (Ca, mg/l)
Chromium (Cr, µg/l)
Cobalt (Co, µg/l)
Copper (Cu, µg/l))
Fluoride (F, mg/l)
Hardness (calculated, mg/l)
Lead (Pb, µg/l)
Magnesium (Mg, mg/l)
Manganese (Mn, µg/l)
Mercury (Hg, µg/l)
Nickel (Ni, mg/l)
Nitrate/Nitrite (NO_3/NO_2, mg/l)
Phosphorus (total P, mg/l)
Selenium (Se, µg/l)
Silver (Ag, µg/l)
Sodium (Na, mg/l)
Sulfate (SO_4, mg/l)
Thallium (Tl, µg/l)
Total Organic Carbon (TOC, mg/l)
Vanadium (V, µg/l)
Zinc (Zn, µg/l)

Organic Constituents

Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform; Tribromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane; Ethyl chloride
Chloroform; Trichloromethane
Dibromochloromethane; Chlorodibromomethane
1,2-Dibromo-3-chloropropane; DBCP
1,2-Dibromoethane; Ethylene dibromide; EDB
o-Dichlorobenzene; 1,2-Dichlorobenzene
p-Dichlorobenzene; 1,4-Dichlorobenzene
trans-1,4-Dichloro-2-butene
1,1-Dichloroethane; Ethylidene chloride
1,2-Dichloroethane; Ethylene dichloride
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride
cis-1,2-Dichloroethylene; cis-1,2-

Dichloroethene
trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene
1,2-Dichloropropane; Propylene dichloride
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone; Methyl butyl ketone
Methyl bromide; Bromomethane
Methyl chloride; Chloromethane
Methylene bromide; Dibromomethane
Methylene chloride; Dichloromethane
Methyl ethyl ketone; MEK; 2-Butanone
Methyl iodide; Iodomethane
4-Methyl-2-pentanone; Methyl isobutyl ketone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene
Toluene
1,1,1-Trichloroethane; Methylchloroform
1,1,2-Trichloroethane
Trichloroethylene; Trichloroethene
Tichlorofluoromethane; CFC-11
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylenes

Appendix II—List of Hazardous Inorganic and Organic Constituents[1]

Common Name[2]	CAS RN[3]
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Acetone	67-64-1
Acetonitrile; Methyl cyanide	75-05-8
Acetophenone	98-86-2
2-Acetylaminofluorene; 2-AAF	53-96-3
Acrolein	107-02-8
Acrylonitrile	107-13-1
Aldrin	309-00-2
Allyl chloride	107-05-1
4-Aminobipheny	l92-67-1
Anthracene	120-12-7
Antimony	(Total)
Arsenic	(Total)
Barium	(Total)
Benzene	71-43-2
Benzo[a]anthracene; Benzanthracene	56-55-3
Benzo[b]fluoranthene	205-99-2
Benzo[k]fluoranthene	207-08-9
Benzo[ghi]perylene	191-24-2
Benzo[a]pylene	50-32-8
Benzyl alcohol	100-51-6
Beryllium	(Total)
alpha-BHC	319-84-6
beta-BHC	319-85-7
delta-BHC	319-86-8
gamma-BHC; Lindane	58-89-9
Bis(2-chloroethoxy)methane	111-91-1
Bis(2-chloroethyl) ether; Dichloroethyl ether	111-44-4
Bis(2-chloro-1-methylethyl) ether;	108-60-1
2,2'-Dichlorodiisopropyl ether; DCIP	See Note 3
Bis(2-ethylhexyl) phthalate	117-81-7
Bromochloromethane; Chlorobromomethane	74-97-5
Bromodichloromethane; Dibromochloromethane	75-27-4
Bromoform; Tribromomethane	75-25-2
4-Bromophenylphenyl ether	101-55-3
Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7
Cadmium	(Total)
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlordane	See Note 4.
p-Chloroaniline	106-47-8
Chlorobenzene	108-90-7
Chlorobenzilate	510-15-6
p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7
Chloroethane; Ethyl chloride	75-00-3
Chloroform; Trichloromethane	67-66-3
2-Chloronaphthalene	91-58-7
2-Chlorophenol	95-57-8
4-Chlorophenyl phenyl ether	7005-72-3
Chloroprene	126-99-8
Chromium	(Total)
Chrysene	218-01-9
Cobalt	(Total)
Copper	(Total)
m-Cresol; 3-methylphenol	108-39-4
o-Cresol; 2-methylphenol	95-48-7
p-Cresol; 4-methylphenol	106-44-5
Cyanide	57-12-5
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7
4,4´-DDD	72-54-8
4,4´-DDE	72-55-9
4,4´-DDT	50-29-3
Diallate	2303-16-4
Dibenz[a,h]anthracene	53-70-3
Dibenzofuran	132-64-9
Dibromochloromethane; Chlorodibromomethane	124-48-1
1,2-Dibromo-3-chloropropane;DBCP	96-12-8
1,2-Dibromoethane; Ethylene dribromide; EDB	106-93-4
Di-n-butyl phthalate	84-74-2
o-Dichlorobenzene; 1,3-Dichlorobenzene	95-50-1
m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7
3,3´-Dichlorobenzidine	91-94-1
trans-1,4-Dichloro-2-butene	110-57-6
Dichlorodifluoromethane; CFC 12;	75-71-8
1,1-Dichloroethane; Ethyldidene chloride	75-34-3
1,2-Dichloroethane; Ethylene dichloride	107-06-2
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethylene trans-1,2-Dichloroethene	156-60-5
2,4-Dichlorophenol	120-83-2
2,6-Dichlorophenol	87-65-0
1,2-Dichloropropane; Propylene dichloride	78-87-5
1,3-Dichloropropane; Trimethylene dichloride	142-28-9
2,2-Dichloropropane; Isopropylidene chloride	594-20-7
1,1-Dichloropropene	563-58-6
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
Dieldrin	60-57-1
Diethyl phthalate	84-66-2
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2
Dimethoate	60-51-5
p-(Dimethylamino)azobenzen	60-11-7
7,12-Dimethylbenz[a]nthracene	57-97-6
3,3´-Dimethylbenzidine	119-93-7
2,4-Dimethylphenol; m-Xylenol	105-67-9
Dimethyl phthalate	131-11-3
m-Dinitrobenzene	99-65-0
4,6-Dinitro-o-cresol 4,6-Dinitro-2-methylphenol	534-52-1
2,4-Dinitrophenol;	51-28-5
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7
Di-n-octyl phthalate	117-84-0
Diphenylamine	122-39-4
Disulfoton	298-04-4
Endosulfan I	959-98-8
Endosulfan II	33213-65-9
Endosulfan sulfate	1031-07-8
Endrin	72-20-8
Endrin aldehyde	7421-93-4
Ethylbenzene	100-41-4
Ethyl methacrylate	97-63-2
Ethyl methanesulfonate	62-50-0
Famphur	52-85-7
Fluoranthene	206-44-0
Fluorene	86-73-79
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene .	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexachloropropene	1888-71-7

2-Hexanone; Methyl butyl ketone	591-78-6
Indeno(1,2,3-cd)pyrene	193-39-5
Isobutyl alcohol	78-83-1
Isodrin	465-73-6
Isophorone	78-59-1
Isosafrole	120-58-1
Kepone	143-50-0
Lead	(Total)
Mercury	(Total)
Methacrylonitrile	126-98-7
Methapyrilene	91-80-5
Methoxychlor	72-43-5
Methyl bromide; Bromomethane	74-83-9
Methyl chloride; Chloromethane	74-87-3
3-Methylcholanthrene	56-49-5
Methyl ethyl ketone; MEK; 2-Butanone	78-93-3
Methyl iodide; Iodomethane	74-88-4
Methyl methacrylate	80-62-6
Methyl methanesulfonate	66-27-3
2-Methylnaphthalene	91-57-6
Methyl parathion; Parathion methyl	298-00-0
4-Methyl-2-pentanone;	
Methyl isobutyl ketone	108-10-1
Methylene bromide; Dibromomethane	74-95-3
Methylene chloride; Dichloromethane	75-09-2
Naphthalene	91-20-3
1,4-Naphthoquinone	130-15-4
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
Nickel	(Total)
o-Nitroaniline; 2-Nitroaniline	88-74-4
m-Nitroaniline; 3-Nitroaniline	99-09-2
p-Nitroaniline; 4-Nitroaniline	100-01-6
Nitrobenzene	98-95-3
o-Nitrophenol; 2-Nitrophenol	88-75-5
p-Nitrophenol; 4-Nitrophenol	100-02-7
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodipropylamine; N-nitroso-N-dipropylamine	
Di-n-propylnitrosamine	621-64-7
N-Nitrosomethylethylamine	10595-95-6
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
5-Nitro-o-toluidine	99-55-8
Parathion	56-38-2
Pentachlorobenzene	608-93-5
Pentachloronitrobenzene	82-68-8
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenanthrene	85-01-8
Phenol	108-95-2
p-Phenylenediamine	106-50-3
Phorate	298-02-2
Polychlorinated biphenyls; PCBs; Aroclors	See Note 5.
Pronamide	23950-58-5
Propionitrile; Ethyl cyanide	107-12-0
Pyrene	129-00-0
Safrole	94-59-7
Selenium	(Total)
Silver	(Total)
Silvex; 2,4,5-TP	93-72-1
Styrene	100-42-5
Sulfide	18496-25-8
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5
1,2,4,5-Tetrachlorobenzene	95-94-3
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene; Tetra-chloroethene; Perchloroethylene	127-18-4
2,3,4,6-Tetrachlorophenol	58-90-2
Thallium	(Total)
Tin	(Total)
Toluene	108-88-3
o-Toluidine	95-53-4
Toxaphene	See Note 6.
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane; Methylchloroform	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethylene; Trichloroethene	79-01-6
Trichlorofluoromethane; CFC-11	75-69-4
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
0,0,0-Triethyl phosphorothioate	126-68-1
sym-Trinitrobenzene	99-35-4
Vanadium	(Total)
Vinyl acetate	108-05-4
Vinyl chloride; Chloroethene	75-01-4
Xylene (total)	See Note 7.
Zinc	(Total)

Notes

1. The regulatory requirements pertain only to the list of substances.

2. Common names are those widely used in government regulations, scientific publications, and commerce; synonym sexist for many chemicals.

3. This substance is often called Bis(2-chloroisopropyl) ether, the name Chemical Abstracts Service applies to its noncommercial isomer, Propane, 2,2´-oxybis, 2-chloro-(CAS RN 39638-32-9).

4. Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12789-03-6).

5. Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Aroclor 1260 (CAS RN 11096-82-5).

6. Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), i.e., chlorinated camphene.

7. Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

10 CSR 80-3.011 Design and Operation

Emergency rule filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Emergency rule filed Jan. 28, 1994, effective Feb. 7, 1994, expired June 6, 1994.

10 CSR 80-3.020 Emergency Landfill Extensions

Emergency rule filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Emergency rule filed Jan. 28, 1994, effective Feb. 7, 1994, expired June 6, 1994.

ATTACHMENT 2

Photographs of Conditions at OU-2

Photo 1:

View of apparent stormwater collection drain (1 of 2) along west side of OU-2.

Photo 2:

View of apparent stormwater collection drain (2 of 2) that has been silted in along west side of OU-2.

Photo 3:

View of concrete standpipe (1 of 2) along west side of OU-2.

Civil & Environmental Consultants, Inc.

Photos of Conditions at OU-2
Photos taken 11/11/08
CEC Project No. 081-926

Photo 4:

View of leachate pumping well along east side of OU-2.

Photo 5:

View of fenceline along western slope of OU-2 (looking toward the south).

Photo 6:

View of fenceline along western slope of OU-2 (looking toward the northeast). Buried fiber optic cables run in a north-south direction beneath this area.

CEC
Civil & Environmental Consultants, Inc.

Photos of Conditions at OU-2
Photos taken 11/11/08
CEC Project No. 081-926

Photo 7:

View of stormwater retention pond to the west of OU-2 (looking toward the northwest).

Photo 8:

View of existing vegetative cover at OU-2 with soil stockpile in background (looking toward the north).

Photo 9:

Concrete stand pipes and vegetative cover on western slope taken 5/14/19.

CEC
Civil & Environmental Consultants, Inc.

Photos of Conditions at OU-2
Photos taken 11/11/08 & 5/14/19
CEC Proj. # 081-926 / 191-750

ATTACHMENT 3

Odor Management Plan

ODOR MANAGEMENT PLAN

Bridgeton Landfill
13570 St. Charles Rock Road
Bridgeton, Missouri

Date: 6-20-2014

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1.0 INTRODUCTION

1.1 BACKGROUND

The Bridgeton Landfill (the landfill or the Site) is located on a 214-acre parcel, of which approximately 52 acres has been permitted for municipal solid waste disposal under the conditions of Permit #118912 held by Bridgeton Landfill, LLC ("Bridgeton Landfill"). In accordance with the permit, waste was placed in former limestone quarries which were reportedly about 240 feet deep. The landfill ceased accepting waste at the end of 2004.

1.2 PURPOSE OF THE ODOR MANAGEMENT PLAN

This Odor Management Plan is intended to become an integrated part of daily operations at the Bridgeton Landfill so as to effect diligent identification and remediation of odors generated by the Bridgeton Landfill.

2.0 ODOR MONITORING

This odor monitoring program has been designed to provide guidance in the identification and documentation of odors through the utilization of self-inspections and odor complaint investigations. In addition, this program outlines the general methods by which odor sources can be identified and resolved.

2.1 IDENTIFYING THE PRESENCE OF ODOR

The first step in the process of controlling odors is to determine if odors are present. These two methods of identifying odors and how they are implemented as part of this Odor Management Plan are discussed in the following sections.

Routine Employee Observations

When any on-site facility employee detects an odor that has sufficient intensity or volume that it could lead to detection off-site, it will be reported to an Environmental Specialist or the Environmental Manager who will investigate to determine the source. The investigator will then assign the proper staff to restore the source area to normal operation to eliminate the odor source. Such on-site investigation, reporting, and remediation are inherent components of the site's standard operating procedures.

Self-Inspection

The primary objective of this method is to identify and mitigate odors from the facility before the odors can result in off-site migration. This is accomplished through the use of regular self-inspections. The self-inspection will be performed at random times with daily and weekly variability until meaningful trend data is collected in order to ensure that trending data is not biased by a pattern in self-inspection. This schedule will then be modified over time in order to include periods of highest historic off-site odor complaints when trending analysis of complaint data allows for the identification of patterns for off-site odor migration potential.

Self-inspection at the facility will be performed on a twice daily basis at minimum. The inspection will be performed by the Site environmental management staff or their designees. The inspection will consist of one or more of these individuals touring the facility perimeter along a pre-planned and consistent route (Figure 2). The focus of this inspection is limited specifically to the tasks detailed in this plan.

Detected odors will be classified with the scale defined by the Nasal Ranger® Field Olfactometer Operations Manual (Attachment 1). This method with accompanying instrument utilizes a "Dilution-to-Threshold" approach where a combination of carbon filtration and unfiltered air pass through the instrument based upon the test value selected on the instrument. These values are separated by 100% carbon filtered air from one another on the device, ensuring a "blank" sample in the progression through the scale. The exact methodology that will be applied is outlined in the previously mentioned Operations Manual (Attachment 1).

In addition to the Nasal Ranger® odors will be classified using the standardized terminology outlined in the St. Croix Odor Parameters Overview (Attachment 2).

The results of the daily odor inspection will be documented in an electronic database via tablet computer. This data shall be completed and maintained as part of the Site Operating Record (SOR). Any odors identified through self-inspection will be mitigated in accordance with the guidance for mitigation provided in the Operations, Maintenance, and Monitoring Plan. The process of self inspection will be as follows:

- Originating from The Bridgeton Landfill, LLC office at 13570 St. Charles Rock Road the inspecting party will drive the designated route from Figure 2 in a clockwise direction.
- This drive shall be performed with windows down (weather dependent) at a slow rate of speed.
- At each of the thirteen (13) designated locations the inspecting party will stop (where safe and in compliance with all traffic laws), turn off the vehicle engine, exit the vehicle, and record any odor observations on the Daily Odor Self-Inspection Form.
- If an odor is documented the investigator will be responsible for tracking back to the source of the odor. If the odor source is determined to be the Bridgeton Landfill the investigator will then request the necessary repair or mitigation. All significant off-site odors (odors evaluated to be >7 on the Nasal Ranger® scale) originating from the Bridgeton Landfill are to have the source and corrective action applied documented.

Odor Complaint Investigation

One of our goals as a company is to be a good neighbor and a contributor to the local community. All real-time odor complaints received will be investigated as soon as is practical within the confines of proper safety protocols and site logistics. A real-time odor complaint is defined as a complaint filed within two hours of the observation time and prior to any significant change in meteorological conditions. The goal of the investigation will be to determine if an odor originates from the landfill site and, if so, to determine the specific source and cause of the odor, and then to remediate the odor. Upon receipt of an odor complaint, the following actions will be taken:

- The complaint will be investigated by the Site environmental management staff.
- The investigation will be documented in a customized electronic database via tablet and will apply the same odor ranking scale as the self-inspection.

- If a complaint is verified (the Bridgeton Landfill investigator confirms that an odor is present and that the landfill cannot be ruled out as a source), the investigator will be responsible for tracking back to the source of the odor, requesting the necessary repair or mitigation, and documenting that the mitigation has occurred.

All off-site odor complaints will be logged in order to provide data for trending analysis of odor complaints in order to better schedule self-inspections and understand potential site problems.

Complaints that are received greater than one hour after the specified time, prior to a significant change in meteorological conditions, or on a different date will be investigated as non-real-time complaints. Non-real-time complaints and real-time complaints received during periods when real-time investigation can not be conducted for safety or site logistics restrictions should still be investigated through a combination of most recent inspection data, weather data, and site work schedules in order to determine if the odor could possibly have originated from the Bridgeton Landfill.

Equipment for Odor Inspection and Investigation

The transmission of odor depends on a number of variables including atmospheric conditions. As a result, an on-site weather station compliant with the EPA Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) (EPA-450/4-87-007) will be employed to track wind direction, windspeed, humidity, precipitation, and other factors that can impact odor transmission. Data from both inspections and investigations will be recorded via tablet computers equipped with custom built software. This software will automatically log latitude and longitude from the tablet computer's built in GPS device and weather data from the nearest public meteorological station, most likely to be Lambert International Airport. The combination of two different weather station data sets and accurate latitude and longitude data will greatly enhance the mapping and analysis of odor sources.

2.2 IDENTIFYING THE SOURCE OF ODOR

Once the presence of odor is identified through either self-inspection or through investigation of an odor complaint, the source of the odor needs to be identified and coded based on the odor descriptors selected during the self-inspection. The source of an odor may not be readily identifiable. If the source of the odor is not obvious and cannot be traced immediately to an issue or activity at the facility, the following steps may be used to identify the source of the odor:

- Use data from the on-site weather station. Determine the wind direction, speed, and barometer reading at the time the odor was identified.
- Collect daily facility inspection data from the Site's environmental technician staff.
- Using an aerial photograph or plan of the facility, draw a vector in the same direction as the wind, and intersect the location where the odor was identified. If the vector crosses the facility and the facility is in an upwind position compared to the location where the odor was identified, then determine the facility features and activities that lie along the vector. Compare the identified odor to any potential odor sources along the vector path and then inspect these potential odor sources in the field to identify the source.
- Collaborate with Site environmental technician staff to prioritize repair and remediation efforts on potential sources of off-site odor.
- Perform a follow up self-inspection of the previously impacted areas to verify successful elimination of off-site odors. If not eliminated, repeat this process at varying times of the day, under varying operational conditions, and with varying wind directions until the source of the odor is identified and repaired or remediated.

2.3 ODOR MANAGEMENT

Odor management and landfill gas management are inter-related. Odor management, for purposes of this Plan, will be the temporary measures employed during any work activity at the site that might generate odors such as excavation, significant well maintenance, etc.

Odor Management During Excavation

Any or all of the following may be used to manage odors during excavations into waste material:

- Minimize aerial extent of excavation to the extent required to maintain safe working conditions.
- If necessary, install a portable odor control unit near the excavation site, and install a 1,500 gallon water tank on a suitable pad.

- Use odor control neutralizers at a suitable concentration during the excavation and backfilling process. The concentration can be adjusted as necessary to achieve acceptable neutralization and to more fully neutralize aggressive odors.
- Adjust concentrations and nozzle spacing as necessary during the activities to neutralize the odors.
- During the backfill process, the neutralization process can be discontinued once more permanent landfill gas extraction methods are employed in this area; otherwise maintain neutralization until backfill is completed.

Odor Control During Transportation of Excavated Wastes

Any or all of the following may be used to manage odors during transportation of excavated waste material:

- In most cases, excavated wastes will be placed in a roll-off container or dump truck to transport to the Bridgeton transfer station. The container or dump truck will be tarped following placement of waste.
- The waste may be covered with an odor control product in the container used for transport, when applicable. If wastes require mixing, then a product can be applied following mixing if odors persist from these waste materials. The producer must be applied to completely cover the wastes with a thin coating.

Odor Management During Gas Emission Activities

Any or all of the following may be used to manage odors during activities that cause gas emissions:

- The wind location will be monitored during the course of the work to determine if odor modification (neutralizers) should be utilized.
- Install a portable odor control system downwind of the work area.
- Use an odor control neutralizer at a suitable concentration during the excavation and backfilling process. The concentration can be adjusted as necessary to achieve acceptable neutralization and to more fully modify aggressive odors.

2.4 REQUIRED DOCUMENTATION

In order to successfully measure the effectiveness of odor remediation, trend the causes of odors, document complaint follow-up, and focus our efforts on the best possible solutions for odor management, it is necessary to create and maintain proper documentation. This documentation should consist of an electronic database for odor self-inspections and odor complaint investigations, odor mitigation efforts, and the transference of this data into the Site Operating Record.

Electronic Database

In order to optimally track and analyze odor self-inspection and complaint investigation data these tasks will be performed through use of a tablet computer. Data will be logged in the field through a forced choice procedure to ensure uniformity in documentation. This data set will be designed with a compatible format to allow for export of the data into Microsoft Excel® or similar data management software.

Odor Mitigation Efforts

When off-site odors necessitate the implementation of the odor mitigation and control practices outlined in section 2.3 of this plan the effectiveness of these methods will be evaluated and documented for use by the management staff in determining the effectiveness of each method.

In the event that a mitigation method is attempted and found to be ineffective, another mitigation method must be attempted and/or outside experts must be contacted until the facility is successful in controlling odor. The decision-making process in choosing a method to control odor should also be documented. In documenting mitigation efforts, the following information must be recorded:

- The reasoning used in selecting the mitigation process.
- The manner and extent to which the mitigation efforts are made.
- The results of the mitigation effort.

Recording these details may be done through memorandum to the Site Operating Record (SOR).

Site Operating Record

Whenever the daily odor self-inspection or odor complaint investigation is performed, the appropriate document should be completed and maintained on site as part of the SOR. In addition to maintaining these documents in the SOR, all efforts to mitigate odors must be documented in detail. It is important to document all efforts taken to mitigate odors whether or not there have been complaints from the public. The SOR is available for MDNR review per request.

2.5 TERM OF MONITORING

Bridgeton Landfill will perform the odor monitoring program for a period of six months upon acceptance of this Plan. Every 90 days thereafter the Environmental Manager and MDNR will review the results of monitoring and consider modification or discontinuation of the program if actionable results are no longer obtained.

ATTACHMENT 1

THE
NASAL RANGER®
FIELD OLFACTOMETER

OPERATION MANUAL
Version 6.2

U.S. Patent No.: 6,595,037

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NASAL RANGER® FIELD OLFACTOMETER

INTRODUCTION TO FIELD OLFACTOMETRY

The Nasal Ranger® Field Olfactometer is the "state-of-the-art" in field olfactometry for confidently measuring and quantifying odor strength in the ambient air. The Nasal Ranger® Field Olfactometer, a portable odor detecting and measuring device, determines ambient odor "Dilution-to-Threshold" (D/T) values objectively.

Field olfactometry can be used as a proactive monitoring or enforcement tool for confident odor measurement at property lines and in the neighboring community. Quantifying ambient odor is often needed for the following purposes:

1. Monitoring daily operations (i.e. management performance evaluations),
2. Comparison of operating practices (i.e. evaluating alternatives),
3. Documenting specific events or episodes (i.e. defensible, credible evidence),
4. Monitoring compliance (i.e. compliance assurance for permits),
5. Determination of compliance (i.e. permit renewal),
6. Determination of status (i.e. baseline data for expansion planning),
7. Investigation of odor control effectiveness (i.e. scientific testing),
8. Verification of odor dispersion modeling (i.e. model calibration),
9. Determination of specific odor sources (i.e. investigation of complaints),
10. Verification of complaints (i.e. notice of violation).

The Nasal Ranger® Field Olfactometer, as a nasal organoleptic instrument, provides field olfactometry with a scientific method for dependable ambient odor quantification.

In 1958 the U.S. Public Health Service sponsored the development of an instrument and procedure for **field olfactometry** (ambient odor strength measurement) through Project Grants A-58-541, A-59-541, and A-60-541. The Barnebey-Cheney Company originally manufactured a field olfactometer instrument based on these grants, known as a "scentometer".

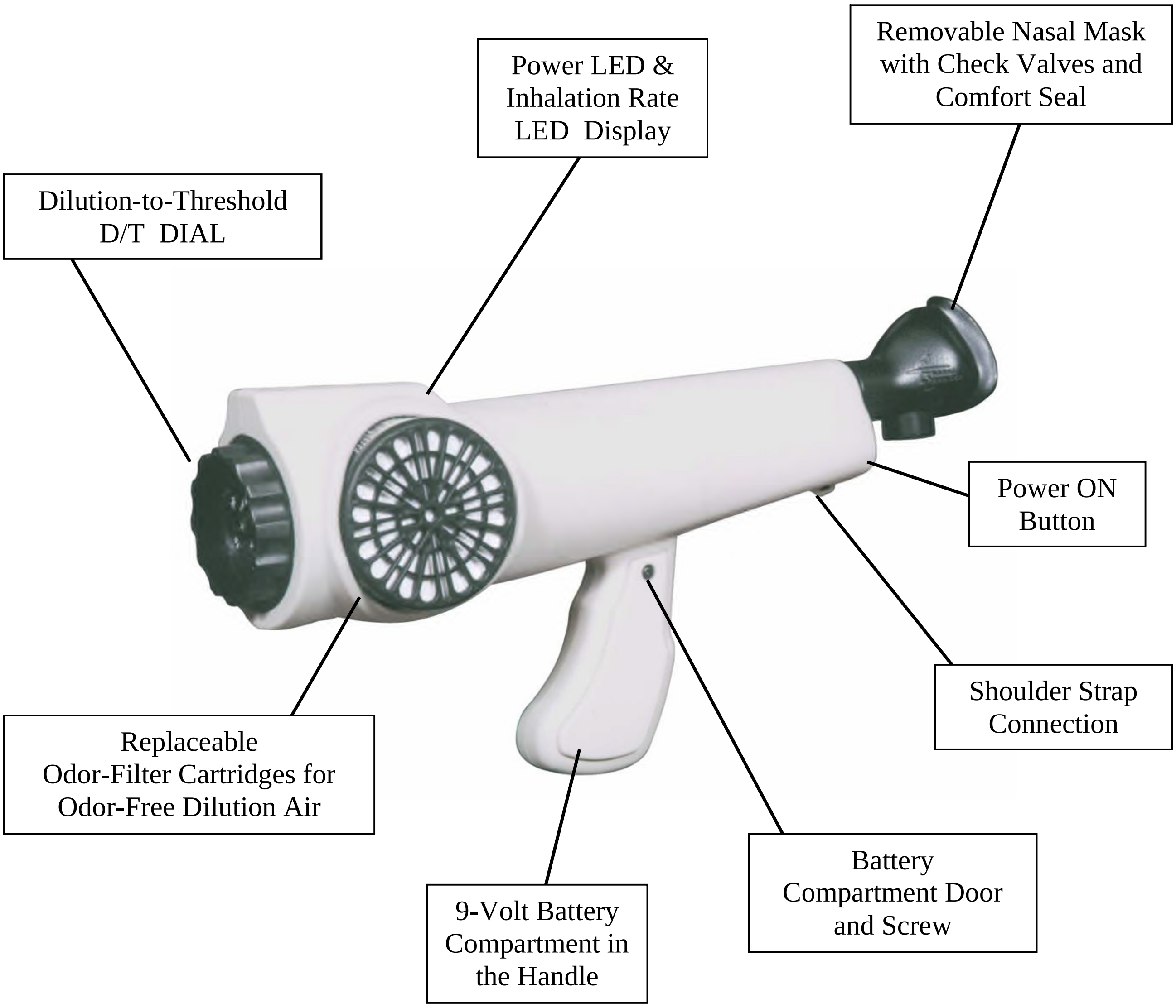
A Nasal Ranger® Field Olfactometer creates a calibrated series of discrete dilutions by mixing the odorous ambient air with odor-free (carbon) filtered air. Field olfactometry defines each discrete dilution level as a "Dilution-to-Threshold," **D/T**, ratio. The "Dilution-to-Threshold" ratio is a measure of the number of dilutions needed to make the odorous ambient air "non-detectable".

Field olfactometry calculates the **"Dilution-to-Threshold"** (D/T) ratio as:

$$\mathbf{D/T} = \frac{\textbf{Volume of Carbon-Filtered Air}}{\textbf{Volume of Odorous Air}}$$

Nasal Ranger® Field Olfactometer

Component Diagram



NASAL RANGER® FIELD OLFACTOMETER

SAFETY AND MAINTENANCE

The Nasal Ranger® Field Olfactometer is a safe and effective means to quantify odor strength in terms of "Dilution-to-Threshold" (D/T) ratios. Facility operators, community inspectors, and neighborhood citizens can use this instrument to monitor ambient odor strength at specific locations within or around a facility's property line and within the community.

Please refer to pages 4-7 of this manual for proper operating procedures.

Safety precautions:

- Be familiar with your surroundings before using the Nasal Ranger® Field Olfactometer.
- Obtain proper permission to use the Nasal Ranger® Field Olfactometer at the desired locations.
- The Nasal Ranger® Field Olfactometer and its related products should not be used for purposes other than its intended purpose.
- The Nasal Ranger® Field Olfactometer is not to be used as a respirator for the reduction or elimination of hazardous chemicals in the air.
- You should not use the Nasal Ranger® Field Olfactometer in atmospheres where contaminant concentrations are unknown, immediately dangerous to life/health, or exceed applicable local standards.
- You should not use the Nasal Ranger® Field Olfactometer in atmospheres that contain less than 19.5% oxygen.
- The Nasal Ranger® Field Olfactometer should not be misused, altered, disassembled, neglected or handled carelessly.
- Use the Nasal Ranger® Field Olfactometer in a stationary position, do not walk or move around with the unit held up to your nose. Remove the unit from your nose before moving to the next measurement location.
- The Nasal Mask is fragile and can break if dropped onto a hard surface. If the Nasal Mask was to become cracked or broken, do not use. Usage of a broken mask could cause injury to face. Discard the broken mask and replace with a new mask.

If a defect with the Nasal Ranger® Field Olfactometer should appear during the warranty period, please refer to the *Warranty Service Procedure* section of the *Sales Terms and Conditions* (pg.13).

Maintenance:

- Comfort Seals should be changed frequently.
- Cartridges (see pg.10).
- Mask should be cleaned with Isopropyl alcohol wipes (also see pg.10).
- Mask o-rings should be changed when necessary.
- Barrel should be cleaned with barrel brush when visible debris is present.
  To clean barrel, follow these simple steps:
  1. Turn dial to blank position.
  2. Take mask off.
  3. Lightly insert brush through barrel at the mask end until it reaches the D/T dial.
  4. Pull brush out giving slight twist.

Be sure to register your Nasal Ranger® Field Olfactometer on-line at www.NasalRanger.com or by completing the Registration Form (pg.22) and faxing or mailing the form as instructed. Your registration will allow us to better serve you with product updates and important information regarding your Nasal Ranger® Field Olfactometer.

If you have any questions about proper usage and safety regarding the Nasal Ranger® Field Olfactometer, please send an e-mail to info@nasalranger.com or call St. Croix Sensory, Inc. at 1-800-879-9231 (+651-439-0177).

Nasal Ranger® Field Olfactometer

QUICK START GUIDE

The Nasal Ranger® Field Olfactometer, a portable odor detecting and measuring device developed by St. Croix Sensory, Inc., is the “state-of-the-art” in field olfactometry for confidently measuring and quantifying odor strength in the ambient air using the Operating Principle of mixing odorous ambient air with odor-free filtered air in discrete volume ratios called “Dilution-to-Threshold” ratios (D/T ratios).

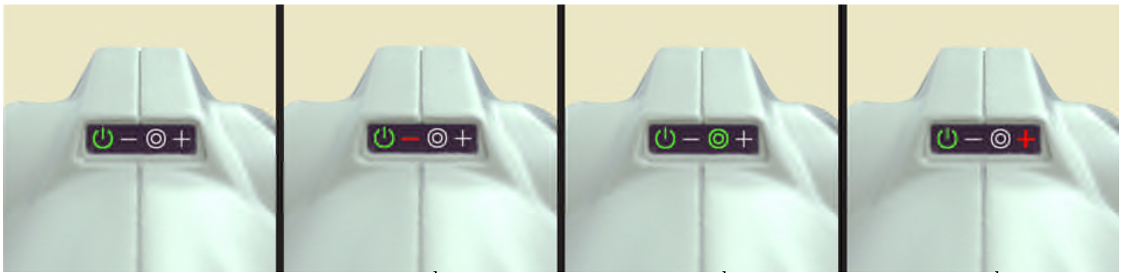
Field olfactometry with the Nasal Ranger® Field Olfactometer is a cost effective means to quantify odor strength. Facility operators, community inspectors, and neighborhood citizens can confidently monitor odor strength at specific locations around a facility’s property line and within the community.

The following information allows an informed user to quickly understand the operation of the Nasal Ranger Field Olfactometer. It assumes the user has some familiarity with field olfactometry and odor monitoring concepts. [See also “Operation Principles” and “Application Guide”]

1. Hold the Nasal Ranger Field Olfactometer parallel to the ground and press the power button which is located below the nasal mask. All four LED lights should illuminate for one second, and then the 1st (left) Power LED will stay illuminated.

2. Follow the Test Procedure Flow Chart for the sequenced testing procedure.

3. The LED's on the Nasal Ranger Field Olfactometer provide feedback for the user to inhale at the “factory calibration flow rate”. The LED's are labeled as follows:



1st	2nd	3rd	4th
Power ON	Inhalation Rate too low Need to increase Inhalation Rate	Correct Inhalation Rate 16-20 LPM	Inhalation Rate too high Need to decrease Inhalation Rate

4. After 45 seconds of non-use, the 1st LED will blink slowly in a “Power Save” mode.

5. After five minutes of non-use, the Power will automatically turn OFF.

6. To turn off the Nasal Ranger Field Olfactometer manually, press and hold the power button for 3 seconds. All four LEDS will illuminate and then power off. The Nasal Ranger Field Olfactometer is now OFF.

Thank you for joining the ranks of Nasal Ranger® owners. The Nasal Ranger® Field Olfactometer is a precision calibrated tool and will yield reliable odor strength results for your monitoring and measurement needs.

NASAL RANGER® FIELD OLFACTOMETER

TEST PROCEDURE FLOW CHART

START

Push the POWER Button **ON** and Position the D/T Dial at the First BLANK Position located between 2-D/T and 60-D/T and inhale at your **NORMAL** breathing rate through the Nasal Mask for **1-minute.**

Turn the D/T Dial **Clockwise** to the 60-D/T Position and inhale **TWICE** at the **Target Inhalation Rate** of 16-20LPM through the Nasal Mask.

Turn the D/T Dial to the next BLANK Position and resume your **NORMAL** breathing rate through the Nasal Mask; and ASK YOURSELF:

Did I Smell an ODOR ?

YES then $D/T \geq 60$

NO

Turn the D/T Dial to the 30-D/T Position and inhale **TWICE** at the T**arget Inhalation Rate of 16-20LPM through the Nasal Mask.**

Turn the D/T Dial to the next BLANK Position and resume your **NORMAL** breathing rate through the Nasal Mask; and ASK YOURSELF:

Did I Smell an ODOR ?

YES then $60 > D/T \geq 30$

NO

REPEAT the above steps with BLANK Positions to "rest" the nose during **NORMAL** breathing and "TEST" the ambient air with subsequent D/T Positions (15, 7, 4, 2) during inhalation at the **Target Inhalation Rate** of 16-20LPM through the Nasal Mask.

Did I Smell an ODOR ?

YES then $4 > D/T \geq 2$

NO

$D/T < 2$

NASAL RANGER® FIELD OLFACTOMETER

OPERATING PRINCIPLE

The Nasal Ranger® Field Olfactometer, a nasal organoleptic instrument, directly measures and quantifies odor strength in the ambient air using the Operating Principle of mixing odorous ambient air with odor-free filtered air in discrete volume ratios. The discrete volume ratios are called "Dilution-to-Threshold" ratios (D/T ratios).

The user's nose is placed firmly inside the nasal mask against the replaceable "comfort seal". The user inhales through the nasal mask at a comfortable breathing rate while standing at rest. The nasal mask has an outlet for exhaled air to exhaust downward. Therefore, the user inhales through the Nasal Ranger and exhales downward through the outlet check valve. The user can stand at rest and continue comfortable breathing exclusively through the Nasal Ranger Field Olfactometer.

A Power Button located on the Nasal Ranger Housing, directly below the nasal mask, is pushed once by the user to turn the Power ON. To turn the Power OFF manually the Power Button must be pressed for 3-seconds. After 5-minutes of non-use the Power will automatically turn OFF.

A set of LED lights that are recessed on top of the Nasal Ranger housing indicate when the inhalation flow rate is within the "factory calibration flow rate" of 16-20 liters per minute. The four (4) LED lights have the following functions:

> **1st LED** (on Left): Indicates POWER ON. After 45-seconds of non-use this first LED blinks slowly in a "Power Save Mode". When the user inhales and initiates flow the LED will "wake" from the Power Save Mode and remain ON. After 5-minutes of non-use the Power will turn OFF. The Power Button must be pushed once by the user to restart the Power.
>
> **2nd LED**: ON when the user is inhaling at a flow rate of less than 16-lpm.
>
> **3rd LED**: ON when the user inhales at a flow rate of greater that 16-lpm and less than 20-lpm.
>
> **4th LED**: ON when the user inhales at a rate greater than 20-lpm.

Therefore, the user of the Nasal Ranger Field Olfactometer learns to inhale at a rate sufficient to ONLY light up the third LED and be assured that the inhalation is within the factory calibrated flow rate range of 16-20lpm.

The Nasal Ranger's Operating Principle of mixing odorous ambient air with odor-free filtered air in discrete volume ratios is achieved using two airflow paths:

1. Flow through the odor-filter cartridge and

2. Flow through one of the orifices in the D/T (Dilution-to-Threshold) Dial.

The first airflow path is the "filtered air" path through both odor-filter cartridges that are attached to each side of the Nasal Ranger housing. Ambient air, that may be odorous, enters through the outside of both odor-filter cartridges and travels through the multi-media odor-filter cartridges to remove odors.

The filtered odor-free air then flows forward inside the Nasal Ranger® and mixes with the second flow path, which is the odorous air that has entered through one of the orifices on the D/T Dial. The mixture of filtered air and odorous air then travels down the PTFE Barrel to the users nose that is in place inside the Nasal Ranger® mask.

OPERATING PRINCIPLE (CONTINUED)

A precision electronic flow meter that is built in to the Nasal Ranger® Barrel measures the "total volume" of mixed airflow that is traveling down the PTFE Barrel on the way to the nasal mask. The LED lights recessed on top of the Nasal Ranger housing indicate to the user when the inhalation flow rate is within the "factory calibration flow rate" of 16-20 liters per minute.

The rotational position of the Nasal Ranger D/T Dial determines the orifice size and, therefore, the volume of odorous air that enters through the selected orifice. A large orifice allows more odorous air through the D/T Dial to mix with odor-free filtered air. A small orifice allows less odorous air through the D/T Dial to mix with odor-free filtered air. The volume ratio of the filtered odor-free air and odorous air is called the Dilution-to-Threshold (D/T) ratio. The principle of field olfactometry calculates the "Dilution to Threshold" (D/T) ratio as:

$$\mathbf{D/T} = \frac{\textbf{Volume of Carbon-Filtered Air}}{\textbf{Volume of Odorous Air}}$$

The D/T Dial contains twelve (12) orifice positions. Six (6) positions are "BLANK" positions for the user to inhale only odor-free filtered air. Alternating on the D/T Dial with the six "BLANK" positions are six "D/T" positions with discrete "Dilution-to-Threshold" (D/T) orifices with traceable calibration.

The following table summarizes the "Dilution-to-Threshold" (D/T) ratios on the standard Nasal Ranger® D/T Dial.

Position Number	D/T
1	Blank
2	60
3	Blank
4	30
5	Blank
6	15
7	Blank
8	7
9	Blank
10	4
11	Blank
12	2

A raised arrow is on the rim of the D/T Dial adjacent to the Blank "Starting Position", Position No. 1.
A Braille raised DOT is on the rim of the D/T Dial adjacent to each of the D/T Positions.

Please contact St. Croix Sensory, Inc. at 1-800-879-9231 (+651-439-0177), or visit www.NasalRanger.com with inquiries regarding Nasal Ranger D/T Dials with other "Dilution-to-Threshold" (D/T) ratios.

NASAL RANGER® FIELD OLFACTOMETER

APPLICATION GUIDE FOR FIELD OLFACTOMETRY

ODOR MONITORING

Field olfactometry with the Nasal Ranger® Field Olfactometer is a cost effective means to quantify odor strength in terms of "Dilution-to-Threshold" (D/T) ratios. Facility operators, community inspectors, and neighborhood citizens can confidently monitor odor strength at specific locations around a facility's property line and within the community.

The following **"protocols"** are presented in brief form as an application guide:

(1) **On-Site Monitoring –** Operators have the unique ability to monitor odors throughout the day with field olfactometry. Operator monitoring can include odor observations of arriving materials, outdoor process activities, and fugitive air emissions. Monitoring with a Nasal Ranger® Field Olfactometer on-site may include odor observations at predetermined locations, i.e. open doorways, driveways, storage areas, and fence lines.

(2) **Random Monitoring –** A frequently used method for ambient odor monitoring is the "random inspection" approach. Random monitoring leads to a compilation of data that can be correlated with meteorological information and on-site activities. Managers and regulators alike find that random odor monitoring with a Nasal Ranger® Field Olfactometer is a cost effective protocol.

(3) **Scheduled Monitoring –** Well-planned scheduled monitoring can be limited to a daily "walk-about" or "drive around", or structured with several visits to predetermined monitoring locations. Data from a Nasal Ranger® Field Olfactometer can be used to correlate the many parameters that influence odor episodes, including meteorological conditions and on-site operating activities.

(4) **Intensive Odor Survey –** An in-depth evaluation of on-site odor generation and off-site odor impact may be needed for permit renewal or facility expansion. Extensive data collection with the Nasal Ranger® Field Olfactometer will identify which sources or operations cause odor and which ones do not cause odor off-site. All potential odor sources and operations could be ranked and their relative contributions determined. Short term trials or tests of odor mitigation measures, e.g. odor counteractants, would also require an intensive period of data collection using a Nasal Ranger® Field Olfactometer.

(5) **Citizen Monitoring –** The implementation of citizen odor monitoring with Nasal Ranger® Field Olfactometers can be part of an interactive community outreach program. The primary function of citizen odor monitoring is to collect information, through accurate record keeping, which represents real conditions in the community. Citizens recruited and trained to measure odors using Nasal Ranger® Field Olfactometers would also report odor descriptors. Citizen odor monitoring will assist in determining prevalent times and prevalent weather conditions of odor episodes. Citizen odor monitoring with Nasal Ranger® Field Olfactometer will also help in understanding the odor strength at which an odor first becomes a nuisance.

(6) **Complaint Response –** The use of "Odor Compliant Hot Lines" is a common method used by facilities and communities to respond to odor episodes. A complaint response plan, with designated "on-call" responders, creates opportunities for verifying odor episodes, tracking odor sources, and quantifying odor strength with a Nasal Ranger® Field Olfactometer.

(7) **Plume Profiling –** Standard and specialized air dispersion modeling predicts the transport and dilution of odors by the wind. A protocol, known as plume profiling, supplements and "calibrates" air dispersion modeling. Several inspectors with Nasal Ranger® Field Olfactometers, spaced cross wind and down wind from an odor source, would measure and record the odor strength as "D/T" values. The odor plume profile would then be documented and overlaid on the local terrain map. Therefore, the air dispersion modeling and the local topography would be integrated with actual odor measurements from the Nasal Ranger® Field Olfactometer.

NASAL RANGER® FIELD OLFACTOMETER

APPLICATION GUIDE FOR FIELD OLFACTOMETRY

(CONTINUED)

ODOR REGULATIONS

A field olfactometer device (“scentometer”) is referenced in a number of existing state odor regulations. The “Dilution to Threshold” (D/T) terminology and the method of calculating the D/T are also referenced.

The criteria of an odor regulation often defines compliance as

“…ambient air that is less than 7 D/T” (7 used for exemplary purpose only).

The exact wording in a regulation is important and may be stated in two ways:

Compliance criteria: “…compliance if…less than 7 D/T.”

Nuisance criteria: “nuisance if…equal to or greater than 7 D/T.”

In these two examples, **if** an air pollution inspector observed “odor” with the field olfactometer set at a 7 D/T

The “odor” would meet the criteria for nuisance or

The ambient air would be “non-compliant”.

Odor regulations that utilize field olfactometry and a calibrated field olfactometer, e.g. Nasal Ranger Field Olfactometer, also define the number of observations needed and the time frame of the observations.

For example, a regulation may read:

“…Two field olfactometer observations in a one-hour period separated by 15 minutes each…” OR

“…Two field olfactometer observations not less than 15 minutes apart within a 1-hour period…”

The “protocols” in this Application Guide for Field Olfactometry are presented in brief example form and are not mutually exclusive, often being integrated into a comprehensive odor management program. Likewise, the “odor regulation” criteria for compliance and nuisance are presented as examples only and are taken from actual odor regulations.

Please contact St. Croix Sensory, Inc. at 1-800-879-9231 (+651-439-0177), or visit www.NasalRanger.com, if you have any questions about the use and application of the Nasal Ranger® Field Olfactometer or if you need additional information or referral to industry or regulatory specialists.

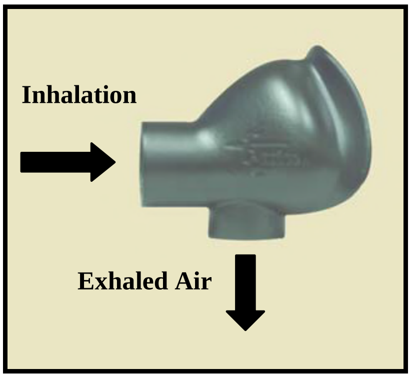
Nasal Ranger® Nasal Mask

INSTRUCTIONS OF USE AND MAINTENANCE

The Nasal Ranger® Nasal Mask is made of a carbon-fiber/epoxy polymer with a fluoropolymer coating. The Nasal Mask was specifically designed for use with the Nasal Ranger® Field Olfactometer. The Nasal Mask has three openings:

1) **Nasal Port –** ergonomically designed to match the geometry of the human nose and face,
2) **Inhalation Inlet** – opposite the nasal port, this port allows air into the mask from the Field Olfactometer, and
3) **Exhalation Outlet** – when the nose is placed in the nasal port, the exhalation outlet is the opening above the upper lip, which allows air exhaled through the nose to exit the mask.

A check valve is placed in both the inhalation inlet and the exhalation outlet in order to control the direction of air flow while using the Nasal Ranger® Field Olfactometer. The check valve placed inside the inhalation inlet allows air to pass from the Nasal Ranger® Field Olfactometer into the Nasal Mask during inhalation and prevents air from passing back into the Nasal Ranger® Field Olfactometer during exhalation. The check valve in the exhalation outlet allows air exhaled through the nose to pass out of the Nasal Mask and prevents ambient air from getting into the mask through this port during inhalation.



The check valves are replaceable if they become dirty or damaged. The valves are pressed into the respective ports and can be removed by applying pressure to the outer rim of the valve from inside the Nasal Mask. The inhalation and exhalation check valves are supplied by St. Croix Sensory as Part Numbers NR0041 and NR0042.

Attachment: To ensure long lasting o-rings give mask a half turn clockwise when mounting to Nasal Ranger.

Cleaning: St. Croix Sensory recommends cleaning the Nasal Mask using disposable wipes wetted with isopropyl alcohol. St. Croix Sensory provides specified wipes as Part Number NR0063. Moist towelettes and other wipes purchased in stores usually contain a fragrance that may leave a background odor on the Nasal Mask. Store purchased wipes should be avoided.

CAUTION: The Nasal Mask is fragile. The mask could break if dropped onto a hard surface.

WARNING: Cleaning the Nasal Mask in a dishwasher or autoclave or otherwise exposing the Nasal Mask to extreme heat (e.g. >120°F) will damage the Nasal Mask.

The Comfort Seal

The Comfort Seal is a disposable accessory designed to improve the mask sealing and comfort during use with the Nasal Ranger® Nasal Mask and Nasal Ranger® Field Olfactometer. The Comfort Seal is manufactured of unique super-soft foam that has been used for years in skin contact applications in the medical industry. The seal is shaped to match the geometry of the Nasal Ranger® Nasal Mask used for the Nasal Ranger® Field Olfactometer. The seals are easy to apply with a pressure sensitive adhesive on one side that attaches to the mask.

To install the Comfort Seal, follow these simple steps:
1. GRIP the pull-tab on the paper backing.
2. PEEL off the paper backing.
3. ALIGN the seal with the mask rim.
4. PRESS the seal onto the mask firmly.

Nasal Ranger® Nasal Mask

INSTRUCTIONS OF USE AND MAINTENANCE

(CONTINUED)

The Comfort Seal "installed" to accommodate noses of all sizes.

WIDE NARROW

The Comfort Seal is designed for use by one person ONLY. The Comfort Seal needs to be wiped at least daily and changed weekly or more frequently in order to be odor-free. Remove and dispose of the seal when it becomes dirty or if another person will be using the mask. Remove the comfort seal; rub off the gummy glue residual; and wipe the face of the mask with an isopropyl wipe.

Mask Fit Test (LEAK TEST) for Best Results:

With the stopper in place (LEAK TEST), you should not be able to inhale through your nose.

NASAL RANGER® REPLACEABLE ODOR-FILTER CARTRIDGES

INSTRUCTIONS OF USE AND MAINTENANCE

NOTICE: The replaceable odor-filter cartridges are ONLY for use with the Nasal Ranger® Field Olfactometer manufactured by St. Croix Sensory, Inc.

The replaceable odor-filter cartridges contain a proprietary blend of granular activated carbon multi-media, which is designed to remove odors from the ambient air.

These cartridges are NOT to be used under the following conditions or scenarios:

1. As respirator cartridges for the reduction or elimination of hazardous chemicals in the air.

2. In atmospheres where contaminant concentrations are unknown, immediately dangerous to life/health, or exceed applicable local standards or U.S. Occupational Safety and Health Administration (OSHA) standards.

3. In atmospheres that contain less than 19.5% oxygen.

Replacement Instructions

The replaceable cartridges are attached to the Nasal Ranger® Field Olfactometer with a right hand thread. The following instructions are used to replace a set of cartridges:

1. Remove the used cartridges by loosening the right hand thread (**Turn Counterclockwise**)

2. Dispose of the used cartridges.

3. Remove the new cartridges from the plastic packaging.

4. Install the new cartridges by inserting the threaded end into the cartridge holder on the Nasal Ranger® Field Olfactometer and turning the cartridge in the direction of the arrow on the label (**Turn Clockwise**).

5. Tighten the cartridge **HAND TIGHT ONLY**. The cartridge will tighten against the o-ring inside the cartridge holder on the Nasal Ranger® Field Olfactometer.

Replace both cartridges in accordance with an established "cartridge change schedule". The user may decide to replace the cartridges before each use of the Nasal Ranger® Field Olfactometer, or may chose a convenient time frame for replacement. Cartridges should be changed immediately if the user detects a smell when inhaling through the Nasal Ranger® Field Olfactometer set on a blank position (odor-filtered air only).

Leave the odor-filter cartridges in factory packaging before they are used. Once the cartridge packages are opened, store the cartridges away from odorous areas when not in use.

Do not alter, misuse or abuse these replaceable odor-filter cartridges.

Please contact St. Croix Sensory, Inc. if you have any questions about the use, application, or maintenance of the Nasal Ranger® Replaceable Odor-Filter Cartridges at 1-800-879-9231 (+651-439-0177), or visit **www.NasalRanger.com**.

NASAL RANGER® FIELD OLFACTOMETER

TROUBLESHOOTING GUIDE

If any problem is not resolved with these suggested solutions, contact St. Croix Sensory for technical support at 1-800-879-9231 (+651-439-0177) or info@nasalranger.com.

Problem	Possible Solutions
Nasal Ranger has no power (Power LED doesn't light up)	Press the power button again to confirm the unit will not restore power.
	Check to be sure the battery is properly connected. Open the battery compartment and check the battery connection.
	The battery may be low on power. Install a new battery.
Power LED is blinking	This is normal. The Nasal Ranger will go into a "Power Save" mode if the unit is not used for 45 seconds.
Power only stays on for a short time	The Nasal Ranger does have an Auto Shut-Off mode if the unit does not sense inhalation over a five-minute period.
	The battery may be low on power. Install a new battery.
Flow Sensor LED's not responding to inhalation by the user.	The battery may be low on power. Install a new battery.
	The nasal mask may not be properly sealing to the user's face. Try to reposition the unit against the face. Try different positions to see if the LED's respond to inhalation.
	The nasal mask check valve(s) may be loose or leaking air. Inspect the check valves to be sure they are properly positioned inside the mask ports. Inspect the check valves for any damage or loose debris (i.e. dust). Check valves may need replacing.
Flow Sensor LED's responding erratically to inhalation.	The battery may be low on power. Install a new battery.
	The nasal mask may not be properly sealing to the user's face. Try to reposition the unit against the face. Try different positions to see if the LED's respond to inhalation.
	The nasal mask check valve(s) may be loose or leaking air. Inspect the check valves to be sure they are properly positioned inside the mask ports. Inspect the check valves for any damage or loose debris (i.e. dust).

Problem	**Possible Solution**
An odor is detected while the dial is set at a "blank" position	The nasal mask may not be properly sealing to the user's face allowing ambient air to leak around the mask diameter. Try to reposition the unit against the face. Try different positions to see if the LED's respond to the inhalation.
	The nasal mask check valve(s) may be loose or leaking air. Inspect the check valves to be sure they are properly positioned inside the mask ports. Inspect the check valves for any damage or loose debris (i.e. dust). Check valves may need replacing.
	The replaceable odor-filter cartridges may not be properly seated in the Nasal Ranger housing. Inspect the position of cartridges. Be sure they are threaded into the housing correctly. Be sure they are threaded tight (Hand Tight ONLY) against the housing O-rings.
	The odor-filter cartridges may need replacing. The odor-filter cartridges have a limited life span, which is dependent on amount and frequency of use. Replace the odor-filter cartridges (Part Number: NR8).
	The ambient odor may be to strong or of the type that exceeds the design of the odor-filter cartridges. Contact St. Croix Sensory for assistance.
	The internal seals may be leaking. Contact St. Croix sensory for assistance.
The D/T Dial does not turn	The dial mounting screw may be too tight. Loosen the dial mounting screw.
	Debris may be impeding movement of the dial. Inspect the dial for loose debris. The dial may need to be removed in order to inspect and clean the dial turning area. Contact St. Croix Sensory for assistance.
The D/T Dial does not stop at a specific position (dial spins freely).	The dial mounting screw may be too loose. Tighten the dial mounting screw.

NASAL RANGER® FIELD OLFACTOMETER

Sales Terms & Conditions
St. Croix Sensory

Offer and Acceptance.
This document is an offer to enter into an agreement. For an effective agreement to be reached a duly authorized agent of Purchaser must accept all of the terms and conditions set forth below, none of which can be altered or amended without St. Croix Sensory's prior written agreement.

Quotations and Prices.
The price stated on a St. Croix Sensory quotation form is firm for the initial order for a Nasal Ranger® Field Olfactometer or related product only. Prices are subject to change without notice and orders calling for future delivery will be billed according to the price in effect at the time of delivery. Oral quotations will not be honored by St. Croix Sensory and written quotations will automatically expire sixty (60) calendar days from the date issued and are subject to earlier termination by written notice. All prices are FOB, St. Croix Sensory's manufacturing facility.

Payment Terms.
The net amount of each invoice is due in full with the order, by credit card payment or other method acceptable to St. Croix Sensory.

Taxes.
All present or future sales, use, revenue, excise or other taxes applicable to the Nasal Ranger® Field Olfactometer or related products which are the subject of this Agreement shall be added to the purchase price and shall be paid by Purchaser, unless Purchaser provides St. Croix Sensory with a tax exemption certificate acceptable to the relevant taxing authorities.

Shipment.
Both the method and the route of shipment are at the discretion of St. Croix Sensory, unless Purchaser supplies explicit instructions to the contrary. All insured shipments will be made at Purchaser's expense. Identification of the particular Nasal Ranger® Field Olfactometer or related products to this agreement and the risk of loss will pass to Purchaser at the time of delivery to the carrier.

Governing Law and Venue.
This agreement shall be governed by and construed under and in accordance with the laws of the State of Minnesota, United States of America (without regard to conflicts of laws principles). The venue of any legal action arising out of this agreement shall be the Federal or State Courts located in Hennepin or Ramsey County in Minnesota, U.S.A., and the parties consent to the jurisdiction of these courts.

Nasal Ranger® Field Olfactometer Limited Warranty.
St. Croix Sensory warrants to Purchaser that in normal and contemplated use and service, the Nasal Ranger® Field Olfactometer purchased from St. Croix Sensory will be free from defects in material or workmanship for a period ending 365 days from the date of original shipment by St. Croix Sensory. Subject to the conditions and exclusions contained in this document, St. Croix Sensory will, at its option, either repair or replace any defective Nasal Ranger® Field Olfactometer or part thereof, or refund the purchase price of the defective Nasal Ranger® Field Olfactometer. Parts, devices or equipment that are supplied by vendors other than St. Croix Sensory, shall carry only the applicable warranties and limitations provided by the relevant vendor. Expendable and/or consumable items or parts included or used in connection with the Nasal Ranger® Field Olfactometer are not covered under this limited warranty. This limited warranty does not cover a Nasal Ranger® Field Olfactometer that has been misused, altered, disassembled, neglected, handled carelessly, or used for purposes other than its intended purpose. This limited warranty also does not cover loss or damage resulting from any casualty loss or from unauthorized use or service. Under no circumstances shall St. Croix Sensory be liable for consequential or other damages, losses, or expenses in connection with or by reason of the use or inability to use the Nasal Ranger® Field Olfactometer for any purpose. **WARNING:** Unscrewing and disassembling the Nasal Ranger® Field Olfactometer housing will break and alter the pressure seal of the instrument (6 screws visible on the left-housing and 2 under the battery door). Doing so will void the limited warranty and require the instrument to be shipped back to St. Croix Sensory to be re-sealed and re-calibrated at Purchaser's expense.

Warranty Service Procedures.
If a defect should appear during the warranty period, Purchaser should return the defective Nasal Ranger® Field Olfactometer, freight and insurance prepaid, if possible in the original shipping container, to such address as shall be specified from time to time by St. Croix Sensory. The appropriate warranty service address may be determined by calling 1-800-879-9231 (+651-439-0177) or by consulting www.nasalranger.com. Any returned Nasal Ranger® Field Olfactometer must be accompanied by a written statement including: the name of Purchaser; a description of the problem(s); and the action desired. St. Croix Sensory shall not be responsible for any loss or damage incurred in shipping. Any warranty work to be performed by St. Croix Sensory shall be subject to St. Croix Sensory's confirmation that the returned Nasal Ranger® Field Olfactometer meets St. Croix Sensory's warranty requirements. If a defect is covered by this limited warranty, the repaired or replaced Nasal Ranger® Field Olfactometer will be returned to Purchaser at St. Croix Sensory's cost. Following a warranty repair or replacement, this limited warranty shall continue in effect until the end of the original warranty period or for sixty (60) days after the repair or replacement, whichever is later.

Sales Terms & Conditions
St. Croix Sensory

(Continued)

Related Product Limited Warranty.
St. Croix Sensory warrants to Purchaser that in normal and contemplated use and service any product related to the Nasal Ranger® Field Olfactometer purchased by Purchaser ("related products" includes components, consumables and similar items such as odor-filter cartridges, nasal masks, check valves, carrying straps, and carrying case) shall be free from defects in material or workmanship for a period ending (i) 90 days from the date of original shipment by St. Croix Sensory, or (ii) upon expiration of the time specified with respect to a particular product, as applicable. Subject to the conditions and exclusions in this document, St. Croix Sensory will, at its option, repair or replace any related product that is defective, or refund the purchase price. Under no circumstances shall St. Croix Sensory be liable for consequential or other damages, losses, or expenses in connection with or by reason of the use or inability to use a related product purchased for any purpose.

Exclusion of Warranty of Fitness for any Purpose.
St. Croix Sensory makes no warranty as to the suitability or fitness of any of its equipment or products, including specifically the Nasal Ranger® Field Olfactometer, for any particular purpose specific to the Purchaser. The Purchaser is solely responsible for the selection, use, efficiency, fitness and suitability of St. Croix Sensory's equipment and products. The Purchaser assumes all risks and liabilities in connection with the use of St. Croix Sensory's equipment and products, including specifically the Nasal Ranger® Field Olfactometer.

Exclusion of Liability for Consequential and Similar Damages.
In no event shall St. Croix Sensory be liable to Purchaser for any indirect, special or consequential damages or lost profits arising out of or relating to the Nasal Ranger® Field Olfactometer or related products, or their performance or non-performance, even if St. Croix Sensory has been advised of this possibility.

Limitation to Amounts Paid. St. Croix Sensory's liability, if any, to Purchaser or to the customers of Purchaser or any other person under this limited warranty shall in no event exceed the total amount paid to St. Croix Sensory by the Purchaser for a defective or non-conforming Nasal Ranger® Field Olfactometer or related product.

THE LIMITED WARRANTY AND REMEDIES SET FORTH IN THIS DOCUMENT ARE THE SOLE AND EXCLUSIVE REMEDIES AVAILABLE TO ANY PERSON FOR ANY DAMAGES OF ANY KIND AND NATURE, INCLUDING INCIDENTAL, CONSEQUENTIAL OR SPECIAL, RELATED TO THE NASAL RANGER® FIELD OLFACTOMETER OR RELATED PRODUCTS, WHETHER ARISING FROM WARRANTY, CONTRACT, NEGLIGENCE, TORT OR OTHERWISE. ST. CROIX SENSORY SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER IMPLIED WARRANTY. NO WAIVER, ALTERATION, OR MODIFICATION OF THE FOREGOING CONDITIONS SHALL BE VALID UNLESS MADE IN WRITING AND SIGNED BY AN EXECUTIVE OFFICER OF ST. CROIX SENSORY.

In the event any implied warranties (including, but not limited to the implied warranties of merchantability or fitness for a particular purpose) are found to exist, such warranties are limited (i) in duration to the period of the limited warranties set forth in this document, and (ii) in amount to the total amount paid to St. Croix Sensory by the Purchaser for the Nasal Ranger® Field Olfactometer or related product in question. (Some States do not permit the exclusion of incidental or consequential damages, and in those States the foregoing limitation may not apply. The limited warranties as set forth in this document give the Purchaser specific legal rights, and the Purchaser may have other legal rights which vary from State to State.)

NASAL RANGER® FIELD OLFACTOMETER

PARTS AND ACCESSORIES

Part Number	***Description***
NR0009	**9-Volt Battery**
NR0010	**Carry Bag**
NR0011	**Odor Sensitivity Test Kit**
NR0020	**O-Ring, Mask Connection (2-pair)**
NR0021	**O-Ring, Odor-Filter Cartridge (pair)**
NR0023	**Battery Cover**
NR0024	**Screw, Battery Cover**
NR0031	**Barrel Brush**
NR0032	**Shoulder Strap**
NR0041	**Check Valve Kit, Inhalation**
NR0042	**Check Valve Kit, Exhalation**
NR0046	**Nasal Ranger Mask Package**
NR0049	**Stopper**
NR0050	**Standard D/T Dial Assembly**
NR0051	**Torx Driver for Obsolete Dial Screw**
NR0052	**Dial Screw-Springs-Washer Set**
NR0053	**T-Handle Hex Key (Allen Wrench) for Dial Assembly**
NR0054	**High D/T Dial Assembly**
NR0062	**Comfort Seal Package (10)**
NR0063	**Isopropyl Alcohol Mask Cleaning Wipes Package (10)**
NR0081	**Type I Universal Odor-Filter Cartridge (pair)**
NR0082	**Type II Organic Vapor Odor-Filter Cartridges (pair)**
NR0083	**Type III Hydrogen Sulfide Odor-Filter Cartridges (pair)**
NR0084	**Type IV Ammonia Odor-Filter Cartridge (pair)**
NR0091	**Type I Universal Odor-Filter Cartridge (case of 6 pairs)**
NR0092	**Type II Organic Vapor Odor-Filter Cartridge (case of 6 pairs)**
NR0093	**Type III Hydrogen Sulfide Odor-Filter Cartridge (case of 6 pairs)**
NR0094	**Type IV Ammonia Odor-Filter Cartridge (case of 6 pairs)**

For pricing and availability, send email request to info@nasalranger.com

Nasal Ranger® Field Olfactometer
Technical Specifications

Detection Technique:	Human Nose
Discrete Dilution Ratios:	2, 4, 7, 15, 30, 60 D/T’s (Standard Dilution-to-Threshold Ratios)
Response Time:	As fast as 3-seconds (2 inhalations)
Accuracy:	+/- 10% of D/T
Repeatability:	+/- 2%
Inhalation Rate:	16-20 liters per minute
Operating Temperature Range:	32° to 104°F, 0° to 40°C
Power Requirements:	Standard 9-Volt Alkaline Battery
Dimensions:	14”(L) x 7.5”(H) x 4”(W) (35.5 x 19 x 10 cm)
Weight:	2.0 lbs (0.91 kg)
Materials of Construction:	PTFE and Polymer Alloys
Odor Filter Cartridge:	3.5” diameter x 1.5” (H) (8.9 cm diameter x 7 cm)
Nasal Mask:	2.75” (H) x 2.25” (W) (7 cm x 5.7 cm)
Patent:	U.S. Patent No.: 6,595,037
Calibration Verification:	Recommended Annually
EMC Verification:	Emissions: EN 61326: 1997, Class B Immunity: EN 61326:1997, Industrial Location
Markings:	89/336/EEC (EMC) 92/59/EEC (General Product Safety) CE

ODOR MONITORING DATA SHEET

DATE:_______________

TIME	LOCATION	60	30	15	7	4	2	<2	ND	DESCRIPTORS	COMMENTS

Weather Conditions	Precipitation	Wind Direction (Blowing From)	Wind Speed
☐ Mostly Sunny	☐ None	N	☐ Calm
☐ Partly Cloudy	☐ Fog	NW NE	☐ Light Breeze (1- 5 mph)
☐ Mostly Cloudy	☐ Rain	W -------------------- E	☐ Moderate Wind (5 – 15 mph)
☐ Overcast	☐ Sleet	SW SE	☐ Strong Winds (15 mph or higher)
☐ Hazy	☐ Snow	S	

Temperature: _______________ F Relative Humidity: _________ % Barometric Pressure ________

Notes: ____
____
____
____
____

______________ ______________________________________ __________________________________

Date Name Signature

Odor Descriptors

Floral - 100

Almond - 101
Cinnamon - 102
Coconut - 103
Eucalyptus - 104
Fragrant - 105
Herbal - 106
Lavender - 107
Licorice - 108
Marigolds - 109
Perfumy - 110
Rose-like - 111
Spicy - 112
Vanilla - 113

Medicinal - 800

Alcohol - 801
Ammonia - 802
Anesthetic - 803
Camphor - 804
Chlorinou- 805
Disinfectant - 806
Menthol - 807
Soapy - 808
Vinegar - 809

Fruity - 200

Apple - 201
Cherry - 202
Citrus - 203
Cloves - 204
Grapes - 205
Lemon - 206
Maple - 207
Melon - 208
Minty - 209
Orange - 210
Strawberry - 211
Sweet - 212

Chemical - 700

Burnt Plastic - 701
Car exhaust - 702
Cleaning fluid - 703
Coal - 704
Creosote - 705
Diesel - 706
Gasoline - 707
Grease - 708
Foundry - 709
Kerosine - 710
Molasses - 711
Mothball - 712
Oil - 713
Paint - 714
Petroleum - 715
Plastic - 716
Resins - 717
Rubber - 718
Solvent - 719
Styrene - 720
Sulfur - 721
Tar / Asphalt - 722
Turpentine - 723
Varnish - 724
Vinegar - 725
Vinyl - 726

Vegetable - 300

Celery - 301
Corn - 302
Cucmber - 303
Dill - 304
Garlic - 305
Green pepper - 306
Nutty - 307
Potato - 308
Tomato - 309
Onion - 310

Earthy - 400

Ashes - 401
Burnt Wood - 402
Chalk like - 403
Coffee - 404
Grain Silage - 405
Grassy - 406
Mold - 407
Mouse-like - 408
Mushroom - 409
Musky - 410
Musty - 411
Peat-like - 412
Pine - 413
Smokey - 414
Stale - 415
Swampy - 416
Woody - 417
Yeast - 418

Fishy - 600

Amine - 601
Dead fish - 602
Perm Solution - 603

Offensive - 500

Blood - 501
Burnt - 502
Burnt Rubber - 503
Decay - 504
Fecal - 505
Garbage - 506
Landfill Leachate - 507
Manure - 508
Mercaptan - 509
Putrid - 510
Rancid - 511
Raw Meat - 512
Rotten Eggs - 513
Septic - 514
Sewer - 515
Sour - 516
Spoiled Milk - 517
Urine - 518
Vomit - 519

NASAL RANGER

County Environmental Dept.

Date: 1/4/08

Time	Location	D/T 60	30	15	7	4	2	<2	Descriptors	Comments
7:05 AM	1 - Industrial Park							x		
7:10 AM	2 - " "						x		718	FACTORY
7:15 AM	3 - " "							x		
7:20 AM	4 - " "				x				718, 723	FACTORY
7:25 AM	5 - Intersection					x			705	FACTORY
7:30 AM	6 - Intersection							x		
7:35 AM	7 - Co. RD. 20		x						718, 723, 515	FACTORY & WWTP
7:40 AM	8 - Intersection			x					718, 723, 515	FACTORY
7:45 AM	9 - Junction Rd.				x				718, 723	FACTORY & WWTP
7:50 AM	10 - Co. Rd. 28			x					718, 515, 601	FACTORY & WWTP
7:55 AM	11 - Division Ave.					x			718, 601	FACTORY & WWTP
8:00 AM	12 - Intersection							x		
8:05 AM	13 - Parking Lot					x			104, 304	VEGETATION
8:10 AM	14 - Intersection						x		707	HIGHWAY
8:15 AM	15 - Intersection							x		
8:20 AM	16 - Intersection							x		
8:25 AM	17 - Housing Devel.						x		201	APPLE TREES
8:30 AM	18 - 3rd & Oak					x			706, 404	COFFEE SHOP

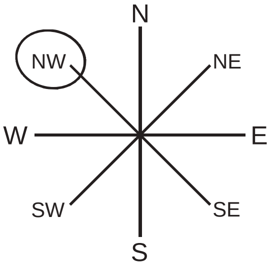
Weather Conditions

- [ ] Sunny
- [ ] Partly Cloudy
- [ ] Mostly Cloudy
- [x] Overcast
- [ ] Hazy

Precipitation:

- [ ] None
- [x] Fog
- [ ] Rain
- [ ] Sleet
- [ ] Snow

Wind Direction
Blowing From: (circel one)



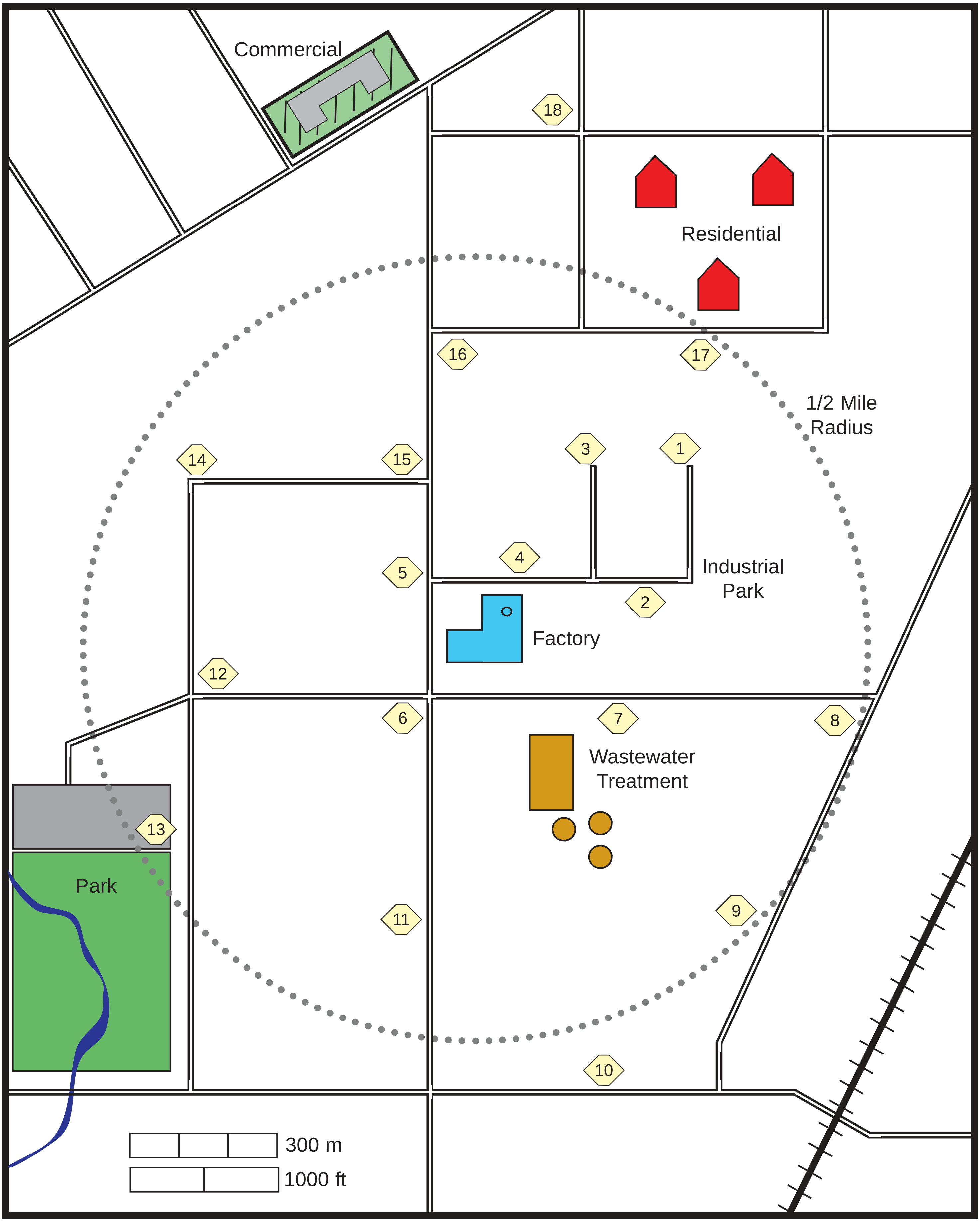
Wind Speed:

- [ ] Calm
- [x] Light Breeze (1-5 mph)
- [ ] Moderate Wind (5-15 mph)
- [ ] Strong Winds (15 or higher mph)

Temperature: 55 °F/°C Relative Humidity: 60 % Barometric Pressure: 30.1

Comments: ______________________________

008	Nigel Mackenzie	Nigel MacKenzie
Code	Name	Signature


Commercial
18
Residential
16
17
1/2 Mile
Radius
14
15
3
1
4
5
Industrial
Park
2
Factory
12
6
7
8
Wastewater
Treatment
13
Park
11
9
10
300 m
1000 ft

ATTACHMENT 2

Odor Parameters

St. Croix Sensory specializes in quantification of perceived odors of air samples and commercial products and materials. Odors are the sensory perception caused by odorants (chemicals) stimulating olfactory receptors in the nose.

Odors can be quantified by five parameters that profile the human response. These parameters include: odor thresholds, odor intensity, odor persistency, hedonic tone, and odor characterization.

The following is a brief explanation of these parameters of the odor evaluation services provided by St. Croix Sensory. For environmental odor samples, an odorous air sample collected in a Tedlar air sample bag is evaluated. For product and material testing, the sample may also be from a Tedlar air sample bag or it may be a direct observation of a headspace developed around the sample or from an environmental test chamber.

Odor Thresholds

The most common measure of odors is the odor threshold value (OTV), also referred to as the odor concentration or odor strength. Odor strength is quantified by determining the amount of dilution needed to bring the odorous air sample to its threshold. The higher the threshold value, the more dilution is needed to bring the odor to threshold, thus the stronger the odor.

The odor threshold is determined by trained human assessors observing presentations of the odorous air sample dynamically diluted with an olfactometer. The testing procedures follow ASTM International E679-04, *Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits*, and EN13725:2003, *Air Quality – Determination of Odour Concentration by Dynamic Olfactometry*. EN13725, the official standard of all European Union countries, exceeds the requirements of ASTM E679-04. The standardization organizations of Australia and New Zealand have also adopted an identical standard (AS/NZ 4323.3-2001).

These testing standards utilize a presentation method called "3-alternative forced-choice" (3-AFC) or "triangular forced-choice (TFC). Each assessor performs the odor evaluation task by sniffing diluted odorous air from the olfactometer. The assessor sniffs three sample presentations; one contains the diluted odor while the other two are "blanks" (odor-free air). They must then select the one of the three that is "different" from the other two. The assessor is required (forced) to choose one of the three and acknowledge their response as a "guess", "detection", or "recognition", as defined by ASTM E679-04.

After the first set of presentations, the assessor is then presented with the next dilution level. At this next level, the assessor is again presented with three sample choices, one of which is the diluted odor sample. However, this next dilution level presents the odor at a higher concentration (i.e. two times higher). This is one-half the dilution ratio (fewer number of dilutions = higher concentration). The first dilution level presented to the assessors is below the odor threshold (subthreshold). The assessor proceeds to higher levels of sample presentation following these methods until the odor concentration is above the recognition threshold. This statistical approach is called "ascending concentration series."

Results are computed for each assessor based on the dilution levels where correct "detection" or "recognition" responses are recorded. The responses of all assessors are averaged to determine the sample's detection and recognition thresholds.

The dynamic dilution of an odorous emission is the physical process that occurs in the atmosphere down-wind of the odor source. An individual, or citizen from the community, observes the diluted odor. The dilution ratio is an estimate of the number of dilutions needed to make the actual odor emission just detectable. This is known as the Detection Threshold (DT). The Recognition Threshold (RT) is the dilution ratio at which the assessor first detects the odor's character ("smells like…"). The recognition threshold value is always lower than the detection threshold value. It takes more dilution to bring an odor to its detection threshold (no odor present) compared to its recognition threshold (odor is not recognizable).

The odor threshold is reported as a dimensionless dilution ratio; however, often the pseudo-dimensions of "Odor Units' (O.U.) are used. Units of "Odor Units per cubic meter" (O.U./m^3) are also commonly applied in order to calculate odor emission rates.

For this testing, St. Croix Sensory utilizes an AC'SCENT® International Olfactometer, a dynamic dilution triangle olfactometer, operating at 20-LPM with 5 assessors, who complete the threshold determination a minimum of two times (EN13725:2003). Final results are retrospectively screened in order to evaluate and identify assessors who may have a specific hypersensitivity or anosmia to the odor sample presented.

The assessors are tested and "certified" with a standard odorant (n-butanol) and are required to meet specific sensitivity criteria outlined in the European testing standard, EN13725. These assessors are required to have an average n-butanol detection threshold between 20-80 ppb based on their last 20 evaluations. Assessors also must maintain a defined standard deviation of n-butanol threshold measurements in order to satisfy repeatability requirements of the standard.

St. Croix Sensory may utilize more assessors when necessary for a specific project. Furthermore, the AC'SCENT International Olfactometer is capable of operating from 3-LPM to 20-LPM if the client requires a specific flow rate that deviates from the EN13725 standard requirements.

Odor Intensity

Odor intensity is the relative strength of the odor above the Recognition Threshold (suprathreshold). The intensity of an odor is referenced on the ASTM Odor Referencing Scale described in ASTM E544-99, *Standard Practice for Referencing Suprathreshold Odor Intensity*. The IITRI Dynamic Dilution Binary Olfactometer (Butanol Wheel) is the dynamic presentation method St. Croix Sensory utilizes for the procedure of odor intensity referencing.

The odor referencing is accomplished by comparison of the odor intensity of the odor sample to the odor intensity of a series of concentrations of the reference odorant n-butanol. The Butanol Wheel olfactometer delivers the butanol in air to 8 glass sniffing ports that make-up a series of increasing concentrations of the butanol. The series starts at 12-ppm butanol and has an increasing concentration ratio of 2 (binary scale).

Each assessor observes the odorous air sample and determines the odor intensity. The average value of the panel of assessors is the reported intensity for the odor sample, expressed in units of parts per million (PPM) butanol equivalent. A larger value of butanol concentration means a stronger odor, but not in a simple numerical proportion, i.e. twice the butanol concentration does not mean twice the perceived odor intensity.

The Odor Intensity Referencing Scale serves as a standard method to quantify the intensity of odors for documentation and comparison purposes.

Odor Persistency ("Dose Response"):

Odor is a psychophysical phenomenon; the perceived odor intensity changes with concentration. Odor persistency is a term used to describe the rate at which the perceived intensity decreases as the odor is diluted, i.e. in the atmosphere down-wind from the odor source. The rate of change in intensity versus odor concentration is not the same for all odors.

The odor intensity is related to the odor concentration by the following equation (Steven's Law),

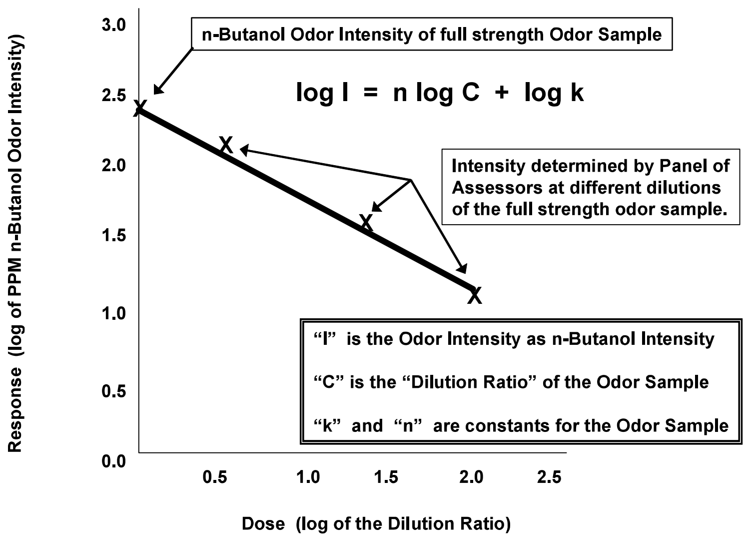
$I = k\,(C)^n$

Where:
I is the odor intensity expressed in ppm n-butanol,
C is the odor concentration expressed in number of dilutions (dilution ratio), and
k and n are constants that are different for every specific odorant or mixture of odorants.

This odor persistency relationship is a "Dose-Response" function (a psychophysical power function), which is linear on a log-log scale with the following equation:

$$\text{Log } I = n \text{ Log } C + \log k$$

The "Dose-Response" function is determined from intensity measurements of an odor at a minimum of three dilutions and possibly at the full strength concentration, utilizing ASTM E544, *Standard Practice for Referencing Suprathreshold Odor Intensity*. The plotted logarithmic values of the odor intensities and the odor dilution ratios (concentrations) create the "Dose-Response" function of the odor sample. The resultant straight line of the log-log plot is specific for each odor, with the slope of the line, n, representing relative persistency and the y-axis intercept, k, representing the full strength intensity. A flatter slope of an odorant mixture represents a more persistent odor.



This "Dose-Response", persistency, graph can be converted to a Power Law graph showing how the intensity changes with the odor concentration, represented in "Odor Units." This conversion is completed by taking the recognition threshold of the odorous air sample, the full strength odor concentration, into consideration.

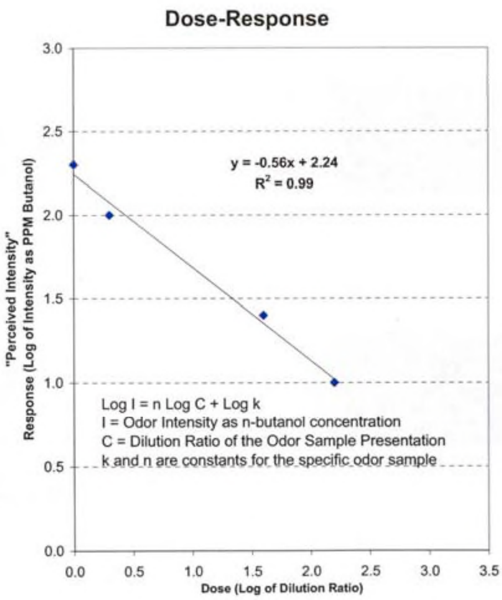
The number of odor units presented at each diluted odor presentation can be determined by dividing the Recognition Threshold (RT) by the Dose-Response dilution ratio test points. For example, if the RT (full strength odor concentration) is 2000 O.U. and the assessor is presented with this odor at 40 dilutions, then the assessor was presented with an odor that is equivalent to 50 O.U. The power law relationship can then be represented as:

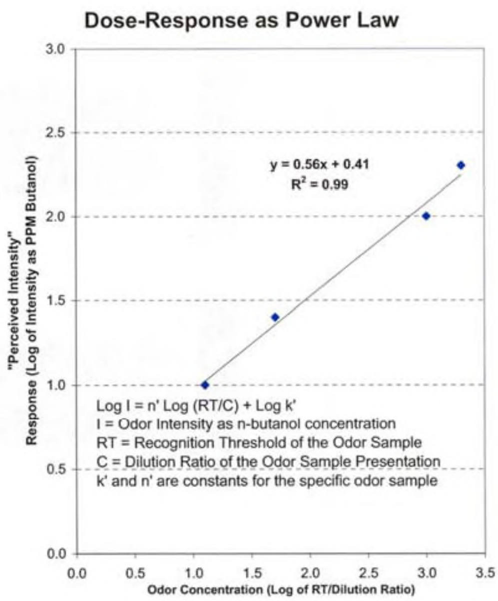
Log I = n' Log (RT/C) + Log k'

This equation will have a positive slope. The slopes of the two curves are related by:

n = - n'

The following pair of graphs illustrates the example of an odor that has a recognition threshold of 2000 O.U. The assessors were presented with this odor sample at full strength and at dilutions of 2, 40, and 160.





The positive slope of the Power Law graph illustrates that the odor intensity of odorants increase as the mass concentration increases. The slope of the Dose-Response and Power Law graphs is less than one for most odors since it takes larger and larger increases in concentration to maintain a constant increase in perceived intensity.

Hedonic Tone HT

Hedonic Tone (HT) is a measure of the pleasantness or unpleasantness of an odor sample. An arbitrary but common scale for ranking odor by hedonic tone is the use of a 21 point scale:

+10	Pleasant
0	Neutral
-10	Unpleasant

The assigning of a hedonic tone value to an odor sample by an assessor is "subjective" to the assessor. An assessor uses her/his personal experiences and memories of odors as a referencing scale. The assessor, during training, becomes aware of their individual odor experience and memory referencing.

The average value of all assessors is the reported hedonic tone (HT) for the odor sample.

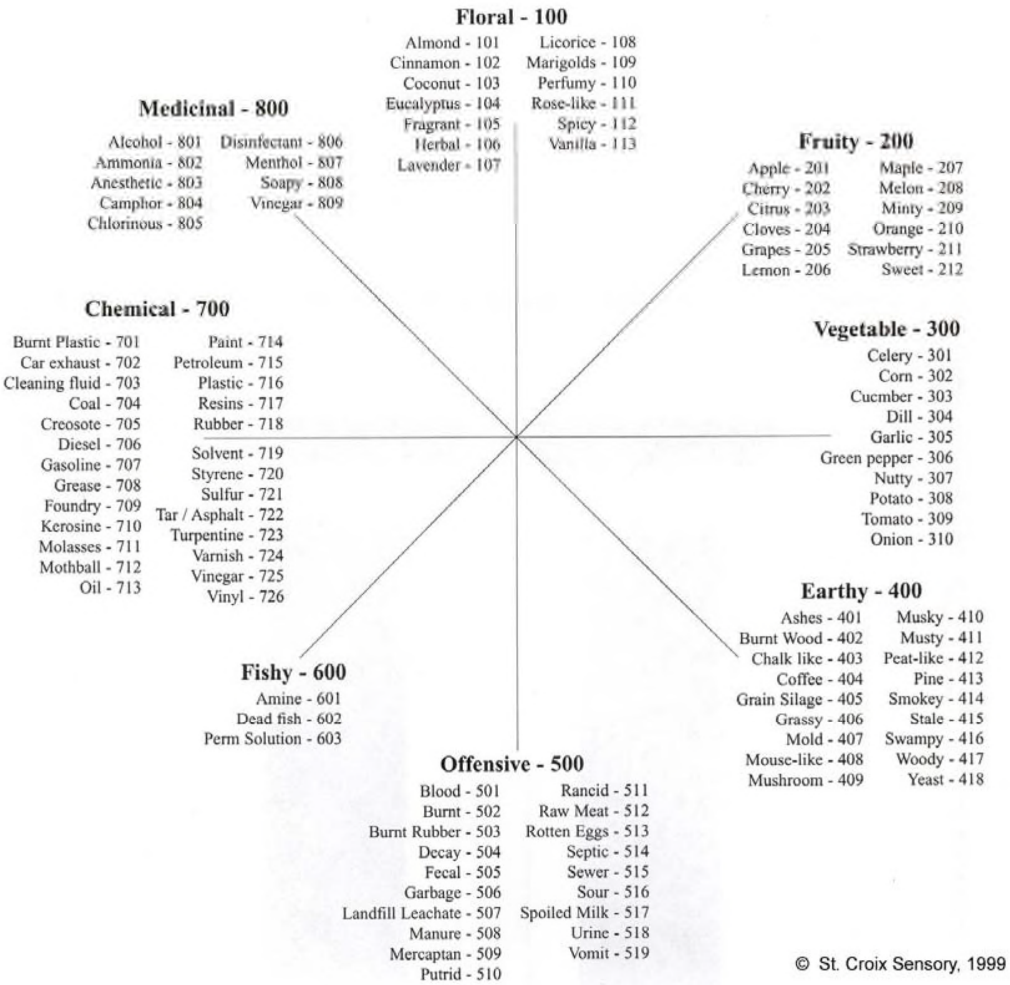
It is important to note that the hedonic tone values provided by the trained assessors should not be considered to represent the opinions of the general population. The values should be used for relative comparison of the pleasantness between samples within one test session since they would be observed by the same panel of assessors.

Odor Characterization

The character of an odor, also referred to as "odor quality," is reported using standard descriptor lists. Assessors report both what the odor "smells like" (e.g. sewer, banana, etc.) and what the odor "feels like" (e.g. burning, cooling, etc.) Assessors also report relative strengths of the different characters identified.

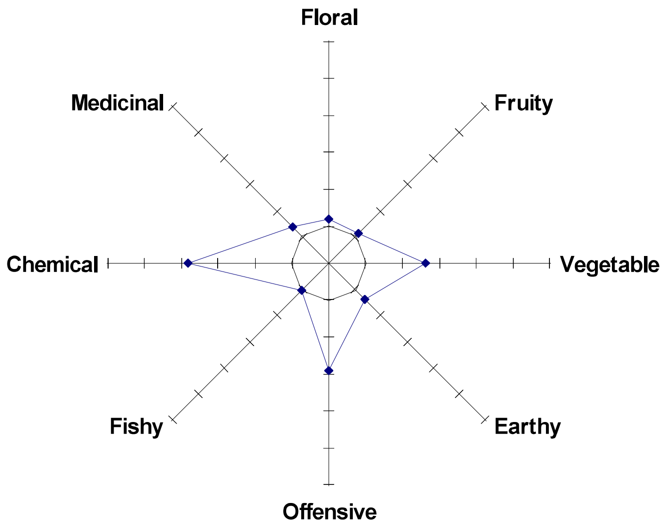
<u>Odor Descriptors</u>

Numerous "standard" *odor* descriptor lists are available to use as a referencing vocabulary. Eight (8) recognized odor descriptor categories, including **Vegetable, Fruity, Floral, Medicinal, Chemical, Fishy, Offensive, and Earthy,** are illustrated as an "odor wheel". Specific descriptors within each of these odor categories are presented in the subsequent diagram.



Each assessor rates these eight main odor descriptor categories on a relative strength scale of zero to five, where zero is “not present”, 1 = faint, 3 = moderate, and 5 = strong. The average results of the panel of assessors are plotted on a spider graph (polar plot). The axis on the spider graph, for example in the direction of Offensive, is the average relative strength on the 0 to 5 scale.

Odor Descriptor Graph



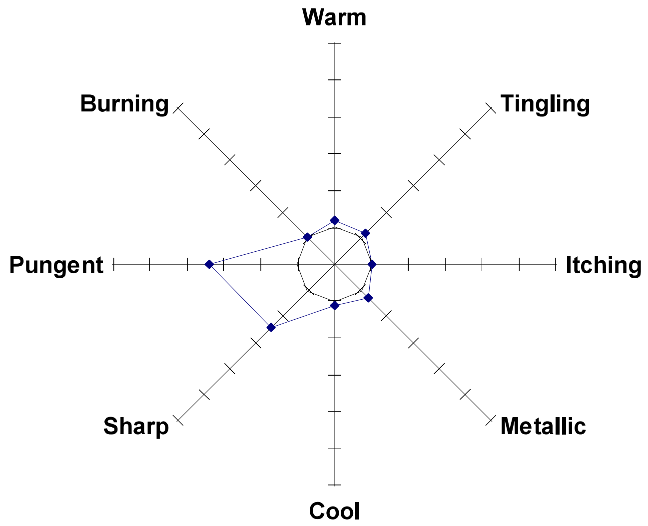
Each assessor also reports the specific Odor Descriptors observed. A histogram presents the percentage of assessors in the panel that assigned specific descriptors to the odor sample.

% of Assessors	❘***********❘***********❘***********❘***********❘ 100%
Vegetable	************************
Garlic	**********
Onion	*******************
Lemon	*****
Floral	*****
Medicinal	**********
Menthol	*****
Chemical	**************************************
Petroleum	************************
Turpentine	*****
Solvent	*****
Gasoline	*****
Sulfur	**********
Offensive	*******************
Sewer	*****
Garbage	*****
Rotten eggs	************************
Decay	*****
Putrid	*****
Earthy	*****
Musty	*****

<u>Sensation Descriptors</u>

The Trigeminal Nerves (Fifth Cranial Nerve), located throughout the nasal cavity and in the upper palate, and the other nerves in these areas sense the presence of some odors (i.e. “feels like…” rather than “smells like…”). Eight (8) common *sensation descriptors* that can be reported include: **Itching, Tingling, Warm, Burning, Pungent, Sharp, Cool, and Metallic**. Each assessor rates each of these sensations on a relative strength scale of zero to five, where zero is “not present”, 1 = faint, 3 = moderate, and 5 = strong. The average results of the panel of assessors are plotted on a spider graph (polar plot). The axis on the spider graph, for example in the direction of **Burning**, is the relative strength scale.

Sensation Descriptor Graph



St. Croix Sensory technical staff works closely with our clients to discuss the specific odor evaluation needs of each project to provide valuable results.

FIGURE 1

BRIDGETON LANDFILL, LLC 13570 SAINT CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL	DATE: MARCH 2014 DESIGNED BY: DMK APPROVED BY: ALK	DRAWING NO.: 001
FACILITY SITE PLAN		REVISION / DATE	
PROJECT NUMBER: BT-021	FILE PATH:		

FIGURE 2

LEGEND

A ODOR MONITORING LOCATION

ROUTE

BRIDGETON LANDFILL, LLC 13570 SAINT CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL	DATE: MARCH 2014 DESIGNED BY: DMK APPROVED BY: ALK	DRAWING NO.: 002
DAILY ODOR SELF-INSPECTION DESIGNATED ROUTE		REVISION / DATE	
PROJECT NUMBER: BT-021	FILE PATH:		

APPENDIX A

REMEDIAL DESIGN QUALITY ASSURANCE PROJECT PLAN

REMEDIAL DESIGN ENVIRONMENTAL QUALITY ASSURANCE PROJECT PLAN (RD QAPP)

APPENDIX A TO REMEDIAL DESIGN WORK PLAN

WEST LAKE LANDFILL SUPERFUND SITE
OPERABLE UNIT 2 (OU-2)
BRIDGETON, MISSOURI

Prepared For:

BRIDGETON LANDFILL, LLC

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PHOENIX, ARIZONA

CEC PROJECT 191-750

MARCH 23, 2020
REVISED MAY 22, 2020

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REMEDIAL DESIGN ENVIRONMENTAL QUALITY ASSURANCE PROJECT PLAN (QAPP)

WEST LAKE LANDFILL OU-2 FACILITY

SIGNATURE / APPROVAL PAGE

Approved by:

Ms. Jamie Schwartz – USEPA Region 7 Regional Project Manager	Date
Ms. Diane Harris – USEPA Region 7 Quality Assurance Manager	Date
Mr. Kevin Kamp– Project Manager	03/23/2020 Date
Mr. Randal Bodnar– Project Principal/QA Manager	03/23/2020 Date

DISTRIBUTION LIST

The following individuals will receive copies of the approved Remedial Design (RD) Environmental Quality Assurance Project Plan (QAPP) and subsequent revisions:

- Jamie Schwartz, Remedial Project Manager, United States Environmental Protection Agency (USEPA) Region 7
- Ryan Seabaugh, P.E., Federal Facilities Section, Missouri Department of Natural Resources (MDNR)
- Paul Rosasco, PE, Project Coordinator, Engineering Management Support, Inc. (EMSI)
- Kevin Kamp, PE, Project Manager, Civil & Environmental Consultants, Inc. (CEC)
- Randal Bodnar, PE, Project Principal / QA Manager, CEC

Courtesy copies will be provided to others, including Respondent and Respondent's individual contractors.

PROJECT / TASK ORGANIZATION

This section lists the key personnel and their roles and responsibilities for this project. A project organization chart is provided as **Figure A-1**. Contact information for the individuals listed below is provided in **Table A-1**.

Jamie Schwartz, Remedial Project Manager, USEPA Region 7

Ms. Schwartz will provide federal regulatory oversight and enforcement of the project.

Ryan Seabaugh, P.E., Federal Facilities Section, MDNR

Mr. Seabaugh will provide state regulatory oversight and enforcement of the project.

Paul Rosasco, PE, Project Coordinator, Engineering Management Support, Inc. (EMSI)

Mr. Rosasco will have oversight responsibility for project and will provide the interface between the USEPA and MDNR, the Respondent, and the Remedial Design Group.

Kevin Kamp, PE, Project Manager, CEC

Mr. Kamp will have overall responsibility for landfill design activities. Mr. Kamp will be responsible for stamping the design plans.

Randal Bodnar, PE, Project Quality Assurance (QA) Manager, CEC

Mr. Bodnar will have overall responsibility for project quality assurance.

Laboratory Quality Assurance Manager (to be determined [TBD]), CEC

The Laboratory Quality Assurance Manager will be responsible for coordination between the field sampling teams and the analytical laboratory and will be responsible for data validation activities.

Geotechnical Laboratory Project Manager (TBD), To Be Determined

The Geotechnical Laboratory Project Manager will be responsible for laboratory analyses of soil and waste samples delivered to the lab from the West Lake Landfill OU-2 facility.

Field Supervisor (TBD), CEC

The Field Supervisor will be responsible for day-to-day oversight of field sampling teams and field sampling equipment.

Health and Safety Manager, Steve Graves, CEC

The Health and Safety Manager will be responsible for non-radiological health and safety of field sampling team members.

Laboratory Project Manager (TBD), Pace Analytical Services, LLC

The Laboratory Project Manager will be responsible for laboratory analyses of samples delivered to Pace Analytical Services, LLC from the West Lake Landfill OU-2 facility and will be responsible for preparing the Level IV laboratory analytical report. The Quality Assurance Manual for Pace Analytical Services, LLC is included in **Attachment 1** of this QAPP.

PROBLEM DEFINITION / BACKGROUND

This Quality Assurance Project Plan (QAPP) has been prepared as an appendix to the Remedial Design Work Plan (RD Work Plan) for Operable Unit 2 (OU-2) of the West Lake Landfill Superfund Site (Site) in Bridgeton, Missouri (see **Figure A-2**). The purpose of this QAPP is to present the data collection activities that will be implemented under the RD Work Plan for the Inactive Sanitary Landfill (ISL) portion of OU-2, and to ensure that all the data produced are of known and documented quality and will satisfy the stated performance criteria.

Proposed activities described in this QAPP are intended to: 1) enhance the decision-making process for the RD by providing updated assessments and data of the existing conditions for and in the vicinity of the ISL portion of OU-2, and 2) provide the design documents necessary to implement the selected remedy for OU-2. The major components of the Selected Remedy, as stated in Section 12.2 of the 2008 Record of Decision for the West Lake Landfill Site, consist of the following:

1. Installation of landfill cover meeting the Missouri regulatory closure and post-closure care requirements for sanitary landfills;

2. Use and application of groundwater monitoring and protection standards consistent with requirements for sanitary landfills;

3. Surface water runoff control;

4. Gas monitoring and control consistent with sanitary landfill requirements as necessary;

5. Institutional controls to prevent land uses that are inconsistent with a closed sanitary landfill site; and

6. Long term surveillance and maintenance of the remedy.

Existing conditions at the ISL portion of the West Lake Landfill (**Figure A-3**) have been previously defined by past studies, including:

- *Draft Report – Inactive Landfill Cap Investigation, West Lake Site*; Golder Associates Inc., August 25, 1995.

- *Remedial Investigation Report, West Lake Landfill Operable Unit 2*; Herst & Associates, Inc., September 2005.

- *Feasibility Study Report, West Lake Landfill Operable unit 2, Bridgeton, Missouri – Revision 1*; Herst & Associates, Inc., June 2006.

Existing facility features, including monitoring wells and other environmental monitoring locations near the ISL, are provided in **Figure A-3**.

1.0 PROJECT / TASK DESCRIPTION AND SCHEDULE

Field, laboratory, and reporting activities to be performed in accordance with this RD QAPP consist of:

- Topographic survey and base map preparation;
- Geotechnical testing and determination of estimated volumes for potential borrow areas;
- Installation and monitoring of temporary landfill gas perimeter monitoring wells*[1];
- Collection and evaluation of existing cover thickness and material samples from the ISL;
- Evaluation of existing stormwater conveyance, utilities, and infrastructure within and near the boundaries of the ISL;
- Slope stability analysis along the western side of the ISL including a western slope waste limit investigation (future plan);
- Waste separation evaluation borings;
- Long-term performance groundwater monitoring;
- Level 4 validation of soil and groundwater sampling laboratory analytical results; and
- Report preparation and submittal to the USEPA and MDNR.

Each of the above-referenced tasks is briefly described below.

It should be noted that the MDNR code of State regulations (CSR) cited in this RD QAPP for the design and operation of landfills and water quality standards are those that were in effect at the time of the signing of the ROD in 2008. Copies of the applicable regulations cited in this QAPP are provided in Attachment 2 of this QAPP.

1.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

The current topographic map is based on a 2005 aerial survey combined with typical ground confirmation and is considered accurate to within plus or minus (±) one (1) foot of vertical elevation. This level of accuracy is insufficient for purposes of calculating volumes of materials necessary to meet the objectives of the OU-2 remedy (i.e., cover placement). Accordingly, during RD, a more accurate flyover survey recently conducted will be combined with ground survey efforts and data collection to provide ground surface elevations accurate to within ± 0.20 feet (60 mm) in the vertical

[1] The term "gas monitoring well" is being used throughout this document per EPA comment and at the recommendation of MDNR. Please note that such gas monitoring "wells" being installed and sampled as part of the OU-2 investigation will be installed outside of the waste boundary and will not be attached to a gas collection and control system. The "wells" will serve as what have traditionally been identified by Bridgeton Landfill as gas monitoring "probes" to monitor if landfill gas is migrating off-site.

and horizontal directions as well as collect detailed special information on features, infrastructure, and utilities throughout the ISL. The ground survey will be conducted by a Missouri registered surveyor. This data will then be used to create a more accurate base map of the existing topographic conditions. This information will be provided in an *Existing Conditions Summary Submittal*.

1.2 TESTING OF POTENTIAL BORROW AREAS

As part of the OU-2 remedy, various soil materials may be placed and compacted within the ISL to achieve planned final grades and allow for positive drainage. As part of the RD phase of the project, laboratory testing will be conducted on various potential sources of materials to determine the suitability to be used as cover material. The frequency and intervals at which these parameters are obtained and measured will be determined by decision criteria included as part of a future *Soil Borrow Area Investigation Plan* submittal. A *Soil Borrow Area Investigation Summary Report* will be submitted after evaluating the laboratory data.

1.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

To assess the environmental conditions in support of the RD Work Plan, temporary landfill gas perimeter monitoring wells* are proposed to be installed at the property boundary adjacent to the ISL and Old St. Charles Rock Road. Well* locations may be coordinated with geotechnical investigations proposed for the western slope of the landfill, and will be spaced at no greater than 500 feet apart. Well* depth will extend to the known lowest base elevation of refuse based on the results of the borings to be drilled for the slope stability evaluation (Section 2.6). The screened interval within each well* will be established following the review of boring logs, the depth of the base of refuse, and static water levels in nearby groundwater monitoring wells. The monitoring wells* are proposed to be installed at the approximate locations presented in **Figure A-4**. As some or all of the monitoring wells* may require relocation or replacement following completion of the landfill cap investigation, they will be considered temporary installations until completion of cap investigation effort. Data collected during installation, including boring logs and as-built details, will be provided in the Summary of Soil Gas Report. An *Explosive Gas Monitoring Plan* will also be prepared and submitted. (*Note: Based on evaluation of data obtained during waste limit and other investigations conducted prior to the slope stability evaluation, early installation of gas monitoring wells* will be considered if sufficient information is available to determine probable depth of refuse and likely zones of off-site gas migration. Installed monitoring wells* will be then evaluated against data obtained during the slope stability evaluation and amended as required to conform to MDNR rule requirements*).

During RD, the gas monitoring wells* will be monitored at an declining frequency beginning with weekly, then monthly and finally quarterly monitoring. Results of the monitoring are expected to be used during RD to assess gas migration potential and the need for controls, and to establish ongoing monitoring frequency. Gas monitoring results will be provided to the USEPA and the MDNR in the monthly progress report following the month in which the data were collected.

1.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

As described in Section 2.2.1 of the 2020 RD Work Plan, in order to meet the State of Missouri closure requirements for sanitary landfills, the final cover on the ISL must consist of at least two (2) feet of compacted clay with a coefficient of permeability of $1x10^{-5}$ centimeters per second (cm/sec) or less and overlaid by at least one (1) foot of soil capable of sustaining vegetative growth. Also, pursuant to 10 CSR 80-3.010(17)(C)11, the compacted clay portion of the final cover will consist of soils classified under the Unified Soil Classification System, including CH (clay of high plasticity), CL (clay of low plasticity), ML (silt), SC (clayey sand) and MH (silt of high plasticity; elastic silt).

Currently, the ISL has a vegetated cover, but the thickness of the current cover is unknown. The 2006 Feasibility Study (Herst & Associates) included an estimate of the volumes of materials needed for final cover on the ISL. The estimate was based on existing cover thickness data collected in 1995 (Golder Associates, Inc.). To help refine the 1995 volume estimate, and in conjunction with the 2020 RD Work Plan sampling effort and topographic survey to be conducted, supplemental cover thickness testing will be performed during RD. The program will include collecting cover thickness samples on a surveyed grid pattern of approximately 150 feet across the ISL, as illustrated on **Figure A-5.** Assuming 2 feet of compacted clay was placed, and an assumed density of 120 pounds per cubic feet (pcf), over the approximate 41 capped acres of the ISL, 214,300 tons of compacted clay material would have been placed. For the 88 proposed cover thickness samples, the sampling frequency is approximately one sample per 2,500 tons of material. This sampling frequency is higher for the soil capable of sustaining vegetative growth, which is only placed a one foot thickness. These sampling frequencies are higher than typical industry values (i.e., 1/10,000 tons of material placed). Therefore, the approximate 150-foot spacing allows for representative coverage of the entire cap area with a spacing close enough to account for significant variabilities in the cover material. If conditions are heterogeneous in certain areas spacing will be adjusted to 75-foot. Proposed cap sampling locations will be in areas that are accessible to heavy equipment (e.g., direct push technology drilling equipment) and within the limits of waste. The proposed sampling locations were selected to avoid select site features that pose physical access constraints on sampling activities (i.e., the steep western slope). Sampling locations do not include the steep slope areas on the west side of the ISL due to access limitations for equipment. Samples immediately adjacent to the west slope of the ISL are assumed to be representative of the steep slope area. A total of 88 cover thickness samples are proposed, or an average of 2.1 samples per acre.

Each sampling point will initially be surveyed for northing, easting, and ground surface elevation by a Missouri registered surveyor. Clear polyethylene tube samplers will then be pushed three (3) to five (5) feet through the existing cover at each sampling location. Each soil sample will be brought to the surface and visually examined to distinguish materials and measure corresponding material thicknesses. The soils materials will be classified per the Unified Soil Classification System based on grain size, liquid limit, and plasticity index. The test locations will be sampled continuously for the full depth of boring using direct push technology. The sample location will advance though the landfill cap to the top of waste.

A minimum of ten (10) Shelby Tube samples will be collected adjacent to the selected direct push sampling locations and subjected to testing at an off-site geotechnical laboratory. Shelby Tube samples will be collected pursuant to ASTM D1587 - Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes (ASTM D1587). The proposed laboratory analyses to be performed are described in Section 8.4 of this QAPP. The proposed Shelby sampling locations are shown on **Figure A-5**. The sampling locations were spaced to provide representative coverage across the existing cap area at a frequency in excess of one (1) per every five (5) acres of cap material placed. At this frequency, the material will be sampled once per every 30,000 tons of material (assuming a 3-foot thickness and 120 pounds per square foot [lbs/cf]). Assuming the landfill cover material is fairly homogeneous, this testing frequency will provide representative results for the in-place landfill cover. If conditions are heterogeneous in certain areas, additional Shelby Tube samples will be collected. If it is observed during the cap sampling procedures that the materials are more heterogeneous, additional samples will be collected.

Based on a previous cap sampling investigation, conducted in May 2009 (The May 2009 investigation consisted of the collection of 11 soil samples for cap evaluation), it is anticipated that the in-place material will meet the hydraulic conductivity regulatory requirement of 1×10^{-5} centimeters per second (cm/sec). However, if the results of the hydraulic conductivity test show results less than the regulatory requirement of 1×10^{-5} cm/sec, additional Shelby tube sampling and hydraulic conductivity testing will be performed to further identify the limits of the substandard materials. Additional Shelby Tube samples to identify limits of substandard materials will be taken at 75-foot intervals in the north, east, south, and west directions from the substandard sample location. Again, these additional samples will be collected pursuant to ASTM D1587 guidelines. This approach allows for further limitation of the substandard materials and corresponds with the cap sampling spacing, so as to correlate changes in soil consistency with changes in soil hydraulic conductivities. Also, laboratory results of Shelby tube samples collected in 2009 will be used to complement the Shelby tube samples and laboratory data described in this QAPP.

Direct push borings will be sampled continuously for the full depth of the boring. The direct push sampler will be advanced until waste materials are encountered. The depth at which waste is encountered will be recorded and interpreted as the thickness of in-place cap material. Per MDNR Solid Waste Regulations 10 CSR 80-3.010(17)(C)4.A, a total of three (3) feet of cap material is required (i.e., two (2) feet of low permeability soil overlain by one (1) foot of soil capable of supporting vegetative growth). If the full three (3)-foot thickness of in-place cap material is confirmed, the upper one (1) foot will be inferred to be comprised of soil capable of supporting vegetative growth and the bottom two (2) feet will be inferred to be the low permeability soil. OU-2 currently has a healthy stand of vegetation; as such, it is understood that the existing soil materials are capable of supporting vegetative growth.

Shelby Tube samples at each of the 10 proposed sampling locations will be collected starting at a depth of 18 inches below ground surface (i.e., six (6) inches below the bottom of the vegetative support layer) and continuing to a depth of at least of 36 inches or until waste is encountered. The Shelby Tube samples will be pushed a total of 18 inches into the low permeability soil layer. If the Shelby Tube sampler is damaged or hits refusal before reaching a depth of 18 inches of sample, the sampling location will be offset five (5) feet and attempted again with a new Shelby Tube.

The depths of soil cover as determined by the direct push sampling data will be used to help indicate and confirm whether excess cover materials are available within portions of OU-2 or if additional material needs to be added to each localized area. This will be done by comparing the thickness of the existing soil cap in-place to the minimum regulatory requirements (i.e., three (3) feet total comprised of two (2) feet of low permeability soil and one (1) foot capable of supporting vegetative growth). If thicknesses of existing cap materials are in excess of three (3) feet, the RD may utilize soil from the in-place soil cap to apply in areas with less than three (3) feet of the cap that do not meet the minimum thickness requirement materials.

The existing thickness of the existing cap analytical results will be compiled and discussed in the *Existing Soil Cap Evaluation Report*.

1.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

Surface drainage diversions, controls, and structures will be designed and constructed to route storm water runoff to the water drainage systems. Stormwater drainage will be investigated and detailed drainage analysis completed as part of RD that includes identification of existing sub watersheds and calculation of anticipated stormwater flow volumes and nature of drainage (overland sheet flow, piped concentrated flow, and time of concentration) for each watershed based on the applicable design storms as required by 10 CSR 80-3.010(8)(B)1.F.II and III .

There are various grates along the western portion of the ISL that are stormwater conveyance structures. In addition, a leachate pumping well located to the east and two concrete standpipes near the center of the ISL were observed. These features are displayed in **Figure A-6**. During the RD, this infrastructure will be further investigated by reviewing available site historical information and record where available. Additionally, clearing of obstructing vegetation and the use of downhole camera inspection to determine and confirm routing and condition of infrastructure will provide important information to determine existing functionality and purpose, potential re-use, abandonment, or removal that will be outlined in the RD.

The locations of the stormwater piping and associated structures as well as other site infrastructure will be previously described in Section 1.1. The data will be obtained by a Missouri registered Professional Land Surveyor (PLS).

1.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

One of the RD tasks is to evaluate and document the stability of the existing slope along the western portion of the ISL near Old St. Charles Rock Road. The 2006 OU-2 Feasibility Study Report (Herst & Associates) noted that slopes along the western portion of the ISL were re-graded in 1992 with a goal of achieving a three (3) horizontal to one (1) vertical (3H:1V) or less slope. Based on recent field observations, the slopes on the western side of the ISL have slopes in excess of 4H:1V. **Figures A-7A** and **A-7B** display the location and contour details of the western slope. MDNR 10 CSR 80-3.010(17)(B)3 specifies that final side slopes of a sanitary landfill must not exceed 25 percent unless a demonstration can be made, and approved, in a detailed slope stability analysis that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill. Also, MDNR 10 CSR 80-3.010(17)(C)3 specifies that no active, intermediate or final slope shall exceed thirty-three and one-third per-cent (i.e., 33 1/3%). Therefore, because the existing slope along the western portion of the ISL is greater than the

MDNR regulation of 25 percent, a detailed demonstration of slope stability will be required. Additionally, MDNR 10 CSR 80-3.010(17)(C)5, requires provisions for slope stability for installation of final cover systems.

In order to address this issue, a *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

1.7 WASTE SEPARATION EVALUATION

A minimum of three (3) borings will be installed in the area between the ISL and the South Quarry portion of the Bridgeton Landfill for the purpose of determining the presence or absence of municipal solid waste (MSW) in the subsurface materials between these two areas and to evaluate separation of waste materials between these units. The proposed waste separation evaluation boring locations are shown on **Figure A-9**. The waste separation evaluation borings will be performed as follows:

- Perform sonic drilling to collect and return waste materials to the surface for visual observations. The proposed sonic drilling program will consist of the following:
  - Perform sonic drilling using a 4-inch minimum diameter sonic tooling at three (3) locations shown on **Figures A-8 and A-9**.
  - Sonic drilling will be performed until the drill rig bit reaches a bedrock layer.
  - Rock coring will be performed for an additional 5 feet to confirm that material encountered is bedrock.
  - Materials returned to the surface will be visually inspected for the presence of MSW materials.
  - The borehole will be observed for the presence of liquid immediately after the boring is completed, 24 hours after the boring is completed, and 48 hours after the boring is completed. Assuming the boreholes remain open.
  - After a period of 48 hours, the borehole will be abandoned in accordance with MDNR 10 CSR 23-6.050.

Conclusions from the waste separation investigation will be submitted to the regulatory agencies in the *Waste Separation Evaluation Report*.

1.8 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Section 9.0 of the OU-2 ROD (2008) states that long-term groundwater monitoring and maintenance is one of the components of the OU-2 remedy that will address the Remedial Action

Objectives. The groundwater monitoring program developed and proposed in the RD Work Plan was designed to meet the objectives in Section 12.2.1 of the ROD and will be consistent with the monitoring requirements and groundwater protection standards found in the Missouri Solid Waste Rules for Sanitary Landfills [10 CSR 80-3.010 (11)].

Long-term performance groundwater monitoring for the ISL portion of the OU-2 is proposed to consist of nineteen (19) groundwater wells. The 19 wells consist of thirteen (13) existing monitoring wells (with historic water quality and water level data) and six (6) proposed but not-yet-constructed OU-3 monitoring wells. Inclusion of any new OU-3 monitoring wells will be subject to finalization and USEPA approval of the OU-3 Remedial Investigation/Feasibility Study (RI/FS) planning documents and consequently, the exact number, location, and completion intervals of the new OU-3 wells could change in the near future.
The proposed groundwater monitoring program will consist of two phases:

- Initial baseline groundwater monitoring – to be conducted quarterly, but not to exceed eight (8) quarters of monitoring. The objective of the baseline groundwater monitoring is to establish current or existing groundwater quality and groundwater conditions prior to closure of the OU-2.

- Detection groundwater monitoring – to begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations, and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*.

The proposed OU-2 groundwater monitoring program will be coordinated with, and conducted in conjunction with, the implementation of the OU-3 RI groundwater monitoring activities. The baseline phase of the proposed OU-2 performance groundwater monitoring program will begin within the first quarter following approval of the OU-3 RI/FS Work Plan by the USEPA. At this time, it is anticipated that the OU-3 RI/FS Work Plan will be approved by the USEPA, and the proposed additional OU-3 monitoring wells will be installed, during the third and fourth quarters of 2020. Therefore, the baseline phase of the proposed OU-2 groundwater monitoring program would begin in the fourth quarter of 2020. However, that date is contingent upon approval of the OU-3 RI/FS project plans by the USEPA. This essential coordination and dependency with the OU-3 groundwater investigation has been referred to in various sections of the RD Work Plan and highlighted in the Project Schedule (Figure 8 of the RD Work Plan).

Groundwater quality and water level measurements from the 19 wells will be used to: establish baseline groundwater water quality in the alluvial aquifer beneath the ISL; provide a basis to assess the protectiveness of the Selected Remedy relative to groundwater quality, identify any future impacts to groundwater quality during or after implementation of the remedial action for the ISL; and demonstrate that the Selected Remedy performs as required over the post-closure period (USEPA ROD, 2008).

This groundwater monitoring program has been developed in accordance MDNR 10 CSR 80-3.020 (11). The 19 monitoring wells were selected based on their geographic/spatial locations relative to each other along the western, southwestern, and southeastern boundaries of the ISL and availability to monitor various hydrogeologic zones of the alluvial aquifer. Based on historic potentiometric surface maps prepared for the Bridgeton Landfill, the western boundary of OU-2 is currently inferred to be the downgradient boundary of the ISL. Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells.

During the baseline phase of the monitoring program, the 19 wells will be monitored for static water level and those parameters listed in 10 CSR 80-3.010 Appendix I, which includes various general water quality parameters, metals, and organic constituents. **Table A-2** of this QAPP provides a complete list of the parameters for analysis of the baseline groundwater samples.

All groundwater quality samples collected under the OU-2 performance groundwater monitoring program will be submitted to a certified laboratory (Pace Analytical Services, LLC) for the requested analyses. The laboratory will be instructed to provide a Level IV data validation package. Section 14.2 of this QAPP provides a list of the various components that will be included in the Level IV data validation package.

Groundwater level and water quality data will be verified and validated in accordance with the procedures described in Section 14 of this QAPP. All laboratory data will be validated on an individual laboratory report basis within 60 days of receipt from the laboratory. Groundwater monitoring reports will be prepared and submitted to the USEPA and MDNR within 30 days after the data have been validated (or 90 days from the receipt of laboratory data). Unvalidated groundwater quality analytical data will be provided to the agencies as part of the monthly progress reports.

Groundwater level, water quality data, and updated potentiometric maps will be summarized and presented in the *Quarterly Groundwater Monitoring Reports*. *Annual Groundwater Monitoring Reports* will include trend analyses, tri-linear plots, and relevant maps and figures of the groundwater quality data. During detection monitoring, the *Annual Groundwater Monitoring Reports* will contain statistical analyses. A *Data Validation Report* will be included with each monitoring report. The Project Schedule, provided as Figure 8 of the OU-2 RD Work Plan, presents the anticipated schedule for the initiation of the baseline groundwater monitoring, laboratory analytical process, data verification/validation, and report preparation/submittals.

Upon completion of the baseline monitoring phase, the groundwater data will be compiled and evaluated for the presence of statistical outliers and trends. The baseline groundwater results will be evaluated using one or more of the five statistical methods specified in MDNR 10 CSR 80-3.010 (11)(C)5. The data will also be compared to applicable or relevant and appropriate requirements (ARARs) for groundwater quality. ARARs that will be used for comparison purposes of the groundwater quality samples include: 1) the Federal Primary Drinking Water Regulations, as specified in the Code of Federal Regulations, Title 40 (40 CFR), Part 141, Subpart B, Maximum Contaminant Levels (MCLs); 2) MDNR 10 CSR 60-4.010 through 4.110; and 3) MDNR 10 CSR 20-7.031(5), including Table A.

Upon completion of the OU-2 RD, groundwater monitoring will continue (as detection groundwater monitoring) in accordance with 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations, and evaluation approach will be included as part of the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*. The OU-2 proposed groundwater monitoring program may be modified based upon approval by the USEPA and the MDNR. Modifications may include revising or eliminating groundwater sampling locations, sampling frequency, and/or reporting frequency.

The OU-2 RD SAP (Appendix B of the RD Work Plan) presents additional information regarding the long-term groundwater monitoring program, including sampling rationale, proposed monitoring wells, water sample collection procedures, instrument calibration, well purging, sample containers, sampling frequency, and sample documentation.

1.9 VALIDATION OF GROUNDWATER LABORATORY ANALYTICAL RESULTS

All groundwater laboratory analytical results will be validated in accordance with the guidance and requirements of the following USEPA documents:

- *National Functional Guidelines for Organic Superfund Methods Data Review*, 2017;
- *National Functional Guidelines for Inorganic Superfund Methods Data Review*, 2017; and
- *Guidance on Environmental Data Verification and Data Validation*, 2002.

The laboratory will be instructed to provide Level IV (or Stage 4) data package deliverables. The laboratory will also be required to provide a comprehensive, standardized electronic pdf format and appropriate Electronic Data Deliverable (EDD) file.

The process for reviewing laboratory data files will consist of the following steps: the laboratory data will be sent electronically to the Bridgeton Landfill LLC's OU-3 consultant/contractor Project Manager. The Project Manager will organize the data set based on the Brideton Landfill LLC's project site and name. The OU-3 Project Manager will then check to see if all the cells in the EDD file are valid (i.e., have the correct CAS values, all necessary cells are not blank). If errors arise, the Project Manager will either revise the file himself/herself or send the data back to the laboratory to revise, depending on the complexity of the issue. Once these steps are completed, the Project Manager will insert the EDD and lab report PDF (and other files) into the software module. Upon completion of all of the above steps, the data can be exported/reported. If any problems arise during these steps, the Project Manager contacts and discusses the issue(s) with the appropriate personnel (laboratory Project Manager and/or Bridgeton Landfill, LLC's Project Manager) to resolve the issue.

Verification and validation of the groundwater laboratory data will also be conducted by Bridgeton Landfill LLC's OU-3 consultant/contractor. Project requirements, including requested parameters, turnaround times, and specific laboratory detection limits, will be handled by the consultant's Project Manager in coordination with the Pace Laboratory Project Manager.

An updated electronic database will be provided to the USEPA and MDNR quarterly (during the baseline monitoring phase) with each *Annual Groundwater Monitoring Report.*

All laboratory data will be validated on an individual laboratory report basis within 60 days of receipt from the laboratory. Groundwater monitoring reports will be prepared and submitted to the USEPA and MDNR within 30 days after the data have been validated (or 90 days from the receipt of laboratory data). Unvalidated analytical data for the groundwater quality samples will be provided as part of the monthly progress reports.

2.0 DATA QUALITY OBJECTIVES

This section discusses the specific Data Quality Objectives (DQOs) for the various investigative components of the RD activities. As defined in the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (2006) document, DQOs are qualitative and quantitative statements that:

1) Define the problem that necessitates the study (**Problem Statement**);
2) Describe how environmental data will be used in solving the problem and identify alternative outcomes (**Goal of Study**);
3) Identify data and information needed to answer study questions (**Information Inputs**);
4) Define the characteristics of interest, spatial limits, and scale of inference (**Boundaries of Study**);
5) Define Parameters of interest, type of inference, and develop logic for drawing conclusions from the findings (**Analytical Approach**);
6) Specify probability limits for false rejection and false decision errors, or develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use (**Performance or Acceptance Criteria**); and
7) Select the resource-effective sampling and analysis plan that meets the performance criteria (**Plan for Obtaining Data**)

Each of the above identified DQO criteria is further described for each of the investigative components of the RD activities**.**

2.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

2.1.1 Problem Statement

The RD will develop documents and specifications to implement the selected remedy for OU-2 which consists of installation of a landfill cover, groundwater monitoring, surface water control, gas monitoring and control, institutional controls, and long-term surveillance and maintenance of the ISL (see Section 12.2 of the ROD). This will require additional survey data collection to more accurately define the topography of the existing ground surface and to accurately locate any existing underground utilities or site infrastructure.

2.1.2 Goal of Study

The ground, aerial, and utility surveys are intended to identify accurate ground surface topography, infrastructure location and detail, and utility locations near and adjacent to the ISL. This data and effort will be the base map utilized in developing the RD.

2.1.3 Information Inputs

Data will be collected through onsite surveys of existing topographic features. Also, utility surveys will be conducted and will utilize previous subsurface utility mapping (Missouri One Call System) for the site and near surface utility sensing equipment. Utilities will be marked in the field prior to subsurface remedial design investigation.

2.1.4 Boundaries of the study

The data will be collected (topography, infrastructure, and utilities) from an area to include the entire ISL and a minimum of 50 feet beyond the limit of the ISL except where constrained by property boundary, access, or existing structures as shown in **Figure A-3**.

2.1.5 Analytical Approach

Data collected during various onsite surveys to map the existing topography and infrastructure will be compiled into one "master" existing conditions plan, which will be prepared by a Missouri registered PLS and shared electronically with the design team for use as the base drawing during the remedial design. The existing conditions plan will be submitted to the agencies for review in the *Existing Conditions Summary Submittal* during the RD submissions.

2.1.6 Performance or Acceptance Criteria

Data collected and used in the development of the RD will be done by a Missouri PLS with accuracy within 0.20 feet. The PLS will reference and tie into known benchmarks that exist in the vicinity of the site.

2.1.7 Plan for Obtaining Data

The data needed for the topographic, aerial, and utility surveys will be obtained by a Missouri registered PLS using typical geospatial survey equipment. The utility surveys will be performed by reviewing available site documents and supplemented by the Missouri One Call System database of underground and above ground utilities.

2.2 TESTING OF POTENTIAL BORROW AREAS

Further description of the borrow area testing, including the DQOs for the Borrow Area Investigation/Evaluation will be provided in the *Soil Borrow Investigation Plan*.

2.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

2.3.1 Problem Statement

Landfill gas perimeter well* installation and monitoring are intended to address an identified data need for determining the current and future gas migration potential at the perimeter of the ISL. Results of the temporary landfill gas perimeter well* monitoring will be utilized to assist RD decision making concerning the potential incorporation of a landfill gas management system in the ISL portion of the OU-2.

2.3.2 Goal of Study

The goal of this study is to define current and future landfill gas migration potential to the west of the ISL and determine the need for any migration controls.

2.3.3 Information Inputs

The information to be acquired to assess gas generation includes observation of:

- Geologic stratigraphy along the western perimeter of the ISL, with an emphasis on identifying zones that may allow gas migration as well as estimated depth of refuse;
- Measurement of subsurface methane concentrations and general gas composition;
- Measurement of subsurface gas pressure and temperatures;
- Measurement of temporal or spatial trends in gas composition, temperature and pressure;
- Measurement of groundwater elevations (as a potential barrier to gas migration) including temporal or seasonal fluctuations; and
- Establishment of trend data via weekly, monthly and quarterly monitoring.

2.3.4 Boundaries of the study

The boundaries of the study or investigation are the western perimeter of the ISL (see **Figure A-4**) from ground surface to the estimated base of refuse (elevation 445 to 455 above mean sea level [amsl]). This elevation is based on two (2) borings previously advanced within the waste limits of the ISL (LR-102 and LR-101) in addition to hydrogeologic cross-sections developed as a component of the OU-3 RI/FS. The western perimeter is coincident with the property boundary.

2.3.5 Analytical Approach

The primary analytical approach is measurement of subsurface gas characteristics using portable meters (% LEL or explosive gas meter) and assessment relative to the potential to promote off-site migration. The threshold requiring additional assessment of gas migration control will be 2.5% methane (by volume) consistent with 10 CSR 80-3.010(14)(C)(2)B. If subsurface methane concentrations exceed this threshold, then correction actions consistent with those set forth in 10 CSR 80-3.010(14)(C)(5) will be implemented.

2.3.6 Performance or Acceptance Criteria

The primary performance or acceptance criteria for data collection in conformance with procedures is set forth in the 1999 MDNR technical bulletin *Sampling of Landfill Gas Monitoring Wells*. Sampling procedures require proper instrument calibration and allowing for the instrument to properly warm up as directed by the manufacturer prior to sample collection. Once the sample collection begins it should continue until the reading stabilizes. A stable reading is one that does not vary by more than 0.5% by volume on the instrument's scale. A proper reading should have 2% oxygen by volume or less. If levels of oxygen are higher, it may indicate that air is being drawn into the system giving a false reading of the true soil gas concentration. If the problem cannot be corrected, those values will be recordedand the problem will be well documented in the report.

2.3.7 Plan for Obtaining Data

The plan for collection of data is primarily via direct field measurement at prescribed intervals (an escalating frequency of weekly, then monthly and finally quarterly monitoring) allowing for both immediate and ongoing assessment of landfill gas migration potential.

2.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

2.4.1 Problem Statement

It is unclear if the existing soil cover meets the requirements of the MDNR regulations at the time of the ROD (2008). Specifically, the current thickness and composition of the existing cover system must be evaluated to determine the need for possible cover amendment and/or replacement in portions of the ISL.

2.4.2 Goal of Study

The evaluation of existing cover thickness and material characteristics is intended to address an identified need to verify the thickness, composition and permeability requirements of the existing cover materials within the boundaries of the ISL.

2.4.3 Information Inputs

The information to be acquired to assess existing thickness and material evaluation of ISL cover includes measurement of Cover soil thickness. Also, the field evaluations are intended to identify the composition of the in-place soil cover material. Additionally, samples will be taken and tested for geotechnical properties as described in Section 8.4. Results of the cover thickness and material evaluation will produce cover thickness data at approximately 88 locations and hydraulic conductivity data at ten (10) locations.

2.4.4 Boundaries of the Study

The boundary of the study is the ISL. The locations of the intended cap sampling locations are shown on **Figure A-5.**

2.4.5 Analytical Approach

Soil borings will be performed to obtain direct measurements of the thickness and description/classification of the existing soil cover over the ISL. The data are expected to show areas where the existing cover material is adequate with respect to thickness and material composition. Select samples will be tested to evaluate the hydraulic conductivity of the lower portion of the existing cover materials. The results are expected to be utilized to refining the estimate of material volumes needed to achieve final cover meeting MDNR cap requirements and to assist in scoping cover placement activities that may be necessary during the remedial action. MDNR requires a final soil cover thickness of three (3) feet (i.e. 1foot of soil cover capable of supporting vegetative growth and two (2) feet of low permeability soil material), and permeability is less than 1 x 10-5 cm/sec. Also, the cover material must meet soil classifications of CH, CL, ML, SC, or MH. If the data meets these requirements, it will be accepted. If it does not, additional investigations will be considered to further identify any substandard materials. If needed, a plan to further identify the limits of substandard soil materials will be prepared and submitted to the USEPA.

2.4.6 Performance or Acceptance Criteria

MDNR requires a final soil cover thickness of three (3) feet (i.e., one (1) foot of soil cover capable of supporting vegetative growth and two (2) feet of low permeability soil material with a permeability of less than 1×10^{-5} cm/sec.) Soil thickness results will be summarized and verified on field forms prepared during the sampling efforts. Also, the cover material must meet soil classifications of CH, CL, ML, SC or MH. Permeability and soil classification data for the cover samples will be provided on laboratory reports for the soil specimens.

2.4.7 Plan for Obtaining Data

Data will be obtained by performing direct push sampling to identify existing cover thicknesses as described in Section 1.4 of this QAPP. Also, Shelby tube samples will be collected at points located on **Figure A-5** and sent to a lab for hydraulic conductivity testing.

2.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

2.5.1 Problem Statement

The RD will need to provide design of stormwater conveyance and potentially infrastructure to implement the selected remedy and will need to preserve and protect utilities and infrastructure that is to remain after RA.

2.5.2 Goal of Study

The goal will be to determine the existing function, condition and long term need for the stormwater conveyance, utilities, and site infrastructure.

2.5.3 Information Inputs

The survey information that is collected along with historical review of documents and records will be needed. Additionally, the clearing of vegetation around the infrastructure and potentially the use of a camera inside of the piping and structures will be used in the evaluation.

2.5.4 Boundaries of the study

The data will be collected on the stormwater features, utilities, and infrastructure in an area that includes the entire ISL and a minimum of 50 feet beyond the limit of the ISL except where constrained by property boundary, access, or existing structures as shown in **Figure A-3**.

2.5.5 Analytical Approach

The parameters of interest include the historical and/or existing purpose, the current operating function and condition, and the assessment of the need, feasibility, appropriateness, and practicality of the stormwater features, utilities, and site infrastructure.

2.5.6 Performance or Acceptance Criteria

If the information collected is relevant to the objective of the remedy or could impact the RD it will be evaluated as potential constraints or considerations during RD.

2.5.7 Plan for Obtaining Data

The data will be obtained by examining historical documents and records and site field visits

2.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

The verification of slope stability along the western portion of the ISL is intended to address an identified need for comparing the existing slope to ARARs. This *Slope Stability Evaluation Plan* will be submitted as a future design investigation.

2.7 WASTE SEPARATION EVALUATION BORINGS

The potential for the subsurface reaction located in the South Quarry portion of the Bridgeton Landfill to migrate to the north into the ISL needs to be evaluated as part of the RD. This evaluation will be performed by drilling soil borings between the ISL and the Bridgeton Landfill to characterize the nature of the materials located between the two landfill units. The Waste Separation Evaluation is a qualitative analysis; (descriptive) evaluation therefore, no DQOs have been provided.

2.8 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

2.8.1 Problem Statement

As stated in the OU-2 ROD (2008), leaching of contaminants to the underlying alluvial aquifer is one of the four potential pathways by which contaminants could migrate from the ISL. Therefore, the objectives of the long-term groundwater monitoring program, as stated in the ROD, are to: 1) protect groundwater from any ongoing or future impacts from the ISL; 2) demonstrate that the Selected Remedy performs as required over the post-closure period; and 3) characterize the existing groundwater conditions and water quality.

Previous groundwater investigative efforts at the West Lake Landfill generally showed sporadic and isolated detections of a small number of contaminants at relatively low concentration levels in the aquifer beneath the landfill. The results did not indicate any on-site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination. Therefore, in accordance with the MDNR solid waste regulations, groundwater sampling for this program is focused on monitoring the unconsolidated, alluvial aquifer (the uppermost aquifer) beneath the site.

2.8.2 Goals of Study

The goal of this study is to evaluate groundwater quality along the presumed downgradient (western and southwestern) boundary of the ISL, to identify any existing impacts to groundwater quality, and to provide a basis for comparison of future groundwater monitoring results.

2.8.3 Information Inputs

Information inputs for the baseline groundwater monitoring phase will consist of: eight (8) quarters of static groundwater level and water quality data from 19 wells completed in the alluvial aquifer and located in the vicinity of the ISL. Wells will be sampled and analyzed for those parameters listed in 10 CSR 80-3 Appendix I, which include various general water quality parameters, metals, and organic constituents. **Table A-2** provides a list of 10 CSR 80-3 Appendix I parameters. **Table A-3** provides the applicable Federal and State water quality standards for those parameters. The water quality standards will be used for comparison purposes only. **Table A-4** lists the typical laboratory method detection limit (MDL) for the each of the requested parameters; MDLs are instrument-specific and are subject to change.

2.8.4 Boundaries of the Study

The spatial boundary of the study is defined by the western, southwestern, and southeastern boundaries of the ISL. The western boundary of the ISL is presumed to be the downgradient boundary of this waste disposal unit. Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells. **Figure 10** shows the location of the 19 wells and the boundaries of the ISL.

- Baseline groundwater monitoring will be conducted quarterly but will not exceed eight (8) quarters.
- Detection groundwater monitoring will begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations, and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*.
- The 19 selected monitoring wells are screened in the shallow, intermediate, and deep portions (i.e., all saturated zones) of the uppermost alluvial aquifer. The alluvial aquifer occurs within the Alluvial Zone, alluvium overlain by loess. The Alluvial Zone beneath the ISL ranges from 120 to 125 feet thick on the western side of the landfill. As stated in Section 2.9.1 above, previous groundwater investigations found no indication of any on-site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination. Therefore, in accordance with 10 CSR 80-3.010(11) (B)3.B, only the uppermost aquifer is proposed to be monitored for baseline and detection groundwater monitoring.

2.8.5 Performance or Acceptance Criteria

- The initial eight (8) quarters of groundwater monitoring results will be compared to ARARs.
- The initial eight (8) quarters of groundwater results will be used to establish statistical background (baseline) values for subsequent evaluation of detection monitoring results from the OU-2 wells.
- Baseline groundwater quality data will also be compared with historical groundwater data (obtained from previous investigations and water sampling efforts) for indications of any contamination in the alluvial aquifer potentially due to the ISL.

- Detection groundwater sample results will be compared to the established baseline values and reviewed for statistical outliers and trends.
- For statistically significant increases, trend tests and re-sampling will be conducted on the affected well(s) (during the next semi-annual event), in accordance with MDNR 10 CSR 80-3.010(11)(C)6.B.

All laboratory reporting limits and/or practical quantitation limits for all parameters analyzed during the long-term performance groundwater monitoring program will be below, equal to, or as close to, as practicable, to the ARARs.

2.8.6 Plan for Obtaining Data

Nineteen (19) monitoring wells have been selected for the long-term performance groundwater monitoring program. Locations of the proposed monitoring wells are shown on **Figure A-10**. Water samples will be collected from 19 wells every quarter for two (2) years. The 19 wells include the following 13 existing wells:

MW-103	PZ-302-AS	PZ-304-AS	S-82
D-81	PZ-303-AS	PZ-205-AS	I-9
PZ-302-AI	PZ-304-AI	D-93	I-73
D-89			

Wells I-73, D-89, and PZ-205-AS are located hydraulically upgradient and will function as background monitoring wells.

Additionally, six (6) wells currently proposed as part of the OU-3 Groundwater Monitoring Plan for the OU-3 RI will be incorporated into the OU-2 groundwater monitoring program upon their installation. Those six (6) wells are:

MW-302-AD	MW-303-AD	MW-304-AD
MW-303-AI	MW-306-AD	MW-306-AI

Because the groundwater monitoring program proposes to utilize six (6) yet-to-be-constructed OU-3 wells, the proposed groundwater monitoring well network is dependent upon coordination and approval of OU-3 RI activities. It is proposed that baseline groundwater monitoring begin, and be conducted, in conjunction with the implementation of the OU-3 RI groundwater monitoring program, the planning documents for which are currently under USEPA review. At this time, it is anticipated that the OU-3 RI/FS Work Plan will be approved by the USEPA, and the proposed additional OU-3 monitoring wells will be installed, during the third and fourth quarters of 2020. Therefore, the baseline phase of the proposed OU-2 groundwater monitoring program would begin in the fourth quarter of 2020 in conjunction with the OU-3 groundwater monitoring activities. However, that date is contingent upon approval of the OU-3 RI/FS Work Plan by the USEPA.

3.0 SPECIAL TRAINING / CERTIFICATION

The tasks included in the proposed field sampling/investigative activities are routine activities that will be performed by competent, knowledgeable, and experienced professionals in the fields of environmental science and engineering.

The CEC field team leader will maintain a certificate of completion for the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER), as well as receiving at least 16 hours of training during the current year (i.e. eight (8) hours of management and supervisory training in addition to eight (8) hours of employee refresher training).

Laboratory analyses will be conducted by a certified laboratory (Pace Analytical Services, LLC) that will use trained, qualified personnel. Training requirements for the laboratory personnel are provided in the Pace Laboratory Quality Manual, included as Attachment 1 of this QAPP.

4.0 DOCUMENTS AND RECORDS

Records and documents associated with the RD Work Plan include plans describing the various field activities, reports summarizing the findings and conclusions of the various field activities, miscellaneous correspondence, field logs, field data worksheets, laboratory analytical reports, and associated maps and figures. Final reports will include the following:

- *RD Stormwater Monitoring Plan*
- *Existing Conditions Summary*
- *Waste Separation Evaluation Report*
- *Western Slope Waste Limit Investigation Plan*
- *Waste Limit Investigation Summary Report*
- *Slope Stability Evaluation Report*
- *Explosive Gas Monitoring Plan*
- *Soil Gas Summary Report*
- *Existing Soil Cap Evaluation Report*
- *Soil Borrow Investigation Plan*
- *Soil Borrow Area Investigation Summary Report*
- *Preliminary (30%) Remedial Design Report*
- *Intermediate (60%) Remedial Design Report* (if required)
- *Re-Final (90%) Remedial Design Report*
- *Final Remedial Design Report*
- *Monthly Progress Reports* (1 – 19)
- *Quarterly Groundwater Monitoring Reports*, which will include the *Data Validation Report*
- *Annual Groundwater Monitoring Reports*, which will include the *Data Validation Report*

Field information logs for perimeter landfill gas well* monitoring will be used to record field measurements. Each page of the field information logs will be dated and signed by the person(s) making the entries.

The types of data that will be generated from the groundwater monitoring program include depth to groundwater measurements, groundwater elevation data, and groundwater quality analytical data. Documentation of these data will include, but not be limited to the following:

- Daily field logs
- Sample collection forms
- Well purging/stabilization forms

- Instrument calibration logs and/or notes
- Chain-of-custody forms
- Internal laboratory receipt forms
- Analytical services request forms
- Shipping receipts (if applicable)
- Laboratory analytical result reports

All data and reports will be electronically submitted to MDNR.

The Bridgeton Landfill, LLC Project Manager will ensure that copies of the RD Work Plan, QAPP, SAP, including the most recent approved versions, and all associated documents, records, and logs, will be maintained and kept at the project Site (West Lake Landfill). Bridgeton Landfill LLC's will maintain the OU-2 RD records (electronically or hard copy) in compliance with record retention requirements from the 1994 Administrative Order on Consent for the RI/FS and subsequent amendments, and as otherwise required by law.

4.1 GROUNDWATER MONITORING DATA VALIDATION REPORT

As discussed in Section 1.10 above, all water quality field and laboratory analytical data will undergo a comprehensive data verification and Level 4 data validation. Upon completion of the data validation, a *Data Validation Report* will be prepared that provides a discussion of validation methods, validated analytical results, and an assessment of data accuracy, precision, representativeness, completeness, comparability, and sensitivity. A *Data Validation Report* will be included with each *Quarterly* or *Annual Groundwater Monitoring Report*. The laboratory will be instructed to provide the data validation package in a comprehensive, standardized electronic format, or EDD. An updated electronic database will be provided to the USEPA and MDNR quarterly (during the baseline monitoring phase) with each *Annual Groundwater Monitoring Report*.

The *Data Validation Reports* will be prepared using guidance from the USEPA documents listed above in Section 1.10.

A tentative Table of Contents for the Data Validation Report is provided below.

- Table of Contents
- Executive Summary
- Introduction
    - Summary of the Project
    - Goal/objective of monitoring program

  - Reiteration/summary of QAPP data quality objectives
- Groundwater Monitoring Sampling Activities
  - Groundwater monitoring activities- discussion of groundwater sampling (including number of samples, wells sampled, variations from groundwater monitoring SAP)
  - Discussion of holding times, sample preservation, and chain of custody form information
  - Detailed discussion of difficulties encountered during the field sampling event, including date, time, samplers' names, well(s) involved, weather conditions, and potential effect(s) on data collected
- Analytical Results for Each Well
  - Discussion and evaluation of sample results
  - Discussion of MDLs in comparison to regulatory criteria
  - Discussion of qualifiers reported
- Laboratory Analytical Results
  - Laboratory report inspection
  - Discussion of calibration issues
  - Discussion and evaluation of laboratory blanks
  - Discussion of laboratory control samples
  - Discussion of laboratory surrogates
  - Discussion of matrix spikes and matrix spike duplicates
  - Discussion of tentatively identified compounds
  - Summary of significant findings and a discussion of their impact on data usability
  - Discussion of any missing documentation or information, calibration issues, and the impact of their absence on the usability of the data
- Conclusions
- References
- Figures, Tables, Appendices

All laboratory data will be validated on an individual laboratory report basis by the appropriate personnel identified in this QAPP within 60 days of receipt from the laboratory. The validated data will be presented in a *Data Validation Report*, which will be included in the *Quarterly* and/or *Annual Groundwater Monitoring Reports*. The groundwater monitoring reports will be prepared and submitted to the USEPA and MDNR within 30 days after the data have been validated (or 90 days from the receipt of laboratory data). (Unvalidated analytical data for the groundwater quality samples will be provided to the agencies as part of the monthly progress reports.)

5.0 SAMPLING PROCESS DESIGN

For the West Lake Landfill OU-2 facility, the number, placement, and frequency of sampling / monitoring locations described below are intended to assist in the decision-making process for the RD.

5.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

There are no specific sampling process design needs associated with the ground and aerial topographic survey, utility locations survey, infrastructure location and detail survey, or base map preparation task. A licensed, experienced surveying company will be used to conduct the needed ground survey in sufficient detail to provide accuracy to within ± 0.20 feet (60 mm) in the vertical and horizontal directions, throughout the ISL.

5.2 TESTING OF POTENTIAL BORROW AREAS

To meet the objectives of this task, samples will be collected and tested from each potential source using standard ASTM methods such that the data is of sufficient quality to assess the suitability of the potential borrow areas and meet the data quality objectives. Protocol regarding borrow area sampling, including minimum sampling and testing frequencies and requirements, will be provided in a future submittal, the *Soil Borrow Area Investigation Plan*. A summary level discussion of the approach and decision criteria that will be used will be included in the future *Soil Borrow Area Investigation Plan.*

5.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

Installation of landfill gas monitoring wells* is proposed for the western perimeter of the ISL. These monitoring wells* will assist in the assessment of subsurface conditions and specifically the potential for subsurface gas migration in support of the RD. The monitoring wells* will be considered as temporary as the potential for relocation or replacement cannot be determined until completion of the cap remedy. If required, the temporary wells* will be replaced by permanent landfill gas perimeter monitoring wells* after RA construction activities are completed. Alternatively, the temporary monitoring wells* may be converted and re-designated as permanent monitoring locations if undisturbed by RA construction.

The temporary monitoring wells* are proposed to be installed at the approximate locations presented in **Figure A-4**. Well* installation activities will be performed by a licensed well driller supervised by CEC personnel. As previously indicated, well* installation may be coordinated with geotechnical investigations with monitoring wells* placed at a spacing of no greater than 500 feet in accordance with relevant regulations (MDNR 10 CSR 80-3.010(14)(B)(1)(C)). Monitoring wells* will be extended to the known base elevation of refuse as determined from the logging of the sonic borings drilled for the slope stability evaluation. (*Note: Based on evaluation of data obtained during waste limit and other investigations conducted prior to the slope stability evaluation, early installation of gas monitoring wells* will be considered if sufficient information is available to determine probable depth of refuse and likely zones of off-site gas migration. Installed monitoring wells* will be then evaluated against data obtained during the slope stability evaluation and amended as required to conform to MDNR rule requirements*).

The screened intervals, and more specifically the need for multiple screened intervals, will be determined in the field based on observations of observed stratigraphy. The need for multiple intervals will be based primarily on the potential for "crosstalk" or interconnection of stratigraphic units that could transmit gas or groundwater flow to otherwise isolated stratigraphic units. **Figure A-11** provides a typical well* installation including a multiple screened interval.

Each monitoring well* will be surveyed by a Missouri-licensed surveyor for state-plane northing, easting, ground surface elevation, top of protective casing elevation, and top of inner riser elevation. Results of the survey will be provided in the Summary of Soil Gas Report.

Methane monitoring will be performed as required by 10 CSR 80-3.010(14)(C)(4) and in accordance with the 1999 MDNR technical bulletin *Sampling of Landfill Gas Monitoring Wells*. Monitoring of these wells* will continue until immediately prior to the commencement of RA construction activities.

Temporary monitoring wells* that require repair or replacement will be repaired or abandoned in accordance with MDNR 10 CSR 23-6.050 (Well Installation rules). Any temporary monitoring wells* that remain operable through the end of construction activities will be incorporated into the long-term landfill gas monitoring program, if necessary.

5.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

The cover soil sampling program will include performing eighty-eight (88) direct push samples at 150-foot intervals from a surveyed grid across the ISL to evaluate the existing cover thickness. **Figure A-5** displays the approximate sampling grid and sample locations. The approximate 150 feet spacing allows for representative coverage of the entire cap area with a spacing close enough to account for significant variabilities in the cover material. Proposed cap sampling locations will be in areas that are accessible to heavy equipment (i.e., direct push drilling rig) and within the limits of waste.

The proposed sampling locations were selected to avoid select site features which pose physical access constraints on sampling activities (i.e., the steep western slope).

After completing the initial direct push boreholes at the locations described above, ten (10) Shelby Tube samples will be collected at locations immediately adjacent to further investigate the material properties of the existing cover. Shelby Tube samples will be collected using the ASTM D1587. Undisturbed soil samples will be collected for material testing purposes. Proposed laboratory testing for cover soil samples is detailed in Section 8.0 of this QAPP.

5.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

No sampling is anticipated for this task.

5.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

As one of the RD tasks, a geotechnical analysis will be performed to assess the stability of the western slope of the ISL. This *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

5.7 WASTE SEPARATION EVALUATION

To evaluate a separation between the South Quarry portion of the Bridgeton Landfill and the ISL portion of OU-2, CEC will perform sonic drilling using a minimum four (4)-inch diameter sonic tooling at a minimum of three (3) locations. Rock coring will also be performed to a depth of five (5) feet below the bottom of the observed soil column using the drill sonic rig, with the purpose being to verify that all of the soil materials above the bedrock have been sampled/visually observed. See **Figure A-9** for the proposed boring locations.

5.8 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Groundwater sampling for the proposed OU-2 long-term performance groundwater monitoring will be conducted in two phases:

- Baseline groundwater monitoring – to be conducted quarterly; and for up to eight (8) quarters.

- Detection groundwater monitoring– to begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*.

Locations of the 19 proposed monitoring wells are shown on **Figure A-10**. The 19 wells include the following thirteen (13) existing wells:

• MW-103	PZ-302-AS	PZ-304-AS	D-89
• D-81	PZ-303-AS	PZ-205-AS	D-93
• PZ-302-AI	PZ-304-AI	S-82	I-9
• I-73			

Additionally, six (6) wells currently proposed as part of the OU-3 Groundwater Monitoring Plan for the OU-3 RI will be incorporated into the OU-2 long-term performance monitoring program upon their installation. Those six (6) wells are:

• MW-302-AD	MW-303-AD	MW-304-AD
• MW-303-AI	MW-306-AD	MW-306-AI

During the baseline monitoring phase, the 19 wells will be monitored for static water level and those parameters listed in MDNR 10 CSR 80-3.010 Appendix I, which includes various general water quality parameters, metals, and organic constituents. **Table A-2** of this QAPP provides a complete list of the parameters that will be analyzed in the baseline groundwater samples.

6.0 SAMPLING METHODS

For the West Lake Landfill OU-2 facility, the sampling methods described below are designed to provide defensible, reliable data to assist the decision-making process for the RD.

6.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

There is no sampling necessary as part of the ground and aerial topographic survey and base map preparation task.

6.2 TESTING OF POTENTIAL BORROW AREAS

Protocols regarding sampling methods for the potential borrow areas will be provided in a future submittal for the Soil Borrow Investigation Plan.

6.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

During installation of the temporary landfill gas monitoring wells*, borings will be logged with geologic samples collected via the selected drilling method (sonic, direct push, or continuous samplers). Following extraction from the drilling rods, soils will be logged for lithology and visually inspected for the presence or absence of solid waste. Following installation of the monitoring wells*, initial methane levels will be measured in addition to water levels. Engineering classification of soils obtained during installation is not anticipated.

All initial and ongoing monitoring of the landfill gas monitoring wells is proposed to be conducted generally in accordance with the procedures described by the 1999 MDNR technical bulletin *Sampling of Landfill Gas Monitoring Wells.* In addition, installation and construction will be generally in accordance with the U.S. EPA Guidance Document EPA-600/R05/123a *"Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities" (September, 2005).*

6.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

The existing thickness and material evaluation of ISL cover sampling program will include the collection of 88 samples spaced at approximately 150-foot grid intervals from a surveyed grid across the ISL. **Figure A-5** displays the approximate sampling grid and sample locations. Each location will be sampled using a direct push rig pushing a tube sampler lined with clear polyethylene liners. Each sampler will be brought to the surface, the liner opened, and the soils visually examined to distinguish materials and measure corresponding material thicknesses. The field engineer will develop a log of the soil conditions encountered in each soil boring.

Ten (10) Shelby tube samples will be collected during the RD in accordance with ASTM D1587 at locations immediately adjacent to the cap thickness sampling locations. Undisturbed soil samples will be collected for material classification and permeability testing purposes. The Shelby Tube samples will be submitted to a qualified geotechnical laboratory where the tubes will be extruded and logged with representative portion of each tube tested for Atterberg Limits, grain size distribution and permeability. Refer to Section 8.4 of this QAPP for reference ASTM Methods to be used. All borings that penetrate the landfill cover will be sealed properly with hydrated bentonite clay plug or other approved methods. The plug will only come to within one foot of ground surface, and the remaining one foot will be filled with soil that supports vegetative growth. Abandoned sample locations will be visually inspected as part of the long term surveillance and monitoring. Any plugs which need repair will be fixed immediately with additional hydrated bentonite clay or other approved methods and re-inspected again one month and one year after the repairs have been made.

6.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

No sampling is anticipated for this task.

6.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

A geotechnical analysis will be performed to assess the stability of the slope. This *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

The limits of waste for the ISL will be identified in a waste limit investigation to be performed at the site. A *Waste Limit Investigation Plan* for the ISL will be submitted at a future date.

6.7 WASTE SEPARATION EVALUATION BORINGS

Subsurface materials will be returned to the surface as a result of the sonic drilling efforts, and will be visually evaluated/photographed to determine if waste materials are present. The borings will be observed for liquid/leachate immediately after boring completion, 24 hours after boring completion, and 48 hours after boring completion assuming the boreholes remain open.

6.8 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Groundwater sampling procedures are specified in Section 8.0 of the SAP (Appendix B of the RD Work Plan). The 19 wells will be monitored quarterly for up to 8 quarters for static water level and those parameters listed in 10 CSR 80-3.010 Appendix I, which includes various general water quality parameters, metals, and organic constituents. **Table A-2** lists the specific parameters that the groundwater samples will be analyzed for comparison purposes and the analytical method.

In summary, all field meters and instruments will be calibrated prior to sampling in accordance with manufacturer's instructions; all field sampling equipment will be decontaminated before use (see Section 8.1.9 of the Sampling and Analysis Plan [Appendix B to RD Work Plan]); wells will be purged before the collection of groundwater samples; the low-flow purging method will be used for purging; field stability parameters (pH, specific conductance, temperature, dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP)) will be collected every five minutes during well purging; samples will be collected in clean, unused, pre-preserved laboratory-provided sample bottles; and sample containers will be filled in order of decreasing sensitivity to potential volatilization of the analytical constituents. Groundwater will be transferred directly into the appropriate sample containers, chilled, and processed for transportation/shipment to the laboratory. Purged water will be containerized and analyzed prior to disposal.

Bridgeton Landfill, LLC's OU-3 consultant/contractor field sampling Project Manager will be responsible for providing oversight and decision making regarding any difficulties encountered during the field sampling event and/or field corrective actions.

Because it is currently anticipated that sampling may be performed by OU-3, these procedures may be modified to be consistent with the OU-3 QAPP and Field Sampling Plan requirements.

7.0 SAMPLE HANDLING AND CUSTODY

7.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

There are no sample handling and/or custody issues associated with the ground and aerial topographic survey and base map preparation task.

7.2 TESTING OF POTENTIAL BORROW AREAS

Since samples for geotechnical testing are disturbed samples, sample handling will involve preservation of the initial quantity of sample by sealing the container properly. A soil testing chain of custody (COC) form will be attached to each soil sample container including the date of sampling, the location of the sampling, the sampler's name, a general description of the material, and the requested tests to be conducted. A copy of the soils testing COC form will be kept by the QA Manager.

Tracking numbering system for borrow area soil samples will use the prefix: OU2-BA.

7.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

Landfill gas measurements will be stored in the monitoring device or written in a field log book or field data form. Therefore, there are no sample handling and/or custody issues associated with the landfill gas perimeter well* installations and measurements.

7.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

Soil samples collected specifically for determining material thicknesses will be measured and documented on-site. Therefore, there are no sample handling and/or custody procedures for these samples.

For the portion of soil samples being collected for off-site geotechnical analysis, sample handling will involve preservation of the sample by properly sealing the container. Each container will be labeled and contain the following information: sampling date, location, sampler's name, a general description of the material, and the requested analytical method. A laboratory COC form will be completed and attached to each shipment. A copy of the COC form will be retained by the QA Officer.

Tracking numbering system for the existing cover soil samples will use the prefix: OU2-EXC.

7.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

There are no sample handling and/or custody issues associated with the evaluation of the stormwater conveyance or site infrastructure.

7.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

The *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

7.7 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Detailed groundwater sample handling and custody procedures are presented in Section 8.1 of the SAP (Appendix B of the RD Work Plan). In summary, the water samples will be collected in appropriate laboratory-cleaned, pre-preserved (if required) bottles, labeled with pertinent information (specified in Section 8.1 of the SAP), placed into an ice-packed cooler immediately after collection, and transported/shipped to the analytical laboratory as soon as feasible.

Samples must be maintained at a temperature of 0-6° Celsius until they are delivered to the laboratory. Samples will be transported to the analytical laboratory as soon as possible to ensure holding times are met.

A laboratory chain-of-custody form will be completed and signed for each sampling event and will accompany groundwater samples to the analytical laboratory. At a minimum, the chain-of-custody form will include: the project name, sampler(s) names, analytical laboratory name, address, and phone number, type of analysis requested, date/time of shipment or delivery, and signature of person involved in shipment/delivery of samples.

These procedures will be followed for all water samples collected during the OU-2 long-term performance groundwater monitoring program.

The tracking numbering system for groundwater samples will use the prefix: OU2-GW.

Because it is currently anticipated that sampling may be performed by OU-3, these procedures may be modified to be consistent with the OU-3 QAPP and Field Sampling Plan requirements.

8.0 ANALYTICAL METHODS

8.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

There will be no collection or submittal of samples associated with the ground and aerial topographic survey and base map preparation task.

8.2 TESTING OF POTENTIAL BORROW AREAS

Analytical methods associated with the testing of potential borrow areas will be detailed in a future *Soil Borrow Area Investigation Plan.*

8.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

Planned activities will not result in collection of samples for laboratory analysis. Therefore, there will not be any samples from the installation and monitoring of the landfill gas monitoring wells* that will be submitted for laboratory analyses.

8.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

The following analytical methods will be employed for geotechnical testing of the Shelby tube soil samples (collected pursuant to ASTM D1587):

- Moisture Content
  - ASTM D2216 (2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

- Unit Weight
  - ASTM D7263 (2018) Standard Test Method for Unconfined Compressive Strength of Cohesive Soil Standard Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens.

- Grain size distribution
    - ASTM D6913 (2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

    - ASTM D1140 (2017) Standard Test Methods for Determining the Amount of Material Finer than 75-m (No. 200) Sieve n Soils by Washing.

- Atterberg Limits
  - ASTM D4318 (2017) Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

- Hydraulic Conductivity
  - ASTM D5084 (2016) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

8.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

There will be no collection or submittal of samples associated with the evaluation of the stormwater conveyance and site infrastructure task.

8.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

Analytical methods associated with the Slope Stability Evaluation and the Western Slope Waste Limit Investigation will be detailed in a future plan.

8.7 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

As stated above in Sections 1.9 and 6.7, during the baseline monitoring phase of the groundwater monitoring program, the 19 selected groundwater wells will be monitored for static water level and those parameters listed in 10 CSR 80-3.010 Appendix I for comparison purposes. **Table A-2** of this QAPP provides a complete list of the parameters that the baseline groundwater samples will be analyzed for comparison purposes, and the specific analytical method.

The process for reviewing laboratory data files is discussed above in Section 1.9. As stated in Section 1.9, Bridgeton Landfill LLC's OU-3 consultant/contractor will be responsible for addressing any corrective actions that may be needed related to laboratory data and testing of groundwater samples, as well as the needed turnaround time. The OU-3 consultant/contractor will also be responsible for the verification and validation of the groundwater quality laboratory data.

Upon completion of the baseline monitoring phase, assuming no revisions or modifications to the currently proposed program, the detection monitoring phase will begin, in accordance with 10 CSR 80-3.010(11)(C)4, and continue through the post-closure of OU-2.

Groundwater quality data will be compared against the following established Federal and State water quality standards: 40 CFR Part 141, the primary drinking water standards, or MCLs, and Missouri regulations 10 CSR 4.010 through 4.110, State primary drinking water standards.

If, during the detection monitoring phase, a parameter in a well shows a statistically significant increase over the background value, notification, along with the well data, will be submitted to the USEPA and MDNR and the well will be resampled in accordance with MDNR 10 CSR 80-3.010 (11)(C)6.

Laboratory MDLs for each parameter must be below the applicable water quality standard for that parameter to the extent practicable. **Table A-3** of this QAPP provides the applicable water quality standard for each required parameter. **Table A-4** lists the typical laboratory MDLs for the requested parameters, however, MDLs are instrument-specific and are subject to change.

A copy of the analytical laboratory Accreditation for Certification provided by Pace Analytical is provided in **Attachment 3** of this RD QAPP.

9.0 QUALITY CONTROL

This section describes the procedures that will be used to ensure quality of the field sampling activities, including groundwater sample collection. Some of these procedures have been discussed in preceding sections, i.e., sampling methods, and sample handling, custody, and transport.

9.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

Data collected for the topographic, aerial, and utility surveys will be obtained by a Missouri PLS. The PLS will reference and tie into known benchmarks that exist in the vicinity of the site.

9.2 TESTING OF POTENTIAL BORROW AREAS

Testing of the potential borrow area materials will be detailed as part of a future *Soil Borrow Investigation Plan* submittal.

9.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

Neither visual inspections of soil samples collected in plastic sleeves during gas well* installation nor methane measurements will result in collection of samples for laboratory analysis. Therefore, quality control issues associated with physical samples are not expected to be associated with the landfill gas perimeter well* installations and measurements.

With respect to collection of field data during well* installation, various quality control measures will be implemented to assure accurate and representative data collection. During collection of gas composition data during well* installation, the primary quality assurance protocol will conform to that set forth in 1999 MDNR technical bulletin *Sampling of Landfill Gas Monitoring Wells.*

The additional provisions recommended include recording of "balance gas" concentration (assumed as nitrogen), evaluation of the nitrogen to oxygen ratio, and measurement of well* gas pressure (as needed).

A nitrogen to oxygen ratio of approximately 4:1 would suggest ambient air intrusion or leakage in the sampling train (effectively diluting or lowering actual landfill gas concentrations). Therefore, in addition to the 2% (by volume) oxygen limit established in the technical bulletin, nitrogen measuring at 8% or more regardless of oxygen concentration may also suggest ambient air intrusion requiring examination of well* or sampling train integrity. This will serve as an immediate sample quality control check during sampling.

If ambient air intrusion is suspected, a second quality control check in the form of well* gas pressure measurement is recommended. As soil gas emission rates often fluctuate inversely to atmospheric pressures, measurement of well* pressure will indicate if air intrusion is due primarily to sampling methods, or atmospheric conditions. For all sampling data collected in which nitrogen exceeds 8% by volume, it is recommended that both diluted and undiluted methane concentrations be reported to assess concentration trends.

9.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

The cover material will be sampled using a direct push technology (DPT) rig. A 3-inch diameter, lined sampling tube (Shelby tube) will be used to retrieve a representative sample.

Shelby tube samples will be collected using the methods outlined in ASTM 1587.

The Shelby tube samples will be subjected to Geotechnical testing to be conducted by an American Association of State Highway and Transportation Officials (AASHTO) certified laboratory. Results of the Shelby Tube geotechnical testing will be compared to the results of the Shelby Tube sample data from 2009. Differences of more than 50 percent from previous data will require further discussion on whether the lab data can be used or not.

9.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

There are no sample quality control issues associated with this task.

9.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

Quality Control associated with the *Slope Stability Evaluation Plan* and the *Western Slope Waste Limit Investigation* will be detailed in a future plan.

9.7 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Quality Assurance/Quality Control (QA/QC) procedures will be conducted as part of the long-term groundwater monitoring program in order to quantify and identify sources of random error associated with the collection and analysis of samples. As stated in Section 8.7 of the SAP, the QA/QC procedures include:

- Collection of field duplicate samples and equipment blanks.
- Evaluation of sample holding times and preservation.
- Evaluation of laboratory control samples.
- Review of lab replicates, spike samples, and calibration blanks.
- Evaluation of field records for consistency.
- Determination of data usability.
- Evaluation of laboratory analytical data in accordance with USEPA Level 4 validation requirements.

9.7.1 Groundwater Field Quality Control Samples

The following field Quality Control samples and sample frequencies will be collected for analysis during the proposed groundwater monitoring event:

- Field Duplicate samples – one (1) field duplicate groundwater sample to be collected per 10 primary groundwater samples (per standard sampling protocols).
- Field (atmospheric) Blank samples – one (1) field blank sample to be collected per sampling event.
- Equipment Blank samples – one (1) equipment blank sample to be collected per sampling event if a non-dedicated pump is utilized for purging and sampling.
- Trip Blank samples – one (1) trip blank sample (provided by the laboratory) to be included with each sample shipment containing samples for analysis of VOCs.

9.8 WASTE SEPARATION EVALUATION

There are no sample quality control issues associated with this task.

10.0 INSTRUMENT / EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

This section discusses the testing, calibration, inspection, and maintenance of field instruments or meters that will be used during the various RD investigations. Only those investigations that require the use of field instruments or meters are addressed in this section.

10.1 LANDFILL GAS MONITORING INSTRUMENT CALIBRATION

Field instrumentation utilized for landfill gas measurements will be calibrated according to the manufacturers' recommendations each day of sampling and prior to monitoring activities. The calibration of field instrumentation will be verified at the end of each sampling day against the calibration solutions or calibration gases. If potentially anomalous field parameter measurements are encountered during gas monitoring activities, the calibration frequency may be increased at the discretion of the field sampling crew to confirm potentially anomalous measurements.

All calibration data will be recorded on sampling logs completed at the time of instrument use and sampling.

10.2 GROUNDWATER MONITORING INSTRUMENT CALIBRATION

All water monitoring instruments, including water-level meters and water quality instruments, will be used, maintained, inspected, and tested in accordance with the manufacturer's instructions and product manual. The meters and instruments will be tested and calibrated prior to each sampling trip and periodically as needed during sampling (i.e., daily). Water-level meters will be tested according the manufacturer's recommendations. For pH, meters must be calibrated with three (3) buffer solutions: 4.0, 7.0, and 10.0. Conductivity must be calibrated with a standard that is similar to the expected conductivity range of the water that will be sampled. The temperature probe must be calibrated once a year with a NIST-certified thermometer.

Calibration of dissolved oxygen (DO) probes, oxidation/reduction potential (ORP), and turbidity probes will follow the respective manufacturer's instructions for calibration.

Calibration information, such as the date/time, standard(s), etc., must be recorded in the instrument log book and/or groundwater sampling field form.

If, at any time, instrument readings seem inaccurate based on historical data or professional judgment, the instrument calibration will be checked and the instrument recalibrated, if necessary, or the field sampler(s) may choose to use another calibrated, functioning instrument.

Spare parts for the water monitoring instruments will be maintained at the facility site.

10.3 LABORATORY INSTRUMENT CALIBRATION AND TESTING

Procedures for calibration, testing, operation, and maintenance of laboratory equipment and analytical instruments are provided in the Pace Analytical Quality Assurance Manual (Attachment 1).

11.0 INSPECTION / ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies and consumables that will be required for the proposed RD activities/investigations described in this RD QAPP are provided below.

11.1 TOPOGRAPHIC SURVEY AND BASE MAP PREPARATION

The ground and aerial topographic survey and base map preparation task will not require any supplies and/or consumables.

11.2 TESTING OF POTENTIAL BORROW AREAS

Testing of the potential borrow areas will not require any supplies and/or consumables.

11.3 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS*

Required supplies and consumables for temporary landfill gas perimeter monitoring well* installation activities are expected to consist of: environmental-grade one (1)-inch diameter PVC riser and screen, steel protective casings, locks, bentonite chips, bentonite/cement grout, and any other drilling compounds or materials used by the drilling contractor to construct the monitoring wells*.

Required supplies and consumables for monitoring well* activities are expected to consist of calibration gases for the combustible gas indicator.

11.4 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

The evaluation of the thickness and material of the existing landfill cap will not require any supplies and/or consumables.

11.5 EVALUATION OF STORMWATER CONVEYANCE AND SITE INFRASTRUCTURE

The evaluation of the stormwater conveyance and site infrastructure will not require any supplies and/or consumables.

11.6 SLOPE STABILITY VERIFICATION ALONG WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

Required supplies and consumables for the Slope Stability Verification along the Western Portion of the ISL will be detailed in a future plan.

11.7 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

Required supplies and consumables for groundwater monitoring activities are expected to consist of:

- Groundwater sample containers provided by the laboratory;
- Calibration solutions for field pH, specific conductance; dissolved oxygen, and oxidation/reduction potential, and turbidity;
- Alconox™ (or equivalent) detergent for equipment decontamination between monitoring wells;
- Deionized water for equipment decontamination between monitoring wells;
- Deionized or distilled water for field blank and / or equipment blank collection;
- Disposable gloves;
- Plastic Ziploc bags
- Trash bags;
- Paper towels; and
- Ice for maintaining cooled samples prior to delivery to the analytical laboratory.

The field sampling contractor Project Manager will be responsible for assessing and determining if supplies ordered and received meet the Project standards.

12.0 NON-DIRECT MEASUREMENTS

Previous information obtained during field activities for the West Lake Landfill OU-2 facility may be used for planning field activities proposed in this RD QAPP. Sources of data obtained from various previous investigation studies or field activities are listed below.

- Previous Monitoring Well Analytical Results
  - Water quality data from previous groundwater investigative efforts may be used to determine the order of monitoring well purging and sampling (from least impacted to most impacted) or other situation. Although preference will be given to validated historic groundwater quality data, unvalidated historic groundwater quality data may also be used for consideration if no other data for that specific well or parameter exists.

- Existing Well Logs
  - Existing well construction logs may be used to aid in evaluating various issues including aquifer data, i.e. transmissivity values, gradient, and formation contacts, screened intervals, well depth, pumping rates, and other construction data. Professional judgement should be used in reviewing and depending on historic well construction logs, i.e., more than 20 years old.

- Previous Shelby Tube Samples
  - Summary of "Results of Laboratory Testing," dated May 20, 2009 for soil samples collected from the OU-2 in-place cap material will be used to complement and compare with the Shelby tube samples to be collected in the near future as proposed by this QAPP.

13.0 REPORTS TO MANAGEMENT

In addition to the one-time submittals listed above in Section 4.0, reports provided to the USEPA and MDNR on a regular basis will include: Monthly Progress Reports, *Quarterly Groundwater Monitoring Reports* (only during the 8 quarters of baseline monitoring), and *Annual Groundwater Monitoring Reports*. Figure 8 of the RD Work Plan lists the projected submittal dates of all anticipated reports.

14.0 VERIFICATION AND VALIDATION OF GROUNDWATER ANALYTICAL DATA

This section describes the QA and QC procedures that may be implemented for the OU-2 RD activities.

- Data verification is the process of checking and comparing the completeness, correctness, and conformance/compliance of a specific data set against the proposed/planned/stated method or procedure in the Work Plan, SAP, and/or QAPP. Data verification applies to activities in the field as well as in the laboratory.

- Data validation is the analyte- and sample-specific process that evaluates the data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality/usability of the data.

14.1 DATA VERIFICATION

Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or project specifications. Data verification is the inspection of the data set and requirements.

QC records that will be checked and evaluated in the data verification process for this project include:

- Sample collection forms/logs, including daily field logs, drilling logs, soil/water sample collection forms, COC forms, and shipper's copies;
- Sample receipts, including COC forms from the sampler, internal laboratory receipt forms, internal laboratory COC forms;
- Sample preparation forms, including analytical services requests, internal laboratory receipt forms; and
- Sample analysis forms, including instrument logs, instruments readouts (raw data), and calculation worksheets.

QC records will be verified to ensure that all necessary and required records are present, correct, consistent, complete, and that all required signatures are present. The data will be verified for correctness to ensure that the information written in the form/document matches with data received or required. Additionally, the data will be checked for technical compliance to ensure, for example, that the samples were properly preserved in accordance with the requested method, and that the holding times were met.

Data will be verified using the following steps, per USEPA *Guidance on Data Verification and Validation* (2002) document:

1. Evaluate the field records for consistency;
2. Review the QC Information;
3. Summarize deviations and determine impact on data quality;
4. Summarize samples collected; and
5. Prepare field data verification summary, which will be included as part of the Data Validation Report.

The data verifier may use a checklist or other means to record the results of the data verification process and will sign and date any records that the data verification produced.

14.2 DATA VALIDATION

This section discusses the validation of environmental data that will be collected under the OU-2 RD activities. Data validation is the process of systematic review of laboratory data deliverables that can help identify laboratory and field sample analytical uncertainty and informs the user of any limitations on a data set. Data validation provides the overall appraisal of a data set.

All groundwater quality samples collected under the OU-2 performance groundwater monitoring program will be submitted to a certified laboratory (Pace Analytical Services, LLC) for the requested analyses. The laboratory will be instructed to provide a Level IV data validation package.

Data validation will be performed on each analytical data package to evaluate the usability of the sample data for meeting the project objectives. The data will be evaluated against the quantitative acceptance limits specified in the sections below for the quality assurance (QA) objective parameters of reporting limits (sensitivity), accuracy, precision, and completeness.

The following references will be used for guidance in the data validation process:

- USEPA *National Functional Guidelines for Inorganic Data Review* (January 2017)
- USEPA *National Functional Guidelines for Organic Superfund Methods Data Review (January 2017)*
- USEPA *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (Final, June 2007)
- USEPA *Guidance on Environmental Data Verification and Data Validation* (2002)
- USEPA *Region 9 Superfund Data Evaluation/Validation Guidance* (Draft, 2001)

The data validation package from the analytical laboratory will include, but is not limited to, the following elements:

- An analytical laboratory report containing narrative, sample ID summary, major/minor issues, and analytical results
- Analytical laboratory report attachments: glossary of data qualifiers, all tentatively identified compounds, quantitation reports
- Analytical results flagged to denote laboratory QC failures
- Data qualifiers/flag definitions
- Copies of COC forms
- Holding time information for each parameter
- Dates of sample preparation and analysis for each analysis, each water sample
- Reporting limits and detection limits listed for all parameters
- Duplicate sample results, as applicable
- Surrogate recovery, as applicable
- MS/MSD sample and duplicate recovery results
- Method Blank summary
- Multiple sample dilutions reported
- Instrument Performance Check, as applicable
- Initial and Continuing Calibration verification form
- Chromatograms and quantitation reports
- Continuing calibration forms
- Internal Standard Area and Retention Time summary
- Linear Range Standard summary, as applicable
- ICP Interference Check samples
- Tuning and Response Factor summary
- ICP serial dilution
- Preparation log
- Analysis run log
- Raw data, including instrument printouts
- Calculation forms for general, inorganic, and organic testing

A Data Validation Report, as discussed above in Section 4.1, will be prepared at the conclusion of the data validation process and will provide a discussion of validation methods, validated analytical results, and an assessment of data accuracy, data precision, and data completeness. The Data Validation Report will be included with each *Quarterly* and/or *Annual Groundwater Monitoring Report*.

14.2.1 Validation of Verified Field Activities Data

After reviewing and verifying the field activities documents as outlined in Section 14.1 above, the data validator will review and evaluate the analytical data using the following steps (*Guidance on Data Verification and Validation,* USEPA, 2002):

1. Assemble the analytical documents and data to be validated. Review the data verification records to determine the method, procedural, and contractual information required for QC compliance/non-compliance;
2. Review verified, reported sample results collectively for the data set as a whole, including laboratory qualifiers;
3. Summarize data and QC deficiencies and evaluate the impact on overall data quality; and
4. Assign data validation qualifiers as necessary.

14.2.2 Review of Laboratory QC Elements

The data validation process will consist of evaluating the results for the following QC parameters as applicable to the method: holding times, blank contamination, laboratory control sample results, surrogate recoveries (applicable to organics only), duplicate sample analysis, MS recoveries, MS/MSD precision, field duplicate result agreement, and completeness of the data package. Following the QC review of each data package for these parameters, an overall assessment with respect to the quantitative and qualitative data quality assurance objectives listed above was formulated for each data package. The QC review reports for each data package provide a discussion of any QA/QC results outside of acceptance limits, an explanation of all data qualification assigned and any professional judgment used by the reviewer, and an overall assessment of the data. The QC review will not include result recalculation or transcription error checking from the raw data.

Laboratory analytical results for each well and each analyte will be assessed and verified for the following elements.

14.2.3 Data Accuracy and Precision

Accuracy is an assessment of the closeness of the measured value to the true (or expected) value. Accuracy for field measurements are determined as follows: known pH buffers and specific conductance standards are used to calibrate and determine the accuracy of the field water quality meter. Accuracy of a laboratory analysis is assessed by analyzing a sample “spiked” with a known concentration and establishing the average recovery. For the OU-2 groundwater monitoring conducted under this QAPP, accuracy for the analytical measurement of spiked samples must be at least 80 percent.

Precision of the data is a measure of the data spread when more than one measurement has been taken on the same sample (or sampling location) under identical, or substantially similar, conditions. Precision is calculated for field and laboratory measurements through sample duplicates and measurement replicates. Duplicate precision is typically analyzed by calculating the relative percent difference (RPD). The formula to calculate RPD is:

RPD = 100 x (S - D)/[(S + D)/2]
Where S = original sample result, D = duplicate sample result

For water programs conducted under this QAPP, RPDs less than 20 percent will be deemed acceptable for field duplicates and laboratory duplicates.

Field blanks, equipment blanks, and trip blanks will be evaluated for the presence of contaminants of concern, and if present, the associated investigated sample results will be qualified in accordance with EPA functional guidelines for validation of organic and inorganic laboratory data.

14.2.4 Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the conditions at the site. It also reflects the ability of the sampling team to collect samples and laboratory personnel to analyze those samples in such manners that the data generated accurately and precisely reflect the conditions at the site.

For this Project, representativeness depends largely on the selected groundwater monitoring wells that will be sampled quarterly. The 19 wells were selected based on geospatial location along the western, southwestern, and southeastern boundaries of the OU-2 and the ability to monitor various hydrogeologic zones in the alluvial aquifer. The selected wells are spaced 50 feet to 450 feet from each other. Six of the selected wells are/will be screened in the shallow alluvial aquifer, 7 are/will be screened in the intermediate portion of the alluvial aquifer, and 6 will be/are screened in the deep portion of the alluvial aquifer. Additionally, the groundwater samples will be analyzed for a list of specific metals, major cations and anions, and volatile organic compounds. Hence, the combination of the spacing and locations of the selected monitoring wells, the monitoring of three hydrogeologic intervals, and the various requested analytes will provide acceptable representative samples of groundwater conditions at OU-2.

14.2.5 Comparability

Comparability is a confidence measure of comparisons between data sets. The ability to compare data sets is particularly critical when comparing a set of data for a specific parameter to historical data for the purpose of determining trends. Adhering to the project-specific SAP and properly handling and analyzing all samples will satisfy the comparability of field data.

14.2.6 Completeness

Completeness is the comparison between the amount of data planned to collect versus the amount of usable data actually collected, expressed as a percentage. While a completeness goal of 100 percent is desirable, achieving an overall completeness of 90 percent is more realistic under normal field sampling and laboratory analysis conditions. A completeness value of less than 90 percent indicates that corrective action is necessary to limit the number of incomplete or unacceptable results and to avoid similar problems in future sampling events.

Each analytical data package will be evaluated for completeness of deliverables against the following criteria:

- Presence of tabulated results of all specified compounds identified and quantified and reporting limits for all analytes. Presence of results for all methods requested on the COC forms for each sample.
- Presence of COC forms, QC summary forms for MS results with calculated percent recoveries; QC summary forms for laboratory duplicates results and calculated RPDs; blank results; and QC summary forms for LCS sample results with calculated spike recoveries (and RPDs if applicable).

Data package deliverables that do not meet the above criteria will be documented, and the missing deliverables will be obtained from the contract laboratory. Any documents not obtainable from the laboratory will be noted in the Data Validation Report.

14.2.7 Sensitivity (Laboratory Reporting Limits)

Sensitivity is related to the laboratory reporting limit (RL). Sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably quantitate the analyte at that concentration. The instrument or method should be able to detect and provide an accurate analyte concentration that is not greater than an applicable standard or screening level.

An MDL is a laboratory-specific number and defined as the lowest concentration at which an analyte can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision. **Table A-4** provides the typical MDL for each of the requested parameters, however, MDLs are instrument-specific and are subject to change.

When possible (i.e., no matrix interference), the laboratory RL value for each and every parameter analyzed in the groundwater samples must be equal to or below (preferably below) the applicable or relevant and appropriate numeric water quality standard as promulgated, revised, and published by the MDNR or USEPA. Water quality standards include:

- 40 CFR Part 141, Subpart B, Federal MCLs;
- MDNR 10 CSR 60-4.010 through 4.110; and
- MDNR 10 CSR 20-7.031(5), including Table A.

14.2.8 Field Duplicate Results

Field duplicate results will be evaluated by comparing the results for the sample and its duplicate. For groundwater sample duplicate results where both reported values are greater than 5 times the reporting limit, the RPD between the sample and its duplicate will be compared against a criterion of ≤20 percent. For groundwater sample duplicate results where either value reported are less than 5 times the reporting limit, the absolute difference between the results will be compared to a criterion of agreeing within ± 2 times the reporting limit. Field duplicates not meeting the above criteria will be discussed in the Data Validation Report. Sample data will not be qualified on the basis of field duplicate results.

14.2.9 Laboratory Duplicates

Laboratory duplicates are a second aliquot of a sample treated exactly the same way through preparation and analysis. Results for the laboratory duplicate sample analyses will be compared to the laboratory determined acceptance limits. The RPD criterion (≤20 percent) will be applied for cases in which both the sample and duplicate results are greater than 5 times the reporting limit. Otherwise, the absolute difference between the sample results will be compared to 1 times the greater reporting limit for water samples. If the duplicate results for an analyte do not satisfy the applicable evaluation criterion, results for that analyte in all associated samples will be qualified as estimated (“J/UJ”).

14.2.10 MS/MSD Analyses

MS and MSD analyses are used to assess the accuracy (MS) and precision (MSD) of the analytical methods in a sample matrix. The analytical laboratory prepares MS samples by splitting off three aliquots of the water sample and adding known amounts of target analytes to two of the three sample aliquots.

The results of the analysis of the unspiked water sample are compared to the MS analysis results, and percent recovery of each spike is calculated to determine the accuracy of the analysis. The acceptance criteria are usually specified by the analytical method. If the results for the MS fall outside of the acceptable range they will be flagged by the laboratory.

The RPD of the MS and the MSD is a measure of the precision of the analytical method on the specific matrix. These results should be within 20 percent. If they are not, discrepancies should be resolved with the analytical laboratory.

The following laboratory QC samples and sample frequencies are proposed to be analyzed concurrently with the OU-2 groundwater samples:

- Method Blank samples – one (1) method blank sample to be analyzed per batch not to exceed 20 samples analyzed in the batch;
- Laboratory Control Samples (LCS) – one (1) LCS to be analyzed per batch not to exceed 20 analyzed samples in the batch; and
- MS / MSD samples – one (1) MS / MSD sample pair to be analyzed per batch not to exceed 20 samples analyzed in the batch.

14.2.11 Method Blanks

For each batch of samples submitted, the analytical laboratory should run a set of method blanks (also called control blanks) to determine the level of contamination associated with laboratory reagents and glassware. Method blanks are prepared by the laboratory by analysis of laboratory reagent or blank water. Method blanks are an aliquot of analyte-free water that is put through all the steps of a specific method along with the samples. Results of the method blank analysis should be reported with the sample results. Method blanks should be free of contamination to ensure cross-contamination of the samples has not occurred in the laboratory.

14.2.12 Sample Holding Times

Completion of laboratory analyses within method-specific holding times will be calculated by computing the difference between the sample collection date and the sample preparation and analysis dates. A comparison of sample collection dates to extraction holding times will be calculated by computing the difference between the sample collection date and the sample preparation date. A comparison of extraction to analysis holding times will be calculated by computing the difference between the sample preparation date and the sample analysis date. The holding times will be compared to the acceptance limits contained in the respective analytical methods. Results for analyses not performed within holding time limits will be qualified as estimated ("J/UJ").

Holding times are provided in **Table A-2** of this QAPP. Samples submitted to the laboratory after the holding time has expired will be analyzed only under direct request from the Project Manager. Appropriate sample and/or data qualifiers should be noted on the final laboratory analytical report.

14.2.13 Laboratory Control Sample Analysis

Laboratory control samples (LCSs) are "clean" well-characterized samples used to monitor the laboratory's day-to-day performance of routine analytical methods. LCSs are prepared by spiking samples of a "clean" matrix with known amounts of target analytes and then processing the sample in the same fashion as all other samples. LCSs are used to monitor the accuracy and precision of the analytical process independent of matrix effects. The accuracy of the analytical process is evaluated using the calculated percent recoveries (%Rs) of the spiked analytes. When LCSs are prepared in duplicate, the duplicate results are compared to each other by means of a RPD and are used to evaluate the precision of the analytical process.

The LCS percent recoveries (and RPDs when LCSs are prepared in duplicate) will be compared to the laboratory-determined acceptance limits for accuracy (and precision when LCSs are prepared in duplicate). If the recovery of a spiked analyte in an LCS exceeds the upper limit of the acceptance range, suggesting a potential high bias in sample results, positive results for that analyte in associated samples will be qualified as estimated ("J"); whereas, nondetect results for that analyte will be considered to be acceptable for use without qualification. If the recovery of a spiked analyte in an LCS is below the lower limit of the acceptance range, suggesting a potential low bias in sample results, both positive and non-detect results for that analyte in all associated samples will be qualified as estimated ("J/UJ").

14.2.14 Surrogate Recoveries (Applicable to Organic Analyses Only)

Surrogate compounds are compounds that are not expected to be contained in field samples. They are spiked into every field and laboratory QC sample at known levels prior to sample preparation. The calculated surrogate recoveries are used to evaluate the accuracy of the analysis on the individual samples and to monitor the laboratory's day-to-day performance of routine analytical methods.

Sample surrogate recoveries will be compared to the laboratory-determined acceptance limits for accuracy. If the recovery of a surrogate compound exceeds the upper limit of the acceptance range, suggesting a potential high bias in sample results, positive results for target analytes in that sample will be qualified as estimated ("J"); whereas, non-detect results for that analyte will be considered to be acceptable for use without qualification. If the recovery of a spiked analyte in a sample is below the lower limit of the acceptance range, suggesting a potential low bias in sample results, both positive and non-detect results in that sample will be qualified as estimated ("J/UJ").

14.2.15 Overall Assessment

Each Data Validation Report will document the results of data validation for both field data and analytical laboratory data. The report will emphasize any deficiencies encountered and clearly describe the effect of such deficiencies on the overall data quality. A summary of the data validation qualifiers will also be included. The Data Validation Report will provide an overall assessment of the data with respect to the data quality assurance objectives and their usability for meeting project objectives.

14.3 RECONCILIATION WITH USER REQUIREMENTS

The processes of data verification and data validation described above will check for precision, completeness, accuracy, sensitivity, comparability, and completeness to determine if the specified project DQOs were achieved. If data quality indicators do not meet the specified project DQOs, Bridgeton Landfill LLC's OU-3 consultant/contractor Project Manager will use professional judgment to determine whether or not the data quality problems are so serious that the data should not be used, or whether the data can be used even if some validations failed.

Examples of data usability/quality control issues include:

- Broken, incomplete, missing chain of custody forms
- Unreadable, missing sample labels

- Holding and/or handling times exceeded
- Reporting limits too high
- Method blanks contamination
- Equipment or trip blank contamination
- Laboratory control samples, duplicates, blank spikes having high or low recoveries
- Surrogates in samples having high or low recoveries
- MS/MSD having high or low recoveries
- Extremely high dilution factors
- Field duplicates not comparable with DQOs

In addition, the EPA document "Guidance on Environmental Data Verification and Data Validation" (2002, EPA QA/G-8, EPA/240/R-02/004) will be consulted for further information regarding the suitability of the project data.

If the cause if found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in the *Data Validation Reports*.

15.0 ASSESSMENTS AND RESPONSE ACTIONS

Quality assessment is a set of external tasks that are performed outside of normal routine operations to provide certainty that the quality assurance system is generating data of sufficient quantity, quality, and meets or exceeds all applicable requirements. Quality assessment is independent from the data generation activities. Quality control activities are internal tasks that are performed during sample collection, handling, analysis, and data reporting to ensure data accuracy and precision.

The following table lists the person(s) responsible for quality control, which includes instrument calibration and QC checks, and to oversee the program objectives.

Assessment Type	Frequency	Internal/External	Organization	Person(s) Responsible
Project surveillance	Ongoing and during field projects	Internal and External	Bridgeton Landfill, LLC, CEC	Project Manager
Field audit of samplers	During field sampling	External	CEC	Project Manager
Laboratory technical systems	Ongoing	External	Pace Laboratories	Project Manager
Data Validation	Quarterly	External	OU-3 consultant/contractor	Project Manager
Data Quality Assessment	Quarterly	External	OU-3 consultant/contractor	Project Manager

If it is found that there are QAPP deviations or project deficiencies, appropriate response to address non-conformances will be chosen in consultation with the field sampling contractor Project Manager and/or data verification/validation contractor (OU-3 consultant/contractor) Project Manager. Appropriate corrective action responses to ensure that the data quality is adequate for its intended use may include: (1) flagging of data with written explanation of the action, (2) rejection of data and exclusion from reports with written explanation, (3) reconstruction of acceptable limits with written explanation of action, (4) rejection of entire sample collection point/well, and/or (5) revision of standard operating procedures.

The corrective actions decided upon will be implemented and directed by the appropriate project manager. Because these actions may involve modifications to this original QAPP, all modifications will be documented and submitted for approval to the EPA. All amendments/changes to the original QAPP will be incorporated in the annual revision of the QAPP.

16.0 REFERENCES

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USEPA *"Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities"* EPA-600/R05/123a. September, 2005.

TABLES

Table A-1
RD QAPP Project Personnel Contact Information
West Lake Landfill OU-2 Facility
Bridgeton, Missouri

Name	Affiliation	Title	Mailing Street Address	City, State, ZIP Code	Telephone Number
Jamie Schwartz	United States EPA, Region 7	EPA Remedial Project Manager	11201 Renner Boulevard	Lenexa, KS 66219	(913) 551-7789
Ryan Seabaugh	Missouri Dept. of Natural Resources	MDNR Project Manager	P.O. Box 176	Jefferson City, MO 65102	(573) 751-8628
Erin Fanning	Bridgeton Landfill, LLC	Respondent	13570 Saint Charles Rock Road	Bridgeton, MO 63044	(209) 227-9531
Paul Rosasco	Engineering Management Support, Inc.	Respondent's Project Coordinator	25923 Gateway Drive	Golden, CO 80401	(303) 808-7227
Randal Bodnar	Civil & Environmental Consultants, Inc.	Project Principal/QA Manager	11811 N Tatum Blvd, Suite 3031	Phoenix, AZ 85028	(602) 760-2324
Kevin Kamp	Civil & Environmental Consultants, Inc.	Project Manager	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566
Matt Stewart	Bridgeton Landfill, LLC	Health and Safety Officer	13570 Saint Charles Rock Road	Bridgeton, MO 63044	(314) 656-2130
Matt Knuth	Civil & Environmental Consultants, Inc.	Designer/CADD	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566
Tim Mitchell	Civil & Environmental Consultants, Inc.	Design QC	4350 Nothern Pike, Suite 141	Monroeville, PA 15146	724-327-5200
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TABLE A-2 PARAMETERS, ANALYTICAL METHODS, SAMPLE CONTAINER TYPES, PRESERVATION METHODS, AND HOLDING TIMES FOR GROUNDWATER SAMPLES

Regulatory Citation	Parameter	Method	Container	Preservative	Holding Time
None	pH - field	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Temperature - field	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Specific conductance - field (Conductivity)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Dissolved Oxygen (DO)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Oxidation/Reduction Potential (ORP)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
Missouri 10 C.S.R. 80-3.010 Appendix I	**General Parameters and Inorganics**				
	pH - laboratory	SM 4500 H B	1 x 250 mL P	Cool to < 4° C	15 minutes of sample collection
	Total dissolved solids (TDS; mg/L)	SM 2540 D	1 x 500 mL P	Cool to < 4° C	7 days
	Chemical oxygen demand (COD; mg/L), dissolved	EPA 410.4	1 x 250 mL P	Cool to < 4° C; H_2SO_4 to pH <2	28 days
	Chloride (CL; mg/l) dissolved	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Specific conductance- laboratory (25° C; umho/cm)	SM 2510B	1 x 250 mL P	Cool to < 4° C	28 days
	Ammonia (NH_3 as N, mg/L)	EPA 350.1	1 x 250 mL P	Cool to < 4° C; H_2SO_4 to pH <2	28 days
	Total Organic Carbon (TOC, mg/L)	SM 5310 B	1 x 250 mL P	Cool to < 4° C; H_2SO_4 to pH <2	28 days
	Fluoride (F, ug/L)	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Hardness (calculated, mg/L)	SM 2340 B	1 x 250 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Nitrate/Nitrite (NO_3/NO_2, mg/L)	EPA 353.2	1 x 250 mL P	Cool to < 4° C; H_2SO_4 to pH <2	28 days
	Phosphorus (total P, mg/L)	EPA 365.1	1 x 250 mL P	Cool to < 4° C; H_2SO_4 to pH <2	28 days
	Sulfate (SO_4, mg/L)	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Metals - to be analyzed for Total Metals				
	Antimony (Sb, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Arsenic (As, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Barium (Ba, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Beryllium (Be, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Boron (B, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Cadmium (Cd, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Calcium (Ca, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Chromium (Cr, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Cobalt (Co, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Copper (Cu, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Lead (Pb, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Magnesium (Mg, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Manganese (Mn, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Mercury (Hg, mg/L	SW-846 7470A	1 x 250 mL P	Cool to < 4° C; HNO_3 to pH <2	28 days
	Nickel (Ni, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Selenium (Se, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Silver (Ag, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Sodium (Na, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Thallium (Tl, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Vanadium (V, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
	Zinc (Zn, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO_3 to pH <2	6 months
Missouri 10 C.S.R. 80-3.010 Appendix I	**Organic Constituents**				
	Acetone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Acrylonitrile	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Benzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromochloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromodichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromoform; Tribromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Carbon disulfide	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Carbon tetrachloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chloroethane; Ethyl chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chloroform; Trichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Dibromochloromethane; Chlorodibromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dibromo-3-chloropropane; DBCP	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dibromoethane; Ethylene dibromide; EDB	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	o-Dichlorobenzene; 1,2-Dichlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	p-Dichlorobenzene; 1,4-Dichlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,4-Dichloro-2-butene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1-Dichloroethane; Ethylidene chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dichloroethane; Ethylene dichloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved

TABLE A-2 PARAMETERS, ANALYTICAL METHODS, SAMPLE CONTAINER TYPES, PRESERVATION METHODS, AND HOLDING TIMES FOR GROUNDWATER SAMPLES

Regulatory Citation	Parameter	Method	Container	Preservative	Holding Time
	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dichloropropane; Propylene dichloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	cis-1,3-Dichloropropene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,3-Dichloropropene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Ethylbenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	2-Hexanone; Methyl butyl ketone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl bromide; Bromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl chloride; Chloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methylene bromide; Dibromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methylene chloride; Dichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl ethyl ketone; MEK; 2-Butanone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl iodide; Iodomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	4-Methyl-2-pentanone; Methyl isobutyl ketone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Styrene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,1,2-Tetrachloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,2,2-Tetrachloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Toluene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,1-Trichloroethane; Methylchloroform	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,2-Trichloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Trichloroethylene; Trichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Trichlorofluoromethane; CFC-11	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2,3-Trichloropropane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Vinyl acetate	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Vinyl chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Xylenes	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved

All metals will be analyzed for total (unfiltered samples) metals analyses.
N/A = not applicable; samples not submitted to laboratory
ug/L = micrograms per liter
mg/L = milligrams per liter
P = plastic, polypropylene, polyethylene
4° C = 39.2° Fahrenheit

TABLE A-3 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS -FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
None	pH - field	NNS	6.5-8.5 [2]
None	Temperature - field	NNS	NNS
None	Specific conductance - field (Conductivity)	NNS	NNS
None	Dissolved Oxygen (DO)	NNS	NNS
None	Oxidation/Reduction Potential (ORP)	NNS	NNS
	General Parameters and Inorganics		
Missouri 10 C.S.R. 80-3.010 Appendix I	pH - laboratory	NNS	6.5-8.5
	Total dissolved solids (TDS; mg/L)	NNS	500 [2]
	Chemical oxygen demand (COD; mg/L), dissolved	NNS	NNS
	Chloride (CL; mg/l) dissolved	NNS	250 [2]
	Specific conductance- laboratory (25° C; umho/cm)	NNS	NNS
	Ammonia (NH3 as N, mg/L)	NNS	NNS
	Total Organic Carbon (TOC, mg/L)	NNS	NNS
	Fluoride (F, mg/L)	4.0	4.0
	Hardness (calculated, mg/L)	NNS	NNS
	Nitrate (as NO_3, mg/L)	10.0	10.0
	Nitrite (as NO_2, mg/L)	1.0	1.0
	Total Nitrate + Nitrite	10.0	10.0
	Phosphorus (total P, mg/L)	NNS	NNS
	Sulfate (SO4, mg/L)	NNS	250 [2]
	Metals - to be analyzed for Total Metals		
	Antimony (Sb, mg/L)	0.006	0.006
	Arsenic (As, mg/L)	0.01	0.01
	Barium (Ba, mg/L)	2.0	2.0
	Beryllium (Be, mg/L)	0.004	0.004
	Boron (B, mg/L)	NNS	NNS
	Cadmium (Cd, mg/L)	0.005	0.005
	Calcium (Ca, mg/L)	NNS	NNS
	Chromium (Cr, mg/L)	0.10	0.10
	Cobalt (Co, mg/L)	NNS	NNS
	Copper (Cu, mg/L)	1.3	1.0 [2]
	Lead (Pb, mg/L)	0.015	0.015
	Magnesium (Mg, mg/L)	NNS	NNS
	Manganese (Mn, mg/L)	NNS	0.05 [2]
	Mercury (Hg, mg/L	0.002	0.002
	Nickel (Ni, mg/L)	NNS	NNS
	Selenium (Se, mg/L)	0.05	0.05
	Silver (Ag, mg/L)	NNS	0.10 [2]
	Sodium (Na, mg/L)	NNS	NNS
	Thallium (Tl, mg/L)	0.002	0.002
	Vanadium (V, mg/L)	NNS	NNS
	Zinc (Zn, mg/L)	NNS	5.0 [2]

TABLE A-3 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS -FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
	Organic Constituents (mg/L)		
Missouri 10 C.S.R. 80-3.010 Appendix I	Acetone	NNS	NNS
	Acrylonitrile	NNS	NNS
	Benzene	0.005	0.005
	Bromochloromethane	NNS	NNS
	Bromodichloromethane	NNS	NNS
	Bromoform; Tribromomethane	NNS	NNS
	Carbon disulfide	NNS	NNS
	Carbon tetrachloride	0.005	0.005
	Chlorobenzene	0.10	0.10
	Chloroethane; Ethyl chloride	NNS	NNS
	Chloroform; Trichloromethane	NNS	NNS
	Dibromochloromethane; Chlorodibromomethane	0.06	NNS
	1,2-Dibromo-3-chloropropane; DBCP	0.0002	0.0002
	1,2-Dibromoethane; Ethylene dibromide; EDB	0.00005	0.00005
	o-Dichlorobenzene; 1,2-Dichlorobenzene	0.60	0.60
	p-Dichlorobenzene; 1,4-Dichlorobenzene	0.075	0.075
	trans-1,4-Dichloro-2-butene	NNS	NNS
	1,1-Dichloroethane; Ethylidene chloride	NNS	NNS
	1,2-Dichloroethane; Ethylene dichloride	0.005	0.005
	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	0.007	0.007
	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	0.07	0.07
	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	0.10	0.10
	1,2-Dichloropropane; Propylene dichloride	0.005	0.005
	cis-1,3-Dichloropropene	NNS	NNS
	trans-1,3-Dichloropropene	NNS	NNS
	Ethylbenzene	0.70	0.70
	2-Hexanone; Methyl butyl ketone	NNS	NNS
	Methyl bromide; Bromomethane	NNS	NNS
	Methyl chloride; Chloromethane	NNS	NNS
	Methylene bromide; Dibromomethane	NNS	NNS
	Methylene chloride; Dichloromethane	0.005	0.005
	Methyl ethyl ketone; MEK; 2-Butanone	NNS	NNS
	Methyl iodide; Iodomethane	NNS	NNS
	4-Methyl-2-pentanone; Methyl isobutyl ketone	NNS	NNS
	Styrene	0.10	0.10
	1,1,1,2-Tetrachloroethane	NNS	NNS
	1,1,2,2-Tetrachloroethane	NNS	NNS
	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	0.005	0.005
	Toluene	1.0	1.0

TABLE A-3 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS -FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
	1,1,1-Trichloroethane; Methylchloroform	0.20	0.20
	1,1,2-Trichloroethane	0.005	0.005
	Trichloroethylene; Trichloroethene	0.005	0.005
	Trichlorofluoromethane; CFC-11	NNS	NNS
	1,2,3-Trichloropropane	NNS	NNS
	Vinyl acetate	NNS	NNS
	Vinyl chloride	0.002	0.002
	Xylenes	10	10

All metals will be analyzed for total (unfiltered samples) metals analyses.

NNS = No numeric water quality standard

ug/L = micrograms per liter

mg/L = milligrams per liter

[1]: Water quality standards in effect at time of ROD signing (2008)

[2]: Secondary MCL (10 CSR 60-4.070): Secondary MCLs are non-enforceable guidelines regulating contaminants that may cause aesthetic effects (such as taste, odor, or color) in drinking water.

TABLE A-4 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS - FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 Primary MCL	Missouri 10 CSR 60-4.010 - 4.110 (mg/L)	Laboratory MDL [1]
None	pH - field	NNS	6.5-8.5 [1]	---
None	Temperature - field	NNS	NNS	---
None	Specific conductance - field (Conductivity)	NNS	NNS	---
None	Dissolved Oxygen (DO)	NNS	NNS	---
None	Oxidation/Reduction Potential (ORP)	NNS	NNS	---
	General Parameters and Inorganics			---
Missouri 10 C.S.R. 80-3.010 Appendix I	pH - laboratory	NNS	6.5-8.5	---
	Total dissolved solids (TDS; mg/L)	NNS	500 [1]	5
	Chemical oxygen demand (COD; mg/L), dissolved	NNS	NNS	3.74
	Chloride (CL; mg/l) dissolved	NNS	250 [1]	0.0911
	Specific conductance- laboratory (25° C; umho/cm)	NNS	NNS	---
	Ammonia (NH3 as N, mg/L)	NNS	NNS	0.0266
	Total Organic Carbon (TOC, mg/L)	NNS	NNS	0.146
	Fluoride (F, mg/L)	4.0	4.0	0.012
	Hardness (calculated, mg/L)	NNS	NNS	NA
	Nitrate (as NO_3, mg/L)	10.0	10.0	0.020
	Nitrite (as NO_2, mg/L)	1.0	1.0	0.005
	Total Nitrate + Nitrite	10.0	10.0	0.020
	Phosphorus (total P, mg/L)	NNS	NNS	0.05
	Sulfate (SO4, mg/L)	NNS	250 [1]	0.173
	Metals - to be analyzed as Total Metals			
	Antimony (Sb, mg/L)	0.006	0.006	0.00018
	Arsenic (As, mg/L)	0.01	0.05	0.000223
	Barium (Ba, mg/L)	2.0	2.0	0.000530
	Beryllium (Be, mg/L)	0.004	0.004	0.0000038
	Boron (B, mg/L)	NNS	NNS	0.00771
	Cadmium (Cd, mg/L)	0.005	0.005	0.0000030
	Calcium (Ca, mg/L)	NNS	NNS	0.07293
	Chromium (Cr, mg/L)	0.10	0.10	0.000177
	Cobalt (Co, mg/L)	NNS	NNS	0.00075
	Copper (Cu, mg/L)	1.3	1.0 [1]	0.000235
	Lead (Pb, mg/L)	0.015	0.015	0.000227
	Magnesium (Mg, mg/L)	NNS	NNS	0.0575
	Manganese (Mn, mg/L)	NNS	0.05 [1]	0.00112
	Mercury (Hg, mg/L	0.002	0.002	0.00001
	Nickel (Ni, mg/L)	NNS	NNS	0.000145
	Selenium (Se, mg/L)	0.05	0.05	0.000311
	Silver (Ag, mg/L)	NNS	0.10 [1]	0.000124
	Sodium (Na, mg/L)	NNS	NNS	0.0393
	Thallium (Tl, mg/L)	0.002	0.002	0.000049
	Vanadium (V, mg/L)	NNS	NNS	0.000219
	Zinc (Zn, mg/L)	NNS	5.0 [1]	0.00692
	Organic Constituents (mg/L)			
Missouri 10 C.S.R. 80-3.010 Appendix I	Acetone	NNS	NNS	0.01
	Acrylonitrile	NNS	NNS	0.05
	Benzene	0.005	0.005	0.0005
	Bromochloromethane	NNS	NNS	0.0005
	Bromodichloromethane	NNS	NNS	0.0005
	Bromoform; Tribromomethane	NNS	NNS	0.0005
	Carbon disulfide	NNS	NNS	0.0025
	Carbon tetrachloride	0.005	0.005	0.0005

TABLE A-4 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS - FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 Primary MCL	Missouri 10 CSR 60-4.010 - 4.110 (mg/L)	Laboratory MDL [1]
	Chlorobenzene	0.10	0.10	0.0005
	Chloroethane; Ethyl chloride	NNS	NNS	0.001
	Chloroform; Trichloromethane	NNS	NNS	0.0005
	Dibromochloromethane; Chlorodibromomethane	0.06	NNS	0.0005
	1,2-Dibromo-3-chloropropane; DBCP	0.0002	0.0002	0.000005
	1,2-Dibromoethane; Ethylene dibromide; EDB	0.00005	0.00005	0.000005
	o-Dichlorobenzene; 1,2-Dichlorobenzene	0.60	0.60	0.0005
	p-Dichlorobenzene; 1,4-Dichlorobenzene	0.075	0.075	0.0005
	trans-1,4-Dichloro-2-butene	NNS	NNS	0.05
	1,1-Dichloroethane; Ethylidene chloride	NNS	NNS	0.0005
	1,2-Dichloroethane; Ethylene dichloride	0.005	0.005	0.0005
	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	0.007	0.007	0.0005
	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	0.07	0.07	0.0005
	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	0.10	0.10	0.0005
	1,2-Dichloropropane; Propylene dichloride	0.005	0.005	0.0005
	cis-1,3-Dichloropropene	NNS	NNS	0.0005
	trans-1,3-Dichloropropene	NNS	NNS	0.0005
	Ethylbenzene	0.70	0.70	0.0005
	2-Hexanone; Methyl butyl ketone	NNS	NNS	0.010
	Methyl bromide; Bromomethane	NNS	NNS	0.0025
	Methyl chloride; Chloromethane	NNS	NNS	0.001
	Methylene bromide; Dibromomethane	NNS	NNS	0.0005
	Methylene chloride; Dichloromethane	0.005	0.005	0.0005
	Methyl ethyl ketone; MEK; 2-Butanone	NNS	NNS	0.010
	Methyl iodide; Iodomethane	NNS	NNS	0.0025
	4-Methyl-2-pentanone; Methyl isobutyl ketone	NNS	NNS	0.010
	Styrene	0.10	0.10	0.0005
	1,1,1,2-Tetrachloroethane	NNS	NNS	0.0005
	1,1,2,2-Tetrachloroethane	NNS	NNS	0.0005
	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	0.005	0.005	0.0005
	Toluene	1.0	1.0	0.0005
	1,1,1-Trichloroethane; Methylchloroform	0.20	0.20	0.0005
	1,1,2-Trichloroethane	0.005	0.005	0.0005
	Trichloroethylene; Trichloroethene	0.005	0.005	0.0005
	Trichlorofluoromethane; CFC-11	NNS	NNS	0.001
	1,2,3-Trichloropropane	NNS	NNS	0.0005
	Vinyl acetate	NNS	NNS	0.01
	Vinyl chloride	0.002	0.002	0.0005
	Xylenes	10	10	1.5

All metals will be analyzed for total (unfiltered samples) metals analyses.

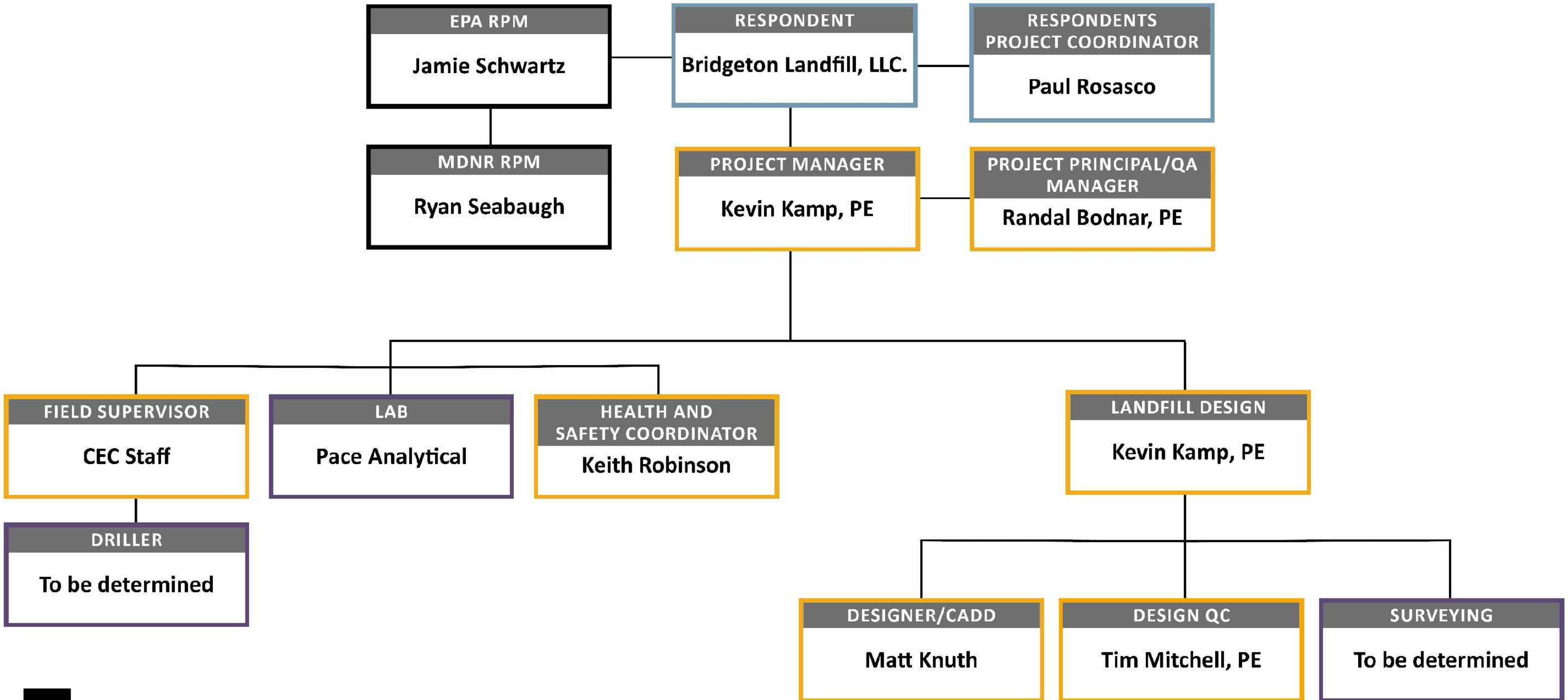
NNS = No numeric water quality standard

ug/L = micrograms per liter

mg/L = milligrams per liter

[1]: Secondary MCL: MDLs per Pace Analytical Laboratory

FIGURES



- Regulatory Entity
- Respondent: Bridgeton Landfill, LLC
- Civil &Environmental Consultants, Inc.
- 3rd Party

*HAND SIGNATURE ON FILE

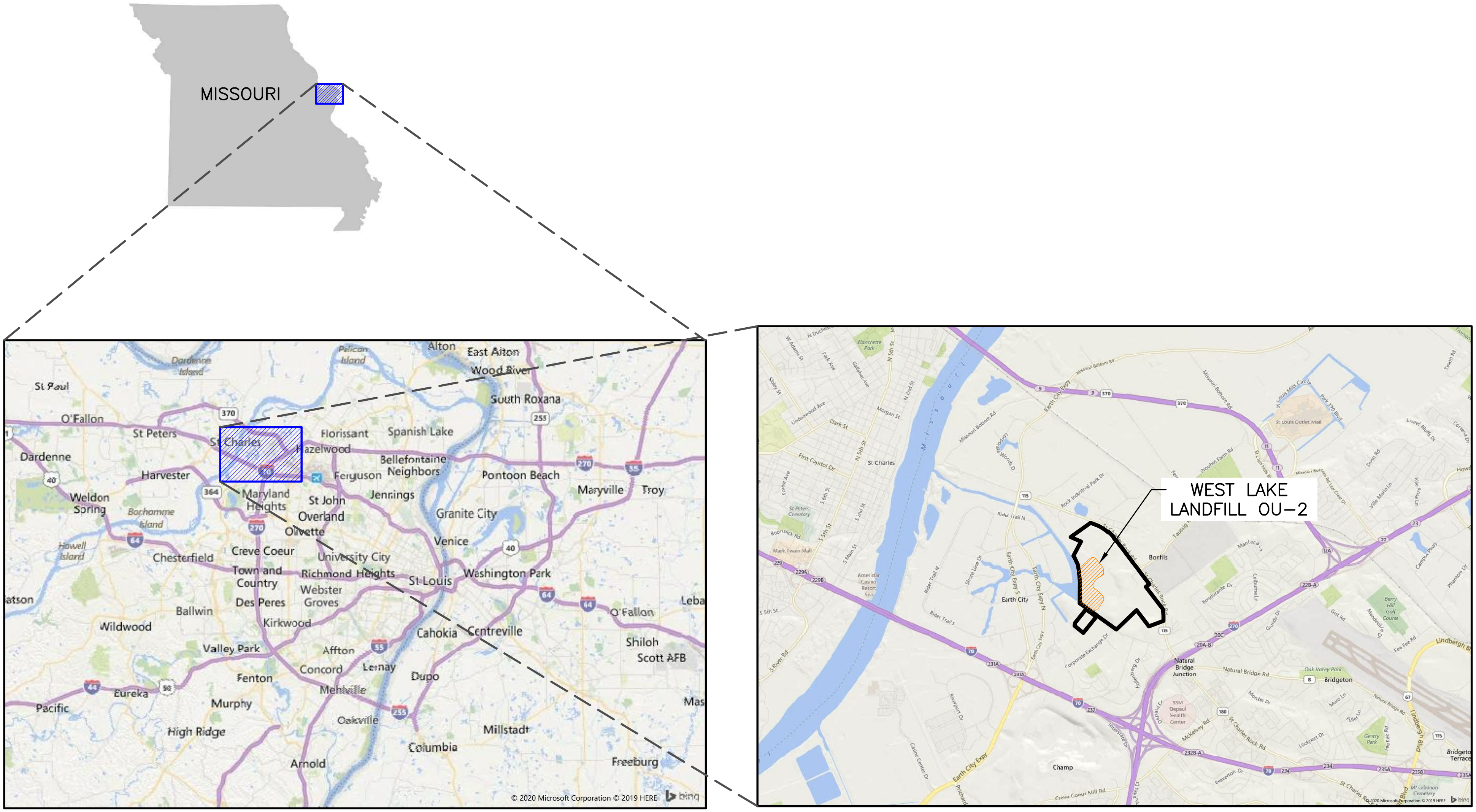
Civil & Environmental Consultants, Inc.
4848 Park 370 Blvd., Suite F - Hazelwood, MO 63042
314-656-4566 · 866-250-3679
www.cecinc.com

WESTLAKE LANDFILL OU-2
13570 ST. CHARLES ROCK RD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

ORGANIZATION CHART

DRAWN BY:	CAN	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	A-1
DATE:	MARCH 2020	DWG SCALE:	N.T.S.	PROJECT NO:	191-750		

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Site Location Map.dwg{8X11} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:32 PM



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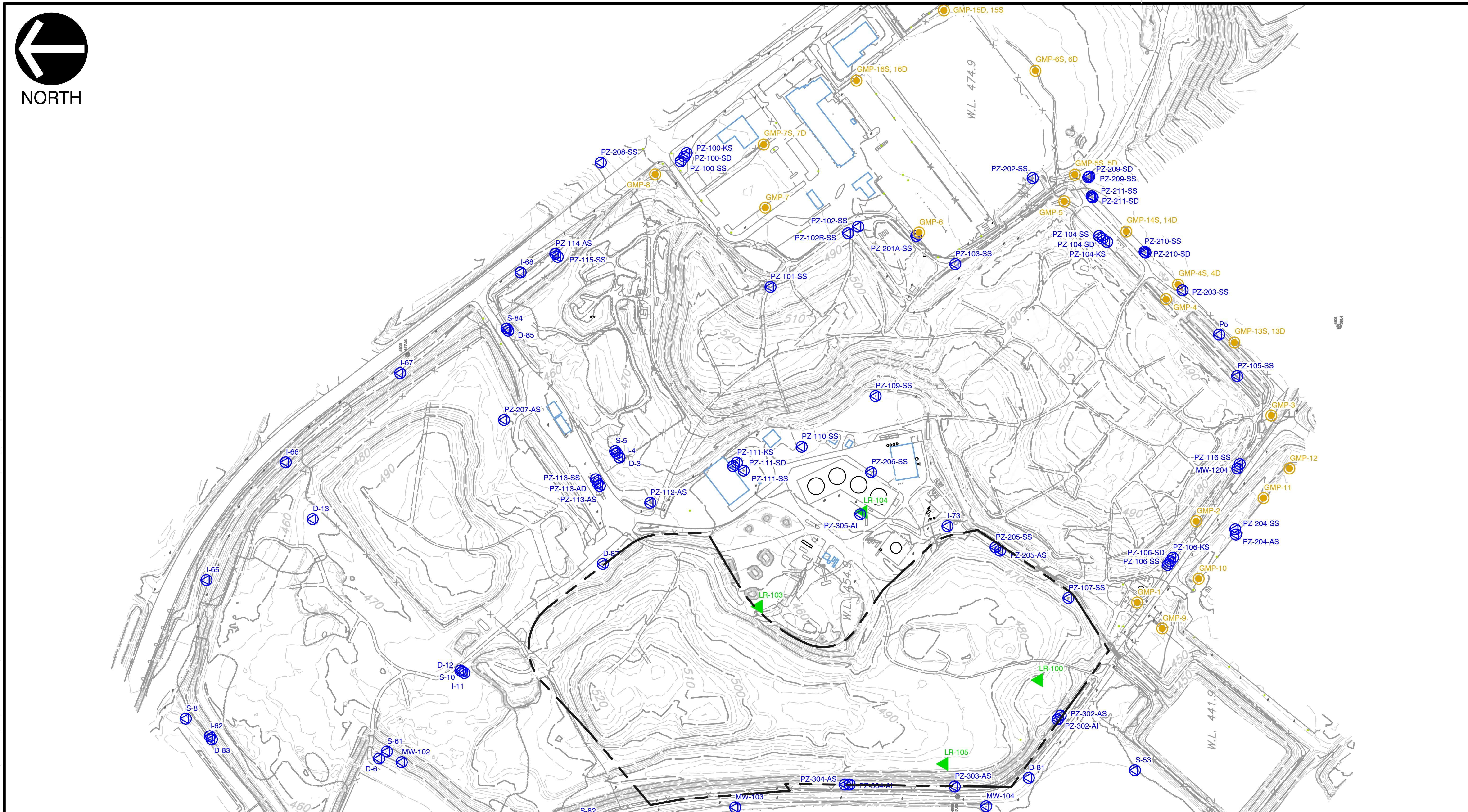
ST. LOUIS COUNTY

SITE LOCATION MAP

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.: A-2
DATE:	FEB. 2020	DWG SCALE:	N.T.S.	PROJECT NO:	191-750	

*HAND SIGNATURE ON FILE



LEGEND

- OU-2 BOUNDARY
- 500 EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- MONITORING WELL
- GAS WELL
- LEACHATE RISER

SCALE IN FEET

0 400 800

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

EXISTING FACILITY FEATURES MAP

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=400'	PROJECT NO: 191-750	A-3

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Existing Facility Features Map.dwg[11X17] LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:29 PM

P:\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Proposed Gas Probe Locations.dwg{11X17} LS:(4/30/2020 - cnagel) - LP: 5/22/2020 11:28 AM

LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

GW-## PROPOSED GAS WELL

GMW-16S EXISTING GAS WELL

SCALE IN FEET

0 200 400

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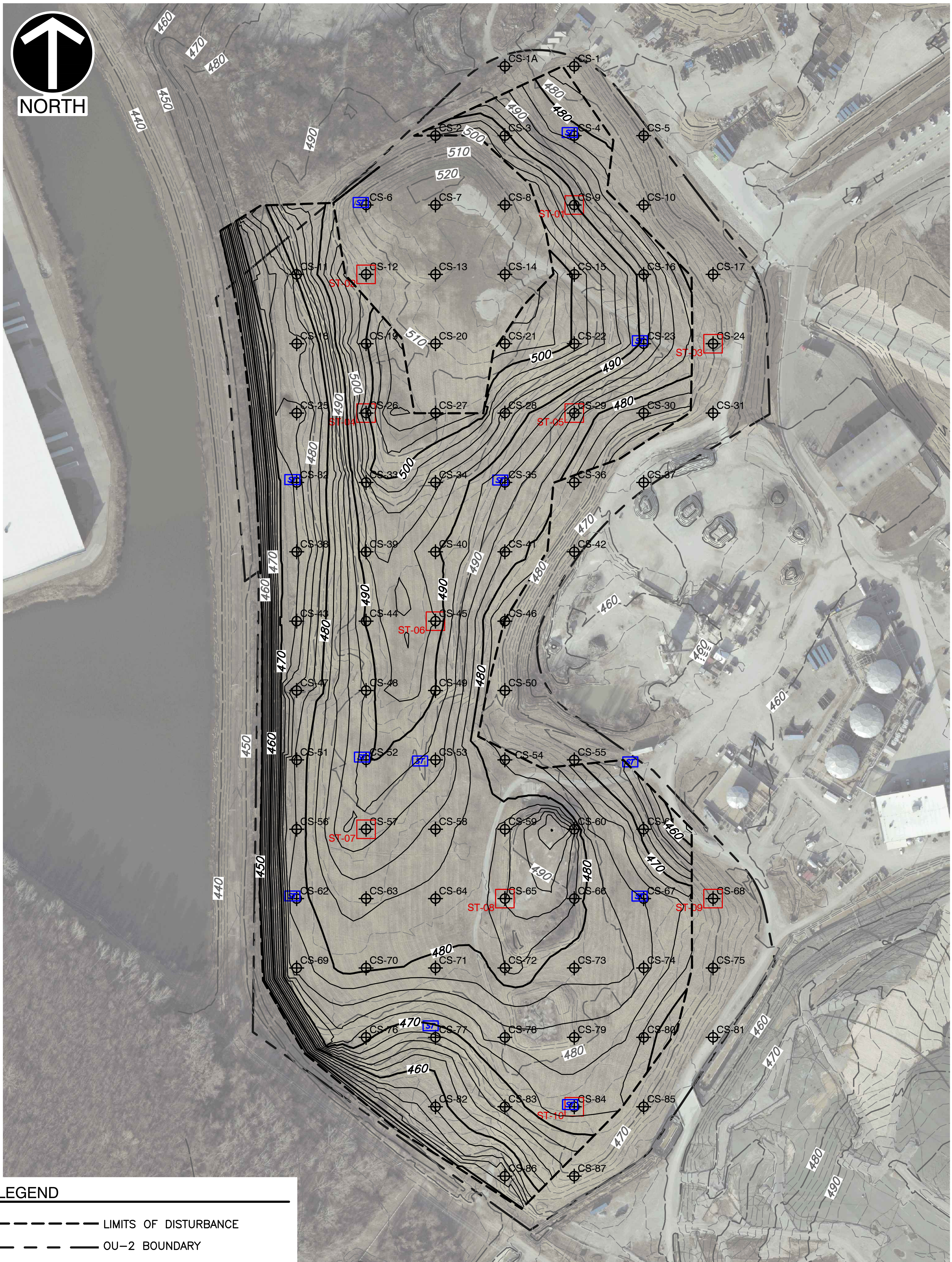
ST. LOUIS COUNTY

PROPOSED GAS WELL LOCATIONS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	
DATE:	APR. 2020	DWG SCALE:	1"=200'	PROJECT NO:	191-750		A-4

P:\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Cap Sampling Locations.dwg{11X17} LS:(3/19/2020 - cnagel) - LP: 3/19/2020 12:40 PM



LEGEND

- LIMITS OF DISTURBANCE
- OU-2 BOUNDARY
- 500 — TOP OF WASTE CONTOUR MAJOR
- TOP OF WASTE CONTOUR MINOR
- 500 — EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- CS-89 — SAMPLING LOCATIONS
- ST-## — SHELBY TUBE SAMPLING LOCATIONS
- ST — PREVIOUS SHELBY TUBE SAMPLING LOCATIONS

SCALE IN FEET

0 200 400

NOTE

1. ADDITIONAL CAP OR SHELBY TUBE SAMPLING LOCATIONS MAY BE UTILIZED FOR IRREGULARITIES OBSERVED DURING THE INACTIVE SANITARY LANDFILL EXISTING CAP EVALUATION

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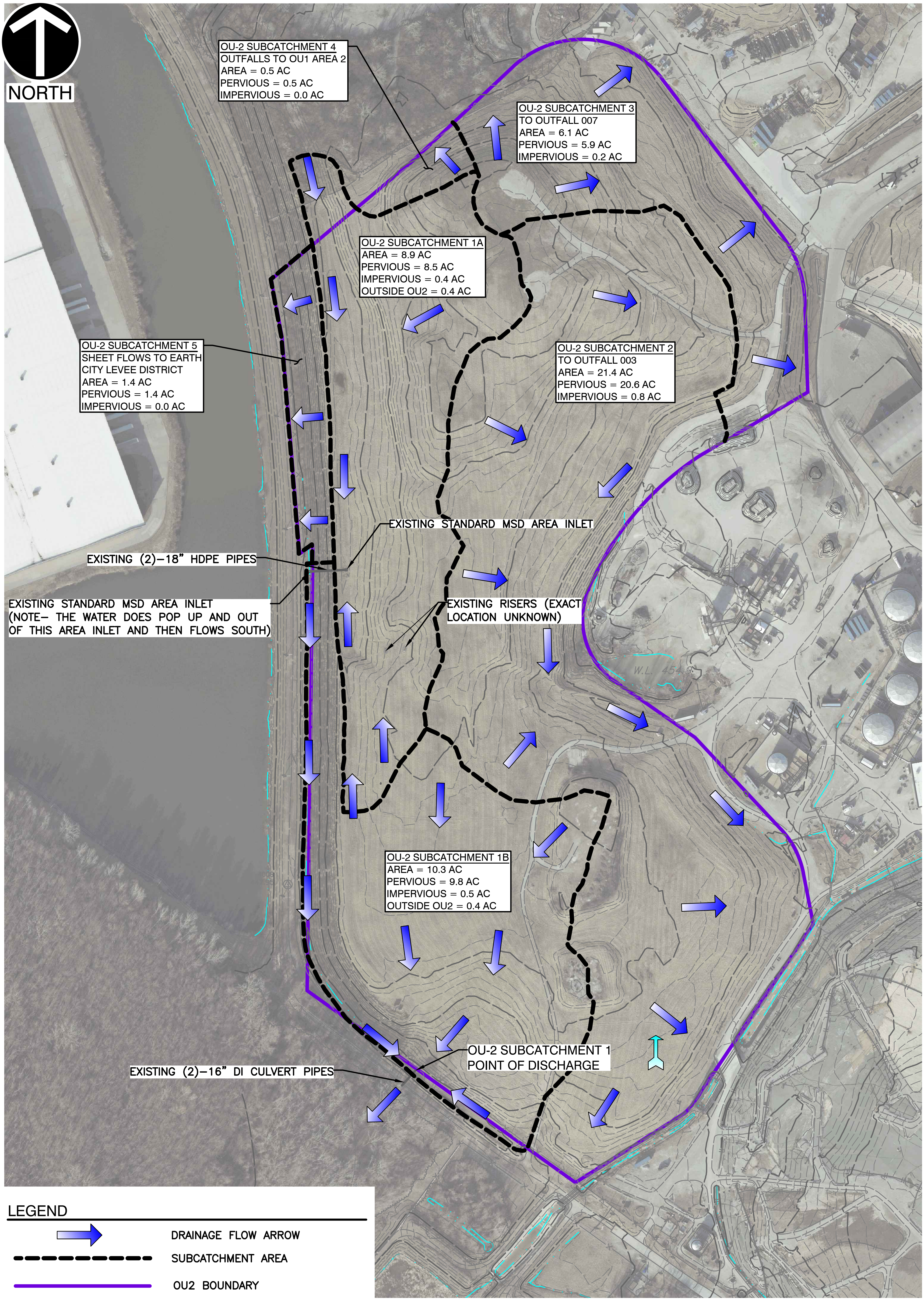
BRIDGETON, MO 63044
ST. LOUIS COUNTY

CAP SAMPLING LOCATIONS

DRAWN BY: MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	A-5
DATE: FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

P:\2019\191-750.0006\-CADD\Dwg\CV02-OU2\191750-CV02 DrainageMaps.dwg{FIGURE A-6} LS:(2/4/2020 - matt.knuth) - LP: 2/4/2020 12:30 PM



SCALE IN FEET

0 200 400

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WESTLAKE LANDFILL OU-2

13570 ST. CHARLES ROCK ROAD

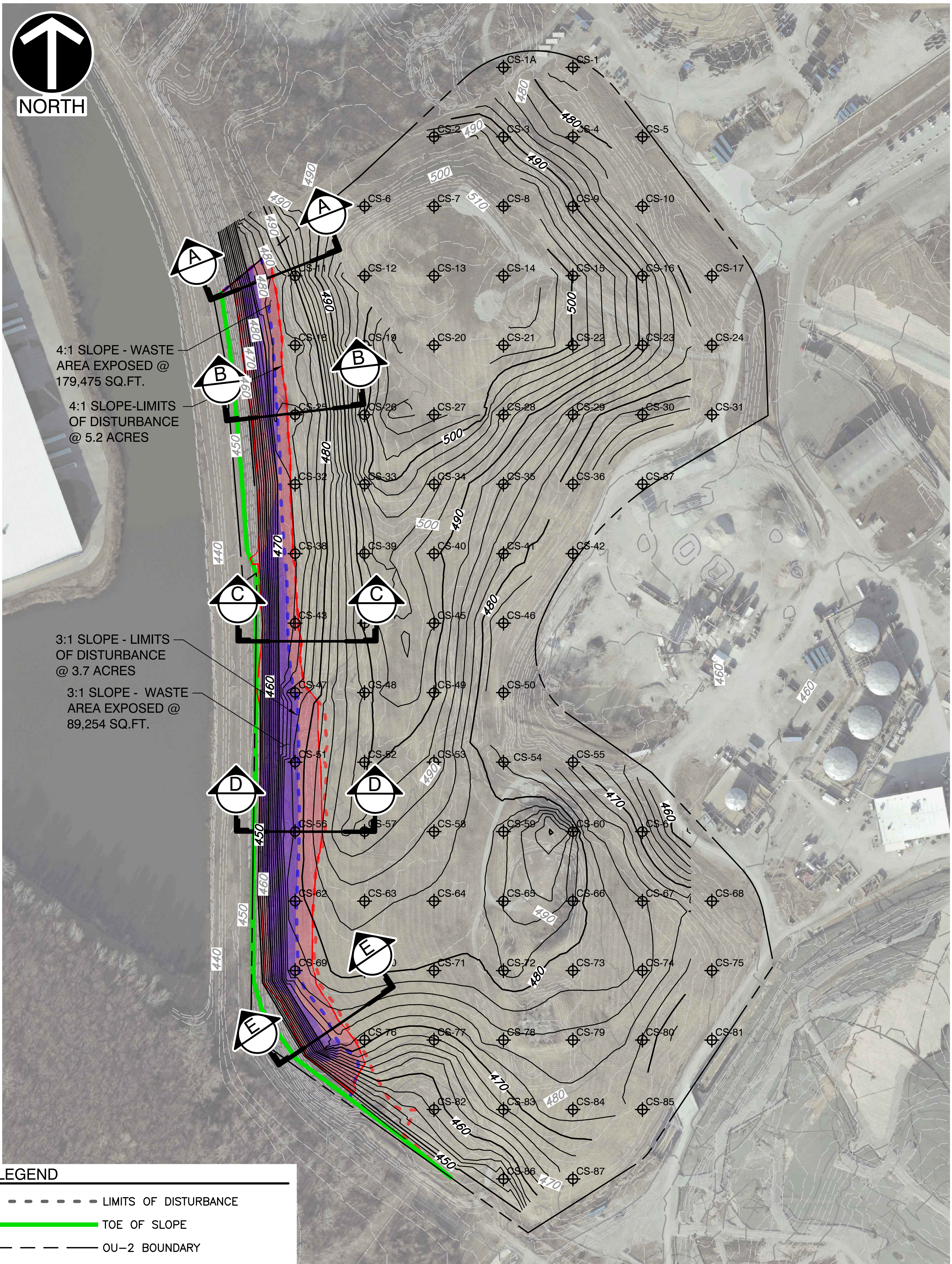
BRIDGETON, MO 63044

ST. LOUIS COUNTY

OU-2 WEST WATERSHED

EXISTING DRAINAGE AREA MAP

DRAWN BY: MAK	CHECKED BY: DRAFT	APPROVED BY: DRAFT	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200'	PROJECT NO: 191-750.0005	A-6



LEGEND

- LIMITS OF DISTURBANCE
- TOE OF SLOPE
- OU-2 BOUNDARY
- 500 TOP OF WASTE CONTOUR MAJOR
- TOP OF WASTE CONTOUR MINOR
- 500 EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- CS-89 SAMPLING LOCATIONS
- WASTE REVEAL AT 3:1
- WASTE REVEAL AT 4:1

SCALE IN FEET

0 200 400

REFERENCE

1. WASTE SURFACE EXPOSED ACCOUNTS FOR THE 3' CAP REQUIRED
2. TOP OF WASTE SURFACE IS APPROXIMATED BASED UPON SAMPLING LOCATIONS AND PROJECTED TO BASE OF SLOPE

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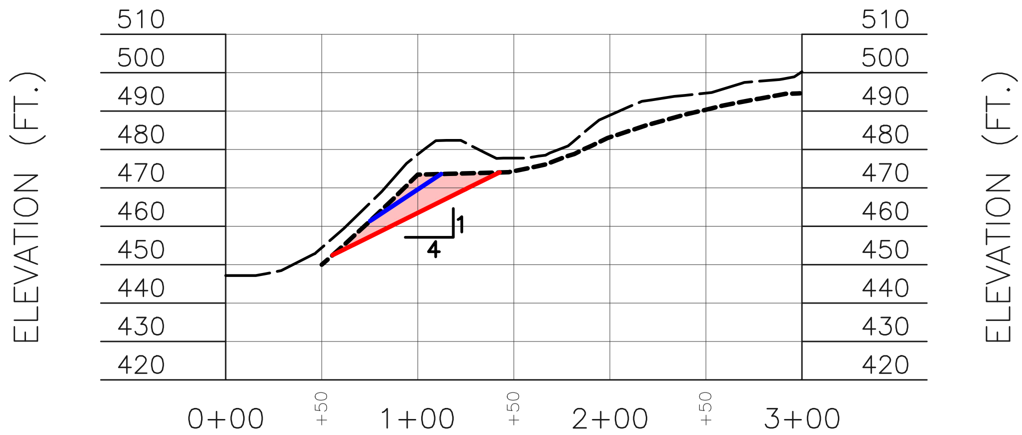
13570 ST. CHARLES ROCK RD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

EXISTING WESTERN SLOPE OF OU-2

DRAWN BY:	CAC	CHECKED BY:	KTK	APPROVED BY:	TDM*	FIGURE NO.:	A-7A
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

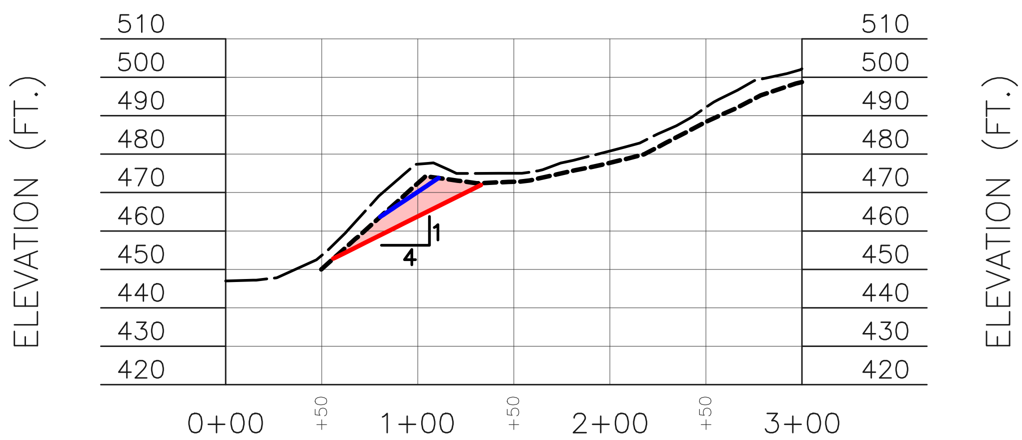
NORTH

STATISTICS	SLOPES	
	3:1	4:1
DISTURBED WASTE 3D AREA	89,254 FT^2	179,475 FT^2
DISTURBED WASTE VOLUME	8,569 YD^3	34,300 YD^3
LIMITS OF DISTURBANCE	3.7 AC	5.2 AC



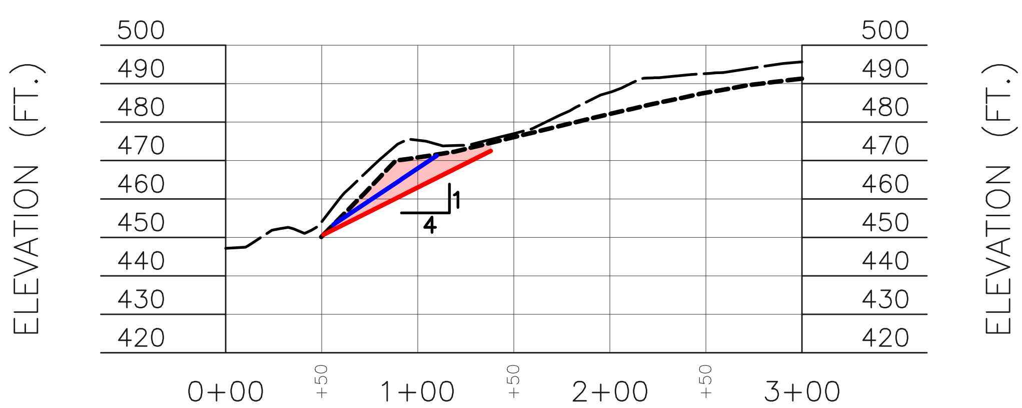
A-A'

SCALE H:1"=100'; V:1"=50'



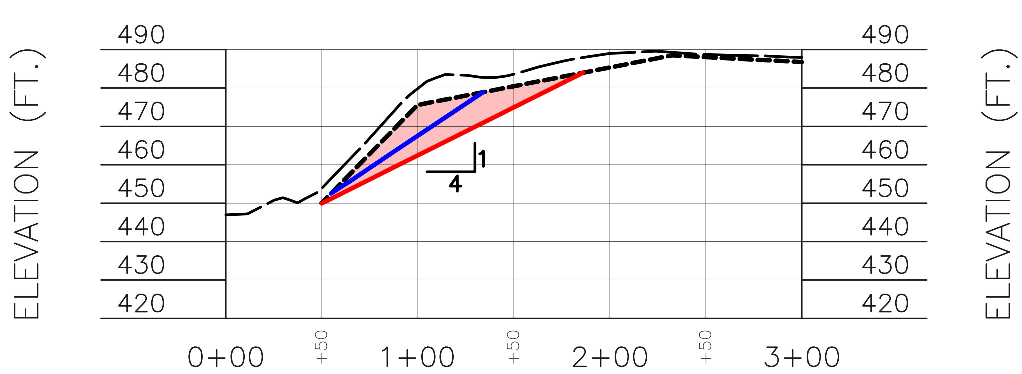
B-B'

SCALE H:1"=100'; V:1"=50'



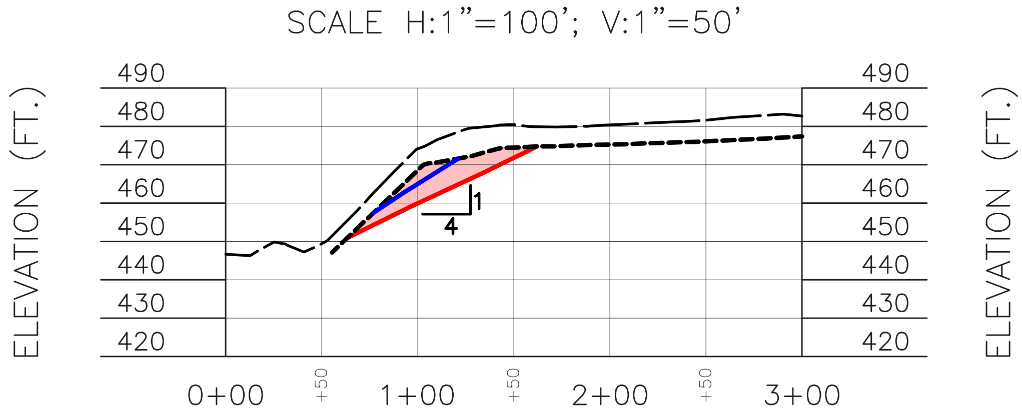
C-C'

SCALE H:1"=100'; V:1"=50'



D-D'

SCALE H:1"=100'; V:1"=50'



E-E'

SCALE H:1"=100'; V:1"=50'

LEGEND

- EXISTING SURFACE
- TOP OF WASTE (SUB-SURFACE)
- DENOTES 3:1 CUT SLOPE W/ WASTE
- DENOTES 4:1 CUT SLOPE W/ WASTE
- 4:1 CUT SLOPE W/ WASTE – FILL

REFERENCE

1. WASTE SURFACE EXPOSED ACCOUNTS FOR THE 3' CAP REQUIRED
2. TOP OF WASTE SURFACE IS APPROXIMATED BASED UPON SAMPLING LOCATIONS AND PROJECTED TO BASE OF SLOPE

HORIZONTAL SCALE IN FEET

0 100 200

VERTICAL SCALE IN FEET

0 50 100

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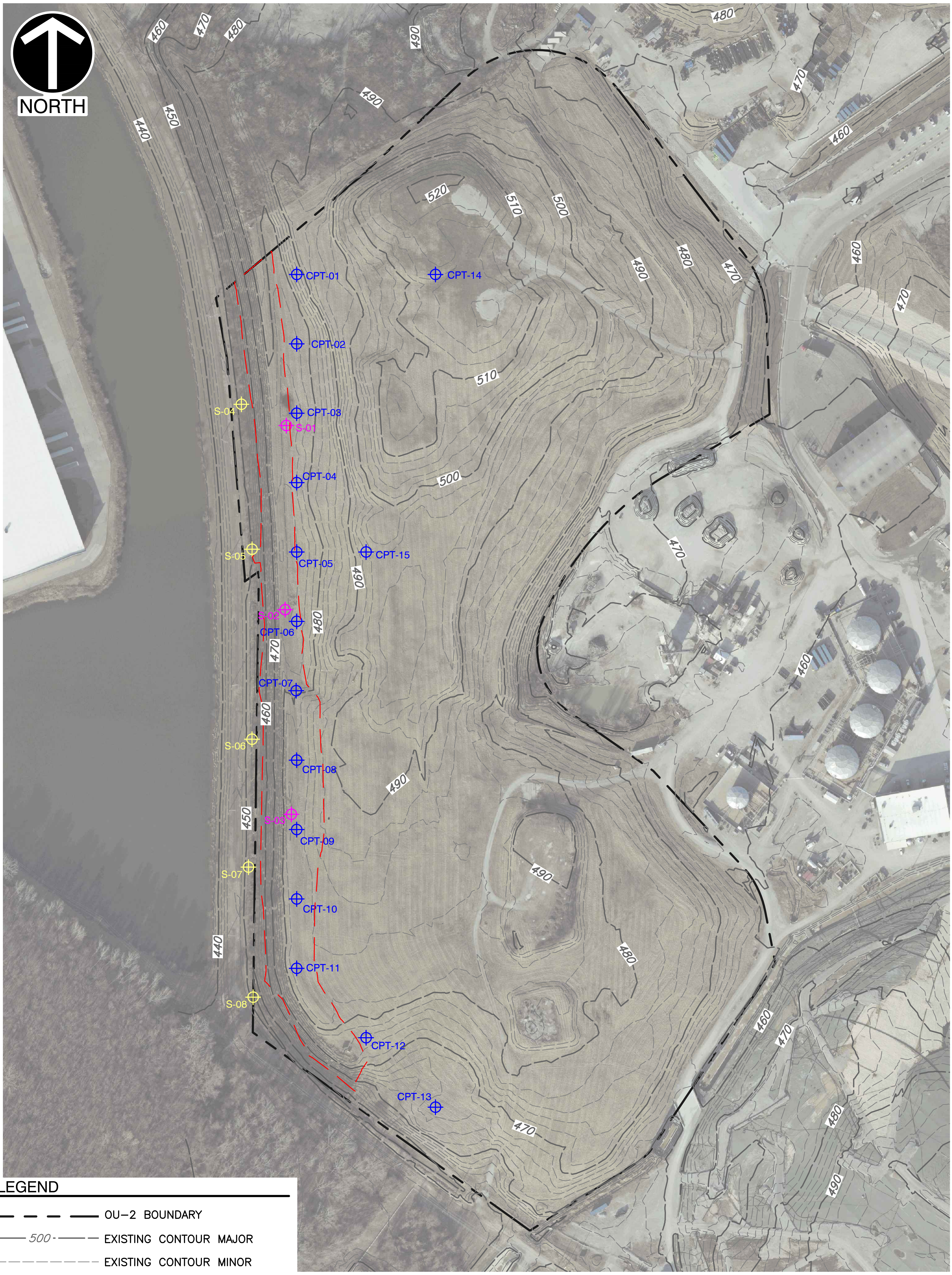
ST. LOUIS COUNTY

EXISTING WESTERN SLOPE
SECTIONS OF OU-2

DRAWN BY: CAC	CHECKED BY: KTK	APPROVED BY: TDM*	FIGURE NO.: A-7B
DATE: FEB. 2020	DWG SCALE: 1"=100	PROJECT NO: 191-750	

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 CPT and Sonic Drilling Locations.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:31 PM



LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

CPT-## PROPOSED CPT LOCATIONS

S-## PROPOSED GEOTECHNICAL EVALUATION BOREHOLE

S-## PROPOSED WASTE PROPERTIES SONIC DRILLING LOCATIONS

NOTE

1. SONIC BORING LOCATIONS IN THE WASTE MASS SHALL BE LOCATED BASED ON THE CPT RESULTS. LOCATIONS SHOWN ARE ONLY FOR DISCUSSION.

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SCALE IN FEET

0 200 400

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ST. LOUIS COUNTY

PROPOSED CPT AND SONIC DRILLING LOCATIONS

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	A-8

LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

BH-# PROPOSED WASTE SEPARATION BOREHOLES

SCALE IN FEET

0 200 400

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

PROPOSED WASTE SEPARATION DEMONSTRATION BOREHOLES

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	A-9
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

XX-## PROPOSED WELLS FOR OU-2 RD WORK PLAN (EXISTING)

MW-###-XX PROPOSED WELLS FOR OU-2 RD WORK PLAN AND OU-3 GROUNDWATER MONITORING (TO BE CONSTRUCTED)

XX-## OTHER MONITORING WELLS (EXISTING AND TO BE CONSTRUCTED)

*HAND SIGNATURE ON FILE

SCALE IN FEET

0 200 400

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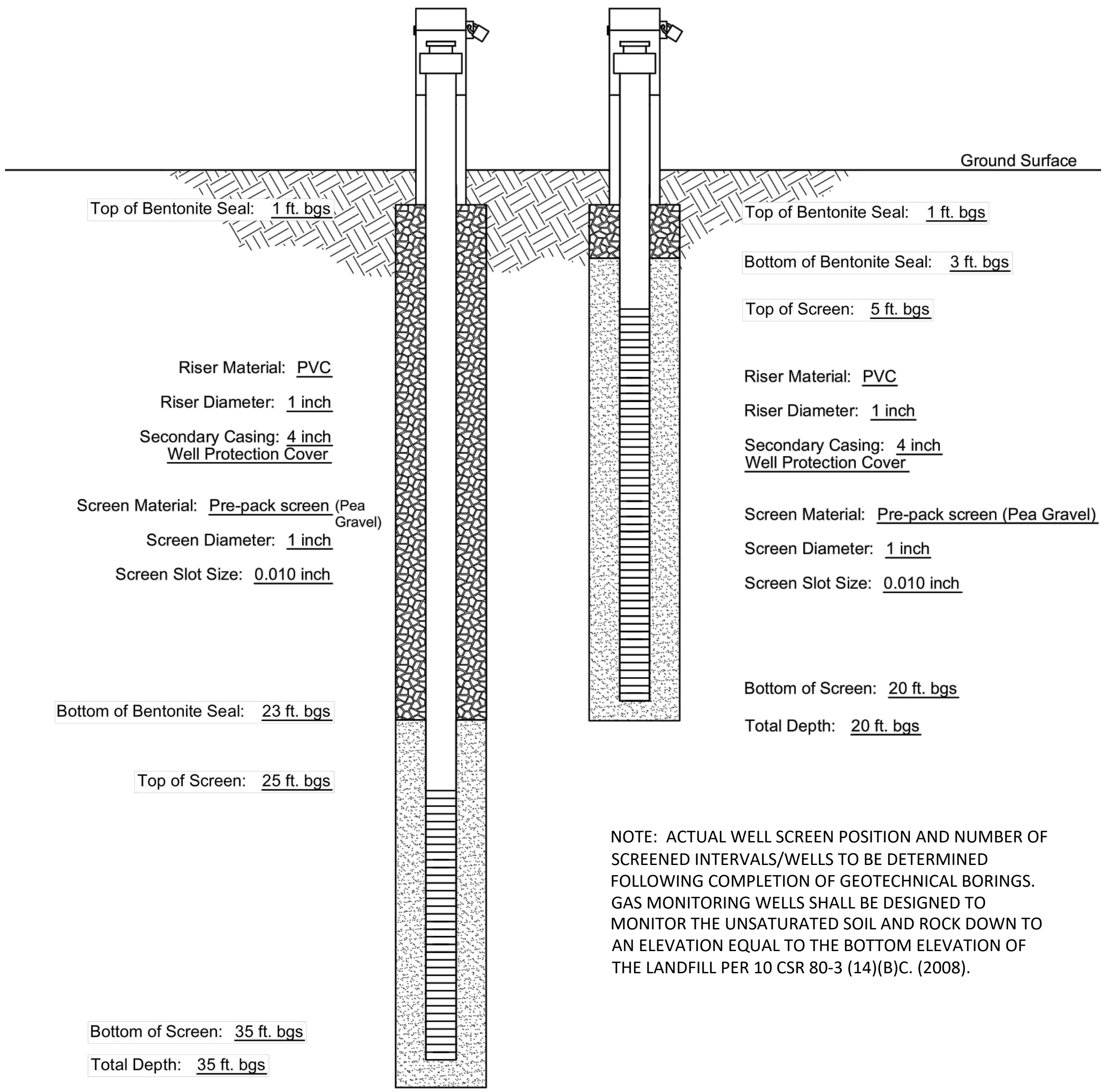
ST. LOUIS COUNTY

PROPOSED OU-2 PERFORMANCE GROUNDWATER MONITORING WELLS

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	A-10

Drilling Contractor: ________________
Driller: ________________
Helper: ________________
Drilling Method: Direct Push
Surveyor: ________________

Consulting Firm: Civil & Environmental Consultants, Inc.
Installation Supervisor: ________________
Registered Professional Geologist: ________
Date Started: ________________
Date Completed: ________________
Northing: ________ Easting: ________



NOTE: ACTUAL WELL SCREEN POSITION AND NUMBER OF SCREENED INTERVALS/WELLS TO BE DETERMINED FOLLOWING COMPLETION OF GEOTECHNICAL BORINGS. GAS MONITORING WELLS SHALL BE DESIGNED TO MONITOR THE UNSATURATED SOIL AND ROCK DOWN TO AN ELEVATION EQUAL TO THE BOTTOM ELEVATION OF THE LANDFILL PER 10 CSR 80-3 (14)(B)C. (2008).

(Not to Scale)

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ST. LOUIS COUNTY

EXAMPLE OF TEMPORARY GAS WELL CONSTRUCTION

DRAWN BY: CAN	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.: A-11
DATE: MAY 2020	DWG SCALE: N.T.S.	PROJECT NO: 191-750	

ATTACHMENT 1

QUALITY ASSURANCE MANUAL FOR PACE ANALYTICAL SERVICES, LLC

ENVIRONMENTAL SCIENCES

Document Information

Document Number: ENV-MAN-IND1-0001 **Revision:** 02

Document Title: Quality Manual

Department(s): Quality

Date Information

Effective Date: 03 Feb 2020

Notes

Document Notes:

All Dates and Times are listed in: Central Time Zone

Signature Manifest

Document Number: ENV-MAN-IND1-0001 **Revision:** 02
Title: Quality Manual

All dates and times are in Central Time Zone.

ENV-MAN-IND1-0001 Quality Manual

QM Approval

Name/Signature	Title	Date	Meaning/Reason
Elizabeth Schrage (008534)	Manager - Quality	31 Jan 2020, 10:41:35 AM	Approved

Management Approval

Name/Signature	Title	Date	Meaning/Reason
Kelly Jones (005070)	Manager	31 Jan 2020, 10:50:41 AM	Approved
Scott Bryan (003661)	Quality Analyst 3	31 Jan 2020, 11:26:14 AM	Approved
Felicia Walker (005354)	Manager	31 Jan 2020, 11:52:22 AM	Approved
Anne Troyer (008754)	Quality Analyst 3	31 Jan 2020, 12:17:51 PM	Approved
Joyce Sarapata (008874)	Supervisor	31 Jan 2020, 12:53:26 PM	Approved
Sarah Potts (007977)	Manager	31 Jan 2020, 01:07:01 PM	Approved
Melanie Booms (005590)	Project Manager 1	31 Jan 2020, 01:55:14 PM	Approved
Timothy Pinckert (003677)	Manager	03 Feb 2020, 09:22:20 AM	Approved
Rachel Wrede (008235)	Manager	03 Feb 2020, 09:22:46 AM	Approved
Steven Sayer (004775)	General Manager 2	03 Feb 2020, 09:22:52 AM	Approved
Jeffrey Worm (005618)	Scientist Team Lead	03 Feb 2020, 09:47:00 AM	Approved
Richard Bowman (009334)	Systems Administrator	03 Feb 2020, 11:05:03 AM	Approved
Jennifer Rice (005579)	Supervisor	03 Feb 2020, 03:35:28 PM	Approved
Karl Anderson (004767)	Regional Director - Operations	03 Feb 2020, 03:59:58 PM	Approved

TITLE PAGE

LABORATORY QUALITY MANUAL

Prepared for:

Pace Analytical Services, LLC
7726 Moller Road
Indianapolis, IN 46268
Phone: 317-228-3100

Pace Analytical Services, LLC
5560 Corporate Exchange Ct. SE
Grand Rapids, MI 49512
Phone: 616-975-4500

Pace Analytical Services, LLC
4860 Blazer Parkway
Dublin, OH 43017
Phone: 614-486-5421

Pace Analytical®

LABORATORY QUALITY MANUAL
Pace Analytical Services, LLC

Manual Approval Signatories

Approval of this manual by managerial personnel is recorded on the Signature Manifest located before the Title Page of this manual.

The individuals listed below represent the management team that was in place on the effective date of this version of the manual for the following location:

Pace Analytical Services, LLC
7726 Moller Road
Indianapolis, IN 46268
Phone: 317-228-3100

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations		
Steve Sayer	General Manager		
Beth Schrage	Quality Manager		
Kelly Jones	Manager – Client Services		
Felicia Walker	Manager – Metals Department		
Tim Pinckert	Manager – Semivolatiles Department		
Rachel Wrede[3]	Manager – Volatiles Department		
Sarah Potts	Manager – Wet Chemistry Department		
Anne Troyer[3]	Quality Assurance Analyst		
Rick Bowman	Systems Administrator		
Scott Bryan	Quality Assurance Analyst/Safety Officer		

[1] *Members of the local management team are subject to change during the life-cycle of this document version.*
[2] *Include if different from the physical address and phone number of the facility.*
[3] *This individual serves as an Acting Technical Manager for TNI for one or more fields of accreditation.*

LABORATORY QUALITY MANUAL
Pace Analytical Services, LLC

Manual Approval Signatories

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Pace Analytical Services, LLC
5560 Corporate Exchange Ct. SE
Grand Rapids, MI 49512
Phone: 616-975-4500

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Steve Sayer	General Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Beth Schrage	Quality Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Jennifer Rice[3]	Supervisor		
Jeff Worm[3]	Scientist – Team Lead		
Rick Bowman	Systems Administrator	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Melanie Booms	Project Manager/Safety Officer		

[1] *Members of the local management team are subject to change during the life-cycle of this document version.*
[2] *Include if different from the physical address and phone number of the facility.*
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Pace Analytical Services, LLC
4860 Blazer Parkway
Dublin, OH 43017
Phone: 614-486-5421

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Steve Sayer	General Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Beth Schrage	Quality Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Joyce Sarapata	Supervisor		
Rick Bowman	Systems Administrator	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Scott Bryan	Quality Assurance Analyst/Safety Officer	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100

[1] *Members of the local management team are subject to change during the life-cycle of this document version.*
[2] *Include if different from the physical address and phone number of the facility.*

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LABORATORY QUALITY MANUAL
Pace Analytical Services, LLC

Pace Analytical®

LABORATORY QUALITY MANUAL
Pace Analytical Services, LLC

1.0 PURPOSE AND SCOPE

1.1 Purpose

This quality manual (manual) outlines the quality management system and management structure of the laboratories and service centers affiliated with Pace Analytical Services, LLC (PAS). A laboratory is defined by PAS as any PAS facility, however named, that provides testing, sampling, or field measurement services. When the term 'laboratory" is used in this manual, the term refers to all locations listed on the Title Page of this manual and in Section 4.1.3 unless otherwise specified.

The PAS quality management system is also referred to as the quality program throughout this document. In this context, the phrase "quality management system" and "quality program" are synonymous.

The quality management system is the collection of policies and processes established by PAS management to consistently meet customer requirements and expectations, and to achieve the goals to provide PAS customers with high quality, cost-effective, analytical measurements and services.

The quality management system is also intended to establish conformance[1] and compliance with the current versions of the following international and national quality system standards:

- ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories*
- NELAC/TNI Standard Volume 1: *Management and Technical Requirements for Laboratories Performing Environmental Analysis*

[1]The statement of conformity to these Standards pertains only to testing and sampling activities carried out by the laboratory at its physical address, in temporary or mobile facilities, in-network, or by laboratory personnel at a customer's facility.

In addition to the international and national standards, the quality management system is designed to achieve regulatory compliance with the various federal and state programs for which the laboratory provides compliance testing and/or holds certification or accreditation. When federal or state requirements do not apply to all PAS locations, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. Customer-specific project and program requirements are not included in the manual in order to maintain client confidentiality.

- A list of accreditation and certifications held by each laboratory associated with this manual is provided in Appendix A.
- A list of analytical testing capabilities offered by each laboratory associated with this manual is provided in Appendix B.

1.2 Scope and Application

This manual applies to each of the PAS locations listed on the Title Page and in Section 4.1.3.

The manual was prepared from a quality manual template (template) created by PAS corporate quality personnel. The template outlines the minimum requirements PAS management considers necessary for every PAS laboratory, regardless of scope of services or number of personnel, established in order to maintain a quality management system that achieves the objectives of PAS's Quality Policy (See 4.2.2). In this regard, the template is the mechanism used by the corporate officers (a.k.a. 'top management') to communicate their expectations and commitment for the PAS quality program to all PAS personnel.

The laboratory also has the responsibility to comply with federal and state regulatory and program requirements for which it provides analytical services and holds certification or accreditation. When those requirements are more stringent than the template, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. This document structure maintains consistency in the presentation of the quality management system across the network while providing the laboratory a mechanism to describe and achieve compliance requirements on a program basis.

1.2.1 Quality Manual Template

The quality manual template is developed by the Corporate Quality Director with contribution and input from corporate quality personnel and the corporate officers. Approval of the template by the corporate officers (aka "top management") confirms their commitment to develop and maintain a quality management system appropriate for the analytical services offered by the organization and to communicate their expectations of the quality program to all personnel.

The template and instructions for use of the template are released by corporate quality personnel to quality assurance manager(s) responsible for each laboratory (Local QA). Local QA uses the template to prepare the laboratory's manual by following the instructions provided. Since the template provides the minimum requirements by which all PAS locations must abide, the laboratory may not alter the font, structure or content of the template except where specified by instruction to do so. As previously stated, program specific requirements are provided in addendum or in documents that supplement this manual.

The template is reviewed by corporate quality personnel every two years and updated if needed. More frequent review and revision may be necessary to manage change, to maintain conformance and compliance to relevant standards, or to meet customer expectations.

See standard operating procedure (SOP) ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.2 Laboratory Quality Manual

The manual is approved and released to personnel under the authority of local management. The manual is reviewed annually and location specific information is updated, if needed. More frequent review and revision may be necessary when there are significant changes to the organizational structure, capabilities, and resources of the laboratory. Review and revision of the manual is overseen by local QA. If review indicates changes to the main body of the manual are necessary to maintain conformance and compliance to relevant standards, or to meet customer expectations, local QA will notify corporate quality personnel to initiate review and/or revision of the template.

See SOP ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.3 References to Supporting Documents

The template and the manual include references to other laboratory documents that support the quality management system such as policies and standard operating procedures (SOPs). These references include the document's document control number and may include the document title.

This information is subject to change. For example, an SOP may be converted to a policy or the document's title may change. For these types of administrative changes, the manual and template are updated to reflect the editorial change during the document's next scheduled review/revision cycle or the next time a new version of the document is released, whichever is sooner.

Local QA maintains a current list of controlled documents used at each PAS location to support the quality management system. This list, known as the Master List, lists each document used by document control number, title, version, effective date, and reference to any document(s) that the current version supersedes. When there is a difference between the template and/or manual and the Master List, the document information in the Master List takes precedence. The current Master List is readily available to personnel for their use and cross-reference. Parties external to the laboratory should contact the laboratory for the most current version.

2.0 REFERENCES

References used to prepare this manual include:

- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, most current version.
- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.
- "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.
- U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis, current version.
- U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, current version.
- "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.
- "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.
- "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.
- "NIOSH Manual of Analytical Methods", U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, most current version.
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory – Cincinnati (Sep 1986).
- Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.
- Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.
- Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.
- Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.

- Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, most current version.
- National Environmental Laboratory Accreditation Conference (NELAC) Standard- most current version.
- ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories- most current version.

  The following are implemented by normative reference to ISO/IEC 17025:

  - ISO/IEC Guide 99, *International vocabulary of metrology –Basic and general concepts and associated terms*
  - ISO/IEC 17000, *Conformity assessment – Vocabulary and general principles*
- Department of Defense Quality Systems Manual (QSM), most current version.
- TNI (The NELAC Institute) Standard- most current version applicable to each lab.
- UCMR Laboratory Approval Requirements and Information Document, most current version.
- US EPA Drinking Water Manual, most current version.

3.0 TERMS AND DEFINITIONS

Refer to Appendix C for terms, acronyms, and definitions used in this manual and in other documents used by the laboratory to support the quality management system.

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

Pace Analytical Services, LLC is authorized under the State of Minnesota to do business as a limited liability company.

4.1.1.1 Change of Ownership

If there is a change of ownership, if a location goes out of business, or if the entire organization ceases to exist, Pace Analytical Services, LLC ensures that regulatory authorities are notified of the change within the time-frame required by each state agency for which the location is certified or accredited.

Requirements for records and other business information are addressed in the ownership transfer agreement or in accordance with appropriate regulatory requirements, whichever takes precedence.

4.1.2 Compliance Responsibility

Laboratory management has the responsibility and authority to establish and implement procedures and to maintain sufficient resources necessary to assure its activities are carried out in such a way to meet the compliance requirements of the quality management system.

4.1.3 Scope of the Quality Management System

The quality management system applies to work carried out at each location covered by this manual including permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

The permanent and mobile facilities to which this manual applies include:

Name	Pace Analytical Services, LLC
Address:	7726 Moller Road
City, State, Zip	Indianapolis, IN 46268
Phone Number	317-228-3100
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	5560 Corporate Exchange Ct. SE
City, State, Zip	Grand Rapids, MI 49512
Phone Number	616-975-4500
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	4860 Blazer Parkway
City, State, Zip	Dublin, OH 43017
Phone Number	614-486-5421
Service Type:	Laboratory

4.1.4 Organization History and Information

Founded in 1978, Pace Analytical Services, LLC (PAS) is a privately held scientific services firm operating one of the largest full service contract laboratory and service center networks in the United States. The company's network offer inorganic, organic and radiochemistry testing capabilities; specializing in the analysis of trace level contamination in air, drinking water, groundwater, wastewater, soil, biota, and waste.

With over 90 laboratories and services centers in the contiguous US and in Puerto Rico, the network provides project support for thousands of industry, consulting, engineering and government professionals.

Pace delivers the highest standard of testing and scientific services in the market. We offer the most advanced solutions in the industry, backed by truly transparent data, a highly trained team, and the service and support that comes from four decades of experience.

4.1.4.1 Organization Structure

Each location maintains a local management structure under the oversight and guidance of corporate personnel. Local management is responsible for making day-to-day decisions regarding the operations of the facility, implementing the quality management system, upholding the requirements of the quality program, and for supervision of personnel.

Local management is provided by a General Manager (GM), Quality Manager (QM), Client Services Manager (CSM), Information Technology (IT) Manager, and/or Department Managers (DM), however named.

Some locations may also have any one of the following management positions: Operations Manager (OM), Technical Director (TD), or Technical Manager (TM). When the location does not have a TD or TM, technical management is provided jointly by the GM, QM, DM, and DS.

The GM, however named reports to a Senior General Manager (SGM), who is responsible for the management of multiple laboratories and service centers within a geographical region, and who reports directly to the Chief Operating Officer (COO). The QM has indirect reporting relationship to the Corporate Director of Quality.

Refer to the organization charts provided in Appendix D to view the management structure, reporting relationships, and the interrelationships between positions.

4.1.5 Management Requirements

4.1.5.1 Personnel

The laboratory is staffed with administrative and technical personnel who perform and verify work under the supervision of managerial personnel.

- Technical personnel include analysts and technicians that generate or contribute to the generation of analytical data and managerial personnel that oversee day to day supervision of laboratory operations, including the reporting of analytical data and results, monitoring QA/QC performance, and monitoring the validity of analysis to maintain data integrity and reliability.
- Administrative personnel support the day-to-day activities of the laboratory.
- IT personnel maintain the information technology systems and software used at the laboratory.
- Client services personnel include project managers and support staff that manage projects.
- Managerial personnel make day-to-day and longer term decisions regarding the operations of the facility, supervise personnel, implement the quality management system and uphold the requirements of the quality program.

All personnel regardless of responsibilities are expected to carry out their duties in accordance with the policies and processes outlined in this manual and in accordance with standard operating procedures (SOPs) and other quality system documents. The laboratory's policies and procedures are designed for impartiality and integrity. When these procedures are fully implemented, personnel remain free from undue pressure and other influences that adversely impact the quality of their work or data.

4.1.5.1.1 Key Personnel

Key personnel include the management positions that have the authority and responsibility to plan, direct, and control, activities of the division (corporate) or the laboratory.

The following tables list key personnel positions by PAS job title and the position's primary deputy:

Key Personnel: Corporate

Key Personnel	Primary Deputy
Chief Executive Officer	Chief Operating Officer
Chief Operating Officer	Chief Executive Officer
Chief Compliance Officer	Quality Director
Corporate Quality Director	Chief Compliance Officer
Health and Safety Director	Chief Compliance Officer
IT Director	LIMS Administrator, however named.

Key Personnel: Laboratory

Key Personnel	Primary Deputy
General Manager	Regional Director of Operations or as designated
Quality Manager	Corporate Quality Manager
Client Services Manager	General Manager
Local IT	Corporate IT Director or as designated.
Department Manager	General Manager

Some state certification programs require the agency to be notified when there has been a change in key personnel. Program-specific requirements and time-frames for notification by agency, are tracked and upheld by local QA, when these requirements apply.

4.1.5.2 Roles and Responsibilities

The qualifications, duties, and responsibilities for each position are detailed in job descriptions maintained by PAS's corporate Human Resource's Department (HR).

The following summaries briefly identify the responsibility of key personnel positions in relation to the quality management system.

Chief Executive Officer (CEO): The CEO has overall responsibility for performance of the organization and endorses the quality program. Working with corporate and laboratory management, the CEO provides the leadership and resources necessary for PAS locations to achieve the goals and objectives of the quality management system and quality policy statement.

Chief Operating Officer (COO): The COO oversees all aspects of operations management including, strategic planning, budget, capital expenditure, and management of senior management personnel. In this capacity, the COO provides leadership and resources necessary to help top management at each PAS location achieve the goals and objectives of the quality management system and quality policy statement.

Chief Compliance Officer (CCO): The CCO oversees the quality assurance and environmental health and safety programs (HSE) for each business unit. The CCO is responsible for planning and policy development for these groups to ensure regulatory compliance and to manage risk. The position provides leadership and guidance necessary for all PAS locations to achieve the goals and objectives of the quality and HSE programs.

The CCO also serves as the Ethics Officer (ECO). The ECO develops the Ethics and Data Integrity Policy and Training Program, and provides oversight for reporting and investigation of ethical misconduct to maintain employee confidentiality during the process. The ECO provide guidance and instruction for follow-up actions necessary to remedy the situation and deter future recurrence.

Corporate Director of Quality: The Corporate Director of Quality is responsible for developing and maintaining the PAS quality program under guidance and assistance from the CEO, COO, and CCO. This position helps develop corporate quality policy and procedure and analyzes metric data and other performance indicators to assess and communicate the effectiveness of the quality program to top management. The position provides leadership and guidance for implementation of the quality program across all PAS locations.

Corporate Director of Information Technology: The Corporate Director of IT oversees the systems and processes of information technology used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Regional Director – Operations: The Regional Director of Operations has full responsibility for administrative and operations management and performance of a group of PAS laboratories and service centers. Working with the COO and local laboratory management, the Regional Director of Operations provides leadership, guidance and resources, including allocation of personnel, necessary to achieve the goals of PAS quality program.

General Manager (GM): The GM is responsible for the overall performance and administrative and operations management of a PAS location and associated service center(s). This position is responsible to provide leadership and resources, including allocation and supervision of personnel, necessary for the location to implement and achieve the goals of the PAS quality program. In this capacity, the position assures laboratory personnel are trained on and understand the structure and components of the quality program defined in this manual as well as the policies and procedures in place to implement the quality management system.

The GM of NELAC/TNI Accredited laboratories are also responsible for the designation of technical personnel to serve as acting technical managers for TNI for the fields of accreditation held by the laboratory (See Section 4.1.5.2.1) and for notifying the accreditation body (AB) of any extended absence or reassignment of these designations.

Quality Manager (QM): The QM oversees and monitors implementation of the quality management system and communicates deviations to laboratory management. The QM is independent of the operation activities for which they provide oversight and has the authority to carry out the roles and responsibilities of their position without outside influence.

Additionally, in accordance with the TNI Standard, the QM:

- serves as the focal point for QA/QC and oversees review of QC data for trend analysis;
- evaluates data objectively and perform assessments without outside influence;
- has documented training and experience in QA/QC procedures and the laboratory's quality system;
- has a general knowledge of the analytical methods offered by the laboratory;
- coordinates and conducts internal systems and technical audits;
- notifies laboratory management of deficiencies in the quality system;
- monitors corrective actions;
- provides support to technical personnel and may serve as the primary deputy for the acting TNI Technical Manager(s).

Client Services Manager (CSM): The CSM oversees project management personnel. This position is responsible for training and management of client facing staff that serve as the liaison between PAS and the customer to ensure that projects are successfully managed to meet the expectations and needs of PAS customers. This position is also responsible for sharing positive and negative customer feedback with laboratory management so that this information may be used to improve the quality program.

Systems Administrator: Local Systems Administrators are responsible for maintaining the IT systems used to support the quality program, ensuring the integrity and security of electronic data. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, and communication systems.

Department Manager (DM): The DM is responsible for administrative and operations management and implementation of the quality management system in the work area he/she oversees. These responsibilities include but are not limited to: training and supervision of personnel, monitoring work activity to maintain compliance with this manual, SOPs, policies and other instructional documents that support the quality management system; method development, validation and the establishment and implementation of SOPs to assure regulatory compliance and suitability for intended purpose; monitoring QA/QC performance, proper handling and reporting of nonconforming work, purchasing of supplies and equipment adequate for use, maintaining instrumentation and equipment in proper working order and calibration, and general maintenance of administrative and technical processes and procedures established by the laboratory.

Technical Director (TD): The TD provides technical oversight and guidance to laboratory personnel. Responsibilities may include but are not limited to: research and development, method development and validation, development of standard operating procedures, proposal and contract review. The TD may also be responsible for QA/QC trend analysis, technical training, and technology improvement.

4.1.5.2.1 Acting Technical Manager (TNI Accreditation):

For PAS locations that are NELAC/TNI accredited:

The TNI Standard specifies requirements for the qualification and duties of technical personnel with managerial responsibility. These requirements are associated in the Standard to the designation 'technical manager(s), however named'. These responsibilities may be assigned to multiple individuals and are not associated with any specific job title.

For PAS, these TNI requirements for personnel that provide technical oversight correlate with PAS's job descriptions for Department Manager or Supervisor. However, the duties may be assigned to any PAS employee that meets the TNI specified qualifications.

Personnel assigned this designation retain their PAS assigned job title. The job title may be appended with *"acting as technical manager for TNI"* and the technology or field of accreditation for which the employee is approved, if necessary.

When TNI Accreditation Bodies (AB) refer to these employees as 'technical manager' or 'technical director' on the official certificate or the scope of accreditation, this reference is referring to their approval to carry out duties of the 'technical manager, however named' as specified in the TNI Standard.

In accordance with the TNI Standard, the acting Technical Manager(s) for TNI are responsible for monitoring the performance of QC/QA in the work areas they oversee.

If the absence of any employee that is approved as acting technical manager for TNI exceeds 15 calendar days, the duties and responsibilities specified in the TNI Standard are reassigned to another employee that meets the qualifications for the technology or field of accreditation or they are assigned to the position's deputy, the Quality Manager.

4.1.5.3 Conflict of Interest

A conflict of interest is a situation where a person has competing interests. Laboratory management looks for potential conflict of interest and undue pressures that might arise in work activities and then includes countermeasures in policies and procedures to mitigate or eliminate the conflict.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.4 Confidentiality

Laboratory management is committed to preserving the confidentiality of PAS customers and confidentiality of business information.

Procedures used by the laboratory to maintain confidentiality include:

- A Confidentiality Agreement which all employees are required to sign at the time of employment and abide by its conditions throughout employment;
- Record retention and disposal procedures that assure confidentiality is maintained;
- Physical access controls and encryption of electronic data; and
- Protocol for handling Confidential Business Information (CBI).

Client information obtained or created during work activities is considered confidential and is protected from intentional release to any person or entity other than the client or the client's authorized representative information provided to PAS, except when the laboratory is required by law to release confidential information to another party, such as a regulatory agency or for litigation purposes. In which case, the laboratory will notify the client of the release of information and the information provided.

The terms of client confidentiality are included in PAS Standard Terms and Conditions (T&C). With the acceptance of PAS Terms and Conditions and/or the implicit contract for analytical services that occurs when the client sends samples to the laboratory for testing, the client authorizes PAS to release confidential information when required.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.5 Communication

Management ensures that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management system.

4.1.5.5.1 Workplace Communication

Good communication in the workplace is necessary to assure work is done correctly, efficiently, and in accordance with client expectations.

Instructions for how to carry out work activities are communicated to personnel via written policy, standard operating procedures, and standard work instructions.

Information about laboratory performance (positive and negative) and ideas for improvement are communicated using various communication channels such as face to face meetings, video conferencing, conference calls, email, memoranda, written reports, and posters.

4.1.5.5.2 External Communication

Communication with external parties such as customers, vendors, business partners, and regulatory agencies takes place every day.

Laboratory management ensures personnel learn to communicate in professional and respectful ways in order to build strong relationships, and learn to communicate effectively to avoid misunderstanding.

4.2 Quality Management System

4.2.1 Quality Management System Objectives

The objectives of the laboratory's quality management system are to provide clients with consistent, exemplary professional service, and objective work product that is of known and documented quality that meets their requirements for data usability and regulatory compliance.

Objective work product is analytical services, data, test results, and information that is not influenced by personal feeling or opinions. The quality of being objective is also known as 'impartiality'.

4.2.1.1 Impartiality

The laboratory achieves and maintains impartiality by implementing and adhering to the policies and processes of the quality management system, which are based on industry accepted standards and methodologies.

The laboratory's procedures for handling nonconforming work (See 4.9), corrective and preventive actions (See 4.12) and management review (See 4.15) are the primary mechanisms used to identify risk to impartiality and to prompt actions necessary to eliminate or reduce the threat when risk to impartiality is suspected or confirmed.

4.2.1.2 Risk and Opportunity Assessment

Risks are variables that make achieving the goals and objectives of the quality management system uncertain. An opportunity is something that has potentially positive consequences for the laboratory.

Laboratory personnel manage risks and opportunities on a daily basis by carrying out the processes that make up the quality management system. Some of the ways in which the quality management system is designed to identify, minimize, or eliminate risk on a daily basis include but are not limited to:

- Capability and capacity reviews of each analytical service request to assure the laboratory can meet the customer's requirements;

- Maintenance of accreditation and certification for test methods in multiple states and programs to cover a broad range of jurisdiction for regulatory compliance;
- SOPs and other controlled instructional documents provided to personnel to eliminate variability in process. These documents include actions to counter risk factors inherent in the process and are reviewed on a regular basis for on-going suitability and relevancy;
- Participation in proficiency testing programs and auditing activities to verify on-going competency and comparability in performance;
- Provision of on-the-job training and established protocol for quality control (QC) corrective action for nonconforming events;
- An established program for ethics, and data integrity;
- Tiered data review process;
- Culture of continuous improvement;
- Monitoring activities to assess daily and long term performance; and
- Annual critical review of the effectiveness the quality management system.

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and to promote standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction. PAS's lean programs and activities help to mitigate risk because they generate a collective understanding of vulnerabilities and utilize group-effort to develop and implement solutions at all levels.

Risk and opportunities may also be formally identified using specific risk and opportunity assessment methods such as SWOT Analysis (Strength, Weakness, Opportunity, Threats) and 3-Stage Impact/Probability Grids.

4.2.1.3 Communication of the Quality Management System

This manual is the primary mechanism used by laboratory management to communicate the quality management system to laboratory personnel.

To assure personnel understand and implement the quality program outlined in the manual:

- All laboratory personnel are required to sign a Read and Acknowledgement Statement to confirm the employee has: 1) been informed of the manual by laboratory management, 2) has access to the manual, 3) has read the manual 4) understands the content of the manual, and 5) agrees to abide by the requirements, policies and procedures therein.

- Personnel are informed that the manual provides the "what" of the quality management system. The "how to" implementation of the quality management system is provided in policies, SOPs, standard work instructions, and other controlled instructional documents.

4.2.2 Quality Policy Statement

The quality policy of the laboratory is to provide customers with data of known and documented quality fit for their intended purpose. The laboratory achieves this policy by implementing the quality management system defined in this manual, by following industry accepted protocol for analytical testing and quality assurance and quality control (QA/QC) activities, by conformance with published and industry accepted testing methodologies, and by compliance with international and national standards for the competency and/or accreditation of testing laboratories.

Intrinsic to this policy statement is each of the following principles:

- The laboratory will provide customers with reliable, consistent, and professional service. This is accomplished by making sure the laboratory has the resources necessary to maintain capability and capacity; that staff are trained and competent to perform the tasks they are assigned; that client-facing staff are trained and prepared to find solutions to problems and to assist customers with their needs for analytical services. Customer feedback, both positive and negative, is shared with personnel and used to identify opportunities for improvement.
- The laboratory maintains a quality program that complies with applicable, state, federal, industry standards for analytical testing and competency.

  ISO/IEC 17025 and the TNI (The NELAC Institute) Standard are used by PAS to establish the minimum requirements of the PAS quality program.

  ISO/IEC 17025 is a competency standard that outlines the general requirements for the management system for calibration and testing laboratories. It is the primary quality system standard from which other quality system standards, such as the TNI Standard, are based. The TNI Standards are consensus standards that provide management and technical requirements for laboratories performing environmental analysis.
- Laboratory management provides training to personnel so that all personnel are familiar with the quality management system outlined in this manual and that they understand that implementation of the quality management system is achieved by adherence to the organization's policies and procedures.
- Laboratory management continuously evaluates and improves the effectiveness of the quality management system by responding to customer feedback, and other measures of performance, such as but not limited to: the results of internal/external audits, proficiency testing, metrics, trend reports, and annual and periodic management reviews.

4.2.2.1 Ethics Policy / Data Integrity Program

PAS has established a comprehensive ethics and data integrity program that is communicated to all PAS employees to ensure that they understand what is expected of them. The program is designed to promote a mindset of ethical behavior and professional conduct that is applied to all work activities.

The key elements of the PAS Ethics / Data Integrity Program include:

- Ethics Policy (COR-POL-0004);
- Ethics Compliance Officer;
- Standardized data integrity training course taken by all new employees on hire and a yearly refresher data integrity training course for all existing employees;
- Policy Acknowledgement Statements that all PAS personnel, including contract and temporary, are required to sign at the time of employment and again during annual refresher training to document the employee's commitment and obligation to abide by the company's standards for ethics, data integrity and confidentiality;
- SOPs that provide instructions for how to carry out a test method or process to assure tasks are done correctly and consistently by each employee;
- On the Job Training;
- Data integrity monitoring activities which include, but are not limited to, secondary and tertiary data review, internal technical and system audits, raw data audits, data mining scans, and proficiency testing; and
- Confidential reporting process for alleged ethics and data integrity issues.

All laboratory managers are expected to provide a work environment where personnel feel safe and can report unethical or improper behavior in complete confidence without fear of retaliation. Retaliation against any employee that reports a concern is not tolerated.

PAS has engaged Lighthouse Services, Inc. to provide personnel with an anonymous reporting process available to them 24 hours a day/7 days per week. The alert line may be used by any employee to report possible violations of the company's ethics and data integrity program. When using the reporting process, the employee does need to specify the location of concern and when reporting by email, also include the company name. Messages are collected, documented, reviewed, and will be followed up on by the Ethics Compliance Officer to resolve the matter. Investigations concerning data integrity are kept confidential.

Lighthouse Compliance Alert Lines:

English Speaking US & Canada	(844) 940-0003
Spanish Speaking North America	(800) 216-1288
Internet	www/lighthouse-services.com/pacelabs
Email	reports@lighthouse-services.com

4.2.3 Management Commitment: Quality Management System

Evidence of management's commitment for the development, maintenance, and on-going improvement of the quality management system is provided by the application of their signature of approval to this manual. Their signature confirms they understand their responsibility to implement the quality management system outlined in this manual, to communicate the quality program to personnel, and to uphold requirements of the program during work activities.

4.2.4 Management Commitment: Customer Service

Management communicates the importance of meeting customer and regulatory requirements to personnel by training personnel on the quality management system outlined in this manual, implementing the quality management system outlined in this manual, and upholding these requirements for all work activities.

4.2.5 Supporting Procedures

Documents that support this manual and quality management system are referenced throughout this manual. The structure of the document management system is outlined in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and summarized in the following subsections.

4.2.5.1 Quality Management System Document Structure

Documents associated with the quality management system are classified into document types that identify the purpose of the document and establish how the document is managed and controlled.

Document types are ranked to establish which documents takes precedence when there is an actual or perceived conflict between documents and to establish the hierarchal relationships between documents. The ranking system also provides information to document writers and reviewers to assure downline documents are in agreement with documents of higher rank. Project-specific documents are not ranked because client-specific requirements are not incorporated into general use documents in order to maintain client confidentiality.

PAS Quality Management System Documents: Internal

Document Type	Purpose
Quality Manual	Outlines the laboratory's quality management system and structure and how it works for a system including policy, goals, objectives and detailed explanation of the system and the requirements for implementation of system. Includes roles and responsibilities, relationships, procedures, systems and other information necessary to meet the objectives of the system described.
Policy	Provide requirements and rules for a PAS process and is used to set course of actions and to guide and influence decisions. Policy describes the "what", not the "how".
Standard Operating Procedure	Provide written and consistent set of instructions or steps for execution of a routine process, method, or set of tasks performed by PAS. Includes both fundamental and operational elements for implementation of the systems described in PAS manual(s). Assures that activities are performed properly in accordance with applicable requirements. Designed to ensure consistency, protect HSE of employees and environment, prevent failure in the process and ensure compliance with company and regulatory requirements. SOPs describes the "how" based on policy.

Document Type	Purpose
Standard Work Instruction	Provide step by step visual and/or written instruction to carry out a specific task to improve competency, minimize variability, reduce work injury and strain, or to boost efficiency and quality of work (performance). SWI are associated with an SOP unless the task described is unrelated to generation of or contribution to environmental data or analytical results.
Template	Pre-formatted document that serves as a starting point for a new document.
Guide	Provide assistance to carry out a task. Most often used for software applications.
Form	Used for a variety of purposes such as to provide a standardized format to record observations, to provide information to supplement an SOP.

PAS Quality Management System Documents: External

Document Type	Purpose
Certificate	Lists parameters, methods, and matrices for which the laboratory is certified/accredited to perform within the jurisdiction of the issuing regulatory agency or accreditation body.
Reference Document	Provide information, protocol, instructions, and/or requirements. Examples include quality system standards such as ISO/IEC, TNI, DoD and published referenced methods such as Standard Methods, ASTM, SW846, EPA, and federal and state regulatory bodies.
Project Document	Provides requirements necessary to meet individual client expectations for intended use of data. Examples include: project quality assurance plans (QAPP), client program technical specifications, contracts, and other agreements.

Document Hierarchy

Rank	Document
1	Reference Documents
2	Corporate Manual
3	Corporate Policy
4	Corporate SOP
5	Corporate SWI, Templates & Forms
6	Laboratory Manual
7	Laboratory SOP
8	Laboratory SWI, Templates, & Forms
NA	Project Documents

4.2.6 Roles and Responsibilities

The roles and responsibilities of technical management and of the Quality Manager are provided in section 4.1.5.2.

4.2.7 Change Management

When significant changes to the quality management system are planned, these changes are managed by corporate quality personnel to assure that the integrity of the quality management system is maintained.

4.3 Document Control

4.3.1 General

The laboratory's procedures for document control are provided in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

The documents that support the quality management system include internally generated documents such as manuals, policies, standard operating procedures, standard work instructions, forms, guides, and templates and external source documents such as but not limited to, regulations, standards, reference methods, manuals, and project-specific documents.

The laboratory uses electronic document management software (eDMS)to administer SOPs and other training documents. eDMS automates the process for unique document identification, version control, approval, access, and archival.

4.3.2 Document Approval and Issue

Documents that are part of the quality management system are reviewed by qualified personnel and approved by laboratory management prior by to release for general use.

Local QA maintains a master list of controlled documents used at the laboratory. The master list includes the document control number, document title, and current revision status and is made available to personnel for their reference.

Only the approved versions of documents are available to personnel for use. The eDMS system does not allow user access to draft versions of documents except to personnel assigned to work on the draft. eDMS also restricts access to archived documents except to authorized users, such as local QA, in order to prevent the use of obsolete documents.

See SOP ENV-SOP-CORQ-0015 *Document Management and Control* for more information.

4.3.3 Document Review and Change

Unless a more frequent review is required by regulatory, certification or accreditation program, the laboratory formally reviews documents at least every two years to ensure the document remains current, appropriate, and relevant.

Documents are also informally reviewed every time the document is used. Personnel are expected to refer to and follow instructions in controlled documents when they carry out their work activities. Consequently, any concerns or problems with the document should be caught and brought to the attention of laboratory management on an on-going basis.

Documents are revised whenever necessary to ensure the document remains usable and correct. Older document versions and documents no longer needed are made obsolete and archived for historical purposes.

The laboratory does not allow manual-edits to documents. If an interim change is needed pending re-issue of the document, the interim change is communicated to those that use the document using a formal communication channel, such as SOP Change in Progress form, email, or memorandum.

The document review, revision, and archival process is managed by local QA at the location from which the document was released using the procedures established in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

4.4 Analytical Service Request, Tender, and Contract Review

The laboratory's management and/or client service personnel perform thorough reviews of requests and contracts for analytical services to verify the laboratory has the capability, capacity, and resources necessary to successfully meet the customer's needs. These review procedures are described in laboratory SOP ENV-SOP-IND1-0011 *Review of Analytical Requests.*

The procedures in this SOP(s) are established to ensure that:

- The laboratory understands the purpose of data collection in order to ensure the test methods requested are appropriate for the intended use of the data and capable of meeting the client's data quality objectives;
- The laboratory and any subcontractor has the capability, capacity, and resources to meet the project requirements and expectations within the requested time frame for delivery of work product;
- Any concerns that arise from review are discussed and resolved with the client; and
- The results of review and any correspondence with the client related to this process and/or any changes made to the contract are recorded and retained for historical purposes.

Capability review confirms that the in-network laboratories and any potential subcontractors hold required certification/accreditation for the test method, matrix, and analyte and verifies the laboratory can achieve the client's target compound list and data quality objectives (DQOs) for analytical sensitivity and reporting limits, QA/QC protocol, and hardcopy test report and electronic data deliverable (EDD) formats.

Capacity review verifies that the in-network laboratories and any potential subcontractors are able to handle the sample load and deliver work production within the delivery time-frame requested.

Resource review verifies that the laboratory and any potential subcontractors have adequate qualified personnel with the skills and competency to perform the test methods and services requested and sufficient and proper equipment and instrumentation needed to perform the services requested.

4.5 Subcontracting and In-Network Work Transfer

The terms 'subcontract' and "subcontracting" refers to work sent to a business external to PAS Analytical Services, LLC (PAS) and the term 'subcontractor' refers to these external businesses, which are also called vendors.

Work transferred within the PAS network is referred to as interregional work orders (IRWO) and network laboratories are referred to as IRWO or network laboratory.

The network of PAS laboratories offers comprehensive analytical capability and capacity to ensure PAS can meet a diverse range of client needs for any type of project. If the laboratory receives a request for analytical services and it cannot fulfill the project specifications, the laboratory's client services team will work with the client to place the work within the PAS network. When it is not possible to place the work within network, the laboratory will, with client approval, subcontract the work to a subcontractor that has the capabilities to meet the project specifications and can meet the same commitment agreed to between the laboratory and the client. Some client programs require client consent even for IRWO work transfer, and when this applies, the client services team obtains consent as required. The laboratory retains the record of client notification and their consent in the project record for historical purposes.

Whenever work is transferred to a subcontractor or an IRWO laboratory, the laboratory responsible for management of the project verifies each of these qualifications:

- The subcontractor or IRWO laboratory has the proper accreditation/certifications required for the project and these are current; and
- The use of the subcontractor or IRWO laboratory is approved by the client and/or regulatory agency, when approval is required. Record of approval is retained in the project record.

When possible, the laboratory selects subcontractors that maintain a quality management system similar to PAS and that complies with ISO/IEC 17025 and the TNI Standard(s).

PAS also evaluates and pre-qualifies subcontractors as part of company's procurement program. The complete list of approved vendors is maintained by the corporate procurement department and is made available to all PAS locations. Pre-qualification of a subcontractor does not replace the requirement for the subcontracting laboratory to verify the capability, capacity, and resources of any selected subcontractor on a project-specific basis to confirm the subcontractor can meet the client's needs.

For both subcontracting and in-network work transfer, the project specifications are always communicated to the subcontractor or the IRWO laboratory by the project manager so that the laboratory performing the work is aware of and understands these requirements.

The procedures for subcontracting are outlined in laboratory SOP ENV-SOP-IND1-0005 *Subcontracting Samples.*

4.6 Purchasing Services and Supplies

Vendors that provide services and supplies to the laboratory are prequalified by corporate procurement personnel to verify the vendor's capability to meet the needs of PAS. These needs include but are not limited to: competitive pricing, capacity to fill purchase orders, quality of product, customer service, and business reputation and stability. The records of vendor evaluation and the list of approved vendors is maintained by the corporate procurement department.

The laboratory may purchase goods and services from any supplier on the approved vendor list.

The specifications (type, class, grade, tolerance, purity, etc.) of supplies, equipment, reagents, standard reference materials and other consumables used in the testing process are specified in SOPs. The SOP specifications are based on the governing requirements of the approved reference methods and any additional program driven regulatory specification, such as drinking water compliance. All requisitions for materials and consumables are approved by the department supervisor to confirm the purchase conforms with specified requirements. After approval the requisition is handled by the laboratory's designated purchasing agent. On receipt, the product is inspected and verified before use, when applicable.

The laboratory's procedure for the purchase of services and supplies is specified in laboratory SOP ENV-SOP-IND1-0084 *Purchasing, Receipt, and Storage of Laboratory Supplies.*

4.7 Customer Service

Project details and management is handled by the laboratory's customer service team. Each customer is assigned a Project Manager (PM) that is responsible for review of contract requirements and handling laboratory to customer communication about the project status.

4.7.1 Commitment to Meet Customer Expectations

The laboratory cooperates and works closely with our customers to ensure their needs are met and to establish their confidence in the laboratory's capability to meet their needs for analytical services and expectations for service.

Each customer's project is handled by a project manager (PM) that is the customer's primary point of contact. The PM gathers information from the customer to ensure the details of their request are understood. After samples are received, the PM monitors the progress of the project and alerts the customer of any delays or excursions that may adversely impact data usability. Laboratory supervisors are expected to keep the PM informed of project status and any delays or major issues, so that the PM can keep the client informed.

PAS also has a team of subject matter experts (SME) available to provide customers with advice and guidance and any other assistance needed. SME are selected by top management based on their knowledge, experience, and qualifications.

The laboratory encourages customers to visit the laboratory to learn more about the laboratory's capabilities, observe performance and to meet laboratory personnel.

PAS customers expect confidentiality. Laboratory personnel will not divulge or release information to a third party without proper authorization unless the information is required for litigation purposes. See Section 4.1.5.4 of this manual and policy COR-POL-0004 *Ethics Policy* for more information on the laboratory's policy for client confidentiality.

4.7.2 Customer Feedback

The laboratory actively seeks positive and negative feedback from customers through surveys and direct communication. Information from the client about their experience working with the laboratory and their satisfaction with work product is used to enhance processes and practices and to improve decision making. Customer feedback is communicated to laboratory management and corporate personnel in monthly reports and analyzed yearly during management review (See 4.15) to identify risk and opportunity. Corrective, preventive, or continuous improvement actions are taken based on nature of and/or feedback trends.

Also see sections 4.9, 4.10, 4.11, 4.12, 4.14, and 4.15 for more information about how customer feedback is managed by the laboratory and used to enhance the quality management system.

4.8 Complaints

Complaints provide opportunities to improve processes and build stronger working relationships with our clients.

The laboratory's complaint resolution process includes three steps. First, handle and resolve the complaint to mutual satisfaction. Second, perform corrective action to prevent recurrence (See 4.11). Third, record and track the complaint and use these records for risk and opportunity assessment and preventive action (See 4.12)

4.9 Nonconforming Work

4.9.1 Definition of Nonconforming Work

Nonconforming work is work that does not conform to customer requirements, standard specifications, laboratory policies and procedures, or that does not meet acceptance criteria.

The discovery of non-conforming work comes from various sources which include, but are not limited to:

- results of quality control samples and instrument calibrations;
- quality checks on consumables and materials;
- general observations of laboratory personnel;
- data review;
- proficiency testing;
- internal and external audits;
- complaints and feedback;
- management review and reports; and
- regulatory and certification and accreditation actions.

The way in which the laboratory handles nonconforming work depends on the significance and impact (risk) of the issue. Some issues may simply require correction, others may require investigation, corrective action (See 4.11) and/or data recall (See 4.16). Data and test results associated with nonconforming QC and acceptance criteria are qualified or non-conformances are noted in the final analytical report to apprise the data user of the situation. (See 5.10)

Nonconforming work also includes unauthorized departure from laboratory policies, procedures and test methods. Authorized departures are explained in the following subsections. Situations that do not conform to these conditions are considered unauthorized departure(s).

4.9.1.1 Authorized Departure from SOP

An authorized departure from a test method SOP is one that has been reviewed and approved by the Department Manager, Technical Manager, Acting Technical Manager for TNI, Quality Manager, or the General Manager. Review is conducted to confirm the departure does not conflict with regulatory compliance requirements for which the data will be used or does not adversely affect data integrity. The departure may originate from client request or may be necessary to overcome a problem.

Departure requests are reviewed and pre-approved by the local Quality Manager. Documentation of SOP departures and approval decisions are retained by the laboratory as evidence that the departure was authorized. When necessary, approved departures from test method SOPs are noted in the final test report to advise the data user of any ramification to data quality.

4.9.1.2 Authorized Departure from Test Methods (Method Modifications)

When test results are associated to a published reference test method, the laboratory's test method SOP must be consistent with the test method. If the test method is mandated for use by a specific regulatory program such as drinking water or wastewater or a certification or accreditation program, such as TNI/NELAC, the SOP must also comply with or include these requirements. If the procedures in the SOP are modified from the test method, these modifications must be clearly identified in the SOP. The conditions under which the laboratory may establish an SOP that is modified from these reference documents, and what is considered a modification are specified in ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.* Modifications that do not meet the requirements of this SOP (ENV-SOP-CORQ-0011) are unauthorized.

4.9.1.3 Stop Work Authority

Stop Work Authority provides laboratory personnel with the responsibility and obligation to stop work when there is a perceived unsafe condition or behavior that may result in an unwanted event.

All laboratory and corporate personnel have the authority to stop work when needed to preserve data integrity or safety of workers.

Once a stop work order has been initiated and the reason for doing so is confirmed valid; laboratory management is responsible for immediate correction and corrective action (see section 4.11) before resumption of work.

4.10 Continuous Improvement

The laboratory's quality management system is designed to achieve continuous improvement through the implementation of the quality policy and objectives outlined in this manual. Information about the laboratory's activities and performance is gained from many sources such as customer feedback, audits, QC, trend analysis, business analytics, management reports, proficiency testing, and management systems review. This information is subsequently used during the laboratory's corrective action (see section 4.11) and preventive action (see section 4.12) processes and to establish goals and objectives during annual review of the management system (see section 4.15).

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction.

4.11 Corrective Action

Corrective action is the process used to eliminate the cause of a detected nonconformity. It is not the same as a correction. A correction is an action taken to fix an immediate problem. The goal of the corrective action process is to find the underlying cause(s) of the problem and to put in place fixes to prevent the problem from happening again. The corrective action process, referred to as CAPA by PAS, is one of the most effective tools used by the laboratory to prevent nonconforming work, identify risk and opportunity, and improve service to our customers.

The laboratory has two general processes for corrective action:

Day-to-day quality control (QC) and acceptance criteria exceptions (nonconformance) are handled as corrections. These events do not usually include formal methods for root cause analysis; instead the reason for the failure is investigated through troubleshooting or other measures. Required actions for correction of routine nonconformance are specified in laboratory SOPs. When correction is not performed, cannot be performed, or is not successful, test results associated with the nonconforming work are qualified in the final test report. Documentation of the nonconformance and correction performed are included in the analytical record.

A formal 7 step corrective action process is used when there is a problem or departure from the quality management system, technical activities, or when the extent of a single problem has significant impact on data, regulatory compliance or customer needs. These problems are identified through various activities such as but not limited to: quality control trends, internal and external audits, management review, customer feedback, and general observation.

The laboratory's 7 Step CAPA Process includes:

1) Define the Problem
2) Define the Scope of the Problem
3) Contain the Problem
4) Root Cause Analysis
5) Plan Corrective Action
6) Implement Corrective Action
7) Follow Up / Effectiveness Check

The formal CAPA process may be initiated by any employee. Once the process is initiated it is overseen and coordinated by laboratory management. The CAPA process is documented using an electronic or paper-based system. The CAPA record includes tracking information, dates, individuals involved, those responsible for action plan implementation and follow-up, and timelines and due dates.

For more information about the laboratory's procedure for corrective action, see laboratory SOP ENV-SOP-IND1-0020 *Corrective and Preventive Actions*. Additional explanation about certain aspects of the laboratory's corrective action process are outlined in the next three subsections.

4.11.1 Root Cause Analysis

Root cause analysis (RCA) is the process of investigation used by the laboratory to identify the underlying cause(s) of the problem. Once causal factors are identified, ways to mitigate the causal factors are reviewed and corrective action(s) most likely to eliminate the problem are selected.

The laboratory uses different methods to conduct this analysis. The most common approach is 5-Why, but fishbone diagrams, or even brainstorming may be appropriate depending on the situation. The method used is documented in the CAPA record.

4.11.2 Effectiveness Review

Monitoring corrective actions for effectiveness is shared by laboratory supervisors and quality assurance personnel. Effectiveness means the actions taken were sustainable and appropriate. Sustainable means the change is still in place. Appropriate means the action(s) taken prevented recurrence of the problem since the time corrective action was taken.

The time-frame in which effectiveness review takes place depends on the event and is recorded in the CAPA record with any addition actions that need to be taken.

Corrective action trends are also monitored by laboratory management and used to identify opportunities for preventive action or to gain lessons learned when actions taken were not adequate to solve the problem. See Section 4.12 (Preventive Action) and 4.15 (Management Review) for more information.

4.11.3 Additional Audits

When non-conformances or other problems cast doubt on compliance with the laboratory's policies, procedures, or compliance to regulatory requirements; laboratory management schedules a special audit of the area of activity in accordance with Section 4.14.1 as soon as possible. These special audits are used to determine the scope of the problem and to provide information for the CAPA process. Additional full-scale audits are done when a serious issue or risk to the laboratory's business is identified.

4.12 Preventive Action

Preventive action is an action taken to eliminate the cause of a potential nonconformity and to achieve improvement. Preventive action is a forward thinking process designed to prevent problems opposed to reacting to them after they have occurred (corrective action).

Some examples of preventative action include, but are not limited to:

- Scheduled instrument maintenance (Preventative maintenance)
- Addition of Staff and Equipment
- Professional Development Activities
- Implementation of New Technology

The laboratory looks for opportunities for preventive action from a variety of sources including but not limited to: employee ideas, customer feedback, input from business partners, trend analysis, business analytics, management reviews, proficiency testing results, lean management events, and risk-benefit analysis.

The process for preventive actions follows the same 7 step process for corrective action except "problem" is replaced with "opportunity", "root cause analysis" is replaced with "benefit analysis", and "corrective action" is replaced with "preventive action".

Laboratory management evaluates the success of preventive actions taken in any given year during annual management review. See Section 4.15 for more information.

4.12.1 Change Management

Preventive actions may sometimes result in significant changes to processes and procedures used by the laboratory. Laboratory management evaluates the risks and benefits of change and includes in its implementation of change process, actions to minimize or eliminate any risk. The types of changes for which risk are considered and managed include: infrastructure change, change in analytical service offerings, certification or accreditation status, instrumentation, LIMS changes, and changes in key personnel.

For more information about the laboratory's procedures for preventive action see laboratory SOP ENV-SOP-IND1-0020 *Corrective and Preventive Actions.*

4.13 Control of Records

A record is a piece of evidence about the past, especially an account of an act or occurrence kept in writing or some other permanent form. Laboratory records document laboratory activities and provide evidence of conformity to the requirements established in the quality management system. These records may be hardcopy or electronic on any form of media.

4.13.1 General Requirements

4.13.1.1 Procedure

The laboratory's procedures for control of records are provided in laboratory SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival.*

The procedures in the SOP are established to assure quality and technical records are identified, retained, indexed, and filed to allow for retrieval during the entire retention time frame. During storage, records are kept secure and protected from deterioration. At the end of the retention time, the records are disposed of properly in order to maintain client confidentiality and to protect the interests of the company.

In general, laboratory records fall into three categories: quality, technical, and administrative.

Examples of each are provided in the following table:

Record Type	Includes Records of:
Quality	Documents: Document Types listed in SOP ENV-SOP-CORQ-016 Audits: Internal and External Certificates and Scopes of Accreditation Corrective & Preventive Action Management Review Data Investigations Method Validation Instrument Verification Training Records
Technical	Raw Data Logbooks Certificates of Traceability Analytical Record Test Reports & Project Information Technical Training Records & Demonstration of Capability
Administrative	Personnel Records Finance/Business

4.13.1.2 Record Legibility and Storage

Records are designed to be legible and to clearly identify the information recorded. Manual entries are made in indelible ink; automated entries are in a typeface and of sufficient resolution to be read. The records identify laboratory personnel that performed the activity or entered the information.

Records are archived and stored in a way that they can be retrieved. Access to archived records is controlled and managed.

For records stored electronically, the capability to restore or retrieve the electronic record is maintained for the entire retention period. Hardcopy records are filed and stored in a suitable environment to protect from damage, deterioration, or loss. Hardcopy records may be scanned to PDF for retention. Scanned records must be checked against the hardcopy to verify the scan is complete and legible.

Records are kept for a minimum of 10 years unless otherwise specified by the client or regulatory program.

The date from which retention time is calculated depends on the record. In general, the retention time of technical records of original observation and measurement is calculated from the date the record is created. If the technical record is kept in a chronological logbook, the date of retention may be calculated from the date the logbook is archived. The retention time of test reports and project records, which are considered technical records, is calculated from the date the test report was issued. The retention time of quality records is usually calculated from the date the record is archived.

Refer to the laboratory's record management SOP for more information.

4.13.1.3 Security

The laboratory is a secure facility and access to records is restricted to laboratory personnel.

4.13.1.4 Electronic Records

The data systems used to store electronic records are backed up in accordance with laboratory SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival.* Access to archived records stored electronically is maintained by personnel responsible for management of the electronic system.

4.13.2 Technical Records

In addition to the requirements identified in subsections 4.13.1.1 through 4.13.1.4, the requirements in the following subsections also apply to technical records.

4.13.2.1 Description

Technical records are the accumulation of data and information generated from the analytical process. These records may include forms, worksheets, workbooks, checklists, notes, raw data, calibration records, final test reports, and project records. The accumulated records need to provide sufficient detail to historically reconstruct the process and identify the personnel that performed the tasks associated with a test result.

4.13.2.2 Real Time Recordkeeping

Personnel are instructed and expected to always record observations, data, and calculations at the time they are made. Laboratory managers are responsible to assure that data entries, whether made electronically or on hardcopy, are relevant and complete.

4.13.2.3 Error Correction

Errors in records must never be erased, deleted or made illegible. Use of correction fluid, such as white-out is prohibited. In hardcopy records, the error is corrected by a single line through the original entry and the new entry recorded alongside or footnoted to allow for readability. Corrections are initialed and dated by the person making the correction. If the correction is not self-explanatory, a reason for the correction is recorded.

For electronic records, equivalent measures of error correction or traceability of changes is maintained. For example, audit trails provide records of change.

Maintenance of proper practices for error correction is monitored through the tiered data review process described in Section 5.9.3. Laboratory records are reviewed throughout the data review process. Individuals performing these reviews flag errors that are not properly corrected and bring these to the attention of the department manager or supervisor of the work area in which the record was generated so that the problem may be addressed and corrected with the individual(s) that made the improper correction.

4.14 Audits

The laboratory performs internal systems and technical audits to assess compliance to this manual and to other laboratory procedures, such as policy, SOP and SWI. Since the processes in this manual are based on the relevant quality system standards and regulatory and accreditation/certification program requirements the laboratory provides services for, the internal audits also assess on-going compliance to these programs.

The laboratory is also audited by external parties such as regulatory agencies, customers, consultants and non-government assessment bodies (NGAB).

Information from internal and external audits is used by laboratory management to address compliance concerns and opportunities where improvement will increase the reliability of data.

Deficiencies, observations, and recommendations from audits are managed by local QA using the laboratory's formal CAPA process. See Section 4.11 for more information.

4.14.1 Internal Audit

The laboratory's internal audit program is managed by local QA in accordance with a pre-determined audit schedule established at the beginning of each calendar year. The schedule is prepared to assure that all areas of the laboratory are reviewed over the course of the year. Conformance to the schedule is reported to both laboratory management and corporate quality personnel in a monthly QA report prepared by the Quality Manager.

Although the Quality Manager creates the audit schedule, it is the shared responsibility of local QA and laboratory managers to assure the schedule is maintained. Laboratory supervisors cooperate with QA to provide the auditors with complete access to the work area, personnel, and records needed.

Internal audits are performed by personnel approved by the Quality Manager. In general, personnel may not audit their own activities unless it can be demonstrated that an effective and objective audit will be carried out. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation.

The laboratory's internal audit program includes:

- System Audits & Method Audits: The purpose of these audits is to determine if daily practice is consistent with laboratory's SOPs and if SOPs are compliant with adjunct policy and procedures. Auditing techniques include analyst interviews and observation and records review. These audits are performed per the pre-determined schedule.

- Raw Data / Final Test Report Audits: The purpose of these audits is to review raw data and/or final test reports to verify the final product is consistent with customer/project requirements and compliant with SOPs and reference methods. Test results should be properly qualified when necessary, should be accurate, and should be of known and documented quality. The reviews should also identify opportunities for improvement and best practices.
- Special Audits: Special audits are those performed ad hoc to follow up on a specific issue such as a client complaint, negative feedback, concerns of data integrity or ethics, or a problem identified through other audits. Special audits may be scheduled or unscheduled. Unscheduled internal audits are conducted whenever doubts are cast on the laboratory's compliance with regulatory requirements or its own policies and procedures. These unscheduled internal audits may be conducted at any time and may be performed without an announcement to laboratory personnel.

When observations and findings from any audit (internal or external) cast doubt on the validity of the laboratory's testing results, the laboratory takes immediate action to investigate the problem and take corrective action. (Also see 4.11 and 4.16)

The laboratory's internal audit program and auditing procedures are further described in laboratory SOP ENV-SOP-IND1-0018 *Internal and External Audits.*

4.14.1.1 Corporate Compliance Audit

The laboratory may also be audited by corporate quality personnel to assess the laboratory's compliance to the company's quality management program and to evaluate the effectiveness of implementation of the policies and procedures that make up the quality management system. The purpose of the compliance audit is to identify risks and opportunities and to assist laboratory management in achieving the goals and objectives of the company's quality program.

4.15 Management Review

The laboratory's management team formally reviews the management system on an annual basis to assess for on-going suitability and effectiveness and to establish goals, objectives, and action plans for the upcoming year.

At a minimum, the following topics are reviewed and discussed:

- The on-going suitability of policies and procedures including HSE (Health, Safety and Environment) and waste management;
- Reports from managerial and supervisory personnel including topics discussed at regular management meetings held throughout the year;
- The outcome of recent internal audits;
- Corrective and preventive actions;
- Assessments by external bodies;

- The results of proficiency tests;
- Changes in the volume and type of the work;
- Customer and personnel feedback, including complaints;
- Recommendations for improvement / preventive actions made since last review;
- Internal and external issues of relevance and risk identification;
- A review of the status of actions from prior management reviews; and
- Other relevant factors, such as quality control activities, resources, and staff training.

The discussion and results of this review are documented in a formal report prepared by laboratory management. This report includes a determination of the effectiveness of the management system and its processes; goals and objectives for improvements in the coming year with timelines and responsibilities, any other need for change. See laboratory SOP ENV-SOP-CORQ-0005 *Management Review* for more information.

Goals and action items from annual management systems review are shared with employees to highlight focus areas for improvement in addition to areas in which the laboratory has excelled.

4.16 Data Integrity

The laboratory's procedures for data integrity reviews are described in SOP ENV-SOP-CORQ-0010 *Data Recall.*

Customers whose data are affected by these events are notified in a timely manner, usually within 30 days of discovery. Some accreditation programs also require notification to the accreditation body (AB) within a certain time-frame from date of discovery when the underlying cause of the issue impacts accreditation. The laboratory follows any program or project-specific client requirements for notification, when applicable.

5.0 TECHNICAL REQUIREMENTS

5.1 General

Many factors contribute to the correctness and reliability of the technical work performed by the laboratory. These factors are fall under these general categories:

- Human Performance
- Facility and Environmental Conditions
- Test Method Performance and Validation
- Measurement Traceability
- Handling of Samples

The impact of each of these factors varies based on the type of work performed. To minimize negative effects from each these factors, the laboratory takes into account the contribution from each of these categories when developing test method and process (administrative) SOPs, evaluating personnel qualifications and competence, and in the selection of equipment and supplies.

5.2 Personnel

5.2.1 Personnel Qualifications

The laboratory's program for personnel management is structured to ensure personnel are selected, qualified, and competent to perform the roles and responsibilities of their position based on education, experience, and training.

Qualifications, duties, responsibilities, and authorities of each position are specified in job descriptions maintained by corporate HR (See Section 5.2.4). These job descriptions provide the general basis for the selection of personnel for hire and are used by the laboratory to communicate to personnel the duties, responsibilities, and authorities of their position.

The term "personnel" refers to individuals employed by the laboratory directly as full-time, part-time, or temporary employees and individuals employed by the laboratory by contract through an employment agency. The term "personnel" is used interchangeably with the term "employee" throughout this manual. For purposes of this manual, these terms are equivalent.

The personnel management program is structured to establish and maintain records for each of the following:

- Selection of personnel;
- Training of personnel;
- Supervision of personnel;
- Authorization of personnel; and
- Monitoring Competence of personnel.

5.2.1.1 Competence

Competence is the ability to apply a skill or series of skills to complete a task or series of tasks correctly within defined expectations.

Competence for technical personnel, authorized by PAS to provide opinion and interpretation of data to customers, also includes the demonstrated ability to:

- Apply knowledge, experience, and skills needed to safely and properly use equipment, instrumentation, and materials required to carry out testing and other work activities in accordance with manufacturer specifications and laboratory SOPs;
- Understand and apply knowledge of general regulatory requirements necessary to achieve regulatory compliance in work product; and
- Understand the significance of departures and deviations from procedure that may occur during the analytical testing process and the capability and initiative to troubleshoot and correct the problem, document the issue, and to properly qualify the data and analytical results.

The laboratory's requirements for the competence of personnel (education, qualification, work experience, technical skills, and responsibilities) are specified in job descriptions created by management and kept by human resources (HR). The job description provides the basis for the selection of personnel for each position.

An employee is considered competent when he/she has completed documented required training.

The policies and standard operating procedures (SOPs) for the following topics are established by management as minimum required training for all personnel:

- Ethics and Data Integrity
- Quality Manual
- Safety Manual
- Technical Process and Procedure relevant to their job tasks
- Successful Demonstration of Capability (DOC) – Analytical Personnel Only

Records of training and qualification provide the record of competence for the individual. Qualification records may include but are not limited to diploma, transcripts, and curriculum vitae (CV).

The on-going competence of each employee is monitored by laboratory management through on-the-job performance. Analytical employees are also required to successfully complete another demonstration capability for each test method performed on an annual basis.

5.2.2 Training

Training requirements are outlined in policies COR-POL-0023 *Mandatory Training Policy.* COR-POL-0004 *Ethics Policy*, and laboratory SOP ENV-SOP-IND1-0027 *Employee Orientation and Training.* Additional training requirements may also be specified in other documents, such as manuals.

5.2.2.1 Training Program and Goals

The laboratory's training program includes 4 elements:

- Identification of Training Needs
- Training Plan Development and Execution
- Documentation and Tracking
- Evaluation of Training Effectiveness

Laboratory management establishes goals and training needs for individual employees based on their role, education, experience, and on-the-job performance.

Training needs for all employees are based on business performance measures that include but are not limited to:

- Quality Control Trends
- Process Error / Rework Trends
- Proficiency Testing Results
- Internal & External Audit Performance

- Management Review Goals

Training is delivered using various methods that incorporate techniques that appeal to the main learning styles: visual, aural, linguistic, and kinesthetic. Techniques include on-the-job, instructor-led, self-study, eLearning, and blended.

The employee's direct supervisor is responsible for oversight of the employee's training plan and for providing adequate time to the employee to complete training assignments. Both the supervisor and employee are responsible to make sure the employee's training status and training records are current and complete.

The laboratory's QA department monitors the training status of personnel and provides the status to the General Manager (GM or AGM) at least monthly or more frequently, if necessary. The status report is used by laboratory management to identify overdue training assignments, the reasons for the gaps, and to make arrangements for completion.

The following subsections highlight specific training requirements:

5.2.2.1.1 New Hire Training

New hire training requirements apply to new personnel and to existing employee's starting in a new position or different work area.

Required new hire training includes each of the following:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Manual and any training requirements specified in the manual.
- Policies & SOPs relevant to their job tasks
- Technical personnel that test samples must also successfully complete an initial demonstration of capability (IDOC) for the test methods performed before independently testing customer samples. (See 5.2.2.1.5). Independent testing means handling of client samples without direct supervision of the work activity by the supervisor or a qualified trainer.

All required training must be current and complete before the employee is authorized to work independently. Until then, the employee's direct supervisor is responsible for review and acceptance of the employee's work product.

5.2.2.1.2 On-Going Training

Personnel receive on-going training in each of the following topics:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)

- Safety Training
- Changes to Policies & SOPs
- Specialized Training
- Technical personnel that carry out testing must also successfully complete continuing demonstration of capability (DOC) for all test methods performed on an annual basis. (See 5.2.2.1.5)

Personnel are expected to maintain their training status and records of training current and complete and to complete training assignments in a timely manner.

5.2.2.1.3 Ethics and Data Integrity Training

Initial data integrity training is provided to all new personnel and refresher data integrity training is provided to all employees on an annual basis. Personnel are required to acknowledge they understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

The initial data integrity training and the annual refresher training is documented with a signature attendance sheet or other form of documentation to provide evidence that the employee has participated in training on this topic and understands their obligations related to data integrity.

The following topics and activities are covered:

- Policy for honesty and full disclosure in all analytical reporting;
- Prohibited Practices;
- How and when to report data integrity issues;
- Record keeping. The training emphasizes the importance of proper written documentation on the part of the analyst;
- Training Program, including discussion regarding all data integrity procedures;
- Data integrity training documentation;
- In-depth procedures for data monitoring; and
- Specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.

All PAS personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including termination and prosecution, if necessary.

Also see SOP-ENV-COR-POL-0004 *Ethics Policy* for more information.

5.2.2.1.4 Management System Documents Training

PAS Manuals, policies, and SOPs are the primary documents used by regulatory bodies and PAS customers to verify the laboratory's capability, competency, and compliance with their requirements and expectations.

In addition to on-the-job training, employees must have a signed Read and Acknowledgement Statement on record for the laboratory Quality Manual and the policies and SOPs relating to his/her job responsibilities. This statement, when signed by the employee electronically or on paper, confirms that the employee has received, read, and understands the contents of the document, that the employee agrees to follow the document when carrying out their work tasks, and that the employee understands that unauthorized change to procedures in an SOP is not allowed except in accordance with the SOP departure policy (See 4.9.1.1) and SOP ENV-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions* for more information.

5.2.2.1.5 Demonstration of Capability (DOC)

Technical personnel must also complete an initial demonstration of capability (IDOC) prior to independent work on client samples analyzed by the test methods they perform. After successful IDOC, the employee must demonstrate continued proficiency (DOC) for the test method on an annual basis. If more than a year has passed since the employee last performed the method; then capability must be re-established with an IDOC.

Demonstration of capability (IDOC and DOC) is based on the employee's capability to achieve acceptable precision and accuracy for each analyte reported by the laboratory for the test method using the laboratory's test method SOP.

Records of IDOC and DOC are kept in the employee's training file.

For more information, see laboratory SOP ENV-SOP-IND1-0027 *Employee Orientation and Training.*

5.2.2.2 Effectiveness of Training

The results of the performance measures used to identify training needs are the same measures used by the laboratory to measure effectiveness of the training program.

Improvements in key performance measures suggest the training program is successful. (See 5.2.2.1)

Effectiveness of individual employee training is measured by their demonstrated ability to comprehend the training material and apply the knowledge and skills gained to their job task. Measurements include but are not limited to:

- Testing of the employee's knowledge of the quality management system, policies, and technical and administrative procedures through various mechanisms, such as quizzes, observation, and interviews.
- Demonstrated ability to convey information correctly and factually in written and verbal communication to internal and external parties.
- Demonstrated ability to carry out tasks in accordance with SOPs and other work instructions.
- Demonstrated ability to make sound decisions based on guidance and information available.
- Demonstrated initiative to seek help or guidance when the employee is unsure of how to proceed.

5.2.3 Personnel Supervision

Every employee is assigned a direct supervisor, however named, who is responsible for their supervision. Supervision is the set of activities carried out by the supervisor to oversee the progress and productivity of the employees that report to them.

General supervisory responsibilities may include but are not limited to:

- Hiring Employees
- Training Employees
- Performance Management
- Development, oversight, and execution of personnel training plans
- Monitoring personnel work product to assure the work is carried out in accordance with this quality manual, policies, SOPs, and other documents that support the quality management system.

5.2.4 Job Descriptions

Job Descriptions that define the required education, qualifications, experience, skills, roles and responsibilities, and reporting relationships for each PAS position are established by top management and kept by corporate HR. The job descriptions apply to employees who are directly employed by PAS, part-time, temporary, technical and administrative and by those that are under contract with PAS through other means.

The job descriptions include the education, expertise, and experience required for the position and the responsibilities and duties, including any supervisory or managerial duties assigned to the position.

5.2.5 Authorization of Technical Personnel

Laboratory management authorizes technical personnel to perform the technical aspects of their position after it has been verified that the employee meets the qualifications for the position, has successfully completed required training, and the employee has demonstrated capability. After initial authorization, technical personnel are expected to maintain a current and complete training record, demonstrate on-going capability at least annually for each test method performed, and produce reliable results through accurate analysis of certified reference materials, proficiency testing samples, and/or routine quality control samples in order to remain authorized to continue to perform their duties.

Records to support authorization including education, experience, training, and other evaluations are kept by the laboratory.

5.3 Accommodations and Facilities

5.3.1 Facilities

The laboratory is designed to appropriately support the performance of procedures and to not adversely affect measurement integrity or safety. Access to the laboratory is controlled by various measures, such as card access, locked doors, and main entry. Visitors to the laboratory are required to sign-in and to be escorted by laboratory personnel during their visit. A visitor is any person that is not an employee of the laboratory.

5.3.2 Environmental Conditions

The laboratory is equipped with energy sources, lighting, heating, and ventilation necessary to facilitate proper performance of calibrations and tests. The laboratory ensures that housekeeping, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled to ensure the integrity of specific measurement results and to prevent adverse effects on accuracy or increases in the uncertainty of each measurement.

Environmental conditions are monitored, controlled, and recorded as required by the relevant specifications, methods, and procedures. Laboratory operations are stopped if it is discovered that the laboratory's environmental conditions jeopardize the analytical results.

5.3.3 Separation of Incompatible Activities

The layout and infrastructure of each work area including air handling systems, power supplies, and gas supplies of each laboratory work area is specifically designed for the type of analytical activity performed. Effective separation between incompatible work activities is maintained. For example, sample storage, preparation, and chemical handling for volatile organic analysis (VOA) is kept separate from semi-volatile organic analysis (SVOA).

The laboratory separates samples known or suspected to contain high concentration of analytes from other samples to avoid the possibility for cross-contamination. If contamination is found, the source of contamination is investigated and resolved in accordance with laboratory SOPs.

5.3.4 Laboratory Security

Security is maintained by controlled access to the building and by surveillance of work areas by authorized personnel. Access is controlled to each area depending on the required personnel, the sensitivity of the operations performed, and possible safety concerns. The main entrance is kept unlocked during normal business hours for visitors, and is continuously monitored by laboratory staff. All visitors must sign a visitor's log and a staff member must accompany them during their stay.

5.3.5 Good Housekeeping

The laboratory ensures good housekeeping practices in work areas to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Minimally, these measures include regular cleaning of the work area. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible safety issues.

5.4 Test Methods

5.4.1 General Requirements

The laboratory uses test methods and procedures that are appropriate for the scope of analytical services the laboratory offers.

Instructions on the use and operation of equipment and sample handling, preparation, and analysis of samples are provided in SOPs. The instructions in SOPs may be supplemented with other documents including but not limited to, standard work instructions (SWI), manuals, guides, project documents and reference documents.

These documents are managed using the procedures described in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and SOP ENV-SOP-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions.*

Deviations to test method and SOPs are allowed under certain circumstances. See sections 4.9.1.1 and 4.9.1.2 for more information.

5.4.2 Method Selection

The test methods and protocols used by the laboratory are selected to meet the needs of the customer and to conform with regulatory requirements, if applicable.

In general, the test methods offered are industry accepted methods published by international, regional, or national standards. The laboratory bases its procedure on the latest approved edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements allow otherwise.

The laboratory confirms that it can perform the test method and achieve desired outcome before analyzing samples (see section 5.4.5). If there is a change in the published analytical method, then the confirmation is repeated.

When a customer does not specify the test method(s) to be used, the laboratory may suggest test methods that are appropriate for the intended use of the data and the type of samples to be tested. The laboratory will also inform customers when test methods requested are considered inappropriate for their purpose and/or out of date. This discourse takes place during review of analytical requests (See Section 4.4).

5.4.3 Laboratory Developed Methods

A laboratory developed method is a method developed from scratch (no published source method), a procedure that modifies the chemistry from the source method, or a procedure that exceeds the scope and application of the source method.

Laboratory developed methods must be validated prior to use (see section 5.4.5) and the procedure documented in a test method SOP.

The requirements for non-standard methods (Section 5.4.4) also apply to laboratory developed methods.

5.4.4 Non-standard Methods

A non-standard method is a method that is not published or approved for use by conventional industry standards for the intended purpose of the data. Non-standard methods must be validated prior to use (see section 5.4.5) and the procedure developed and documented in a test method SOP.

At a minimum, the following information must be included in the procedure:

- Title / Identification of Method;
- Scope and Application;
- Description of the type of item to be analyzed;
- Parameters or quantities and ranges to be determined;
- Apparatus and equipment, including technical performance requirements;
- Reference standards and reference materials required;
- Environmental conditions required and any stabilization period needed
- Description of the procedure, including:
    - Affixing identification marks, handling, transporting, storing and preparing of items;
    - Checks to be made before the work is started;
    - Verifying equipment function and, where required, calibrating and/or adjusting the equipment before each use;
    - Method of recording the observations and results;
    - Any safety measures to be observed;
    - Criteria and/or requirements for approval/rejection of data;
    - Data to be recorded and method of analysis and presentation; and
    - Uncertainty or procedure for estimating uncertainty.

Use of a non-standard method for testing must be agreed upon with the customer. The agreement, which is retained by the laboratory in the project record, must include the specifications of the client's requirements, the purpose of testing, and their authorization for use of the non-standard method.

5.4.5 Method Validation

5.4.5.1 Validation Description

Validation is the process of conformation and the provision of objective evidence that the stated requirements for a specific method/procedure are fulfilled.

The laboratory's requirements and procedures for method validation are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.4.5.2 Validation Summary

All test methods offered by the laboratory are validated before use to confirm the procedure works and the data and results achieved meet the goals for the method. The extent of validation performed is based on technology and other factors as defined in the validation SOP (ENV-SOP-CORQ-0011).

Results of validation are retained are kept in accordance with the laboratory's SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival* for retention of technical records.

The need to repeat validation is assessed by laboratory management when there are changes to the test method.

5.4.5.3 Validation of Customer Need

Laboratory management reviews the results of test method validation, which include accuracy, precision, sensitivity, selectivity, linearity, repeatability, reproducibility, and robustness, against general customer needs to ensure the laboratory's procedure for the test method will meet those needs.

The review procedure is detailed in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

The following subsections highlight some of these concepts:

5.4.5.3.1 Accuracy

Accuracy is the degree to which the result of a measurement, calculation, or specification conforms to the correct value of a standard. When the result recovers within a specified range from the known value (control limit); the result generated using the laboratory's test method SOP is considered accurate.

5.4.5.3.2 Precision

Precision refers to the closeness of two or more measurements to each other. It is generally measured by calculating the relative percent difference (RPD) or relative standard deviation (RSD) from results of separate analysis of the same sample. Precision provides information about repeatability, reproducibility, and robustness of the laboratory's procedure.

5.4.5.3.3 Limits of Detection (LOD)

The LOD is the minimum result which can be reliably differentiated from a blank with a predetermined confidence level. The LOD establishes the limit of method sensitivity and is also known as the detection limit (DL) or the method detection limit (MDL).

Values below the LOD cannot be reliably measured and are not reported by the laboratory unless otherwise specified by regulatory program or test method. If reported, values below the LOD are qualified as estimated.

The LOD is established during method validation and after major changes to the analytical system or procedure that affect sensitivity are made.

The laboratory's procedure for LOD determination is detailed in laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*. The SOP complies with 40 CFR 136 Appendix B or the current industry approved and accepted guidance for this process.

5.4.5.3.4 Limits of Quantitation (LOQ) and Reporting Limit (RL)

The LOQ is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence. The LOQ is established at the same time as the LOD. The laboratory's procedure for determination and verification of the LOQ is detailed in laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*.

The Lowest Limit of Quantitation (LLOQ) is the value of the lowest calibration standard. The LOQ establishes the routine limit of quantitation.

The LOQ and LLOQ represent quantitative sensitivity of the test method.

- The LOQ must always be equal to or greater than the LLOQ and the LLOQ must always be greater than the LOD.
- Any reported value (detect or non-detect) less than the LLOQ is a qualitative value.

The RL is the value to which the presence of a target analyte is reported as detected or not-detected. The RL is project-defined based on project data quality objectives (DQO). In the absence of project specific requirements, the RL is usually set to the LOQ or the LLOQ.

For more information, refer to laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*.

5.4.5.3.5 Linearity

Linearity is a mathematical concept applied to calibration models that employ multiple points to establish a calibration range used for quantitative analysis. Linearity is measured differently based on the calibration model. The accuracy of the linear regression and non-linear curves is verified by checking percent error or relative standard error (RSE), which is the process of refitting calibration data back to the model to determine if the results are accurate. For linear curves that use average calibration or response factor, error is measured by relative standard difference (RSD).

Linearity also establishes the range of quantitation for the test method used which directly impacts the sensitivity of the test method and uncertainty in measurement results. As previously noted, the LLOQ establishes the lower limit of quantitation. Similarly, the upper range of linearity establishes the upper limit of quantitation. In general, results outside of this range are considered qualitative values. However, some inorganic methods allow for extension of the linear range above the upper limit of quantitation when accuracy at this value is verified.

Linearity can also be used to establish repeatability, reproducibility, and robustness of the laboratory's test method. When linearity is demonstrated using a specific calibration model during method validation, then use of this same calibration model to achieve linearity on a day to day basis confirms the laboratory's method is repeatable, reproducible, and robust.

5.4.5.3.6 Demonstration of Capability (DOC)

The DOC performed during method validation confirms that the test method demonstrates acceptable precision and accuracy. The procedure used for DOC for method validation is the same as described in section 5.2.2.1.5 for demonstration of analyst capability.

5.4.6 Measurement Uncertainty

The laboratory provides an estimate of uncertainty in testing measurements when required or on client request. In general, the uncertainty of the test method is reflected in the control limits used to evaluate QC performance. (See 5.9.1.1.10).

When measurement uncertainty cannot be satisfied through control limits, the laboratory will provide a reasonable estimation of uncertainty. A reasonable estimation is based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation are taken into account.

5.4.7 Control of Data

The laboratory has policies and processes in place to assure that reported data is free from calculation and transcription errors, that quality control is reviewed and evaluated before data is reported, and to address manual calculation and integration.

5.4.7.1 Calculations, Data Transfer, Reduction and Review

Whenever possible, calculations, transfer of data, and data reduction are performed using validated software programs. (See 5.4.7.2)

If manual calculations are necessary, the results of these calculations are verified during the data review process outlined in section 5.9.3.

5.4.7.1.1 Manual Integration

The laboratory's policy and procedures for manual integration are provided in SOP ENV-SOP-CORQ-0006 *Manual Integration.*

This SOP includes the conditions under which manual integration is allowed and the requirements for documentation.

Required documentation of manual integration includes:

- complete audit trail to permit reconstruction of before and after results;
- identification of the analyst that performed the integration and the reason the integration was performed; and
- the individual(s) that reviewed the integration and verified the integration was done and documented in compliance with the SOP.

5.4.7.2 Use of Computers and Automated Acquisition

Whenever possible the laboratory uses software and automation for the acquisition, processing, recording, reporting, storage, and/or retrieval of data.

Software applications developed by PAS are validated by corporate IT for adequacy before release for general use. Commercial off-the-shelf software is considered sufficiently validated when the laboratory follows the manufacturer's or vendor's manual for set-up and use. Records of validation are kept by the corporate information technology (IT) group or by the local laboratory, whichever group performed the validation.

The laboratory's process for the protection of data stored in electronic systems includes:

- Individual user names and passwords for Laboratory Information Management Systems (LIMS) and auxiliary systems used to store or process data.
- Employee Training in Computer Security Awareness

- Validation of spreadsheets used for calculations to verify formulas and logic yield correct results and protection of these cells to prevent unauthorized change.
- Operating system and file access safeguards
- Protection from Computer Viruses
- Regular system backup; and testing of retrieved data

The laboratory's process for software development and testing process includes:

- Verification the software application works as expected and is adequate for use and fulfills compliance requirements, such as the need to record date/time of data generation.
- Change control to assure requests for changes are reviewed and approved by management before the change is made.
- Communication channels to assure all staff are aware of changes made.
- Version Control and maintenance of historical records.

5.5 Equipment

5.5.1 Availability of Equipment

The laboratory is furnished with all equipment and instrumentation necessary to perform the tests offered in compliance with the specifications of the test method and to achieve the accuracy and sensitivity required.

5.5.2 Calibration

Equipment and instrumentation is checked prior to use to verify it performs within tolerance for its intended application.

Laboratory management is made aware of the status of equipment and instrumentation and any needs for either on a daily basis. This information is obtained during laboratory Lean Daily Management (LDM) walkthroughs that are conducted as part of the laboratory's lean program.

5.5.2.1 Support Equipment

The laboratory confirms support equipment is in proper working order and meets the specifications for general laboratory use prior to placement in service and with intermediate checks thereafter. Equipment that does not meet specifications is removed from service until repaired or replaced. Records of repair and maintenance activities are maintained.

Procedures used to carry out and record these checks are outlined laboratory SOP ENV-SOP-IND1-0086 *Support Equipment.*

5.5.2.2 Analytical Instruments

Analytical instruments are checked prior to placement in service in accordance with SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.* After the initial service date, the calibration of instruments and verification calibration is performed in accordance with local test method SOPs.

The calibration procedures in the test method SOPs comply with the requirements for acceptable calibration practices outlined in corporate document ENV-SOT-CORQ-0026 *Calibration Procedures*, the reference methods, and any applicable regulatory or program requirements.

5.5.3 Equipment Use and Operation

Equipment is operated and maintained by laboratory personnel that are trained on the test method SOP. Up-to-date instructions and procedures for the use and maintenance of analytical equipment are included in SOPs and/or supplemental documents such as standard work instructions (SWI), maintenance logbooks, or instrument manuals which are made readily accessible in the work area to all laboratory personnel.

5.5.4 Equipment Identification

The laboratory uniquely identifies equipment by serial number or any other unique ID system, when practical.

5.5.5 Equipment Lists and Records

5.5.5.1 Equipment List

The laboratory maintains a master list of equipment that includes equipment description, manufacturer, model, associated methods, and the year it was placed into service. The date of purchase is tracked by the procurement record. The equipment list(s) for each location covered by this manual is provided in Appendix E.

5.5.5.2 Equipment Records

In addition to the equipment list, the laboratory maintains records of equipment that include:

- Verification that equipment conforms with specifications.
- Calibration records including dates, results, acceptance criteria, and next calibration date, if scheduled.
- Maintenance plan and records
- Records of damage, malfunction, or repair

The laboratory follows an equipment maintenance program designed to optimize performance and to prevent instrument failure which is described in laboratory SOPs, instrument maintenance logbooks, or instrument user manuals.

The maintenance program includes routine maintenance activities which are performed as recommended by the manufacturer at the frequency recommended and non-routine maintenance, which is performed to resolve specific problems such as loss of sensitivity or repeated failure of instrument performance checks and quality control samples.

Maintenance is performed by laboratory personnel or by outside service providers.

All maintenance activities performed by laboratory personnel are recorded by the individual(s) that performed the activity at the time the maintenance was performed in an instrument maintenance log.

The maintenance record minimally includes the date of maintenance, the initials of the person(s) performing maintenance, the problem encountered, a description of the activity performed, and evidence of return to analytical control. When maintenance is performed by an external vendor, the laboratory staples the service record into hardcopy maintenance logs or scans the record for easy retrieval. The laboratory provides unrestricted access to instrument maintenance logs in order to promote good instrument maintenance and recordkeeping practices.

If an instrument must be moved, the laboratory will use safe practices for handling and transport to minimize damage and contamination.

5.5.6 Out of Service Protocol

Equipment that has been subjected to overloading, mishandling, gives suspect results, has been shown to be defective, or is performing outside of specified limits is taken out of service. The equipment is either removed from the work area or labeled to prevent accidental use until it has been repaired and verified to perform correctly.

When analytical equipment is taken out of service, the laboratory examines the potential effect it may have had on previous analytical results to identify any non-conforming work. (See section 4.9).

5.5.7 Calibration Status

The laboratory labels support equipment to indicate calibration status, whenever practicable, or otherwise maintains the calibration status in a visible location in the work area. These procedures are described in laboratory SOP ENV-SOP-IND1-0086 *Support Equipment*.

The calibration status of analytical instruments is documented in the analytical record. Analysts verify on-going acceptability of calibration status prior to use and with instrument performance check standards. These procedures are described in test method SOPs.

5.5.8 Returned Equipment Checks

When equipment or instruments are sent out of the laboratory for service, the laboratory ensures that the function and calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service. These procedures are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification*.

5.5.9 Intermediate Equipment Checks

The laboratory performs intermediate checks on equipment to verify the on-going calibration status. For example, most test methods require some form of continuing calibration verification check and these procedures are included in the test method SOP. Periodic checks of support equipment are also performed.

5.5.10 Safeguarding Equipment Integrity

The laboratory safeguards equipment integrity using a variety of mechanisms that include but are not limited to:

- Adherence to manufacturer's specifications for instrument use so that settings do not exceed manufacturer's recommendations or stress the performance of the equipment.
- Established maintenance programs.
- Transparent maintenance records and unrestricted access to maintenance logs.
- Validation and approval of software before use.
- Audits to confirm instrument settings are consistent with SOPs.
- On-the-job training for safe and proper use of laboratory equipment.

5.6 Measurement Traceability

5.6.1 General

Measurement traceability refers to a property of a measurement result whereby the result can be related to a reference through an unbroken chain of calibration, each contributing to the measurement uncertainty. Traceability requires an established calibration of equipment used during testing including support equipment. The laboratory assures this equipment is calibrated prior to being put into service and that the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard.

When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.2 Equipment Correction Factors

When correction factors are used to adjust results the laboratory will assure that results in computer software are also updated. For example, if the direct instrument or reading output must be corrected based on preparation factor or concentration factors, laboratory management will assure the corrected result is also updated in the software, whenever possible.

5.6.3 Specific Requirements

5.6.3.1 Requirements for Calibration Laboratories

The laboratory does not offer calibration services to customers.

5.6.3.2 Requirements for Testing Laboratories

The laboratory has procedures in place to verify equipment is calibrated prior to being put into service (See 5.5.2), and ensures the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard. When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.4 Reference Standards and Reference Materials

5.6.4.1 Reference Standards

The laboratory uses reference standards of measurement to verify adequacy of working weights and thermometers. The working weight is the weight(s) used for daily balance calibration checks and the working thermometers are used for temperature measurements on a daily basis.

The measurements from working weights and thermometers are compared to measurement taken by the reference standard which is traceable to SI or a national standard. The reference weights and thermometers are used solely for verification purposes unless the laboratory can prove that daily use does not adversely affect performance of the reference standard.

The laboratory performs intermediate checks of the working weights at least annually.

Working thermometers are checked against the reference thermometer annually (glass) or quarterly (digital).

The calibration of liquid in glass reference thermometers is verified every 5 years and the calibration of digital reference thermometers is verified bi-annually by an ISO/IEC 17025 accredited calibration laboratory or service provider that provides traceability to a national standard.

The calibration of the reference weight(s) is verified every 5 years by an ISO/IEC 17025 accredited calibration laboratory.

See laboratory ENV-SOP-IND1-0086 *Support Equipment* for more information about this process.

5.6.4.2 Reference Materials

The laboratory purchases chemical reference materials used as analytical standards and reagents from vendors that are accredited to ISO 17034 or Guide 34. Purchased reference materials must be received with a Certificate of Analysis (COA), where available. If a reference material cannot be purchased with a COA, it must be verified by analysis and comparison to a certified reference material and/or there must be a demonstration of capability for characterization. COA are reviewed for adequacy and retained by the laboratory for future reference.

The laboratory procedure for traceability and use of these materials is provided in laboratory SOP ENV-SOP-IND1-0031 *Standard and Reagent Management and Traceability*.

This SOP includes each of the following requirements:

- Procedures for documentation of receipt and tracking. The record of entry includes name of the material, the lot number, receipt date, and expiration date.
- Storage conditions and requirements. Reference materials must be stored separately from samples, extracts, and digestates.

- Requirements to assure that preparations of intermediate or working solutions are recorded and assigned a unique identification number for tracking. Records of preparation include the lot number of the stock standard(s) used, the type and lot number of the solvent, the formulation, date, expiration date, and the preparer's initials. The lot number of the working standards is recorded in the analytical record to provide traceability to the standard preparation record. The preparation record provides traceability to the COA, which is traceable to SI or the national measurement standard.

- A requirement that the expiration dates of prepared standards may not exceed the expiration date of the parent standard. Standards, reference materials, and reagents are not used after their expiration dates unless their reliability is thoroughly documented and verified by the laboratory. If a standard exceeds its expiration date and is not re-certified, the laboratory removes the standard and/or clearly designates it as acceptable for qualitative/troubleshooting purposes only. All prepared standards, reference materials, and reagents are verified to meet the requirements of the test method through routine analysis of quality control samples.

- The second source materials used for verification of instrument calibration are obtained from a different manufacturer or different lot from the same manufacturer.

- Procedures to check reference materials for degradation and replacement of material if degradation or evaporation is suspected.

- Procedures for labeling. At a minimum the container must identify the material, the ID of the material and the expiration date. Original containers should also be labeled with date opened.

5.6.4.3 Intermediate Checks

Checks to confirm the calibration status of standards and materials are described in laboratory SOPs. These checks include use of second source standards and reference materials reserved only for the purpose of calibration checks.

5.6.4.4 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials. Standards and reference materials are stored separately from samples, extracts, and digestates. All standards are stored according to the manufacturer's recommended conditions. Temperatures colder than the manufacturer's recommendation are acceptable if it does not compromise the integrity of the material (e.g. remains in liquid state and does not freeze solid). In the event a standard is made from more than a single source with different storage conditions, the standard will be stored according to the conditions specified in the analytical method.

See the applicable analytical SOPs for specific reference material storage and transport protocols.

5.7 Sampling

Sampling refers to the field collection of samples for analytical testing.

Subsampling refers to a measured portion of sample used for analysis. Procedures are included SOP ENV-SOP-IND1-0028 *Sample Homogenization, Subsampling, and Compositing* to assure the portion used for testing is representative of the field collected sample.

The requirements in the following subsections apply when field sampling is performed by the laboratory.

5.7.1 Sampling Plans and SOPs

When the laboratory performs field collection of samples, sampling is carried out in accordance with a written sample plan prepared by the customer or by the laboratory and by relevant sampling SOPs. These documents are made readily accessible at the sampling location. Sampling plans and SOPs are, whenever reasonable, based on appropriate governing methods and addresses the factors to be controlled to ensure the validity of the analytical results.

5.7.2 Customer Requested Deviations

When the customer requires deviations, additions, or exclusions from the documented laboratory sampling plan and/or procedure, the laboratory records the client's change request in detail with the sampling record, communicates the change to sampling personnel, and may include this information in the final test report.

5.7.3 Recordkeeping

The laboratory assures the sampling record includes the sampling procedure used, any deviations from the procedure, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), and the sampling location.

5.8 Sample Management & Handling

5.8.1 Procedures

The laboratory's procedures for sample management and handling are outlined in laboratory SOP ENV-SOP-IND1-0001 *Sample Management.*

The procedures in this SOP are established to maintain the safe handling and integrity of samples from receipt, transport, storage, to disposal and during all processing steps in-between; to maintain client confidentiality, and to protect the interests of PAS and its customers.

5.8.1.1 Chain of Custody

All samples received by the laboratory must be accompanied with a Chain of Custody (COC) record. The COC provides information about the samples collected and submitted for testing and it documents the possession of samples from time of collection to receipt by the laboratory.

The COC record must minimally include the following information:

- Client name, address, phone number
- Project Reference
- Client Sample Identification (Client ID)
- Date, Time, and Location of Sampling
- Samplers Name or Initials
- Matrix of samples
- Type of container, and total number of containers collected for each sample
- Preservatives, if applicable
- Analyses Requested
- Any special instructions
- The date, time, and signature documenting each sample transfer from the time of collection to receipt in the laboratory. When the COC is transported inside the cooler, independent couriers do not sign the COC. Shipping manifests and/or air bills are the records of possession during transport.

A complete and legible COC is required. If the laboratory observes that the COC is incomplete or illegible, the client is contacted for resolution. The COC must be filled out in indelible ink. Personnel correct errors by drawing a single line through the original entry so the entry is not obscured, entering the correct information, and initialing and dating the change.

5.8.1.2 Legal Chain of Custody

Legal chain of custody is a chain of custody protocol used for evidentiary or legal purposes. The protocol is followed by the laboratory when requested by customer or where mandated by a regulatory program.

Legal chain of custody (COC) protocol establishes an intact, continuous record of the physical possession*, storage, and disposal of "samples" which includes sample aliquots and sample extracts/digestates/distillates.

Legal COC records account for all time periods associated with the samples, and identify all individuals who physically handled individual samples. Legal COC begins at the point established by legal authority, which is usually at the time the sample containers are provided by the laboratory for sample collection or when sample collection begins.

*A sample is in someone's custody if:

- It is in one's physical possession;
- It is in one's view after being in one's physical possession;
- It has been in one's physical possession and then locked or sealed so that no one can tamper with it; and/or

- It is kept in a secure area, restricted to authorized personnel only.

Refer to laboratory SOP ENV-SOP-IND1-0051 *Internal Chain-of-Custody* for more information.

5.8.2 Unique Identification

Each sample is assigned a unique identification number by the laboratory (Lab ID) after the sample has been checked and accepted by the laboratory in accordance with the laboratory's sample acceptance policy (See 5.8.3). The Lab ID is affixed to the sample container using a durable label.

The unique identification of samples also applies to subsamples, and prepared samples, such as extracts, digestates, etc.

The lab ID is linked to the field ID (client ID) in the laboratory's record. Both IDs are linked to the testing activities performed on the sample and the documentation records of the test.

For additional information, see 5.8.4.

5.8.3 Sample Receipt Checks and Sample Acceptance Policy

The laboratory checks the condition and integrity of samples at the time of receipt and compares the labels on the sample containers to the COC record. Any problem or discrepancy is recorded. If the problem impacts the suitability of the sample for analysis or if the documentation is incomplete, the client is notified for resolution. Decisions and instructions from the client are documented in the project record.

5.8.3.1 Sample Receipt Checks

The following checks are performed:

- Verification that the COC is complete and legible.
- Verification that each sample's container label includes the client sample ID, the date and time of collection and the preservative, if applicable, in indelible ink.
- The container type and preservative, if applicable, is appropriate for each test requested.
- Adequate volume is received for each test requested.
- Visual inspection for damage or evidence of tampering.
- Visual inspection for presence of headspace in VOA vials. (VOA = volatile organic analysis).
- Thermal Preservation: For chemical testing methods for which thermal preservation is required, temperature on receipt is acceptable if the measurement is above freezing but $\leq$6°C. For samples that are hand-delivered to the laboratory immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. The requirements for thermal preservation vary based on the scope of testing performed. For example, for microbiology, temperature on receipt is acceptable if the measurement is <10°C. Refer to the laboratory's SOP for sample receipt for more information.

- Chemical Preservation, if applicable
- Holding Time: Sample receiving personnel are trained to recognize tests with holding time ≤48 hours and to expedite the login of these samples. When samples are received out of hold, the laboratory will notify the client and request instruction. If the decision is made to proceed with analysis, the final test report will include documentation of this instruction. Samples that include tests with a holding time of 15 minutes or less from collection are processed without client approval and final test report is qualified.

5.8.3.2 Sample Acceptance Policy

The laboratory maintains a sample acceptance policy in accordance with regulatory guidelines to clearly establish the circumstances in which sample receipt is accepted or rejected. When receipt does not meet acceptance criteria for any one of these conditions, the laboratory must document the noncompliance, contact the customer, and either reject the samples or fully document any decisions to proceed with testing. In accordance with regulatory specifications, receipt conditions that do not meet criteria are documented in the final test report.

All samples received must meet each of the following:

- Be listed on a complete and legible COC.
- Be received in properly labeled sample containers.
- Be received in appropriate containers that identify preservative, if applicable.
- The COC must include the date and time of collection for each sample.
- The COC must include the test requested for each sample.
- Be received within holding time. Any samples received beyond the holding time will not be processed without prior customer approval. An exception to this policy is made for tests with a 15 minute holding time, such as pH, residual chlorine, and ferrous iron. Those tests are performed without customer approval and the data is qualified.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges (not frozen but ≤6°C) unless program requirements or customer contractual obligations mandate otherwise. The cooler temperature is recorded directly on the COC. For samples that are hand-delivered to the laboratory immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time.

5.8.4 Sample Control and Tracking

The samples are controlled and tracked using the Laboratory Information Management System (LIMS). The LIMS stores information about the samples and the project. The process of entering information into the LIMS is called login and these procedures are described in laboratory SOP ENV-SOP-IND1-0001 *Sample Management*. After login, a label is generated and affixed to each sample container. Information on this label, such as the lab ID, links the sample container to the information in LIMS.

At a minimum, the following information is entered during login:

- Client Name and Contact Information;
- The laboratory ID linked to the client ID;
- Date and time of sample collection;
- Date and time of sample receipt;
- Matrix of sample;
- Tests Requested.

5.8.5 Sample Storage, Handling, and Disposal

The laboratory procedures for sample storage, handling and disposal are detailed in laboratory SOPs ENV-SOP-IND1-0001 *Sample Management* and ENV-SOP-IND1-0004 *Waste Handling and Management*.

5.8.5.1 Sample Storage

The samples are stored according to method and regulatory requirements as per test method SOPs. Samples are stored away from all standards, reagents, or other potential sources of contamination and stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

Refrigerated storage areas are maintained at ≤6°C (but not frozen) and freezer storage areas are maintained at <-10°C (unless otherwise required per method or program). The temperature of each storage area is checked and documented at least once each day of use. If the temperature falls outside the acceptable limits, then corrective actions are taken and appropriately documented.

The laboratory is operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times. Samples are taken to the appropriate storage location immediately after sample receipt and login procedures are completed. All sample storage areas have limited access. Samples are removed from storage areas by designated personnel and returned to the storage areas as soon as possible after the required sample quantity has been taken.

5.8.5.2 Sample Retention and Disposal

The procedures used by the laboratory for sample retention and disposal are detailed in laboratory SOP ENV-SOP-IND1-0004 *Waste Handling and Management.*

In general, unused sample volume and prepared samples such as extracts, digestates, distillates and leachates are retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

Samples may be stored at ambient temperature when all analyses are complete, the hold time is expired, the report has been delivered, and/or when allowed by the customer or program. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity to store them refrigerated or frozen and their presence does not compromise the integrity of other samples.

After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer.

5.9 Assuring the Quality of Test Results

5.9.1 Quality Control (QC) Procedures

The laboratory monitors the validity and reliability of test results using quality control (QC) samples that are prepared and analyzed concurrently with field samples in the same manner as field samples. See the glossary for definition of preparation and analytical batch.

The results of QC performed during the testing process are used by the laboratory to assure the results of analysis are consistent, comparable, accurate, and/or precise within a specified limit. When the results are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken. These actions may include retesting samples or reporting data with qualification to alert the end user of the situation.

Other QC measures performed include the use of certified reference materials (see 5.6.4), participation in interlaboratory proficiency testing (see 5.9.1.2), verification that formulae used for reduction of data and calculation of results is accurate (see 5.9.3), on-going monitoring of environmental conditions that could impact test results (see 5.3.2), and evaluation and verification of method selectivity and sensitivity (see 5.4.5).

QC results are also used by the laboratory to monitor statistical trends in performance over time and to establish acceptance criteria when no method or regulatory criteria exist (see 5.9.1.4).

5.9.1.1 Essential QC

Although the general principles of QC for the testing process apply to all testing, the QC protocol used for each test depends on the type of test performed.

QC protocol used by the laboratory to monitor the validity of the test are specified in test method SOPs. The SOP includes QC type, frequency, acceptance criteria, corrective actions, and procedures for reporting of nonconforming work.

These requirements in the SOP conform to the reference method and any applicable regulations or certification and accreditation program requirement for which results of the test are used. When a project requires more stringent QC protocol than specified in the SOP, project specification is followed.

The following are examples of essential QC for Chemistry:

5.9.1.1.1 Second-Source Standard (ICV/QCS)

The second-source standard is obtained from a different vendor than the standards used for calibration or is a different standard lot from the same vendor. It is a positive control used to verify the accuracy of a new calibration. This check is referred to in test method and quality system standards as the Initial Calibration Verification (ICV) or Quality Control Sample (QCS). The second source standard is analyzed immediately after the calibration and before analysis of any samples. When the ICV is not within acceptance criteria, a problem with the purity or preparation of the standards may be indicated.

5.9.1.1.2 Continuing Calibration Verification (CCV)

CCV is analyzed to determine if the analytical response has significantly changed since initial calibration. If the response of the CCV is within criteria, the initial calibration is considered valid. If not, there is a problem that requires further investigation. Actions taken are technology and method specific.

5.9.1.1.3 Method Blank (MB) / Other Blanks

A method blank is a negative control used to assess for contamination during the prep/analysis process. The MB consists of a clean matrix, similar to the associated samples, that is known to be free of analytes of interest. The MB is processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure.

In general, contamination is suspected when the target analyte is detected in the MB above the reporting limit. Some programs may require evaluation of the MB to ½ the reporting limit or to the detection limit (LOD). When contamination is evident, the source is investigated and corrections are taken to reduce or eliminate it. Analytical results associated with a MB that does not meet criteria are qualified in the final test report when applicable.

Other types of blanks that serve as negative controls in the process may include:

- Trip Blanks (VOA)
- Storage Blanks
- Equipment Blanks
- Field Blanks

- Calibration Blanks
- Cleanup Blanks
- Instrument Blanks

5.9.1.1.4 Laboratory Control Sample (LCS)

The LCS is positive control used to evaluate the performance of the total analytical system, including all preparation and analytical steps. The LCS is spiked by the laboratory with a known amount of analyte. The spike is a standard solution that is pre-made or prepared from a certified reference standard.

When the percent recovery (%R) of the LCS is within the established control limit, sufficient accuracy has been achieved. If not, the source of the problem is investigated and corrected and the procedure may be repeated. Analytical results associated with LCS that does not meet criteria are qualified in the final test report when applicable.

5.9.1.1.5 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

Matrix spikes measure the effect the sample matrix has on precision and accuracy of the determinative test method. The MS and MSD are replicates of a client sample that are spiked with a known amount of target analyte.

Due to the heterogeneity of matrices even of the same general matrix type, matrix spike results mostly provide information on the effect of the matrix to the client whose sample was used and on samples of the same matrix from the same sampling site. Therefore, MS should be client-specific when the impact of matrix on accuracy and precision is a project data quality objective. When there is not a client-specified MS for any sample in the batch, the laboratory randomly selects a sample from the batch; the sample selected at random is called a "batch" matrix spike.

The MS/MSD results for percent recovery and relative percent difference are checked against control limits. Because the performance of matrix spikes is matrix-dependent, the result of the matrix spike is not used to determine the acceptability of the test batch.

5.9.1.1.6 Sample Duplicate (SD)

A sample duplicate is a second replicate of sample that is prepared and analyzed in the laboratory along another replicate. The SD is used to measure precision.

The relative percent difference between replicates is evaluated against the method or laboratory derived criteria for relative percent difference (RPD), when this criterion is applicable. If RPD is not met, associated test results are reported with qualification.

5.9.1.1.7 Surrogates

Surrogates, when required, are compounds that mimic the chemistry of target analytes but are not expected to occur naturally in real world samples. Surrogates are added to each sample and matrix QC samples (MS, MSD, SD) at known concentration to measure the impact of the matrix on the accuracy of method performance. Surrogates are also added to the positive and negative control samples (MB, LCS) to evaluate performance in a clean matrix, and included in the calibration standards and calibration check standards.

The percent recovery of surrogates is evaluated against method-specified limits or statistically derived in-house limits. Project-specific limits and/or program-specific limits are used when required. Results with surrogate recovery out of limits in samples are reported with qualification. Samples with surrogate failures can also be re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error.

5.9.1.1.8 Internal Standards

Internal Standards are compounds not expected to occur naturally in field samples. They are added to every standard and sample at a known concentration prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. The laboratory follows specific guidelines for the treatment of internal standard recoveries and further information can be found in the applicable laboratory SOP.

5.9.1.1.9 QC Acceptance Criteria and Control Limits

The QC acceptance criteria are specified in test method SOPs. The criteria in the SOP are based on the requirements in the published test method or regulatory program. When there are no established acceptance criteria, the laboratory develops acceptance criteria in accordance with recognized industry standards.

Some methods and programs require the laboratory to develop and use control limits for LCS, MS/MSD and surrogate evaluation. Laboratory-developed limits are referred to as "in-house" control limits or statistical control limits. Statistical control limits represent ± 3 Standard Deviations (99% confidence level) from the average recovery of at least 20 data points generated using the same preparation and analytical procedure in a similar matrix.

See laboratory SOP ENV-SOP-IND1-0039 *Control Chart Generation* for more information.

5.9.1.2 Proficiency Testing (PT)

The laboratory participates in proficiency testing (PT) studies to measure performance of the test method and to identify or solve analytical problems. PT samples measure laboratory performance through the analysis of unknown samples provided by an external source.

The PT samples are obtained from accredited proficiency testing providers (PTP) and handled as field samples which means they are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results during the duration of the study, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

The laboratory initiates an investigation and corrective action plan whenever PT results are deemed unacceptable by the PT provider.

The frequency of PT participation is based on the certification and accreditation requirements held by the laboratory.

5.9.2 QC Corrective Action

When the results of QC are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken per the specifications in the test method SOP. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

5.9.3 Data Review

The laboratory uses a tiered system for data review. The tiered process provides sequential checks to verify data transfer is complete; manual calculations, if performed, are correct, manual integrations are appropriate and documented, calibration and QC requirements are met, appropriate corrective action was taken when required, test results are properly qualified, process and test method SOPs were followed, project specific requirements were met, when applicable, and the test report is complete.

The sequential process includes three tiers referred to as primary review, secondary review, and administrative/completeness review.

Detailed procedures for the data review process are described in laboratory SOP ENV-SOP-IND1-0023 *Data Review Process*. The general expectations for the tiered review process are described in the following sections:

5.9.3.1 Primary Review

Primary review is performed by the individual that performed the analytical testing. All laboratory personnel are responsible for review of their work product to assure it is complete, accurate, documented, and consistent with policy and SOPs.

Checks performed during primary review include but are not limited to:

- Verification that data transfer and acquisition is complete

- Manual calculations, if performed, are documented and accurate
- Manual integrations, if performed, are documented and comply with SOP ENV-SOP-CORQ-006 *Manual Integration*
- Calibration and QC criteria were met, and/or proper correction and corrective actions were taken, and data and test results associated with QC and criteria exceptions are properly qualified
- Work is consistent with SOPs and any other relevant instructional document such as SWI, program requirements, or project QAPP

5.9.3.2 Secondary Review

Secondary review is performed by qualified peer or supervisor. Secondary review is essentially a repeat of the checks performed during primary review by another person. In addition to the checks of primary review, secondary review includes chromatography review to check the accuracy of analyte identification.

5.9.3.3 Completeness Review

Completeness review is an administrative review performed prior to release of the test report to the customer. Completeness review verifies that the final test report is complete and meets project specification. This review also assures that information necessary for the client's interpretation of results are explained in the case narrative, if applicable, or qualified in the test report.

5.9.3.4 Data Audits

In addition to the 3 tier data review process, test reports may be audited by local QA to verify compliance with SOPs and to check for data integrity, technical accuracy, and regulatory compliance. These audits are not usually done prior to issuance of the test report to the customer. The reports chosen for the data audits are selected at random.

If any problems with the data or test results are found during the data audit, the impact of the nonconforming work is evaluated using the process described in Section 4.9.

Also see Section 4.14 for internal audits.

5.10 Reporting

5.10.1 General Requirements

The laboratory reports the results of testing in a way that assures the results are clear and unambiguous. All data and results are reviewed prior to reporting to assure the results reported are accurate and complete.

Test results are summarized in test reports that include all information necessary for the customer's interpretation of the test results. Additional information necessary to clarify the data or disclose nonconformance, exceptions, or deviations that occurred during the analytical process are also reported to the customer in the test report.

The specifications for test reports and electronic data deliverables (EDD) are established between the laboratory and the customer at the time the request for analytical services is initiated. The report specifications include the test report format, protocol for the reporting limit (RL) and conventions for the reporting of results less than the limit of quantitation (LOQ). Information about review of analytical service requests is provided in Section 4.4.

5.10.2 Test Reports: Required Items

Test Reports are prepared by the laboratory at the end of the testing process. The format of the report depends on the level of reporting requested by the customer. The laboratory offers a variety of standardized test report formats and can also provide custom test report formats, when necessary.

The level of detail required in the test report depends on the customer's needs for data verification, validation, and usability assessments that occur after the laboratory releases the test report to the customer. The test report formats offered by the laboratory provide gradient levels of detail to meet the unique needs of each customer. The laboratory project manager helps the customer select the test report format that best meets their needs. When a specific report format or protocol is required for regulatory or program compliance, the laboratory project manager must ensure the test report selected meets those requirements.

Every test report issued by the laboratory includes each of the following items:

a) Title

b) Name and phone number of a point of contact from the laboratory issuing the report.

c) Name and address of the laboratory where testing was performed. When testing is done at multiple locations within network (IRWO), the report must clearly identify which network laboratory performed each test and must include the physical address of each laboratory.

d) Unique identification of the test report, an identifier on each page of the report, and clear identification of the end of the report.

e) The name and address of the customer

f) Identification of test methods used

g) Cross reference between client sample identification number (Sample ID) and the laboratory's identification number for the sample (Lab ID) to provide unambiguous identification of samples.

h) The date of receipt of samples, condition of samples on receipt, and identification of any instance where receipt of the samples did not meet sample acceptance criteria.

i) Date and times of sample collection, receipt, preparation, and analysis.

j) Test results and units of measurement.

k) Qualifiers appended to results, when required.

l) Name, title, signature of the person(s) authorizing release of the test report and date of release.

m) A statement that the results in the test report relate only to the items tested.

n) Statement that the test report may not be reproduced except in full without written approval from the laboratory.

5.10.3 Test Reports: Supplemental Items

5.10.3.1 Supplemental Requirements

The following items are included in the test report when required or relevant:

a) Explanation of departure from test method SOPs including, what the departure was and why it was necessary.

b) Statistical methods used. (Required for Whole Effluent Toxicity)

c) For solid samples, specification that results are reported on a dry weight or wet weight basis.

d) Signed Affidavit, when required by client or regulatory agency.

e) A statement of compliance / non-compliance with requirements or specifications (client, program, or standard) that includes identification of test results that did not meet acceptance criteria.

f) When requested by the client, statement of estimated measurement uncertainty. In general, for environmental testing, estimated uncertainty of measurement is extrapolated from LCS control limits. Control limits incorporate the expected variation of the data derived from the laboratory's procedure. When the control limits are specified by the test method or regulatory program, the control limits represent the expected variation of the test method and/or matrices for which the test method was designed.

g) Opinions and Interpretations (See Section 5.10.5).

h) If a claim of accreditation/certification is included in the test report, identification of any test methods or analytes for which accreditation/certification is not held by the laboratory. The fields of accreditation/certification vary between agencies and it cannot be presumed that because accreditation/certification is not held that it is offered or required.

i) Certification Information, including certificate number and issuing body.

5.10.3.2 Test Reports: Sampling Information

The following items are included in the test report when samples are collected by the laboratory or when this information is necessary for the interpretation of test results:

a) Date of Sampling.

b) Unambiguous identification of material samples.

c) Location of sampling including and diagrams, sketches, or photographs.

d) Reference to the sampling plan and procedures used.

e) Details of environmental conditions at time of sample that may impact test results.

f) Any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

g) Results of field measurements, if requested.

5.10.4 Calibration Certificates

The laboratory does not perform calibration activities for its customers and calibration certificates are not offered or issued.

5.10.5 Opinions and Interpretations

The laboratory provides objective data and information to its customers of sufficient detail for their interpretation and decision making. Objective data and information is based solely on fact and does not attempt to explain the meaning (interpret) or offer a view or judgment (opinion). Sometimes the customer may request the laboratory provide opinion or interpretation to assist them with their decisions about the data.

When opinions and interpretations are included in the test report, the laboratory will document the basis upon which the opinions and interpretations have been made and clearly identify this content as opinion or interpretation in the test report.

Examples of opinion and interpretation include but are not limited to:

- The laboratory's viewpoint on how a nonconformance impacts the quality of the data or usability of results.
- The laboratory's judgment of fulfillment of contractual requirements.
- Recommendations for how the customer should use the test results and information.
- Suggestions or guidance to the customer for improvement.

When opinions or interpretations are verbally discussed with the customer, the content of these conversations is summarized by the laboratory and kept in the project record.

5.10.6 Subcontractor Reports

When analytical work has been subcontracted to an organization external to PAS, the test report from the subcontractor is included in its entirety as an amendment to the final test report.

Note: Test results for analytical work performed within the PAS network may be merged into a single test report. The merged test report issued clearly identifies the location and address of each network laboratory that performed testing and which tests they performed. (See 5.10.2)

5.10.7 Electronic Transmission of Results

When test results and/or reports are submitted to the customer through electronic transmission, the procedures established in this manual are followed for confidentiality and protection of data.

5.10.8 Format of Test Reports

The test formats offered by the laboratory are designed to accommodate each type of analytical test method carried out by the laboratory and to minimize the possibility of misunderstanding or misuse of analytical results. The format of electronic data deliverables (EDD) follows the specifications for the EDD.

5.10.9 Amendments to Test Reports

Test reports that are revised or amended by the laboratory after date of release of the final test report to the customer are issued as a new test report that is clearly identified as an amendment or revision and that includes a reference to the originally issued final test report.

Changes made to test results and data before the final test report is issued to the customer are not amendments or revisions, these are corrections to errors found during the laboratory's data verification and review process.

The laboratory's procedure for report amendments and revision are outlined in laboratory SOP ENV-SOP-IND1-0048 *Final Report and Data Deliverable Content.*

6.0 Revision History

This Version:

Section	Description of Change
All	This version is a complete rewrite of the document this version supersedes.

This document supersedes the following documents:

Document Number	Title	Version
ENV-MAN-CORQ-0001	Quality Assurance Manual	01

7.0 APPENDICES

7.1 Appendix A: Certification / Accreditation Listing

The certifications / accreditation lists provided in this manual represent those that were held by the named location on the effective date of this manual. This information is subject to change without notice and must not be considered valid proof of certification or accreditation status. Current certificates are maintained by Local QA and a copy of the certificate is posted to PAS's eDMS Portal for access by all PAS employees. External parties should contact the laboratory for the most current information.

7.1.1 PAS-Indianapolis and PAS-Grand Rapids

Indianapolis Laboratory Certifications			
Accrediting Authority	**Program Category**	**Accrediting Agency**	**Accreditation #**
Illinois (Secondary TNI)	Hazardous Waste	IL-EPA	200074
Illinois (Secondary TNI)	Non-Potable Water	IL-EPA	200074
Indiana	Drinking Water	IN-SDH	C-49-06
Kansas (Primary TNI)	Hazardous Waste	KS-DHE	E-10177
Kansas (Primary TNI)	Non-Potable Water	KS-DHE	E-10177
Kentucky	UST	KY-DEP	80226
Kentucky	Wastewater	KY-DEP	KY98019
Michigan	Drinking Water	MI-DEQ/EGLE	9050
Ohio	VAP-Hazardous Waste	OH-EPA	CL0065
Ohio	VAP-Non-Potable Water	OH-EPA	CL0065
Oklahoma	Non-Potable Water	OK-DEQ	9204
Oklahoma	Solids	OK-DEQ	9204
Texas (Secondary TNI)	Non-Potable Water	TX-CEQ	T104704355
Texas (Secondary TNI)	Solid Chemical Mat.	TX-CEQ	T104704355
USDA	Foreign Soil Permit	USDA	P330-19-00257
West Virginia	Hazardous Waste	WV-DEP	330
West Virginia	Non-Potable Water	WV-DEP	330
Wisconsin	Non-Potable Water	WI-DNR	999788130
Wisconsin	Potable Water	WI-DNR	999788130
Grand Rapids Laboratory Certifications			
Accrediting Authority	**Program Category**	**Accrediting Agency**	**Accreditation #**
Minnesota (Primary TNI)	Non-Potable Water	MDH	026-999-161
Michigan	Drinking Water	MI-EGLE	0034

7.2 Appendix B: Capability Listing

The capabilities listed in this Appendix were held by the location referenced on the effective date of this manual. This information is subject to change without notice. External parties should contact the laboratory for the most current information regarding laboratory capabilities and certifications.

Table Legend:

- DW = Drinking Water
- NPW = Non-Potable Water
- SCM = Solid and Chemical Materials
- Waste = Non-Aqueous Phase Liquid (NAPL), Oil

7.2.1 PAS-Indianapolis

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Specific Conductance	EPA 120.1/SM 2510B		x		
Mercury, Low-Level	EPA 1631E		x		
Oil and Grease, HEM/SGT-HEM	EPA 1664A		x		
Turbidity	EPA 180.1		x		
ICP Metals	EPA 200.7	x	x		
ICP Metals	SW 6010B		x	x	x
ICP-MS Metals	EPA 200.8	x	x		
ICP-MS Metals	SW 6020		x	x	x
Apparent Color	SM 2120B		x		
Acidity	SM 2310B		x		
Alkalinity	SM 2320B		x		
Hardness	SM 2340B		x		
Mercury	EPA 245.1	x	x		
Mercury	SW 7470A		x		
Mercury	SW 7471A			x	x
Total Solids	SM 2540B		x	x	x
Total Dissolved Solids	SM 2540C		x		
Total Suspended Solids	SM 2540D		x		
Total Volatile Solids	SM 2540E		x		
Settleable Solids	SM 2540F		x		
Percent Moisture/Percent Solids/Total Volatile Solids	SM 2540G			x	x
Anions	EPA 300.0	x	x		

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Anions	SW 9056A		x	x	
Cyanide	EPA 335.4	x	x		
Cyanide	SM 4500CN-E/SW 9012A		x	x	x
Cyanide, Amenable	EPA 335.4		x		
Cyanide, Amenable	SM 4500CN-G/SW 9012A		x	x	x
Cyanide, Free	SW 9014/OIA 1677		x	x	
Cyanide, Available	OIA 1677		x	x	
Hexavalent Chromium	SM 3500Cr-B		x		
Hexavalent Chromium	SW 7196A		x	x	x
Ferrous Iron	Hach 8146		x		
Ammonia	EPA 350.1/SM 4500NH3-G		x	x	
Total Kjeldahl Nitrogen	EPA 351.2		x	x	
Nitrogen, Nitrate/Nitrite	EPA 353.2	x	x	x	
Total Phosphorus	EPA 365.1		x	x	
Chemical Oxygen Demand (COD)	EPA 410.4		x		
Total Recoverable Phenolics	EPA 420.4/SW 9066		x	x	
Chloride	SM 4500Cl-E		x		
Residual Chlorine	SM 4500Cl-G		x		
Fluoride	SM 4500F-C		x		
pH	SM 4500H+-B		x		
pH	SW 9045C			x	x
Orthophosphate as P	SM 4500P-E		x		
Sulfide	SM 4500S2- D		x		
Sulfate	SW 9038/ASTM D516		x		
Biochemical Oxygen Demand (BOD)	SM 5210B		x		
Total Organic Carbon (TOC)	SM 5310C		x		
Anionic Surfactants (MBAS)	SM 5540C		x		
Volatile Organic Compounds (VOCs)	EPA 524.2	x			
Volatile Organic Compounds (VOCs)	EPA 624.1		x		
Volatile Organic Compounds (VOCs)	SW 8260C		x	x	x
Polynuclear Aromatic Hydrocarbons (PAHs)	SW 8270C SIM		x	x	
Semivolatile Organic Compounds (SVOCs)	EPA 625.1		x		

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Semivolatile Organic Compounds (SVOCs)	SW 8270C		x	x	x
Organochlorine Pesticides	EPA 608.3		x		
Organochlorine Pesticides	SW 8081B		x	x	x
Polychlorinated Biphenyls (PCBs)	EPA 608.3		x		
Polychlorinated Biphenyls (PCBs)	SW 8082A		x	x	x
EDB and DBCP	SW 8011		x		
Diesel Range Organics (DRO/ERO)	SW 8015D		x	x	
Gasoline Range Organics (GRO)	SW 8015D		x	x	
Alcohols and Glycols	SW 8015D		x	x	
Organophosphorus Pesticides	SW 8141B		x	x	
Chlorinated Herbicides	SW 8151A		x	x	
Flash Point	EPA 1010A			x	x
Toxicity Characteristic Leaching Procedure (TCLP)	SW 1311		x	x	x
Synthetic Precipitation Leaching Procedure (SPLP)	SW 1312		x	x	x
Free Liquids (Paint Filter Test)	SW 9095			x	x
Dissolved Gases	RSK 175		x		

7.2.2 PAS-Grand Rapids

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Apparent Color	SM 2120B		x		
Turbidity	SM 2130B		x		
Hexavalent Chromium	SM 3500Cr-B/SW 7196A		x		
Ferrous Iron	SM 3500Fe-B		x		
Nitrogen, Nitrate/Nitrite	SM 4500NO3-F	x	x		
Orthophosphate as P	SM 4500P-E		x		
Sulfite	SM 4500SO3-B		x		
Biochemical Oxygen Demand (BOD)	SM 5210B		x		
Carbon Dioxide	SM 4500CO2-C		x		
Fecal Coliform	SM 9222D	x	x		
Total Coliform	SM 9223B	x	x		
True Color	NCASI 71.01		x		

7.3 Appendix C: Glossary

This glossary provides common terms and definitions used in the laboratory. **It is not intended to be a complete list of all terms and definitions used.** The definitions have been compiled mostly from the TNI Standard and DoD QSM. Although this information has been reproduced with care, errors cannot be entirely excluded. Definitions for the same term also vary between sources. When the meaning of a term used in a laboratory document is different from this glossary or when the glossary does not include the term, the term and definition is included or defined in context in the laboratory document.

Term	Definition
3P Program	PAS-The continuous improvement program used by PAS that focuses on Process, Productivity, and Performance.
Acceptance Criteria	TNI- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. DoD- Refers to accreditation in accordance with the DoD ELAP.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program. DoD- Entities recognized in accordance with the DoD-ELAP that are required to operate in accordance with ISO/IEC 17011, *Conformity assessment: General requirements for accreditation bodies accrediting conformity assessment bodies.* The AB must be a signatory, in good standing, to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that its accredited laboratories comply with ISO/IEC 17025.
Accuracy	TNI- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Activity, Absolute	TNI- Rate of nuclear decay occurring in a body of material, equal to the number of nuclear disintegrations per unit time. NOTE: Activity (absolute) may be expressed in becquerels (Bq), curies (Ci), or disintegrations per minute (dpm), and multiples or submultiples of these units.
Activity, Areic	TNI- Quotient of the activity of a body of material and its associated area.
Activity, Massic	TNI- Quotient of the activity of a body of material and its mass; also called specific activity.
Activity, Volumic	TNI- Quotient of the activity of a body of material and its volume; also called activity concentration. NOTE: In this module [TNI Volume 1, Module 6], unless otherwise stated, references to activity shall include absolute activity, areic activity, massic activity, and volumic activity.
Activity Reference Date	TNI- The date (and time, as appropriate to the half-life of the radionuclide) to which a reported activity result is calculated. NOTE: The sample collection date is most frequently used as the Activity Reference Date for environmental measurements, but different programs may specify other points in time for correction of results for decay and ingrowth.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
American Society for Testing and Materials (ASTM)	An international standards organization that develops and publishes voluntary consensus standards for a wide range of materials, products, systems and services.
Analysis	DoD- A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI- The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analyte	TNI- A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Method	DoD- A formal process that identifies and quantifies the chemical components of interest (target analytes) in a sample.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Annual (or Annually)	Defined by PAS as every 12 months ± 30 days.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- An all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance conducted on-site.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.
Batch	TNI- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours or the time-frame specified by the regulatory program. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples.
Batch, Radiation Measurements (RMB)	TNI- An RMB is composed of 1 to 20 environmental samples that are counted directly without preliminary physical or chemical processing that affects the outcome of the test (e.g., non-destructive gamma spectrometry, alpha/beta counting of air filters, or swipes on gas proportional detectors). The samples in an RMB share similar physical and chemical parameter, and analytical configurations (e.g., analytes, geometry, calibration, and background corrections). The maximum time between the start of processing of the first and last in an RMB is 14 calendar days.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (See Method Blank). DoD- Blank samples are negative control samples, which typically include field blank samples (e.g., trip blank, equipment (rinsate) blank, and temperature blank) and laboratory blank samples (e.g., method blank, reagent blank, instrument blank, calibration blank, and storage blank).
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

Calibration	TNI- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of Custody Form (COC)	TNI- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures. DoD- Includes verification of the identity and quantity of the analyte being measured by another means (e.g., by another determinative method, technology, or column). Additional cleanup procedures alone are not considered confirmation techniques.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a Calibration Verification Standard (CVS) in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.

Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Continuous Improvement Plan (CIP)	The delineation of tasks for a given laboratory department or committee to achieve the goals of that department.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Critical Value	TNI- Value to which a measurement result is compared to make a detection decision (also known as critical level or decision level). NOTE: The Critical Value is designed to give a specified low probability α of false detection in an analyte-free sample, which implies that a result that exceeds the Critical Value, gives high confidence $(1 - \alpha)$ that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
Data Integrity	TNI- The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability (DOC)	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Department of Defense (DoD)	An executive branch department of the federal government of the United States charged with coordinating and supervising all agencies and functions of the government concerned directly with national security.
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.
Detection Limit (DL) for Safe Drinking Water Act (SDWA) Compliance	TNI- Laboratories that analyze drinking-water samples for SDWA compliance monitoring must use methods that provide sufficient detection capability to meet the detection limit requirements established in 40 CFR 141. The SDWA DL for radioactivity is defined in 40 CFR Part 141.25.c as the radionuclide concentration, which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).
Deuterated Monitoring Compounds (DMCs)	DoD- SIM specific surrogates as specified for GC/MS SIM analysis.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).

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Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the target analytes in the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.
Environmental Protection Agency (EPA)	An agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Extracted Internal Standard Analyte	Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and batch QC samples prior to the first step of sample extraction and to standards and instrument blanks prior to analysis. Used for isotope dilution methods.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and sPAS to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT)	TNI- Matrix, technology/method, analyte combinations for which the composition, spike concentration ranges and acceptance criteria have been established by the PTPEC.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement. DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard, ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure. DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract-specified or method-specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Incremental Sampling Method (ISM)	Soil preparation for large volume (1 kg or greater) samples.
In-Depth Data Monitoring	TNI- When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.

Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Injection Internal Standard Analyte	Isotopically labeled analogs of analytes of interest (or similar in physiochemical properties to the target analytes but with a distinct response) to be quantitated. Added to all blanks, standards, samples and batch QC after extraction and prior to analysis.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standard	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
International Organization for Standardization (ISO)	An international standard-setting body composed of representatives from various national standards organizations.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI- (also known as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	DoD- The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

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Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD/DOE projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	TNI- A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	DoD- Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement Quality Objective (MQO)	TNI- The analytical data requirements of the data quality objectives are project- or program-specific and can be quantitative or qualitative. MQOs are measurement performance criteria or objectives of the analytical process. Examples of quantitative MQOs include statements of required analyte detectability and the uncertainty of the analytical protocol at a specified radionuclide activity, such as the action level. Examples of qualitative MQOs include statements of the required specificity of the analytical protocol, e.g., the ability to analyze for the radionuclide of interest given the presence of interferences.
Measurement System	TNI- A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s). DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation and test and the operator(s).
Measurement Uncertainty	DoD- An estimate of the error in a measurement often stated as a range of values that contain the true value within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit (MDL)	TNI- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
Minimum Detectable Activity (MDA)	TNI- Estimate of the smallest true activity that ensures a specified high confidence, 1 – β, of detection above the Critical Value, and a low probability β of false negatives below the Critical Value. For radiometric methods, β is often set at 0.05. NOTE 1: The MDS is a measure of the detection capability of a measurement process and as such, it is an a priori concept. It may be used in the selection of methods to meet specified MQOs. Laboratories may also calculate a "sample specific" MDA, which indicates how well the measurement process is performing under varying real-world measurement conditions, when sample-specific characteristics (e.g., interferences) may affect the detection capability. However, the MDA must never be used instead of the Critical Value as a detection threshold. NOTE 2: For the purpose of this Standard, the terms MDA and minimum detectable concentration (MDC) are equivalent.
MintMiner	Program used by PAS to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Environmental Laboratory Accreditation Conference (NELAC)	See definition of The NELAC Institute (TNI).
National Institute of Occupational Safety and Health (NIOSH)	National institute charged with the provision of training, consultation and information in the area of occupational safety and health.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	DoD- A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Physical Parameter	TNI- A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical and biological components.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.

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Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI and DoD- Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis.
Primary Accreditation Body (Primary AB)	TNI- The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing (PT)	TNI- A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
Proficiency Testing Program (PT Program)	TNI- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Provider (PT Provider)	TNI- A person or organization accredited by a TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT Program.
Proficiency Testing Provider Accreditor (PTPA)	TNI- An organization that is approved by TNI to accredit and monitor the performance of proficiency testing providers.
Proficiency Testing Reporting Limit (PTRL)	TNI- A statistically derived value that represents the lowest acceptable concentration for an analyte in a PT sample, if the analyte is spiked into the PT sample. The PTRLs are specified in the TNI FoPT tables.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory, and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Proficiency Testing (PT) Study	TNI- a) Scheduled PT Study: A single complete sequence of circulation and scoring of PT samples to all participants in a PT program. The study must have the same pre-defined opening and closing dates for all participants; b) Supplemental PT Study: A PT sample that may be from a lot previously released by a PT Provider that meets the requirements for supplemental PT samples given in Volume 3 of this Standard [TNI] but that does not have a pre-determined opening date and closing date.
Proficiency Testing Study Closing Date	TNI- a) Scheduled PT Study: The calendar date by which all participating laboratories must submit analytical results for a PT sample to a PT Provider; b) Supplemental PT Study: The calendar date a laboratory submits the results for a PT sample to the PT Provider.
Proficiency Testing Study Opening Date	TNI- a) Scheduled PT Study: The calendar date that a PT sample is first made available to all participants of the study by a PT Provider; b) Supplemental PT Study: The calendar date the PT Provider ships the sample to a laboratory.
Protocol	TNI- A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.
Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.

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Quality Manual	TNI- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	TNI and DoD- These matrix definitions shall be used for purposes of batch and quality control requirements and may be different from a field of accreditation matrix: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard used to relate instrument response to analyte concentration. The quantitation range (adjusted for initial sample volume/weight, concentration/dilution and final volume) lies within the calibration range.
Quantitative Analysis	DoD- Analysis designed to determine the amounts or proportions of the components of a substance.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Method	TNI- A published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a "standard method", that term is equivalent to "reference method"). When a laboratory is required to analyze by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is no regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.

Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (RLVS)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall" or "must".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Revocation	TNI- The total or partial withdrawal of a laboratory's accreditation by an accreditation body.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a chain-of-custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selected Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector. DoD- Using GC/MS, characteristic ions specific to target compounds are detected and used to quantify in applications where the normal full scan mass spectrometry results in excessive noise.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall (also Must)	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should (also May)	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio (S/N)	DoD- A measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

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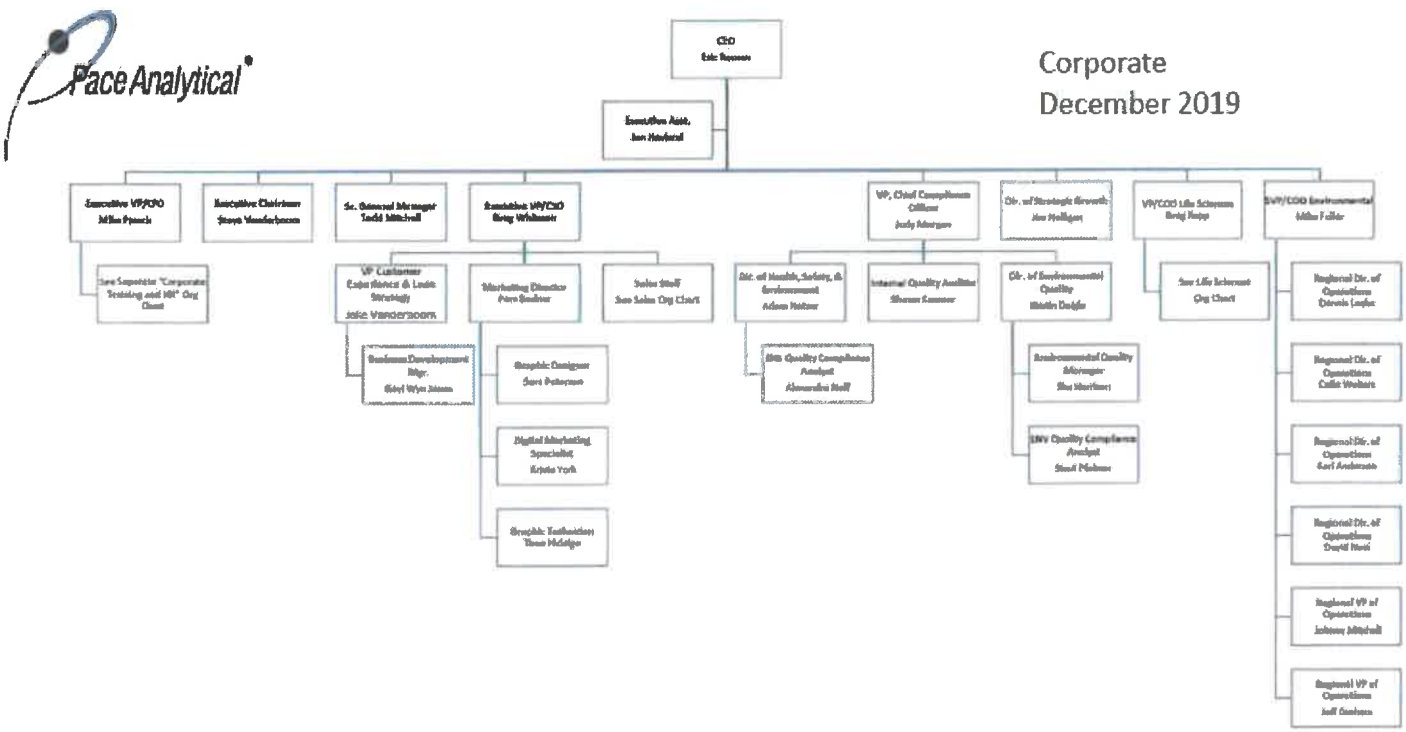
Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Suspension	TNI- The temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed 6 months or the period of accreditation, whichever is longer, in order to allow the laboratory time to correct deficiencies or area of non-conformance with the Standard.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern identified by the customer on a project-specific basis.
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Test Source	TNI- A radioactive source that is tested, such as a sample, calibration standard, or performance check source. A Test Source may also be free of radioactivity, such as a Test Source counted to determine the subtraction background, or a short-term background check.
The NELAC Institute (TNI)	A non-profit organization whose mission is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. Previously known as NELAC (National Environmental Laboratory Accreditation Conference).
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.

Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty, Counting	TNI- The component of Measurement Uncertainty attributable to the random nature of radioactive decay and radiation counting (often estimated as the square root of observed counts (MARLAP). Older references sometimes refer to this parameter as Error, Counting Error or Count Error (c.f., Total Uncertainty).
Uncertainty, Expanded	TNI- The product of the Standard Uncertainty and a coverage factor, k, which is chosen to produce an interval about the result that has a high probability of containing the value of the measurand (c.f., Standard Uncertainty). NOTE: Radiochemical results are generally reported in association with the Total Uncertainty. Either if these estimates of uncertainty can be reported as the Standard Uncertainty (one-sigma) or as an Expanded Uncertainty (k-sigma, where k > 1).
Uncertainty, Measurement	TNI- Parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand.
Uncertainty, Standard	TNI- An estimate of the Measurement Uncertainty expressed as a standard deviation (c.f., Expanded Uncertainty).
Uncertainty, Total	TNI- An estimate of the Measurement Uncertainty that accounts for contributions from all significant sources of uncertainty associated with the analytical preparation and measurement of a sample. Such estimates are also commonly referred to as Combined Standard Uncertainty or Total Propagated Uncertainty, and in some older references as the Total Propagated Error, among other similar items (c.f., Counting Uncertainty).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results where failed method or contractual requirements are made to appear acceptable.
United States Department of Agriculture (USDA)	A department of the federal government that provides leadership on food, agriculture, natural resources, rural development, nutrition and related issues based on public policy, the best available science, and effective management.
United States Geological Survey (USGS)	Program of the federal government that develops new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.
Unregulated Contaminant Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminants in drinking water.
Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	TNI- Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.
Voluntary Action Program (VAP)	A program of the Ohio EPA that gives individuals a way to investigate possible environmental contamination, clean it up if necessary and receive a promise from the State of Ohio that no more cleanup is needed.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

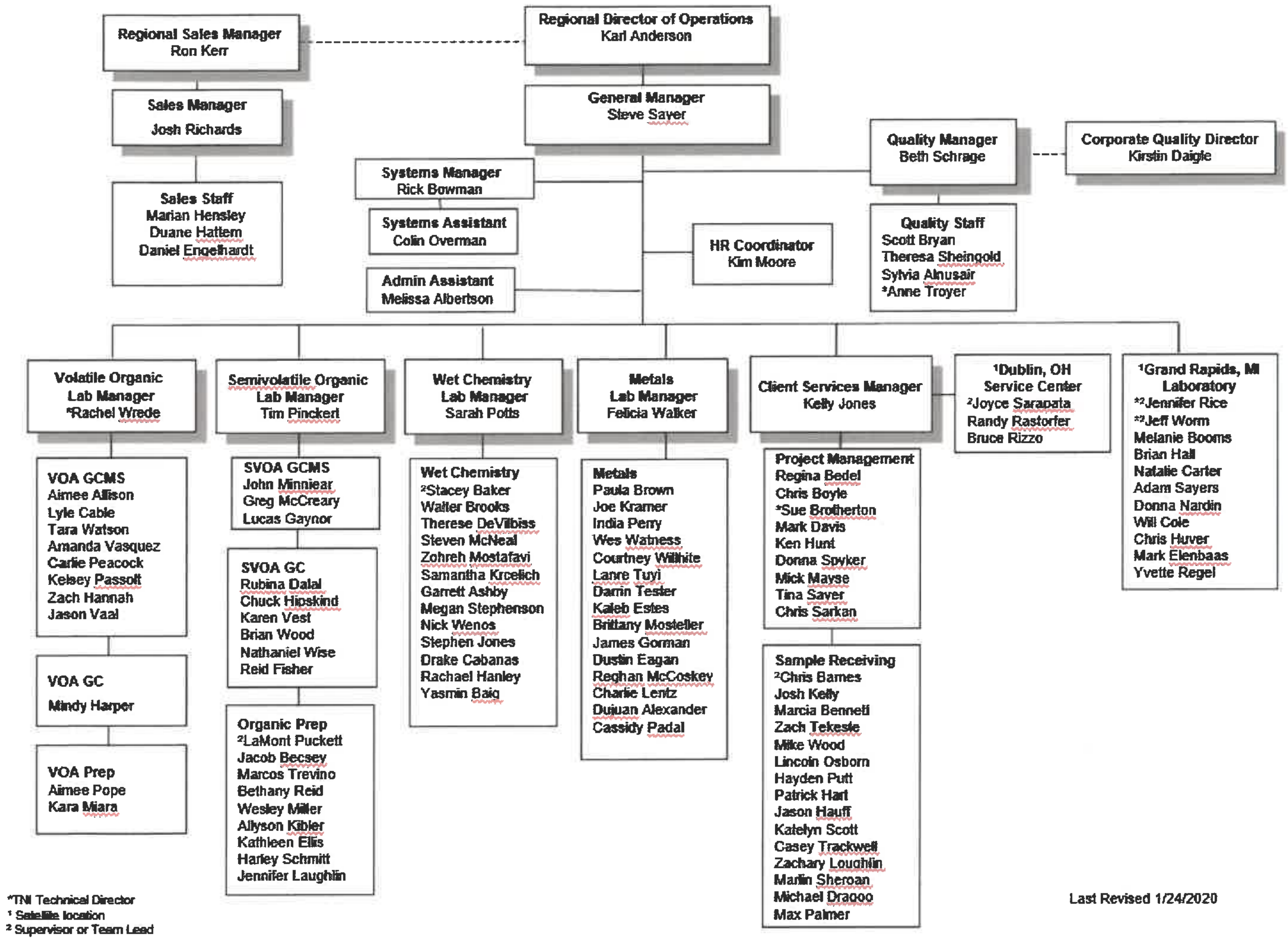
7.4 Appendix D: Organization Chart(s)

7.4.1 PAS-Corporate



7.4.2 PAS-Indianapolis/Grand Rapids/Dublin

PACE ANALYTICAL SERVICES - INDIANAPOLIS



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7.5 Appendix E: Equipment Listing

The equipment listed represents equipment held by each location on the effective date of this manual. This information is subject to change without notice. External parties should contact the location for the most current information.

7.5.1 PAS-Indianapolis and PAS-Grand Rapids

Pace Analytical - Indianapolis Equipment/Instrumentation List

INSTRUMENT	MANUFACTURER	MODEL NUMBER	DETECTOR	AUTOSAMPLER	SERVICE ANALYSIS	YEAR
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2003
GC/MS	Agilent	6890	MS 5973	Centurion	8260/624/524.2 VOC	2007
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2003
GC/MS	Agilent	6850N	MS 5975	Centurion	8260/624/524.2 VOC	2007
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2004
GC/MS	Agilent	6850N	MS 5975	Centurion	8260/624 VOC	2010
GC/MS	Agilent	6890	MS 5973	Archon	8260/624 VOC	2010
GC/MS	Agilent	6890N	MS 5975	Centurion	8260/624/524.2 VOC	2010
GC/MS	Hewlett-Packard	6890	MS 5973	7683	8270 PAH SIM	2000
GC/MS (2)	Agilent	7890	MS 5975	7683	8270/625 BNA	2008
GC/MS (2)	Agilent	6890	MS 5975	7683	8270 PAH SIM	2009
GC/MS (3)	Agilent	6890	MS 5973	7683	8270/625 BNA	2008
GC/MS	Agilent	7890	MS 5975	7683	8270 PAH SIM	2009
GC/MS (2)	Hewlett-Packard	5890	MS 5971	7673	Solvent Screen	2007
GC/MS	Agilent	7890B	MS 5977	7693	8270/PAH SIM	2017
GC/MS	Agilent	7890B	MS 5977	7693	8270/PAH SIM	2018
Gas Chromatograph	Agilent	6890	FID	7683	8015 Alcohols	2006
Gas Chromatograph	Hewlett-Packard	6890	FID	6890	8015 Glycols	2008
Gas Chromatograph	Agilent	7890A	FID	7693	8015 DRO/ERO	2009
Gas Chromatograph	Agilent	7890A	Dual ECD	7693	8082/608 PCBs/8011 EDB/DBCP	2009/2013
Gas Chromatograph	Hewlett-Packard	5890	FID	6890	Benzene	2006
Gas Chromatograph	Hewlett-Packard	5890	FID	8100	8015 GRO	2011
Gas Chromatograph	Hewlett-Packard	5890	FID	EST LGX50	RSK175 Dissolved gases	2006
Gas Chromatograph	Agilent	6890N	FID	Archon	8015 GRO	2008
Gas Chromatograph	Agilent	6890	Dual NPD	7683	Pesticides	2008
Gas Chromatograph (2)	Agilent	6890	Dual ECD	7683	PCBs	2008
Gas Chromatograph	Hewlett-Packard	6890	Dual ECD	7683	Herbicides	2008
Gas Chromatograph	Agilent	7890	Dual ECD	7693	Pesticides	2010
Microwave Extractors (2)	CEM	230/60	n/a	n/a	soil extraction	2008/2011
Spe-Dex	Horizon	4790	n/a	n/a	1664A Oil & Grease	2008
Trace ICP (2)	Thermo Scientific	ICAP 6500	n/a	ASX520	6010/200.7 Metals	2008/2011
Trace ICP	Thermo Scientific	ICAP 6500	n/a	ESI SC-4 FAST	6010/200.7 Metals	2011
ICP/MS	Agilent	7700	n/a	ASX520	6020/200.8 Metals	2012
ICP/MS	Agilent	7800	n/a	ASX520	6020/200.8 Metals	2018
Mercury Analyzer	CETAC	M-6100	n/a	ASX520	7470/7471/245 Mercury	2012/2010
Mercury Analyzer	Teledyne Leeman	M-7600	n/a	ASX520	7470/7471/245 Mercury	2016
Low-Level Mercury Analyzer (2)	CETAC	M-8000	n/a	ASX520/ASX560	Low-Level Mercury	2015/2018
Auto Analyzer (2)	Lachat	Quick Chem	n/a	n/a	NO3,Cl,Phenol, NH3,TKN	2010/2012
Titrosampler	Metrohm	855	n/a	n/a	Alkalinity, Acidity	2014
Automated Flash Point	Tanaka	APM-8	n/a	n/a	flash point	2010
Spectrophotometer	Hach	DR5000	n/a	n/a	Sulfate,Cr6+,Fe2+, PO4	2007
Spectrophotometer	Thermo	AquaMatePlus	n/a	n/a	Surfactants, COD	2005
Turbidimeter	Hach	2100P	n/a	n/a	Turbidity	2006
pH/ISE Meter (2)	Accumet	AR25/XL25	n/a	n/a	pH, Fluoride, Redox	2003/2010
pH/ISE Meter	Thermo Orion Star	A214	n/a	n/a	pH, Fluoride, Redox	2013
Conductivity Meter	Oakton	CON 700	n/a	n/a	Conductivity	2016
Dissolved Oxygen/pH Meter	Hach	HQ440d	n/a	n/a	BOD, cBOD	2014
BOD Analyzer	Thermo	AutoEz	n/a	n/a	BOD, cBOD	2013
TOC Analyzer	Shimadzu	TOC-Vwp	n/a	n/a	TOC, DOC	2008
Discrete Analyzer	Smart Chem	200	n/a	n/a	Cyanide, Phosphorus	2006
Flow Analyzer	OIA	FS3100	n/a	n/a	Free and Available Cyanide	2018
Ion Chromatograph	Dionex	ICS2100	n/a	AS-AP	Cl-, F-, SO4-, Br-, NO3/NO2	2013
Ion Chromatograph (3)	Dionex	AQUION	n/a	AS-AP	Cl-, F-, SO4-, Br-, NO3/NO2	2019
Pace Analytical - Grand Rapids Equipment/Instrumentation List						
pH/ISE Meter (2)	Accumet	AB150	n/a	n/a	pH	2017
BOD Meter and Probe	Hach	HQ40d	n/a	n/a	BOD, cBOD	2017
FIA Analyzer	OIA	FS-3100	n/a	n/a	Nitrate and Nitrite	2017
Spectrophotometer	Shimadzu	UV-1800	n/a	n/a	Cr6+,Fe2+, PO4, Color	2017
Turbidimeter	Hach	2100N	n/a	n/a	Turbidity	2017

ATTACHMENT 2

APPLICABLE MDNR REGULATIONS IN 2008

MDNR Regulations

Title 10

Division 23 – Division of Geology and Land Survey

Chapter 3 – Well Construction Code

Date: 11/30/2001

Rules of

Department of Natural Resources

Division 23—Division of Geology and Land Survey
Chapter 3—Well Construction Code

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 23—Division of Geology and Land Survey
Chapter 3—Well Construction Code

Editor's Note: Forms that are mentioned in this chapter may be found following 10 CSR 23-6. Area maps mentioned in the rule may be found following 10 CSR 23-3.110.

10 CSR 23-3.010 Location of Wells

PURPOSE: This rule sets criteria as to the areas a well should be placed.

(1) A well shall be located consistent with the general layout and surrounding area giving due consideration of the size of the lot, contour of the land, the water table, soil deposits, rock formation, local groundwater conditions and other factors necessary to implement the basic policies that follow:

(A) A well shall be—

1. Located on a site which has good surface drainage and, if possible, at a higher elevation than possible sources of contamination. The top of the casing shall extend at least one foot (1') above the finished surface grade;

2. Located so that the well and its surrounding area can be kept in a sanitary condition and provide ready access for repairs, maintenance and inspection;

3. Adequately sized, designed and developed for the intended use;

4. Constructed so as to maintain existing natural protection against pollution of water-bearing formations and to exclude all known sources of contamination from the well including sources of contamination from adjacent property;

5. Located so that proper drainage in the vicinity of the well shall be provided so as to prevent the accumulation and ponding of surface water within ten feet (10') of the well; and

6. If at all possible, located in areas that do not flood. If no reasonable alternative site exists, wells may be constructed in floodplains provided special construction is included. The casing of the well shall terminate not less than two feet (2') above the maximum known floodwater elevation or when flooding is eminent, well vent must be sealed and well discontinued from operation until floodwater subsides.

(2) Lateral distances from Pollution or Contamination Sources.

(A) A well shall be at least—

1. Three hundred feet (300') from a storage area for commercial fertilizers or chemicals, landfill, lagoon, above ground or underground storage, tank distribution lines for liquid petroleum, petroleum products or chemicals. Petroleum or petroleum products that are not liquid at standard temperatures and pressure are exempt from these set-back requirements;

2. Three hundred feet (300') from earthen, concrete or other manure storage structures or lagoons, from land application areas for domestic or animal waste and from animal composting facilities except as stated in paragraph (2)(A)4. of this rule;

3. One hundred feet (100') from cesspools and unplugged abandoned wells, except as noted in paragraph (2)(A)6. of this rule;

4. One hundred feet (100') from a subsurface disposal field, grave, single family lagoon, building or yard used for livestock or poultry, bird composting facility constructed with a concrete floor cell design covered with a roof, dry litter storage within a poultry building as accumulation of litter occurs during normal facility operations, privy or other contaminants that may drain into the soil;

5. Fifty feet (50') from a buried sewer, septic tank or sewer holding tank, a pit or unfilled space below ground surface, a sump, an existing operating well, except that a well may be drilled closer than fifty feet (50') to a basement and an above ground petroleum storage tank if it is necessary for the operation of the well pump;

6. Wells with casings less than eighty feet (80') in depth and not encountering at least ten feet (10') of impervious material shall be located at least one hundred fifty feet (150') from cesspools and unplugged abandoned wells and at least one hundred fifty feet (150') from a subsurface disposal field, and septic tank, manure storage pile or similar source of contamination. For example, a manure storage pile would be considered as a potential source of contamination to the well; however, the presence of animals in open pasture in an area would not necessarily concentrate contaminants to the degree that would cause contaminants to enter the groundwater; and

7. Ten feet (10') from the right-of-way of any federal, state or county road.

(B) Waste landfill or lagoons. The safe distance that a well should be located from a waste landfill or waste stabilization ponds (lagoon) cannot be assigned a fixed number because of the varieties of hydrologic and geologic parameters associated with the undetermined types and amounts of materials that may be carried by groundwater from leachates discharged from the waste landfill or waste stabilization ponds (lagoon). It is recommended that wells not be located in an area between the landfill or waste stabilization ponds (lagoons) sites and the point of groundwater discharge to a surface water source. Any well that may intercept leachates from a waste landfill or waste stabilization pond (lagoon) by water withdrawal from the well shall not be used for human consumption and must be plugged unless it is used for a monitoring well.

(C) Irrigation wells require increased setbacks and shall be at least two hundred feet (200') from—

1. Sewer lines, septic tanks, lateral fields, pit privy, seepage pits, feed lots, barnyards, fuel, fertilizer and pesticide storage. Fuel, fertilizer and pesticide tanks up to one thousand gallons (1000 gals.) in capacity will be allowed at well while irrigating and chemigating but must be removed from well site when not is use; and

2. Any well producing potable water.

AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.020 General Protection of Groundwater Quality and Resources

PURPOSE: This rule is for the overall protection of water quality and resources in Missouri.

(1) Reuse of Water, Disposal, Recharge or Gas Storage Wells.

(A) A well for the storage of gas or liquid under pressure may not be drilled without first having secured a permit from the Department of Natural Resources in accordance with the Missouri Statutes.

(B) Water used for cooling parts of engines, air compressors or other equipment shall not be returned to any part of the groundwater system. A well shall not be used for disposal or injection of any substance, including surface water, groundwater or any liquid, gas or chemical associated with the drilling of an oil or gas well, including coal bed methane wells, without first receiving a permit from the Underground Injection

Control Program's rules and 10 CSR 50-2, Oil and Gas Council, Oil and Gas Drilling and Production. A permit through the Division of Environmental Quality, Water Pollution Control Program may be required.

(C) A well previously used for storage of gas or liquid under pressure may not be converted to a well used for water supply.

(2) Maintenance and Repair of Wells.

(A) Every well shall be maintained by the owner in a condition where it will conserve and protect the groundwater resources and where it will not be a source or channel of contamination or pollution to the water supply of that well or any aquifer.

(B) All materials used in maintenance, replacement or repair of any well subject to these rules shall meet the requirement of these rules for new installation.

(C) Broken, punctured or otherwise defective or unserviceable casing, screens, fixtures, seals or any part of the wellhead shall be repaired or replaced. The well shall be plugged in accordance with the requirements of these rules if that repair or replacement is not performed.

(D) Repairs to wells originally completed with the wellhead terminating below ground (buried seal) should include extending the well casing one foot (1') above the finished surface grade. The casing extension material must be of similar material to the original casing (for example, steel to steel and plastic to plastic). On steel casing the joint must be welded, coupled or threaded. On plastic casing, the joint must be glued or fused. All joints and extensions must be sealed to prevent contamination from entering the groundwater. Sealing material must not be a contaminant such as tar. When this type of repair to a well is completed, it must not move at the joint under normal operating conditions. The use of devices specially designed to join dissimilar casing materials together will be considered on a case-by-case basis by the division. Approval must be received in advance.

(3) Cross connections between wells and other systems or equipment containing water or other substances of unknown or questionable safety, including pesticides and fertilizers, are prohibited, except where equipped with a suitable protective device such as a break tank or backflow preventer which is approved by the division and which the owner agrees to install, test and maintain to assure proper operation.

(4) All other wells except those specifically exempted by the law shall be constructed and maintained in accordance with standards from the division.

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.025 Public Water Supply—Notification to Division

PURPOSE: This rule establishes requirements regarding notification by a public water supplier to the division when a well is to be abandoned in order to connect a structure to a public water supply system.

(1) Public water supplier notification requirements concerning abandoned wells (as stated in section 256.628, RSMo).

(A) A public water supplier subject to the provisions of Chapter 640, RSMo which connects to any structure or location previously serviced by any well which is not that of another public water supplier shall notify the well owner of his/her obligation to plug any abandoned well pursuant to the requirements of section 256.628, RSMo. The public water supplier shall not connect any person to the public water system until the person submits information which identifies the location of wells and attests that—

1. Existing well will remain in use and will be properly plugged when no longer used;

2. Known abandoned wells on the property have been plugged;

3. There are no known abandoned wells on the property; or

4. Any abandoned wells will be plugged within ninety (90) days.

(B) The public water supplier shall submit a copy of information to the division within sixty (60) days of connection on forms provided by the division, along with sufficient information to enable the division to locate existing and abandoned wells. The division shall inspect, within a reasonable time, any well identified in paragraph (1)(A)4. of this rule. If the division determines that an abandoned well has not been plugged, it shall order the owner to have it plugged by a permitted well installation contractor or permitted pump installation contractor within thirty (30) days. The division shall immediately seek injunctive relief through the office of the prosecuting attorney of the county where the alleged violation occurred to enforce its order and shall notify the appropriate public water supplier who shall terminate water service to the property thirty (30) days after receipt of notice if the well has not been plugged. Any person who fails to plug an abandoned well pursuant to the provisions of this subsection shall be subject, upon conviction, to the penalties specified in section 256.637, RSMo.

AUTHORITY: sections 256.606 and 256.628, RSMo Supp. 1991. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995.*

**Original authority: 256.606, RSMo 1991 and 256.628, RSMo 1991.*

10 CSR 23-3.030 Standards for Construction of Wells

PURPOSE: This rule describes the minimum standards for a properly constructed well but does not apply to community or noncommunity public water supply wells. It is the obligation and responsibility of the driller to construct community and noncommunity wells following procedures set forth by the Missouri Public Drinking Water rules.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Casing for Permanent Wells. Steel well casing used for the outside casing must be new and shall be of at least six-inch (6") nominal size (6.625 outside diameter in inches, actual dimensions), thirteen pounds (13 lbs.) per foot, 0.188 wall thickness. Coated casings are permitted as long as they are not a source of contamination to the groundwater. Larger diameter casing shall have minimum weights and thicknesses as specified in

subsection (1)(G) of this rule. Concrete casing is permitted for use. Casing for permanent wells shall be of ferrous material, or where permitted by rule, plastic or concrete material. For ferrous pipe, the specifications and installation procedures are prescribed as follows. For plastic pipe, the specifications and installations procedures are prescribed in 10 CSR 23-3.070.

(A) Casing Joints. A protective well casing shall have watertight joints throughout its length. The joints shall be made by being continuously welded, threaded or other types of joints given written approval by the division. Tongue and groove type of joints are acceptable for concrete casings. Recessed or reamed and drifted couplings shall be used on threaded casing, or as an alternate, other couplings can be used but the design, taper and type of thread of the coupling shall match that of the pipe. Other casing design or materials shall be approved only by official written order of the division.

(B) Standard for Pipe. Pipe used as the casing in the permanent construction of a well shall be new pipe produced to recognized standards of the American Society for Testing and Materials, A53 grade A or B, A500 grade A or B, or A589 or other grade weldable new pipe having a quality equal to or greater than those specified. New pipe, when salvaged within thirty (30) days of the drilling of a well for water supply may be used as new pipe if still in new condition and must be decontaminated.

(C) Inside Casing Diameter. Under no condition shall the casing inside diameter be less than six inches (6") unless specifically exempted in 10 CSR 23-3 except for a driven well point or jetted well which shall be equipped with a casing pipe of at least one and one-fourth inches (1 1/4") inside diameter. The well shall also be of sufficient diameter to receive a pump or pumping apparatus of sufficient size to discharge the design capacity including anticipated decline in water levels.

(D) Vertical Extension. A well casing or its extension shall extend vertically at least one foot (1') above the finished surface grade. If the well is located in a floodplain see 10 CSR 23-3.010(1)(A)6. for requirements.

(E) A table of minimum specifications for steel casing for domestic, multifamily, high yield and unconsolidated material irrigation wells and bedrock irrigation wells follows: (A variance must be obtained in advance from the division to install casing not on this table.)

STEEL CASING TABLE

Domestic and Multi-Family Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.188	13 lbs.

High Yield and Bedrock Irrigation Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.280	19 lb.
8	8.625	.322	29 lb.
10	10.75	.365	40 lb.
12	12.75	.375	50 lb.
14	14.00	.375	55 lb.
16	16.00	.375	63 lb.
18	18.00	.375	71 lb.
20	20.00	.375	79 lb.
22	22.00	.500	115 lb.
24	24.00	.500	125 lb.
26	26.00	.500	136 lb.
28	28.00	.500	147 lb.
30	30.00	.500	158 lb.
32	32.00	.500	168 lb.
34	34.00	.500	179 lb.
36	36.00	.500	190 lb.

Unconsolidated Material Irrigation Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.188	13 lb.
8	8.625	.188	17 lb.
10	10.75	.188	21 lb.
12	12.75	.188	25 lb.
14	14.00	.188	28 lb.
16	16.00	.188	32 lb.

(2) Minimum Protective Depths of Well Casing. All wells shall be watertight to such depth as may be necessary to exclude contaminants. A well shall be constructed so as to seal off formations that are likely to pose a threat to the aquifer or human health. Requirements will be fulfilled to the minimum extent when the protective casing has been installed in conformity with the applicable construction set forth in 10 CSR 23-3.030–10 CSR 23-3.110. Sections (17)–(20) state the amount of grout needed to fill the minimum required amount of annular space in the different areas across Missouri. Where it is not feasible to follow the standards contained in this part, the permittee shall obtain approval of the division as to the design of the well before proceeding. The acceptability of the formation for well development shall be based on the satisfactory results of analysis of the water. Any water-bearing formation yielding water which is contaminated, as evidenced by the presence of chemicals or bacteria which may be harmful, shall be regarded as unsatisfactory for use as a potable supply unless adequate treatment is provided. The division will decide acceptable water treatment measures only after all well construction remedies have been exhausted.

(3) Grouting.

(A) Grouting Required for Wells. It is the obligation and responsibility of the well installation contractor to ensure that the annular space is sealed and that the casing does not leak. This obligation and responsibility ends three (3) years after the date of certification unless it can be shown that the well seal has been damaged by other persons. The following is a list of approved grouting methods:

1. Gravity installation method. The grout is poured into the annular space without the use of a tremie or grout pipe. Cement or bentonite slurry may never be poured through standing water without the use of a tremie pipe. The Gravity Grouting Table is a table which states the minimum requirements concerning the depth that grout can be gravity fed in wells that have an annulus from one inch to two inches (1"–2"). This table reflects the use of actual drill bit sizes and a six and five-eighths-inch (6 5/8") outside diameter casing. Nominal sizes may not be used when determining the annular space. Contact the division for instructions concerning grouting wells with larger than a two-inch (2") annulus. Note: When using plastic casing, a larger hole is recommended due to the belled casing ends reducing the annular space.

Gravity Grouting Table

Size Hole (inches)	Outside Diameter of Casing (inches)	Annular Space (inches)	Gravity Feed Depth (feet)
8 5/8	6 5/8	1	100
8 3/4	6 5/8	1 1/16	106
8 7/8	6 5/8	1 1/8	112
9	6 5/8	1 3/16	119
9 1/8	6 5/8	1 1/4	125
9 1/4	6 5/8	1 5/16	131
9 3/8	6 5/8	1 3/8	137
9 1/2	6 5/8	1 7/16	144
9 5/8	6 5/8	1 1/2	150
9 3/4	6 5/8	1 9/16	156
9 7/8	6 5/8	1 5/8	162
10	6 5/8	1 11/16	169
10 1/8	6 5/8	1 3/4	175
10 1/4	6 5/8	1 13/16	181
10 3/8	6 5/8	1 7/8	187
10 1/2	6 5/8	1 15/16	193
10 5/8	6 5/8	2	200

2. Tremie method. In this method the grout is placed in the annular space by gravity through a tremie or grout pipe suspended in the annular space. The tremie pipe is placed into the annulus and extends to within five feet (5') from the bottom of the interval to be grouted. The grout is added into the tremie pipe which should remain submerged in the grouting material during the entire time the grout is being placed. The tremie pipe is gradually withdrawn as the grouting material is placed or may be removed after the annular space is full and before the grout sets;

3. Pressure grouting through tremie method. For this method the same procedure is followed as described in the tremie method, except the grout is pumped into the tremie pipe instead of placed by gravity flow;

4. Pressure grouting through the casing method. Instead of using a tremie pipe placed in the annular space a grout pump is attached to the top of the casing and grout pumped through the casing and allowed to fill the annular space from the bottom. Pumping continues until grout reaches the surface of the annular space. Grout must be allowed to set up before drilling continues;

5. Open-hole method. Grout is poured into the drill hole from the surface and allowed to fill the drill hole to the required level. Note: Much more grout is required to fill the bottom thirty feet (30') of drill hole when using the open-hole method. See 10 CSR 23-3.030(17)–(20) for specific amounts. Then the casing is placed into the drill hole through the grouting material. This method may not be used if water is standing in the drill hole unless grout is placed by one (1) of the tremie grouting methods or if bentonite chips are used, they must be allowed to completely hydrate before the casing is pushed into the grout;

6. Positive displacement method. Casing is set into the borehole to a point about five feet (5') above the casing point. Grout is poured into the well casing followed by a drillable plug. This is designed to push all grout to the bottom of the well. If there is water in the borehole and bentonite or cement slurry is used it must be emplaced via a tremie to the bottom of the borehole. The plug is pushed to the bottom of the casing forcing the grout down the inside of the casing and up the annular space. The casing is then set into the bottom of the drill hole; and

7. Other grouting methods must be approved by the division in advance.

(4) Approved Grouting Methods.

(A) Neat Cement Grout. Neat cement grout is a mixture of one (1) bag, ninety-four pounds (94 lbs.) of Portland cement (ASTM C150) to not more than six (6) gallons of clean water. Bentonite, up to six percent (6%) by weight of cement to reduce shrinkage or other additives (ASTM C688) to reduce permeability or control time of set or both, may be used. If bentonite is used, additional water should be added to the mix.

(B) Bentonite Grout. Sodium bentonite (swelling clay) is available in many forms from granules to pellets to chips. When grouting annular spaces with nonslurry bentonite, great care must be exercised to ensure the bentonite is placed properly. Flash swelling may occur and bridge off the annular space preventing an adequate seal when using powdered, granular, tablets or pelletized bentonite. Therefore, only bentonite specifically designed to prevent flash hydration and to fall through standing water may be used. Chipped or pelletized bentonite may not be used in annular spaces less than one inch (1"). Bentonite must be applied slower than manufacturer's specifications. If there is no water in the annular space, the bentonite must be hydrated after each bag or water poured into the hole before application of the bentonite.

(C) Bentonite Slurry Grout. Sodium bentonite slurry grout is a bentonite/water mixture. There are many additives available that effect viscosity and set-up time. These additives are acceptable unless they are a potential contaminant. Bentonite slurry must have a solids content of at least twenty percent (20%).

(D) Other Grout Types. Other types of grout may be used when necessary if prior approval by the division is granted.

(5) Drill cuttings used by themselves or in conjunction with a drive shoe, packer or boot

are not approved materials for grouting the annulus of any well.

(6) Grouting required for Community and Noncommunity Public Water Supply Wells. It is the obligation and responsibility of the driller to follow procedures set forth by the Missouri public drinking water rules.

(7) Driven Casing Wells. The bottom of the steel well casing shall be equipped with a drive shoe or otherwise protected from damage during construction of the well as dictated by drilling procedures and conditions of each particular well (see 10 CSR 23-3.100(4)(D)3. for grouting techniques).

(8) Capping. Temporary capping of a well until the pumping equipment is installed shall allow no pollution or foreign objects to enter the well.

(9) Alignment. A well shall not vary from the vertical or alignment so as to interfere with installation and operation of the pump.

(10) Well Development. The well shall be developed to remove any material deposited on the aquifer face during the drilling, drilling fluid and the predetermined finer fraction of a gravel pack, all of which shall be done to ensure that the maximum practical specific capacity will be obtained from the completed well.

(11) For further construction requirements for domestic wells see 10 CSR 23-3.090 Regionalization and 10 CSR 23-3.100 Sensitive Areas.

(12) Multifamily wells are water supply wells constructed for the purpose of serving more than three (3) dwellings but having less than fifteen (15) service connections and regularly serves less than twenty-five (25) individuals daily at least sixty (60) days out of the year. A multifamily well must be constructed as follows:

(A) Minimum casing lengths for multifamily wells are the same as domestic wells. Liner may not substitute for casing;

(B) The drill hole shall be constructed a minimum of ten inches (10") in diameter. An increase in hole size to ten and five-eighths inches (10 5/8") in diameter will be effective May 1, 1999. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed;

(C) The casing used must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for multifamily wells. Plastic casing may be used if approved in advance on a case-by-case basis;

(D) The casing must be grouted full-length with grout utilizing the tremie method or one (1) of the pressure grouting methods set out in section (3) of this rule;

(E) The neat cement grout must be allowed to set up based on the parameter of the following:

1. Hi-early cement—minimum of twelve (12) hours;

2. Portland Type I cement—minimum of seventy-two (72) hours; and

3. High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(F) When drilling starts, after cement has set, care should be taken when drilling out the bottom of the casing so that curing cement is not damaged.

(13) Unconsolidated Material Irrigation Well. A well drilled into alluvial, glacial drift or glacial outwash aquifers that is not deeper than two hundred feet (200') and produces water not for human consumption shall conform to the following construction requirements:

(A) The selection of casing shall take into consideration the stress to which the pipe will be subjected during construction and the corrosiveness of the groundwater. Used pipe is prohibited. If steel casing is selected, see subsection (1)(E) Steel Casing Table, for size, wall thickness and weight per foot specifications. If plastic casing is selected (see 10 CSR 23-3.070 for specifications);

(B) Unconsolidated material irrigation wells greater than two hundred feet (200') in depth must be constructed using bedrock irrigation specifications contained in section (14);

(C) The drill hole shall be constructed a minimum of four inches (4") in diameter larger than the outside diameter of the casing to be installed;

(D) Set Screen and Casing. Screen openings shall provide the maximum amount of open area consistent with strength of screen and the grading of the water-bearing formation and gravel pack. The openings shall permit maximum transmitting ability without clogging or jamming;

(E) Gravel Pack. All gravel placed into well shall be clean, washed and disinfected prior to placement or provisions made for disinfection in place. When an oversized drill hole is constructed to permit the placement of a gravel wall around the well screen and casing, grouting and sealing may be suspended for sixty (60) days to allow for gravel to settle and for well development; and

(F) Grouting. After the well has been developed and pumped, but in no case later than sixty (60) days, dig around the well to a depth of four feet to five feet (4'–5') and fill with sodium bentonite granules, pellets, tablets or chips. Bentonite slurry or organic polymers shall not be used.

(14) Bedrock Irrigation Well. These wells are drilled into bedrock aquifers that are constructed to meet required standards and are equipped with a pump that has the capacity to produce more than seventy (70) gallons of water per minute. The produced water is for irrigating crops but may be used for human consumption. This type of well shall conform to the following construction requirements:

(A) The minimum amount of casing set must be determined by the division in advance on a casing point request form. A casing point request form is available from the division;

(B) The drill hole shall be constructed a minimum of ten inches (10") in diameter. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed;

(C) The casing used must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for high yield and bedrock irrigation wells; and

(D) The casing must be grouted full-length with neat cement grout utilizing the tremie method or one (1) of the pressure grouting methods set out in section (3).

(15) High Yield Well. Those wells that are constructed to meet required standards and are equipped with a pump that has the capacity to produce more than seventy (70) gallons of water per minute.

(A) The minimum amount of casing set must be determined by the division in advance on a casing point request form. A casing point request form is available from the division.

(B) The drill hole a minimum of ten inches (10") in diameter shall be constructed. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed.

(C) The casing must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for high yield and bedrock irrigation wells.

(D) The casing must be grouted full-length with neat cement grout utilizing the tremie method or one (1) of the pressure grouting methods set out in section (3).

(16) Lubricants Used During the Drilling Process. During the drilling of a well, some lubricants may be necessary to ensure protection of the drilling machine. The lubricants used must not adversely affect the groundwater quality and must be biodegradable. Special care must be taken to ensure leaking hoses on the drilling machine do not allow harmful lubricants or fluids to enter the borehole.

(17) Most domestic bedrock wells drilled in the state have an eight and five-eighths-inch (8 5/8") hole drilled to casing point and a six and five-eighths-inch (6 5/8") outside diameter casing installed into bedrock. The rules state that the bottom thirty feet (30') of the annulus must be grouted. Table 1 states the minimum amount of grout required to fill the bottom thirty feet (30') of annulus taking into account the use of a six and five-eighths-inch (6 5/8") outside diameter casing, borehole size differences, type of grout utilized, and method of emplacement of the grout.

TABLE 1
Number of Bags for Minimum Amount of Required Grout for a Domestic Bedrock Water Well

Outer Diameter of Steel/Plastic Casing: 6 5/8 Inches—Minimum Length of Grout: 30 feet

Borehole Diameter	8 5/8" *Ann.	^O.H.	8 3/4" *Ann.	^O.H.	9" *Ann.	^O.H.	10" *Ann.	^O.H.	10 5/8" *Ann.	^O.H.	11" *Ann.	^O.H.
Type of Grout												
CEMENT												
Portland Type I	5	11	5	11	6	12	8	15	10	17	12	18
Portland Type III	5	11	5	11	6	12	8	15	10	17	12	18
BENTONITE												
Pellets—												
1/2" Baroid Pellets	7	17	7	17	8	18	13	22	15	25	17	27
3/8" Baroid Pellets	7	17	8	18	9	19	13	23	16	27	18	28
1/4" Baroid Pellets	7	17	8	19	19	13	23	16	26	18	28	28
Wyo-Bend Tablets	8	18	8	19	9	20	14	25	17	28	19	30
Volclay 1/2"	8	19	8	19	9	20	14	25	17	28	19	30
Volclay 3/8"	8	19	8	20	10	21	14	26	18	29	20	31
Volclay 1/4"	8	20	9	20	10	22	15	27	18	30	21	32
Chips—												
Baroid HolePlug	7	18	8	18	9	19	13	24	16	27	18	29
Wyo-bend Coarse	6	15	7	15	7	16	11	20	14	22	15	24
Wyo-bend Medium	6	15	7	16	8	17	12	21	14	23	16	25
Volclay Coarse	7	16	7	17	8	18	12	22	15	25	17	27
Volclay Medium	7	17	7	17	8	18	13	23	16	26	17	27
Granular—												
Benseal	6	15	7	16	8	17	12	21	14	23	16	25
Wyo-bend No. 8	6	15	7	15	7	16	11	20	14	22	15	24
Wyo-bend No. 16	6	15	7	15	7	16	11	20	14	22	15	24
Slurry—												
Baroid	1	4	2	4	2	4	3	5	3	5	4	6
Wyo-bend	2	4	2	4	2	4	3	5	4	6	4	6
Volclay	1	3	2	4	2	4	3	5	3	5	4	6

*Ann. = Bags needed to fill Annular Space
^O.H. = Bags needed to fill the Open Bore Hole

(18) Most alluvial domestic wells drilled in the state have a ten and five-eighths-inch (10 5/8") hole drilled and a six and five-eighths-inch (6 5/8") outside diameter casing installed. The rules state that the top twenty feet (20') of annulus must be grouted. The following amounts of grout are necessary, at a minimum, to fill this space: Table 2 states the minimum amount of grout required to fill the top twenty feet (20') of annulus taking into account the use of a six and five-eighths- inch (6 5/8") outside diameter casing and screen, borehole size differences, type of grout utilized, and method of emplacement of the grout.

TABLE 2
Number of Bags for Minimum Amount of Required Grout for Domestic Unconsolidated Water Wells

Outer Diameter of Steel/Plastic Casing: 6 5/8 inches—Minimum Length of Grout: 20 feet

Borehole Diameter	10 5/8" *Ann.	10 5/8" ^O.H.	12 5/8" *Ann.	12 5/8" ^O.H.	14 5/8" *Ann.	14 5/8" ^O.H.	16" *Ann.	16" ^O.H.	18" *Ann.	18" ^O.H.
Type of Grout										
CEMENT										
Portland Type I	7	11	12	16	17	21	21	26	28	32
Portland Type III	7	11	12	16	17	21	21	26	28	32
BENTONITE										
Pellets—										
1/2" Baroid Pellets	10	17	17	24	25	32	32	38	42	48
3/8" Baroid Pellets	11	18	18	25	27	33	33	40	44	51
1/4" Baroid Pellets	11	18	18	25	26	33	33	40	44	50
Wyo-Bend Tablets	11	19	19	26	28	35	35	42	46	53
Volclay 1/2"	11	19	19	27	28	36	35	43	47	54
Volclay 3/8"	12	19	20	27	29	37	36	44	48	56
Volclay 1/4"	12	20	20	28	30	38	38	45	50	57
Chips—										
Baroid HolePlug	11	18	18	25	27	34	34	41	44	51
Wyo-bend Coarse	9	15	15	21	23	28	28	34	37	43
Wyo-Bend Medium	9	15	16	22	23	29	29	35	38	44
Volclay Course	10	17	17	23	25	31	31	38	42	48
Volclay Medium	10	17	17	24	26	32	32	39	42	49
Granular—										
Benseal	9	16	16	22	23	29	29	35	39	45
Wyo-bend No. 8	9	15	15	21	23	28	28	34	37	43
Wyo-bend No. 16	9	15	15	21	23	28	28	34	37	43
Slurry—										
Bariod	2	4	4	5	6	7	7	8	9	10
Wyo-bend	2	4	4	5	6	7	7	9	10	11
Volclay	2	3	4	5	5	7	7	8	9	10

*Ann. = Bags needed to fill Annular Space
^O.H. = Bags needed to fill the Open Bore Hole

(19) When drilling in Area 2 or 3, under certain circumstances, domestic wells may be constructed where the upper forty feet (40') of annulus is grouted. This annulus is created by a ten and five-eighths-inch (10 5/8") hole and a five and one-half-inch (5 1/2") outside diameter casing. The following amounts of grout are necessary, at a minimum, to fill this space:

Grout Material	Size	Amount to Fill 40' of Annulus	
		Open-Hole Method	All Other Methods
Bentonite (50 lb.)	Medium chip	30.0 bags	21.5 bags
	Coarse chip	30.0 bags	21.5 bags
	#8 mesh (cannot be poured through water)	30.0 bags	21.5 bags
Cement Slurry (one 94 lb. bag with 6 gallons water) (must be tremmied through standing water)		23.0 sacks	16.5 sacks

(20) Domestic wells drilled in Area 5 can have casing as small as four and one-half-inch (4 1/2") outside diameter placed in a hole that is eight and five-eighths-inch (8 5/8") in diameter. To grout the upper twenty feet (20') of this type of well the following amounts of grout are necessary, at a minimum, to fill this space:

Grout Material	Size	Amount to Fill 20' of Annulus	
		Open-Hole Method	All Other Methods
Bentonite (50 lb.)	Medium chip	10.2 bags	7 bags
	Coarse chip	10.0 bags	7 bags
	#8 mesh (cannot be poured through water)	10.0 bags	7 bags
Cement Slurry (one 94 lb. bag with 6 gallons water) (must be tremmied through standing water)		7.5 sacks	5.5 sacks

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.040 Well Casing Seals and Connections

PURPOSE: This rules describes the types of well casing seals and connections that are to be used.

(1) Above-Grade Connections. An above-grade connection into the top or side of a well casing shall be at least one foot (1') above the finished grade surface and constructed to exclude dirt or other foreign matter by one (1) or more of the following methods, as may be applicable:
(A) Threaded connection;
(B) Welded connection;
(C) Rubber expansion sealer;
(D) Bolted flanges with rubber gaskets;
(E) Overlapping well cap; and
(F) Extension of the casing at least one inch (1") into the base of a power pump.

(2) In wells that utilize an above grade connection, special attention must be paid to the sealing capabilities of the selected well casing seal. In many cases the electric wire hole, the drop pipe hole and the vent pipe hole may not be sealed adequately. The casing seal must stop all bacteria from entering the well through the seal. It is recommended that these holes be caulked, with silicone caulk or equivalent, to ensure that bacteria or other contaminants are not pulled into the well when the pump is operating.

(3) The practice of cutting the rubber well seal to make removal and reinstallation easier is strictly prohibited.

(4) Below-Grade Connection. A connection to a well casing made below ground, or less than one foot (1') above the finished surface grade, shall be protected by a pitless adapter or pitless unit. The pitless adapter or pitless unit shall be composed of material of sufficient strength to withstand normal operating stress. A below-ground connection shall not be submerged in water at the time of installation. Holes cut in the casing through which the pitless adaptors are installed must be sized and constructed so as to guarantee a watertight seal with the pitless adaptor in place. Native materials shall be packed tightly around the casing and pitless adapter or pitless unit after installation.

(5) Well Caps for Wells Using Pitless Adapters. Well caps used on wells that have a pitless adapter or pitless unit must have a screened vent hole pointing downward at least one-half inch (1/2") in diameter and must seal tightly against the casing to exclude dirt, insects or any foreign matter from entering the well. Hub cap type well caps that are secured to the casing by set screws that leave an opening allowing contaminants to enter are not approved for use.

(6) Other methods. Any other method of connection to a well casing shall be specifically approved by the division before installation.

(7) Wells drilled in floodplains must have casing that terminates at least two feet (2') above the maximum known floodwater elevation or when flooding is eminent, the well vent must be sealed and the well discontinued from operation until the floodwater subsides.

AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.050 Pump Installation

PURPOSE: This rule sets specific standards as to the proper procedures for the installation of pumps for wells.

(1) Pumps and Pumping Equipment.
(A) A pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist. A hand pump, hand pump head, stand or similar device shall have a closed spout directed downward and a pump rod that operates through a stuffing box. A power driven pump shall be attached to the casing or approved suction or discharge line by a watertight connection, including flange connections, hose clamp-type connections or other flexible couplings.
(B) Priming Requirements. A pump shall be designed, installed and maintained so that priming is not required for ordinary use. Pumps installed for use only on a well water irrigation system are exempted but priming water shall be clear water, free of contamination and carrying a chlorine residual. An irrigation well equipped with a centrifugal pump may be primed without chlorination when the pump is filled with water taken directly from the well.
(C) Backflow Prevention for Chemical Injection Systems on Irrigation Wells. A chemical injection system may not be connected to a well used for human consumption.
1. Where a chemical injection system is connected directly to a well used for irrigation and which is not used as a potable water supply, a single check-spring loaded backflow prevention shall be installed between the point of chemical injection on the pump discharge piping and the water well in accordance with the manufacturer's instructions and shall have the following:
A. Valving so that water can be drained from the system to prevent freezing;
B. A vacuum relief valve to prevent back-siphoning of chemicals into the well;
C. An automatic low pressure drain at least three-quarters inch (3/4") in diameter, positioned so that when draining occurs liquid will run away from the well. The automatic low pressure drain shall quickly drain the check valve body of water when operation of the irrigation pump is discontinued;
D. A watertight seal around the check valve;
E. An inspection port at least four inches (4") in diameter to allow inspections of the inside of the check valve; and
F. The check valve shall withstand a minimum hydraulic pressure of one hundred fifty (150) pounds per square inch (psi) without leaking. Valve shall be galvanized, epoxy coated or similar material that resists corrosion.
2. The irrigation well pump and the chemical injection pump shall be electrically or mechanically connected so that when the well pump stops, the chemical pump will shut off automatically.
(D) Temporary Pump Removal. If the pump is removed temporarily from the well for any reason, the well shall be capped with a watertight seal strong enough to prevent entry of contamination or foreign objects.
(E) Pump Bearing Lubrication. Lubrication of bearings of power driven pumps shall be with water or oil which will not adversely affect the groundwater.

1. Water lubrication. If a storage tank is required for lubrication water, it shall be designed to protect the water from contamination.

2. Oil lubrication. The reservoir shall be designed to protect the oil from contamination with a shutoff valve to stop oil flow when not pumping.

(F) Electrical Installation. All electrical installations shall be performed and maintained in accordance with the existing electric codes. A permitted well installation contractor or pump installation contractor must perform all electric wiring which impacts the operation of the pump or pumping system. This includes wiring from the pump to the control boxes to the main power supply such as the breaker box in a house. The electric wire must never be run through the pitless adapter.

(G) All plumbing or water supply distribution from the well to the point of entry hookup shall be installed and maintained in accordance with existing plumbing codes. A permitted well installation contractor or pump installation contractor must perform all plumbing which impacts the distribution of water from its source, through the pressure system to the point of entry inside or outside of the structure or building being served. This includes, but is not limited to, pressure tanks, water treatment equipment and any other materials needed to complete the initial installation of the water system, inside and outside of the structure, except as exempted in section 256.607, RSMo.

(2) Operational domestic and multifamily wells must have a pump, either surface mounted or submersible. Wells must have a watertight seal at the top of the well to prevent contamination from entering the well from the top. Water may not be withdrawn from a drilled well by use of a well bucket that is lowered down the well for the purpose of retrieving water for human consumption or for nonhuman uses.

(3) Water Suction Lines. A water suction line shall be constructed of galvanized iron or steel, cast iron or plastic pipe as approved by the division or other material given approval by the division. Aluminum pipe is acceptable for well water irrigation systems in addition to the previously mentioned materials. When connecting metallic pipes or casing of dissimilar types, care must be taken so that electrolysis does not occur. If the pump is located next to the well with the pump suction line emerging from the top of the well, a well seal or equivalent shall be installed between the well casing and suction pipe to provide a watertight closure.

(4) Pump Discharge Lines.

(A) A buried discharge line between the well casing and the pressure tank in any installation, including a deep well turbine or a submersible pump, shall not be under negative pressure at any time. If a check valve is installed in a buried water line between the well casing and the pressure tank, the water line between the well casing and the check valve shall meet the requirements for a suction line unless equipped with an air release valve.

(B) Pump discharge ports on irrigation wells shall be covered when not in use.

(5) Drop Pipe. The pipe used to hang the pump in a well must be composed of thermoplastic acrylonitrile-butadene-styrene (ABS) or polyvinyl chloride (PVC) materials that have Schedule 80 (SCH 80) or thicker walls or if metallic drop pipe is used, a wall thickness of at least Schedule 40 (SCH 40) is required.

(6) Vents. All wells shall be vented with watertight caps terminating at least two feet (2') above the regional flood level (see 10 CSR 23-3.010(1)(A)6. for exception) or one foot (1') above the finished grade surface or the floor of a pump room, well room, whichever is higher. The casing vent shall be a minimum one-half inch (1/2") in diameter, screened and point downward. Vents may be offset provided they meet the provisions of this section. Any submersible pump shall be installed with a vented cap on the top of the well casing to prevent drawing near surface contamination into the well. When a well with a submersible pump kicks on and pumps water from the well, the drawdown of the water in the well creates a vacuum pulling air into the well. If the well is not vented properly, air will be pulled from around the drop pipe, through the electric wire hole, from around the well seal, and the like. If a well is not vented properly, it could be contaminating itself every time the pump kicks on by pulling near surface contaminants into the well.

(7) Disinfection.

(A) A new, repaired or reconditioned well or pump installation shall be thoroughly pumped to waste until the water is as clear as is reasonably possible, dependent upon groundwater conditions in the area. After that the well and pumping equipment shall be disinfected with chlorine so applied that a concentration of at least one hundred (100) parts per million (ppm) of chlorine shall be obtained in all parts of the well and plumbing system. The chlorine solution shall be introduced into the well in a manner to flush the well surfaces above the static water level with chlorine solution. A minimum contact period of two (2) hours (overnight is better) shall be provided before pumping the well to waste and flushing the chlorine solution from the distribution system. The well owner shall be instructed by the permittee concerning these procedures and can be responsible for pumping and flushing of the well following disinfection. A permittee shall be responsible for disinfecting the work performed on the well, pump or pumping equipment. Disinfection in a well repair operation may be accomplished at the beginning of the operation with chlorine applied to obtain a concentration of two hundred (200) ppm for the period of the well repair operation. The water shall be pumped to waste prior to the taking of water samples or use being made of the water. Caution: The chlorinated water must not leave the owner's property. If it does, the owner must report to the Water Pollution Control Program, Division of Environmental Quality.

(B) Special care must be exercised when replacing a pump because bacteria can easily contaminate what is pulled from the well (pump, drop pipe, electric wire) and it is difficult to disinfect the portions of the electric wire and drop pipe that are above water level. When pulling a pump, the electric wire should not be allowed to touch the ground. This may be accomplished by laying plastic on the ground or utilizing a mechanical system that winds up the electric wire as it is withdrawn from the well or other appropriate means. The drop pipe should be placed on pipe racks or other precautions should be taken to keep it from contacting the ground. If contamination does occur, special care must be taken to disinfect the contaminated areas.

(C) The following table will help in determining how much chlorine to add during disinfection of the well. First you will need to determine height of the water column in the well.

1. Formula to find height of water column: (total depth of well) minus (static water level) equals (height of water column). Example: (216 ft. well depth) - (37 ft. water level) = (179 ft. of water column). Then using the table find the casing size of the well, read across to the corresponding chlorine product column and use these amounts in the following formula:

2. Formula to find amount of chlorine product needed to disinfect well: (height of water column) times (amount of product from table) equals (amount of product needed to disinfect well) Example: For a six inch (6") casing using 5.25% Clorox product: (179 ft.) × (0.381) = 68 oz. or about one-half (1/2) gallon.

Table 1

Disinfection Table
(Produces a 100 mg/liter chlorine solution per-foot of casing size)

Casing Size Nominal Diameter (Inches)	Gallons of Water Per One Foot Of Casing Size (Gal/Ft/Case Size)	Ounces of Product Added To Disinfect One (1) Foot of Water Per Casing Size		
		5.25% to 6.0% Chlorine **PRODUCT**: Clorox, Purex, Sno-White Kandu, Topco, Action, White Magic, Surefine and MC_2 or other brand names (sodium hypochlorite) (Fluid Ounces)	10% Chlorine **PRODUCT**: Liquid Bleach. Purchased from a chemical supply company (sodium hypochlorite) (Fluid Ounces)	70% Chlorine **PRODUCT**: High-Test Calcium Hypochlorite. Purchased from a chemical company (calcium hypochlorite) (Dry Ounces)
1.25	0.06	0.015	0.008	0.0011
1.50	0.09	0.023	0.012	0.0017
2	0.16	0.041	0.021	0.0031
2.5	0.25	0.064	0.033	0.0048
3	0.37	0.094	0.049	0.0071
3.5	0.50	0.127	0.067	0.0095
4	0.65	0.165	0.087	0.0124
5	1.02	0.259	0.136	0.0194
6	1.50	0.381	0.200	0.0286
8	2.60	0.660	0.347	0.0495
10	4.08	1.036	0.544	0.0777
12	5.87	1.490	0.782	0.1118
14	8.00	2.031	1.066	0.1523
16	10.44	2.650	1.391	0.1988
18	13.21	3.354	1.761	0.2515
24	23.50	5.966	3.132	0.4474
30	36.70	9.317	4.891	0.6988

(D) When placing the chlorine into the well it must be thoroughly mixed with the existing water to disperse the chlorine throughout the water column. This is best done by batch dumping large volumes of chlorinated water into the well or by placing chlorine tablets in a porous bag and lowering it and raising it within the entire water column until the chlorine is dissolved.

(E) A practical alternative is to divide the amount of needed chlorine product calculated using the Disinfection Table into liquid and tablet form. Then—

1. Pour the tablets into the well which will dissolve near the bottom of the well;
2. Pour liquid chlorine product into the well being sure to wash down all surfaces that are above the static water level;
3. Circulate water into the house by running cold water until chlorine smell is detected, turning off cold, then running hot until chlorine smell is detected, in each faucet in the house. Proper ventilation must be maintained during this step and step 5 (see paragraph (7)(E)5.) to avoid overpowering potentially toxic chlorine fumes;
4. Stop circulating water and let set at least two (2) hours (preferably overnight); and
5. Flush system by running water until no chlorine odor is detected.

AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.060 Certification and Registration Reports

PURPOSE: This rule sets required standards for certification and registration report form submittal.

(1) The certification process involves the review of the certification report form to be sure that the well meets all construction requirements necessary for the specific area the well has been drilled. The minimum construction standards were written to protect Missouri's groundwater and to help ensure that the construction of the wells does not constitute a threat to this resource. Due to the varied quantity and quality of groundwater in Missouri, the certification number does not necessarily indicate that the well produces potable water or usable quantities of water.

(2) A certification report form, supplied by the division, shall be used too report new well construction, new pump installation (initial pump set in newly drilled well), monitoring well construction (see 10 CSR 23-4) and heat pump well construction (see 10 CSR 23-5). The certification report form shall be completed and submitted to the division by the permittee within sixty (60) days after completion of any well. If the well installation contractor does not set the pump, the well installation contractor is responsible to submit a certification report form documenting work performed, otherwise the certification report form will reflect all areas of reporting. The pump installation contractor is responsible for submitting a certification report form documenting work performed. The certification report form shall be accompanied by the certification fee. The permittee shall furnish the well owner one (1) copy, the division one (1) copy and retain one (1) copy in the permittee's files. The report form shall contain all available required information. A certification report form shall be submitted for a dry hole, but no certification fee is required.

(3) The registration process involves the documentation of certain types of activities according to the requirements and reported on forms supplied by the division.

(4) A registration report form, supplied by the division, shall be used to report plugging of wells, raising of casing, lining of wells, drilling of jetted wells (unless exempted), deepening of wells, major repairs and alteration of wells and must be submitted to the division by the permittee within sixty (60) days after completion of the appropriate operations. Records for replacement pumps will not be required unless requested by the division. Pump replacement cannot change status of the well from domestic to multifamily or from domestic to high yield. The registration report form shall be accompanied by the registration fee, if required. The permittee shall furnish the well owner one (1) copy, the division one (1) copy and retain one (1) copy in the permittee's files. The report form shall contain all available required information.

(5) If work is performed by the landowner, following strict requirements under section 256.607, RSMo and 10 CSR 23-3.020(7), the landowner must submit all required forms and fees and is subject to all laws and rules as if a permitted entity.

AUTHORITY: sections 256.606, 256.614, 256.623 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency rescission and emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Rescinded and readopted: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991 and 256.614, 256.623 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.070 Plastic Well Casing

PURPOSE: This rule designates special standards for the use of plastic casing in the water well.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Standards.

(A) Approved Materials. Any thermo-plastic pipe used for well casing shall meet the standards of the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103, which are referenced as ASTM F-480 *Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80.* Acceptable casings used for wells that produce potable water must be composed of certain classes of polyvinyl chloride (PVC) or acrylonitrile-butadiene-styrene (ABS) thermoplastics accepted by ASTM for well casings. Other casing may be used if advance written approval is obtained by the division.

(B) Standard dimension ratio (SDR) is determined by the following (outside diameter divided by wall thickness equals SDR). Casing must have SDR ratings of SDR 26, SDR 21, SDR 17 or SDR 13.5 to be acceptable for usage. Schedule 40 (SCH 40) is the most commonly used casing for wells producing potable water and is acceptable.

(C) A minimal nominal casing size for domestic wells is six inches (6") in diameter (average actual size is six and six hundred twenty-five thousandths inches (6.625")).

(D) The thermoplastic well casing must have the following markings displayed on the casing according to ASTM standards. If a casing does not have these markings, it is not permitted for use unless given advance written approval by the division.

(E) Well casing may be joined by solvent weld, mechanical joints such as splined couplings, threaded or other types of joints approved in advance by the division. All joints must be watertight. Solvent welded joints are not permitted for monitoring wells.

Example

1	2	3	4	5	6	7	8	9
ABC Plastics	6"	Well Casing	PVC 1120	SDR 21	IC-1	F480	SF-WC	C9APIE4

1 Manufacturer's name or trademark.
2 Nominal Casing Size. Must be six inches (6") or larger.
3 Intended application for product. Must state "Well Casing" to be used as casing.
4 Type of material. Must be PVC or ABS material.
5 SDR—Standard Dimension Ratio. Must be SDR 26, SDR 21, SDR 17, SDR 13.5 or SCH 40.
6 Impact Classification. Must have IC-0, IC-1, IC-2 or IC-3.
7 ASTM Specification Number. Must have F-480 = Standard for Plastic Well Casing.
8 National Sanitation Foundation Logo. Must have NSF-WC = Well Casing. This is an independent laboratory's seal of approval.
9 Manufacturer's Code Number.

(2) Storage, Handling and Components. The installer—

(A) Shall store pipe in such a manner to prevent sagging or bending;

(B) Shall inspect pipe and couplings carefully for cuts, gouges, deep scratches, damaged ends and other major imperfections and shall not use any plastic pipe or coupling which has these defects or imperfections;

(C) Shall use solvent cement meeting the requirements of the specifications for the particular plastic used. The cement used shall provide sufficient open time for making good joints but the installer shall complete joints immediately upon applying the solvent cement;

(D) Shall use only pipe and coupling combinations that give close and satisfactory interference fits which will readily mate when the solvent cement is applied and the pieces are joined. The pipe shall enter the socket to between two-thirds (2/3) and full depth of the socket depth when inserted and turned;

(E) May use plastic pipe coupling with molded or formed threads but must use only the thread lubricant which is suitable for the particular type of plastic being used and the lubricant must not be a source of contamination to the water; and

(F) Shall use a coupling appropriate for the specific transition intended when connecting plastic pipe to a non-plastic well screen.

(3) Technique for Joining Solvent Weld Plastic Well Casing.

(A) Cutting. The installer shall use fine-tooth blades with little or no set for when cutting the pipe is necessary. Pipe ends shall be cut square. A plastic pipe cutter equipped with extra-wide rollers and thin cutting wheels may be used. Standard steel pipe or tubing cutters shall not be used for cutting plastic pipe.

(B) Cleaning. The installer shall clean all dirt, dust, moisture and burrs from pipe ends and couplings. The installer may use only chemical or mechanical cleaners which are suitable for the particular plastic material being used.

(C) Primer. The installer shall use a primer when, because of the type of plastic material being used, the pipe and coupling surfaces must be softened and dissolved in order to form a continuous bond between the mating surfaces or when the particular type of solvent cement being used requires one, or both.

(D) Cement Application. The installer shall apply a moderate and even coat of cement to the inside of the coupling to cover the distance of the joining surface only. The installer shall then quickly apply an even coat of cement to the outside of the pipe being joined to a distance which is equal to the depth of the pipe coupling socket. Caution should be used when handling solvent cement to avoid skin contact or inhalation of vapors.

(E) Assembly. The installer shall—

1. Make the joint as quickly as possible after application of the cement and before it dries;

2. Reapply cement before assembling if the cement dries partially;

3. Insert the pipe into the coupling socket, turning the pipe to ensure even distribution of cement;

4. Make sure that the pipe is inserted to the full depth of the coupling socket;

5. Remove excess solvent cement from the exterior of the joint with a clean, dry cloth;

6. Tighten a threaded joint by no more than one (1) full turn using a strap wrench;

7. Not disturb the coupling joint until after the cement has set, in order to avoid damage to the joint and loss of fit; and

8. Allow sufficient time for the joint to develop good handling strength based on manufacturer's specifications (usually two to seven (2–7) minutes). When temperatures exceed one hundred degrees Fahrenheit (100°F), difficulty in proper bonding may be experienced because the active solvent agent evaporates too rapidly. The ends of the casing to be joined should be cooled below one hundred degrees Fahrenheit (100°F) before they can be solvent cemented. Keeping casing in the shade will help. When temperatures fall below forty degrees Fahrenheit (40°F), the use of specially formulated cements may be advisable to ensure optimum strength development.

(F) Drilling Inside of Plastic Casing. An installer should use extreme care if drilling inside the plastic casing is required when drilling any kind of well because the drilling process can fracture or abraid the plastic casing.

(G) Grouting of Plastic Casing.

1. Rapid-setting cement is not to be used. Because of its high heat of hydration, grout made of rapid-setting cement is not permitted for use in wells which are cased with PVC or ABS pipe. The following shows the strength of PVC at various temperatures based on 73.4 degrees Fahrenheit being one hundred percent (100%) of its test strength:

A. 50 degrees Fahrenheit, 114 percent;
B. 60 degrees Fahrenheit, 107 percent;
C. 70 degrees Fahrenheit, 101 percent;
D. 80 degrees Fahrenheit, 95 percent;
E. 90 degrees Fahrenheit, 88 percent;
F. 100 degrees Fahrenheit, 83 percent;
G. 110 degrees Fahrenheit, 77 percent;
H. 120 degrees Fahrenheit, 72 percent;
I. 130 degrees Fahrenheit, 65 percent;
J. 140 degrees Fahrenheit, 40 percent; and
K. 150 degrees Fahrenheit, 10 percent.

2. Bentonite and bentonite slurry grout is encouraged. The use of chip bentonite or bentonite slurry grout is encouraged when grouting the annulus of wells utilizing plastic casing because these grouts do not increase in temperature during the curing process.

3. Cement slurry is usable with some restrictions. The use of neat cement slurry can cause problems in certain situations. During the curing process of neat cement slurry temperature increases are a by-product. In a typical well with a two inch (2") annulus, temperature increases in the range of seventeen to thirty-five degrees (17°–35°) are normal. When annular spaces are larger resulting in thicker grout, the temperature increase that results may cause the casing to fail. The addition of two to nine percent (2–9%) bentonite powder to the cement slurry will reduce the rate at which heat is generated allowing the heat to be dissipated, resulting in less potential damage to the casing. If cement slurry is used, it is recommended that bentonite be added or that cold water be circulated in the casing while the grout is curing. Maximum grout hydration temperatures in wells with annular spaces less than five inches (5") are reached between seven and ten (7–10) hours after mixing.

(H) Cavernous Rock Walls. As a general rule, plastic well casing is not recommended to be used as casing in wells cased and grouted through cavernous rock formations. However, in these cases, plastic casing will work. This determination will be made by the well installation contractor.

(I) Use of Screws. When extra strength is desired in solvent weld joints, stainless steel screws may be used, but must not penetrate through to the inside of the casing. The use of any type of rivets that penetrate to the inside of the casing is prohibited.

(J) Screws Required on Unconsolidated Material Irrigation Wells. When PVC or ABS casing is used that requires gluing, at least four (4) stainless steel screws must be used in each coupling. The screws shall not penetrate through to the inside of the casing.

(K) PVC and ABS casing may never be used when known gasoline or solvent contamination exists within one hundred (100) yards of the well being repaired or drilled. When gasoline or solvent contamination levels do not present a potential threat to the integrity of the casing, the use of PVC or ABS pipe material will be considered on a case-by-case basis. Approval must be received in advance.

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.080 Liners

PURPOSE: This rule sets guidelines for the use of liners in wells in Missouri.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Use of Liners. Liners are generally used for three (3) purposes. They are used to—

(A) Hold the well bore open when caving or spalling rock is encountered. These liners are usually slotted to allow water to enter the well from the aquifer; or

(B) Seal out problem areas below the existing casing or to correct inadequate grouting seals of the casing annulus and other problems arising concerning contamination of subsurface waters. Plastic liners may be used effectively to solve iron bacteria problems on steel casings. If a plastic liner is installed to seal out an iron bacteria problem, it must extend from the bottom of the steel casing and must have its upper end no deeper than ten feet (10') below the top of the well casing. The liner must also be grouted as stated in subsection (3)(B) of this rule; or

(C) If the liner is just used to solve a rust problem in the casing, a packer must be placed within five feet (5') of the bottom of the rusted casing interval. The liner must extend from the bottom of the steel casing to a point less than 10 feet (10') from the surface. The packer must be inside the casing and no grout is required.

(2) General Specifications and Guidelines.

(A) Liners may be composed of either steel or thermoplastic.

1. Steel liners must be new and have an inside diameter at least four inches (4") and have a minimum wall thickness not less than .188 inches.

2. Plastic liners must meet American Society for Testing and Materials (ASTM) standards concerning thermoplastic well casing and be composed of polyvinyl (PVC) or acrylonitrile-butadiene-styrene (ABS) materials formulated for well casing.

A. The inside diameter must not be smaller than four inches (4").

B. The Standard Dimension Ratio (SDR) ratings allowable for liner is SDR 26, SDR 21, SDR 17 and SDR 13.5. Schedule ratings allowable are SCH 40 and SCH 80.

(B) All liners used to seal out potential groundwater contamination areas below the existing casing or to correct inadequate grouting seals of the casing annulus, and other problems arising concerning the contamination of subsurface water must have their upper end set no deeper than ten feet (10') below the top of the well casing. The liner must be secured in the hole.

(C) Packers shall be secured on plastic liners with screws (making sure they do not penetrate the liner) or other methods and on steel liners the packer shall be welded or mechanically attached so that it will not move during liner placement. Packers are not required on liners used only to hold open the well bore.

(D) Whenever a liner is needed it is recommended that the bottom of the liner be at the bottom of the well. This will help prevent potential future problems with pump replacement.

(3) Method of Installation.

(A) When liners are used only to hold open the well bore they may be placed in the well following normal industry installation procedures.

(B) All other liners must be sealed into place following these procedures:

1. The liner must have a rubber packer (first packer) secured near the bottom of the interval to be grouted. Another rubber packer (the second packer) must be secured about twenty feet (20') above the first packer. This will result in two (2) rubber packers spaced about twenty feet (20') apart on the liner. These packers must hold the grout in place. Grout must be placed between the first and second packer and completely fill this interval as the liner is being installed into the casing. Grout must also be placed on top of the second packer filling it to at least a point twenty feet (20') above the third packer. Care must be taken by the well installation contractor when selecting the type of grout used, keeping in mind the time of liner installation and grout set-up time. The liner shall be placed into the well casing being careful not to damage the packers or liner, or two (2) packers must be placed close together near the bottom of the liner and grouted after the liner is set by pressure grouting through a tremie pipe. The bottom sixty feet (60') of annulus created when installing a four and one-half-inch (4 1/2") or five-inch (5") outside diameter liner must be grouted. If a liner must be grouted, a minimum annulus of one-half inch (1/2") must be present. Tables 5 and 6 state the required amount of grout to fill the annulus sixty feet (60'); or

2. Alternate grouting procedures will be considered on a case-by-case basis. Written approval in advance by the division is required.

(4) Permittee Responsibility to Seal Liner. In wells that have a liner used for any purpose, other than holding the well bore open, it is the responsibility of the permittee to ensure that the annulus between the well bore and the liner is sealed.

(5) PVC and ABS liners may never be used when known gasoline or solvent contamination exists within one hundred (100) yards of the well being repaired or drilled. When gasoline or solvent contamination levels do not present a potential threat to the integrity of the pipe or liner, the use of PVC or ABS pipe material will be considered on a case-by-case basis. Approval must be received in advance.

TABLE 5

Number of Bags for Minimum Amount of Required Grout for Lining Water Wells

Outer Diameter of Plastic Liner: 4 1/2 inches—Minimum Length of Grout: 60 feet

Borehole Diameter	6 *Ann.	^O.H.	8 *Ann.	^O.H.	10 *Ann.	^O.H.
Type of Grout						
CEMENT						
Portland Type I	5	11	13	19	24	30
Portland Type III	5	11	13	19	24	30
BENTONITE						
Pellets—						
1/2" Baroid Pellets	7	16	19	29	36	45
3/8" Baroid Pellets	7	17	21	30	37	47
1/4" Baroid Pellets	7	17	17	20	37	47
Wyo-bend Tablets	8	17	22	32	39	49
Volclay 1/2"	8	18	22	32	40	50
Volclay 3/8"	8	19	23	33	41	52
Volclay 1/4"	8	19	23	34	42	53
Chips—						
Baroid HolePlug	7	17	21	30	38	47
Wyo-bend Coarse	6	14	17	25	32	40
Wyo-bend Medium	6	15	18	26	33	41
Volclay Coarse	7	16	19	28	35	44
Volclay Medium	7	16	20	29	36	45
Granular—						
Benseal	6	15	18	26	33	41
Wyo-bend No. 8	6	14	17	25	32	40
Wyo-bend No. 16	6	14	17	25	32	40
Slurry—						
Baroid	2	3	4	6	8	10
Wyo-bend	2	4	4	7	8	10
Volclay	1	3	4	6	7	9

*Ann. = Bags needed to fill Annular Space
^O.H. = Bags needed to fill the Open Bore Hole

TABLE 6

Number of Bags for Minimum Amount of Required Grout for
Lining Water Wells

Outer Diameter of Plastic Liner: 5 inches—Minimum Length of Grout: 60 feet

Borehole Diameter	6 *Ann.	6 ^O.H.	8 *Ann.	8 ^O.H.	10 *Ann.	10 ^O.H.
Type of Grout						
CEMENT						
Portland Type I	3	11	12	19	23	30
Portland Type III	3	11	12	19	23	30
BENTONITE						
Pellets—						
1/2" Baroid Pellets	5	16	18	29	34	45
3/8" Baroid Pellets	5	17	19	30	35	47
1/4" Baroid Pellets	5	17	18	30	35	47
Wyo-bend Tablets	6	18	19	32	37	49
Volclay 1/2"	6	18	20	32	38	50
Volclay 3/8"	6	19	20	33	39	52
Volclay 1/4"	6	19	21	34	40	53
Chips—						
Baroid HolePlug	5	17	19	30	36	47
Wyo-bend Coarse	5	14	16	25	30	40
Wyo-bend Medium	5	15	16	26	31	41
Volclay Coarse	5	16	17	28	33	44
Volclay Medium	5	16	18	29	34	45
Granular—						
Benseal	5	15	16	26	31	41
Wyo-bend No. 8	5	14	16	25	30	40
Wyo-bend No. 16	5	14	16	25	30	40
Slurry—						
Baroid	1	3	4	6	7	10
Wyo-bend	1	4	4	7	8	10
Volclay	1	3	4	6	7	9

*Ann. = Bags needed to fill Annular Space
^O.H. = Bags needed to fill the Open Bore Hole

AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Emergency rescission and emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expire April 9, 1994. Rescinded and readopted: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.090 Regionalization

PURPOSE: This rule sets specific additional standards for certain regions in Missouri.

Editor's Note: Area maps mentioned in this rule may be found following 10 CSR 23-3.110.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Area 1. All persons engaged in drilling domestic wells in Area 1, a limestone or dolomite area (Figure 1 and 8) shall—

(A) Set no less than eighty feet (80') of casing, extending not less than thirty feet (30') into bedrock. Example: if sixty feet (60') of residual (weathered rock) material is encountered in drilling before bedrock, then ninety feet (90') of casing must be set.

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point.

(C) Install new, steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic).

(D) Install and seal casing as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout material and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space—

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

B. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

C. The following times must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours.

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours; and

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(E) If the well is to be drilled as an alluvial well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger than the casing to be placed into it. Well casing must be at least six inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural gravels in the formation being drilled can be allowed to cave back against the screen;

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(2) Area 2. All persons engaged in drilling domestic wells in Area 2, Central Western Missouri (Figure 2) shall—

(A) Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock. Areas where Cherokee Group sediments are present; set casing through caving zones and into waterbearing sands. In some instances this might require several hundred feet of casing. Liners may be used with minimum amount of casing listed for this area;

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel or plastic casings as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23.3.070 (plastic).

(D) Install and seal casing as follows: Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout material. Drill cuttings may be placed above the grouted interval to fill in the annular space—

1. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

2. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

3. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(E) In areas where shale or shaley material is present above the waterbearing zones, casing or liner shall be set so as to exclude intervals which would cave into the drill hole or cause muddy water to be pumped;

(F) If the well is to be drilled as an alluvial well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet

(20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required;

(G) Five-Inch (5") Casing Wells. A well may be completed using a five-inch (5") nominal casing if the following standards are met:

1. The casing must be set full length and be slotted across the producing horizons.

2. The drill hole must be eight and five-eighths inches (8 5/8") in diameter with the upper forty feet (40') to be reamed out to ten and five-eighths inches (10 5/8") in diameter; and

3. The upper forty feet (40') of annular space must be grouted and the remainder of the borehole below the grout must be gravel packed.

(3) Area 3. All persons engaged in drilling domestic wells in area 3, northwest Missouri area, (Figure 3) shall—

(A) If the well is to be drilled as a glacial drift or alluvial well;

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen;

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(B) If the well is to be drilled as a bedrock well—

1. Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic); and

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(C) If usable amounts of water are not expected to be available in deeper bedrock horizons and water is only available from the upper, fractured and weathered portion of bedrock, and if the water is coming from a zone that is at least forty feet (40') deep, you must set a minimum of forty feet (40') of casing but only one foot (1') of this casing need be set into the bedrock. This allows the use of shallower water horizons under some circumstances; and

(D) Five-Inch (5") Casing Wells. A well may be completed using a five-inch (5") nominal casing if the following standards are met:

1. The casing must be set full-length and be slotted across the producing horizons;

2. The drillhole must be eight and five-eighths inches (8 5/8") in diameter with the upper forty feet (40') to be reamed out to ten and five-eighths inches (10 5/8") in diameter; and

3. The upper forty feet (40') of annular space must be grouted and the remainder of the borehole below the grout must be gravel packed.

(4) Area 4. All persons engaged in drilling domestic wells in Area 4, northeast Missouri area, (Figure 7) shall—

(A) If the well is to be drilled as a bedrock well—

1. Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic); and

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(B) If the well is to be drilled as an unconsolidated materials well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(C) If usable amounts of water or water of acceptable quality are not expected to be available in deeper bedrock horizons and water is only available from the upper, fractured and weathered portion of bedrock, and if the water is coming from a zone that is at least forty feet (40') deep, a minimum of forty feet (40') of casing must be set but only one foot (1') of this casing need be set into the bedrock. This allows the use of shallower water horizons under some circumstances.

(5) Area 5. All persons engaged in drilling domestic wells in area 5, Missouri Bootheel and all major stream alluvial areas (Figure 5) shall—

(A) If the well is to be drilled as a bedrock well—

1. Set no less than eighty feet (80') of casing, extending not less than thirty feet (30') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(B) If the well is to be drilled as an unconsolidated materials well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of four inches (4") larger than the casing to be placed into it. Well casing must be at least four-inch (4") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(C) Shallow unconsolidated wells located in Area 5, the Missouri Bootheel (Figure 8) and all major stream alluvial areas may be exempted from this rule. If the wells and drillers of the wells meet the following specifications they are exempted:

1. Wells are drilled, jetted, driven, washed or constructed in other ways;

2. Wells are constructed in unconsolidated materials; and

3. Well casing diameters are no larger than two inches (2").

(6) Area 6. All persons engaged in drilling domestic wells in Area 6, St. Francois Mountain area (Figure 6) shall—

(A) Where granite or igneous rock is within one hundred feet (100') below the surface, set not less than forty feet (40') of casing extending not less than fifteen feet (15') into bedrock—

1. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

2. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

3. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications.

(B) In areas where granite is more than one hundred feet (100') below the surface, set not less than eighty feet (80') of casing not less than thirty feet (30') into bedrock.

1. Construct the drillhole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point.

2. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

3. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications.

AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.100 Sensitive Areas

PURPOSE: This rule sets specific additional standards for sensitive areas shown on the map that have been designated on the basis of either naturally occurring problems caused by unique groundwater chemistry or because they are located in a fragile groundwater environment which is experiencing rapid population growth or urbanization.

Editor's Note: Area maps referred to in this rule may be found following 10 CSR 23-3.110.

(1) Sensitive Area A. All persons engaged in drilling wells in this area (Figure 8) and encounter Pennsylvanian shales and/or sandstones shall—

(A) Set no less than eighty feet (80') of casing extending not less than thirty feet (30') into bedrock where Pennsylvanian shale and sandstone are not present and no less than one hundred fifty feet (150') of casing extending not less than thirty feet (30') into bedrock where the Pennsylvanian shale and sandstone are present;

(B) Construct the drillhole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(D) Install and seal casing as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes; and

B. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

2. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications.

(2) Sensitive Area B. Wells drilled within one-quarter (1/4) mile of the major lakes in Missouri (Figure 8) (see list of lakes) must be cased so that they do not produce lake water into their wells. Wells drilled within one-quarter (1/4) mile of the major lakes that are not drilled below normal pool level of the lake are not required to meet sensitive Area B requirements. These wells must be constructed to Area 1 requirements stated in 10 CSR 23-3.090(1). The following specifications shall be followed:

(A) List of Lakes—

1. Truman;
2. Stockton;
3. Table Rock;
4. Bull Shoals;
5. Lake of the Ozarks;
6. Wappappello;
7. Pomme de Terre;
8. Norfolk; and
9. Clearwater.

(B) If the well is to be drilled closer than one-quarter (1/4) mile to the shoreline of the lake, casing must be set to a point fifty feet (50') below the bottom of the lake. The deepest part of the lake within one-quarter (1/4) mile radius from the well location shall be used in this determination. Example: If the drill site is located one thousand feet (1,000') from the lake, is located fifty feet (50') higher in elevation than the shoreline and the deepest estimated bottom of the lake within one-quarter (1/4) mile from the well is thirty feet (30') deep, then one hundred and thirty feet (130') of casing must be set. Fifty feet (50') (elevation above lake) + thirty feet (30') (depth of water) + fifty feet (50') (below lake bottom) = one hundred thirty feet (130') casing;

(C) It is highly recommended that before a well is drilled that is located closer than one-quarter (1/4) mile to the shoreline of any major lake, a casing point request form (supplied by the division) be submitted to the division. The casing point request form will be used to establish the required amount of casing and will supply information on requested water yield amounts and corresponding total depth of well. To ensure the location of the proposed drill site a copy of the landowner's property deed showing detailed location information and a copy of the landowner's plat (if available) showing proposed drilling site location, must be attached to completed casing point request form. The casing point request form will be processed quickly and returned to the landowner or driller, or both. After the well is drilled the casing point request form must be submitted with the certification form. If a well is drilled within one-quarter (1/4) mile of one (1) of the lakes contained in section (2) and less than the required amount of casing is set, the well installation contractor must bring the well up to the standards set in this rule and will be subject to disciplinary action deemed necessary by the division;

(D) A minimum of eighty feet (80') of casing must be set;

(E) The drill hole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(F) The new steel or plastic casing shall be installed as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(G) The casing shall be installed and scaled as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

B. If plastic casing is used, a packer, coupling or inverted bell is required near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

C. The following time must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours;

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours; and

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(H) In areas that have water quality problems that would be aggravated by the use of steel casing, plastic casing is recommended. If it is necessary to set steel casing due to geologic reasons, the following may substitute for casing:

1. Set no less than eighty feet (80') of casing; and

2. Liner must be set through the casing to point as determined in subsection (1)(C). Example: If the casing point was determined to be one hundred and eighty feet (180'), one hundred and eighty feet (180') of liner must be set. The liner must meet all requirements as stated in 10 CSR 23-3.080, including grouting.

(3) Sensitive Area C. The Springfield area is one in which urbanization is occurring at a rapid rate in an extremely sensitive and fragile geologic and hydrologic setting. The area is underlain by fractured, and cavernous limestone and pollutants are able to migrate quickly, both vertically and horizontally. Because of these factors, it is necessary to treat this area differently than surrounding areas and have stricter well construction standards. All persons engaged in drilling of wells in the sensitive area C (Figure 8) shall—

(A) The casing shall be set as determined by Area C casing depth map. When drilling in Sensitive Area C, it is strongly recommended that a casing point request be submitted so that the exact amount of casing can be set, limiting the amount of grout required. Approval must be obtained before drilling begins. Area C casing depth map sets the minimum amount of required casing that will extend at least ten feet (10') below the Northview Shale. Due to surface elevation changes within the quarter (1/4) section (one-quarter (1/4) mile), the amount of casing stated on the casing depth map may extend more than ten feet (10') below the bottom of the Northview Shale. In those instances, where the casing extends more than ten feet (10') below the bottom of the Northview Shale, more than thirty feet (30') of grout is required to seal off the Northview Shale. See 10 CSR 23-3.100(3)(D);

(B) The drillhole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) New steel or plastic casing shall be installed as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(D) Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required if the casing does not go more than ten feet (10') below the bottom of the Northview Shale. Due to surface elevation changes within the quarter (1/4) section (one-quarter (1/4) mile), the amount of casing required is calculated at the highest elevation. Therefore, if a well is drilled in a lower elevation area, the required casing will go more than ten feet (10') below the bottom of the Northview Shale. In many cases, thirty feet (30') of grout will not seal off the Northview Shale since the bottom of the casing is much deeper. The Northview Shale interval must be grouted from ten feet (10') below to the top of the shale regardless of the amount of casing set. A minimum of thirty feet (30') of grout is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space. Install and seal casing as follows:

1. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

2. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

3. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(E) In areas that have water quality problems that would be aggravated by the use of steel casing, plastic casing is recommended. If it is necessary to set steel casing due to geologic reasons, the following may substitute for casing:

1. No less than one hundred feet (100') of casing shall be set. The drill hole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter and new six-inch (6") inside diameter steel casing shall be installed as specified in 10 CSR 23-3.030. A six-inch (6") hole is then drilled to total depth and a plastic liner having an outside diameter no greater than four and one-half inches (4 1/2") shall be secured into place. No variances will be issued for this requirement; and

2. Liner must be set through the casing to the required casing point. The liner must be set to the casing depth as determined by Area C casing depth map. The liner must meet all requirements as stated in 10 CSR 23-3.080 concerning liners, including grouting. More than sixty feet (60') of grout may be required as stated in 10 CSR 23-3.100(3)(D).

(4) Special Area. Due to the unique and varied geological conditions present because the bedrock is deeply weathered and often highly fractured, openings filled with mud may extend deep into the bedrock. Caving-in of the hole during drilling and after well construction is a problem. The following rules are the minimum that are required but in many cases much more steel casing may be necessary to secure the well bore. Also, in some cases plastic liner is not strong enough to hold the well bore open and steel should be used. All persons engaged in the drilling of a domestic well in special area 1 (see Figure 1 and Figure 7 included herein) shall—

(A) Set no less than eighty feet (80') of casing. The hole shall be cased fifteen feet (15') below residuum, broken rock, or mud pockets into solid bedrock or if rock is not encountered within one hundred and fifty feet (150') consult the division for further instructions concerning a variance, unless casing will be set into deeper bedrock;

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel casing as specified in 10 CSR 23-3.030. Plastic casing of any type will not be allowed in this area; and

(D) Install and seal casing as follows:

1. Full-length grout is highly recommended and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings with a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

2. A drive shoe is required except on wells where the grout is allowed to cure before drilling resumes.

A. The following times must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours;

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours;

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

3. If drilling conditions do not permit a bottom seal, then the casing must be driven and grouting material introduced around the outside casing while the casing is being driven. If the casing cannot be sealed to prevent surface contamination from entering the well, a liner must be set and sealed according to 10 CSR 23-3.080.

(E) In areas where poor drilling conditions exist and it is necessary to drive multiple strings of smaller diameter casing through the surface casing, each succeeding liner should extend into the preceding liner or casing at least twenty feet (20') and the annulus created between the casing and liner must be grouted.

(F) In wells where it is necessary to set casing below static water levels, it may be advisable to set plastic liner as stated in 10 CSR 23-3.080 from the surface to a point below the pumping water level to avoid excessive iron in the produced well water.

(5) Special Area 2 Definitions.

(A) "Lower aquifer" means that portion of transmissive, water-bearing geologic material extending from the Cotter Dolomite to igneous bedrock. The lower aquifer includes all formations constituting the Ozark Aquifer and the St. Francois Aquifer in the southwestern portion of the state.

(B) "Low-permeability bedrock" means that portion of geologic material between the lower aquifer and upper aquifer that does not readily transmit water in sufficient quantities to supply a well. The Northview Formation, the Chattanooga Shale, and the upper thirty feet (30') of the Cotter Dolomite shall constitute the low-permeability bedrock. The low-permeability bedrock serves as a natural barrier to groundwater mixing between the upper aquifer and lower aquifer. See Figure 7A included herein for an illustration of geology in Special Area 2.

(C) "Upper aquifer" means that portion of the transmissive, water-bearing geologic material above the top of the low-permeability bedrock. The upper aquifer includes all formations constituting the Springfield Plateau Aquifer in the southwestern portion of the state.

(D) "Maximum contaminant level (MCL)" is the maximum permissible concentration of a contaminant in drinking water as listed by the National Primary Drinking Water Regulations (NPDWR).

(E) "Action level (AL)" is the maximum permissible concentration of lead in drinking water as specified in the *Code of Federal Regulations*. ALs are levels used for contaminants that do not have established MCLs.

(F) "TCE" shall mean the organic chemical trichloroethylene (a common solvent) and its known degradation products, including but not limited to dichloroethylene and vinyl chloride.

(G) "Impact area" is defined as that land surface area that is underlain or surrounded by water-bearing units that contain groundwater above the MCL or AL for at least one (1) contaminant of concern (lead, cadmium, TCE or TCE degradation products, or other contaminants of the NPDWR). Standard contouring methodology shall be used to delineate the MCL and AL isoconcentration line, which will define the geographic limit of an impact area.

(6) Special Area 2. All of Newton County and Jasper County shall be listed as Special Area 2 (Figure 7B included herein) due to the contamination of portions of the upper aquifer by one (1) or more of the following: lead, cadmium, TCE, TCE degradation products or other contaminants of the NPDWR. The upper aquifer and lower aquifer are separated by a thickness of low-permeability bedrock (Figure 7A). This low-permeability bedrock limits migration of groundwater and any associated contamination from the upper aquifer to the lower aquifer. Wells that penetrate the low-permeability bedrock without an adequate length of surface casing which has had the annulus sealed by approved methods through the low-permeability bedrock may place the lower aquifer at risk to future contamination. Due to chemical and metal contamination present in the upper aquifer in portions of this area, it is necessary to require more stringent well construction standards for new wells that are drilled into the lower aquifer, to cease construction of additional upper aquifer wells in impact areas, and to limit deepening of existing upper aquifer wells in impact areas. New wells constructed outside of the impact area shall be constructed to standards that are no less stringent than the minimum well construction requirements for Area 1. All persons engaged in drilling wells in Special Area 2 shall—

(A) Before beginning construction of the well, determine if the well to be drilled is located within the impact area as shown on maps provided by the division or as determined by division staff. If data indicate change in impact area status, the impact area map may be modified by the division during January of the calendar year and that map will be maintained and available at: Department of Natural Resources, PO Box 250, Rolla, MO 65402-0250.

(B) Drill new wells within the impact area to a depth required to produce water from the lower aquifer. All new wells drilled in the impact area shall have steel or plastic casing properly installed and grouted to the depth determined by the Special Area 2 casing depth map.

1. The drill hole shall be a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

2. New steel casing shall be installed as specified in 10 CSR 23-3.030 (steel);

3. The well must be sealed by positive displacement grouting with high-solids bentonite slurry. The annulus between the casing and the borehole wall shall be grouted from the base of the borehole. The volume of grout shall be no less than the calculated volume necessary to accomplish full-length grouting of the annulus. Alternatively, full-length pressure grouting (10 CSR 23-3.030(3)(A)4.) with high-solids bentonite slurry or neat cement meets the requirements of this rule. In addition, casing must be sealed as follows:

A. When steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure as specified in subparagraph (6)(B)3.C. of this rule before drilling resumes;

B. If plastic casing is used, a drill hole shall be constructed a minimum of ten inches (10") in diameter to the casing point. Plastic casing shall be installed as specified in 10 CSR 23-3.070 (plastic) and, a packer, coupling, or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. PVC and ABS plastic casing shall not be used when known gasoline or solvent contamination exists within the impact area. The annular space shall be sealed as specified in paragraph (6)(B)3. of this rule. No packer, coupling, or inverted bell is required on wells where the grout is allowed to cure as specified in subparagraph (6)(B)3.C. of this rule before drilling resumes; and

C. The following times must be allowed for curing grout when no packer is used:

(I) High-solids bentonite slurry—varies based on additives and manufacturer's specifications. At least one hour of curing after initial slurry placement is suggested. This amount of curing time should elapse during casing placement.

(C) Uncontaminated upper aquifer wells in impact areas of Special Area 2 existing before the date of this rule may be deepened to the top of the low-permeability bedrock.

(D) Water from all new wells and deepened old wells throughout Special Area 2 shall be sampled and analyzed for lead and cadmium, plus TCE and its degradation products within

TCE impact areas. Where indicated by objective factors, the division may require sampling and analysis for other contaminants listed in the NPDWR. Qualified and properly trained persons must complete sample collection. The laboratory that analyzes the sample must be approved by the EPA for such analysis. A copy of the chain of custody form shall be submitted to the division with the well certification report form to document sampling has occurred. An appropriate chain of custody form will be available from the division.

1. In order to ensure proper well development, the well pump must run continuously for five (5) hours or until the water clears, whichever occurs first, but in no case shall the well be pumped less than two (2) continuous hours.

2. After proper well development, water samples shall be collected from the tap nearest the well.

3. All new and deepened old wells in Special Area 2 shall be constructed with a sampling port or tap within ten feet (10') of the wellhead. Water must be purged from the sampling port prior to collection of a sample.

4. Water from all new wells in Special Area 2 with less than three (3) times the applicable maximum contaminant level (MCL) or action level (AL) may be retested over a one (1)-month period following pump installation and development to assess water quality changes that may have resulted from drilling and/or well construction. The well cannot be used for human consumption until contaminant levels are below MCLs or ALs. Qualified and properly trained persons must complete sample collection. The laboratory that analyzes the sample must be approved by the EPA for such analysis. A copy of the chain of custody form shall be submitted to the division with the well certification report form to document sampling has occurred. An appropriate chain of custody form will be available from the division. The division may require any new well, whose contaminant levels do not fall below MCLs or ALs after the retest period, to be plugged.

5. Properly constructed new lower aquifer wells that are determined to be contaminated may be allowed to use water treatment systems on a variance basis, if other domestic water sources are not available at the time of well construction. Otherwise, the well must be plugged by using full-length, high-solids bentonite grout emplaced by tremie pipe which extends to within twenty-five feet (25') of the bottom of the borehole. Grout, extending from the bottom of the borehole to within two feet (2') of land surface and finished per 10 CSR 23-3.110 (2)(A)3.G., is preferred; in any case, the minimum volume of grout shall be no less than the volume calculated as necessary to accomplish full length plugging of the well.

6. Existing wells that extend uncased and/or unsealed through the low-permeability bedrock and that are found to be contaminated with lead, or cadmium, or TCE, TCE degradation products, or other contaminants of the NPDWR may be required to be plugged full-length with high-solids bentonite grout, emplaced by tremie pipe, which extends to within twenty-five feet (25') of the bottom of the borehole. Grout, extending from the bottom of the borehole to within two feet (2') of land surface and finished per 10 CSR 23-3.110(2)(A)3.G., is preferred; in any case, the minimum volume of grout shall be no less than the volume calculated as necessary to accomplish full-length plugging of the well.

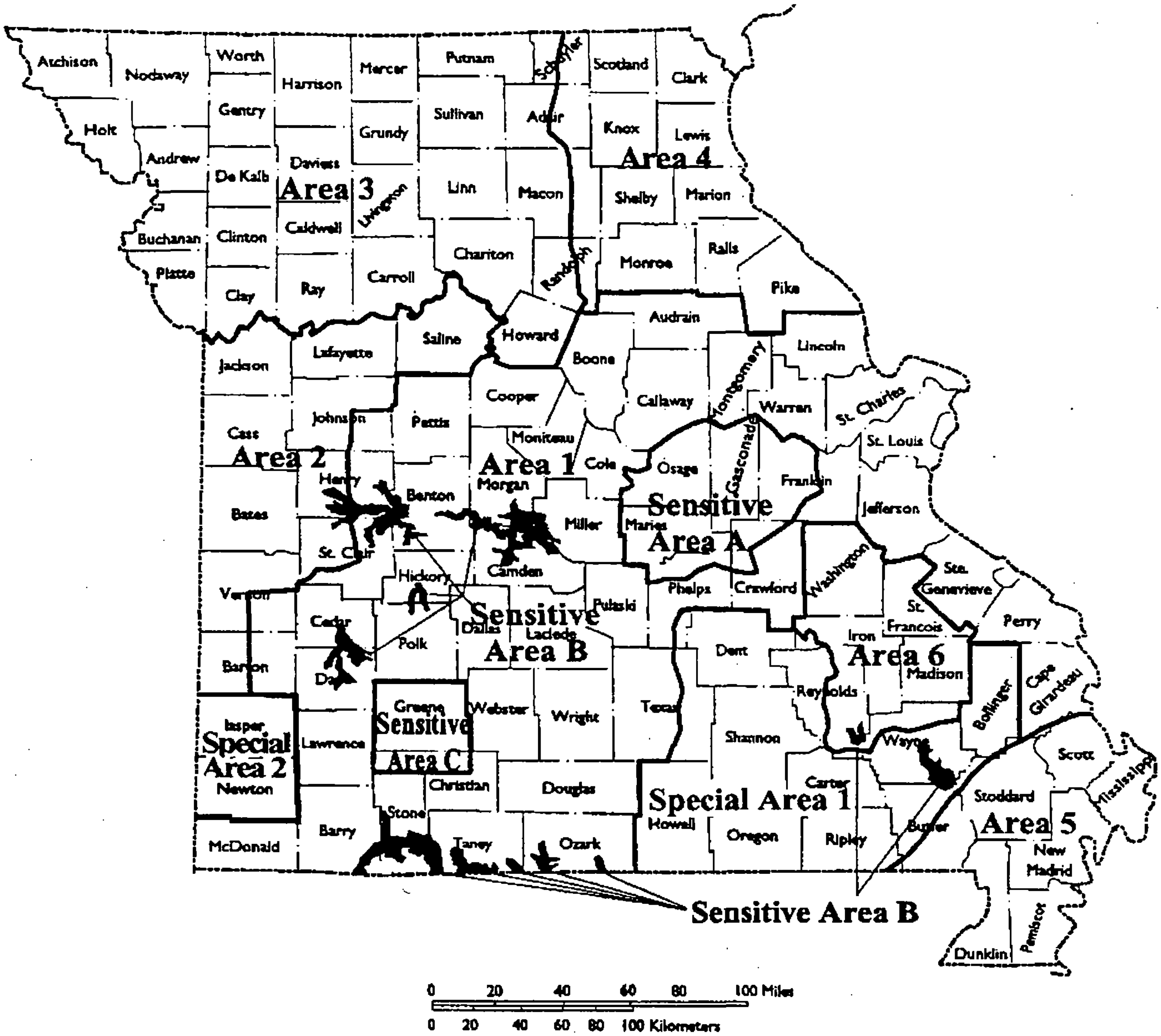


Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on following pages.

Special Area 1

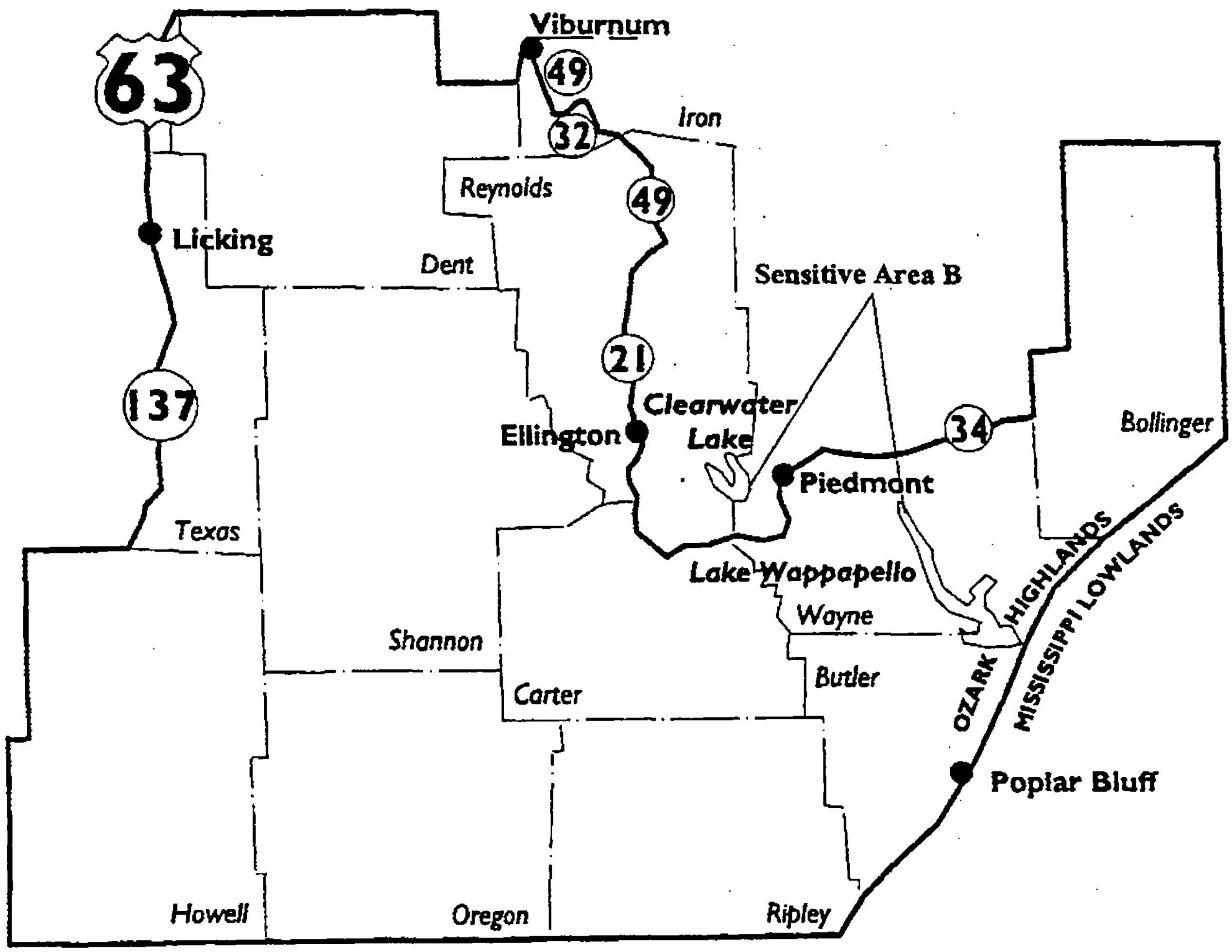
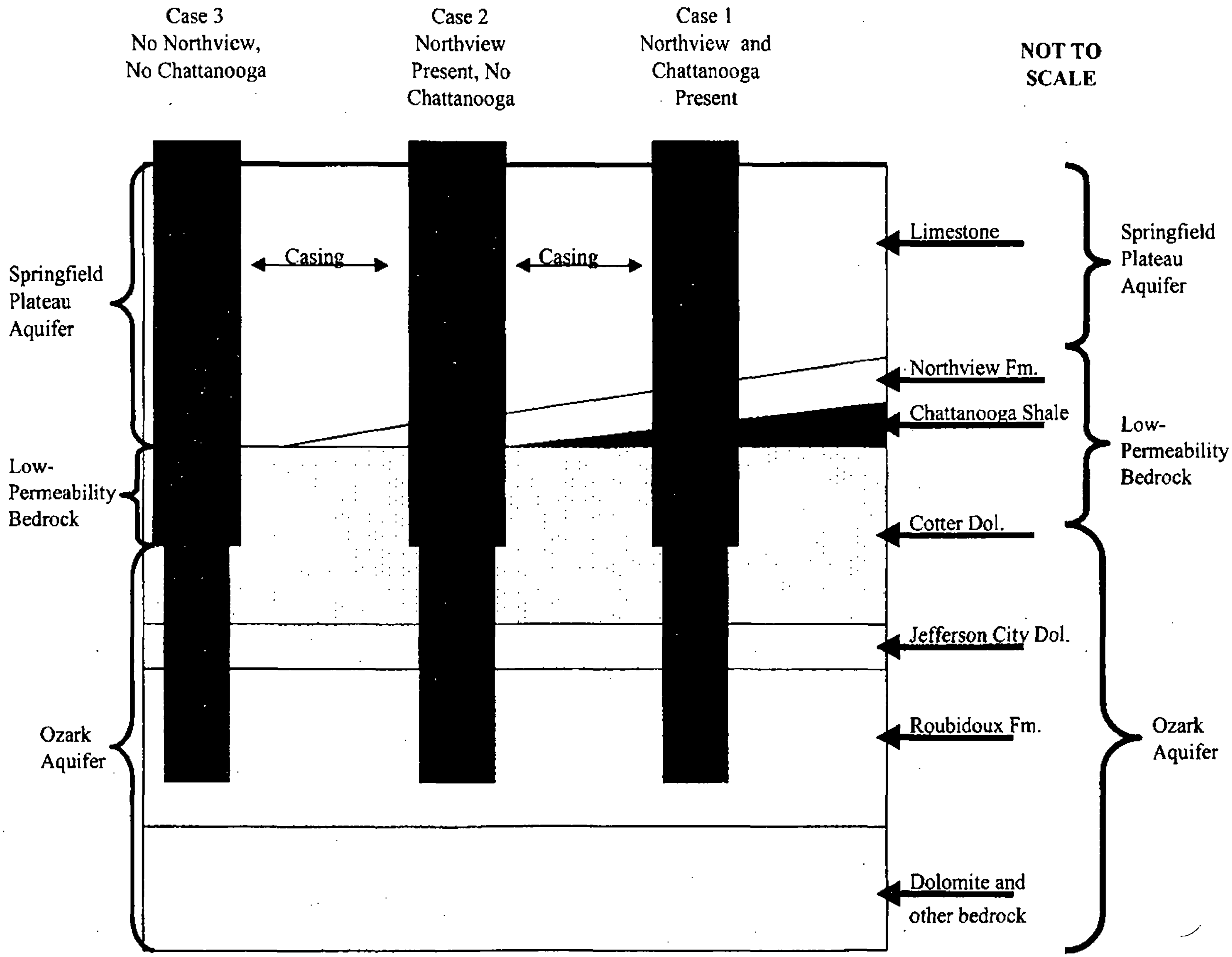


Figure 7. Enlargement of Special Area 1 and part of Sensitive Area B map.



Missouri Well Construction Rules (5-01)

Figure 7 A. Special Area 2 Geology and Well Casing

Area 1, Special Area 2, and Sensitive Areas A, B, and C

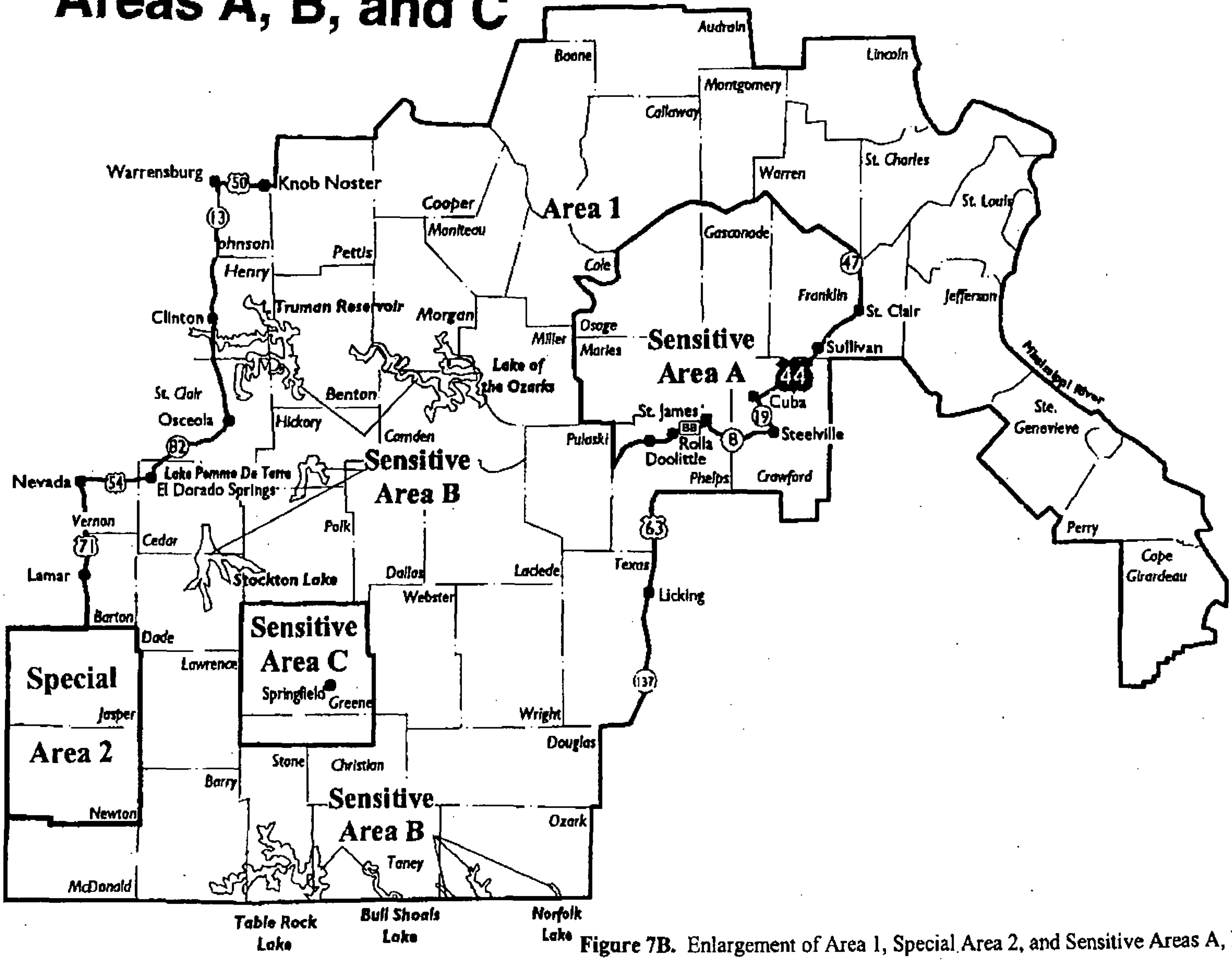


Figure 7B. Enlargement of Area 1, Special Area 2, and Sensitive Areas A, B, and C map.

AUTHORITY: sections 256.606 and 256.626, RSMo 2000. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed April 23, 2001, effective Dec. 30, 2001.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.110 Plugging of Wells

PURPOSE: This rule establishes criteria for the proper plugging procedures to be followed when abandoning a well. Plugging procedures for monitoring wells are contained in 10 CSR 23-4.080, for heat pump wells in 10 CSR 23-5.080 and for test holes in 10 CSR 23-6.050.

Editor's Note: This rule was originally filed as part of 10 CSR 23-3.020 General Protection of Groundwater. It is proposed as a separate rule because of added emphasis given to abandonment procedures in the amendment to the law.

(1) Any well which is to be abandoned must be plugged in accordance with these rules. If a well has been determined to present a threat to groundwater, the division may order that the well be permanently plugged. If a well is in such a state of disrepair (such as the pump has been removed or the water line disconnected) that continued use for purposes of obtaining groundwater is impractical and the well has not been in use for a period of two (2) years or more, the division may order that the well be permanently plugged.

(2) Permanent Abandonment of Wells.

(A) Plugging the Well.

1. A well that is to be permanently abandoned shall be disconnected from the water distribution system and the hole filled to prevent contaminating materials from entering the subsurface water-bearing formations and groundwater from one (1) aquifer mixing with that of another aquifer. Bentonite or cement grout shall be used for grouting material. If the well is so large that the use of these materials is not practical, the division will determine a proper plugging schedule. All materials, debris and obstructions that may interfere with plugging operations shall be removed from the well. Liner pipe shall be removed or perforated when necessary to assure placement of an effective plug.

2. The division must be consulted for instruction in case of abandonment of a contaminated well or where there is a question of proper procedure. Sampling of the fluids in the well may be required. A permitted well installation or pump installation contractor must be utilized to plug the well.

(B) An abandoned well shall be plugged by one (1) of the following methods in this section in accordance with the materials penetrated, in such a manner as to prevent it from acting as a channel for pollution. A report of the method of plugging shall be filed with the division on a registration report form that is provided by the division.

(C) Plugging requirements contained in 10 CSR 23-3.010–10 CSR 23-3.100 do not pertain to bedrock irrigation wells and public water supply wells which include community, noncommunity and nontransient noncommunity type wells. Plugging requirements for these types of wells will be determined on a case-by-case basis by the division and must be performed by a permitted contractor, and may be more stringent than those for domestic and multifamily wells.

1. Hand dug wells and bored wells no deeper than eighty feet (80'). To plug this type of well, the following steps must be followed (see Figure 9):

A. Remove all pumps, pipe, debris and surface coverings or concrete cap;

B. Push in top three feet (3') of well lining. Lining may be composed of rock, brick or tile. If lining is composed of any other material consult the division for further instructions;

C. Fill well to within three feet (3') from the surface with clean fill such as gravel, sand, varied sized agricultural lime or other approved material;

D. Disinfect fill material. If there is water in the well, chlorine must be added to bring its concentration to at least one hundred (100) parts per million (ppm) (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect the fill material before it is placed into the well;

E. Fill the remaining hole with clay or clay-rich soil. Soil should be mounded slightly at the top to help offset settling; and

F. Submit the registration report form and fee to the division.

2. Wells completed in unconsolidated deposits. This type of well includes alluvial wells, glacial drift wells and nonbedrock wells. To plug this type of well, the following steps must be followed:

A. Remove all pumps, pipe and debris from well;

B. Dig around casing and remove top three feet (3') of casing. The remaining hole must be at least two feet (2') in diameter larger than the existing casing (see Figure 10);

C. Fill well from total depth to fifty feet (50') from surface with clean fill such as gravel, sand, varied sized agricultural lime or other approved material;

D. Disinfect fill material. If there is water in the well, you must add chlorine to the water bringing it to a concentration of at least one hundred (100 ppm) (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect the fill material before it is placed into the well;

E. Place a grout plug that fills the upper fifty feet (50') of casing and extends into the larger excavated area, at least one foot (1'). In agricultural or yard settings the remaining hole above the grout plug must be filled with soil. In other settings, the remaining hole above the grout plug may be filled with clean fill if the well site is to be paved; and

F. Submit registration report form and fee to the division.

3. Wells completed in bedrock. This type of well includes any domestic well that produces water from bedrock aquifers (see Figure 11). To plug this type of well, the following steps must be followed:

A. Remove all pumps, pipe and debris from well. Any liner must be removed or perforated if possible;

B. Dig around casing and remove top three feet (3') of casing. The remaining hole must be at least two feet (2') in diameter larger than the existing casing;

C. Fill well from total depth to fifty feet (50') below bottom of casing with clean fill such as gravel, sand, varied sized agricultural lime or other approved fill material;

D. Disinfect fill material. If there is water in the well, you must add chlorine to the water bringing it to a concentration of at least one hundred (100) ppm (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect any fill material used before it is placed into the well;

E. Place cement or bentonite from a point fifty feet (50') below the bottom of the casing to two fee (2') from the suface making sure the grout extends into the excavated area at least one foot (1'). If the water level is above a point fifty feet (50') below the bottom of the casing, then bentonite chips must be used or the cement or bentonite slurry must be emplaced through a tremie pipe lowered through the water level to the top of the fill. Under no circumstances may cement or bentonite slurry be poured through large columns of water without the use of a tremie pipe (see paragraph (2)(C)6. for alternative cement plugging technique);

F. May plug the well, if the well has one hundred fifty feet (150') or more of casing, by filling the well with clean aggregate to a point fifty feet (50') below the bottom of the casing, placing a grout plug from this point extending up into the casing thirty feet (30'). From this point to within fifty feet (50') of the surface, clean aggregate fill may be used. From fifty feet (50') to two feet (2') must be filled with grout making sure the grout extends into the excavated area at least one foot (1');

G. Cut casing off at top of bedrock, if bedrock is encountered when digging around the casing, and fill remaining hole with cement slurry. In agricultural or yard settings, the plug must terminate at least two feet (2') below the finished surface grade and the remaining hole filled with soil. In other settings, the remaining hole may be filled with clean fill if the well site is to be paved; and

H. Submit registration report form and fee to division.

4. For those wells which casing depth, water level and total depth are not known and cannot be determined, plugging instructions will be determined on a case-by-case basis and may be more stringent.

5. As clean fill is being placed into a well, periodic measurements should be taken to ensure that the fill does not reach a point closer than fifty feet (50') below the bottom of the existing casing. If fill is placed above this point, plugging schedules will be determined by the division and may result in removal of fill material.

6. When plugging a well that contains water that is above a point of fifty feet (50') below the bottom of the casing or liner, whichever is deeper, cement slurry may be poured into the well if a tremie pipe is placed in the well to near the bottom and acts as a conduit for the water to escape through as the cement slurry is poured into the well casing from the surface. The cement slurry must be poured in one (1) continuous operation. Mixing small batches and pouring is not permitted.

7. The flow in a flowing well shall be confined, if possible, and the well plugged in accordance with well plugging requirements supplied by the division which will be determined on a case-by-case basis. Proper judgment shall be exercised in the feasibility of plugging flowing wells. In some cases the confining formation may have been so badly disturbed that plugging may only cause the flow to discharge in a less appropriate location. In other situations, the flow may have eroded so much material that the landscape has taken on the appearance of a natural spring. The plugging in this case may be impractical, if not impossible.

(3) Owners Responsibility for Plugging Well. The owner shall be responsible for the permanent plugging of an abandoned well except when the permittee improperly locates, constructs or completes the well. The permittee shall then be responsible for the plugging of the well.

(4) Wells Abandoned by Landowners. Wells abandoned by landowners after August 28, 1991, shall be plugged or cause to be plugged, in accordance with this rule. Landowners may plug their own wells located on property they own or lease, if the wells were intended for use only in single-family houses which are their permanent residences, or were intended for use only for farming purposes on their farms, and where the waters that were produced were not intended for use by the public or in any residence other than their own. If a landowner pays someone to assist with the plugging of the well, that person must hold a current Missouri well installation contractor permit or Missouri pump installation contractor permit except as stated in 10 CSR 23-1.090(2) concerning hand dug wells. If the division makes a finding that certain unusual conditions exist at a well that is to be plugged, the division may require that the well be plugged by a permitted well installation contractor or a permitted pump installation contractor. Unusual conditions exist at a well that is to be plugged if the total depth, amount of casing and water level are not known; a liner is in the well; foreign objects are stuck in the well; the well is contaminated with pollutants other than bacteria; or other conditions determined by the division on a case-by-case basis.

(5) A permittee or landowner who permanently abandons any well that is removed from service shall report the abandonment to the division on a registration report form provided by the division. A permittee or landowner shall report to the division any unplugged abandoned wells existing on his/her property (landowner) or property on which a permittee is hired to perform well drilling repair or pump installation.

(6) All wells may be plugged by filling the well via tremie or pressure grouting with cement slurry, bentonite or bentonite slurry from total depth to two feet (2') from the surface, if this method exceeds other minimum standards.

(7) If the division finds that certain conditions for high potential of groundwater contamination exist at a well, the division may require that a permitted well installation contractor or pump installation contractor be contracted to plug the well.

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo Supp. 1991. This rule was previously filed as 10 CSR 23-3.020(3)–(9). Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

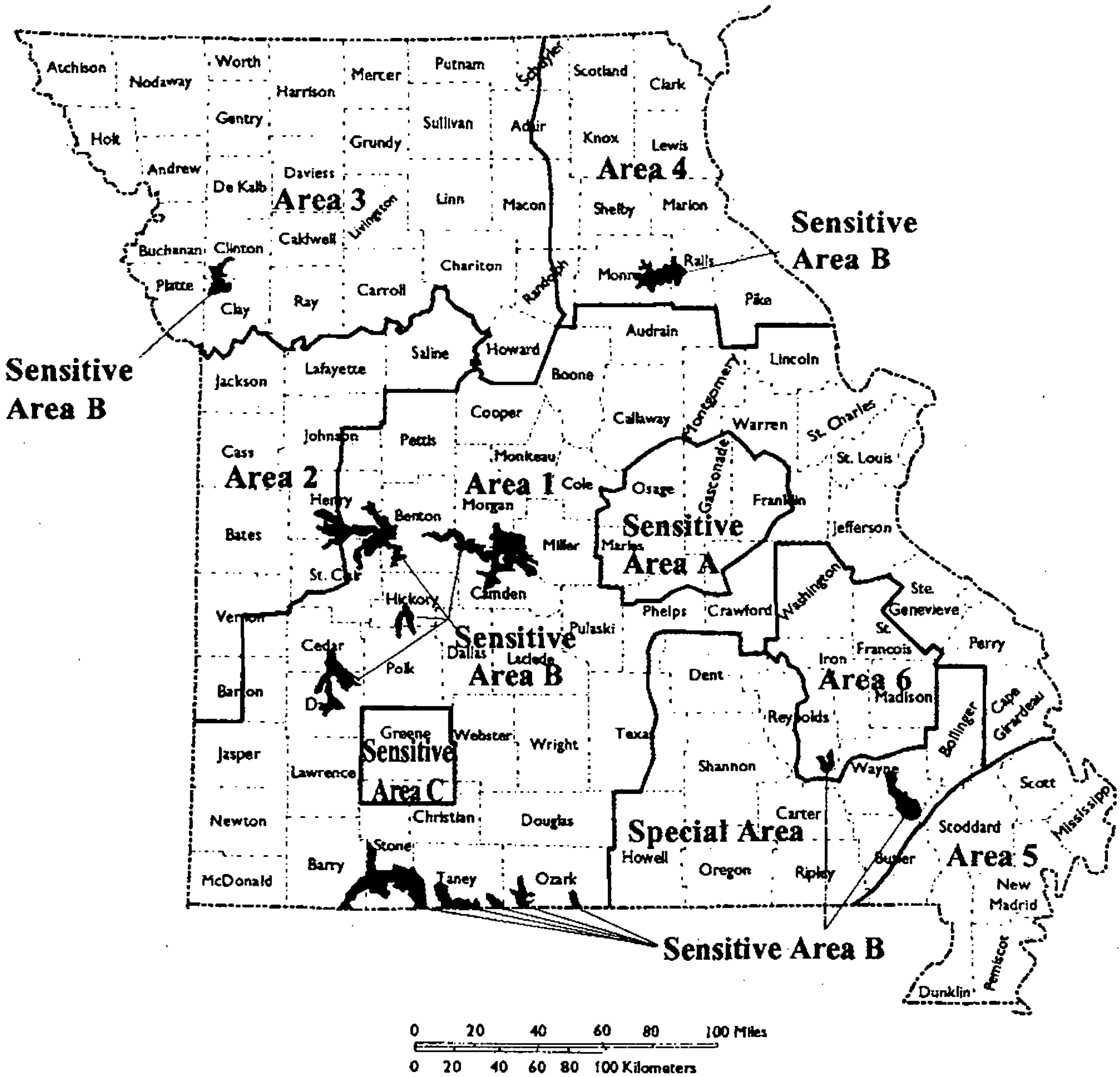


Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on following pages.

Area 2

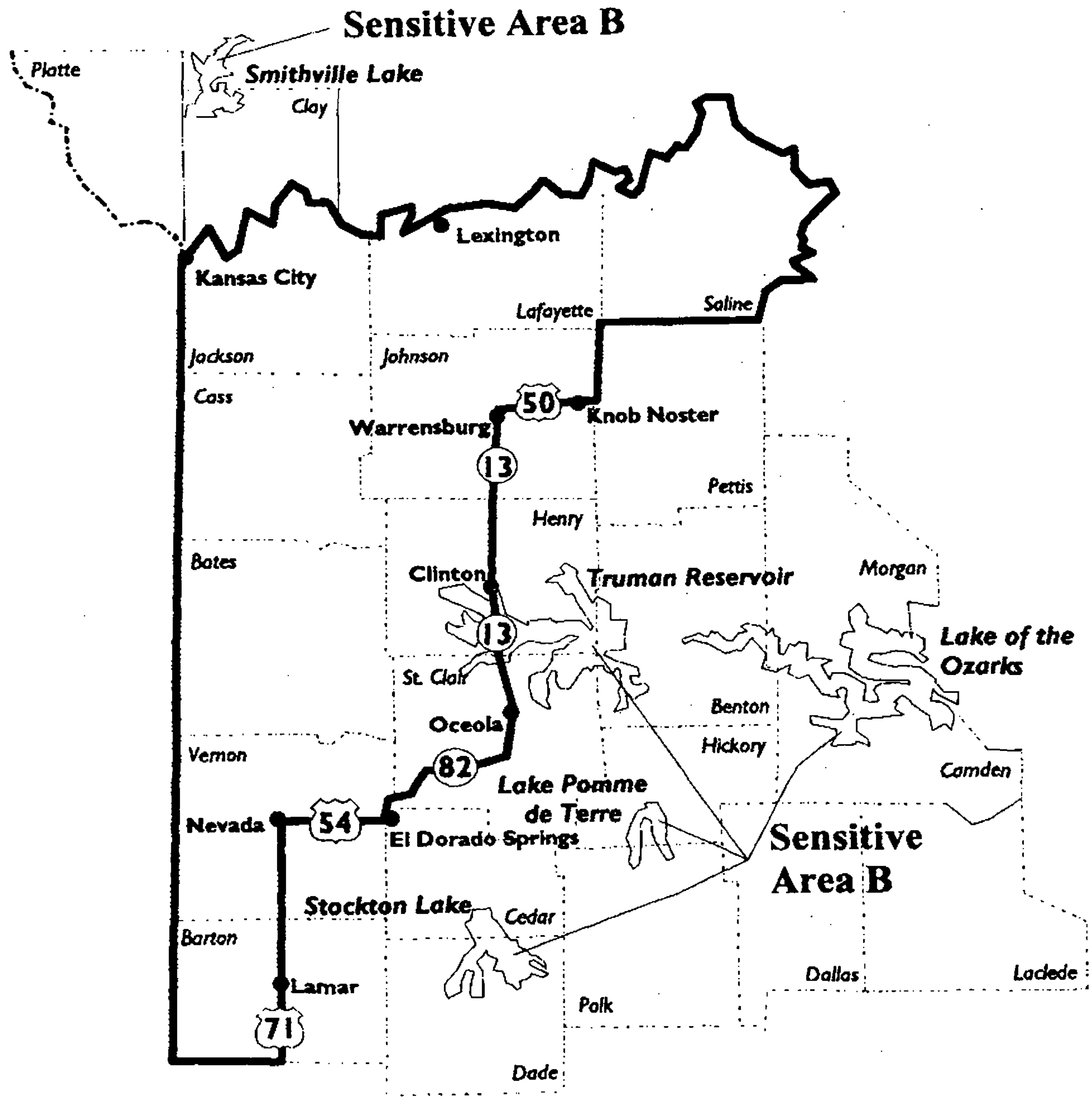


Figure 2. Enlargement of Area 2 and Sensitive Area B map.

Area 3

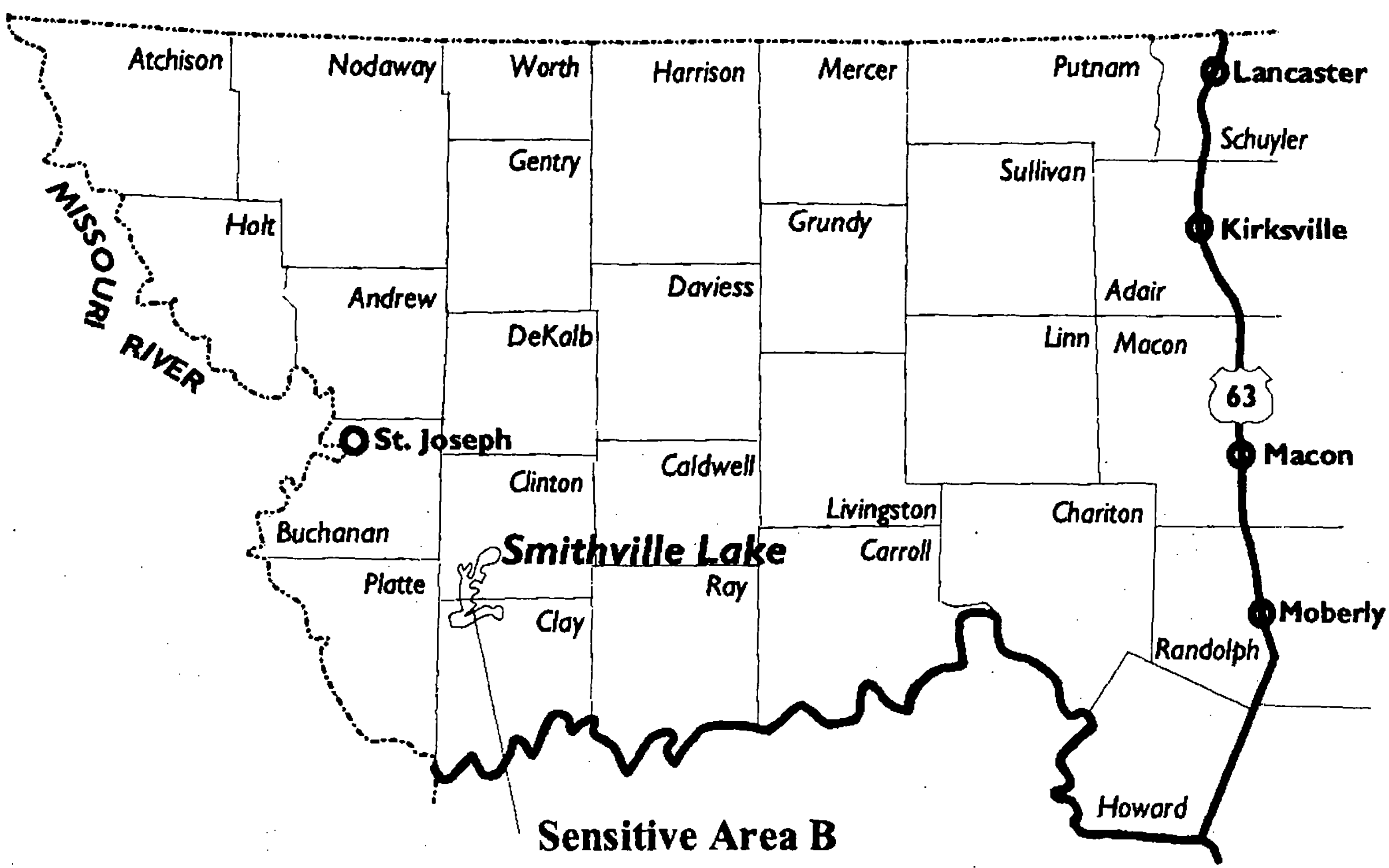


Figure 3. Enlargement of Area 3 and part of Sensitive Area B map.

Area 4

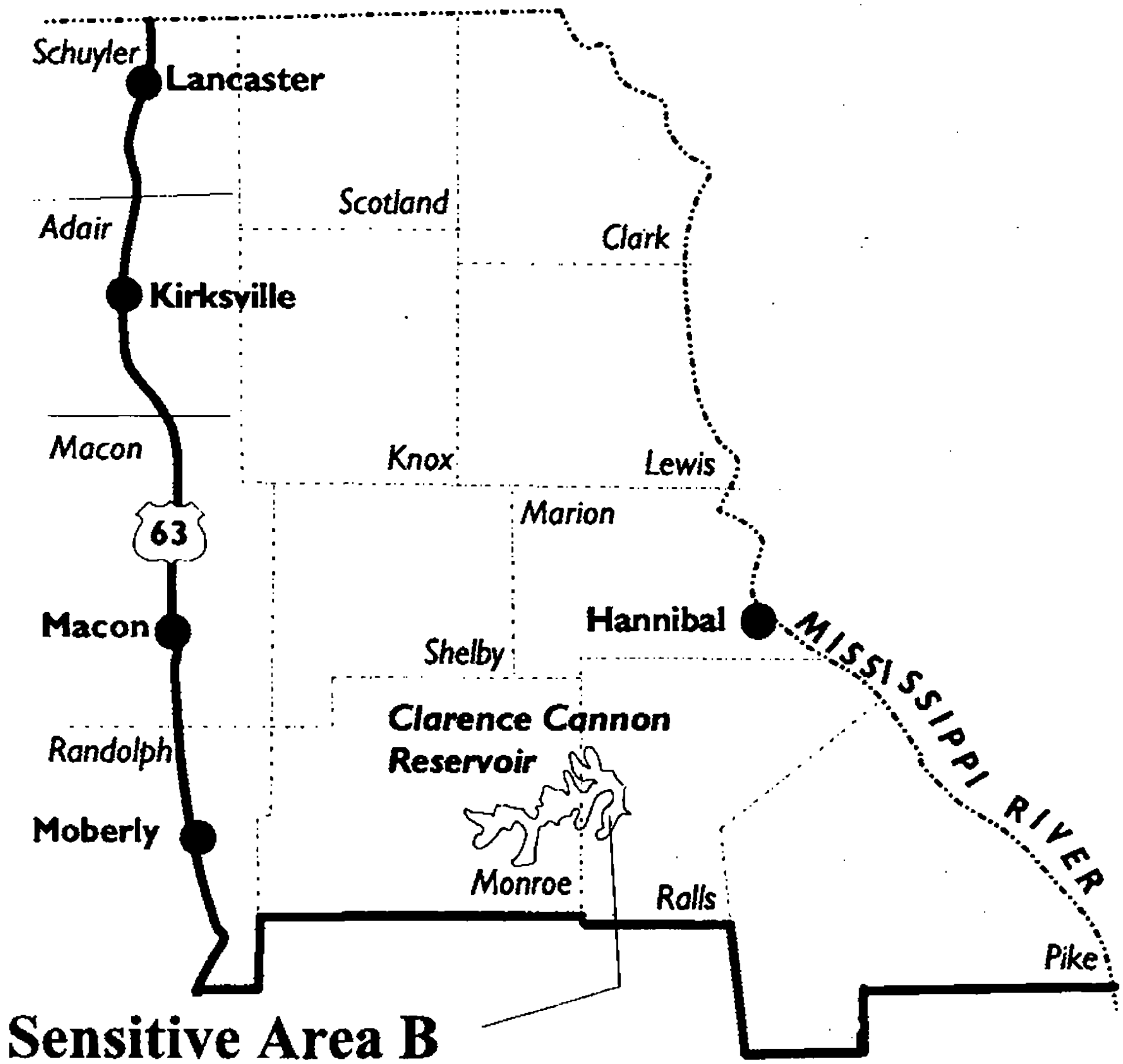


Figure 4. Enlargement of Area 4 and part of Sensitive Area B map.

Area 5

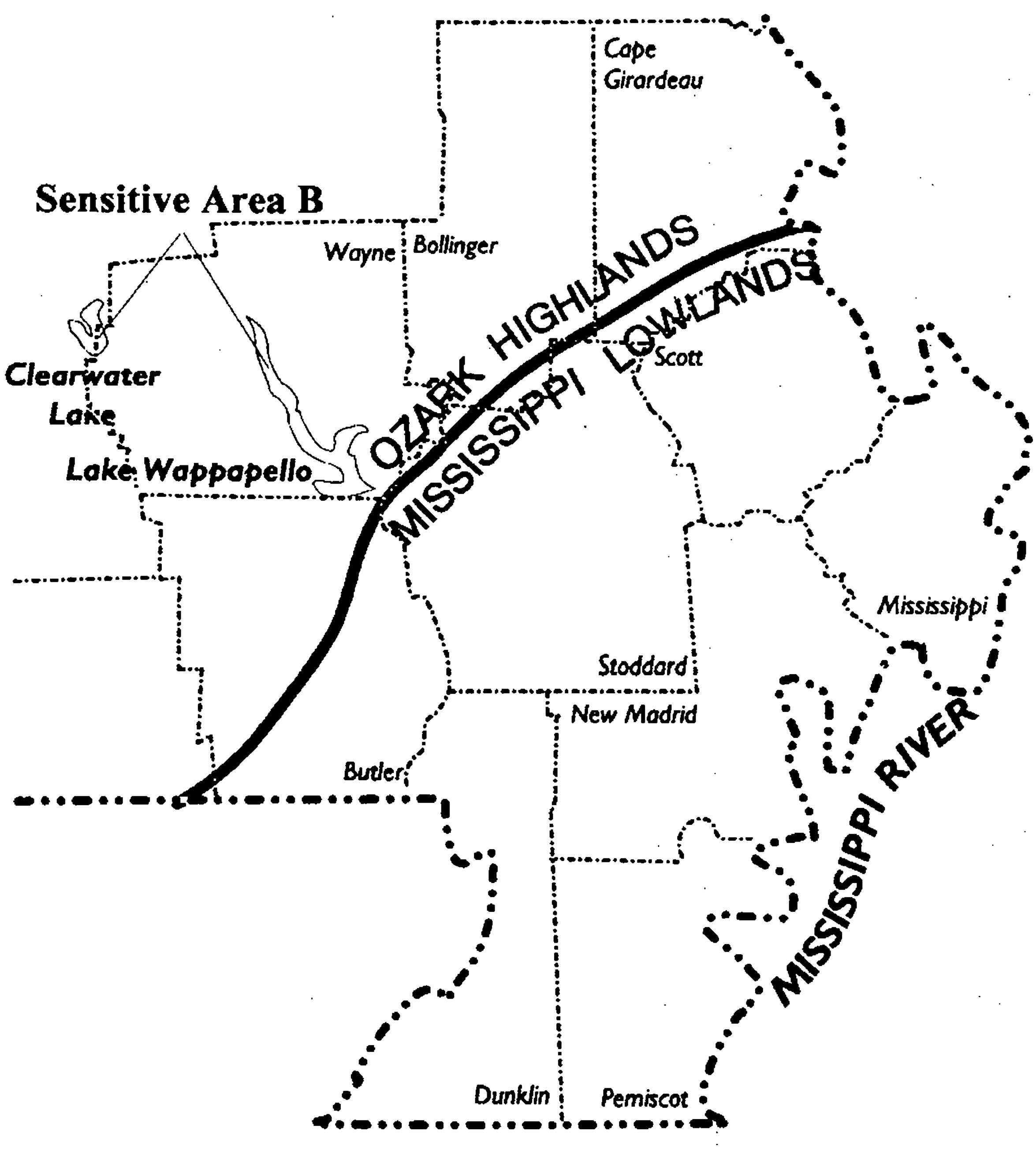


Figure 5. Enlargement of Area 5 and part of Sensitive Area B map.

Area 6

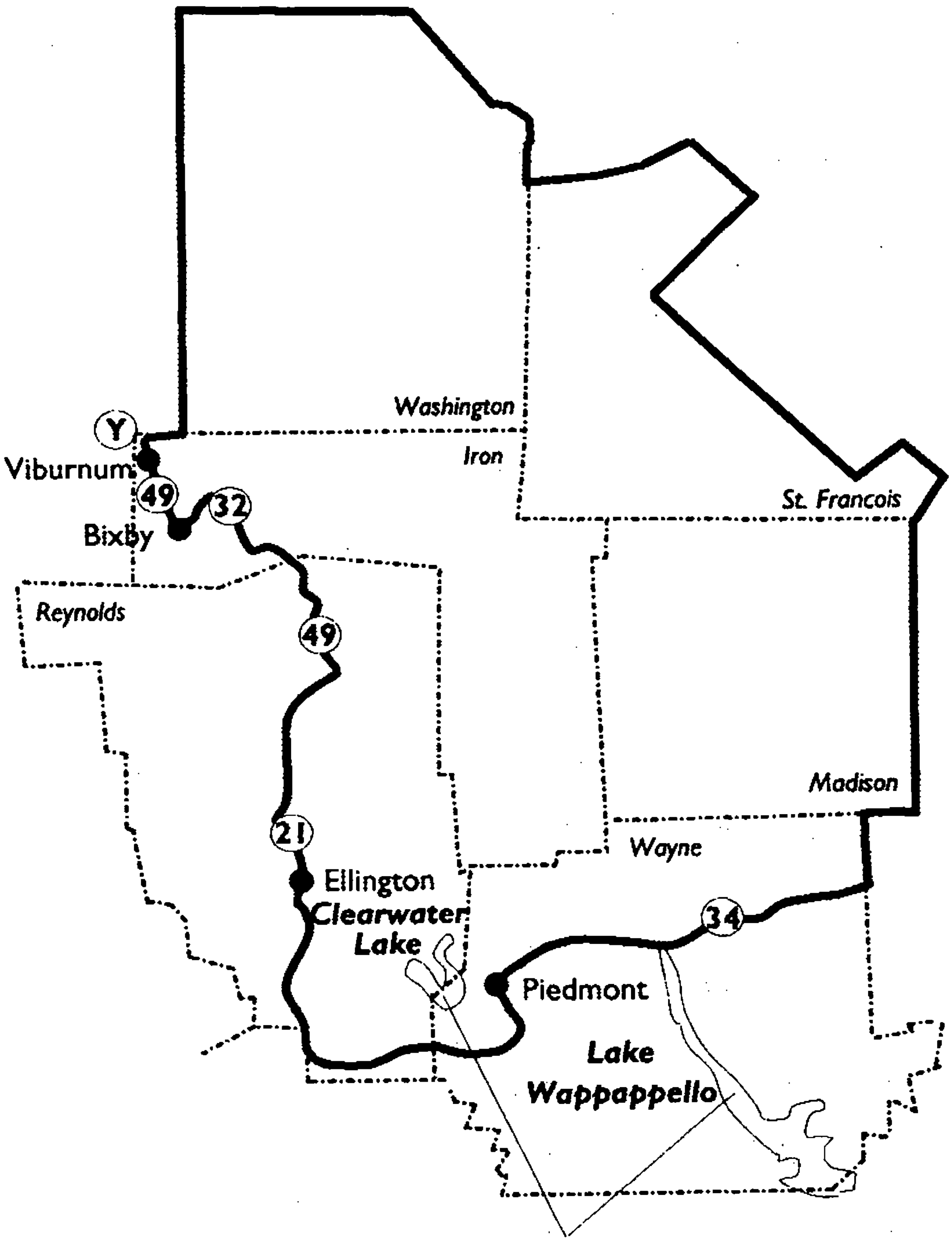


Figure 6. Enlargement of Area 6 and part of Sensitive Area B map.

Special Area

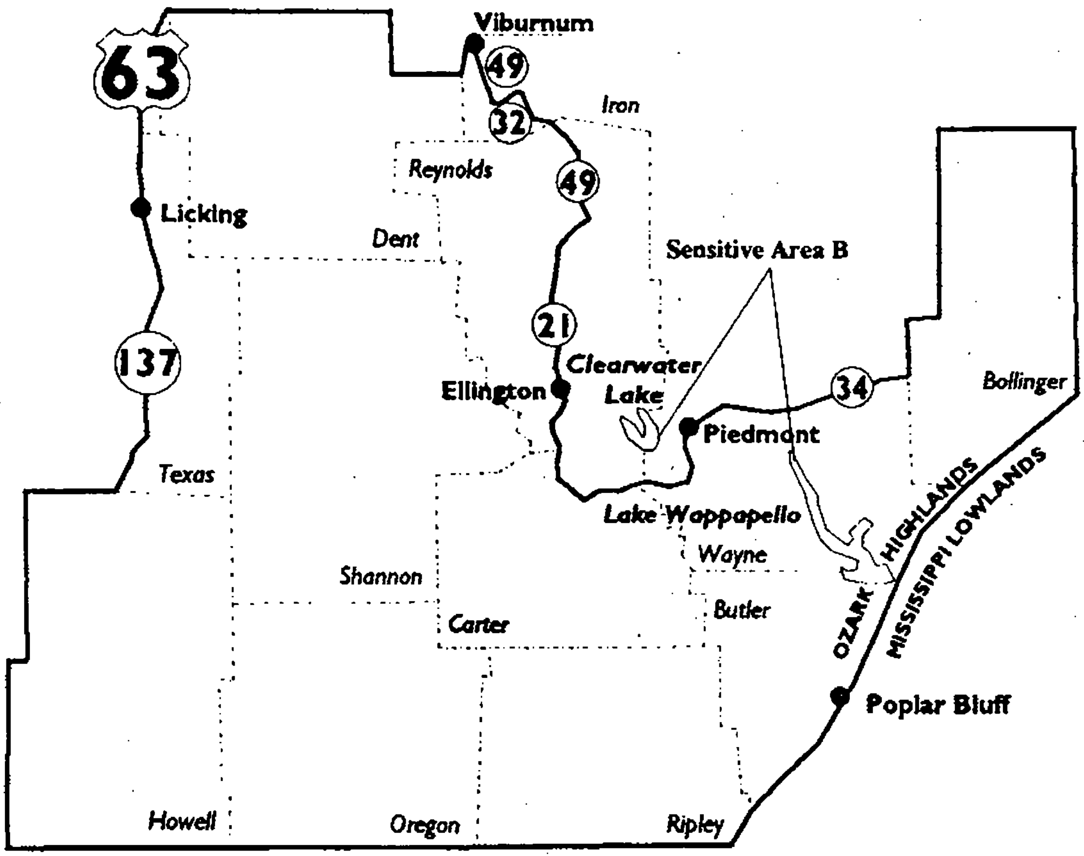


Figure 7. Enlargement of Special Area and part of Sensitive Area B map.

Area 1 and Sensitive Areas A, B, and C

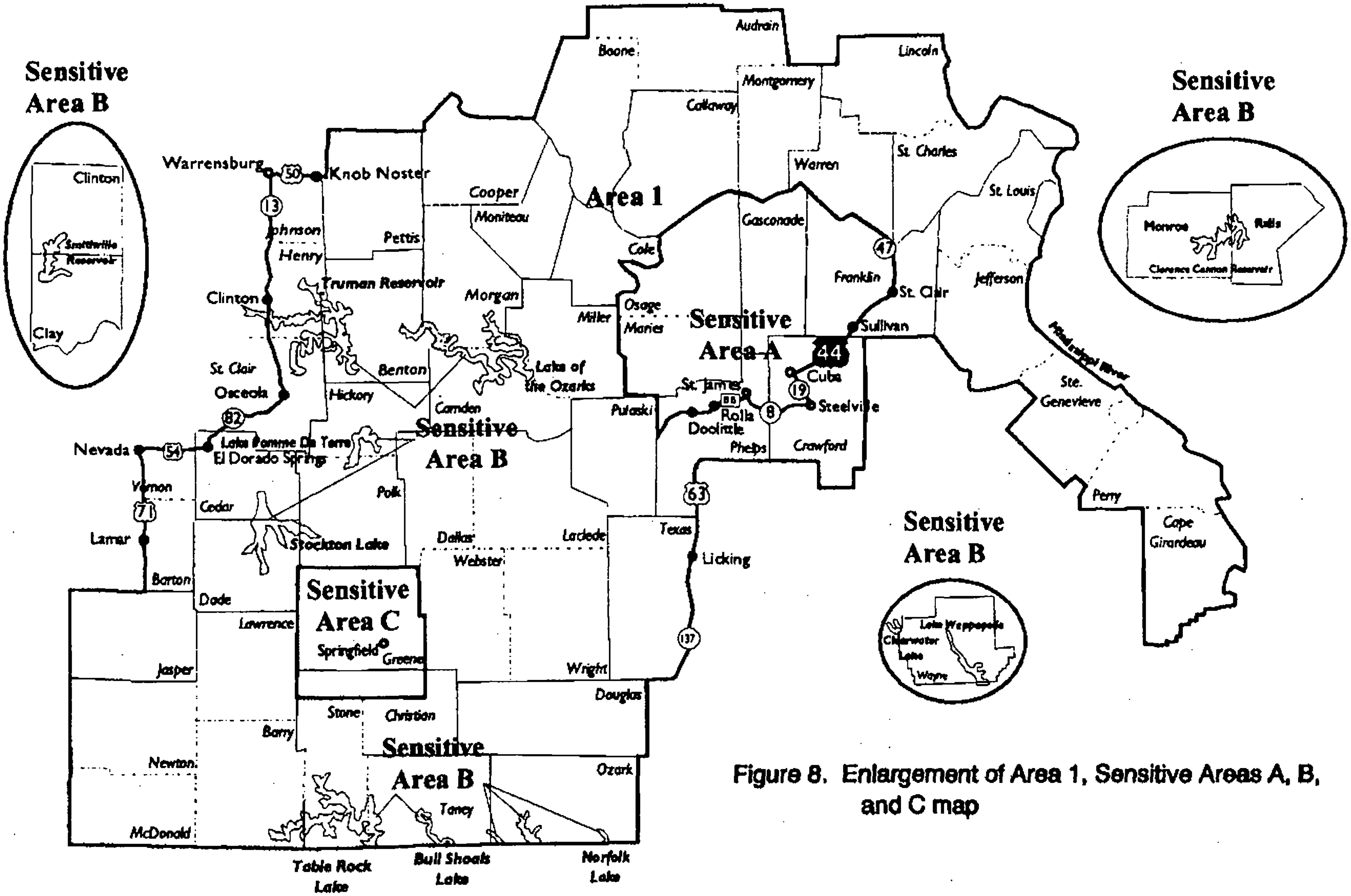


Figure 8. Enlargement of Area 1, Sensitive Areas A, B, and C map

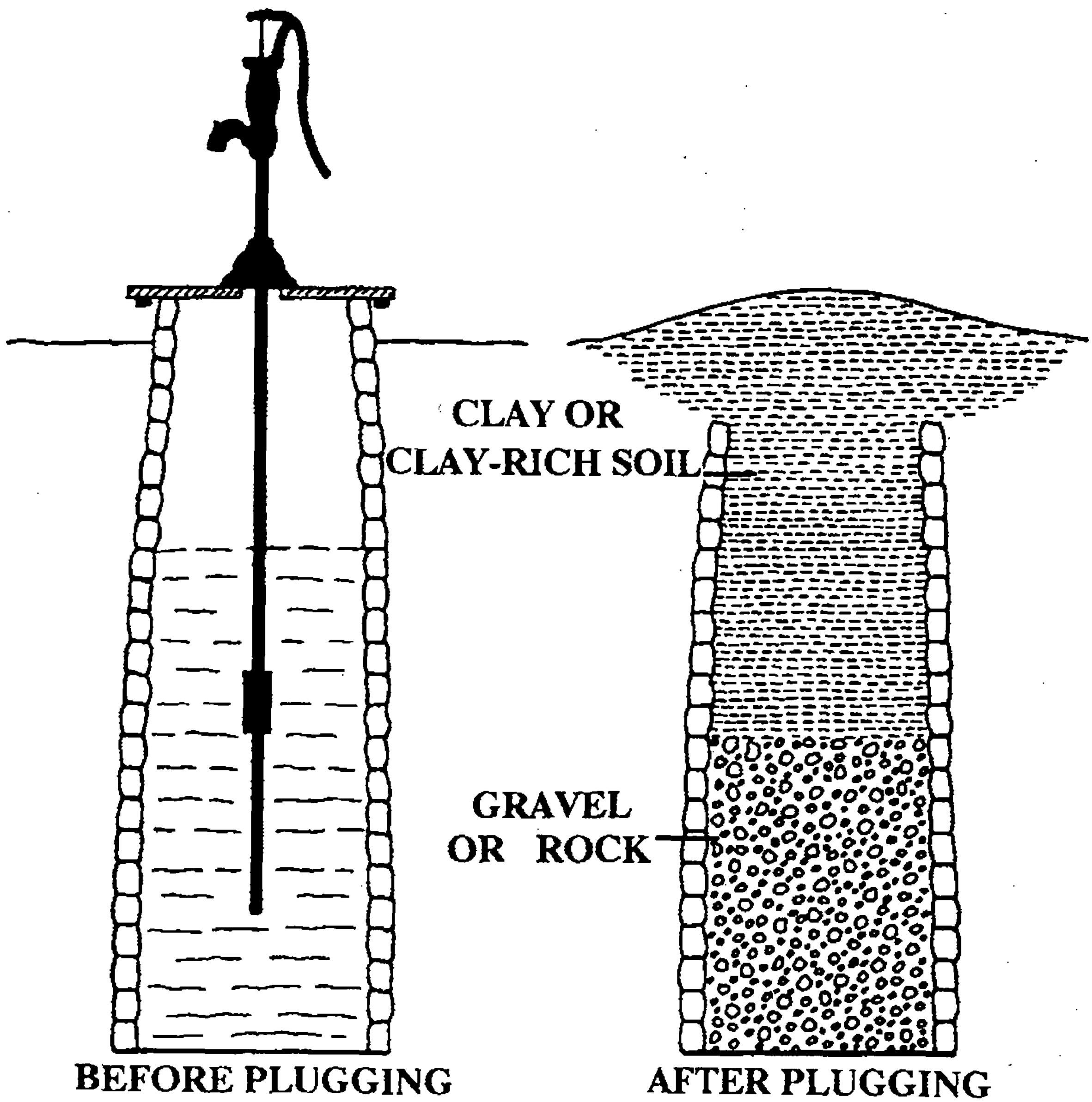


Figure 9 - Plugging diagram for dug wells.

PLUGGING DOMESTIC WELLS IN UNCONSOLIDATED DEPOSITS

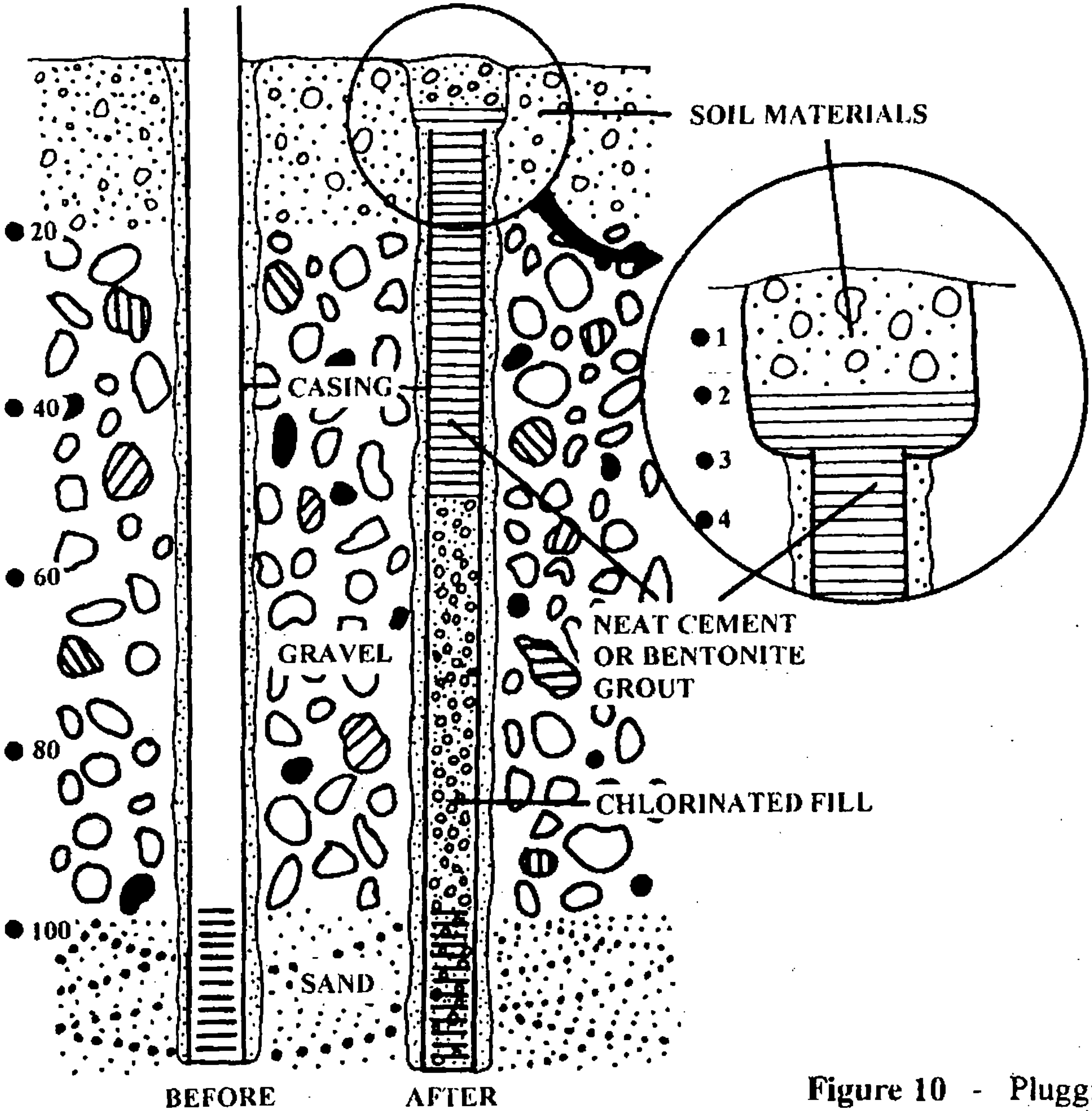


Figure 10 - Plugging diagram for domestic wells in unconsolidated deposits.

PLUGGING DOMESTIC WELLS IN BEDROCK

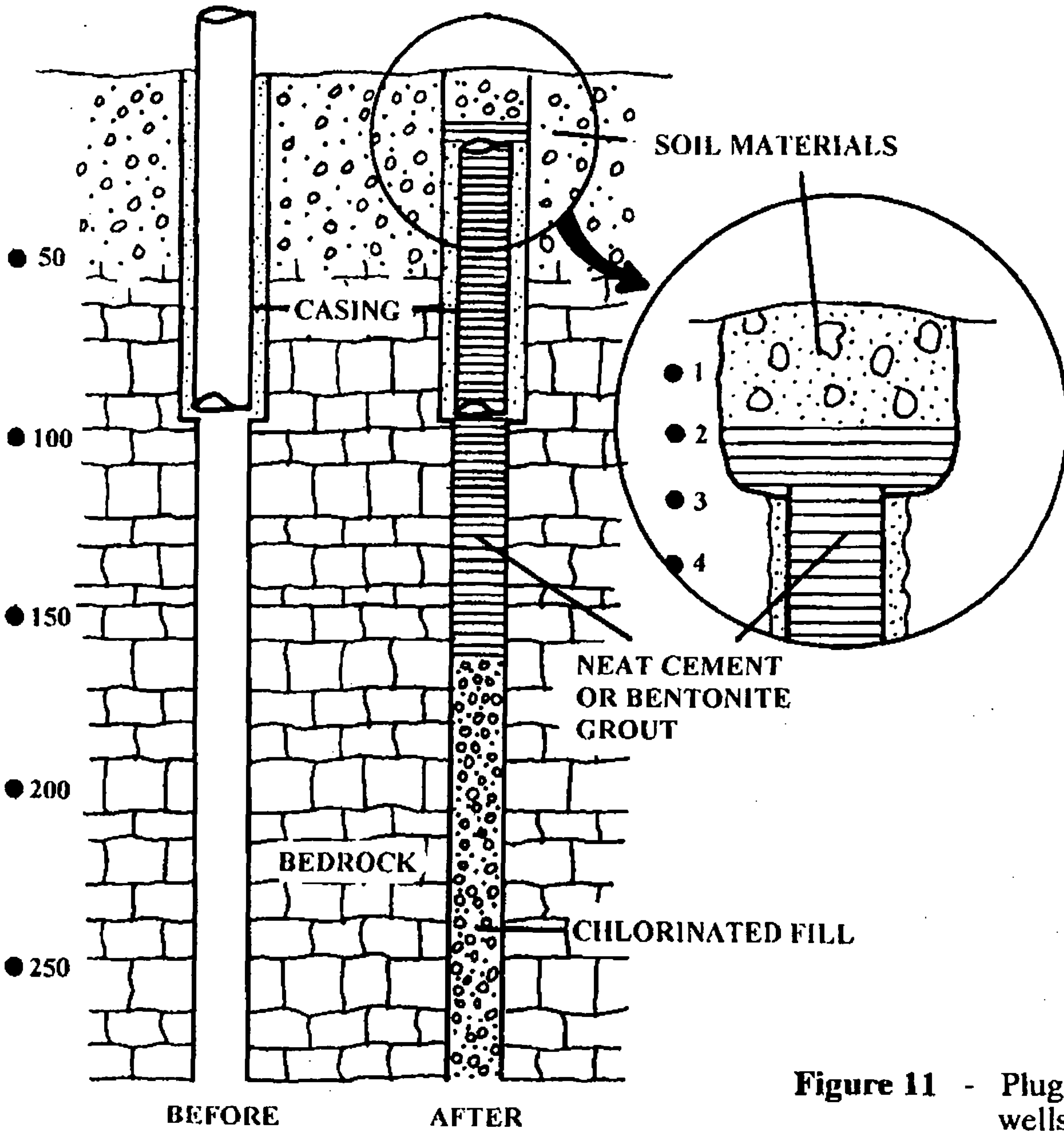


Figure 11 - Plugging diagram for domestic wells in bedrock.

MDNR Regulations

Title 10

Division 80 – Solid Waste Management

Chapter 3 – Sanitary Landfill

Date: 07/31/1998

Rules of
Department of Natural Resources
Division 80—Solid Waste Management
Chapter 3—Sanitary Landfill

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 80—Solid Waste Management
Chapter 3—Sanitary Landfill

10 CSR 80-3.010 Design and Operation

PURPOSE: This rule pertains to the design and operation of a sanitary landfill.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) General Provisions.

(A) This rule is intended to provide for sanitary landfill area operations that will have minimal impact on the environment. The rule sets forth requirements and the method of satisfactory compliance to ensure that the design, construction and operation of sanitary landfills will protect the public health, prevent nuisances and meet applicable environmental standards. The requirement subsections contained in this rule delineate minimum levels of performance required of any sanitary landfill operation. The satisfactory compliance subsections are presented as the authorized methods by which the objectives of the requirements can be realized. The satisfactory compliance subsections are based on the practice of sanitary landfilling municipal solid waste. If techniques other than those listed as satisfactory compliance in design or operation are used, it is the obligation of the sanitary landfill owner/operator to demonstrate to the department in advance that the techniques to be employed will satisfy the requirements. Procedures for the techniques shall be submitted to the department in writing and approved by the department in writing prior to being employed. Notwithstanding any other provision of these rules, when it is found necessary to meet objectives of the requirement subsections, the department may require changes in design or operation as the condition warrants.

(B) Owners/operators of sanitary landfills that close after October 9, 1991 and prior to October 9, 1993, and do not apply the final cover and establish vegetation on the sanitary landfill within one hundred eighty (180) days of last receipt of waste, or an alternative time frame negotiated with the department, are subject to all the requirements of this rule.

(C) Sanitary landfills not in compliance with the requirements of this chapter and of 10 CSR 80-2 are considered to be open dumps, which are prohibited by state law.

(2) Solid Waste Accepted.

(A) Requirement. Only the following solid wastes shall be accepted for disposal in a sanitary landfill: municipal waste; bulky waste; demolition and construction wastes; brush and wood wastes; cut, chipped or shredded tires as defined in 10 CSR 80-8; soil; rock; concrete; related inert solids relatively insoluble in water; and incinerator and air pollution control residues generated from facilities exempted under 10 CSR 80-2.020(9)(A)2.

(B) Satisfactory Compliance—Design. The plans shall specify the types of waste to be accepted for disposal at a sanitary landfill.

(C) Satisfactory Compliance—Operations.

1. Certain bulky solid wastes, such as automobile bodies and furniture shall be crushed on solid ground and then pushed onto the working face near the bottom of the cell. Other bulky items, such as demolition wastes, tree stumps and large timbers shall be pushed onto the working face near the bottom of the cell. Bulky waste shall be excluded from the first layer of waste placed above a composite liner to ensure that the integrity of the liner and leachate collection system has been maintained.

2. Dead animals shall be placed on the working face with other municipal solid wastes and covered immediately with solid waste or soil.

3. The disposal of special wastes which have been approved in the construction permit shall be conducted in accordance with the approved design and operating plans plus any additional procedures determined by the department as necessary to protect the environment.

4. For the disposal of special wastes not specifically approved in the construction permit, a special waste disposal request form shall be completed by the generator of the waste and the operator of the sanitary landfill prior to acceptance and disposal of the waste. The completed request shall be retained in the sanitary landfill operating record. Neither a permit modification nor prior approval is required unless deemed necessary by the department due to the characteristics of the special waste.

(3) Solid Waste Excluded.

(A) Requirement. The following are excluded from disposal:

1. Regulated quantities of hazardous waste;

2. Radioactive materials as follows:

A. The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content as defined in the Atomic Energy Act of 1954, 42 U.S.C. section 2014(e)(2)(1996);

B. Any radioactively-contaminated material used in or resulting from the cleanup of radioactively-contaminated sites;

C. Any byproduct, source or special nuclear material regulated by the Atomic Energy Act of 1954;

D. Radioactive material used in or resulting from medical processes or liquid radioactive material, unless the material has a half-life of less than thirty (30) days;

E. Naturally Occurring Radioactive Material (NORM) except with prior written approval from the Missouri Department of Natural Resources;

F. Any accelerator-produced radioisotopes, unless the material has a half-life of less than thirty (30) days;

G. Smoke detectors, electron tubes, luminous wristwatches and clocks, luminous lock illuminators, luminous automobile shift quadrants, luminous marine compasses and luminous thermostat dials and pointers in quantities greater than ten (10) items from any single source;

H. "Low-level radioactive waste" as defined in section 260.700, RSMo as radioactive waste that is not classified as high-level radioactive waste and that is class A, B, or C low-level radioactive waste as defined in 10 CFR 61.55, as that section existed on January 26, 1983. "Low-level radioactive waste" or "waste" does not include any such radioactive waste that is owned or generated by the United States Department of Energy; by the United States Navy as a result of the decommissioning of its vessels, or as a result of any research, development, testing or production of any atomic weapon; and

I. Any greater-than-class-C radioactive waste;

3. Explosives;

4. Regulated quantities of polychlorinated biphenyls (PCBs);

5. Bulk liquids;

6. Highly flammable or volatile substances;

7. Septic tank pumpings;

8. Major appliances;

9. Waste oil;

10. Lead-acid batteries;

11. Waste tires as provided by 10 CSR 80-8.020;

12. Yard waste; and

13. Infectious waste as provided by 10 CSR 80-7.010.

(B) Satisfactory Compliance—Design.

1. In consultation with the department, the applicant shall determine what wastes are to be accepted and shall identify them in the plan and the application for a construction permit. The criteria used to determine whether the waste can be accepted shall include the design of the landfill, the physical and chemical characteristics of the wastes, the quantity of the wastes, and the proposed operating procedures.

2. The plans shall specify the operating procedures for screening and removal of wastes which are excluded from disposal according to subsection (3)(A) of this rule. Operating procedures for the screening and removal of excluded wastes shall include:

A. At a minimum, random inspections of incoming loads unless the owner/operator takes other steps to ensure that incoming solid wastes do not contain wastes excluded from disposal at sanitary landfills;

B. Records of any inspections;

C. Training of facility personnel to recognize unacceptable wastes; and

D. Immediate notification of the department if a regulated hazardous waste, regulated PCB waste, or infectious waste is discovered at the facility.

(C) Satisfactory Compliance—Operations.

1. A sign with the following wording shall be displayed prominently at the site entrance. "Regulated hazardous waste, radioactive materials, polychlorinated biphenyls (PCBs), bulk liquids, highly flammable or volatile substances, septic tank pumpings, major appliances, waste oil, lead-acid batteries, waste tires as provided by 10 CSR 80-8, yard waste, explosives and regulated infectious waste are excluded from disposal."

2. The operating procedures for screening of wastes and for removal of wastes which are excluded from disposal according to subsection (3)(A) of this rule shall be implemented.

3. Bulk or noncontainerized liquid waste shall not be placed in a sanitary landfill unless—

A. The waste is household waste other than septic waste; or

B. The waste is leachate or gas condensate derived from the sanitary landfill, and the sanitary landfill is designed with a composite liner and leachate collection system as described in sections (9) and (10). The owner/operator of sanitary landfill conducting recirculation shall submit a request for departmental approval to recirculate leachate or gas condensate.

4. Containers holding liquid waste may not be placed in a sanitary landfill unless—

A. The container is a small container similar in size to that normally found in household waste; or

B. The waste is household waste.

(4) Site Selection.

(A) Requirement. Site selection and utilization shall include a study and evaluation of geologic and hydrologic conditions and soils at the proposed sanitary landfill and an evaluation of the environmental effect upon the projected use of the completed sanitary landfill. Owners/operators shall document compliance with all applicable siting restrictions and shall submit this documentation to the department by April 9, 1994, for existing sanitary landfills or prior to receiving a construction permit for sanitary landfills permitted after January 1, 1996. Any existing sanitary landfill that cannot demonstrate compliance with paragraphs (4)(B)1. through (4)(B)6. must close by October 9, 1996.

(B) Satisfactory Compliance—Design.

1. Airport safety.

A. Owners/operators of sanitary landfills operating after October 9, 1993, that are located within ten thousand feet (10,000') of any airport runway end used by turbojet aircraft or within five thousand feet (5,000') of any airport runway end used by only piston-type aircraft shall demonstrate to the department that the sanitary landfills are designed and operated so that the landfill does not pose a bird hazard to aircraft.

B. Owners/operators proposing to site new sanitary landfills and horizontal expansions of existing sanitary landfills within a five (5)-mile radius of any airport runway end used by turbojet aircraft or piston-type aircraft shall notify the affected airport and the Federal Aviation Administration (FAA).

2. Owners/operators of sanitary landfills, operating after October 9, 1993, located in one hundred (100)-year floodplains shall demonstrate to the department that the sanitary landfill will not restrict the flow of the one hundred (100)-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to public health or the environment.

3. Wetlands.

A. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills shall not be located in wetlands, unless the owner/operator can make the following demonstrations to the department:

(I) The presumption that a practicable alternative to the proposed landfill is available which does not involve wetlands is clearly rebutted;

(II) The construction and operation of the sanitary landfill will not—

(a) Cause or contribute to violations of any applicable state water quality standard;

(b) Violate any applicable toxic effluent standard or prohibition under section 307 of the federal Clean Water Act;

(c) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and

(d) Violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary;

(III) The sanitary landfill will not cause or contribute to significant degradation of wetlands. The owner/operator shall demonstrate the integrity of the sanitary landfill and its ability to protect ecological resources by addressing the following factors:

(a) Erosion, stability and migration potential of native wetland soils, muds and deposits used to support the landfill;

(b) Erosion, stability and migration potential of dredged and fill materials used to support the landfill;

(c) The volume and chemical nature of the waste disposed of in the landfill;

(d) Impacts on fish, wildlife and other aquatic resources and their habitat from potential release of solid waste from the landfill;

(e) The potential effects of contamination of the wetland and the resulting impacts on the environment; and

(f) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected;

(IV) Steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by subparagraph (4)(B)3.A. of this rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (for example, restoration of existing degraded wetlands or creation of man-made wetlands); and

(V) The requirements of paragraph (4)(B)3. may be satisfied by the owner/operator obtaining a United States Army Corps of

Engineers permit for construction in a wetland or by demonstrating that the wetland is not regulated by the United States Army Corps of Engineers, or other appropriate agency.

4. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills located in the seismic impact zone shall not be located within two hundred feet (200') of a fault that has had displacement in Holocene time unless that owner/operator demonstrates to the department that an alternative setback distance of less than two hundred feet (200') will prevent damage to the structural integrity of the landfill and will be protective of public health and the environment.

5. Sanitary landfills permitted after October 9, 1993, and unfilled surfaces of existing sanitary landfills shall not be located in seismic impact zones, unless the owner/operator demonstrates to the department that all containment structures, including liners, final covers, leachate collection systems and surface water control systems, are designed to resist permanent cumulative earthquake displacements not to be greater than six inches (6"), resulting from the maximum credible Holocene time earthquake event's acceleration versus time history.

6. Owners/operators of sanitary landfills, operating after October 9, 1993, located in an unstable area shall demonstrate to the department that the sanitary landfill's design ensures that the integrity of the structural components of the sanitary landfill will not be disrupted. The owner/operator shall consider the following factors, at a minimum, when determining whether an area is unstable:

A. On-site or local rock or soil conditions that may result in failure or significant differential settling;

B. On-site or local geologic or geomorphologic features; and

C. On-site or local human-made features or events (both surface and subsurface).

7. Plans shall include:

A. A map showing initial and proposed topographies at contour intervals of five feet (5') or less. This map shall have a scale of not less than one inch (1") equal to one hundred feet (100'). If the entire site cannot be illustrated on one (1) plan sheet, an additional map with appropriate horizontal and vertical scales that allows the site to be shown on one (1) standard plan sheet is required;

B. A map showing the land use and zoning within one-fourth (1/4) mile of the sanitary landfill including location of all residences, buildings, wells, water courses, springs, lakes, rock outcroppings, caves, sinkholes and soil or rock borings. All electric, gas, water, sewer and other utility easements or lines that are located on, under or over the sanitary landfill shall be shown on the map. This map shall have a scale of not less than one inch (1") equals four hundred feet (400');

C. A description of the projected use of the closed sanitary landfill. In addition to maintenance programs and provisions, where necessary for monitoring and controlling decomposition gases and leachate, the plans shall address the following ultimate use criteria:

(I) Structures. It is not recommended practice to construct major structures within the permitted area of a closed sanitary landfill. If major structures are to be built within the permitted area of a closed sanitary landfill, prior written approval from the department is required. A professional engineer shall approve their design and construction, including provision for protection against potential hazards of solid waste decomposition gases; and

(II) Other uses. Appropriate design, construction and operating provisions for the sanitary landfill shall be specified to complement the projected future use; and

D. An evaluation of the characteristics and quantity of available on-site soil with respect to its suitability for sanitary landfilling operations. The engineering properties and quantity estimates of the on-site soil shall be discussed and shall include:

(I) Texture. Sieve and hydrometer analyses shall be performed to determine grain size distribution of representative soil samples. Texture may be determined by using the procedures described in ASTM method D422-63 or the procedures described in Appendix D of *Engineer Manual 1110-2-1906*, prepared by the United States Army Corps of Engineers;

(II) Plasticity. The liquid limit, plastic limit and plasticity index of representative soil samples shall be determined. Plasticity may be determined by using the procedures described in ASTM method D4318-84 or the procedures described in Appendix III of *Engineer Manual 1110-2-1906*, prepared by the United States Army Corps of Engineers;

(III) Hydraulic conductivity. Laboratory hydraulic conductivity tests shall be performed upon undisturbed representative soil samples using a flexible wall permeameter (ASTM D-5084). If an aquifer is found to be laterally continuous across the anticipated limit of the proposed landfill, the hydraulic conductivity of each significant continuous geologic unit must be determined. Examples of accepted field tests are *in situ* slug or pump tests which isolate the geologic unit of interest; and

(IV) Area extent and depth. The area extent and depth of soil suitable for landfill construction shall be determined. Variations in soil depth shall be clearly described.

8. If the base of the landfill liner will be in contact with groundwater, the applicant shall demonstrate to the department's satisfaction that the groundwater will not adversely impact the liner.

(C) Satisfactory Compliance—Operations.

1. The sanitary landfill shall be accessible to vehicles which the sanitary landfill is designed to serve by all-weather roads leading from the public road system; temporary roads shall be provided as needed to deliver wastes to the working face.

2. The sanitary landfill shall not be located in an area where the public roads or access roads to the sanitary landfill may be flooded preventing use of the sanitary landfill unless an alternate sanitary landfill is available.

(5) Design.

(A) Requirement. Plans, addendums, as-built drawings, or other documents which describe the design, construction, operation, or closure of a sanitary landfill or which request an operating permit modification for the sanitary landfill shall be prepared or approved by a professional engineer. These documents shall be stamped or sealed by the professional engineer and submitted to the department for review and approval.

(B) Satisfactory Compliance—Design.

1. Plans submitted as part of an application for a construction permit after the effective date of this rule shall provide for the maintenance of a one hundred foot (100')-buffer zone between the outer edge of the landfill liner and any property line(s) or any right-of-way(s) of adjoining road(s) when the property line(s) is inside the right-of-way(s) to provide room for assessment and/or remedial actions.

2. The plan shall include an operating manual describing the various tasks that shall be performed during a typical shift.

3. Owners/operators of sanitary landfills shall demonstrate how adverse geologic and hydrologic conditions may be altered or compensated for via surface water drainage diversion, underdrains, sumps, and other structural components. All alterations of the site shall be detailed in the plans.

A. Precipitation, evapotranspiration and climatological conditions shall be considered in site selection and design.

B. Engineering plans and specifications that have computer models attached to them shall list the limitations and assumptions of each model used in the application.

4. Plans shall include stability analyses for all stages of landfill construction.

A. Settlement and bearing capacity analysis shall be performed on the in-place foundation material beneath the disposal area. The effect of foundation material settlement on the liner and leachate collection system shall be evaluated.

B. Stability analysis shall be performed on all liner and leachate system components.

C. Leachate collection pipe material and drainage media shall be analyzed to demonstrate that these components possess structural strength to support maximum loads imposed by overlying waste materials and equipment.

D. Waste mass stability analysis shall be performed on the disposal area at final waste grade conditions and at intermediate slope conditions.

E. Stability analysis shall be performed on all final cover system components, including an evaluation of the effect of waste settlement on the final cover system components, side-slope liner system components, surface water management system components and gas migration system components.

(C) Satisfactory Compliance—Operations.

1. Construction and operation of the sanitary landfill shall be conducted in accordance with the engineering plans and specifications approved by the department.

2. The operating manual describing the various tasks that shall be performed during a typical shift shall be available to employees for reference and to the department upon request.

3. Phase development drawings shall be included with the application.

(6) Quality Assurance/Quality Control (qa/qc).

(A) Requirement. The construction, operation and closure of the sanitary landfill shall include quality assurance and quality control measures to ensure compliance with approved plans and all applicable federal, state and local requirements. The permittee shall be responsible for ensuring that the quality assurance/quality control supervision is conducted by a qualified professional.

(B) Satisfactory Compliance—Design.

1. Plans shall include:

A. A detailed description of the qa/qc testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;

B. A detailed procedure for the reporting and recording of qa/qc activities and testing results; and

C. Continuous visual classification of borrow soil during landfill construction by qualified qa/qc inspector(s) or certifying professional engineer.

2. All qa/qc reports shall be reviewed and approved by a professional engineer.

(C) Satisfactory Compliance—Operations.

1. At a minimum qa/qc testing shall include:

A. Testing of each lift of the soil component of the final cover and landfill liner for field density and field moisture once per every ten thousand (10,000) square feet and providing relatively uniform coverage over the landfill surface;

B. Laboratory hydraulic conductivity testing of the soil used for liner construction once for every five thousand (5,000) cubic yards of liner constructed;

C. Continuous visual classification of borrow soil during landfill construction by qualified qa/qc inspector(s) or certifying professional engineer;

D. Measuring the elevations of the final cover and the landfill liner on a maximum spacing of one hundred-foot (100') centers and at one hundred-foot (100') intervals along each line where a break in slope occurs.

(I) Landfill liner. Measuring the elevations of the top and bottom of the landfill liner.

(II) Final cover. Measuring the elevations of the top and bottom of—

(a) The compacted clay layer supporting the geomembrane liner; and

(b) The soil layer supporting vegetative growth;

E. Nondestructive testing of all seams of the geomembrane in the landfill liner and final cover;

F. Random destructive testing of the seams of the geomembrane liner in the landfill liner and final cover on an average frequency of at least one (1) every five hundred (500) linear feet of seams; and

G. Verification of the thickness of the leachate collection media by qualified qa/qc inspector(s) or certifying professional engineer on one hundred-foot (100') centers.

2. All testing shall be performed under the direction of qualified qa/qc inspectors for every major phase of construction.

3. The qa/qc plan shall provide the following components:

A. Leachate collection system. Reports prepared or approved by the professional engineer transmitting the results of the qa/qc procedures and stating that the leachate collection system was constructed according to the approved design or describing any deviations from the approved design; and

B. Liner. The liner specified by section (10) of this rule shall be constructed in accordance with the approved design specifications. The qa/qc procedures shall include:

(I) Evidence that the liner material(s) utilized meet the minimum design specifications;

(II) Evidence that field construction techniques are resulting in the minimum design specifications (for example, soil density tests);

(III) Evidence that the liner construction is proceeding as designed through regular verification using a predetermined system of horizontal and vertical survey controls; and

(IV) Oversight of the liner construction and qa/qc procedures by a professional engineer. This shall include reports prepared, or approved, by the professional engineer transmitting the results of the qa/qc procedures and stating that the liner was constructed according to design or describing any deviations from the design.

(7) Survey Control.

(A) Requirement. Benchmarks, horizontal controls and boundary markers shall be established by a land surveyor to check and mark the location and elevations of the sanitary landfill. Construction stakes marking an individual section(s) or phase(s) shall be established as necessary to ensure the construction and operation proceed in accordance with approved plans.

(B) Satisfactory Compliance—Design.

1. Boundary survey. A survey of the entire permitted acreage shall be conducted in accordance with the current Minimum Standards for Property Boundary Surveys 10 CSR 30-2.010.

2. Vertical control. The land surveyor shall establish a permanent monument as a benchmark or confirm the prior establishment of a benchmark on or adjacent to the property. The elevation shall be on the North American Vertical Datum, 1929 or similar well documented datum. If no such established datum exists within one (1) mile of the property, a project datum may be assigned to the benchmark. The benchmark shall be clearly shown on the survey plat.

3. Horizontal control. The land surveyor shall establish three (3) permanent monuments as horizontal control stations. These

stations shall form a triangle whose sides shall not be less than one thousand feet (1000'). The location of the horizontal control will be shown on the survey plat.

4. The land surveyor shall establish boundary markers designating the entire permitted acreage which shall be composed of material which will last throughout the life of the sanitary landfill.

5. Construction stakes. Stakes marking the individual section(s) or phase(s) specifically designated for the placement of solid waste are to be placed in locations and composed of material that is consistent with the operating life of the section or phase.

(C) Satisfactory Compliance—Operations.

1. All boundary markers, benchmarks, horizontal control stations and construction stakes shall be clearly marked and identified.

2. Missing or displaced benchmarks or horizontal control stations shall be replaced or reestablished by or under the supervision of a land surveyor. The registered surveyor shall prepare a plat showing the replacement or reestablishment and furnish a copy to the department.

3. Missing or displaced construction stakes shall be replaced or reestablished as necessary to ensure the operations proceed in accordance with approved plans.

4. The permanent monuments designating vertical and horizontal control stations and boundary markers designating the entire permitted acreage shall be placed prior to receiving an operating permit as required by 10 CSR 80-2.020(2)(B).

5. Construction stakes marking the active area shall be placed prior to deposition of waste in individual areas, sections or phases of the sanitary landfill as designated by the approved engineering plans.

(8) Water Quality.

(A) Requirement. The location, design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ground and surface water quality standards and requirements. Applicable standards are federal, state or local standards and requirements that are legally enforceable.

(B) Satisfactory Compliance—Design.

1. Plans shall include:

A. A report on the detailed geologic and hydrologic investigation of the site as required by 10 CSR 80-2.015.

B. Current and projected use of water resources in the potential zone of influence of the sanitary landfill;

C. Groundwater elevation and proposed separation between the lowest point of the lowest cell and the predicted maximum water table elevation;

D. Potential interrelationship of the sanitary landfill, local aquifers and surface waters based on historical records or other sources of information;

E. Proposed location and design of observation wells, sampling stations and testing program planned; and

F. Provisions for surface water runoff control to minimize infiltration and erosion of cover. All applicable permits and approvals necessary to comply with requirements of the Missouri Clean Water Law and corresponding rules shall be obtained from the department.

(I) The area of the watershed which will be affected by the sanitary landfill shall be specified.

(II) On-site drainage structures and channels shall be designed to prevent flow onto the active portion of the sanitary landfill during peak discharge from at least a twenty-five (25)-year storm. The engineering calculations and assumptions shall be included and explained in the engineering report.

(III) On-site drainage structures and channels shall be designed to collect and control at least the water volume resulting from a twenty-four (24)-hour, twenty-five (25)-year storm.

(IV) On-site drainage and channels shall be designed to empty expeditiously after storms to maintain the design capacity of the system.

(V) Contingency plans for on-site management of surface water which comes in contact with solid waste shall be specified.

(C) Satisfactory Compliance—Operations.

1. Surface water courses and runoff shall be diverted from the sanitary landfill (especially from the working face) by devices such as ditches, berms, and proper grading. The sanitary landfill shall be constructed and graded so as to promote rapid surface water runoff without excessive erosion. Regrading shall be done as required during construction and after completion to avoid ponding of precipitation and to maintain cover integrity.

2. The quantity of water coming in contact with solid waste shall be minimized by the daily operational practices. Water which comes in contact with solid waste shall be managed as leachate in accordance with the approved plans.

(9) Leachate Collection System.

(A) Requirement. A leachate collection system shall be designed, constructed, maintained and operated to collect and remove leachate from the sanitary landfill.

(B) Satisfactory Compliance—Design. The potential for leachate generation shall be evaluated in determining the design of the system. Leachate flow quantities shall be estimated and the method(s) of leachate treatment and disposal shall be outlined. Leachate storage and treatment facilities shall comply with all currently applicable requirements of the Missouri Clean Water Law and corresponding rules. Construction quality assurance/quality control (qa/qc) procedures shall be included. Where a leachate treatment system is designed to have a discharge to the waters of the state, any required discharge permit(s) shall be obtained from the department in accordance with requirements of the Missouri Clean Water Law and corresponding rules.

1. Minimum design criteria for leachate collection systems shall include the following:

A. Ponds and/or tanks of sufficient capacity to store, equalize flow to disposal systems, and allow system/operating flexibility;

B. Construction material chemically resistant to the waste managed in the sanitary landfill and the leachate expected to be generated;

C. Construction materials of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying solid wastes, cover, leachate, and by any equipment used at the sanitary landfill;

D. Design and operate systems to function without clogging through the scheduled operating life, closure and post-closure of the sanitary landfill;

E. Design and operate systems to maintain less than one foot (1') depth of leachate over the disposal area liner; and

F. Design and operate systems so that any leachate formed will flow by gravity into collection areas from which the leachate can be removed, treated, and disposed.

2. Leachate management by recirculation within the permitted fill area shall be conducted in accordance with an approved engineering method.

3. Any leachate collection system open to the atmosphere must be designed to prevent discharge during a twenty-five (25)-year, twenty-four (24)-hour storm event. Plans shall include the calculations detailing the design.

4. The applicant shall provide a method of leachate management in the application. A secondary or “backup” method of leachate disposal will be required unless the applicant can demonstrate that a secondary method will not be necessary.

(C) Satisfactory Compliance—Operations.

1. The leachate collection systems specified by subsection (9)(B) shall be properly installed and operated in accordance with the permit and the approved design and plans and maintained for the thirty (30)-year post-closure care period, or as long as the department determines necessary.

2. Leachate generated by the sanitary landfill shall be controlled on-site and not be allowed to discharge off the sanitary landfill property or discharge into the waters of the state, except in accordance with the approved plans and the Missouri Clean Water Law and corresponding rules.

(10) Liner System.

(A) Requirement. A liner shall be placed on all surfaces to minimize the migration of leachate from the sanitary landfill.

(B) Satisfactory Compliance—Design. A composite liner shall be installed at all landfills permitted after October 9, 1993, and existing landfills with uncovered surfaces, as determined by the department on a site-by-site basis, that consists of two (2) components—

1. An upper component that shall consist of a minimum thirty (30) mil thick geomembrane. Geomembrane components consisting of high density polyethylene (HDPE) shall be at least sixty (60) mil thick;

2. A lower component that shall consist of a least a two foot (2')-layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. A compacted soil liner at a minimum shall be constructed of six to eight-inch (6–8") lifts, compacted to ninety-five percent (95%) of standard Proctor density with the moisture content between optimum moisture content and four percent (4%) above the optimum moisture content, or within other ranges of density and moisture that are shown to provide for the liner to have a hydraulic conductivity no more than 1×10^{-7} cm/sec. The design shall include a detailed explanation of the construction techniques and equipment necessary to achieve ninety-five percent (95%) of the standard Proctor density under field conditions. The design also shall include qa/qc procedures to be followed during construction of the liner. The composite liner shall be protected from the adverse effects of desiccation or freeze/thaw cycles after construction, but prior to placement of waste. Traffic shall be routed so as to minimize the detrimental impact on the constructed liner prior to placement of waste. The soils used for this purpose shall meet the following minimum specifications:

A. Be classified under the Unified Soil Classification Systems as CL, CH, or SC (ASTM Test D2487-85);

B. Allow more than thirty percent (30%) passage through a No. 200 sieve (ASTM Test D1140);

C. Have a liquid limit equal to or greater than twenty (20) (ASTM Test D4318-84);

D. Have a plasticity index equal to or greater than ten (10) (ASTM Test D4318-84); and

E. Have a coefficient of permeability equal to or less than 1×10^{-7} cm/sec when compacted to ninety-five percent (95%) of standard Proctor density with the moisture content between optimum moisture content and four percent (4%) above the optimum moisture content, when tested by using (ASTM D-5084) a flexible wall permeameter or other procedures approved by the department;

3. The geomembrane component shall be installed in direct and uniform contact with the compacted soil component so as to minimize the migration of leachate through the geomembrane should a break occur; and

4. All solid waste disposal areas shall have a minimum bottom slope in any direction of flow of at lease one percent (1%).

(C) Satisfactory Compliance—Operations.

1. A test pad shall be constructed at the site and tested to verify that the proposed construction and quality control (qc) procedures are adequate to ensure that the soil component of the composite liner system will meet the requirements of (10)(B)2. of this rule.

A. Construction and qc procedures to be used during test pad construction shall be described in detail in the approved engineering report, and shall be identical to those proposed for liner construction with the following additions:

(I) At least two laboratory hydraulic conductivity tests shall be performed on undisturbed samples of the completed test pad;

(II) At least one (1) *in situ* hydraulic conductivity test shall be performed on the completed test pad; and

(III) At least two (2) test pits shall be excavated into the completed test pad to observe interlift bonding.

B. If test pad construction and testing shows that the proposed methods are not sufficient to meet the requirements of paragraph (10)(B)2. of this rule, a new test pad shall be constructed using revised procedures approved by the department.

2. For phased construction, only one test pad will be required.

3. A final report shall be submitted to the department which describes in detail the construction and qc procedures which were used to achieve satisfactory test pad performance.

A. The report must be approved by the department prior to beginning construction of any portion of the composite liner system in the disposal area.

B. The report shall serve as guidance for construction of the soil component of the composite liner system.

4. The requirement for a test pad may be waived provided—

A. The applicant can demonstrate to the department's satisfaction that construction and qc procedures identical to those described in the approved engineering report have resulted in construction of a liner which meets the requirements of paragraph (10)(B)2. of this rule; and

B. The soils proposed for liner construction meet the following minimum specifications:

(I) Have a plasticity index greater than fifteen (15) and less than thirty (30) (ASTM test D4318-84);

(II) Allow more than fifty percent (50%) passage through a number 200 serve (ASTM D1140); and

(III) Have less than ten percent (10%) by weight particle sizes greater than two (2) mm.

5. The liner specified by subsection (10)(B) of this rule shall be constructed in accordance with the approved design specifications.

(11) Groundwater Monitoring.

(A) Requirements. The owner/operator of a sanitary landfill shall implement a groundwater monitoring program capable of determining the sanitary landfill's impact on the quality of groundwater underlying the sanitary landfill.

(B) Satisfactory Compliance—Design.

1. All sanitary landfills permitted after October 9, 1993, shall be in compliance with all of the groundwater monitoring requirements of this section before an operating permit is issued. Existing sanitary landfills shall be in compliance with section (11)—

A. By October 9, 1994, if located less than one (1) mile from a drinking water intake (surface or subsurface);

B. By October 9, 1995, if located between one (1) mile and two (2) miles from a drinking water intake (surface or subsurface); or

C. By October 9, 1996, if located greater than two (2) miles from a drinking water intake (surface or subsurface).

2. The owner/operator of a sanitary landfill shall establish the potential for migration of fluid generated by the sanitary landfill into the groundwater by an evaluation of—

A. A water balance of precipitation, evapotranspiration, runoff and infiltration;

B. At a minimum, the following characteristics:

(I) Geologic materials;

(II) Description of soil and bedrock to a depth adequate to allow evaluation of water quality protection provided by the soil and bedrock;

(III) Groundwater elevation;

(IV) Proposed separation between the lowest point of the lowest cell and the maximum water table elevation;

(V) Proximity of the sanitary landfill to water supply wells or surface water;

(VI) Rate and direction of groundwater flow; and

(VII) Current and projected use of water resources in the potential zone of influence of the sanitary landfill.

3. A groundwater monitoring system shall be capable of yielding groundwater samples for analysis and shall consist of—

A. Monitoring wells (at least one (1) installed hydraulically upgradient; that is, in the direction of increasing static head from the sanitary landfill. The numbers, locations and depths shall be sufficient to yield groundwater samples that are—

(I) Representative of background water quality in the groundwater near the sanitary landfill; and

(II) Not affected by the sanitary landfill; and

B. Monitoring wells (at least three (3)) installed hydraulically downgradient; that is, in the direction of decreasing hydraulic head from the sanitary landfill. The number, locations and depths shall ensure that they detect any significant amounts of fluids generated by the sanitary landfill that migrate from the sanitary landfill to the groundwater. Monitoring wells, or clusters of monitoring wells, shall be capable at a minimum, of monitoring all saturated zones down to and including the uppermost aquifer.

4. All monitoring wells shall be constructed as per 10 CSR 23-4.

(C) Satisfactory Compliance—Operations.

1. Groundwater monitoring wells.

A. Groundwater monitoring wells shall be installed so that the number, spacing and depths of monitoring systems shall be determined based upon site-specific technical information that shall include thorough characterization of—

(I) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and

(II) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities and porosities.

B. The design and installation of groundwater monitoring well systems shall be observed, supervised, and certified by a qualified groundwater scientist and approved by the department.

C. All groundwater monitoring wells shall be operational prior to the acceptance of wastes, unless other arrangements are approved by the department.

D. The design, installation, development, and decommissioning of monitoring wells and piezometers must be performed in accordance with 10 CSR 23-4.

2. Sampling and reporting.

A. Each groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells installed in compliance with subsection (11)(B). The owner/operator must submit the sampling and analysis program to the department for approval. The program must include procedures and techniques for—

(I) Monitoring well maintenance;

(II) Monitoring well redevelopment;

(III) Monitoring well depth measurement and hydraulic levels;

(IV) Monitoring well purging and sampling utilizing dedicated equipment;

(V) Equipment calibration;

(VI) Decontamination and field blanks;

(VII) Sample and duplicate sample collection;

(VIII) Sample preservation;

(IX) Sample labeling;

(X) Sample handling;

(XI) Field measurements;

(XII) Field documentation;

(XIII) Chain of custody control;

(XIV) Sample shipment;

(XV) Analytical procedures;

(XVI) Qa/qc control—field and laboratory; and

(XVII) Statistical testing strategy per paragraph (11)(C)5. for each parameter's concentrations.

B. Each groundwater monitoring program shall include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents and other monitoring parameters in groundwater samples. Analysis shall be performed on unfiltered samples.

C. The sampling procedures and frequency shall be protective of human health and the environment.

D. Groundwater elevations shall be measured in each well immediately prior to purging, each time groundwater is sampled. The owner/operator shall determine the direction of groundwater flow each time groundwater is sampled. Groundwater elevations in wells which monitor the same solid waste disposal area shall be measured within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow direction.

3. Baseline/background monitoring.

A. The owner/operator shall establish background groundwater quality for each of the monitoring parameters or constituents required under paragraphs (11)(C)4. To establish background, a minimum of four (4) quarterly samples of statistically independent sample data shall be obtained and analyzed from all monitoring wells during a minimum of one (1) year following well installation.

B. The number of samples collected to establish background values for groundwater quality data shall satisfy the requirements of subsection (11)(C) and shall be consistent with the appropriate statistical procedures determined pursuant to paragraph (11)(C)5. The sampling procedures shall be those specified under paragraph (11)(C)4. for detection monitoring, paragraph (11)(C)6. for assessment monitoring and section (12) for corrective action.

4. Detection monitoring.

A. The owner/operator shall obtain and analyze water samples from the groundwater monitoring wells during the months of May and November of each calendar year.

B. The following parameters shall be analyzed each time a sample is obtained:

Chemical Oxygen Demand (COD in milligrams per liter (mg/l));

Chlorides (Cl, (mg/l));

Iron (Fe, (mg/l));

pH (units);

Specific Conductance (Conductivity at twenty-five degrees Celsius (25°C) in micromhos per centimeter (μmho/cm));

Total Dissolved Solids (TDS, (mg/l)); and
All parameters listed in Appendix 1 of this rule.

Additionally, the water level in each well shall be measured at the time the sample is taken.

C. The sample results, and any results of statistical analysis determining statistically significant increases for any parameter per paragraph (11)(C)5., shall be submitted to the department in one (1) report within ninety (90) days of when samples are collected.

D. In the case of all detection monitoring requirements previously listed, the department may specify an appropriate alternative frequency for repeated sampling and analysis during the active life of the sanitary landfill (including closure) and the post-closure period. The department may add additional parameters or delete parameters on a site-by-site basis through an evaluation of waste and leachate characteristics of the sanitary landfill.

E. The electronic submission of groundwater data is required. This submission shall be in the format and method as prescribed by the department.

5. The owner/operator shall specify in the operating record one (1) or more of the following statistical methods to be used in evaluating groundwater monitoring data for each monitoring constituent. The statistical test chosen shall be conducted separately for each constituent:

A. A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The procedure shall include estimation and testing of the contrasts between each downgradient well's mean and the upgradient means for each parameter;

B. An ANOVA based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The procedure shall include estimation and testing of the contrasts between each downgradient well's median and the background medians for each parameter;

C. A confidence interval procedure in which an interval for each parameter in each downgradient well is constructed around the mean/median of the particular well's data or data residuals and compared to the mean/median of pooled background well data;

D. A prediction interval procedure in which an upper prediction limit for an interval for each parameter in each well is compared to subsequently obtained values from the same well;

E. A prediction interval procedure in which an upper prediction limit for an interval for each parameter constructed on the pooled background well data or data residuals is compared to subsequently obtained values from each downgradient well;

F. A tolerance interval procedure in which an upper tolerance limit for an interval for each parameter's pooled background well data is compared to each downgradient well's concentration values;

G. A multicomparison procedure utilizing any recommended U.S. Environmental Protection Agency combinations of intra-well and inter-well procedures for each parameter;

H. A control chart approach, meeting the performance standards of part (11)(C)5.J.(III), that gives control limits for each parameter;

I. A different statistical test method that meets the performance standards of subparagraph (11)(C)5.J. of this rule. The owner/operator must submit the statistical test method to the department for approval before the use of the alternative test;

J. Any statistical method chosen under subparagraph (11)(C)5.J. of this rule shall comply with the following performance standards, as appropriate:

(I) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of the concentration data for the chemical parameters or hazardous constituents. If the distribution of the concentration data for the chemical parameters or hazardous constituents is shown by the owner/operator to be inappropriate for a normal data distribution theory test, then the data should be transformed or a distribution-free (nonparametric) theory test should be used. If the concentration data distributions for the constituents of each well differ, more than one (1) statistical method will be needed;

(II) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentration or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment-wide error rate for each testing period shall be no less than 0.05, however, the Type I error of no less than 0.01 for individual well comparisons shall be maintained. This performance standard does not apply to tolerance intervals, prediction intervals or control charts;

(III) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The selection of this method shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern;

(IV) If a confidence interval, tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, then the level of confidence for each interval, and the percentage of the population that each interval contains, shall be protective of human health and the environment. Selection of one (1) or more of these methods shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern;

(V) The statistical method shall account for data below the limit of detection with one (1) or more statistical procedures that are protective of human health and the environment. Any practical quantization limit that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility; and

(VI) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

6. Response to statistical analysis.

A. If the comparison for the upgradient wells show a statistically significant increase (or pH change) over background, the owner/operator shall submit this information to the department.

B. If the comparisons for downgradient wells show a statistically significant increase (or pH change) over background, the owner/operator shall immediately obtain two (2) additional groundwater samples from each downgradient well where a statistically significant difference was detected. One shall be analyzed by the owner; the other shall be analyzed by the department to determine whether the statistically significant difference was a result of laboratory error.

C. If the additional samples show a statistically significant increase (or pH change) over background, the owner/operator must demonstrate to the department within ninety (90) days that a source other than the sanitary landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation or natural variation. If the owner/operator cannot make this demonstration to the department, the owner/operator shall submit a plan to the department for a groundwater assessment monitoring program and implement the program as described in subparagraphs (11)(C)6.D. through J. of this rule. The plan shall specify the following:

(I) The number, location and depth of wells;

(II) Sampling and analytical methods for the monitoring parameters listed in Appendix II of this rule;

(III) Evaluation procedures, including any use of previously gathered groundwater quality information;

(IV) The rate and extent of migration of a contaminant plume in the groundwater; and

(V) The concentrations of the contaminant plume in the groundwater.

D. Within ninety (90) days of beginning an assessment monitoring program, and semiannually after that, the owner/operator shall sample and analyze the groundwater for all constituents identified in Appendix II of this rule. A minimum of one (1) sample from each downgradient well shall be collected and analyzed during the initial sampling event. A minimum of one (1) sample from each downgradient well at which Appendix II constituents were detected shall be collected and analyzed at each subsequent sampling event. For any new constituent detected during assessment monitoring (that was not detected during detection monitoring) in the downgradient wells, a minimum of four (4) statistically independent samples from each well (upgradient and downgradient) shall be collected and analyzed to establish background for the new constituents. The department may add additional parameters or delete parameters on a site-by-site basis through an evaluation of waste and leachate characteristics of the sanitary landfill.

E. The owner/operator shall establish a groundwater protection standard for each constituent specified in Appendix II of this rule and detected in the groundwater. The groundwater protection standard shall be—

(I) For constituents for which a maximum contaminant level (MCL) has been promulgated under section 1412 of the Federal Safe Drinking Water Act and found at 40 CFR part 141, the MCL for that constituent;

(II) For constituents for which MCLs have not been promulgated, the background concentration for the constituent established from wells in accordance with paragraph (11)(C)3. of this rule;

(III) For constituents for which the background level is higher than the MCL identified in part (11)(C)6.E.(I) of this rule, the background concentration; or

(IV) A level established by the department based upon a consideration of relevant factors, including: multiple contaminants in the groundwater, exposure threats to sensitive environmental receptors, and other site-specific exposure or potential exposure to groundwater.

F. After obtaining the results from the initial or subsequent sampling events required in subparagraph (11)(C)6.D. the owner/operator shall—

(I) Within fourteen (14) days, notify the department and place a notice in the operating record identifying the constituents that have been detected;

(II) Within ninety (90) days, and on at least a semiannual basis after that, resample all wells and conduct analysis for all constituents listed in Appendix I to this rule and for those constituents listed in Appendix II of this rule that are detected in response to the requirements of subparagraph (11)(C)6.D. of this rule. Record the concentrations of each constituent in the facility operating record and notify the department of the constituent concentrations. A minimum of one (1) sample from each well sampled (background and downgradient) shall be collected and analyzed during these sampling events;

(III) Establish background concentrations for any new constituents detected during subsequent monitoring events; and

(IV) Establish groundwater protection standards for all new constituents detected during subsequent monitoring events.

G. If the concentrations of all constituents listed in Appendix II to this rule are shown to be at or below background levels as established in paragraph (11)(C)3. of this rule for two (2) consecutive sampling periods, the owner/operator may reinstate detection monitoring at the sanitary landfill as specified under subparagraph (11)(C)3.C. of this rule.

H. If the concentrations of any constituents listed in Appendix II of this rule are above background values, but all concentrations are below the groundwater protection standard established under subparagraph (11)(C)6.E. of this rule using the statistical procedures in paragraph (11)(C)5. of this rule, the owner/operator shall notify the department, and the department may require the owner/operator to—

(I) Continue assessment monitoring; or

(II) Develop a corrective measures assessment, or both.

I. If one (1) or more constituents listed in Appendix II of this rule are detected at levels above the groundwater protection standard as established under subparagraph (11)(C)6.E., the owner/operator shall—

(I) Provide the department with a report assessing potential corrective measures as required under subsection (11)(A);

(II) Characterize the nature and extent of the release by installing additional monitoring wells as necessary; install at least one (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with paragraph (11)(C)6. of this rule and notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site as indicated by sampling of wells; and

(III) Continue assessment monitoring as per the groundwater quality assessment plan and as per the implementation of the corrective action program specified in section (12) of this rule.

J. The results of implementation of the assessment monitoring program shall be submitted to the department at the end of each year or an alternate time period approved by the department.

(12) Corrective Action.

(A) Assessment of Corrective Measures.

1. Within ninety (90) days of finding that any of the constituents listed in Appendix II of this rule have been detected at a statistically significant level exceeding the groundwater protection standards defined under subparagraph (11)(C)6.E. of this rule, the owner/operator shall initiate an assessment of corrective measures. This assessment shall be completed within a reasonable period of time, and a report describing the assessment of corrective measures shall be submitted to the department.

2. The owner/operator shall continue to monitor in accordance with the assessment monitoring program as specified in subparagraph (11)(C)6.F. of this rule.

3. The assessment shall include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under subsection (12)(B) of this rule, addressing at least the following:

A. The performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts and control of exposure to any residual contamination;

B. The time required to begin and complete the remedy;

C. The costs of remedy implementation; and

D. The institutional requirements such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(ies).

4. The owner/operator shall discuss the results of the corrective measures assessment, prior to the selection of remedy, in a public meeting with interested and affected parties.

(B) Selection of Remedy.

1. Based on the results of the corrective measures assessment conducted under subsection (12)(A) of this rule the owner/operator shall propose a remedy that, at a minimum, meets the standards listed in paragraph (12)(B)2. of this rule. The owner/operator shall submit to the department, within fourteen (14) days of selecting a proposed remedy, a report describing the proposed remedy and shall place a copy of the report in the operating record that describes how the proposed remedy meets the standards in paragraph (12)(B)2. of this rule.

2. Remedies shall—

A. Be protective of the public health and the environment;

B. Attain the groundwater protection standard as specified pursuant to subparagraph (11)(C)6.E. of this rule;

C. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of constituents listed in Appendix II of this rule into the environment that may pose a threat to human health or the environment; and

D. Comply with standards for management of wastes as specified in paragraph (12)(C)4.

3. In proposing a remedy that meets the standards of paragraph (12)(B)2. of this rule, the owner/operator, and, in approving a remedy, the department shall consider the following evaluation factors:

A. The long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:

(I) Magnitude of reduction of existing risks;

(II) Magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of the proposed remedy;

(III) The type and degree of long-term management required, including monitoring, operation and maintenance;

(IV) Short-term risks that might be posed to the community, workers or the environment during implementation of the remedy, including potential threats to human health and the environment associated with excavation, transportation and redisposal or containment;

(V) Time until full protection is achieved;

(VI) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, redisposal or containment;

(VII) Long-term reliability of the engineering and institutional controls; and

(VIII) Potential need for replacement of the remedy;

B. The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(I) The extent to which containment practices will reduce further releases; and

(II) The extent to which treatment technologies may be used;

C. The ease or difficulty of implementing the potential remedy(ies) based on consideration of the following types of factors:

(I) Degree of difficulty associated with constructing the remedy technology;

(II) Expected operational reliability of the proposed technologies;

(III) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(IV) Availability of necessary equipment and specialists; and

(V) Available capacity and location of needed treatment, storage and disposal services; and

D. The degree to which community concerns are addressed by the proposed remedy(ies).

4. The owner/operator shall specify as part of the proposed remedy a schedule(s) for initiating and completing remedial activities. This schedule shall require the initiation of remedial activities within a reasonable period of time taking into consideration the factors set forth in subparagraphs (12)(D)4.A. through H. of this rule. The owner/operator shall consider the following factors in determining, and the department will consider the following factors in approving, the schedule of remedial activities:

A. Extent and nature of contamination;

B. Practical capabilities of remedial technologies in achieving compliance with groundwater protection standards established under subparagraph (11)(C)6.E. of this rule and other objectives of the remedy;

C. Availability of treatment or disposal capacity for wastes managed during implementation of the remedy;

D. Desirability of utilizing technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety or ability to achieve remedial objectives;

E. Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

F. Resource value of any affected aquifer including:

(I) Current and future uses;

(II) Proximity and withdrawal rate of users;

(III) Groundwater quantity and quality;

(IV) The potential damage to wildlife, crops, vegetation and physical structures caused by exposure to the waste constituent;

(V) The hydrogeologic characteristic of the facility and surrounding land;

(VI) Groundwater removal and treatment costs; and

(VII) The cost and availability of alternative water supplies;

G. Practicable capability of the owner/operator; and

H. Other relevant factors.

5. The department may determine that remediation of a release of any constituent listed in Appendix II of this rule from a sanitary landfill is not necessary if the owner/operator demonstrates to the satisfaction of the department that—

A. The groundwater is additionally contaminated by substances that have originated from a source other than a sanitary landfill and those substances are present in concentrations such that cleanup of the release from the sanitary landfill unit would provide no significant reduction in risk to actual or potential receptors;

B. The constituent(s) is present in groundwater that—

(I) Is not a current or potential source of drinking water; and

(II) Is not hydraulically connected with waters to which the hazardous constituents are migrating or are likely to migrate in a concentration(s) that represents a statistically significant increase over background concentrations;

C. Remediation of the release(s) is technically impracticable; or

D. Remediation would result in unacceptable cross-media impacts.

6. A determination by the department pursuant to paragraph (12)(B)5. of this rule

shall not affect the authority of the state to require the owner/operator to undertake source control measures or other measures that may be necessary to eliminate or minimize further releases to the groundwater, to prevent exposure to the groundwater, or to remediate the groundwater to concentrations that are technically practicable and which significantly reduce threats to human health or the environment.

(C) Implementation of the Corrective Action Program.

1. Based on the schedule established under paragraph (12)(B)4. of this rule for initiation and completion of remedial activities the owner/operator shall—

A. Establish and implement a corrective action groundwater monitoring program that—

(I) At a minimum, meets the requirements of an assessment monitoring program under paragraph (11)(C)6. of this rule;

(II) Indicates the effectiveness of the corrective action remedy; and

(III) Demonstrates compliance with groundwater protection standard pursuant to subparagraph (11)(C)6.E. of this rule.

B. Implement the corrective action remedy selected under subsection (12)(B) of this rule; and

C. Take any interim measures necessary, any measures determined to be necessary by the department, or both, to ensure the protection of human health and the environment. Interim measures shall, to the greatest extent practicable, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to subsection (12)(B) of this rule. The following factors shall be considered by an owner/operator, and will be considered by the department, in determining whether interim measures are necessary:

(I) Time required to develop and implement a final remedy;

(II) Actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;

(III) Actual or potential contamination of drinking water supplies or sensitive ecosystems;

(IV) Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;

(V) Weather conditions that may cause hazardous constituents to migrate or be released;

(VI) Risks of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or failure of a container or handling system; and

(VII) Other situations that may pose threats to human health and the environment.

2. The department may determine, based on information developed after implementation of the remedy has begun or other information, that compliance with requirements of paragraph (12)(B)2. of this rule are not being achieved through the remedy selected. In those cases, the owner/operator shall implement other methods or techniques that will achieve compliance with the requirements, unless the department makes the determination under paragraph (12)(C)3. of this rule.

3. If the department determines that compliance with requirements under paragraph (12)(B)2. of this rule cannot be practically achieved with any currently available methods, the owner/operator shall—

A. Obtain the certification of a qualified groundwater scientist and approval from the department that compliance with the requirements under paragraph (12)(B)2. cannot be practically achieved with any currently available methods;

B. Implement alternative measures to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment;

C. Implement alternative measures for control of the sources of contamination, or for removal or decontamination of equipment, units, devices or structures that are—

(I) Technically practicable; and

(II) Consistent with the overall objective of the remedy; and

D. Submit a report to the department justifying the alternative measures. The alternative measures must be approved by the department prior to implementation.

4. All solid wastes that are managed pursuant to a remedy required under subsection (12)(C) or an interim measure required under subparagraph (12)(C)1.C. of this rule, shall be managed in a manner—

A. That is protective of the public health and the environment; and

B. That complies with all applicable state and federal requirements.

5. Remedies selected pursuant to subsection (12)(B) of this rule shall be considered complete when—

A. The owner/operator complies with the groundwater protection standards established under subparagraph (11)(C)6.E. of this rule at all points within the plume of contamination;

B. Compliance with the groundwater protection standards established under subparagraph (11)(C)6.E. of this rule has been achieved by demonstrating that concentrations of all constituents listed in Appendix II of this rule have not exceeded the groundwater protection standard(s) for a period of three (3) consecutive years using the statistical procedures and performance standards in subsection (11)(C). The department may specify an alternative length of time during which the owner/operator shall demonstrate that concentrations of all constituents listed in Appendix II of this rule have not exceeded the groundwater protection standard(s) taking into consideration—

(I) Extent and concentration of the release(s);

(II) Behavioral characteristics of the hazardous constituents in the groundwater;

(III) Accuracy of monitoring or modeling techniques, including any seasonal meteorological, or other environmental variabilities that may affect the accuracy; and

(IV) Characteristics of the groundwater; and

C. All actions required to complete the remedy have been completed.

6. Upon completion of the remedy, the owner/operator shall submit a certification to the department within fourteen (14) days after the remedy has been completed in compliance with the requirements of paragraph (12)(C)5. and shall place a copy of the certification in the facility's operating record. The certification shall be signed by the owner/operator and by a qualified groundwater scientist and approved by the department.

7. When, upon completion of the certification, the owner/operator and the department determines that the corrective action remedy has been completed in accordance with the requirements under paragraph (12)(C)5. of this rule, the owner/operator shall be released from the requirements for financial assurance for corrective action under 10 CSR 80-2.030(4)(C).

(13) Air Quality.

(A) Requirement. The design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ambient air quality and source control regulations.

(B) Satisfactory Compliance—Design. Plans shall include an effective dust control program.

(C) Satisfactory Compliance—Operations. Burning of solid waste shall be prohibited. A burning permit or exemption may be obtained from the department permitting the burning of tree trunks, tree limbs, vegetation and untreated waste lumber. In areas operating under exemption certificates authorized by Chapter 643, RSMo approval shall be obtained from the local pollution control agency. The operating procedures and location for burning practices shall be submitted to the department for review and written approval. Burning at the sanitary landfill shall be conducted in accordance with Chapter 643, RSMo, the corresponding rules, the terms conditions, or both, of the plans, permit, or both, and all local requirements.

(14) Gas Control.

(A) Requirement. Decomposition gases generated within the sanitary landfill shall be controlled on-site, as necessary, to avoid posing a hazard to the environment or to public health and the safety of occupants of adjacent property.

(B) Satisfactory Compliance—Design.

1. Plans shall contain a monitoring program capable of detecting decomposition gas migration.

A. The monitoring program must specify the type of monitoring and be based on—

(I) Soil conditions;

(II) The hydrogeologic and topographic conditions surrounding the facility; and

(III) The location of facility structures, property boundaries, and off-site features.

B. The monitoring program described in the plans must include:

(I) A written description of the monitoring system, including spacing of monitoring locations and frequency of monitoring;

(II) The results of any gas assessment that has been performed;

(III) The location of all gas monitoring wells shown on a plan sheet;

(IV) A drawing detailing the typical gas monitoring well design;

(V) The design depths and bottom elevations of the gas monitoring wells; and

(VI) Boring logs that support the design gas monitoring well depths.

C. The gas monitoring specified in the plans shall be performed at gas monitoring wells. The monitoring program shall specify how buildings on the landfill property are to be monitored. Gas monitoring wells shall be designed to monitor the unsaturated soil and rock down to an elevation equal to the bottom elevation of the landfill. Gas monitoring wells shall be placed between the landfill and off-site buildings and other features that may be harmed by landfill gas or may easily transmit gas from the landfill. Gas monitoring well locations at the property boundary shall not be more than five hundred feet (500') apart unless the permittee can show that the potential for gas migration is low.

2. Plans shall assess the need for gas control and indicate the location and design of any vents, barriers or other control measure to be provided.

A. The gas control system shall be constructed of materials that are chemically resistant to the solid wastes managed in the sanitary landfill and the gas expected to be generated. These materials shall be specified in the engineering report and the choice of materials justified.

B. The gas control system shall be constructed of materials that are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying solid wastes, cover and by any equipment used at the sanitary landfill. Overburden pressure calculations, material specifications and system installation procedures shall be included in the engineering report.

C. Maintenance and repair options shall be considered in the design and specified in the engineering report.

D. All applicable permits and approvals necessary to comply with the requirements of the Air Conservation Law and rules promulgated shall be obtained from the department.

E. The plan shall estimate the maximum anticipated rate of gas generation at the disposal area and the length of time over which it is anticipated to be generated. The method by which these calculations are arrived at shall also be included.

(C) Satisfactory Compliance—Operations.

1. Decomposition gases shall not be allowed to migrate laterally from the sanitary landfill to endanger public health and safety or to pose a hazard to the environment. They shall be controlled on-site, flared or vented to the atmosphere directly through the cover, cut-off trenches or ventilation systems in a way that they do not accumulate in explosive or toxic concentrations, especially within structures. (Information on the limits of flammability of gases is available in such references as the *Handbook of Chemistry and Physics*, 68th ed. Cleveland, Chemical Rubber Publishing Co., 1987.)

2. Decomposition gases shall not be allowed to concentrate above the following levels:

A. Twenty-five percent (25%) of the lower explosive limit (LEL) or one and one-quarter percent (1.25%) by volume for methane in buildings on the sanitary landfill property; and

B. Fifty percent (50%) of the LEL or two and one-half percent (2.5%) by volume for methane in the soil at the property boundary of the sanitary landfill.

3. For purposes of this section, lower explosive limit (LEL) means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at twenty-five degrees Celsius (25°C) and atmospheric pressure.

4. Owners/operators of all sanitary landfills shall implement a methane monitoring program capable of detecting decomposition gas migration in the most likely zone(s) of migration, to ensure that the standards of paragraph (14)(C)2. of this rule are met. Methane monitoring shall be conducted at least quarterly with equipment warranted by the manufacturer to detect explosive gases under the conditions the equipment is to be used. Facilities shall submit the results of this methane monitoring to the department at least quarterly. The electronic submission of methane monitoring data is required. This submission shall be in a format and manner as prescribed by the department.

5. If methane gas levels exceeding the limits specified in paragraph (14)(C)2. of this rule are detected, the owner/operator shall—

A. Notify the department and immediately take all necessary steps to ensure protection of public health and safety which include:

(I) When results of monitoring in on-site or off-site structures indicate levels in excess of those specified, the operator shall take appropriate action to mitigate the effects of landfill gas accumulation in those structures until a permanent remediation is completed. Actions which must be undertaken include:

(a) Notification of the fire department or other appropriate local public safety authorities;

(b) Notification of adjacent property owners and/or occupants;

(c) Ventilation of any confined spaces that may trap decomposition gases or the installation of alarm systems in any confined spaces that may trap decomposition gases; and

(d) Establishment of a temporary methane monitoring program in affected structures.

B. Within seven (7) days of detection, submit to the department a report describing the steps taken to protect public health and safety;

C. Within sixty (60) days of detection, submit to the department for approval a remediation plan designed by a professional engineer for the methane gas releases. A gas control system shall be designed to—

(I) Prevent methane accumulation in on-site and off-site buildings;

(II) Reduce methane concentrations at monitored property boundaries to below compliance levels; and

(III) Reduce methane concentrations off-site to below compliance levels;

D. Landfill gas corrective action plans shall describe the nature and extent of the problem and the proposed remedy. The plan shall be implemented upon departmental approval; and

E. The department may establish alternative schedules for demonstrating compliance with subparagraphs (14)(C)5.B. and C. of this rule.

6. The sanitary landfill shall operate in compliance with all applicable requirements of Chapter 643, RSMo and corresponding rules.

(15) Vectors.

(A) Requirements. Conditions shall be maintained that are unfavorable for the harboring, feeding and breeding of vectors.

(B) Satisfactory Compliance—Design. Plans shall include contingency programs for vector control and the operator shall be prepared at all times to implement those procedures.

(C) Satisfactory Compliance—Operations. Vector control contingency programs shall be implemented when necessary to prevent or rectify vector problems.

(16) Aesthetics.

(A) Requirement. The sanitary landfill shall be designed and operated at all times in an aesthetically acceptable manner.

(B) Satisfactory Compliance—Design. Plans shall include an effective litter control facility and operating program.

(C) Satisfactory Compliance—Operations.

1. Portable litter fences or other devices shall be used in the immediate vicinity of the working face and at other appropriate locations to control blowing litter. At the end of each operating day, or more often as required, litter shall be removed from the fences and the ground and incorporated into the cell being used. Alternatively, the litter may be containerized for disposal on the next operating day.

2. Solid wastes that are easily moved by wind shall be covered, as necessary, to prevent becoming airborne and scattered.

3. On-site vegetation should be cleared only as necessary. Natural windbreaks, such as green belts, should be maintained where they will improve the appearance and operation of the sanitary landfill.

4. Salvage operations shall be conducted in such a manner as to not detract from the appearance of the sanitary landfill. Salvaged materials shall be removed from the sanitary landfill daily or stored in aesthetically acceptable containers or enclosures.

(17) Cover.

(A) Requirement. Cover shall be applied to minimize fire hazards, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance.

(B) Satisfactory Compliance—Design. The owner/operator shall prepare a written closure plan that describes the steps necessary to close all sanitary landfill phases at any point during the active life of the sanitary landfill in accordance with the requirements of 10 CSR 80-2.030(4)(A). In addition, the final cover requirements specified in the closure and post-closure plans shall specify—

1. Cover sources, quantities and soil classification (Unified Soil Classification System or United States Department of Agriculture classification system);

2. The capability of the cover to perform the functions listed in subsection (17)(A) of this rule;

3. Surface grades and side slopes needed to promote maximum runoff, without excessive erosion, to minimize infiltration. Final side slopes shall not exceed twenty-five percent (25%) unless it has been demonstrated in a detailed slope stability analysis approved by the department that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill.

4. Procedures to establish and maintain vegetative growth to combat erosion and improve appearance of idle and completed areas. Procedures shall include seeding rate, fertilizer rate, soil conditioning rate and provisions for mulching;

5. Procedures to maintain a cover integrity, for example, regrading and recovering;

6. Methods for borrow areas to be reclaimed so as to restore aesthetic qualities and prevent excessive erosion;

7. The final slope of the top of the sanitary landfill shall have a minimum slope of five percent (5%); and

8. Shear failure analyses shall be included where intermediate or final slopes exceed twenty-five percent (25%). However, the department will waive the analysis for slopes of twenty-five percent (25%) or less, except in seismic impact zones.

(C) Satisfactory Compliance—Operations.

1. Cover shall be applied by the end of each operating day regardless of weather; sources of cover, therefore, shall be accessible on all operating days. The thickness of the compacted cover shall not be less than six inches (6"). Sanitary landfills operating twenty-four (24) hours per day shall incorporate all solid waste into one (1) or more cells at least every twenty-four (24) hours. Where a liner and leachate collection system are in place, an alternative daily cover may be approved by the department on a site-specific basis, if the owner/operator demonstrates that the alternative material controls run-on, runoff, disease vectors, fires, odors, blowing litter and scavenging without presenting a threat to human health and the environment.

2. Cover shall be increased to a total thickness of at least one foot (1') of compacted cover on filled areas of the sanitary landfill which are idle for more than sixty (60) days.

3. No active, intermediate or final slope shall exceed thirty-three and one-third percent (33 1/3%).

4. As each phase of the sanitary landfill is completed, a final cover system shall be installed at portions of—

A. Existing sanitary landfills without composite liners. This final cover shall consist of at least two feet (2') of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less and overlaid by at least one foot (1') of soil capable of sustaining vegetative growth;

B. Sanitary landfills with composite liners. This final cover shall consist of component layers, in order from top to bottom, as follows:

(I) Two feet (2') of soil capable of sustaining vegetative growth;

(II) A drainage layer;

(III) A geomembrane liner at least as thick as the geomembrane liner described in subparagraph (10)(B)1.G.;

(IV) One foot (1') of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less; and

C. The geomembrane liner shall be in intimate contact with the underlying compacted clay.

5. The installation of the final cover systems shall include provisions for slope stability.

6. The department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate to the department that the alternative design will be at least equivalent to the final cover system described in paragraph (17)(C)3. of this rule.

7. Surface grades and side slopes shall be maintained to promote runoff without excessive erosion.

8. Vegetation shall be established within one hundred eighty (180) days of application of the cover required by paragraphs (17)(C)2. and 3. of this rule. Vegetation shall be established and maintained to minimize erosion and surface water infiltration.

9. Regrading and recovering shall be performed as necessary to maintain cover slope and integrity.

10. Borrow areas shall be reclaimed in accordance with the approved plans.

11. The compacted clay portion of the final cover shall consist of soils classified under the Unified Soil Classification System as CH, CL, ML, SC or MH.

(18) Compaction.

(A) Requirement. In order to conserve sanitary landfill site capacity, thereby preserving land resources and to minimize moisture infiltration and settlement, solid waste and cover shall be compacted to the smallest practicable volume.

(B) Satisfactory Compliance—Design.

1. Arrangements shall be made and indicated in the plans where substitute equipment will be available to provide uninterrupted service during routine maintenance periods or equipment breakdowns.

2. The plans shall specify the equipment that should be available to conduct the sanitary landfill operation at the projected solid waste loading.

(C) Satisfactory Compliance—Operations.

1. Solid waste handling equipment, on any operating day shall be capable of performing and shall perform the following functions:

A. Spread the solid wastes to be compacted in layers no more than two feet (2') thick, while confining it to the smallest practicable area;

B. Compact the spread solid wastes to the smallest practicable volume; and

C. Place, spread and compact the cover as much as practicable.

2. A preventive maintenance program should be employed to maintain equipment in operating order.

3. No solid waste shall be disposed of in water where the presence of the water will prohibit the proper spreading and compaction of the solid waste or where a mosquito breeding problem would be created.

(19) Safety.

(A) Requirement. The sanitary landfill shall be designed, constructed and operated in a manner so as to protect the health and safety of personnel and others associated with and affected by the operation.

(B) Satisfactory Compliance—Design.

1. Provisions shall be included in the plans to control and limit access to the sanitary landfill in a manner that is compatible with the surrounding land use.

2. Provisions shall be included in the plans to control dust for safety purposes and to prevent a nuisance to the surrounding area.

3. The plans shall specify the facilities and methods to be provided for extinguishing fires.

(C) Satisfactory Compliance—Operation.

1. A fire extinguisher shall be provided on all solid waste handling equipment.

2. Any fires in wastes being delivered to the sanitary landfill or which occur at the working face or within equipment or personnel facilities shall be extinguished.

3. Adequate communications equipment shall be available at the sanitary landfill for emergency situations.

4. Scavenging shall be prohibited at all times to avoid injury and to prevent interference with sanitary landfill operations.

5. Access to the sanitary landfill shall be controlled and shall be by established roadways only. The sanitary landfill shall be accessible only when operating personnel are on duty. Large containers may be placed at the sanitary landfill entrance so that users can conveniently deposit solid waste after hours. The containers and the areas around them shall be maintained in a sanitary and litter-free condition.

6. Traffic signs or markers should be provided to promote an orderly traffic pattern to and from the discharge area and, if necessary, to restrict access to hazardous areas or to maintain efficient operating conditions. Drivers of manually discharging vehicles should not hinder operation of mechanically discharging vehicles. Vehicles should not be left unattended at the working face or along traffic routes. If a regular user persistently poses a safety hazard, s/he should be barred from the sanitary landfill.

7. Dust control provisions shall be utilized as necessary for safety purposes and to prevent a nuisance to the surrounding area.

(20) Records.

(A) Requirement. The owner/operator of a sanitary landfill shall maintain records and monitoring data as specified by the department and file appropriate documents with the county recorder(s) of deeds.

(B) Satisfactory Compliance—Design. Plans shall prescribe methods to be used in maintaining records and monitoring the environmental impact of the sanitary landfill. Information on recording and monitoring requirements may be obtained from the department.

(C) Satisfactory Compliance—Operations.

1. Records shall be maintained at the landfill office. Records five (5) years old or older may be stored at an alternate site if approved by the department; such stored records must be made available at the landfill upon request of department personnel. Records must cover at least the following:

A. Major operational problems, complaints or difficulties;

B. Gas monitoring results from monitoring and any remediation plans required under section (14) of this rule;

C. Any demonstration, certification, finding, monitoring, testing or analytical data required under sections (4) and (11) of this rule;

D. Vector control efforts;

E. Dust and litter control efforts;

F. Quantitative measurements of the solid waste handled and an estimate of the air space left at the facility. Every two (2) years after the date of the permit issuance and within sixty (60) days of the anniversary date of the permit issuance, the owner/operator shall submit to the department two (2) copies of a topographic map, prepared under the direction of a land surveyor or by aerial photography, showing the current horizontal and vertical boundaries of solid waste in the sanitary landfill and the boundaries of the sanitary landfill. Maps prepared by aerial photography shall meet the current National Map Accuracy Standards for Photogrammetry as indicated in United States Bureau of the Budget "Circular A-16 Exhibit C," dated October 10, 1958;

G. Description, source and volume of special wastes that are received;

H. Any sanitary landfill design documentation for recirculation of leachate or gas condensate in a landfill;

I. Closure and post-closure care plans and any monitoring, testing or analytical data as required under 10 CSR 80-2.030(4)(A);

J. Any cost estimates and financial assurance documentation required under 10 CSR 80-2.030(4)(B) and (C);

K. Inspection records and training procedures as required under 10 CSR 80-2.060 and subsection (3)(B) of this rule;

L. Records associated with fees as required under 10 CSR 80-2.080(2);

M. Records associated with corrective measures as required under section (10) of this rule; and

N. Effective January 1, 1998, on or before January 31 of each calendar year and annually thereafter each solid waste disposal area shall submit a report to the department specifying the amount of solid waste received for disposal from states other than Missouri. The landfill operator shall keep a detailed report of the origin of all waste received.

2. Upon closing of the sanitary landfill, the existence of the sanitary landfill shall be recorded with the recorder(s) of deeds in the county(ies) where the sanitary landfill is located. The owner/operator may request permission from the department to remove the notation from the deed if all wastes are removed from the facility.

A. A survey and plat meeting the requirements of the current Minimum Standards of Property Boundary Survey 10 CSR 30-2.010 and detailed description of the sanitary landfill shall be prepared by a land surveyor. The survey plat and detailed description, at a minimum, shall contain the following information:

(I) The name of the property owner as it appears on the property deed;

(II) The detailed description of the property;

(III) The general types and location of the solid wastes and the depth(s) of fill within the property; and

(IV) The location of any leachate control, gas control or water monitoring systems which shall be maintained after closure and the length of time that these systems are to be maintained.

B. The owner/operator shall obtain approval from the department of the survey plat and detailed description prior to filing with the county recorder of deeds. After receiving approval from the department and before filing with the county recorder of deeds, the detailed description shall be notarized by a lawful notary public. Filing the notarized plat or detailed description shall be accomplished within thirty (30) days of departmental approval. Two (2) copies of the notarized and properly recorded plat or detailed description showing the recorder of deeds' seal or stamp, the book and page numbers and the date of filing shall be submitted to the department within thirty (30) days of the date of filing.

C. Owners of solid waste disposal areas permitted prior to January 1, 1987, and which close after January 1, 1989, as a part of closure of the solid waste disposal area shall—

(I) Execute an easement with the department, which allows the department, its agents or its contractors to enter the premises to complete work specified in the closure plan, to monitor or maintain the solid waste disposal area or take remedial action during post-closure period; and

(II) Submit evidence to the department that a notice and covenant running with the land has been recorded with the recorder of deeds in the county where the sanitary landfill is located. The notice and covenant shall specify the following:

(a) That the property has been permitted as a sanitary landfill; and

(b) That use of the land in any manner which interferes with closure plans, and post-closure plans filed with the department, is prohibited.

AUTHORITY: section 260.225, RSMo Supp. 1997. Original rule filed Dec. 11, 1973, effective Dec. 21, 1973. Amended: Filed July 14, 1986, effective Jan. 1, 1987. Amended: Filed Jan. 5, 1987, effective June 1, 1987. Amended: Filed Jan. 29, 1988, effective Aug. 1, 1988. Amended: Filed Aug. 15, 1988, effective Dec. 29, 1988. Emergency amendment filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Amended: Filed May 3, 1993, effective Jan. 13, 1994. Amended: Filed March 17, 1992.** Emergency rescission of the 1992 amendment filed March 19, 1997, effective April 1, 1997, expired Sept. 27, 1997. Amended: Filed Oct. 10, 1996, effective July 30, 1997. Rescission of the 1992 amendment filed April 3, 1997, effective Aug. 30, 1997. Amended: Filed Dec. 15, 1997, effective Aug. 30, 1998.*

**Original authority 1972, amended 1975, 1986, 1988, 1990, 1993, 1995.*

The Missouri Supreme Court in* ***Missouri Coalition for the Environment, et al., v. Joint Committee on Administrative Rules, et al., *Case No. 78628, dated February 25, 1997, ordered the secretary of state to publish this amendment. The Missouri Department of Natural Resources subsequently filed an emergency rescission of this amendment as well as a proposed rescission of this amendment which became effective August 30, 1997. See the above authority section for filing dates.*

Op. Atty. Gen. No. 42, Frappier (3-20-74). *With respect to the Solid Waste Management Law, Senate Bill No. 387, 76th General Assembly, sections 260.200–260.245, RSMo Supp. 1978. Cities and counties are required to provide for the collection and disposal of solid wastes including industrial wastes and may contract for such collection and disposal. Service charges may be imposed if not already imposed under some other law although these charges must be billed and collected directly by the cities or counties. General revenue of the city and federal revenue sharing funds may also be expended for such purposes.*

Appendix I—Constituents for Detection Monitoring

Inorganic Constituents

Ammonia (NH_3 as N, mg/l)
Antimony (Sb, μg/l)
Arsenic (As, μg/l)
Barium (Ba, μg/l)
Beryllium (Be, μg/l)
Boron (B, μg/l)
Cadmium (Cd, μg/l)
Calcium (Ca, mg/l)
Chromium (Cr, μg/l)
Cobalt (Co, μg/l)
Copper (Cu, μg/l))
Fluoride (F, mg/l)
Hardness (calculated, mg/l)
Lead (Pb, μg/l)
Magnesium (Mg, mg/l)
Manganese (Mn, μg/l)
Mercury (Hg, μg/l)
Nickel (Ni, mg/l)
Nitrate/Nitrite (NO_3/NO_2, mg/l)
Phosphorus (total P, mg/l)
Selenium (Se, μg/l)
Silver (Ag, μg/l)
Sodium (Na, mg/l)
Sulfate (SO_4, mg/l)
Thallium (Tl, μg/l)
Total Organic Carbon (TOC, mg/l)
Vanadium (V, μg/l)
Zinc (Zn, μg/l)

Organic Constituents

Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform; Tribromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane; Ethyl chloride
Chloroform; Trichloromethane
Dibromochloromethane; Chlorodibromomethane
1,2-Dibromo-3-chloropropane; DBCP
1,2-Dibromoethane; Ethylene dibromide; EDB
o-Dichlorobenzene; 1,2-Dichlorobenzene
p-Dichlorobenzene; 1,4-Dichlorobenzene
trans-1,4-Dichloro-2-butene
1,1-Dichloroethane; Ethylidene chloride
1,2-Dichloroethane; Ethylene dichloride
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride
cis-1,2-Dichloroethylene; cis-1,2-

Dichloroethene
trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene
1,2-Dichloropropane; Propylene dichloride
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone; Methyl butyl ketone
Methyl bromide; Bromomethane
Methyl chloride; Chloromethane
Methylene bromide; Dibromomethane
Methylene chloride; Dichloromethane
Methyl ethyl ketone; MEK; 2-Butanone
Methyl iodide; Iodomethane
4-Methyl-2-pentanone; Methyl isobutyl ketone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene
Toluene
1,1,1-Trichloroethane; Methylchloroform
1,1,2-Trichloroethane
Trichloroethylene; Trichloroethene
Tichlorofluoromethane; CFC-11
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylenes

Appendix II—List of Hazardous Inorganic and Organic Constituents[1]

Common Name[2]	CAS RN[3]
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Acetone	67-64-1
Acetonitrile; Methyl cyanide	75-05-8
Acetophenone	98-86-2
2-Acetylaminofluorene; 2-AAF	53-96-3
Acrolein	107-02-8
Acrylonitrile	107-13-1
Aldrin	309-00-2
Allyl chloride	107-05-1
4-Aminobipheny	l92-67-1
Anthracene	120-12-7
Antimony	(Total)
Arsenic	(Total)
Barium	(Total)
Benzene	71-43-2
Benzo[a]anthracene; Benzanthracene	56-55-3
Benzo[b]fluoranthene	205-99-2
Benzo[k]fluoranthene	207-08-9
Benzo[ghi]perylene	191-24-2
Benzo[a]pylene	50-32-8
Benzyl alcohol	100-51-6
Beryllium	(Total)
alpha-BHC	319-84-6
beta-BHC	319-85-7
delta-BHC	319-86-8
gamma-BHC; Lindane	58-89-9
Bis(2-chloroethoxy)methane	111-91-1
Bis(2-chloroethyl) ether; Dichloroethyl ether	111-44-4
Bis(2-chloro-1-methylethyl) ether; 2,2'-Dichlorodiisopropyl ether; DCIP	108-60-1 See Note 3
Bis(2-ethylhexyl) phthalate	117-81-7
Bromochloromethane; Chlorobromomethane	74-97-5
Bromodichloromethane; Dibromochloromethane	75-27-4
Bromoform; Tribromomethane	75-25-2
4-Bromophenylphenyl ether	101-55-3
Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7
Cadmium	(Total)
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlordane	See Note 4.
p-Chloroaniline	106-47-8
Chlorobenzene	108-90-7
Chlorobenzilate	510-15-6
p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7
Chloroethane; Ethyl chloride	75-00-3
Chloroform; Trichloromethane	67-66-3
2-Chloronaphthalene	91-58-7
2-Chlorophenol	95-57-8
4-Chlorophenyl phenyl ether	7005-72-3
Chloroprene	126-99-8
Chromium	(Total)
Chrysene	218-01-9
Cobalt	(Total)
Copper	(Total)
m-Cresol; 3-methylphenol	108-39-4
o-Cresol; 2-methylphenol	95-48-7
p-Cresol; 4-methylphenol	106-44-5
Cyanide	57-12-5
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7
4,4´-DDD	72-54-8
4,4´-DDE	72-55-9
4,4´-DDT	50-29-3
Diallate	2303-16-4
Dibenz[a,h]anthracene	53-70-3
Dibenzofuran	132-64-9
Dibromochloromethane; Chlorodibromomethane	124-48-1
1,2-Dibromo-3-chloropropane;DBCP	96-12-8
1,2-Dibromoethane; Ethylene dribromide; EDB	106-93-4
Di-n-butyl phthalate	84-74-2
o-Dichlorobenzene; 1,3-Dichlorobenzene	95-50-1
m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7
3,3´-Dichlorobenzidine	91-94-1
trans-1,4-Dichloro-2-butene	110-57-6
Dichlorodifluoromethane; CFC 12;	75-71-8
1,1-Dichloroethane; Ethyldidene chloride	75-34-3
1,2-Dichloroethane; Ethylene dichloride	107-06-2
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethylene trans-1,2-Dichloroethene	156-60-5
2,4-Dichlorophenol	120-83-2
2,6-Dichlorophenol	87-65-0
1,2-Dichloropropane; Propylene dichloride	78-87-5
1,3-Dichloropropane; Trimethylene dichloride	142-28-9
2,2-Dichloropropane; Isopropylidene chloride	594-20-7
1,1-Dichloropropene	563-58-6
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
Dieldrin	60-57-1
Diethyl phthalate	84-66-2
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2
Dimethoate	60-51-5
p-(Dimethylamino)azobenzen	60-11-7
7,12-Dimethylbenz[a]nthracene	57-97-6
3,3´-Dimethylbenzidine	119-93-7
2,4-Dimethylphenol; m-Xylenol	105-67-9
Dimethyl phthalate	131-11-3
m-Dinitrobenzene	99-65-0
4,6-Dinitro-o-cresol 4,6-Dinitro-2-methylphenol	534-52-1
2,4-Dinitrophenol;	51-28-5
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7
Di-n-octyl phthalate	117-84-0
Diphenylamine	122-39-4
Disulfoton	298-04-4
Endosulfan I	959-98-8
Endosulfan II	33213-65-9
Endosulfan sulfate	1031-07-8
Endrin	72-20-8
Endrin aldehyde	7421-93-4
Ethylbenzene	100-41-4
Ethyl methacrylate	97-63-2
Ethyl methanesulfonate	62-50-0
Famphur	52-85-7
Fluoranthene	206-44-0
Fluorene	86-73-79
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene .	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexachloropropene	1888-71-7

2-Hexanone; Methyl butyl ketone	591-78-6
Indeno(1,2,3-cd)pyrene	193-39-5
Isobutyl alcohol	78-83-1
Isodrin	465-73-6
Isophorone	78-59-1
Isosafrole	120-58-1
Kepone	143-50-0
Lead	(Total)
Mercury	(Total)
Methacrylonitrile	126-98-7
Methapyrilene	91-80-5
Methoxychlor	72-43-5
Methyl bromide; Bromomethane	74-83-9
Methyl chloride; Chloromethane	74-87-3
3-Methylcholanthrene	56-49-5
Methyl ethyl ketone; MEK; 2-Butanone	78-93-3
Methyl iodide; Iodomethane	74-88-4
Methyl methacrylate	80-62-6
Methyl methanesulfonate	66-27-3
2-Methylnaphthalene	91-57-6
Methyl parathion; Parathion methyl	298-00-0
4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1
Methylene bromide; Dibromomethane	74-95-3
Methylene chloride; Dichloromethane	75-09-2
Naphthalene	91-20-3
1,4-Naphthoquinone	130-15-4
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
Nickel	(Total)
o-Nitroaniline; 2-Nitroaniline	88-74-4
m-Nitroaniline; 3-Nitroaniline	99-09-2
p-Nitroaniline; 4-Nitroaniline	100-01-6
Nitrobenzene	98-95-3
o-Nitrophenol; 2-Nitrophenol	88-75-5
p-Nitrophenol; 4-Nitrophenol	100-02-7
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodipropylamine; N-nitroso-N-dipropylamine Di-n-propylnitrosamine	621-64-7
N-Nitrosomethylethylamine	10595-95-6
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
5-Nitro-o-toluidine	99-55-8
Parathion	56-38-2
Pentachlorobenzene	608-93-5
Pentachloronitrobenzene	82-68-8
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenanthrene	85-01-8
Phenol	108-95-2
p-Phenylenediamine	106-50-3
Phorate	298-02-2
Polychlorinated biphenyls; PCBs; Aroclors	See Note 5.
Pronamide	23950-58-5
Propionitrile; Ethyl cyanide	107-12-0
Pyrene	129-00-0
Safrole	94-59-7
Selenium	(Total)
Silver	(Total)
Silvex; 2,4,5-TP	93-72-1
Styrene	100-42-5
Sulfide	18496-25-8
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5
1,2,4,5-Tetrachlorobenzene	95-94-3
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene; Tetra-chloroethene; Perchloroethylene	127-18-4
2,3,4,6-Tetrachlorophenol	58-90-2
Thallium	(Total)
Tin	(Total)
Toluene	108-88-3
o-Toluidine	95-53-4
Toxaphene	See Note 6.
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane; Methylchloroform	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethylene; Trichloroethene	79-01-6
Trichlorofluoromethane; CFC-11	75-69-4
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
0,0,0-Triethyl phosphorothioate	126-68-1
sym-Trinitrobenzene	99-35-4
Vanadium	(Total)
Vinyl acetate	108-05-4
Vinyl chloride; Chloroethene	75-01-4
Xylene (total)	See Note 7.
Zinc	(Total)

Notes

1. The regulatory requirements pertain only to the list of substances.

2. Common names are those widely used in government regulations, scientific publications, and commerce; synonym sexist for many chemicals.

3. This substance is often called Bis(2-chloroisopropyl) ether, the name Chemical Abstracts Service applies to its noncommercial isomer, Propane, 2,2´-oxybis, 2-chloro- (CAS RN 39638-32-9).

4. Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12789-03-6).

5. Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Aroclor 1260 (CAS RN 11096-82-5).

6. Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), i.e., chlorinated camphene.

7. Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

10 CSR 80-3.011 Design and Operation

Emergency rule filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Emergency rule filed Jan. 28, 1994, effective Feb. 7, 1994, expired June 6, 1994.

10 CSR 80-3.020 Emergency Landfill Extensions

Emergency rule filed Sept. 29, 1993, effective Oct. 9, 1993, expired Feb. 5, 1994. Emergency rule filed Jan. 28, 1994, effective Feb. 7, 1994, expired June 6, 1994.

MDNR Regulations

Title 10

Division 60 – Public Drinking Water Program

Chapter 4 – Contaminant Levels and Monitoring

Date: 10/31/2003

Rules of
Department of Natural Resources
Division 60—Public Drinking Water Program
Chapter 4—Contaminant Levels and Monitoring

Title **Page**

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 60—Public Drinking Water Program
Chapter 4—Contaminant Levels and Monitoring

10 CSR 60-4.010 Maximum Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes sampling and monitoring requirements for public water systems and criteria for significant defiencies at surface water systems.

(1) The rules in this chapter contain maximum contaminant levels (MCLs) permissible in public water systems and describe associated monitoring requirements. A supplier of water must collect or have collected samples of the water and shall provide for analysis of these samples for designated contaminants. Nothing in this chapter shall preclude a duly designated representative of the department from taking samples or from using the results from the samples to determine compliance by a supplier of water with applicable provisions of these rules.

(2) Laboratory services required by this chapter to determine contaminant levels are available from the Department of Natural Resources (DNR) or the Department of Health according to the fee schedule set out in 10 CSR 60-16.030.

(A) Samples must be collected at no less than the required frequency and in accordance with schedules established by the department when samples are submitted to the DNR or the Department of Health laboratory for analysis.

(B) A supplier of water which submits samples to the DNR or the Department of Health laboratory must collect and submit samples using containers provided by the department in accordance with the instructions enclosed.

(C) A supplier of water not using the DNR or the Department of Health laboratory must have the analysis done by a laboratory certified by the department.

(3) Samples taken to determine compliance with the requirements of this chapter shall be taken at representative points of the public water system, as approved by the department. The supplier of water shall provide satisfactory sampling taps. Samples for microbiological analysis must be received in the laboratory for analysis within forty-eight (48) hours of collection.

(4) All analytical results must be accurate to at least the same number of significant figures as the applicable MCL.

(5) All analyses must be consistent with the methods and procedures described in 10 CSR 60-5.010 and 10 CSR 60-5.020. The results of all analyses must be used to determine compliance with the MCLs unless the analytical results are invalidated for technical reasons, such as obvious sampling errors.

(6) When a public water supply system supplies water to one (1) or more other public water supply systems, the department may modify the monitoring requirements imposed by these rules to the extent that the interconnection of the systems justifies treating them as a single system for monitoring purposes. Any modified monitoring must be conducted pursuant to a schedule specified by the department.

(7) Inspections and Sanitary Surveys of Surface Water Systems.

(A) Sanitary surveys of all surface water systems and systems using groundwater under the direct influence of surface water will be conducted at least every three (3) years for community systems and every five (5) years for noncommunity systems. Sanitary survey as used in this section (7) means an on-site review, under the supervision of an engineer, of the water source (identifying its sources of contamination using the results of source water assessments where available), facilities, equipment, operation, maintenance, and monitoring compliance, in order to evaluate the adequacy of the system, its sources and operations and the distribution of safe drinking water. It also includes a review of the disinfection profile for systems that are required to comply with disinfection profiling requirements.

(B) For community water systems determined by the department to have no significant deficiencies (for example, defects or inadequacies that increase risk from waterborne disease, such as deficiencies involving the removal, inactivation or reintroduction of pathogens or prevention or removal of chemical contamination) in two (2) consecutive sanitary surveys, the frequency of sanitary surveys may be decreased to once every five (5) years. Upon finding a significant deficiency, the department may return the community water system to the three (3)-year schedule.

(C) Public water systems must respond in writing to significant deficiencies outlined in sanitary survey reports no later than forty-five (45) days after receipt of the report. The response must indicate how and on what schedule the system will address significant deficiencies noted in the survey. Failure to respond within forty-five (45) days is a violation. Public water systems shall take necessary steps to address significant deficiencies identified in sanitary survey reports if such deficiencies are within the control of the public water system and its governing body.

(D) The department, at its discretion, may conduct routine inspections of any public water system or make other necessary inspections to determine compliance with these rules. If, after investigation, the department finds that any public water system is incompetently supervised, improperly operated, inadequate, of defective design or if the water fails to meet standards established in 10 CSR 60, the water supplier must implement changes that may be required by the department.

(8) The provisions of this rule are declared severable. If any fee fixed by this rule is held invalid by a court of competent jurisdiction or by the Administrative Hearing Commission, the remaining provisions of this rule shall remain in full force and effect, unless otherwise determined by a court of competent jurisdiction or by the Administrative Hearing Commission.

AUTHORITY: section 640.100, RSMo Supp. 1999. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed Aug. 13, 1982, effective Jan. 13, 1983. Amended: Filed June 2, 1988, effective Aug. 31, 1988. Amended: Filed Dec. 4, 1990, effective July 8, 1991. Amended: Filed April 14, 1994, effective Nov. 30, 1994. Amended: Filed Dec. 15, 1999, effective Sept. 1, 2000.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-4.020 Maximum Microbiological Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for microbiological contaminants.

(1) Routine Monitoring.

(A) Public water systems must collect total coliform samples according to a written sample siting plan at sites which are representative of water throughout the distribution system. This plan shall be made available to the inspector conducting a sanitary survey or on-site inspection, or to the department upon request and the department will either approve or recommend improvements.

1. All routine samples should be taken from the distribution system.

2. Distribution sampling points should be chosen where both upstream and downstream repeat samples can be taken within five (5) service connections of the principal sampling point. The same distribution points may be used each month, but there must be a separate point for each distribution sample collected each day.

3. Groundwater supplies collecting five (5) or fewer samples per month may collect all samples on the same day with departmental approval; provided, that the samples are all collected from different points. Other supplies shall collect samples at regular intervals throughout the month.

4. Groundwater supplies under the direct influence of surface water that do not practice filtration must identify a sample point near the first service connection which is one (1) of twenty percent (20%) of all service connections in the entire system that are nearest the water supply treatment facility as measured by water transport time within the distribution system.

5. Supplies should identify at least five (5) sampling taps since these are needed for five (5) routine samples in the month following an unsafe sample.

(B) The monitoring frequency for total coliforms for community water systems is based on the population served by the system as follows except that systems utilizing surface or ground water under the direct influence of surface water and systems practicing iron removal or lime softening must collect at least five (5) samples per month. In addition, the department may require a greater frequency if necessary:

Total Coliform Monitoring Frequency for Community Water Systems

Population Served	Minimum Samples Per Month
25—1000*	1
1001—2500	2
2501—3300	3
3301—4100	4
4101—4900	5
4901—5800	6
5801—6700	7
6701—7600	8
7601—8500	9
8501—12,900	10
12,901—17,200	15
17,201—21,500	20
21,501— 25,000	25
25,001—33,000	30
33,001—41,000	40
41,001—50,000	50
50,001—59,000	60
59,001—70,000	70
70,001—83,000	80
83,001—96,000	90
96,001—130,000	100
130,001—220,000	120
220,001—320,000	150
320,001—450,000	180
450,001—600,000	210
600,001—780,000	240
780,001—970,000	270
970,001—1,230,000	300
1,230,001—1,520,000	330
1,520,001—1,850,000	360
1,850,001—2,270,000	390
2,270,001—3,020,000	420
3,020,001—3,960,000	450
3,960,001—more	480

*Includes public water systems which have at least fifteen (15) service connections but serve fewer than twenty-five (25) persons.

(C) The monitoring frequency for total coliforms for noncommunity water systems is as follows, except that the department may require a greater frequency:

1. A noncommunity water system using only groundwater (except groundwater under the direct influence of surface water) and serving one thousand (1,000) persons or fewer per day must monitor each calendar quarter that the system provides water to the public, except that the department may reduce this monitoring frequency, in writing, if a sanitary survey or on-site inspection shows that the system is free of sanitary defects. Beginning June 29, 1994, the department cannot reduce the monitoring frequency for a noncommunity water system using only groundwater (except groundwater under the direct influence of surface water) and serving one thousand (1,000) persons or fewer per day to less than once per year;

2. A noncommunity water system using only groundwater (except groundwater under the direct influence of surface water) and serving more than one thousand (1,000) persons per day during any month must monitor at the same frequency as a like-sized community water system, as specified in subsection (1)(B) of this rule, except that the department may reduce this monitoring frequency, in writing, for any month the system serves less than one thousand (<1,000) persons per day. The department cannot reduce the monitoring frequency to less than once per year. For systems using groundwater under the direct influence of surface water, paragraph (1)(C)4. of this rule applies;

3. A noncommunity water system using surface water, in total or in part, must monitor at the same frequency as a like-sized community water system that uses surface water, as specified in subsection (1)(B) of this rule; and

4. A noncommunity water system using groundwater under the direct influence of surface water must monitor at the same frequency as a like-sized community water system that uses surface water, as specified in subsection (1)(B) of this rule. The system must begin monitoring at this frequency beginning six (6) months after the department determines that the groundwater is under the direct influence of surface water.

(D) The public water system must collect samples at regular time intervals throughout the monitoring period, except that a system which uses groundwater (except groundwater under the direct influence of surface water) and serves four thousand nine hundred (4,900) persons or fewer, may collect, with departmental approval, all samples on a single day if they are taken from different sites.

(E) A public water system that uses groundwater under the direct influence of surface water and does not practice filtration must collect at least one (1) sample near the first service connection each day the turbidity level of the source water, measured as specified in 10 CSR 60-5.010(1), exceeds one (1) nephelometric turbidity unit (NTU). This sample must be analyzed for the presence of total coliforms. When one (1) or more turbidity measurements in any day exceeds one (1) NTU, the system must collect this coliform sample within twenty-four (24) hours of the exceedance unless the department determines that the system, for logistical reasons outside its control, cannot have the sample analyzed within thirty (30) hours of collection. Sample results from this coliform monitoring must be included in determining compliance with the maximum contaminant levels (MCLs) for total coliforms in section (7) of this rule.

(F) Special purpose samples, such as those taken to determine whether disinfection practices are sufficient following pipe placement, replacement or repair, shall not be used to determine compliance with the MCL for total coliforms in section (7) of this rule. Repeat samples taken pursuant to section (2) of this rule are not considered special purpose samples and must be used to determine compliance with the MCL for total coliforms in section (7) of this rule.

(2) Repeat Monitoring.

(A) If a routine sample is total coliform-positive, the public water system must collect a set of repeat samples within twenty-four (24) hours of being notified of the positive result. The department may extend the twenty-four (24)-hour limit on a case-by-case basis if the system has a logistical problem in collecting repeat samples that is beyond its control. In the case of an extension, the department must specify how much time the system has to collect the repeat samples. A system which collects more than one (1) routine sample per month must collect no fewer than three (3) repeat samples for each total coliform-positive sample found. A system which collects one (1) routine sample per month or fewer must collect no fewer than four (4) repeat samples for each total coliform-positive sample found.

(B) The system must collect at least one (1) repeat sample from the sampling tap where the original total coliform-positive sample was taken and at least one (1) repeat sample at a tap within five (5) service connections upstream and at least one (1) repeat sample at a tap within five (5) service connections downstream of the original sampling site. If a total coliform-positive sample is at the end of the distribution system, or one (1) away from the end of the distribution system, the department may waive the requirement to collect at least one (1) repeat sample upstream or downstream of the original sampling site except that the total number of repeat samples shall not be reduced.

(C) The system must collect all repeat samples on the same day, except that the department may allow a system with a single service connection to collect the required set of repeat samples over a four (4)-day period or to collect a larger volume repeat sample(s) in one (1) or more sample containers of any size, as long as the total volume collected is at least four hundred milliliters (400 ml) (three hundred milliliters (300 ml) for systems which collect more than one (1) routine sample per month). Systems with more than one (1) service connection, but fewer service connections than the required number of repeat samples, shall collect repeat samples as directed by the department.

(D) If one (1) or more repeat samples in the set is total coliform-positive, the public water system must collect an additional set of repeat samples in the manner specified in subsections (2)(A)–(C) of this rule. The additional samples must be collected within twenty-four (24) hours of being notified of the positive result, unless the department extends the limit as provided in subsection (2)(A) of this rule. The system must repeat this process until either total coliforms are not detected in one (1) complete set of repeat samples or the system determines that the MCL for total coliforms in section (7) of this rule has been exceeded and notifies the department.

(E) If a system collecting fewer than five (5) routine samples per month has one (1) or more total coliform-positive samples and the department does not invalidate the sample(s) under section (3) of this rule, it must collect at least five (5) routine samples during the next month the system provides water to the public, except that the department may waive this requirement if the following conditions are met (the department cannot waive the requirement for a system to collect repeat samples in subsections (2)(A)–(D) of this rule):

1. The department may waive the requirement to collect five (5) routine samples the next month the system provides water to the public if the department, or an agent approved by the department, performs a site visit before the end of the next month the system provides water to the public. Although a sanitary survey need not be performed, the site visit must be sufficiently detailed to allow the department to determine whether additional monitoring, any corrective action, or both, is needed. The department cannot approve an employee of the system to perform this site visit, even if the employee is an agent approved by the department to perform sanitary surveys; and

2. The department may waive the requirement to collect five (5) routine samples the next month the system provides water to the public if the department has determined why the sample was total coliform-positive and establishes that the system has corrected the problem or will correct the problem before the end of the next month the system serves water to the public. In this case, the department must document this decision to waive the following month's additional monitoring requirement in writing, have it approved and signed by the supervisor of the department official who recommends the decision, and make this document available to the Environmental Protection Agency (EPA) and the public upon request. The written documentation must describe the specific cause of the total coliform-positive sample and what action the system has taken, or will take, to correct this problem. The department cannot waive the requirement to collect five (5) routine samples the next month the system provides water to the public solely on the grounds that all repeat samples are total coliform-negative. Under this paragraph, a system must still take at least one (1) routine sample before the end of the next month it serves water to the public and use it to determine compliance with the MCL for total coliforms in section (7) of this rule, unless the department has determined that the system has corrected the contamination problem before the system took the set of repeat samples required in subsections (2)(A)–(D) of this rule and all repeat samples were total coliform-negative.

(F) After a system collects a routine sample and before it learns the results of the analysis of that sample, if it collects another routine sample(s) from within five (5) adjacent service connections of the initial sample, and the initial sample, after analysis, is found to contain total coliforms, then the system may count the subsequent sample(s) as a repeat sample instead of as a routine sample.

(G) Results of all routine and repeat samples not invalidated by the department must be included in determining compliance with the MCL for total coliforms in section (7) of this rule.

(3) Invalidation of Total Coliform Samples. A total coliform-positive sample invalidated under this section does not count towards meeting the minimum monitoring requirements of this rule.

(A) The department may invalidate a total coliform-positive sample only if any one (1) of the following conditions is met:

1. The laboratory establishes that improper sample analysis caused the total coliform-positive result;

2. The department, on the basis of the results of repeat samples collected as required by subsections (2)(A)–(D) of this rule, determines that the total coliform-positive sample resulted from a domestic or other nondistribution system plumbing problem. The department cannot invalidate a sample on the basis of repeat sample results unless all repeat

samples collected at the same tap as the original total coliform-positive sample are also total coliform-positive, and all repeat samples collected within five (5) service connections of the original tap are total coliform-negative (that is, the department cannot invalidate a total coliform-positive sample on the basis of repeat samples if all the repeat samples are total coliform-negative or if the public water system has only one (1) service connection); or

3. The department has substantial grounds to believe that a total coliform-positive result is due to a circumstance or condition which does not reflect water quality in the distribution system. In this case, the system must still collect all repeat samples required in subsections (2)(A)–(D) of this rule and then use them to determine compliance with the MCL for total coliforms in section (7) of this rule. To invalidate a total coliform-positive sample under this section, the decision with the rationale for the decision must be documented in writing, and approved and signed by the supervisor of the department official who recommended the decision. The department must make this document available to the EPA and to the public upon request. The written documentation must state the specific cause of the total coliform-positive sample and what action the system has taken, or will take, to correct this problem. The department may not invalidate a total coliform-positive sample solely on the grounds that all repeat samples are total coliform-negative.

(B) A laboratory must invalidate a total coliform sample (unless total coliforms are detected) if the sample produces a turbid culture in the absence of gas production using an analytical method where gas formation is examined (that is, the multiple-tube fermentation (MTF) technique), produces a turbid culture in the absence of an acid reaction in the presence-absence (P-A) coliform test, or exhibits confluent growth or produces colonies too numerous to count with an analytical method using a membrane filter (that is, membrane filter technique (MFT)). When a laboratory invalidates a sample because of this interference, the system must collect another sample from the same location as the original sample within twenty-four (24) hours of being notified of the invalidation and have it analyzed for the presence of total coliform. The system must continue to resample within twenty-four (24) hours and have the samples analyzed until it obtains a valid result. The department may extend the twenty-four (24)-hour limit on a case-by-case basis if the system has a logistical problem in collecting the sample that is beyond its control. In the case of an extension, the department must specify how much time the system has to collect the replacement samples.

(4) Sanitary Surveys.

(A) Public water systems which do not collect five (5) or more routine samples per month must undergo an initial sanitary survey or on-site inspection by June 29, 1994, for community public water systems and June 29, 1999, for noncommunity water systems. After that, systems must undergo another sanitary survey or on-site inspection every five (5) years, except that noncommunity water systems using only protected and disinfected groundwater, as defined by the department, must undergo subsequent sanitary surveys or on-site inspections at least every ten (10) years after the initial sanitary survey or on-site inspection. The department must review the results of each sanitary survey or on-site inspection to determine whether the existing monitoring frequency is adequate and what additional measure, if any, the system needs to undertake to improve drinking water quality.

(B) Sanitary surveys or on-site inspections must be performed by the department or an agent approved by the department. The system is responsible for ensuring that the sanitary survey or on-site inspection takes place. Agents that can be approved by the department to conduct sanitary surveys include engineers. Agents that can be approved by the department to conduct on-site inspections include, but are not limited to, sanitarians and environmental specialists from other state agencies acting in their official capacity. Reports of sanitary surveys and on-site inspections shall include completed forms approved by the department. Sanitary surveys and on-site inspections shall be done in accordance with criteria established by the department.

(5) Fecal Coliforms/*Escherichia coli (E. coli*) Testing.

(A) If any routine or repeat sample is total coliform-positive, the system must analyze that total coliform-positive culture medium to determine if fecal coliforms are present, except that the system may test for *E. coli* in lieu of fecal coliforms. If fecal coliforms or *E. coli* are present, the system must notify the department by the end of the day when the system is notified of the result, unless the system is notified of the result after the department office is closed, in which case the system must notify the department before the end of the next business day.

(B) The department has the discretion to allow a public water system, on a case-by-case basis, to forego fecal coliform or *E. coli* testing on a total coliform-positive sample if that system assumes that the total coliform-positive sample is fecal coliform-positive or *E. coli*-positive. The system must notify the department as specified in subsection (5)(A) of this rule, except as provided in subsection (5)(C) of this rule, and must provide Tier 1 notice to the public as specified in 10 CSR 60-8.010, including the mandatory health effects language for fecal coliform/*E.coli*.

(C) The department, after consideration of the circumstances surrounding a specific incident, may reduce or extend the public notice period for acute violations, as it deems appropriate.

(6) Response to Violation.

(A) A public water system which has exceeded the MCL for total coliforms in section (7) of this rule must report the violation to the department no later than the end of the next business day after it learns of the violation and notify the public in accordance with 10 CSR 60-8.010.

(B) A public water system which has failed to comply with a coliform monitoring requirement, including the sanitary survey requirement, must report the monitoring violation to the department within ten (10) days after the system discovers the violation and notify the public in accordance with the applicable requirement in 10 CSR 60-8.010.

(7) MCLs for Microbiological Contaminants.

(A) The MCL is based on the presence or absence of total coliforms in a sample, rather than coliform density. Public water systems need only determine the presence or absence of total coliforms; a determination of total coliform density is not required.

1. For a system which collects at least forty (40) samples per month, if no more than five percent (5.0%) of the samples collected during a month are total coliform-positive, the system is in compliance with the MCL for total coliforms.

2. For a system which collects fewer than forty (40) samples per month, if no more than one (1) sample collected during a month is total coliform-positive, the system is in compliance with the MCL for total coliforms.

(B) Any fecal coliform-positive repeat sample or *E. coli*-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or *E. coli*-positive routine sample constitutes a violation of the MCL for total coliforms. For purposes of the public notification requirements in 10 CSR 60-8.010, this is a violation that may pose an acute risk to health.

(C) A public water system must determine compliance with the MCL for total coliforms in subsections (7)(A) and (B) of this rule for each month in which it is required to monitor for total coliforms.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Rescinded and readopted: Filed Dec. 4, 1990, effective July 8, 1991. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.030 Maximum Inorganic Chemical Contaminant Levels, Action Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels, action levels and monitoring requirements for inorganic contaminants.

(1) Maximum Contaminant Levels (MCL) or Action Levels.

(A) The maximum contaminant or action level listed as follows for inorganic chemicals 1.–17. apply to community water systems. The maximum contaminant or action level listed as follows for inorganic chemicals 1.–9. and 11.–17. apply to nontransient noncommunity water systems. The maximum contaminant or action level listed as follows for inorganic chemicals 13.–15. apply to transient noncommunity water systems:

Contaminant	Maximum Contaminant Level (MCL)
1. Antimony	0.006 mg/l
2. Arsenic	0.05 mg/l (until Jan. 23, 2006) 0.010 mg/l (effective Jan. 23, 2006)
3. Asbestos	7 million fibers/liter (longer than 10 μm in length)
4. Barium	2 mg/l
5. Beryllium	0.004 mg/l
6. Cadmium	0.005 mg/l
7. Chromium	0.1 mg/l
8. Copper	* (See 10 CSR 60-15.010(3)(B).)
9. Cyanide	0.2 mg/l
10. Fluoride	4.0 mg/l
11. Lead	* (See 10 CSR 60-15.010(3)(A).)
12. Mercury	0.002 mg/l
13. Nitrate	10 mg/l (as nitrogen)
14. Nitrite	1 mg/l (as nitrogen)
15. Total Nitrate and Nitrite	10 mg/l (as nitrogen)
16. Selenium	0.05 mg/l
17. Thallium	0.002 mg/l

*Indicates action levels rather than maximum contaminant levels.

(B) Nitrate levels not to exceed twenty (20) mg/l may be allowed in a noncommunity water system if the supplier of water demonstrates to the satisfaction of the department that all of the following factors apply to the situation:

1. Such water will not be available to children under six (6) months of age;

2. The noncommunity water system is meeting the public notification requirements under 10 CSR 60-8.010(9), including continuous posting of the fact that nitrate levels exceed ten (10) mg/l and the potential health effects of exposure;

3. Local and state public health authorities will be notified annually of nitrate levels that exceed ten (10) mg/l; and

4. No adverse health effects shall result.

(2) Monitoring Frequency.

(A) Asbestos. The frequency of monitoring to determine compliance with the maximum contaminant level (MCL) for asbestos specified in section (1) of this rule shall be conducted as follows:

1. Each community and nontransient noncommunity water system is required to monitor for asbestos during the first three (3)-year compliance period of each nine (9)-year compliance cycle;

2. If monitoring data collected after January 1, 1990, are generally consistent with the requirements of subsection (2)(A) of this rule, then the state may allow systems to use those data to satisfy the monitoring requirement for the initial three (3)-year compliance period;

3. Waivers.

A. The system may apply to the department for a use waiver as described in 10 CSR 60-6.060(2). If the department grants the waiver, the system is not required to monitor while the waiver is effective. A waiver remains in effect until the completion of the three (3)-year compliance period and must be renewed for subsequent compliance periods. Systems not receiving a waiver must monitor in accordance with the provisions of paragraph (2)(A)1. of this rule.

B. The department may grant a waiver based on the potential asbestos contamination of the water source and the use of asbestos-cement pipe for finished water distribution and the corrosive nature of the water;

4. Increased and decreased monitoring.

A. A system that is out of compliance with the MCL as determined in section (6) of this rule shall monitor quarterly beginning in the next quarter after the violation occurs.

B. The department may decrease the quarterly monitoring requirement to the frequency specified in paragraph (2)(A)1. of this rule provided the department has determined that the analytical results for the system are reliably and consistently less than the MCL. In no case can the department make this determination unless a groundwater system takes a minimum of two (2) quarterly samples and a surface (or combined surface/ground) water system takes a minimum of four (4) quarterly samples; and

5. Sample collection.

A. A system vulnerable to asbestos contamination due solely to corrosion of asbestos-cement pipe shall take at least one (1) sample at a tap served by asbestos-cement pipe and under conditions where asbestos contamination is most likely to occur.

B. A system vulnerable to asbestos contamination due solely to source water shall monitor in accordance with the provision of section (4) of this rule.

C. A system vulnerable to asbestos contamination due both to its source water supply and corrosion of asbestos-cement pipe shall take at least one (1) sample at a tap served by asbestos-cement pipe and under conditions where asbestos contamination is most likely to occur.

(B) Inorganic Chemicals. Community and nontransient noncommunity water systems shall monitor for antimony, arsenic, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium and thallium as set forth here.

1. Groundwater systems shall take one (1) sample at each sampling point during each three (3)-year compliance period beginning in the initial compliance period. Surface water systems (or combined surface/ground) shall take one (1) sample annually at each sampling point beginning in the initial compliance period.

2. Waivers.

A. The system may apply to the department for a susceptibility waiver as described in 10 CSR 60-6.060(3). If the department grants the waiver, the system is required to take a minimum of one (1) sample while the waiver is effective. The term during which the waiver is effective shall not exceed one (1) nine (9)-year compliance cycle. Systems not receiving a waiver must monitor in accordance with the provisions of paragraph (2)(B)1. of this rule.

B. The department may grant a waiver provided surface water systems have monitored annually for at least three (3) years and groundwater systems have conducted a minimum of three (3) rounds of monitoring. At least one (1) sample shall have been taken since January 1, 1990. Both surface and ground water systems shall demonstrate that all previous analytical results were reliably and consistently less than the MCL. Systems that use a new water source are not eligible for a waiver until three (3) rounds of monitoring from the new source have been completed.

C. In determining the appropriate reduced monitoring frequency, the department shall consider the reported concentrations from all previous monitoring, the degree of variation in reported concentrations and other factors which may affect contaminant concentrations (such as changes in groundwater pumping rates, changes in the system's configuration, changes in the system's operating procedures, or changes in stream flows or characteristics).

D. A decision by the department to grant a waiver shall be made in writing and shall set forth the basis for the determination. The determination may be initiated by the department or upon an application by the public water system. The public water system shall specify the basis for its request. The department shall review and, where appropriate, revise its determination of the appropriate monitoring frequency when the system submits new monitoring data or when other data relevant to the system's appropriate monitoring frequency become available.

E. The department may grant a waiver for monitoring for cyanide, if the department determines that the system is not vulnerable due to lack of proximity to any industrial source of cyanide.

3. Increased and decreased monitoring.

A. Systems which exceed the MCLs as calculated in section (6) of this rule shall monitor quarterly beginning in the next quarter after the violation occurs.

B. Where the results of sampling for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium, or thallium indicate an exceedance of the maximum contaminant level, the department may require that one (1) additional sample be collected as soon as possible after the initial sample was taken (but not to exceed two (2) weeks) at the same sampling point.

C. The department may decrease the quarterly monitoring requirement to the frequencies specified in paragraph (2)(B)1. of this rule provided it has determined that the analytical results for the system are reliably and consistently below the MCL. In no case can the department make this determination unless a groundwater system takes a minimum of two (2) quarterly samples and a surface water system (or combined surface/ground) takes a minimum of four (4) quarterly samples.

D. All new systems or systems that use a new source of water that begin operation after January 22, 2004 must demonstrate compliance with the MCL within a period of time specified by the department. The system must also comply with the initial sampling frequencies specified by the department to ensure a system can demonstrate compliance with the MCL. Routine and increased monitoring frequencies shall be conducted in accordance with the requirements in this section (2).

E. For systems which are conducting monitoring at a frequency greater than annual, compliance with the maximum contaminant levels for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium, or thallium is determined by a running annual average at any sampling point. If the average at any sampling point is greater than the MCL, then the system is out of compliance. If any one (1) sample would cause the annual average to be exceeded, then the system is out of compliance immediately. Any sample below the method detection limit shall be calculated at zero (0) for the purpose of determining the annual average. If a system fails to collect the required number of samples, compliance (average concentration) will be based on the total number of samples collected.

F. For systems which are monitoring annually, or less frequently, and whose sample exceeds one-half (1/2) the MCL for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium, or thallium, the system must begin quarterly monitoring. The system will not be in violation of the MCL until is has completed one (1) year of quarterly monitoring. If any sample result will cause the running annual average to exceed the MCL at any sampling point, the system is out of compliance with the MCL. If a system fails to collect the required number of samples, compliance (average concentration) will be based on the total number of samples collected.

G. Arsenic sampling results will be reported to the nearest 0.001 mg/l.

(C) Nitrate. All public water systems (community; nontransient noncommunity; and transient noncommunity) shall monitor to determine compliance with the MCL for nitrate specified in section (1) of this rule. The frequency of monitoring shall be conducted as follows:

1. Groundwater systems.

A. All public water systems (community; nontransient noncommunity; and transient noncommunity) served by groundwater systems shall monitor annually beginning in the initial compliance period.

B. The repeat monitoring frequency for groundwater systems shall be quarterly for at least one (1) year following any one (1) sample in which the concentration is greater than or equal to fifty percent ($\geq$50%) of the MCL.

C. The department may allow a groundwater system to reduce the sampling frequency to an annual basis after four (4) consecutive quarterly samples are reliably and consistently less than fifty percent ($<$50%) of the MCL.

D. After a round of quarterly sampling is completed, a system which is monitoring annually shall take subsequent samples during the quarter(s) which previously resulted in the highest analytical result; and

2. Surface water systems.

A. All public water systems (community; nontransient noncommunity; and transient noncommunity) served by a surface water system shall monitor quarterly beginning in the initial compliance period.

B. The department may allow a surface water system to reduce the sampling frequency to annually if all analytical results from four (4) consecutive quarters are less than fifty percent ($<$50%) of the MCL.

C. A surface water system shall return to quarterly monitoring if any one (1) sample is greater than or equal to fifty percent ($\geq$50%) of the MCL.

D. After a round of quarterly sampling is completed, a system which is monitoring annually shall take subsequent samples during the quarter(s) which previously resulted in the highest analytical result.

(D) Nitrite. All public water systems (community; nontransient noncommunity; and transient noncommunity) shall monitor to determine compliance with the MCL for nitrite specified in section (1) of this rule. The frequency of monitoring shall be conducted as follows:

1. All public water systems shall take one (1) sample at each sampling point in the initial three (3)-year compliance period;

2. After the initial sample, systems where an analytical result for nitrite is less than fifty percent (<50%) of the MCL shall monitor at the frequency specified by the department; and

3. Repeat monitoring.

A. The repeat monitoring frequency for any water system shall be quarterly for at least one (1) year following any one (1) sample in which the concentration is greater than or equal to fifty percent (≥50%) of the MCL.

B. The department may allow a system to reduce the sampling frequency to annually after determining the analytical results for the system are reliably and consistently less than the MCL.

C. Systems which are monitoring annually shall take each subsequent sample during the quarter(s) which previously resulted in the highest analytical result.

(E) Lead and Copper. All community and nontransient noncommunity water systems are required to monitor for lead and copper (see 10 CSR 60-15.070 for monitoring frequency, requirements and protocol for lead and copper).

(3) Monitoring Requirements.

(A) Each public water system shall monitor at the time designated by the department during each three (3)-year compliance period.

(B) Systems may apply to the department to conduct more frequent monitoring than the minimum monitoring frequencies specified in this chapter.

(C) The department may require more frequent monitoring than specified in section (2) of this rule or may require confirmation samples for positive and negative results at its discretion.

(4) Monitoring Protocol. For the purpose of determining compliance with MCLs, samples must be collected for analyses as follows:

(A) All public water systems shall take a minimum of one (1) sample at every entry point to the distribution system after any application of treatment which is representative of each source after treatment (called a sampling point) beginning in the initial compliance period;

(B) The system shall take each sample at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant; and

(C) If a system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions (that is, when water is representative of all sources being used).

(5) Confirmation Samples.

(A) Where the results of sampling for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, selenium or thallium indicate an exceedance of the MCL, the department may require that one (1) additional sample be collected as soon as possible after the initial sample was taken (but not to exceed two (2) weeks) at the same sampling point.

(B) Nitrate and Nitrite.

1. Where nitrate or nitrite sampling results indicate an exceedance of the MCL, the system shall take a confirmation sample within twenty-four (24) hours of the system's receipt of notification of the analytical results of the first sample.

2. Systems unable to comply with the twenty-four (24)-hour sampling requirement must immediately notify persons served by the public water system in accordance with 10 CSR 60-8.010(2). Systems exercising this option must take and analyze a confirmation sample within two (2) weeks of notification of the analytical results of the first sample.

(C) If a department-required confirmation sample is taken for any contaminant, then the results of the initial and confirmation sample shall be averaged. The resulting average shall be used to determine the system's compliance in accordance with section (6) of this rule. The department has the discretion to delete results of obvious sampling errors.

(6) Compliance. Compliance with section (1) of this rule shall be determined based on the analytical result(s) obtained at each sampling point.

(A) For systems which are conducting monitoring at a frequency greater than annual, compliance with the MCLs for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, selenium or thallium is determined by a running annual average at each sampling point. If the average at any sampling point is greater than the MCL, then the system is out of compliance. If any one (1) sample would cause the annual average to be exceeded, then the system is out of compliance immediately. Any sample below the method detection limit shall be calculated at zero (0) for the purpose of determining the annual average.

(B) For systems which are monitoring annually, or less frequently, the system is out of compliance with the MCLs for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, selenium or thallium if the level of a contaminant at any sampling point is greater than the MCL. If a confirmation sample is required by the department, the determination of compliance will be based on the average of the two (2) samples.

(C) Compliance with the MCLs for nitrate and nitrite is determined based on one (1) sample if the levels of these contaminants is below the MCLs. If the levels exceed the MCLs in the initial sample, a confirmation sample is required in accordance with subsection (5)(B) of this rule and compliance shall be determined based on the average of the initial and confirmation samples.

(D) All community and nontransient noncommunity water systems are required to monitor for lead and copper (see 10 CSR 60-15.070 for compliance requirements if lead and copper action levels are exceeded).

(7) Public Notice. If the result of analyses indicates that the level of antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, selenium or thallium exceeds the MCL, the supplier of water must report to the department within seven (7) days.

(A) When the system is out of compliance for antimony, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, selenium or thallium, as determined by section (6) of this rule, the supplier of water must notify the department as required by 10 CSR 60-7.010 and give public notice as required by 10 CSR 60-8.010.

(B) When the system is out of compliance for nitrate, nitrite or total nitrate and nitrite, as determined by section (6) of this rule, the supplier of water must notify the department as required by 10 CSR 60-7.010 and give public notice as required by 10 CSR 60-8.010.

(C) When the system is out of compliance for lead or copper as determined by 10 CSR 60-15.070, 10 CSR 60-15.080 and 10 CSR 60-15.090, the supplier of water must notify the department as required by 10 CSR 60-7.020 and give public notice as required by 10 CSR 60-8.010.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed Aug. 4, 1987, effective Jan. 1, 1988. Rescinded and readopted: Filed March 31, 1992, effective Dec. 3, 1992. Amended: Filed Aug. 4, 1992, effective May*

6, 1993. Amended: Filed May 4, 1993, effective Jan. 13, 1994. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed March 17, 2003, effective Nov. 30, 2003.

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.040 Maximum Synthetic Organic Chemical Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for synthetic organic chemical contaminants.

(1) The following are the maximum contaminant levels (MCLs) for synthetic organic chemical contaminants.

Contaminant	Maximum Contaminant Level, Milligrams Per Liter
1. Alachlor	0.002
2. Atrazine	0.003
3. Benzo(a)pyrene	0.0002
4. Carbofuran	0.04
5. Chlordane	0.002
6. Dalapon	0.2
7. Di(2-ethylhexyl) adipate	0.4
8. Dibromochloro-propane (DBCP)	0.0002
9. Di(2-ethylhexyl) phthlate	0.006
10. Dinoseb	0.007
11. Diquat	0.02
12. Endothall	0.1
13. Endrin	0.002
14. 2,4-D	0.07
15. Ethylene dibromide (EDB)	0.00005
16. Glyphosate	0.7
17. Heptachlor	0.0004
18. Heptachlor epoxide	0.0002
19. Hexachlorobenzene	0.001
20. Hexachlorocyclo-pentadiene	0.05
21. Lindane	0.0002
22. Methoxychlor	0.04
23. Oxamyl (Vydate)	0.2
24. Picloram	0.5
25. Polychlorinated biphenyls (PCBs)	0.0005 (as determined by Method 508A only)
26. Pentachlorophenol	0.001
27. Simazine	0.004
28. Toxaphene	0.003
29. 2,3,7,8-TCDD (Dioxin)	0.00000003
30. 2,4,5-TP (Silvex)	0.05

(2) For the purpose of determining compliance with MCLs, a supplier of water must collect samples of the product water for analysis as follows:

(A) During the initial three (3)-year compliance period, all community and nontransient noncommunity water systems must collect an initial round of four (4) consecutive quarterly samples unless a waiver has been granted by the department. The department will designate the year in which each system samples within this compliance period;

(B) All public water systems shall sample at points in the distribution system representative of each water source or at each entry point to the distribution system. The sampling point will be after the application of treatment, if any. Each sample must be taken at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant;

(C) If the system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions; and

(D) The department may require more frequent monitoring than specified in this section of the rule and may require confirmation samples for positive or negative results, at its discretion.

(3) If contaminants are not detected during the initial sampling as indicated in section (2) of this rule, systems may decrease their sampling frequency beginning in the next three (3)-year compliance period.

(A) Systems that serve greater than three thousand three hundred ($>$3,300) persons may reduce their sampling frequencies to two (2) quarterly samples at each sampling point in one (1) year in each compliance period.

(B) Systems that serve less than or equal to three thousand three hundred ($\leq$3,300) persons may reduce their sampling frequencies to one (1) sample in each compliance period.

(4) The department may allow sampling data collected between January 1, 1990 and December 31, 1995, to satisfy the initial base sampling requirements, if the sampling was completed as required by subsections (2)(B) and (C) of this rule.

(5) If contaminants are detected in any sample, then systems must sample quarterly beginning in the next quarter at each sampling point which resulted in a detection.

(A) Groundwater systems must sample a minimum of two (2) quarters and surface water must sample a minimum of four (4) quarters to establish a baseline.

(B) If the MCL is exceeded as described in subsection (5)(E) or (F) of this rule, then systems must sample quarterly beginning in the next quarter. Systems must sample a minimum of four (4) quarters to establish a baseline.

(C) If the baseline indicates a system's analytical results are reliably and consistently below the MCL, the department may reduce the system's sampling frequency to annually. (Annual sampling must be conducted during the quarter which previously yielded the highest analytical result.)

(D) Systems which have three (3) consecutive annual samples with no detection of a contaminant may apply to the department for a waiver.

(E) If one (1) sampling point is in violation of an MCL, the system is in violation of the MCL.

1. For systems monitoring more than once per year, compliance with the MCL is determined by a running annual average at each sampling point.

2. Systems monitoring annually or less frequently whose sample result exceeds the regulatory detection level as defined by 10 CSR 60-5.010(6)(B) must begin quarterly sampling. The system will not be considered in violation of the MCL until it has completed one (1) year of quarterly sampling.

3. If any sample result will cause the running annual average to exceed the MCL at any sampling point, the system is out of compliance with the MCL immediately.

4. If a system fails to collect the required number of samples, compliance will be based on the total number of samples collected.

5. If a sample result is less than the detection limit, zero will be used to calculate the annual average.

(F) If monitoring results in detection of one (1) or more of certain related contaminants (aldicarb, aldicarb sulfone, aldicarb sulfoxide and heptachlor, heptachlor epoxide), then subsequent monitoring shall analyze for all related contaminants.

(6) A public water system may apply to the department for a waiver from required sampling. Systems are eligible for reduced monitoring in the initial three (3)-year compliance period. The waiver is effective for one (1) compliance period. It must be renewed in subsequent compliance periods or the system must conduct sampling as required by subsection (2)(A) of this rule.

(A) A public water system may apply to the department for a use waiver for reduced monitoring from required sampling if previous use of the chemical can be ruled out as required by 10 CSR 60-6.060(2).

(B) A public water system may apply to the department for a susceptibility waiver for reduced monitoring contingent on the conduct of a thorough vulnerability assessment as required by 10 CSR 60-6.060(3).

(7) As determined by the department, a confirmation sample may be required for either positive or negative results. If a confirmation sample is used, the compliance determination is based on the average of the results of both the confirmation sample and the initial sample. The department has the discretion to delete results of obvious sampling errors from this calculation.

(8) Any public water system violating MCLs or monitoring and reporting requirements for any of the contaminants listed in section (1) of this rule must notify the department within seven (7) days and give public notice as required by 10 CSR 60-8.010.

(9) Treatment Techniques.

(A) All public water systems shall use treatment techniques in lieu of MCLs for specified contaminants.

(B) Each public water system must certify annually in writing to the department (using third-party or manufacturers' certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified as follows:

Acrylamide = 0.05% dosed at 1 part per million (ppm) (or equivalent)
Epichlorohydrin = 0.01% dosed at 20 ppm (or equivalent)

Certifications can rely on manufacturers or third parties, as approved by the department.

(10) All new systems or systems that use a new source of water that begin operation after January 22, 2004 must demonstrate compliance with the MCL or treatment technique within a period of time specified by the department. The system must also comply with the initial sampling frequencies specified by the department to ensure a system can demonstrate compliance with the MCL or treatment technique. Routine and increased monitoring frequencies shall be conducted in accordance with the requirements in section (5) of this rule.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Rescinded and readopted: Filed March 31, 1992, effective Dec. 3, 1992. Amended: Filed May 4, 1993, effective Jan. 13, 1994. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.050 Maximum Turbidity Levels and Monitoring Requirements and Filter Backwash Recycling

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for turbidity.

(1) Applicability.

(A) This rule applies to all public water systems that use surface water or groundwater under the direct influence of surface water. Requirements and compliance dates vary depending on system size.

(B) Beginning on November 30, 2002, any water treatment plant proposed for construction or major modification must be designed to meet the filter backwash requirements in section (4) of this rule.

(2) Systems Serving Less Than Ten Thousand (10,000) People. (Note: This section remains in effect only until January 13, 2005. Beginning January 14, 2005, the turbidity levels and other requirements in section (3) of this rule replace the requirements of this section.)

(A) Maximum Turbidity Levels.

1. The turbidity level must be less than or equal to 0.5 turbidity units in at least ninety-five percent (95%) of the measurements taken each month.

2. The turbidity level must at no time exceed five (5) turbidity units in any one (1) confirmed measurement.

(B) The frequency of sampling shall be as set forth in 10 CSR 60-4.080(3).

(C) If the result of a single turbidity measurement exceeds the level established in subsection (2)(A), the measurement must be confirmed by resampling, preferably within one (1) hour. The resample result must replace the original sample result for determining compliance with subsection (2)(A) of this rule.

(D) If any confirmed sample result exceeds five (5) turbidity units, the supplier of water must notify the department by the end of the next business day and give notice as required by 10 CSR 60-8.010(2).

(E) The department, on a case-by-case basis, may allow a system to operate at a maximum turbidity level of 1.0 turbidity units in at least ninety-five percent (95%) of the measurements taken each month if the following criteria are met: the total percent removal and inactivation of *Giardia lamblia* is ninety-nine and nine-tenths percent (99.9%), required treatment is provided, the treatment facilities are properly operated, none of the treatment units are malfunctioning due to mechanical failure or incorrect construction, the system is in compliance with all of the disinfection requirements of 10 CSR 60-4.055(1)–(4), the treatment facilities are providing ninety-nine percent (99%) *Giardia* cyst removal and the system cannot meet the turbidity level of 0.5 turbidity units due to raw water quality, iron, manganese or similar compelling factors. The request to operate at the higher turbidity level must be made in writing and be accompanied by an engineering report which includes the results of full scale particle or *Giardia* cyst removal studies, operational test data, water analyses results, a report of the sanitary survey of the treatment facilities and any other information that the department may require to assure that the criteria of this rule are met. Approval of the engineering report is the approval to operate at the higher turbidity level.

(3) Enhanced Turbidity Requirements.

(A) Beginning January 1, 2002 for systems serving ten thousand (10,000) or more people and beginning January 14, 2005 for systems serving less than ten thousand (10,000) people maximum turbidity levels and other requirements are as set forth in this section.

(B) Maximum Turbidity Levels.

1. Turbidity must be equal to or less than 0.3 turbidity units in at least ninety-five percent (95%) of the measurements taken each month; and

2. There must be no more than one (1) turbidity unit in any one (1) measurement.

(C) The frequency of sampling shall be as set forth in 10 CSR 60-4.080(3).

(D) Reporting to the Department.

1. If at any time the turbidity exceeds one (1) nephelometric turbidity unit (NTU) in representative samples of filtered water in a system using conventional filtration treatment or direct filtration, the system must inform the department as soon as possible, but no later than the end of the next business day.

2. If any sample result exceeds five (5) turbidity units, the supplier of water must

consult with the department as soon as practical, but no later than twenty-four (24) hours after the exceedance is known, except that the department may allow additional time in the event of extenuating circumstances beyond the control of the owner or operator, such as a natural disaster.

3. If at any time the turbidity in representative samples of filtered water exceeds the maximum level set by the department under subsection (3)(G) of this rule for filtration technologies other than conventional filtration treatment, the system must inform the department as soon as possible, but no later than the end of the next business day.

(E) Filtration Sampling Requirements for Surface Water Systems

1. A public water system subject to the requirements of 10 CSR 60-4.055(6) that provides conventional filtration treatment must conduct continuous monitoring of turbidity for each individual filter using an approved method in 10 CSR 60-5.010 and must calibrate turbidimeters using the procedure specified by the manufacturer. Systems must record the results of individual filter monitoring every fifteen (15) minutes.

2. If there is a failure in the continuous turbidity monitoring equipment, the system must conduct grab sampling every four (4) hours in lieu of continuous monitoring, until the turbidimeter is repaired and back on-line. A system has a maximum of five (5) working days after failure in the continuous monitoring equipment to repair the equipment before the system is in violation. With department approval, systems serving less than ten thousand (10,000) people may be granted up to fourteen (14) days to repair the equipment before the system is in violation.

(F) Lime Softening.

1. A system that uses lime softening may acidify representative samples prior to analysis using a protocol approved by the department.

2. Systems that use lime softening may apply to the department for alternative exceedance levels for the levels specified in 10 CSR 60-7.010(7)(B) if they can demonstrate that higher turbidity levels in individual filters are due to lime carryover only and not due to degraded filter performance.

(G) Filtration Technologies Other Than Conventional Filtration Treatment.

1. A public water system may use a filtration technology other than conventional filtration if it demonstrates to the department, using pilot plant studies or other means, that the alternative filtration technology, including direct filtration, in combination with disinfection treatment that meets the requirements of 10 CSR 60-4.055, consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses, and ninety-nine percent (99%) removal of *Cryptosporidium* oocysts, and the department approves the use of the filtration technology.

2. For each approval, the department will set turbidity performance requirements that the system must meet at least ninety-five percent (95%) of the time and that the system may not exceed at any time at a level that consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts, 99.99 percent removal or inactivation of viruses, or both, and 99 percent removal of *Cryptosporidium* oocysts.

(4) Filter Backwash Recycling.

(A) Applicability. All surface water and groundwater under the direct influence of surface water systems that use conventional filtration or direct filtration treatment and that recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes must meet the requirements of this section.

(B) Reporting. A system must notify the department in writing by December 8, 2003, if the system recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes. This notification must include, at a minimum, the following information:

1. A plant schematic showing the origin of all flows which are recycled (including, but not limited to, spent filter backwash water, thickener supernatant, and liquids from dewatering processes), the hydraulic conveyance used to transport them, and the location where they are reintroduced back into the treatment plant; and

2. Typical recycle flow in gallons per minute (gpm), the highest observed plant flow experienced in the previous year (gpm), design flow for the treatment plant (gpm), and department-approved operating capacity for the plant where the department has made such determinations.

(C) Treatment Technique Requirement. Any system that recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes must return these flows through the processes of a system's existing conventional or direct filtration system or at an alternate location approved by the department by June 8, 2004. If capital improvements are required to modify the recycle location to meet this requirement, all capital improvements must be completed not later than June 8, 2006.

(D) Record Keeping. The system must collect and retain on file recycle flow information for review and evaluation by the department beginning June 8, 2004. This information shall include, but may not be limited to:

1. A copy of the recycle notification and information submitted to the department under subsection (4)(B) of this rule;

2. A list of all recycle flows and the frequency with which they are returned;

3. Average and maximum backwash flow rate through the filters and the average and maximum duration of the filter backwash process in minutes;

4. Typical filter run length and a written summary of how filter run length is determined;

5. The type of treatment provided for the recycle flow; and

6. Data on the physical dimensions of the equalization and/or treatment units, typical and maximum hydraulic loading rates, type of treatment chemicals used and average dose and frequency of use, and frequency at which solids are removed, if applicable.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed July 12, 1991, effective Feb. 6, 1992. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed Dec. 15, 1999, effective Sept. 1, 2000. Amended: Filed Jan. 16, 2002, effective Nov. 30, 2002. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.055 Disinfection Requirements

PURPOSE: This rule establishes minimum disinfectant levels and treatment requirements to assure the inactivation and removal of pathogenic organisms.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This *note refers only to the incorporated by reference material.*

(1) The requirements of this rule apply to primary community and noncommunity public water systems that the department has required to disinfect and to secondary systems with a source of water from a primary water system that the department has required to disinfect, even if the water is obtained through another secondary system.

(A) Water systems using water obtained in whole or in part from a source determined by the department to be surface or ground water under the direct influence of surface water must install or construct facilities to provide conventional filtration treatment as a required treatment technique within eighteen (18) months of the determination.

(B) Any water system that the department determines to be a groundwater system under the direct influence of surface water may appeal the decision by notifying the department in writing. The appeal must be accompanied by a report prepared by an engineer that confirms that the water system's groundwater source is not directly influenced by surface water. The report must be supported by analytical data prepared by a laboratory that is acceptable to the department. Source sampling must be accomplished during the period the source is most susceptible to surface water influence. The department's approval of the report will result in the water system's source being redefined as groundwater not under the direct influence of surface water.

(C) If at any time in the department's opinion, the quality of a water source appears to have changed to be under the direct influence of surface water, the water system must submit, at the department's written request, an engineer-prepared report that describes the current condition of the water source. If a report is not submitted, the source will be reclassified as groundwater supply under the direct influence of surface water.

(D) The department reserves the authority to make the final determination of whether or not a source is defined as groundwater under the direct influence of surface water.

(E) Primary systems which use water obtained from groundwater not under the direct influence of surface water and which the department requires to disinfect and secondary public water systems do not have to meet the requirements of section (2) of this rule but may be required to provide disinfection detention as deemed necessary by the department. These systems also do not have to submit reports to the department as required by 10 CSR 60-7.010(5) but must maintain the information on file at the system treatment plant or office.

(2) Contact Time and Removal Credit.

(A) Any water system providing required treatment, and existing water systems practicing conventional filtration treatment on February 6, 1992, will be credited with 99.68 percent (2.5 log) *Giardia lamblia* cyst removal and 99.0 percent (2.0 log) virus removal, excluding the disinfection process, provided that they meet the turbidity maximum contaminant levels in 10 CSR 60-4.050. A system may request additional credit for treatment process removal or inactivation of *Giardia lamblia* cysts and viruses by submitting a report prepared by an engineer to the department including studies of *Giardia* cyst and virus removal or inactivation. The department reserves the authority to make the final determination of removal credit.

(B) The residual disinfectant concentration (C) disinfectant contact time (T) values in the *Missouri Guidance Manual for Surface Water System Treatment Requirements,* 1992, must be used for determining the percentage of *Giardia lamblia* cyst and virus removal or inactivation by disinfection.

(C) The percentage of removal and inactivation of *Giardia lamblia* cysts and viruses will be determined as the sum of the percent removals and inactivations of the individual treatment and disinfection processes. The percent removal and inactivation of *Giardia lamblia* cysts must be at least 99.9 percent (3.0 log) and of viruses must be 99.99 percent (4.0 log).

(D) Disinfectant contact time must be determined for each system by evaluations performed as specified in the *Missouri Guidance Manual For Surface Water System Treatment Requirements,* 1992, which is incorporated by reference. Results of the evaluations, including the determined disinfectant contact times, must be submitted to the department for review. The evaluation must be submitted within one (1) year of the date that the system is covered by the requirements of this rule, except that new water treatment facilities will not be issued a Final Approval of Construction under 10 CSR 60-3.010 until disinfection contact times are determined and submitted to the department.

(3) For any water system adding a disinfectant, only free available chlorine or chloramines will be accepted as the disinfectant entering the distribution system. The residual disinfectant concentration in the water entering the distribution system cannot be less than 0.5 milligrams per liter (mg/l) free available chlorine or 1.0 mg/l chloramines for more than four (4) hours.

(A) Systems using chloramines as the disinfectant residual entering the distribution system must add and mix the chlorine prior to the addition of ammonia.

(B) At the department's discretion, any system may be required to provide breakpoint chlorination or to provide operational test data and other information that the department may require to demonstrate that the system daily meets all of the requirements of section (2) of this rule and all of the other requirements of this section.

(C) At least one (1) application point for chlorine or chloramines must be prior to filtration with a residual maintained through the filters.

(D) If at any time the disinfectant residual entering the distribution system falls below the levels established in this section, the system must notify the department as soon as possible but no later than by the end of the next business day. The system must notify the department by the end of the next business day whether or not the disinfectant residual was restored to the levels established in this section within four (4) hours. The department may require public notice for continuing or persistent violations of this requirements.

(E) A residual disinfectant concentration in the water entering the distribution system of less than 0.2 mg/l for at least four (4) hours is a treatment technique violation which requires public notice pursuant to 10 CSR 60-8.010.

(F) The frequency of sampling shall be as set forth in 10 CSR 60-4.080(3).

(4) The residual disinfectant concentration in the distribution system measured as total chlorine or combined chlorine cannot be less than 0.2 mg/l in more than five percent (5%) of the samples each month for any two (2) consecutive months that the system supplies water to the public.

(A) Heterotrophic plate count may be used in lieu of or as a supplement to residual disinfectant concentration analysis.

(B) Water in the distribution system with a heterotrophic bacteria concentration less than or equal to five hundred (500) colonies per milliliter is deemed to have 0.2 mg/l residual disinfectant concentration for the purpose of determining compliance with this rule.

(C) Water in the distribution system with a heterotrophic bacteria concentration of greater than five hundred (>500) colonies per milliliter is deemed to have less than 0.2 mg/l residual disinfectant concentration for the purpose of compliance with this rule.

(D) Failure to maintain the minimum residual disinfectant concentration required in this rule is a violation of a treatment technique which requires public notification as specified in 10 CSR 60-8.010.

(E) The residual disinfectant concentration must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled as specified in 10 CSR 60-4.020. Failure to comply with this subsection is a monitoring violation which requires public notification as specified in 10 CSR 60-8.010.

(5) Maximum Residual Disinfectant Levels.

(A) Maximum residual disinfectant levels (MRDL) are—

Disinfectant Residual	MRDL (mg/l)
Chlorine	4.0 (as Cl_2)
Chloramines	4.0 (as Cl_2)
Chlorine dioxide	0.8 (as ClO_2)

(B) Control of Disinfectant Residuals. For chlorine and chloramines, a public water system is in compliance with the MRDL when the running annual average of monthly averages of samples taken in the distribution system, computed quarterly, is less than or equal to the MRDL. For chlorine dioxide, a public water system (PWS) is in compliance with the MRDL when daily samples are taken at the entrance to the distribution system and no two (2) consecutive daily samples exceed the MRDL. MRDLs are enforceable in the same manner as maximum contaminant levels. Notwithstanding the MRDLs, systems may increase residual disinfectant levels in the distribution system of chlorine or chloramines (but not chlorine dioxide) to a level and for a time necessary to protect public health, to address specific microbiological contamination problems caused by circumstances such as, but not limited to, distribution line breaks, storm run-off events, source water contamination events, or cross-connection events.

(C) Compliance Dates.

1. Community water systems and non-transient noncommunity water systems.

A. Systems serving ten thousand (10,000) or more persons and using surface water or groundwater under the direct influence of surface water must comply with the MRDLs beginning January 1, 2002.

B. Systems serving fewer than ten thousand (10,000) persons and using surface water or groundwater under the direct influence of surface water and systems using only groundwater not under the direct influence of surface water must comply with the MRDLs beginning January 1, 2004.

2. Transient noncommunity water systems.

A. Systems serving ten thousand (10,000) or more persons and using surface water or groundwater under the direct influence of surface water and using chlorine dioxide as a disinfectant or oxidant must comply with the chlorine dioxide MRDL beginning January 1, 2002.

B. Systems serving less than ten thousand (10,000) persons, using surface water or groundwater under the direct influence of surface water and using chlorine dioxide as a disinfectant or oxidant, and systems using only groundwater not under the direct influence of surface water and using chlorine dioxide as a disinfectant or oxidant, must comply with the chlorine dioxide MRDL beginning January 1, 2004.

(6) Enhanced Disinfection Requirements. Enhanced disinfection requirements and compliance dates vary depending on system size.

(A) Compliance Dates. In addition to the requirements in sections (1)–(4) of this rule, surface water and groundwater under the direct influence of surface water systems serving at least ten thousand (10,000) people also must comply with the requirements in this section beginning January 1, 2002 unless otherwise specified. Those systems serving less than ten thousand (10,000) people must comply with the requirements in this section beginning January 14, 2005 unless otherwise specified.

(B) General Requirements.

1. This section (6) establishes or extends treatment technique requirements in lieu of maximum contaminant levels for the following contaminants: *Giardia lamblia,* viruses, heterotrophic plate count bacteria, *Legionella*, *Cryptosporidium*, and turbidity. Each surface water and groundwater under the direct influence of surface water system, including those serving less than ten thousand (10,000) people beginning January 14, 2005, must provide treatment of its source water that complies with these treatment technique requirements and are in addition to those identified in sections (1)–(4) of this rule. The treatment technique requirements consist of installing and properly operating water treatment processes which reliably achieve:

A. At least ninety-nine percent (99%) (2-log) removal of *Cryptosporidium* between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer; and

B. Compliance with the profiling and benchmark requirements under the provisions of subsection (6)(C) of this rule.

2. A public water system subject to the requirements of this section (6) is in compliance with the requirements of paragraph (6)(B)1. of this rule if it meets the applicable filtration requirements in 10 CSR 60-4.050 and the disinfection requirements in sections (2)–(4) and subsection (6)(C) of this rule.

(C) Disinfection Profiling and Benchmarking.

1. Disinfection profile. A disinfection profile is a summary of *Giardia lamblia* inactivation through the treatment plant measured through the course of a year. A public water system subject to the requirements of this section (6) must determine its total trihalomethanes (TTHM) annual average and its HAA5 annual average. The annual average is the arithmetic average of the quarterly averages of four (4) consecutive quarters of monitoring. Surface water systems serving fewer than ten thousand (10,000) people must determine the arithmetic average based on samples collected after January 1, 1998. If the annual average exceeds the levels in subparagraph (6)(C)1.D. then the requirements in paragraph (6)(C)2. apply.

A. The TTHM annual average must be the annual average during the same period as is used for the HAA5 annual average.

(I) Those systems that use "grandfathered" HAA5 occurrence data that meet the provisions of part (5)(C)1.B.(I) of this rule must use TTHM data collected at the same time under the provisions of 10 CSR 60-4.090.

(II) Those systems that use HAA5 occurrence data that meet the provisions of subpart (6)(C)1.B.(II)(a) of this rule must use TTHM data collected at the same time under the provisions of 10 CSR 60-4.090.

B. The HAA5 annual average must be the annual average during the same period as is used for the TTHM annual average.

(I) Those systems that have collected four (4) quarters of HAA5 occurrence data that meets the routine monitoring sample number and location requirements for TTHM in 10 CSR 60-4.090 and handling and analytical method requirements of 40 CFR 141.142 may use those data to determine whether the requirements of this section apply.

(II) Those systems that did not collect four (4) quarters of HAA5 occurrence data that meets the provisions of part (6)(C)1.B.(I) of this rule by March 31, 2000 must either:

(a) Conduct monitoring for HAA5 that meets the routine monitoring sample number and location requirements for TTHM in 10 CSR 60-4.090(2) and handling and analytical method requirements of 40 CFR 141.142(b)(1) to determine the HAA5 annual average and whether the requirements of paragraph (6)(C)2. of this rule apply; or

(b) Comply with all other provisions of this section as if the HAA5 monitoring had been conducted and the results required compliance with paragraph (6)(C)2. of this rule.

C. The system must submit data to the department on the schedule required by the department.

D. Any system having either a TTHM annual average greater than or equal to 0.064 mg/l or an HAA5 annual average greater than or equal to 0.048 mg/l during the period identified in subparagraphs (6)(C)1.A. and B. of this rule must comply with paragraph (6)(C)2. of this rule.

2. Disinfection profiling requirements and compliance dates vary depending on system size. Surface water systems serving a population of less than ten thousand (10,000) must monitor profiling data according to subparagraph (6)(C)2.D. beginning July 1, 2003. Surface water and groundwater under the direct influence of surface water (GWUDISW) systems serving a population of less than five hundred (500) must monitor profiling data according to subparagraph (6)(C)2.D. beginning January 1, 2004.

A. Any system that meets the criteria in subparagraph (6)(C)1.D. of this rule must develop a disinfection profile of its disinfection practice for a period of up to three (3) years.

B. The system must monitor daily for a period of twelve (12) consecutive calendar months to determine the total logs of inactivation for each day of operation, based on the $CT_{99.9}$ values in Tables 1 through 8 of the Missouri "Guidance Manual for Surface Water System Treatment Requirements," as appropriate, through the entire treatment plant. This system must begin this monitoring when requested by the department. As a minimum, the system with a single point of disinfectant application prior to entrance to the distribution system must conduct the monitoring set forth in this subparagraph (6)(C)2.B. A system with more than one (1) point of disinfectant application must conduct this monitoring for each disinfection segment. The system must monitor the parameters necessary to determine the total inactivation ratio, using analytical methods in 10 CSR 60-5.010, as follows:

(I) The temperature of the disinfected water must be measured once per day at each residual disinfectant concentration sampling point during peak hourly flow;

(II) If the system uses chlorine, the pH of the disinfected water must be measured once per day at each chlorine residual disinfectant concentration sampling point during peak hourly flow;

(III) The disinfectant contact time(s) must be determined for each day during peak hourly flow; and

(IV) The residual disinfectant concentration(s) of the water before or at the first customer and prior to each additional point of disinfection must be measured each day during peak hourly flow.

C. In lieu of the monitoring conducted under the provisions of subparagraph (6)(C)2.B. of this rule to develop the disinfection profile the system may elect to meet the requirements of part (6)(C)2.C.(I) of this rule. In addition to the monitoring conducted under the provisions of subparagraph (6)(C)2.B. of this rule to develop the disinfection profile, the system may elect to meet the requirements of part (6)(C)2.C.(II) of this rule.

(I) A PWS that has three (3) years of existing operational data may submit those data, a profile generated using those data, and a request that the department approve use of those data in lieu of monitoring under the provisions of paragraph (6)(C)2. of this rule. The department must determine whether these operational data are substantially equivalent to data collected under the provisions of subparagraph (6)(C)2.B. of this rule. These data must also be representative of *Giardia lamblia* inactivation through the entire treatment plant and not just of certain treatment segments. Until the department approves this request, the system is required to conduct monitoring under the provisions of subparagraph (6)(C)2.B. of this rule.

(II) In addition to the disinfection profile generated under subparagraph (6)(C)2.B. of this rule, a PWS that has existing operational data may use those data to develop a disinfection profile for additional years. Such systems may use these additional yearly disinfection profiles to develop a benchmark under the provisions of paragraph (6)(C)3. of this rule. The department will determine whether these operational data are substantially equivalent to data collected under the provisions of subparagraph (6)(C)2.B. of this rule. These data must also be representative of inactivation through the entire treatment plant and not just of certain treatment segments.

D. The system must monitor once per week on the same calendar day, for a period of twelve (12) consecutive calendar months, to determine the total logs of inactivation for each week of operation, based on the $CT_{99.9}$ values in Tables 1 through 8 of the Missouri "Guidance Manual for Surface Water System Treatment Requirements," as appropriate, through the entire treatment plant. As a minimum, the system with a single point of disinfectant application prior to entrance to the distribution system must conduct the monitoring set forth in this subparagraph. A system with more than one (1) point of disinfectant application must conduct this monitoring for each disinfection segment. The system must monitor the parameters necessary to determine the total inactivation ratio, using analytical methods in 10 CSR 60-5.010, as follows:

(I) The temperature of the disinfected water must be measured at each residual disinfectant concentration sampling point during peak hourly flow;

(II) If the system uses chlorine, the pH of the disinfected water must be measured at each chlorine residual disinfectant concentration sampling point during peak hourly flow;

(III) The disinfectant contact time(s) must be determined during peak hourly flow; and

(IV) The residual disinfectant concentration(s) of the water before or at the first customer and prior to each additional point of disinfection must be measured during peak hourly flow.

E. The system must calculate the total inactivation ratio as follows:

(I) The system may determine the total inactivation ratio for the disinfection segment based on either of the following methods:

(a) Determine one (1) inactivation ratio ($CTcalc/CT_{99.9}$) before or at the first customer during peak hourly flow; or

(b) Determine successive ($CTcalc/CT_{99.9}$) values, representing sequential inactivation ratios, between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Under this alternative, the system must calculate the total inactivation ratio by determining ($CTcalc/CT_{99.9}$) for each sequence and then adding the ($CTcalc/CT_{99.9}$) values together to determine ($\sum(CTcalc/CT_{99.9})$); and

(II) The system must determine the total logs of inactivation by multiplying the value calculated in part (6)(C)2.D.(I) of this rule by three (3.0).

F. A system that uses either chloramines or ozone for primary disinfection must also calculate the logs of inactivation for viruses using a method identified in EPA's "Alternative Disinfectants and Oxidants Guidance Manual."

G. The system must retain disinfection profile data in graphic form, as a spreadsheet, or in some other format acceptable to the department for review as part of sanitary surveys conducted by the department.

3. Disinfection benchmarking.

A. Any system required to develop a disinfection profile under the provisions of paragraphs (6)(C)1. and 2. of this rule and that decides to make a significant change to its disinfection practice must consult with the department in writing prior to making such change. Significant changes to disinfection practice are:

(I) Changes to the point of disinfection;

(II) Changes to the disinfectant(s) used in the treatment plant;

(III) Changes to the disinfection process; and

(IV) Any other modification identified by the department.

B. Any system that is modifying its disinfection practice must calculate its disinfection benchmark using one of the following procedures:

(I) For each year of profiling data collected and calculated under paragraph (6)(C)2. of this rule, the system must determine the lowest average monthly *Giardia lamblia* inactivation in each year of profiling data. The system must determine the average *Giardia lamblia* inactivation for each calendar month for each year of profiling data by dividing the sum of *Giardia lamblia* inactivation by the number of values calculated for that month; or

(II) The disinfection benchmark is the lowest monthly average value (for systems with one (1) year of profiling data) or average of lowest monthly average values (for systems with more than one (1) year of profiling data) of the monthly logs of *Giardia lamblia* inactivation in each year of profiling data.

C. A system that uses either chloramines or ozone for primary disinfection must also calculate the disinfection benchmark for viruses using a method approved by the department.

D. The system must submit the following information to the department as part of its consultation process:

(I) A description of the proposed change;

(II) The disinfection profile for *Giardia lamblia* (and, if necessary, viruses) under paragraph (6)(C)2. of this rule and benchmark as required by subparagraph (6)(C)3.B. of this rule; and

(III) An analysis of how the proposed change will affect the current levels of disinfection.

(D) Filtration Sampling Requirements. A public water system subject to the requirements of this section (6) that provides conventional filtration treatment must conduct continuous monitoring of turbidity for each individual filter as indicated in 10 CSR 60-4.050(3)(E).

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed July 12, 1991, effective Feb. 6, 1992. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed Dec. 15, 1999, effective Sept. 1, 2000. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.060 Maximum Radionuclide Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for radionuclides.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Maximum Contaminant Levels (MCL) and Compliance Dates.

(A) MCL for Combined Radium-226 and Radium-228. The maximum contaminant level for combined radium-226 and radium-228 is five picocuries per liter (5 pCi/l). The combined radium-226 and radium-228 value is determined by the addition of the results of the analysis for radium-226 and the analysis for radium-228.

(B) MCL for Gross Alpha Particle Activity (Excluding Radon and Uranium). The maximum contaminant level for gross alpha particle activity (including radium-226 but excluding radon and uranium) is fifteen picocuries per liter (15 pCi/l).

(C) MCL for Beta Particle and Photon Radioactivity.

1. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than four (4) millirem/year (mrem/year).

2. Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing four (4) mrem total body or organ dose equivalents must be calculated on the basis of two (2) liter per day drinking water intake using the one hundred sixty-eight (168) hour data list in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," NBS (National Bureau of Standards) Handbook 69 as amended August 1963, U.S. Department of Commerce, which is incorporated by reference. If two (2) or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed four (4) mrem/year.

Table A.—Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of Mrem/Year

Radionuclide	Critical Organ	pCi per Liter
Tritium	Total body	20,000
Strontium-90	Bone Marrow	8

(D) MCL for Uranium. The maximum contaminant level for uranium is thirty micrograms per liter (30 μg/l).

(E) Compliance Dates. Community water systems (CWSs) must comply with the MCLs listed in subsections (1)(A)–(D) of this rule beginning December 8, 2003. Compliance shall be determined in accordance with the requirements of 10 CSR 60-5.010 and section (2) of this rule. Compliance with Consumer Confidence Report and public notice requirements for radionuclides is required on December 8, 2003.

(2) Monitoring Frequency and Compliance Requirements for Radionuclides in Community Water Systems.

(A) Monitoring and Compliance Requirements for Gross Alpha Particle Activity, Radium-226, Radium-228, and Uranium.

1. Community water systems must conduct initial monitoring to determine compliance with subsections (1)(A), (B) and (D) of this rule by December 31, 2007. For the purposes of monitoring for gross alpha particle activity, radium-226, and radium-228, the detection limits are:

A. The detection limit for gross alpha particle activity is three (3) pCi/l;

B. The detection limit for radium-226 is one (1) pCi/l; and

C. The detection limit for radium-228 is one (1) pCi/l.

2. Applicability and sampling location for existing community water systems or sources. All existing CWSs using groundwater, surface water, or systems using both ground and surface water must sample at every entry point to the distribution system that is representative of all sources being used (hereafter called a sampling point) under normal operating conditions. The system must take each sample at the sample sampling point unless conditions make another sampling point more representative of each source or the department has designated a distribution system location, in accordance with part (2)(A)4.B.(III) of this rule.

3. Applicability and sampling location for new community water systems or sources. All new CWSs or CWSs that use a new source of water must begin to conduct initial monitoring for the new source within the first quarter after initiating use of the source. CWSs must conduct more frequent monitoring when ordered by the department in the event of possible contamination or when changes in the distribution system or treatment processes occur which may increase the concentration of radioactivity in finished water.

4. Initial monitoring for gross alpha particle activity, radium-226, radium-228, and uranium.

A. Systems without acceptable historical data, as defined below, shall collect four (4) consecutive quarterly samples at all sampling points before December 31, 2007.

B. Grandfathering of data. Systems may use historical monitoring data collected at a sampling point to satisfy the initial monitoring requirements for that sampling point, for the following situations.

(I) To satisfy initial monitoring requirements, a community water system having only one (1) entry point to the distribution system may use the monitoring data from the last compliance monitoring period that began between June 1, 2000 and December 8, 2003.

(II) To satisfy initial monitoring requirements, a community water system with multiple entry points and having appropriate historical monitoring data for each entry point to the distribution system may use the monitoring data from the last compliance monitoring period that began between June 1, 2000 and December 8, 2003.

(III) To satisfy initial monitoring requirements, a community water system with appropriate historical data for a representative point in the distribution system may use the monitoring data from the last compliance monitoring period that began between June 1, 2000 and December 8, 2003, provided that the department finds that the historical data satisfactorily demonstrate that each entry point to the distribution system is expected to be in compliance based upon the historical data and reasonable assumptions about the variability of contaminant levels between entry points. The department must make a written finding indicating how the data conforms to the these requirements.

C. For gross alpha particle activity, uranium, radium-226, and radium-228 monitoring, the department will waive the final two (2) quarters of initial monitoring for a sampling point if the results of the samples from the previous two (2) quarters are below the detection limit.

D. If the average of the initial monitoring results for a sampling point is above the MCL, the system must collect and analyze quarterly samples at that sampling point until the system has results from four (4) consecutive quarters that are at or below the MCL, unless the system enters into another schedule as part of a formal compliance agreement with the department.

3. Reduced monitoring. Community water systems may reduce the future frequency of monitoring from once every three (3) years to once every six (6) or nine (9) years at each sampling point, based on the following criteria.

A. If the average of the initial monitoring results for each contaminant (that is, gross alpha particle activity, uranium, radium-226, or radium-228) is below the detection limit specified in paragraph (2)(A)1. of this rule, the system must collect and analyze for that contaminant using at least one (1) sample at that sampling point every nine (9) years.

B. For gross alpha particle activity and uranium, if the average of the initial monitoring results for each contaminant is at or above the detection limit but at or below one-half (1/2) the MCL, the system must collect and analyze for that contaminant using at least one (1) sample at that sampling point every six (6) years. For combined radium-226 and radium-228, the analytical results must be combined. If the average of the combined initial monitoring results for radium-226 and radium-228 is at or above the detection limit but at or below one-half (1/2) the MCL, the system must collect and analyze for that contaminant using at least one (1) sample at that sampling point every six (6) years.

C. For gross alpha particle activity and uranium, if the average of the initial monitoring results for each contaminant is above one-half (1/2) the MCL but at or below the MCL, the system must collect and analyze at least one (1) sample at that sampling point every three (3) years. For combined radium-226 and radium-228, the analytical results must be combined. If the average of the combined initial monitoring results for radium-226 and radium-228 is above one-half (1/2) the MCL but at or below the MCL, the system must collect and analyze at least one (1) sample at that sampling point every three (3) years.

D. Systems must use the samples collected during the reduced monitoring period to determine the monitoring frequency for subsequent monitoring periods (for example, if a system's sampling point is on a nine (9)-year monitoring period, and the sample result is above one-half (1/2) the MCL, then the next monitoring period for that sampling point is three (3) years).

E. If a system has a monitoring result that exceeds the MCL while on reduced monitoring, the system must collect and analyze quarterly samples at that sampling point until the system has results from four (4) consecutive quarters that are below the MCL, unless the system enters into another schedule as part of a formal compliance agreement with the department.

4. Compositing. To fulfill quarterly monitoring requirements for gross alpha particle activity, radium-226, radium-228, or uranium, a system may composite up to four (4) consecutive quarterly samples from a single entry point if analysis is done within a year of the first sample. The department will treat analytical results from the composited as the average analytical result to determine compliance with the MCLs and the future monitoring frequency. If the analytical result from the composited sample is greater than one-half (1/2) the MCL, the department may direct the system to take additional quarterly samples before allowing the system to sample under a reduced monitoring schedule.

5. Gross alpha particle activity measurement.

A. A gross alpha particle activity measurement may be substituted for the required radium-226 measurement provided that the measured gross alpha particle activity does not exceed five (5) pCi/l. A gross alpha particle activity measurement may be substituted for the required uranium measurement provided that the measured gross alpha particle activity does not exceed fifteen (15) pCi/l.

B. The gross alpha measurement shall have a confidence interval of ninety-five percent (95%) (1.65σ, where σ is the standard deviation of the net counting rate of the sample) for radium-226 and uranium. When a system uses a gross alpha particle activity measurement in lieu of a radium-226 and/or uranium measurement, the gross alpha particle activity analytical result will be used to determine the future monitoring frequency for radium-226 and/or uranium. If the gross alpha particle activity result is less than detection, one-half (1/2) the detection limit will be used to determine compliance and the future monitoring frequency.

(B) Monitoring and Compliance Requirements for Beta Particle and Photon Radioactivity. To determine compliance with the maximum contaminant levels in subsection (1)(C) of this rule for beta particle and photon radioactivity, a system must monitor at a frequency as follows:

1. Community water systems (both surface and ground water) designated by the department as vulnerable must sample for beta particle and photon radioactivity. Systems must collect quarterly samples for beta emitters and annual samples for tritium and strontium-90 at each entry point to the distribution system (hereafter called a sampling point), beginning within one (1) quarter after being notified by the department. Systems already designated by the department must continue to sample until the department reviews and either reaffirms or removes the designation.

A. If the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity at a sampling point has a running annual average (computed quarterly) less than or equal to fifty (50) pCi/L (screening level), the department may reduce the frequency of monitoring at that sampling point to once every three (3) years. Systems must collect all samples required in paragraph (2)(B)1. of this rule during the reduced monitoring period.

B. For systems in the vicinity of a nuclear facility, the department may allow the CWS to use environmental surveillance data collected by the nuclear facility in lieu of monitoring at the system's entry point(s), where the department determines such data is applicable to the community water system. In the event that there is a release from a nuclear facility, systems, using surveillance data must begin monitoring at the community water system's entry point(s) in accordance with paragraph (2)(B)1. of this rule.

2. Community water systems (both surface and ground water) designated by the department as using waters contaminated by effluents from nuclear facilities must sample for beta particle and photon radioactivity. Systems must collect quarterly samples for beta emitters and iodine-131 and annual samples for tritium and strontium-90 at each entry point to the distribution system (hereafter called a sampling point), beginning within one (1) quarter after being notified by the department. Systems already designated by the department as systems using waters contaminated by effluents from nuclear facilities shall continue to sample until the department reviews and either reaffirms or removes the designation.

A. Quarterly monitoring for gross particle activity shall be based on the analysis of monthly samples or the analysis of a composite of three (3) monthly samples. The former is recommended.

B. For iodine-131, a composite of five (5) consecutive daily samples shall be analyzed once each quarter. As ordered by the department, more frequent monitoring shall be conducted when iodine-131 is identified in the finished water.

C. Annual monitoring for strontium-90 and tritium shall be conducted by means of analysis of four (4) quarterly samples, or with department approval, a composite of samples collected in four (4) consecutive quarters.

D. If the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity at a sampling point has a running annual average (computed quarterly) less than or equal to fifteen (15) pCi/l, the department may reduce the frequency of monitoring at that sampling point to every three (3) years. Systems must collect all samples required in paragraph (2)(B)2. of this rule during the reduced monitoring period.

E. For systems in the vicinity of a nuclear facility, the department may allow the CWSs to utilize environmental surveillance data collected by the nuclear facility in lieu of monitoring at the system's entry point(s), where the department determines if such data is applicable to the water system. In the event that there is a release from a nuclear facility, systems using surveillance data must begin monitoring at the community water system's entry point(s) in accordance with paragraph (2)(B)2. of this rule.

3. Community water systems designated by the department to monitor for beta particle and photon radioactivity shall not apply to the department for a waiver from the monitoring frequencies specified in paragraph (2)(B)1. or (2)(B)2. of this rule.

4. Community water systems may analyze for naturally occurring potassium-40 beta particle activity from the same or equivalent sample used for the gross beta particle activity analysis. Systems are allowed to subtract the potassium-40 beta particle activity value from the total gross beta particle activity value to determine if the screening level is exceeded. The potassium-40 beta particle activity must be calculated by multiplying elemental potassium concentrations (in mg/l) by a factor of 0.82.

5. If the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity exceeds the screening level, an analysis of the sample must be performed to identify the major radioactive constituents present in the sample and the appropriate doses must be calculated and summed to determine compliance with paragraph (1)(C)1., using the formula in paragraph (1)(C)2. Doses must also be calculated and combined for measured levels of tritium and strontium to determine compliance.

6. Systems must monitor monthly at the sampling point(s) which exceed the maximum contaminant level in subsection (1)(C) beginning the month after the exceedance occurs. Systems must continue monthly monitoring until the system has established, by a rolling average of three (3) monthly samples, that the MCL is being met. Systems who establish that the MCL is being met must return to quarterly monitoring until they meet the requirements set forth in subparagraph (2)(B)1.B. or subparagraph (2)(B)2.A of this rule.

(C) General Monitoring and Compliance Requirements for Radionuclides.

1. The department may require more frequent monitoring than specified in subsections (2)(A) and (2)(B) of this rule, or may require confirmation samples at its discretion. The results of the initial and confirmation samples will be averaged for use in compliance determinations.

2. Each public water system shall monitor at the time designated by the department during each compliance period.

3. Compliance with subsections (1)(A)–(D) of this rule will be determined based on the analytical result(s) obtained at each sampling point. If one (1) sampling point is in violation of an MCL, the system is in violation of the MCL.

A. For systems monitoring more than once per year, compliance with the MCL is determined by a running annual average at each sampling point. If the average of any sampling point is greater than the MCL, then the system is out of compliance with the MCL.

B. For systems monitoring more than once per year, if any sample result will cause the running average to exceed the MCL at any sample point, the system is out of compliance with the MCL immediately.

C. Systems must include all samples taken and analyzed under the provisions of this section in determining compliance, even if that number is greater than the minimum required.

D. If a system does not collect all required samples when compliance is based on a running annual average of quarterly samples, compliance will be based on the running average of the samples collected.

E. If a sample result is less than the detection limit, zero (0) will be used to calculate the annual average, unless a gross alpha particle activity is being used in lieu of radium-226 and/or uranium. If the gross alpha particle activity result is less than detection, one-half (1/2) the detection limit will be used to calculate the annual average.

4. The department has the discretion to delete results of obvious sampling or analytic errors.

5. If the MCL for radioactivity set forth in subsection (1)(A)–(D) of this rule is exceeded, the operator of a community water system must give notice to the department pursuant to 10 CSR 60-7.010 and to the public as required by 10 CSR 60-8.010.

(3) Non-Community Water Systems. Non-community water systems must monitor for radionuclides as directed by the department.

AUTHORITY: section 640.100, RSMo 2000. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Rescinded and readopted: Filed Jan. 16, 2002, effective Nov. 30, 2002.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-4.070 Secondary Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for secondary contaminants.

(1) The following are the recommended secondary maximum contaminant levels for community and nontransient noncommunity water systems:

Contaminant	Level
Aluminum	0.05–0.2 mg/l
Chloride	250 mg/l
Color	15 color units
Copper	1.0 mg/l
Corrosivity	Noncorrosive
Fluoride	2.0 mg/l
Foaming agents	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 Threshold Odor number
pH	6.5–8.5
Silver	0.1 mg/l
Sulfate	250 mg/l
Total dissolved solids (TDS)	500 mg/l
Zinc	5 mg/l

(2) Groundwater systems shall take one (1) sample at each sampling point during each three (3)-year compliance period beginning in the compliance period starting January 1, 1993. Surface water systems (or combined surface/ground) shall take one (1) sample annually at each sampling point beginning January 1, 1993. Color, foaming agents and odor should be analyzed at the water system site, as needed.

(3) For community water systems, if the result of analyses indicates that the secondary contaminant level for fluoride is exceeded, the supplier of water must report to the department within seven (7) days and must collect three (3) additional samples from designated sampling points to be submitted for analysis within one (1) month at intervals determined by the department. When the average of the results of four (4) analyses as required by this section exceeds the secondary contaminant level, the supplier of water must notify the department as required by 10 CSR 60-7.010 and give notice as required by 10 CSR 60-8.010.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed Aug. 4, 1987, effective Jan. 1, 1988. Rescinded and readopted: Filed March 31, 1992, effective Dec. 3, 1992. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.080 Operational Monitoring

PURPOSE: This rule establishes criteria for operation and operational monitoring.

Editor's Note: The following material is incorporated into this rule by reference:

*1) **Methods for Chemical Analysis of Water and Wastes, Revised March 1983** (Springfield VA: U.S. Department of Commerce, 1983);*

*2) **Standard Methods for the Examination of Water and Wastewater,** 18th Edition (Baltimore, MD, Victor Graphics, Inc., 1992).*

In accordance with section 536.013(4), RSMo, the full text of material incorporated by reference will be made available to any interested person at the Office of the Secretary of State and the headquarters of the adopting state agency.

(1) Public water systems utilizing any treatment process must perform sufficient analyses to maintain control of the treatment process, using methods as required by 10 CSR 60-5.010 and as acceptable to the department.

(2) Automatic instrumentation may be used if properly installed, maintained and periodically calibrated against known standards prepared in accordance with *Standard Methods for the Examination of Water and Wastewater 1992*, American Public Health Association, 18th edition, New York, NY or *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring Support Laboratory, USEPA, Cincinnati, OH 45268, EPA-600/4-79-020.

(3) Sufficient analyses must be done to assure control of water quality, the following requirements notwithstanding. Continuous monitoring and recording may be used for any operational analysis instead of grab sampling provided that the requirements of section (2) are met. For those analyses where continuous monitoring is required, if there is a failure in the continuous monitoring equipment, grab sampling every two (2) hours of operation may be conducted in lieu of continuous monitoring but for no more than five (5) working days following the failure of the equipment. Applicable analyses and testing frequencies are as follows:

Operational Testing

Test	Frequency	Sample Location	Disinfection	Sequestration	Iron Removal	Zeolite Softening	Clarification	Lime Softening	Fluoride Adjustment
Alkalinity (phenolphthalein and total)	As necessary for control	Raw water					X	X	
	As necessary for control	Entry point to distribution					X	X	
Disinfectant Residual	Continuous[1]	Entry point to distribution			X[5]		X	X[5]	
	Daily	Entry point to distribution	X[6,7]	X[6]		X[6]			
	At time of bacti sampling	Sampling Points	X[6,7]	X[6]	X	X[6]	X	X	
	Start-up and every 2 hours of operation	Filter influent and effluent					X	X	
	Start-up and every 2 hours of operation	Entry point to distribution			X[5]		X	X	
	Start-up and every 4 hours of operation	Entry point to distribution			X[6]				
Fluoride (if fluoride compounds are added)	Daily	Entry point(s) to distribution							X
	Monthly	Representative point in distribution							X
Hardness	Daily	Entry point to distribution				X	X	X	
Iron	Start-up and every 4 hours of operation	Filter influent and and effluent			X	X[2]	X[2]	X[2]	
pH	As necessary for control	Entry point to distribution			X		X	X	
	As necessary for control	Raw Water					X		
	Start-up and every 4 hours of operation	Filter effluent			X				
	As necessary for control	Primary & secondary basins						X	

Test	Frequency	Sample Location	Disinfection	Sequestration	Iron Removal	Zeolite Softening	Clarification	Lime Softening	Fluoride Adjustment
Phosphate	As necessary for control	Downstream from point of application		X	X[3]	X[3]	X[3]	X[3]	
Sludge concentration[4]	As necessary for control	Center cone and sludge blowoff and sample taps					X	X	
Temperature[5]	As necessary for control	Entry point to distribution	X		X		X	X	
Turbidity[5]	Every 4 hours of plant operation	Entry point to distribution and filter influent			X[5]		X	X[5]	

X—Indicates test(s) needed
1—If system serves greater than 3300 population
2—If raw water contains > 0.3 mg/l iron
3—If phosphate compounds are added to the water
4—For facilities utilizing solids contact basins
5—Surface and ground water under the direct influence of surface water
6—Groundwater system not under the direct influence of surface water required to provide disinfection
7—Secondary system required to supplement disinfection or redisinfect

(4) The department, at its discretion, may conduct routine inspections of any public water system or make other necessary inspections to determine compliance with these rules.

(5) If, after investigation, the department finds that any public water system is incompetently supervised, improperly operated, inadequate, of defective design or if the water fails to meet standards established in these rules, the water supplier must implement changes that may be required by the department.

(6) Every supplier of water to a public water system must disinfect all newly constructed or repaired water distribution mains, finished water storage facilities or wells by methods acceptable to the department before being placed in or returned to service.

(7) All finished water reservoirs must be covered by a permanent, protective material, adequately vented with properly screened openings.

(8) Chemicals, materials and protective coatings used in public water systems must be acceptable to the department.

(9) Public water systems must maintain a minimum positive pressure of twenty pounds per square inch (20 psi) throughout the distribution system under all normal operating conditions.

(10) Within thirty (30) days, public water systems must inform the department of a change of the person in charge of the water system.

(11) A supplier of water that adds fluoride to the water system must submit two (2) samples per month for analyses to the Department of Health Laboratory or another approved laboratory.

AUTHORITY: section 640.100, RSMo 1994. Original rule filed May 4, 1979, effective Sept. 14, 1979. Amended: Filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed July 12, 1991, effective Feb. 6, 1992. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995.*

10 CSR 60-4.090 Maximum Contaminant Levels and Monitoring Requirements for Disinfection By-Products

PURPOSE: This rule establishes the maximum contaminant levels and monitoring requirements for total trihalomethanes and other disinfection by-products.

(1) Applicability. This rule applies to community water systems and nontransient noncommunity water systems that add a chemical disinfectant to the water in any part of the drinking water treatment process or provide water that contains a chemical disinfectant and to water treatment plants proposed for construction or major modification as indicated in this section. The rule has different requirements and compliance dates, based on system size and type of source water.

(A) Community water systems serving 10,000 or more people and using surface water or groundwater under the direct influence of surface water (GWUDISW) must continue complying with the maximum contaminant level (MCL) of 0.10 for total trihalomethanes (TTHM) and section (3) of this rule until December 31, 2001. Beginning January 1, 2002, these systems and nontransient noncommunity water systems serving 10,000 or more people and using surface water or GWUDISW must comply with sections (4)–(5) of this rule and the MCLs of 0.080 for TTHM, 0.060 for haloacetic acids five (HAA5), 0.010 for bromate, and 1.0 for chlorite.

(B) Community water systems and nontransient noncommunity water systems serving less than 10,000 people and using surface water or GWUDISW. Beginning January 1, 2004, these systems must comply with sections (4)–(5) of this rule and the MCLs of 0.080 for TTHM, 0.060 for HAA5, 0.010 for bromate, and 1.0 for chlorite.

(C) Community water systems and nontransient noncommunity water systems using groundwater. Beginning January 1, 2004, these systems must comply with sections (4)–(5) of this rule and the MCLs of 0.080 for TTHM, 0.060 for HAA5, 0.010 for bromate, and 1.0 for chlorite.

Table 1. Compliance with Disinfection By-Product Requirements

Who must comply	When	MCLs (mg/l)	Compliance Requirements
Community water systems serving 10,000 or more people and using surface water or groundwater under the direct influence of surface water (GWUDISW)	Oct. 11, 1981 to Dec. 31, 2001	TTHM 0.10	Section (2)
Community water systems and nontransient noncommunity water systems serving 10,000 or more people and using surface water or GWUDISW	Jan. 1, 2002	TTHM 0.080 HAA5 0.060 Bromate 0.010 Chlorite 1.0	Sections (3) and (4)
Community water systems and nontransient noncommunity water systems serving less than 10,000 people and using surface water or GWUDISW	Jan. 1, 2004	TTHM 0.080 HAA5 0.060 Bromate 0.010 Chlorite 1.0	Sections (3) and (4)
Community water systems and nontransient noncommunity water systems using groundwater	Jan. 1, 2004	TTHM 0.080 HAA5 0.060 Bromate 0.010 Chlorite 1.0	Sections (3) and (4)

(D) A system that is installing granular activated carbon (GAC) or membrane technology to comply with this rule may apply to the department for an extension of up to twenty-four (24) months past December 16, 2001 but not beyond December 31, 2003. In granting the extension, the department will set a schedule for compliance and may specify any interim measures that the system must take. Failure to meet the schedule or interim treatment requirements constitutes a violation of the drinking water regulations.

(E) Beginning September 1 2000, any water treatment plant proposed for construction or major modification must be designed to meet the disinfection by-product MCLs of 0.080 for TTHM, 0.060 for HAA5, 0.010 for bromate, and 1.0 for chlorite and the requirements of sections (3) and (4) of this rule.

(2) Compliance with the TTHM MCL of 0.10.

(A) A supplier of water must collect samples of the product water for analyses as follows:

1. Community water systems must perform sampling at quarterly intervals.

A. Analyses for TTHM shall be performed at quarterly intervals on at least four (4) water samples for each treatment plant used by the system.

B. The minimum number of samples required shall be based on the number of treatment plants used by the system except that multiple wells drawing raw water from a single aquifer, with the department's approval, may be considered one (1) treatment plant for determining the minimum number of samples.

C. Community water systems serving fewer than ten thousand (10,000) persons, at the discretion of the department, may be required to submit fewer samples; and

2. All samples taken within an established frequency shall be collected within a twenty-four (24)-hour period.

(B) At least twenty-five percent (25%) of the samples shall be taken at locations within the distribution system reflecting the maximum residence time of the water in the system. The remaining shall be taken at representative locations in the distribution system, taking into account the number of persons served, different sources of water and different treatment methods employed.

(C) The results of all analyses per quarter shall be arithmetically averaged and all samples collected shall be used in the computation of the average.

(D) Upon a community water system's written request, the department may reduce the TTHM analysis monitoring frequency to a minimum of one (1) sample per quarter.

1. The sample shall be taken at a point in the distribution system that reflects the maximum residence time of the water in the system.

2. The department shall provide, in writing, a determination that local conditions and data from at least one (1) year of monitoring in accordance with subsection (2)(A) of this rule demonstrate that TTHM concentrations will be consistently below the MCL.

3. The supplier of water immediately shall begin monitoring in accordance with the requirements of subsection (2)(A) of this rule upon finding that—

A. At any time during the reduced monitoring, the results from any analysis for TTHM exceed 0.10 milligrams per liter (mg/l) and the results are confirmed by at least one (1) check sample taken promptly after the results are received; or

B. The system makes any significant change(s) to its source of water or treatment process; and

C. This monitoring shall continue at least one (1) year before the frequency may be reduced again.

(E) Upon the written request of a community water system that utilizes only groundwater sources, the department may allow the water system to substitute a minimum of one (1) sample per year for maximum TTHM potential in place of quarterly sampling for TTHM.

1. This monitoring frequency applies separately to each treatment plant used in the system.

2. The sample shall be taken at a point in the distribution system that reflects the maximum residence time of the water in the system.

3. The department shall provide, in writing, a determination that—

A. The system has a maximum TTHM potential of less than 0.10 mg/l based upon data submitted by the water supplier; and

B. Based upon an assessment of local conditions, the system is not likely to approach or exceed the MCL for TTHM.

4. A water supplier immediately shall begin monitoring in accordance with the requirements of subsection (2)(A) of this rule upon finding that—

A. The results from any analysis taken by the water supplier for maximum TTHM potential are equal to or greater than 0.10 mg/l; and

B. The results are confirmed by at least one (1) check sample which was taken promptly after the results were received; and

C. This monitoring shall continue for at least one (1) year before the frequency may be reduced again.

5. If the system makes any significant change(s) in the raw water or treatment program at any time during the period of reduced monitoring frequency, the water supplier immediately shall collect an additional sample to be analyzed for maximum TTHM potential. The sample shall be taken at a point in the distribution system that reflects the maximum residence time of the water in the system. The results of the analysis shall be used to determine whether the system must comply with the monitoring requirements of subsection (2)(A) of this rule.

(F) Compliance with the MCL of 0.10 for TTHM shall be determined based on a running annual average of quarterly samples collected by the supplier of water as prescribed in subsection (2)(A). If the average of samples covering any twelve (12)-month period exceeds the MCL, the supplier of water shall report to the department pursuant to 10 CSR 60-7.010 and notify the public pursuant to 10 CSR 60-8.010. Monitoring after public notification shall be at a frequency designated by the department and shall continue until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

(G) Samples for TTHM shall be dechlorinated upon collection to prevent further production of trihalomethanes. Samples for maximum TTHM potential shall not be dechlorinated and must be held for seven (7) days at twenty-five degrees Celsius (25°C) prior to analysis.

(H) At the option of the department, monitoring frequencies may be increased above the minimum where this is necessary to detect variations of TTHM levels within the distribution system.

(I) Before a community water system makes any significant modifications to its existing treatment process for the purposes of achieving compliance with this rule, the system must obtain departmental approval of its proposed modifications and those safeguards that it will implement to ensure that the microbiological quality of the drinking water served by the system will not be adversely affected by the modifications. At a minimum, the department shall require the system modifying its disinfection practice to—

1. Evaluate the source water for microbiological quality;

2. Evaluate its existing treatment practices and consider improvements that will minimize disinfectant demand and optimize finished water quality throughout the distribution system; and

3. Conduct additional monitoring and studies as required by the department to assure continued maintenance of optimal biological quality in finished water.

(3) Monitoring Requirements and Plan.

(A) General Requirements.

1. Systems must take all samples during normal operating conditions.

2. With department approval, systems may consider multiple wells drawing water from a single aquifer as one treatment plant for determining the minimum number of TTHM and HAA5 samples required. The department may approve as one treatment plant—

A. Multiple wells located in the same unconsolidated formation; or

B. Multiple wells located in the same consolidated formation.

3. Each system required to monitor under this section (3) must develop and implement a monitoring plan. This includes systems purchasing water, unless the system is included in the seller's monitoring plan.

A. The monitoring plan must include at least the following elements:

(I) Specific locations and schedules for collecting samples;

(II) How the system will calculate compliance with MCLs, maximum residual disinfection levels (MRDLs), and treatment techniques; and

(III) If approved for monitoring as a consecutive system, or if providing water to a consecutive system, under the provisions of 10 CSR 60-4.010(6), the sampling plan must reflect the entire distribution system.

B. The system must maintain the monitoring plan and make it available for inspection by the department and the general public no later than thirty (30) days following the applicable compliance dates in section (1) of this rule.

C. All systems serving more than three thousand three hundred (>3,300) people and using surface water or groundwater under the direct influence of surface water (GWUDISW) must submit a copy of the monitoring plan to the department no later than the date of the first report required under 10 CSR 60-7.010(6). The department may also require the plan to be submitted by any other system at the department's discretion. After review, the department may require changes in any plan elements.

D. Systems that purchase water must provide a monitoring plan and meet the monitoring requirements of this section unless the purchaser is included in the seller's monitoring plan.

4. Failure to monitor in accordance with the monitoring plan is a monitoring violation.

5. Failure to monitor will be treated as a violation for the entire period covered by the annual average where compliance is based on a running annual average of monthly or quarterly samples or averages and the system's failure to monitor makes it impossible to determine compliance with MCLs or MRDLs.

6. Systems may use only data collected under the provisions of this section (3) or EPA's Information Collection Rule (40 CFR Subpart M) to qualify for reduced monitoring.

(B) Monitoring Requirements for Disinfection By-Products.

1. TTHMs and HAA5.

A. Routine monitoring. Systems must monitor at the frequency indicated in Table 2.

Table 2. Routine Monitoring Frequency for TTHM and HAA5

Surface water or GWUDISW system serving at least 10,000 people.	Four (4) water samples per quarter per treatment plant.	At least 25 percent of all samples collected each quarter at locations representing maximum residence time. Remaining samples taken at locations representative of at least average residence time in the distribution system and representing the entire distribution system, taking into account number of persons served, different sources of water, and different treatment methods.[1]
Surface water or GWUDISW system serving from 500 to 9,999 people.	One (1) water sample per quarter per treatment plant.	Locations representing maximum residence time.[1]
Surface water or GWUDISW system serving fewer than 500 people.	One (1) sample per year per treatment plant during month of warmest water temperature.	Locations representing maximum residence time.[1] If the sample (or average of annual samples, if more than one sample is taken) exceeds MCL, system must increase monitoring to one sample per treatment plant per quarter, taken at a point reflecting the maximum residence time in the distribution system, until system meets reduced monitoring criteria in subsection (3)(C) of this rule.
System using only groundwater not under the direct influence of surface water using chemical disinfectant and serving at least 10,000 people.	One (1) water sample per quarter per treatment plant.[2]	Locations representing maximum residence time.[1]
System using only groundwater not under the direct influence of surface water using chemical disinfectant and serving fewer than 10,000 persons.	One (1) sample per year per treatment plant[2] during month of warmest water temperature.	Locations representing maximum residence time.[1] If the sample (or average of annual samples, if more than one sample is taken) exceeds MCL, the system must increase monitoring to one sample per treatment plant per quarter, taken at a point reflecting the maximum residence time in the distribution system, until system meets the criteria in subsection (3)(C) of this rule for reduced monitoring.

[1]If a system elects to sample more frequently than the minimum required, at least 25 percent of all samples collected each quarter (including those taken in excess of the required frequency) must be taken at locations that represent the maximum residence time of the water in the distribution system. The remaining samples must be taken at locations representative of at least average residence time in the distribution system.

[2]Multiple wells drawing water from a single aquifer may be considered one (1) treatment plant for determining the minimum number of samples required, with department approval.

B. Systems may reduce monitoring except as otherwise provided, in accordance with Table 3.

Table 3. Reduced Monitoring Frequency TTHM and HAA5

If you are a	You may reduce monitoring if you have monitored at least one year and your	To this level
Surface water or GWUDISW system serving at least 10,000 persons which has a source water annual average total organic carbon (TOC) level, before any treatment, ≤4.0 mg/l.	TTHM annual average ≤0.040 mg/l and HAA5 annual average ≤0.030 mg/l.	One (1) sample per treatment plant per quarter at distribution system location reflecting maximum residence time.
Surface water or GWUDISW system serving from 500 to 9,999 persons which has a source water annual average TOC level, before any treatment, ≤4.0 mg/l.	TTHM annual average ≤0.040 mg/l and HAA5 annual average ≤0.030 mg/l.	One (1) sample per treatment plant per year at distribution system location reflecting maximum residence time during month of warmest water temperature. NOTE: Any surface water or GWUDISW system serving fewer than 500 persons may not reduce its monitoring to less than one sample per treatment plant per year.
System using only groundwater not under direct influence of surface water using chemical disinfectant and serving at least 10,000 persons.	TTHM annual average ≤0.040 mg/l and HAA5 annual average ≤0.030 mg/l.	One (1) sample per treatment plant per year at distribution system location reflecting maximum residence time during month of warmest water temperature.
System using only groundwater not under direct influence of surface water using chemical disinfectant and serving fewer than 10,000 persons.	TTHM annual average ≤0.040 mg/l and HAA5 annual average ≤0.030 mg/l for two consecutive years OR TTHM annual average ≤0.20 mg/l and HAA5 annual average ≤0.015 mg/l for one year.	One (1) sample per treatment plant every three (3) years at distribution system location reflecting maximum residence time during month of warmest water temperature, with the three-year cycle beginning on January 1 following quarter in which system qualifies for reduced monitoring.

C. Systems on a reduced monitoring schedule may remain on that reduced schedule as long as the average of all samples taken in the year (for systems which must monitor quarterly) or the result of the sample (for systems which must monitor no more frequently than annually) is no more than 0.060 mg/l for TTHMs and 0.045 mg/l for HAA5. Systems that do not meet these levels must resume monitoring at the frequency identified in Table 2: Routine Monitoring in the quarter immediately following the quarter in which the system exceeds 0.060 mg/l for TTHMs and 0.045 mg/l for HAA5. For systems using only groundwater not under the direct influence of surface water and serving fewer than ten thousand (10,000) persons, if either the TTHM annual average is greater than 0.080 mg/l or the HAA5 annual average is greater than 0.060 mg/l, the system must go to increased monitoring. Systems on increased monitoring may return to routine monitoring if after at least one (1) year of monitoring their TTHM annual average is less than or equal to 0.060 mg/L and HAA5 annual average is less than or equal to 0.045 mg/l, respectively.

D. The department may return a system to routine monitoring at the department's discretion.

2. Chlorite. Community and nontransient noncommunity water systems using chlorine dioxide, for disinfection or oxidation, must conduct monitoring for chlorite.

A. Routine monitoring.

(I) Daily monitoring. Systems must take daily samples at the entrance to the distribution system. For any daily sample that exceeds the chlorite MCL, the system must take additional samples in the distribution system the following day at the following locations: near the first customer; at a location representative of average residence time; and at a location reflecting maximum residence time in the distribution system, in addition to the sample required at the entrance to the distribution system.

(II) Monthly monitoring. Systems must take a three (3)-sample set each month in the distribution system. The system must take one (1) sample at each of the following locations: near the first customer; at a location representative of average residence time; and at a location reflecting maximum residence time in the distribution system. Any additional routine sampling must be conducted in the same manner (as three (3)-sample sets, at the specified locations). The system may use the results of additional monitoring conducted under subparagraph (3)(B)2.B. to meet the requirement for monthly monitoring.

B. Additional monitoring. On each day following a routine sample monitoring result that exceeds the chlorite MCL at the entrance to the distribution system, the system is required to take three (3) chlorite distribution system samples at the following locations: as close to the first customer as possible, in a location representative of average residence time, and as close to the end of the distribution system as possible (reflecting maximum residence time in the distribution system).

C. Reduced monitoring.

(I) Chlorite monitoring at the entrance to the distribution system required by item (3)(B)2.A.(I) of this rule may not be reduced.

(II) Chlorite monitoring in the distribution system required by item (3)(B)2.A.(II) of this rule may be reduced to one (1) three (3)-sample set per quarter after one (1) year of monitoring where no individual chlorite sample taken in the distribution system under item (3)(B)2.A.(II) of this rule has exceeded the chlorite MCL and the system has not been required to conduct monitoring under subparagraph (3)(B)2.B. of this rule. The system may remain on the reduced monitoring schedule until either any of the three (3) individual chlorite samples taken quarterly in the distribution system under item (3)(B)2.A.(II) of this rule exceeds the chlorite MCL or the system is required to conduct monitoring under subparagraph (3)(B)2.B. of this rule, at which time the system must revert to routine monitoring.

3. Bromate.

A. Routine monitoring. Community and nontransient noncommunity systems using ozone for disinfection or oxidation must take one (1) sample per month for each treatment plant in the system using ozone. Systems must take samples monthly at the entrance to the distribution system while the ozonation system is operating under normal conditions.

B. Reduced monitoring. Systems required to analyze for bromate may reduce monitoring from monthly to once per quarter, if the system demonstrates that the average source water bromide concentration is less than 0.05 mg/l based upon representative monthly bromide measurements for one (1) year. The system may remain on reduced bromate monitoring until the running annual average source water bromide concentration, computed quarterly, is equal to or greater than 0.05 mg/l based upon representative monthly measurements. If the running annual average source water bromide concentration is greater than or equal to 0.05 mg/l, the system must resume routine monitoring.

(C) Monitoring Requirements for Disinfectant Residuals.

1. Chlorine and chloramines.

A. Routine monitoring. Community and nontransient noncommunity water systems must measure the residual disinfectant level at the same points in the distribution system and at the same time as total coliforms are sampled, as specified in 10 CSR 60-4.020. System using surface water or groundwater under the direct influence of surface water may use the results of residual disinfectant concentration sampling conducted under 10 CSR 60-4.080(3) and 10 CSR 60-4.055(4), in lieu of taking separate samples.

B. Reduced monitoring. Monitoring may not be reduced.

2. Chlorine dioxide.

A. Routine monitoring. Community, nontransient noncommunity, and transient noncommunity water systems that use chlorine dioxide for disinfection or oxidation must take daily samples at the entrance to the distribution system. For any daily sample that detects chlorine dioxide, the system must take additional samples in the distribution system the following day, in addition to the sample required at the entrance to the distribution system.

B. Additional monitoring. On each day following a routine sample monitoring result that detects chlorine dioxide, the system is required to take three (3) chlorine dioxide distribution system samples as close to the first customer as possible, at intervals of at least six (6) hours. If chloramines are used to maintain a disinfectant residual in the distribution system, or if chlorine is used to maintain a disinfectant residual in the distribution system and there are no disinfection addition points after the entrance to the distribution system (that is, no booster chlorination), the system must take three (3) samples as close to the first customer as possible, at intervals of at least six (6) hours. If chlorine is used to maintain a disinfectant residual in the distribution system and there are one (1) or more disinfection addition points after the entrance to the distribution system (that is, booster chlorination), the system must take one (1) sample at each of the following locations: as close to the first customer as possible; in a location representative of average residence time; and as close to the end of the distribution system as possible (reflecting maximum residence time in the distribution system).

C. Reduced monitoring. Chlorine dioxide monitoring may not be reduced.

(D) Monitoring Requirements for Disinfection By-Product Precursors (DBPP).

1. Routine monitoring. Systems using surface water or groundwater under the direct influence of surface water and using conventional filtration treatment must monitor each treatment plant for total organic carbon (TOC) no later than the point of combined filter effluent turbidity monitoring and representative of the treated water. These systems must also monitor for TOC in the source water prior to any treatment at the same time as monitoring for TOC in the treated water. These samples (source water and treated water) are referred to as paired samples. At the same time as the source water sample is taken, all systems must monitor for alkalinity in the source water prior to any treatment. Systems must take one (1) paired sample and one (1) source water alkalinity sample per month per plant at a time representative of normal operating conditions and influent water quality.

2. Reduced monitoring. Systems using surface water or groundwater under the direct influence of surface water with an average treated water TOC of less than 2.0 mg/l for two (2) consecutive years, or less than 1.0 mg/l for one (1) year, may reduce monitoring for both TOC and alkalinity to one (1) paired sample and one (1) source water alkalinity sample per plant per quarter. The system must revert to routine monitoring in the month following the quarter when the annual average treated water TOC greater than or equal to 2.0 mg/l.

(E) Bromide. Systems required to analyze for bromate may reduce bromate monitoring from monthly to once per quarter, if the system demonstrates that the average source water bromide concentration is less than 0.05 mg/l based upon representative monthly measurements for one (1) year. The system must continue bromide monitoring to remain on reduced bromate monitoring.

(4) Compliance Requirements.

(A) General Requirements.

1. Where compliance is based on a running annual average of monthly or quarterly samples or averages and the system fails to monitor for TTHM, HAA5, or bromate, this failure to monitor will be treated as a monitoring violation for the entire period covered by the annual average.

2. Where compliance is based on a running annual average of monthly or quarterly samples or averages and the system's failure to monitor makes it impossible to determine compliance with MRDLs for chlorine and chloramines, this failure to monitor will be treated as a monitoring violation for the entire period covered by the annual average.

3. All samples taken and analyzed under the provisions of this rule must be included in determining compliance, even if that number is greater than the minimum required.

4. If, during the first year of monitoring, any individual quarter's average will cause the running annual average of that system to exceed the MCL, the system is out of compliance at the end of that quarter.

(B) Disinfection By-Products.

1. TTHMs and HAA5.

A. For systems monitoring quarterly, compliance must be based on a running annual arithmetic average, computed quarterly, of quarterly arithmetic averages of all samples collected by the system as prescribed by paragraph (3)(B)1. of this rule.

B. For systems monitoring less frequently than quarterly, systems demonstrate compliance if the average of samples taken that year under the provisions of paragraph (3)(B)1. of this rule does not exceed the MCL. If the average of these samples exceeds the MCL, the system must increase monitoring to once per quarter per treatment plant. The system is not in violation until it has completed one (1) year of quarterly monitoring, unless the result of fewer than four (4) quarters of monitoring will cause the running annual average to exceed the MCL, in which case the system is in violation at the end of that quarter. Systems required to increase to quarterly monitoring must calculate compliance by including the sample that triggered the increased monitoring plus the following three (3) quarters of monitoring.

C. If the running annual arithmetic average of quarterly averages covering any consecutive four-quarter period exceeds the MCL, the system is in violation of the MCL and must notify the public pursuant to 10 CSR 60-8.010 addition to reporting to the department pursuant to 10 CSR 60-7.010.

D. If a public water system fails to complete four (4) consecutive quarters of monitoring, compliance with the MCL for the last four-quarter compliance period must be based on an average of the available data.

2. Bromate. Compliance must be based on a running annual arithmetic average, computed quarterly, of monthly samples (or, for months in which the system takes more than one sample, the average of all samples taken during the month) collected by the system as prescribed by paragraph (3)(B)3. of this rule. If the average of samples covering any consecutive four-quarter period exceeds the MCL, the system is in violation of the MCL and must notify the public pursuant to 10 CSR 60-8.010, in addition to reporting to the department pursuant to 10 CSR 60-7.010. If a PWS fails to complete twelve (12) consecutive months' monitoring, compliance with the MCL for the last four (4)-quarter compliance period must be based on an average of the available data.

3. Chlorite. Compliance must be based on an arithmetic average of each three (3) sample set taken in the distribution system as prescribed by item (3)(B)2.A.(II) and subparagraph (3)(B)2.B. of this rule. If the arithmetic average of any three (3) sample set exceeds the MCL, the system is in violation of the MCL and must notify the public pursuant to 10 CSR 60-8.010, in addition to reporting to the department pursuant to 10 CSR 60-7.010.

(C) Disinfectant Residuals.

1. Chlorine and chloramines.

A. Compliance must be based on a running annual arithmetic average, computed quarterly, of monthly averages of all samples collected by the system under paragraph (3)(C)1. of this rule. If the average covering any consecutive four (4)-quarter period exceeds the MRDL, the system is in violation of the MRDL and must notify the public pursuant to 10 CSR 60-8.010, in addition to reporting to the department pursuant to 10 CSR 60-7.010.

B. In cases where systems switch between the use of chlorine and chloramines for residual disinfection during the year, compliance must be determined by including together all monitoring results of both chlorine and chloramines in calculating compliance. Reports submitted pursuant to 10 CSR 60-7.010(6) must clearly indicate which residual disinfectant was analyzed for each sample.

2. Chlorine dioxide.

A. Acute violations. Compliance must be based on consecutive daily samples collected by the system under paragraph (3)(C)2. of this rule. If any daily sample taken at the entrance to the distribution system exceeds the MRDL, and on the following day one (1) (or more) of the three (3) samples taken in the distribution system exceed the MRDL, the system is in violation of the MRDL and must take immediate corrective action to lower the level of chlorine dioxide below the MRDL and must notify the public pursuant to the procedures for acute health risks in 10 CSR 60-8.010(2), in addition to reporting to the department pursuant to 10 CSR 60-7.010. Failure to take samples in the distribution system the day following an exceedance of the chlorine dioxide MRDL at the entrance to the distribution system will also be considered an MRDL violation and the system must notify the public of the violation in accordance with the provisions for acute violations under 10 CSR 60-8.010(2), in addition to reporting to the department pursuant to 10 CSR 60-7.010.

B. Nonacute violations. Compliance must be based on consecutive daily samples collected by the system in compliance with this rule.

(I) If any two (2) consecutive daily samples taken at the entrance to the distribution system detect chlorine dioxide, the system must take corrective action to lower the chlorine dioxide level.

(II) If any two (2) consecutive daily samples taken at the entrance to the distribution system exceed the MRDL and all distribution system samples taken are below the MRDL, the system is in violation of the MRDL and must take corrective action to lower the level of chlorine dioxide below the MRDL at the point of sampling and notify the public pursuant to the procedures for nonacute health risks in 10 CSR 60-8.010(3), in addition to reporting to the department pursuant to 10 CSR 60-7.010. Failure to monitor at the entrance to the distribution system the day following an exceedance of the chlorine dioxide MRDL at the entrance to the distribution system is also an MRDL violation and the system must notify the public of the violation in accordance with the provisions for nonacute violations in 10 CSR 60-8.010(3), in addition to reporting to the department pursuant to 10 CSR 60-7.010.

(D) Disinfection By-Product Precursors (DBPP).

1. Systems using surface water or groundwater under the direct influence of surface water and using conventional filtration treatment must operate with enhanced coagulation or enhanced softening to achieve the TOC percent removal levels specified in this rule unless the system meets at least one (1) of the alternative compliance criteria listed here. These systems must still comply with monitoring requirements in sections (3)–(4) of this rule. The alternative compliance criteria for enhanced coagulation and enhanced softening are:

A. The system's source water TOC level, measured according to 10 CSR 60-5.010, is less than 2.0 mg/l, calculated quarterly as a running annual average;

B. The system's treated water TOC level, measured according to 10 CSR 60-5.010, is less than 2.0 mg/l, calculated quarterly as a running annual average;

C. The system's source water TOC level, measured according to 10 CSR 60-5.010, is less than 4.0 mg/l, calculated quarterly as a running annual average; the source water alkalinity, measured according to 10 CSR 60-5.010, is greater than sixty (60) mg/l (as $CaCO_3$), calculated quarterly as a running annual average; and either the TTHM and HAA5 running annual averages are no greater than 0.040 mg/l and 0.030 mg/l, respectively; or prior to the effective date for compliance with this rule, the system has made a clear and irrevocable financial commitment not later than the effective date for compliance with this rule to use of technologies that will limit the levels of TTHMs and HAA5 to no more than 0.040 mg/l and 0.030 mg/l, respectively. Systems must submit evidence of a clear and irrevocable financial commitment, in addition to a schedule containing milestones and periodic progress reports for installation and operation of appropriate technologies, to the department for approval not later than the effective date for compliance with this rule. These technologies must be installed and operating not later than June 30, 2005. Failure to install and operate these technologies by the date in the approved schedule will constitute a violation;

D. The TTHM and HAA5 running annual averages are no greater than 0.040 mg/l and 0.030 mg/l, respectively, and the system uses only chlorine for primary disinfection and maintenance of a residual in the distribution system;

E. The system's source water SUVA, prior to any treatment and measured monthly according to 10 CSR 60-5.010, is less than or equal to 2.0 l/mg-m, calculated quarterly as a running annual average. SUVA refers to Specific Ultraviolet Absorption at two hundred fifty-four nanometers (254nm), an indicator of the humic content of water. It is a calculated parameter obtained by dividing a sample's ultraviolet absorption at a wavelength of 254nm (UV_{254}) (in m^{-1}) by its concentration of dissolved organic carbon (DOC) (in mg/l); and

F. The system's finished water SUVA, measured monthly according to 10 CSR 60-5.010, is less than or equal to 2.0 l/mg-m, calculated quarterly as a running annual average.

2. Additional alternative compliance criteria for softening systems. Systems practicing enhanced softening that cannot achieve the Step 1 TOC removals may use the alternative compliance criteria listed here in lieu of complying with paragraph (4)(D)3. of this rule. Systems must still comply with monitoring requirements in sections (3)–(4) of this rule.

A. Softening that results in lowering the treated water alkalinity to less than sixty (60) mg/l (as $CaCO_3$), measured monthly according to 10 CSR 60-5.010 and calculated quarterly as a running annual average.

B. Softening that results in removing at least ten (10) mg/l of magnesium hardness (as $CaCO_3$), measured monthly and calculated quarterly as an annual running average.

3. Enhanced coagulation and enhanced softening performance requirements.

A. Systems must achieve the percent reduction of TOC specified in Table 4 between the source water and the combined filter effluent, unless the department approves a system's request for alternate minimum TOC removal (Step 2) requirements. Systems may begin monitoring to determine whether Step 1 TOC removals can be met twelve (12) months prior to the compliance date for the system. This monitoring is not required and failure to monitor during this period is not a violation. However, any system that does not monitor during this period, and then determines in the first twelve (12) months after the compliance date that it is not able to meet the Step 1 requirements and must therefore apply for alternate minimum TOC removal (Step 2) requirements, is not eligible for retroactive approval of alternate minimum TOC removal (Step 2) requirements and is in violation. Systems may apply for alternate minimum TOC removal (Step 2) requirements any time after the compliance date. For systems required to meet Step 1 TOC removals, if the value calculated under part (4)(D)4.A.(IV) of this rule is less than 1.00, the system is in violation of the treatment technique requirements and must notify the public pursuant to 10 CSR 60-8.010 in addition to reporting to the department pursuant to 10 CSR 60-7.010.

B. Required Step 1 TOC reductions, indicated in the following table, are based upon specified source water parameters measured in accordance with 10 CSR 60-5.010. Systems practicing softening are required to meet the Step 1 TOC reductions in the far-right column (Source water alkalinity >120 mg/l) for the specified source water TOC.

Table 4: Required Step 1 TOC Reduction

Step 1 Required Removal of TOC by Enhanced Coagulation and Enhanced Softening for Surface Water and GWUDISW Systems Using Conventional Treatment[1,2]

Source water TOC, mg/l	Source water alkalinity, mg/l as $CaCO_3$ 0–60	>60–120	>120[3]
>2.0–4.0	35.0%	25.0%	15.0%
>4.0–8.0	45.0%	35.0%	25.0%
>8.0	50.0%	40.0%	30.0%

[1]Systems meeting at least one of the conditions in paragraph (4)(D)1. of this rule are not required to operate with enhanced coagulation.

[2]Softening systems meeting one of the alternative compliance criteria in paragraph (4)(D)1. of this rule are not required to operate with enhanced softening.

[3]Systems practicing softening must meet the TOC removal requirements in this column.

C. Conventional treatment systems using surface water or groundwater under the direct influence of surface water that cannot achieve the Step 1 TOC removals due to water quality parameters or operational constraints must apply to the department, within three (3) months of failure to achieve the Step 1 TOC removals, for approval of alternative minimum TOC (Step 2) removal requirements submitted by the system. If the department approves the alternative minimum TOC removal (Step 2) requirements, the department may make those requirements retroactive for the purposes of determining compliance. Until the department approves the alternate minimum TOC removal (Step 2) requirements, the system must meet the Step 1 TOC removals.

D. Alternate minimum TOC removal (Step 2) requirements. Applications made to the department by enhanced coagulation systems for approval of alternative minimum TOC removal (Step 2) requirements under subparagraph (4)(D)3.C. of this rule must include, as a minimum, results of bench- or pilot-scale testing conducted under this subparagraph (4)(D)3.D. and used to determine the alternate enhanced coagulation level.

(I) Alternate enhanced coagulation level is defined as coagulation at a coagulant dose and pH as determined by the method described here such that an incremental addition of ten (10) mg/l of alum (or equivalent amount of ferric salt) results in a TOC removal of less than or equal to 0.3 mg/l. The percent removal of TOC at this point on the "TOC removal versus coagulant dose" curve is then defined as the minimum TOC removal required for the system. Once approved by the department, this minimum requirement supersedes the minimum TOC removal required by Table 4 of this rule. This requirement will be effective until such time as the department approves a new value based on the results of a new bench- and pilot-scale test. Failure to achieve department-set alternative minimum TOC removal levels is a violation.

(II) Bench- or pilot-scale testing of enhanced coagulation must be conducted by using representative water samples and adding 10 mg/l increments of alum (or equivalent amounts of ferric salt) until the pH is reduced to a level less than or equal to the enhanced coagulation Step 2 target pH shown in Table 5.

Table 5: Enhanced Coagulation Step 2 Target pH

Alkalinity (mg/l as $CaCO_3$)	Target pH
0–60	5.5
>60–120	6.3
>120–240	7.0
>240	7.5

(III) For waters with alkalinities of less than sixty (60) mg/l for which addition of small amounts of alum or equivalent addition of iron coagulant drives the pH below 5.5

before significant TOC removal occurs, the system must add necessary chemicals to maintain the pH between 5.3 and 5.7 in samples until the TOC removal of 0.3 mg/l per 10 mg/l alum added (or equivalent addition of iron coagulant) is reached.

(IV) The system may operate at any coagulant dose or pH necessary (consistent with other regulatory requirements) to achieve the minimum TOC percent removal approved under subsection (3)(C) of this rule.

(V) If the TOC removal is consistently less than 0.3 mg/l of TOC per 10 mg/l of incremental alum dose at all dosages of alum (or equivalent addition of iron coagulant), the water is deemed to contain TOC not amenable to enhanced coagulation. The system may then apply to the department for a waiver of enhanced coagulation requirements.

4. Compliance calculations.

A. Systems using surface water or groundwater under the direct influence of surface water, other than those identified in paragraphs (4)(D)1. or 2. of this rule, must comply with requirements contained in subparagraph (4)(D)3.B. of this rule. Systems must calculate compliance quarterly, beginning after the system has collected twelve (12) months of data, by determining an annual average using the following method:

(I) Determine actual monthly TOC percent removal, equal to: (1 – (treated water TOC/source water TOC)) $\times$ 100;

(II) Determine the required monthly TOC percent removal;

(III) Divide the value in part (4)(D)4.A.(I) by the value in part (4)(D)4.A(II); and

(IV) Add together the results of part (4)(D)4.A.(III) for the last twelve (12) months and divide by twelve (12). If the value calculated is less than 1.00, the system is not in compliance with the TOC percent removal requirements.

B. Systems may use the following provisions in lieu of the calculations in subparagraph (4)(D)4.A. of this rule to determine compliance with TOC percent removal requirements:

(I) In any month that the system's treated or source water TOC level, measured according to 10 CSR 60-5.010, is less than 2.0 mg/l, the system may assign a monthly value of 1.0 (in lieu of the value calculated in part (4)(D)4.A.(III) of this rule);

(II) In any month that a system practicing softening removes at least 10 mg/l of magnesium hardness (as $CaCO_3$), the system may assign a monthly value of 1.0 (in lieu of the value calculated in part (4)(D)4.A.(III) of this rule);

(III) In any month that the system's source water SUVA, prior to any treatment and measured according to 10 CSR 60-5.010, is less than or equal to 2.0 l/mg-m, the system may assign a monthly value of 1.0 (in lieu of the value calculated in part (4)(D)4.A.(III) of this rule);

(IV) In any month that the system's finished water SUVA, measured according to 10 CSR 60-5.010, is less than or equal to 2.0 l/mg-m, the system may assign a monthly value of 1.0 (in lieu of the value calculated in part (4)(D)4.A.(III) of this rule); and

(V) In any month that a system practicing enhanced softening lowers alkalinity below sixty (60) mg/l (as $CaCO_3$), the system may assign a monthly value of 1.0 (in lieu of the value calculated in part (4)(D)4.A.(III) of this rule).

C. Systems using conventional treatment and surface water or groundwater under the direct influence of surface water may also comply with the requirements of this rule by meeting the criteria in paragraph (4)(D)1. or 2. of this rule.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed April 14, 1981, effective Oct. 11, 1981. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed Dec. 15, 1999, effective Sept. 1, 2000. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.100 Maximum Volatile Organic Chemical Contaminant Levels and Monitoring Requirements

PURPOSE: This rule establishes maximum contaminant levels and monitoring requirements for volatile organic chemicals.

(1) This rule applies to community and nontransient noncommunity public water systems.

(2) The following are the maximum contaminant levels (MCLs) for volatile organic chemicals (VOCs).

Contaminant	Maximum Contaminant Level, Milligrams Per Liter
(A) Eight (8) original VOCs	
1. Benzene	0.005
2. Carbon tetrachloride	0.005
3. 1,2-dichloroethane	0.005
4. 1,1-dichloroethylene	0.007
5. para-dichlorobenzene	0.075
6. 1,1,1-trichloroethane	0.2
7. Trichloroethylene	0.005
8. Vinyl chloride	0.002

Contaminant	Maximum Contaminant Level, Milligrams Per Liter
(B) Thirteen (13) VOCs	
1. cis-1,2-dichloroethylene	0.07
2. Dichloromethane	0.005
3. 1,2-dichloropropane	0.005
4. Ethylbenzene	0.7
5. Monochlorobenzene	0.1
6. o-dichlorobenzene	0.6
7. Styrene	0.1
8. Tetrachloroethylene	0.005
9. Toluene	1
10. 1,2,4-Trichlorobenzene	0.07
11. 1,1,2-Trichloroethane	0.005
12. trans-1,2-dichloroethylene	0.1
13. Xylenes (total)	10

(3) For the purpose of determining compliance with MCLs, a supplier of water must collect samples of the product water for analyses as follows:

(A) During the initial three (3)-year compliance, all community and nontransient noncommunity water systems must collect an initial round of four (4) consecutive quarterly samples for each of the contaminants listed in section (2) unless a waiver has been granted by the department. The department will designate the year in which each system samples within this compliance period;

(B) All public water systems shall sample at points in the distribution system representative of each water source or at each entry point to the distribution system. Each sample must be taken at the same sampling point, unless conditions make another sampling point more representative of each source or treatment plant. The sampling point will be after the application of treatment, if any;

(C) If the system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions;

(D) The department may require more frequent monitoring than specified in subsection (3)(A) of this rule and may require confirmation samples for positive and negative results at its discretion; and

(E) If one (1) sampling point is in violation of an MCL, the system is in violation of the MCL.

1. For systems monitoring more than once per year, compliance with the MCL is determined by a running annual average at each sampling point.

2. Systems monitoring annually or less frequently whose sample result exceeds the MCL must begin quarterly sampling. The system will not be considered in violation of the MCL until it has completed one (1) year of quarterly sampling.

3. If any sample result will cause the running annual average to exceed the MCL at any sampling point, the system is out of compliance with the MCL immediately.

4. If a system fails to collect the required number of samples, compliance will be based on the total number of samples collected.

5. If a sample result is less than the detection limit, zero will be used to calculate the annual average.

(4) The department may allow the use of monitoring data collected after January 1, 1988, to satisfy the initial base sampling requirements. If the initial monitoring for all contaminants has been completed by December 31, 1992, in accordance with the requirements of subsections (3)(B) and (C) of this rule, and the system did not detect any contaminants listed in section (2), then the system shall sample annually beginning in the initial compliance period.

(5) If contaminants are not detected during the first three (3)-year compliance period, systems may decrease their sampling frequency beginning in the next year.

(A) Groundwater systems must sample annually. After three (3) years of annual sampling and no previous detection, groundwater systems may reduce their sampling frequency to one (1) sample per compliance period.

(B) Surface water systems must sample annually after the initial sampling period if there are no contaminants detected in the initial sampling.

(6) If contaminants are detected in any sample, then systems must sample quarterly beginning in the next quarter at each sampling point which resulted in a detection.

(A) Groundwater systems must sample a minimum of two (2) quarters and surface water systems must sample a minimum of four (4) quarters to establish a baseline.

(B) If the MCL is exceeded, as described in subsection (6)(E) or (F) of this rule, then systems must sample quarterly beginning in the next quarter. Systems must sample a minimum of four (4) quarters to establish a baseline.

(C) If the baseline indicates a system's analytical results are reliably and consistently below the MCL, the department may reduce the system's sampling frequency to annually. (Annual sampling must be conducted during the quarter which previously yielded the highest analytical result.)

(D) Systems which have three (3) consecutive annual samples with no detection of a contaminant may apply to the department for a waiver.

(E) If a system conducts sampling more frequently than annually, the system will be in violation when the running annual average at any sampling point exceeds the MCL.

(F) If a system conducts sampling annually or on a less frequent basis, the system will be in violation when one (1) sample (or the average of the initial and confirmation samples) at any sampling point exceeds the MCL.

(7) A public water system may apply to the department for susceptibility waivers from required sampling. Systems are eligible for reduced monitoring in the initial three (3)-year compliance period. Waivers are effective for two (2) compliance periods. The waiver must be renewed in subsequent compliance periods, or the system must conduct sampling as required by section (3) of this rule. A public water system may apply to the department for susceptibility waivers for reduced monitoring contingent on the conduct of a thorough vulnerability assessment as required by 10 CSR 60-6.060(3).

(A) As a condition of the susceptibility waiver, a groundwater system must take one (1) sample at each sampling point during the time the waiver is effective (that is, one (1) sample during two (2) compliance periods or six (6) years) and update its vulnerability assessment by the end of the first compliance period. The department must confirm that the system is not vulnerable.

(B) Surface water systems must sample at a frequency determined by the department. A vulnerability assessment according to 10 CSR 60-6.060(3) must be required in subsequent compliance periods in order for the system to return to its nonvulnerable status.

(C) For the purposes of this section, detection is defined as greater than 0.0005 mg/l.

(8) As determined by the department, confirmation samples may be required for either positive or negative results. If a confirmation sample is used, the compliance determination is based on the average of the results of both the confirmation sample and the initial sample.

(9) Any public water system violating MCLs or monitoring and reporting requirements for any of the contaminants listed in section (2) of this rule must notify the department within seven (7) days and give public notice as required by 10 CSR 60-8.010.

(10) All new systems or systems that use a new source of water that begin operation after January 22, 2004 must demonstrate compliance with the MCL or treatment technique within a period of time specified by the department. The system must also comply with the initial sampling frequencies specified by the department to ensure a system can demonstrate compliance with the MCL or treatment technique. Routine and increased monitoring frequencies shall be conducted in accordance with the requirements in this rule.

AUTHORITY: section 640.100, RSMo Supp. 2002. Original rule filed June 2, 1988, effective Aug. 31, 1988. Rescinded and readopted: Filed March 31, 1992, effective Dec. 3, 1992. Amended: Filed May 4, 1993, effective Jan. 13, 1994. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996. Amended: Filed March 17, 2003, effective Nov. 30, 2003.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999, 2002.*

10 CSR 60-4.110 Special Monitoring for Unregulated Chemicals

PURPOSE: This rule establishes monitoring requirements for organic chemicals, volatile organic chemicals, and an inorganic chemical, which are unregulated in that they do not have maximum contaminant levels.

(1) This rule applies to community and nontransient noncommunity public water systems.

(2) Unless a waiver has been granted by the department, all public water systems shall conduct a one (1)-time round of sampling. All public water systems shall monitor for the following contaminants:

(A) Organics—

1. Aldicarb;
2. Aldicarb sulfoxide;
3. Aldicarb sulfone;
4. Aldrin;
5. Butachlor;
6. Carbaryl;
7. Dicamba;
8. Dieldrin;
9. 3-Hydroxycarbofuran;
10. Methomyl;
11. Metolachlor;
12. Metribuzin; and
13. Propachlor;

(B) Inorganics—

1. Sulfate.

(3) All public water systems shall monitor at least once for the following contaminants:

(A) All public water systems shall monitor for the following contaminants:

1. Bromobenzene;
2. Bromodichloromethane;
3. Bromoform;
4. Bromomethane;
5. Chlorodibromomethane;
6. Chloroethane;
7. Chloroform;
8. Chloromethane;
9. o-Chlorotoluene;
10. p-Chlorotoluene;
11. Dibromomethane;
12. m-Dichlorobenzene;
13. 1,1-Dichloroethane;
14. 1,1-Dichloropropene;
15. 1,3-Dichloropropane;
16. 1,3-Dichloropropene;
17. 2,2-Dichloropropane;
18. 1,1,1,2-Tetrachloroethane;
19. 1,1,2,2-Tetrachloroethane; and
20. 1,2,3-Trichloropropane; and

(B) The department will determine which water systems shall monitor for the following chemicals:

1. Bromochloromethane;
2. n-Butylbenzene;
3. Dichlorodifluoromethane;
4. Fluorotrichloromethane;
5. Hexachlorobutadiene;
6. Isopropylbenzene;
7. p-Isopropyltoluene;
8. Naphthalene;
9. n-Propylbenzene;
10. sec-Butylbenzene;
11. tert-Butylbenzene;
12. 1,2,3-Trichlorobenzene;
13. 1,2,4-Trimethylbenzene; and
14. 1,3,5-Trimethylbenzene.

(4) All public water systems shall sample at points in the distribution system representative of each water source or at entry points to the distribution system. The sampling point will be after the application of treatment. The minimum number of samples is four consecutive quarterly samples per water source for the organic chemicals listed under subsection (2)(A) of this rule, and one (1) sample per water source for the inorganic chemical listed under subsection (2)(B) of this rule. Sampling must be completed no later than the end of the initial three (3)-year compliance period and results reported to the department. Each sample must be taken at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant.

(5) If the system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions.

(6) A public water system may apply to the department for a waiver from the required sampling in section (3) for either organics or inorganics. All public water systems must conduct a one (1) time round of sampling.

(A) A public water system may apply to the department for a use waiver for reduced monitoring from required organics sampling as required by 10 CSR 60-6.060(2) if previous use of the chemical can be ruled out or a public water system may apply to the department for a susceptibility waiver for reduced monitoring from required organics sampling contingent on the conduct of a thorough vulnerability assessment as required by 10 CSR 60-6.060(3).

(B) A public water system may apply to the department for susceptibility waivers for reduced monitoring from required inorganic sampling contingent on the conduct of a thorough vulnerability assessment as required by 10 CSR 60-6.060(3). Only data collected after January 1, 1990, will be considered in making this assessment.

(C) A public water system serving fewer than one hundred fifty (150) service connections shall be treated as complying with the monitoring requirement if the owner or operator sends a letter to the department specifying that their system is available for sampling. This letter must be sent to the department no later than January 1, 1994.

(7) As determined by the department, confirmation samples may be required for either positive or negative results.

AUTHORITY: section 640.100, RSMo 1994. Original rule filed June 2, 1988, effective Aug. 31, 1988. Rescinded and readopted: Filed March 31, 1992, effective Dec. 3, 1992. Amended: Filed May 4, 1993, effective Jan. 13, 1994. Amended: Filed Feb. 1, 1996, effective Oct. 30, 1996.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995.*

MDNR Regulations

Title 10

Division 20 – Clean Water Commission

Chapter 7 – Water Quality

Date: 07/31/2007

Pages 18–40 Pages 41–111 Pages 112–135

Rules of
Department of Natural Resources
Division 20—Clean Water Commission
Chapter 7—Water Quality

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 20—Clean Water Commission
Chapter 7—Water Quality

10 CSR 20-7.010 Prevention of Pollution from Wells to Subsurface Waters of the State
(Rescinded July 10, 1980)

AUTHORITY: section 204.026, RSMo 1978. Original rule filed June 19, 1974, effective June 29, 1974. Amended: Filed April 1, 1975, effective April 11, 1975. Rescinded: Filed Oct. 12, 1979, effective July 10, 1980.

10 CSR 20-7.015 Effluent Regulations

PURPOSE: This rule sets forth the limits for various pollutants which are discharged to the various waters of the state. The two previous rules 10 CSR 20-6.050 and 10 CSR 20-7.010 have been rescinded and this rule combines certain aspects of both rules and modifies the format of the effluent regulations. This rule also complies with the latest changes to the Federal Clean Water Act, P.L. 97-117 (1981).

(1) Designations of Waters of the State.

(A) For the purpose of this rule, the waters of the state are divided into the following categories:

1. The Missouri and Mississippi Rivers;

2. Lakes and reservoirs, including natural lakes and any impoundments created by the construction of a dam across any waterway or watershed. An impoundment designed for or used as a disposal site for tailings or sediment from a mine or mill shall be considered a wastewater treatment device and not a lake or reservoir. Releases to lakes and reservoirs include discharges into streams one-half (1/2) stream mile (.80 km) before the stream enters the lake as measured to its normal full pool;

3. A losing stream is a stream which distributes thirty percent (30%) or more of its flow through natural processes such as through permeable geologic materials into a bedrock aquifer within two (2) miles' flow distance downstream of an existing or proposed discharge. Flow measurements to determine percentage of water loss must be corrected to approximate the seven (7)-day Q_{10} stream flow. If a stream bed or drainage way has an intermittent flow or a flow insufficient to measure in accordance with this rule, it may be determined to be a losing stream on the basis of channel development, valley configuration, vegetation development, dye tracing studies, bedrock characteristics, geographical data and other geological factors. Only discharges which in the opinion of the department reach the losing section and which occur within two (2) miles upstream of the losing section of the stream shall be considered releases to a losing stream. A list of known losing streams is available in the Water Quality Standards, 10 CSR 20-7.031 Table J—Losing Streams. Other streams may be determined to be losing by the Missouri Department of Natural Resources;

4. Metropolitan no-discharge streams. These streams and the limitations on discharging to them are listed in the commission's Water Quality Standards 10 CSR 20-7.031. This rule shall in no way change, amend or be construed to allow a violation of the existing or future water quality standards;

5. Special streams—wild and scenic rivers, Ozark National Scenic Riverways and Outstanding State Resource Waters;

6. Subsurface waters in aquifers; and

7. All other waters except as noted in paragraphs (1)(A)1.–6. of this rule.

(2) Effluent Limitations for the Missouri and Mississippi Rivers.

(A) The following limitations represent the maximum amount of pollutants which may be discharged from any point source, water contaminant source or wastewater treatment facility.

(B) Discharges from wastewater treatment facilities which receive primarily domestic waste or from publicly-owned treatment works (POTWs) shall undergo treatment sufficient to conform to the following limitations:

1. Biochemical Oxygen $Demand_5$ (BOD_5) and nonfilterable residues (NFRs) equal to or less than a monthly average of thirty milligrams per liter (30 mg/L) and a weekly average of forty-five milligrams per liter (45 mg/L);

2. pH shall be maintained in the range from six to nine (6–9) standard units;

3. Exceptions to paragraphs (2)(B)1. and 2. are as follows:

A. If the facility is a wastewater lagoon, the NFRs shall be equal to or less than a monthly average of eighty (80) mg/L and a weekly average of one hundred twenty (120) mg/L and the pH shall be maintained above 6.0, and the BOD_5 shall be equal to or less than a monthly average of forty-five (45) mg/L and a weekly average of sixty-five (65) mg/L;

B. If the facility is a trickling filter plant the BOD_5 and NFRs shall be equal to or less than a monthly average of forty-five (45) mg/L and a weekly average of sixty-five (65) mg/L;

C. Where the use of effluent limitations set forward in this section is known or expected to produce an effluent that will endanger or violate water quality, the department will set specific effluent limitations for individual dischargers to protect the water quality of the receiving streams. When a waste load allocation or a total maximum daily load study is conducted for a stream or stream segment, all permits for discharges in the study area shall be modified to reflect the limits established in the study;

D. The department may require more stringent limitations than authorized in subsections (3)(A) and (B) under the following conditions:

(I) If the facility is an existing facility, the department may set the BOD_5 and NFR limits based upon an analysis of the past performance, rounded up to the next five (5) mgL range; and

(II) If the facility is a new facility, the department may set the BOD_5 and NFR limits based upon the design capabilities of the plant considering geographical and climatic conditions;

(a) A design capability study has been conducted for new lagoon systems. The study reflects that the effluent limitations should be BOD_5 equal to or less than a monthly average of forty-five (45) mg/L, a weekly average of sixty-five (65) mg/L, NFRs equal to or less than a monthly average of seventy (70) mg/L and a weekly average of one hundred ten (110) mg/L.

(b) A design capability study has been conducted for new trickling filter systems and the study reflects that the effluent limitations should be BOD_5 and NFRs equal to or less than a monthly average of forty (40) mgL and a weekly average of sixty (60) mg/L; and

E. If the facility is a POTW wastewater treatment facility providing at least primary treatment during a precipitation event and discharges on a noncontinuous basis, the discharge may be allowed provided that:

(I) BOD_5 and NFRs equal to or less than a weekly average of forty-five (45) mg/L. The NFR (total suspended solids) limit may be higher than forty-five (45) mg/L for combined sewer overflow treatment devices when organic solids are demonstrated to be an insignificant fraction of total inorganic storm water generated solids, and the permittee can demonstrate that achieving a limit of forty-five (45) mg/L is not cost effective relative to water quality benefits. In these cases, an alternative total suspended solids limit would be developed.

(II) pH shall be maintained in the range from six to nine (6–9) standard units; and

(III) Only the wastewater in excess of the capacity of the noncontinuous wastewater treatment plant hydraulic capacity may be discharged;

4. Fecal coliform. Discharges into segments identified as whole body contact areas shall not contain more than a monthly geometric mean of four hundred (400) fecal coliform colonies per one hundred milliliters (100 ml) and a daily maximum of one thousand (1,000) fecal coliform colonies per one hundred milliliters (100 ml) from April 1 to October 31. The department may waive or relax this limitation if the owner or operator of the wastewater treatment facility can demonstrate that neither health nor water quality will be endangered by failure to disinfect. Facilities without disinfected effluent shall comply with the implementation schedule found in subsection (9)(H) of this rule. During periods of wet weather, a temporary suspension of accountability for bacteria standards may be established through the process described in subsection (9)(I) of this rule.

5. Sludges removed in the treatment process shall not be discharged. Sludges shall be routinely removed from the wastewater treatment facility and disposed or used in accordance with a sludge management practice approved by the department; and

6. When the wastewater treatment process causes nitrification which affects the BOD_5 reading, the permittee can petition the department to substitute carbonaceous BOD_5 in lieu of regular BOD_5 testing. If the department concurs that nitrification is occurring, the department will set a carbonaceous BOD_5 at five (5) mg/L less than the regular BOD_5 in the operating permit.

(C) The suspended solids which are present in stream water and which are removed during treatment may be returned to the same body of water from which they were taken, along with any additional suspended solids resulting from the treatment of water to be used as public potable water or industrial purposes using essentially the same process as a public water treatment process. This includes the solids that are removed from potable waters that are withdrawn from wells located in the alluvial valley of the Missouri and Mississippi Rivers.

(D) Monitoring Requirements.

1. The department will develop a wastewater and sludge sampling program based on design flow that shall require, at a minimum, one (1) wastewater sample per year for each fifty thousand (50,000) gallons per day (gpd) of effluent, or fraction thereof, except that—

A. Point sources that discharge less than twenty-five thousand (25,000) gpd may only be required to submit an annual report;

B. Point sources that discharge more than one (1) million gallons per day (mgd) will be required at a minimum to collect twenty (20) wastewater samples per year unless the applicant can show that the wastewater has a consistent quality, such as once through cooling water or mine dewatering, then the department may set less frequent sampling requirements; and

C. Sludge sampling will be established in the permit.

2. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall collect samples on a regular evenly spaced schedule, while point sources with seasonal discharges shall collect samples evenly spaced during the season of discharge.

3. Sample types shall be as follows:

A. Samples collected from lagoons may be grab samples;

B. Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

C. Sludge samples will be grab samples unless otherwise specified in the operating permit.

4. The monitoring frequency and sample types stated in paragraph (2)(D)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site-specific informational needs of the department.

(3) Effluent Limitations for the Lakes and Reservoirs.

(A) The following limitations represent the maximum amount of pollutants which may be discharged from any point source, water contaminant source or wastewater treatment facility to a lake or reservoir designated in 10 CSR 20-7.031 as L2 and L3 which is publicly owned.

(B) Discharges from wastewater treatment facilities which receive primarily domestic waste or from POTWs shall undergo treatment sufficient to conform to the following limitations:

1. BOD_5 and NFRs equal to or less than a monthly average of twenty (20) mg/L and a weekly average of thirty (30) mg/L;

2. pH shall be maintained in the range from six to nine (6–9) standard units;

3. Discharge to lakes and reservoirs identified as whole body contact areas shall not contain more than a monthly geometric mean of four hundred (400) fecal coliform colonies per one hundred milliliters (100 ml) and a daily maximum of one thousand (1,000) fecal coliform colonies per one hundred milliliters (100 ml) from April 1 to October 31. The department may waive or relax this limitation if the permittee can demonstrate that neither health nor water quality will be endangered by failure to disinfect. Facilities without disinfected effluent shall comply with the implementation schedule found in subsection (9)(H) of this rule. During periods of wet weather, a temporary suspension of accountability for bacteria standards may be established through the process described in subsection (9)(I) of this rule;

4. Where the use of effluent limitations set forth in section (3) is known or expected to produce an effluent that will endanger or violate water quality, the department may either—conduct waste load allocation studies in order to arrive at a limitation which protects the water quality of the state or set specific effluent limitations for individual dischargers to protect the water quality of the receiving streams. When a waste load allocation study is conducted for a stream or stream segment, all permits for discharges in the study area shall be modified to reflect the limits established in the waste load allocation study;

5. If the facility is a POTW wastewater treatment facility providing at least primary treatment during a precipitation event and discharges on a noncontinuous basis, the discharge may be allowed subject to the following:

A. BOD_5 and NFRs equal to or less than a weekly average of forty-five (45) mg/L;

B. pH shall be maintained in the range from six to nine (6–9) standard units; and

C. Only the wastewater in excess of the capacity of the noncontinuous wastewater treatment plant hydraulic capacity may be discharged;

6. Sludges removed in the treatment process shall not be discharged. Sludges shall be routinely removed from the wastewater treatment facility and disposed of or used in accordance with a sludge management practice approved by the department; and

7. When the wastewater treatment process causes nitrification which affects the BOD_5 reading, the permittee can petition the department to substitute carbonaceous BOD_5 in lieu of regular BOD_5 testing. If the department concurs that nitrification is occurring, the department will set a carbonaceous BOD_5 at five (5) mg/L less than the regular BOD_5 in the operating permit.

(C) Monitoring Requirements.

1. The department will develop a wastewater and sludge sampling program based on design flow that will require, at a minimum, one (1) wastewater sample per year for each twenty-five thousand (25,000)

gpd of effluent, or fraction thereof, except that—

A. Point sources that discharge less than five thousand (5,000) gpd may only be required to submit an annual report;

B. Point sources that discharge more than one point three (1.3) mgd will be required, at a minimum, to collect fifty-two (52) wastewater samples per year unless the applicant can show that the wastewater has a consistent quality, such as once through cooling water or mine dewatering, then the department may set less frequent sampling requirements; and

C. Sludge sampling will be established in the permit.

2. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall take samples on a regular evenly spaced schedule, while point sources with seasonal discharges shall collect samples evenly spaced during the season of discharge.

3. Sample types shall be as follows:

A. Samples collected from lagoons may be grab samples;

B. Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

C. Sludge samples shall be grab samples unless otherwise specified in the operating permit.

4. The monitoring frequency and sample types stated in paragraph (3)(C)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site specific informational needs of the department.

(D) For lakes designated in 10 CSR 20-7.031 as L1, which are primarily used for public drinking water supplies, there will be no discharge into the watersheds above these lakes from domestic or industrial wastewater sources regulated by these rules. Discharges from potable water treatment plants, such as filter wash, may be permitted. Separate storm sewers will be permitted, but only for the transmission of storm water. Discharges permitted prior to the effective date of this requirement may continue to discharge so long as the discharge remains in compliance with its operating permit.

(E) For lakes designated in 10 CSR 20-7.031 as L3 which are not publicly owned, the discharge limitations shall be those contained in section (8).

(F) In addition to other requirements in this section, discharges to Lake Taneycomo and its tributaries between Table Rock Dam and Power Site Dam (and excluding the discharges from the dams) shall not exceed five-tenths (0.5) mg/L of phosphorus as a monthly average. Discharges meeting both the following conditions shall be exempt from this requirement:

1. Those permitted prior to May 9, 1994; and

2. Those with design flows of less than twenty-two thousand five hundred gallons per day (22,500 gpd). All existing facilities whose capacity is increased would be subject to phosphorus limitations. The department may allow the construction and operation of interim facilities without phosphorus control provided their discharges are connected to regional treatment facilities with phosphorus control not later than three (3) years after authorization. Discharges in the White River basin and outside of the area designated above for phosphorus limitations shall be monitored for phosphorus discharges, and the frequency of monitoring shall be the same as that for BOD_5 and NFR, but not less than annually. The department may reduce the frequency of monitoring if the monitoring data is sufficient for water quality planning purposes.

(G) In addition to other requirements in this section, discharges to Table Rock Lake watershed, defined as hydrologic units numbered 11010001 and 11010002, shall not exceed five-tenths milligrams per liter (0.5 mg/L) of phosphorus as a monthly average according to the following schedules except as noted in paragraph (3)(G)5.:

1. Any new discharge shall comply with this new requirement upon the start of operations;

2. Any existing discharge, or any sum of discharges operated by a single continuing authority, with a design flow of 1.0 mgd or greater shall comply no later than November 30, 2003;

3. Any existing discharge, or any sum of discharges operated by a single continuing authority, with a design flow of 0.1 mgd or greater, but less than 1.0 mgd, shall comply no later than November 30, 2007, and shall not exceed one milligram per liter (1.0 mg/L) as a monthly average as soon as possible and no later than November 30, 2003;

4. Any existing discharge with a design flow of twenty-two thousand five hundred gallons per day (22,500 gpd) or greater, but less than 0.1 mgd, shall comply no later than November 30, 2007;

5. Any existing discharge with a design flow of less than twenty-two thousand five hundred gallons per day (22,500 gpd) permitted prior to November 30, 1999 shall be exempt from this requirement unless the design flow is increased; and

6. Any existing discharge in which the design flow is increased shall comply according to the schedule applicable to the final design flow.

(4) Effluent Limitations for Losing Streams.

(A) Discharges to losing streams shall be permitted only after other alternatives including land application, discharge to a gaining stream and connection to a regional wastewater treatment facility have been evaluated and determined to be unacceptable for environmental and/or economic reasons.

(B) If the department agrees to allow a release to a losing stream, the permit will be written using the limitations contained in subsections (4)(B) and (C). Discharges from wastewater treatment facilities which receive primarily domestic waste or from POTWs permitted under this section shall undergo treatment sufficient to conform to the following limitations:

1. BOD_5 equal to or less than a monthly average of ten (10) mg/L and a weekly average of fifteen (15) mg/L;

2. NFRs equal to or less than a monthly average of fifteen (15) mg/L and a weekly average of twenty (20) mg/L;

3. pH shall be maintained in the range from six to nine (6–9) standard units;

4. Discharges to losing streams shall not contain more than a monthly geometric mean of four hundred (400) fecal coliform colonies per one hundred milliliters (100 ml) and a daily maximum of one thousand (1,000) fecal coliform colonies per one hundred milliliters (100 ml);

5. All chlorinated effluent discharges to losing streams or within two (2) stream miles flow distance upstream of a losing stream shall also be dechlorinated prior to discharge;

6. If the facility is a POTW wastewater treatment facility providing at least primary treatment during a precipitation event and discharges on a noncontinuous basis, the discharge may be allowed subject to the following:

A. BOD_5 and NFRs equal to or less than a weekly average of forty-five (45) mg/L;

B. pH shall be maintained in the range from six to nine (6–9) standard units; and

C. Only the wastewater in excess of the capacity of the noncontinuous wastewater treatment plant hydraulic capacity may be discharged;

7. Sludges removed in the treatment process shall not be discharged. Sludges shall be routinely removed from the wastewater treatment facility and disposed of or used in accordance with a sludge management practice approved by the department; and

8. When the wastewater treatment process causes nitrification which effects the BOD_5 reading, the permittee can petition the

department to substitute carbonaceous BOD_5 in lieu of regular BOD_5 testing. If the department concurs that nitrification is occurring, the department will set a carbonaceous BOD_5 at five (5) mg/L less than the regular BOD_5 in the operating permit.

(C) Monitoring Requirements.

1. The department will develop a wastewater and sludge sampling program based on design flow that shall require at a minimum one (1) wastewater sample per year for each twenty-five thousand (25,000) gpd of effluent, or fraction thereof, except that—

A. Point sources that discharge less than five thousand (5,000) gpd may only be required to submit an annual report;

B. Point sources that discharge more than one point three (1.3) mgd will be required at a minimum to collect fifty-two (52) wastewater samples per year unless the applicant can show that the wastewater has a consistent quality, such as once through cooling water or mine dewatering, then the department may set less frequent sampling requirements; and

C. Sludge samples will be established in the permit.

2. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall take samples on a regular schedule, while point sources with seasonal discharges shall collect samples during the season of discharge.

3. Sample types shall be as follows:

A. Samples collected from lagoons may be grab samples;

B. Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

C. Sludge samples shall be a grab sample unless otherwise specified in the operating permit.

4. The monitoring frequency and sample types stated in paragraph (4)(C)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site specific informational needs of the department.

(5) Effluent Limitations for Metropolitan No-Discharge Streams.

(A) Discharge to metropolitan no-discharge streams is prohibited, except as specifically permitted under the Water Quality Standards, 10 CSR 20-7.031 and noncontaminated storm water flows.

(B) All permits for discharges to these streams shall be written to ensure compliance with the water quality standards.

(C) Monitoring Requirements.

1. The department will develop a wastewater and sludge sampling program based on design flow that shall require, at a minimum, one (1) wastewater sample per year for each twenty-five thousand (25,000) gpd of effluent, or fraction thereof, except that—

A. Point sources that discharge less than five thousand (5,000) gpd may only be required to submit an annual report;

B. Point sources that discharge more than one point three (1.3) mgd will be required at a minimum to collect fifty-two (52) wastewater samples per year; and

C. Sludge sampling will be established in the permit.

2. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall take samples on a regular schedule, while point sources with seasonal discharges shall collect samples during the season of discharge.

3. Sample types shall be as follows:

A. Samples collected from lagoons may be grab samples;

B. Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

C. Sludge samples shall be a grab sample unless otherwise specified in the operating permit.

4. The monitoring frequency and sample types stated in paragraph (5)(C)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site-specific informational needs of the department.

(6) Effluent Limitations for Special Streams.

(A) Limits for Wild and Scenic Rivers and Ozark National Scenic Riverways and Drainages Thereto.

1. The following limitations represent the maximum amount of pollutants which may be discharged from any point source, water contaminant source or wastewater treatment facility to waters included in this section.

2. Discharges from wastewater treatment facilities, which receive primarily domestic waste or from POTWs are limited as follows:

A. New releases from any source are prohibited;

B. Discharges from sources that existed before June 29, 1974, or if additional stream segments are placed in this section, discharges that were permitted at the time of the designation will be allowed.

3. Industrial, agricultural and other nondomestic contaminant sources, point sources or wastewater treatment facilities which are not included under subparagraph (6)(A)2.B. shall not be allowed to discharge. Agrichemical facilities shall be designed and constructed so that all bulk liquid pesticide nonmobile storage containers and all bulk liquid fertilizer nonmobile storage containers are located within a secondary containment facility. Dry bulk pesticides and dry bulk fertilizers shall be stored in a building so that they are protected from the weather. The floors of the buildings shall be constructed of an approved design and material(s). At an agrichemical facility, all transferring, loading, unloading, mixing and repackaging of bulk agrichemicals shall be conducted in an operational area. All precipitation collected in the operational containment area or secondary containment area as well as process generated wastewater shall be stored and disposed of in a no-discharge manner.

4. Monitoring requirements.

A. The department will develop a wastewater and sludge sampling program based on design flow that will require, at a minimum, one (1) wastewater sample per year for each twenty-five thousand (25,000) gpd of effluent, or fraction thereof, except that—

(I) Point sources that discharge less than five thousand (5,000) gpd may only be required to submit an annual report;

(II) Point sources that discharge more than one point three (1.3) mgd will be required at a minimum to collect fifty-two (52) wastewater samples per year; and

(III) Sludge sampling will be established in the permit.

B. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall take samples on a regular schedule, while point sources with seasonal discharges shall collect samples during the season of discharge.

C. Sample types shall be as follows:

(I) Samples collected from lagoons may be grab samples;

(II) Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

(III) Sludge samples shall be a grab sample unless otherwise specified in the operating permit.

D. The monitoring frequency and sample types stated in paragraph (6)(D)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site-specific informational needs of the department.

(B) Limits for Outstanding State Resource Waters as per Water Quality Standards.

1. Discharges shall not cause the current water quality in the streams to be lowered.

2. Discharges will be permitted as long as the requirements of paragraph (6)(B)1. are met and the limitations in section (8) are not exceeded.

(7) Effluent Limitations for Subsurface Waters.

(A) No person shall release any water into aquifers, store or dispose of water in a way which causes or permits it to enter aquifers either directly or indirectly unless it meets the appropriate groundwater protection criteria set in 10 CSR 20-7.031, Table A at a point ten feet (10') under the release point except as provided in subsections (7)(E) and (F). The permit writer shall review the complete application and other data to determine which parameter to include in the permit.

(B) No wastewater shall be introduced into sinkholes, caves, fissures or other openings in the ground which do or are reasonably certain to drain into aquifers except as provided in section (4) of this rule.

(C) All abandoned wells and test holes shall be properly plugged or sealed to prevent pollution of subsurface waters, as per the requirements of the Missouri Department of Natural Resources.

(D) Where any wastewater treatment facility or any water contaminant source or point source incorporates the use of land treatment systems which allows or can reasonably be expected to allow wastewater effluents to reach the aquifer. Compliance with subsection (7)(A) shall be determined by a site specific monitoring plan.

(E) The effluent limitations specified in subsection (7)(A) shall not apply to facilities designed and constructed to meet department design criteria provided these designs have been reviewed and approved by the Department of Natural Resources. The Department of Natural Resources has the right to require monitoring, reporting, public notice and other information as deemed appropriate. This exemption may be revoked by the department should any monitoring indicate an adverse effect on a beneficial water use or if the numeric criteria in the Water Quality Standards are being exceeded.

(F) Any person not included in subsection (7)(E) who releases, stores or disposes of water in a manner which results in releases of water to an aquifer having concentrations in excess of one (1) or more parameter limitations provided in subsection (7)(A) may be allowed to resample for purposes of verification of the excess. At their discretion, persons may demonstrate, at the direction of the Department of Natural Resources, that the impact on the water quality in the aquifer is negligible on the beneficial uses. The demonstration shall consider, at a minimum, the following factors:

1. Site geology;

2. Site geohydrology;

3. Existing and potential water uses;

4. Existing surface water and groundwater quality;

5. Characteristics of wastes or wastewater contained in facilities; and

6. Other items as may be required by the Department of Natural Resources to assess the proposal.

A. All demonstrations shall be reviewed by the department if the demonstrations show that the impact on groundwater quality will not result in an unreasonable risk to the public, alternate effluent limitation(s) will be proposed by the Department of Natural Resources and presented to the Clean Water Commission for approval. The Clean Water Commission has the right to require monitoring, reporting, public notice and other information as deemed appropriate in the approval of the alternate limitation for one (1) or more parameters from (7)(A). The Clean Water Commission may hold a public hearing to secure public comment prior to final action on an alternate limitation.

B. No alternate limitations will be granted which would impair beneficial uses of the aquifer or threaten human health or the environment.

C. Alternate limitations may be revoked by the department should any monitoring indicate an adverse effect on a beneficial water use or violations of the alternate limitation.

(8) Effluent Limitations for All Waters, Except Those in Paragraphs (1)(A)1.–6.

(A) The following limitations represent the maximum amount of pollutants which may be discharged from any point source, water contaminant source or wastewater treatment facility.

(B) Discharges from wastewater treatment facilities which receive primarily domestic waste or POTWs shall undergo treatment sufficient to conform to the following limitations:

1. BOD_5 and NFRs equal to or less than a monthly average of thirty (30) mg/L and a weekly average of forty-five (45) mg/L;

2. pH shall be maintained in the range from six to nine (6–9) standard units;

3. The limitations of paragraphs (8)(B)1. and 2. will be effective unless a water quality impact study has been conducted by the department, or conducted by the permittee and approved by the department, showing that alternate limitation will not cause violations of the Water Quality Standards or impairment of the uses in the standards. When a water quality impact study has been completed to the satisfaction of the department, the following alternate limitation may be allowed:

A. If the facility is a wastewater lagoon, the NFRs shall be equal to or less than a monthly average of eighty (80) mg/L and a weekly average of one hundred twenty (120) mg/L and the pH shall be maintained above 6.0 and the BOD_5 shall be equal to or less than a monthly average of forty-five (45) mg/L and a weekly average of sixty-five (65) mg/L;

B. If the facility is a trickling filter plant, the BOD_5 and NFRs shall be equal to or less than a monthly average of forty-five (45) mg/L and a weekly average of sixty-five (65) mg/L;

C. Where the use of effluent limitations set forth in section (8) is known or expected to produce an effluent that will endanger water quality, the department will set specific effluent limitations for individual dischargers to protect the water quality of the receiving streams. When a waste load allocation study is conducted for a stream or stream segment, all permits for discharges in the study area shall be modified to reflect the limits established in the waste load allocation study;

D. The department may require more stringent limitations than authorized in subsections (3)(A) and (B) under the following conditions:

(I) If the facility is an existing facility, the department may set the BOD_5 and NFR limits based upon an analysis of the past performance, rounded up to the next five (5) mg/L range; and

(II) If the facility is a new facility, the department may set the BOD_5 and NFR limits based upon the design capabilities of the plant considering geographical and climatic conditions;

(a) A design capability study has been conducted for new lagoon systems. The study reflects that the effluent limitations should be BOD_5 equal to or less than a monthly average of forty-five (45) mg/L, a weekly average of sixty-five (65) mg/L, NFRs equal to or less than a monthly average of seventy (70) mg/L and a weekly average of one hundred ten (110) mg/L;

(b) A design capability study has been conducted for new trickling filter systems and the study reflects that the effluent limitations should be BOD_5 and NFR equal to or less than a monthly average of forty (40) mg/L and a weekly average of sixty (60) mg/L; and

E. If the facility is a POTW wastewater treatment facility providing at least primary treatment during a precipitation event and discharges on a noncontinuous basis, the discharge may be allowed provided that:

(I) BOD_5 and NFRs are equal to or less than a weekly average of forty-five (45) mg/L. The NFR (total suspended solids) limit may be higher than forty-five (45) mg/L for combined sewer overflow treatment devices when organic solids are demonstrated to be an insignificant fraction of total inorganic storm water generated solids, and the permittee can demonstrate that achieving a limit of forty-five (45) mg/L is not cost effective relative to water quality benefits. In these cases, an alternative total suspended solids limit would be developed.

(II) pH shall be maintained in the range from six to nine (6–9) units; and

(III) Only the wastewater in excess of the capacity of the noncontinuous wastewater treatment plant hydraulic capacity may be discharged;

4. Fecal coliform.

A. Discharges to streams identified as whole body contact areas, discharges within two (2) miles upstream of these areas and discharges to streams with a seven (7)-day Q_{10} flow of zero (0) in metropolitan areas where the stream is readily accessible to the public shall not contain more than a monthly geometric mean of four hundred (400) fecal coliform colonies per one hundred milliliters (100 ml) and a daily maximum of one thousand (1,000) fecal coliform colonies per one hundred milliliters (100 ml) from April 1 to October 31. The department may waive or relax this limitation if the owner or operator of the wastewater treatment facility can demonstrate that neither health nor water quality will be endangered by failure to disinfect. Facilities without disinfected effluent shall comply with the implementation schedule found in subsection (9)(H) of this rule. During periods of wet weather, a temporary suspension of accountability for bacteria standards may be established through the process described in subsection (9)(I) of this rule.

B. Where chlorine is used as a disinfectant, the effluent shall be dechlorinated except when the discharge is—

(I) Into an unclassified stream at least one (1) mile from a Water Quality Standards classified stream; or

(II) Into a flowing stream where the seven (7)-day Q_{10} flow is equal to or greater than fifty (50) times the design effluent flow;

5. Sludges removed in the treatment process shall not be discharged. Sludges shall be routinely removed from the wastewater treatment facility and disposed of or used in accordance with a sludge management practice approved by the department; and

6. When the wastewater treatment process causes nitrification which affects the BOD_5 reading, the permittee can petition the department to substitute carbonaceous BOD_5 in lieu of regular BOD_5 testing. If the department concurs that nitrification is occurring, the department will set a carbonaceous BOD_5 at five (5) mg/L less than the regular BOD_5 in the operating permit.

(C) Monitoring Requirements.

1. The department will develop a wastewater and sludge sampling program based on design flow that will require at a minimum one (1) wastewater sample per year for each fifty thousand (50,000) gpd of effluent, or fraction thereof, except that—

A. Point sources that discharge less than twenty-five thousand (25,000) gpd may only be required to submit an annual report;

B. Point sources that discharge more than one (1) mgd will be required at a minimum to collect twenty (20) wastewater samples per year unless the applicant can show that the wastewater has a consistent quality, such as once through cooling water or mine dewatering, then the department may set less frequent sampling requirements; and

C. Sludge sampling will be established in the permit.

2. Sampling frequency shall be spread evenly throughout the discharge year. This means that a point source with a continuous discharge shall take samples on a regular schedule, while point sources with seasonal discharges shall collect samples during their season of discharge.

3. Sample type shall be as follows:

A. Samples collected from lagoons may be grab samples;

B. Samples collected from mechanical plants shall be twenty-four (24)-hour composite samples, unless otherwise specified in the operating permit; and

C. Sludge samples shall be a grab sample unless otherwise specified in the operating permit.

4. The monitoring frequency and sample types stated in paragraph (8)(C)3. are minimum requirements. The permit writer shall establish monitoring frequencies and sampling types to fulfill the site-specific informational needs of the department.

(9) General Conditions.

(A) Monitoring, Analysis and Reporting.

1. All construction and operating permit holders shall submit reports at intervals established by the permit or at any other reasonable intervals required by the department. The monitoring and analytical schedule shall be as established by the Missouri Department of Natural Resources in the operating permit.

2. The analytical and sampling methods used must conform to the following reference methods unless alternates are approved by the department:

A. *Standard Methods for the Examination of Waters and Wastewaters* (14, 15, 16, 17, 18, 19 and 20th Edition), published by the Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314;

B. *Water Testing Standards, Vol. 11.01 and 11.02,* published by American Society for Testing and Materials, West Conshohocken, PA 19428;

C. *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020), published by the Environmental Protection Agency, Water Quality Office, Analytical Quality Control Laboratory, 1014 Broadway, Cincinnati, OH 54202; and

D. *NPDES Compliance Sampling Inspection Manual*, published by Environmental Protection Agency, Enforcement Division, Office of Water Enforcement, 401 Main Street, S.W., Washington DC 20460.

3. Sampling and analysis by the department to determine violations of this regulation will be conducted in accordance with the methods listed in paragraph (9)(A)2. or any other approved by the department. Violations may be also determined by review of the permittee's self-monitoring reports. Analysis conducted by the permittee or his/her laboratory shall be conducted in such a way that the precision and accuracy of the analyzed results can be determined.

4. If, for any reason, the permittee does not comply with or will be unable to comply with any discharge limitations or standards specified in the permit, the permittee shall provide the department with the following information, with the next discharge monitoring report as required under subsection (9)(A):

A. A description of the discharge and cause of noncompliance;

B. The period of noncompliance, including exact dates and times and/or the anticipated time when the discharge will return to compliance; and

C. Steps being taken to reduce, eliminate and prevent recurrence of the noncompliance.

5. In the case of any discharge subject to any applicable toxic pollutant effluent standard under section 307(a) of the Federal Clean Water Act, the information required by paragraph (9)(A)4. regarding a violation of this standard shall be provided within twenty-four (24) hours from the time the owner or operator of the water contaminant source,

point source or wastewater treatment facility becomes aware of the violation or potential violation. If this information is provided orally, a written submission covering these points shall be provided within five (5) working days of the time the owner or operator of the water contaminant source, point source or wastewater treatment facility becomes aware of the violation.

(B) Dilution Water. Dilution of treated wastewater with cooling water or other less contaminated water to lower the effluent concentration to limits required by an effluent regulation of the Clean Water Law shall not be an acceptable means of treatment.

(C) Compliance.

1. New sources. Water contaminant sources, point sources and wastewater treatment facilities and their tributary sewer systems on which construction begins after the effective date of the applicable effluent guidelines shall meet all requirements of this regulation and the Missouri Clean Water Law.

2. Sources for which construction and operating permits were issued prior to the effective date of this regulation shall meet all the requirements of the existing permit. Where the existing permit contains more stringent limitations than those contained in this regulation, the permittee may apply to the department for a modification of the permit to contain the new limitations. The department will notify the applicant of its decision to modify or deny the application within sixty (60) days after receiving an application.

(D) Compliance with New Source Performance Standards.

1. Except as provided in paragraph (9)(D)2., any new water contaminant source, point source or wastewater treatment facility on which construction commenced after October 18, 1972, or any new source, which meets the applicable promulgated new source performance standards before the commencement of discharge, shall not be subject to any more stringent new source performance standards or to any more stringent technology-based standards under subsection 301(b)(2) of the Federal Clean Water Act for the shortest of the following periods:

A. Ten (10) years from the date that construction is completed;

B. Ten (10) years from the date the source begins to discharge process or other nonconstruction related wastewater; or

C. The period of depreciation or amortization of the facility for the purposes of section 167 or 169 (or both) of the *Internal Revenue Code* of 1954.

2. The protection from more stringent standards of performance afforded by paragraph (9)(D)1. does not apply to—

A. Additional or more stringent permit conditions which are not technology based, for example, conditions based on water quality standards or effluent standards or prohibitions under section 307(a); and

B. Additional permit conditions controlling pollutants listed as toxic under section 307(a) of the Federal Clean Water Act or as hazardous substances under section 311 of the Federal Clean Water Act and which are not controlled by new source performance standards. This exclusion includes permit conditions controlling pollutants other than those identified as hazardous where control of those other pollutants has been specifically identified as the method to control the hazardous pollutant.

(E) Bypassing.

1. Any bypass or shutdown of a wastewater treatment facility and tributary sewer system or any part of a facility and sewer system that results in a violation of permit limits or conditions is prohibited except—

A. Where unavoidable to prevent loss of life, personal injury or property damages;

B. Where unavoidable excessive storm drainage or runoff would damage any facilities or processes necessary for compliance with the effluent limitations and conditions of this permit; and

C. Where maintenance is necessary to ensure efficient operation and alternative measures have been taken to maintain effluent quality during the period of maintenance;

2. The permittee shall notify the department by telephone within twenty-four (24) hours and follow with a written report within five (5) days of all bypasses or shutdowns that result in a violation of permit limits or conditions. POTWs that bypass during storm water infiltration events need only report on their discharge monitoring reports. This section does not excuse any person from any liability, unless this relief is otherwise provided by the statute.

(F) Sludge facilities shall meet the applicable control technology for sewage sludge treatment, use and disposal as published by the Environmental Protection Agency (EPA) in 40 CFR 503 and applicable state standards and limitations published in 10 CSR 20 and 10 CSR 80. Where there are no standards available or applicable, or when more stringent standards are appropriate to protect human health and the environment, the department shall set specific limitations in permits on a case-by-case basis using best professional judgment.

(G) Industrial, agricultural and other nondomestic water contaminant sources, point sources or wastewater treatment facilities which are not included under subsection (2)(B), (3)(B), (4)(B), or (8)(B)—

1. These facilities shall meet the applicable control technology currently effective as published by the EPA in 40 CFR 405–471. Where there are no standards available or applicable, the department shall set specific parameter limitations using best professional judgment. pH shall be maintained in the range from six to nine (6–9) standard units, except that discharges of uncontaminated cooling water and water treatment plant effluent may exceed nine (9) standard units, but may not exceed ten and one-half (10.5) standard units, if it can be demonstrated that the pH will not exceed nine (9) standard units beyond the regulatory mixing zone; and

2. Agrichemical facilities shall be designed and constructed so that all bulk liquid pesticide nonmobile storage containers and all bulk liquid fertilizer nonmobile storage containers are located within a secondary containment facility. Dry bulk pesticides and dry bulk fertilizers shall be stored in a building so that they are protected from the weather. The floors of the buildings shall be constructed of an approved design and material(s). At an agrichemical facility, the following procedures shall be conducted in an operational area: all transferring, loading, unloading, mixing and repackaging of bulk agrichemicals. All precipitation collected in the operational containment area or secondary containment area as well as process generated wastewater shall be stored and disposed of in a no-discharge manner or treated to meet the applicable control technology referenced in paragraph (9)(G)1.

(H) Implementation Schedule for Protection of Whole Body Contact and Secondary Contact Recreation.

1. For all permitted wastewater discharges containing bacteria, the department shall, upon the issuance or first renewal or first significant modification of each permit on or after December 31, 2005, include within each permit a compliance schedule that provides up to five (5) years for the permittee to either install disinfection systems, present an evaluation sufficient to show that disinfection is not required to protect one (1) or both designated recreational uses, or present a use attainability analysis (UAA) that demonstrates one (1) or both designated recreational uses are not attainable in the classified waters receiving the effluent. This provision does not apply to permits issued for construction applications submitted to the department after December 31, 2005.

2. Notwithstanding the provisions of (9)(H)1., all permits shall insure compliance with effluent limits to protect whole body contact and secondary contact recreation by no later than December 31, 2013, unless the permittee presents an evaluation sufficient to show that disinfection is not required to protect one (1) or both designated recreational uses, or a use attainability analysis (UAA) demonstrates that one (1) or both designated recreational uses are not attainable in the classified waters receiving the effluent.

(I) Temporary Suspension of Accountability for Bacteria Standards during Wet Weather. The accountability for bacteria standards may be temporarily suspended for specific discharges when conditions contained in paragraphs (9)(I)1. through 3. are met.

1. No existing recreational uses downstream of the discharge will be impacted during the period of suspension as confirmed through a water quality review for reasonable potential for downstream impacts and a use attainability analysis performed in accordance with the *Recreational Use Attainability Analysis Protocol* approved by the Missouri Clean Water Commission on November 3, 2004.

2. The period of suspension must be restricted to the defined wet weather event that corresponds to the period when recreational uses are unattainable. The period must be determinable at any time by the discharger and the general public (such as from stream depth or flow readings or other stream conditions on which publicly accessible records are kept).

3. The suspension shall be subject to public review and comment, Missouri Clean Water Commission approval, and U.S. Environmental Protection Agency approval before becoming effective and shall be contained as a condition in a discharge permit or other written document developed through public participation.

AUTHORITY: section 644.026, RSMo 2000. Original rule filed June 6, 1974, effective June 16, 1974. Amended: Filed April 1, 1975, effective April 11, 1975. Rescinded: Filed Oct. 16, 1979, effective July 11, 1980. Readopted: Filed Feb. 4, 1980, effective July 11, 1980. Rescinded and readopted: Filed Nov. 10, 1982, effective May 12, 1983. Amended: Filed Sept. 11, 1984, effective March 12, 1985. Amended: Filed July 25, 1985, effective Dec. 26, 1985. Amended: Filed Feb. 1, 1988, effective June 13, 1988. Amended: Filed Sept. 13, 1988, effective Feb. 14, 1989. Amended: Filed July 15, 1991, effective Jan. 13, 1992. Amended: Filed Sept. 2, 1993, effective May 9, 1994. Amended: Filed March 1, 1999, effective Nov. 30, 1999. Amended: Filed Dec. 30, 1999, effective Sept. 30, 2000. Amended: Filed March 31, 2005, effective Dec. 31, 2005.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995, 2000.*

10 CSR 20-7.020 Effluent Regulations
(Rescinded July 10, 1980)

AUTHORITY: section 204.026, RSMo 1978. Original rule filed June 6, 1974, effective June 16, 1974. Amended: Filed April 1, 1975, effective April 11, 1975. Rescinded: Filed Oct. 12, 1979, effective July 10, 1980.

10 CSR 20-7.030 Water Quality Standards
(Rescinded December 11, 1977)

AUTHORITY: sections 204.021 and 204.026, RSMo Supp. 1973. Rescinded: effective Dec. 11, 1977.

10 CSR 20-7.031 Water Quality Standards

PURPOSE: This rule identifies beneficial uses of waters of the state, criteria to protect those uses and defines the antidegradation policy. It is developed in response to the Missouri Clean Water Law and the federal Clean Water Act, Section 303(c)(1) and (2), which requires that state water quality standards be reviewed at least once every three years. These revisions are pursuant to the national goal of protection of fish, shellfish and wildlife and recreation in and on the water as outlined in Section 101(a)(2) of the Act.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Definitions.

(A) Acute toxicity—Conditions producing adverse effects or lethality on aquatic life following short-term exposure. The acute criteria in Tables A and B are maximum concentrations which protect against acutely toxic conditions. Acute toxicity is also indicated by exceedence of whole-effluent toxicity (WET) test conditions of paragraph (3)(I)2. For substances not listed in Table A or B, 0.3 of the median lethal concentration, or the no observed acute effect concentration for representative species, may be used to determine absence of acute toxicity.

(B) Aquifer—A subsurface water-bearing bed or stratum which stores or transmits water in recoverable quantities that is currently being used or could be used as a water source for private or public use. It does not include water in the vadose zone.

(C) Beneficial or designated uses. Those uses specified in paragraphs 1.–15. of this subsection for each water body segment whether or not they are attained. Beneficial or designated uses (1)(C)1.–11. of classified waters are identified in Tables G and H. Beneficial or designated uses (1)(C)12.–15. of classified waters must be determined on a site-by-site basis and are therefore not listed in Tables G and H.

1. Irrigation—Application of water to cropland or directly to plants that may be used for human or livestock consumption. Occasional supplemental irrigation, rather than continuous irrigation, is assumed.

2. Livestock and wildlife watering—Maintenance of conditions to support health in livestock and wildlife.

3. Cold-water fishery—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a naturally reproducing or stocked trout fishery and other naturally reproducing populations of recreationally important fish species.

4. Cool-water fishery—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a sensitive, high-quality sport fishery (including smallmouth bass and rock bass) and other naturally reproducing populations of recreationally important fish species.

5. Protection of aquatic life (General warm-water fishery)—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a wide variety of warm-water biota, including naturally reproducing populations of recreationally important fish species. This includes all Ozark Class C and P streams, all streams with seven (7)-day Q_{10} low flows of more than one-tenth cubic foot per second (0.1 cfs), all P1 streams and all classified lakes. However, individual Ozark Class C streams may be determined to be limited warm-water fisheries on the basis of limited habitat, losing-stream classification, land-use characteristics or faunal studies which demonstrate a lack of recreationally important fish species.

6. Protection of aquatic life (Limited warm-water fishery)—Waters in which natural water quality and/or habitat conditions

prevent the maintenance of naturally reproducing populations of recreationally important fish species. This includes non-Ozark Class C streams and non-Ozark Class P streams with seven (7)-day Q_{10} low flows equal to or less than 0.1 cfs and Ozark Class C streams with the characteristics outlined in paragraph (1)(C)5.

7. Human health protection (Fish consumption)—Criteria to protect this use are based on the assumption of an average amount of fish consumed on a long-term basis. Protection of this use includes compliance with Food and Drug Administration (FDA) limits for fish tissue, maximum water concentrations corresponding to the 10^{-6} cancer risk level and other human health fish consumption criteria.

8. Whole body contact recreation—Activities in which there is direct human contact with the raw surface water to the point of complete body submergence. The raw water may be ingested accidentally and certain sensitive body organs, such as the eyes, ears and the nose, will be exposed to the water. Although the water may be ingested accidentally, it is not intended to be used as a potable supply unless acceptable treatment is applied. Water so designated is intended to be used for swimming, water skiing or skin diving. All waters in Tables G and H of this rule are presumed to support whole body contact recreation unless a Use Attainability Analysis (UAA) has shown that the use is unattainable. The use designation for whole body contact recreation may be removed or modified through a UAA for only those waters where whole body contact is not an existing use. Assignment of this use does not grant an individual the right to trespass when a land is not open to and accessible by the public through law or written permission of the landowner.

A. Category A—This category applies to those water segments that have been established by the property owner as public swimming areas allowing full and free access by the public for swimming purposes and waters with existing whole body contact recreational use(s). Examples of this category include, but are not limited to, public swimming beaches and property where whole body contact recreational activity is open to and accessible by the public through law or written permission of the landowner.

B. Category B—This category applies to waters designated for whole body contact recreation not contained within category A.

9. Secondary contact recreation—Uses include fishing, wading, commercial and recreational boating, any limited contact incidental to shoreline activities, and activities in which users do not swim or float in the water. These recreational activities may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal. Assignment of this use does not grant an individual the right to trespass when a land is not open to and accessible by the public through law or written permission of the landowner.

10. Drinking water supply—Maintenance of a raw water supply which will yield potable water after treatment by public water treatment facilities.

11. Industrial process water and industrial cooling water—Water to support various industrial uses; since quality needs will vary by industry, no specific criteria are set in these standards.

12. Storm- and flood-water storage and attenuation—Waters which serve as overflow and storage areas during flood or storm events slowly release water to downstream areas, thus lowering flood peaks and associated damage to life and property.

13. Habitat for resident and migratory wildlife species, including rare and endangered species—Waters that provide essential breeding, nesting, feeding and predator escape habitats for wildlife including waterfowl, birds, mammals, fish, amphibians and reptiles.

14. Recreational, cultural, educational, scientific and natural aesthetic values and uses—Waters that serve as recreational sites for fishing, hunting and observing wildlife; waters of historic or archaeological significance; waters which provide great diversity for nature observation, educational opportunities and scientific study.

15. Hydrologic cycle maintenance—Waters hydrologically connected to rivers and streams serve to maintain flow conditions during periods of drought. Waters that are connected hydrologically to the groundwater system recharge groundwater supplies and assume an important local or regional role in maintaining groundwater levels.

(D) Biocriteria—Numeric values or narrative expressions that describe the reference biological integrity of aquatic communities inhabiting waters that have been designated for aquatic-life protection.

(E) Chronic toxicity—Conditions producing adverse effects on aquatic life or wildlife following long-term exposure but having no readily observable effect over a short time period. Chronic numeric criteria in Tables A and B are maximum concentrations which protect against chronic toxicity; these values shall be considered four (4)-day averages. Chronic toxicity is also indicated by exceedence of WET test conditions of subsection (4)(P). For substances not listed in Table A or B, commonly used endpoints such as the no-observed effect concentration or inhibition concentration of representative species may be used to demonstrate absence of toxicity.

(F) Classified waters—All waters listed as L1, L2 and L3 in Table G and P, P1 and C in Table H. During normal flow periods, some rivers back water into tributaries which are not otherwise classified. These permanent backwater areas are considered to have the same classification as the water body into which the tributary flows.

1. Class L1—Lakes used primarily for public drinking water supply.

2. Class L2—Major reservoirs.

3. Class L3—Other lakes which are waters of the state. These include both public and private lakes. For effluent regulation purposes, publicly owned L3 lakes are those for which a substantial portion of the surrounding lands are publicly owned or managed.

4. Class P—Streams that maintain permanent flow even in drought periods.

5. Class P1—Standing-water reaches of Class P streams.

6. Class C—Streams that may cease flow in dry periods but maintain permanent pools which support aquatic life.

7. Class W—Wetlands that are waters of the state that meet the criteria in the *Corps of Engineers Wetlands Delineation Manual* (January 1987), and subsequent federal revisions. Class W waters do not include wetlands that are artificially created on dry land and maintained for the treatment of mine drainage, stormwater control, drainage associated with road construction, or industrial, municipal or agricultural waste. Class W determination on any specific site shall be consistent with federal law.

(G) Early life stages of fish—The pre-hatch embryonic period, the post-hatch free embryo or yolk-sac fry, and the larval period during which the organism feeds. Juvenile fish, which are anatomically rather similar to adults, are not considered an early life stage.

(H) Existing uses—Those uses actually attained in the water body on or after November 28, 1975, whether or not they are identified in the water quality standards.

(I) Ecoregion—A major region within the state which contains waters with similar geological, hydrological, chemical and biological characteristics.

(J) Epilimnion—Zone of atmospheric mixing in a thermostratified lake.

(K) Fecal coliform bacteria—A group of bacteria originating in intestines of warm-blooded animals which indicates the possible presence of pathogenic organisms in water.

(L) Hypolimnion—Zone beneath the zone of atmospheric mixing in a thermostratified lake.

(M) Lethal concentration$_{50}$ (LC_{50})—Concentration of a toxicant which would be expected to kill fifty percent (50%) of the individuals of the test species organisms in a test of specified length of time.

(N) Losing stream—A stream which distributes thirty percent (30%) or more of its flow during low flow conditions through natural processes, such as through permeable geologic materials into a bedrock aquifer within two (2) miles' flow distance downstream of an existing or proposed discharge. Flow measurements to determine percentage of water loss must be corrected to approximate the seven (7)-day Q_{10} stream flow. If a stream bed or drainage way has an intermittent flow or a flow insufficient to measure in accordance with this rule, it may be determined to be a losing stream on the basis of channel development, valley configuration, vegetation development, dye tracing studies, bedrock characteristics, geographical data and other geological factors. Losing streams are listed in Table J; additional streams may be determined to be losing by the Missouri Department of Natural Resources.

(O) Low-flow conditions—Where used in this regulation in the context of mixing zones, the low-flow conditions shall refer to the minimum amount of stream flow occurring immediately upstream of a wastewater discharge and available, in whole or in part, for attenuation of wastewater pollutants.

1. Seven (7)-day, one (1)-in-ten (10)-year low flow (7-day Q_{10})—The lowest average flow for seven (7) consecutive days that has a probable recurrence interval of once-in-ten (10) years.

2. Sixty (60)-day, one (1)-in-two (2)-year low flow (60-day Q_2)—The lowest average flow for sixty (60) consecutive days that has a probable recurrence interval of once-in-two (2) years.

3. Thirty (30)-day, one (1)-in-ten (10)-year low flow (30-day Q_{10})—The lowest average flow for thirty (30) consecutive days that has a probable recurrence interval of once-in-ten (10) years.

4. One (1)-day, one (1)-in-ten (10)-year low flow (1-day Q_{10})—The lowest average flow for one (1) day that has a probable recurrence interval of once-in-ten (10) years.

(P) Mixing zone—An area of dilution of effluent in the receiving water beyond which chronic toxicity criteria must be met.

(Q) Outstanding national resource waters—Waters which have outstanding national recreational and ecological significance. These waters shall receive special protection against any degradation in quality. Congressionally designated rivers, including those in the Ozark national scenic riverways and the wild and scenic rivers system, are so designated (see Table D).

(R) Outstanding state resource waters—High quality waters with a significant aesthetic, recreational or scientific value which are specifically designated as such by the Clean Water Commission (see Table E).

(S) Ozark streams—Streams lying within the Ozark faunal region as described in the *Aquatic Community Classification System for Missouri*, Missouri Department of Conservation, 1989.

(T) Reference lakes or reservoirs—Lakes or reservoirs determined by Missouri Department of Natural Resources to be the best available representatives of ecoregion waters in a natural condition with respect to habitat, water quality, biological integrity and diversity, watershed land use, and riparian conditions.

(U) Reference stream reaches—Stream reaches determined by the department to be the best available representatives of ecoregion waters in a natural condition, with respect to habitat, water quality, biological integrity and diversity, watershed land use and riparian conditions.

(V) Regulated-flow streams—A stream that derives a majority of its flow from an impounded area with a flow-regulating device.

(W) Use Attainability Analysis (UAA)—A structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological, and economic factors as described in 40 CFR 131.10(g).

(X) Water effect ratio—Appropriate measure of the toxicity of a material obtained in a site water divided by the same measure of the toxicity of the same material obtained simultaneously in a laboratory dilution water.

(Y) Water hardness—The total concentration of calcium and magnesium ions expressed as calcium carbonate. For purposes of this rule, hardness will be determined by the lower twenty-fifth percentile value of a representative number of samples from the water body in question or from a similar water body at the appropriate stream flow conditions.

(Z) Water quality criteria—Chemical, physical and biological properties of water that are necessary to protect beneficial water uses.

(AA) Waters of the state—All rivers, streams, lakes, and other bodies of surface and subsurface water lying within or forming a part of the boundaries of the state which are not entirely confined and located completely upon lands owned, leased, or otherwise controlled by a single person or by two (2) or more persons jointly or as tenants in common and includes waters of the United States lying within the state.

(BB) Wetlands—Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. This definition is consistent with both the United States Army Corps of Engineers 33 CFR 328.3(b) and the United States Environmental Protection Agency 40 CFR 232.2(r).

(CC) Whole effluent toxicity tests—A toxicity test conducted under specified laboratory conditions on specific indicator organisms. To estimate chronic and acute toxicity of the effluent in its receiving stream, the effluent may be diluted to simulate the computed percent effluent at the edge of the mixing zone or zone of initial dilution.

(DD) Zone of initial dilution—A small area of initial mixing below an effluent outfall beyond which acute toxicity criteria must be met.

(EE) Zone of passage—A continuous water route necessary to allow passage of organisms with no acutely toxic effects produced on their populations.

(FF) Other definitions as set forth in the Missouri Clean Water Law and 10 CSR 20-2.010 shall apply to terms used in this rule.

(2) Antidegradation. The antidegradation policy shall provide three (3) levels of protection.

(A) Tier One. Public health, existing instream water uses and a level of water quality necessary to protect existing uses shall be maintained and protected.

(B) Tier Two. For all waters of the state, if existing water quality is better than applicable water quality criteria established in these rules, that existing quality shall be fully maintained and protected. Water quality may be lowered only if the state finds, after full satisfaction of the intergovernmental coordination and public participation requirements, that the lowered water quality is necessary to allow important economic and social development in the geographical area in which the waters are located. In allowing the lowering of water quality, the state shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control before allowing any lowering of water quality. This provision allows a proposed new or modified point or nonpoint source of pollution to result in limited lowering of water quality provided that—

1. The source does not violate any of the general criteria set forth in section (3) of this rule, or any of the criteria for protection of beneficial uses set forth in section (4) of this rule;

2. The source meets all applicable technological effluent limitations and minimum standards of design for point sources or minimum pollution control practices for nonpoint sources; and

3. The lowering of water quality, in the judgment of the department, is necessary for the accommodation of important economic and social development in the geographical vicinity of the discharge. In making a preliminary determination based on socioeconomic development considerations, the department may consider the potential for regional increases in utility rates, taxation levels or recoverable costs associated with the production of goods or services that may result from the imposition of a strict no-degradation policy. Consideration may also be given to the possible indirect effects of a policy on per capita income and the level of employment in the geographical vicinity of the proposed pollution source. Any preliminary decision by the department to allow a limited lowering of water quality will be stated as such in a public notice issued pursuant to 10 CSR 20-6.010. Pursuant to that provision, a public hearing will be held in the geographical vicinity of the proposed pollution source, if the department determines there is significant public interest in and need for a hearing.

(C) Tier Three. There shall be no lowered water quality in outstanding national resource waters or outstanding state resource waters, as designated in Tables D and E.

(D) The three (3) levels of protection provided by the antidegradation policy in subsections (A) through (C) of this section shall be implemented according to procedures developed by the department. The antidegradation implementation procedure shall go through stakeholder development and the finalized procedure shall be referenced by this rule before it becomes effective.

(3) General Criteria. The following water quality criteria shall be applicable to all waters of the state at all times including mixing zones. No water contaminant, by itself or in combination with other substances, shall prevent the waters of the state from meeting the following conditions:

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses;

(B) Waters shall be free from oil, scum and floating debris in sufficient amounts to be unsightly or prevent full maintenance of beneficial uses;

(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses;

(D) Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal or aquatic life;

(E) There shall be no significant human health hazard from incidental contact with the water;

(F) There shall be no acute toxicity to livestock or wildlife watering;

(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community;

(H) Waters shall be free from used tires, car bodies, appliances, demolition debris, used vehicles or equipment and solid waste as defined in Missouri's Solid Waste Law, section 260.200, RSMo, except as the use of such materials is specifically permitted pursuant to section 260.200–260.247;

(I) Waters in mixing zones and unclassified waters which support aquatic life on an intermittent basis shall be subject to the following requirements:

1. The acute toxicity criteria of Tables A and B and the requirements of subsection (4)(B); and

2. The following whole effluent toxicity conditions must be satisfied:

A. Single dilution method. The percent effluent at the edge of the zone of initial dilution will be computed and toxicity tests performed at this percent effluent. These tests must show statistically insignificant mortality on the most sensitive of at least two (2) representative, diverse species; and

B. Multiple dilution method. An LC_{50} will be derived from a series of test dilutions. The computed percent effluent at the edge of the zone of initial dilution must be less than three-tenths (0.3) of the LC_{50} for the most sensitive of at least two (2) representative, diverse species.

(4) Specific Criteria. The specific criteria shall apply to classified waters. Protection of drinking water supply is limited to surface waters designated for raw drinking water supply and aquifers. Protection of whole body contact recreation is limited to classified waters designated for that use.

(A) The maximum chronic toxicity criteria in Tables A and B shall apply to waters designated for the indicated uses given in Tables G and H. All Table A and B criteria are chronic toxicity criteria, except those specifically identified as acute criteria. Water contaminants shall not cause or contribute to concentrations in excess of these values. Table A values listed as health advisory levels shall be used in establishing discharge permit limits and management strategies until additional data becomes available to support alternative criteria, or other standards are established. However, exceptions may be granted in the following cases:

1. Permanent flow streams when the stream flow is less than seven (7)-day Q_{10};

2. Regulated flow streams if the flow is less than the minimum release flow agreed upon by the regulating agencies;

3. For the natural and unavoidable chemical and physical changes that occur in the hypolimnion of lakes. Streams below impoundments shall meet applicable specific criteria;

4. For mixing zones.

A. The mixing zone shall be exempted from the chronic criteria requirements of this section for those components of waste that are rendered nontoxic by dilution, dissipation or rapid chemical transformation. Acute numeric criteria of Tables A and B and whole effluent acute toxicity requirements of subsection (3)(I) must be met at all times within the mixing zone, except within the zone of initial dilution. The following criteria do not apply to thermal mixing zones. Criteria for thermal mixing zones are listed in paragraph (4)(D)6.

B. The maximum size of mixing zones and zone of initial dilution will be determined as follows:

(I) Streams with seven (7)-day Q_{10} low flows of less than 0.1 cfs.

(a) Mixing zone—not allowed; and

(b) Zone of initial dilution—not allowed;

(II) Streams with seven (7)-day Q_{10} low flow of one-tenth to twenty (0.1–20) cfs—

(a) Mixing zone—one-quarter (1/4) of the stream width, cross-sectional area or volume of flow; length one-quarter (1/4) mile. If the discharger can document that rapid and complete mixing of the effluent occurs in the receiving stream, the mixing zone may be up to one-half (1/2) of the stream width, cross-sectional area or volume of flow; and

(b) Zone of initial dilution—one-tenth (0.1) of the mixing zone width, cross-sectional area or volume of flow;

(III) Streams with seven (7)-day Q_{10} low flow of greater than twenty (20) cfs—

(a) Mixing zone—one-quarter (1/4) of stream width, cross-sectional area or volume of flow; length of one-quarter (1/4) mile; and

(b) Zone of initial dilution—one-tenth (0.1) of the mixing zone width, cross-sectional area or volume of flow and no more than ten (10) times the effluent design flow volume unless the use of diffusers or specific mixing zone studies can justify more dilution; and

(IV) Lakes.

(a) Mixing zone—not to exceed one-quarter (1/4) of the lake width at the discharge point or one hundred feet (100') from the discharge point, whichever is less.

(b) Zone of initial dilution—not allowed.

C. A mixing zone shall not overlap another mixing zone in a manner that the maintenance of aquatic life in the body of water in the overlapping area would be further adversely affected.

D. Other factors that may prohibit or further limit the size and location of mixing zones are the size of the river, the volume of discharge, the stream bank configuration, the mixing velocities, other hydrologic or physiographic characteristics and the designated uses of the water, including type of aquatic life supported, potential effects on mouths of tributary streams and proximity to water supply intakes.

E. Zones of passage must be provided wherever mixing zones are allowed.

F. Mixing zone and zone of initial dilution size limits will normally be based on streams at the seven (7)-day Q_{10} low flow. However, this percent of stream size limits also applies at higher stream flows and discharge limitations may be based on higher stream flows if discharge volume or quality may be adjusted to correlate with stream flow; and

5. For wetlands. Water quality needs will vary depending on the individual characteristics of wetlands. Application of numeric criteria will depend on the specific aquatic life, wildlife and vegetational requirements.

A. Specific criteria for wetlands shall be developed using scientific procedures including, but not limited to, those procedures described in the U.S. Environmental Protection Agency's *Water Quality Standards Handbook*, Second Edition, August 1994.

B. Specific criteria shall protect all life stages of species associated with wetlands and prevent acute and chronic toxicity in all parts of the wetland.

C. Specific criteria shall include both chronic and acute concentrations to better reflect the different tolerances to the inherent variability between concentrations and toxicological characteristics of a condition.

D. Specific criteria shall be clearly identified as maximum "not to be exceeded" or average values, and if an average, the averaging period and the minimum number of samples. The conditions, if any, when the criteria apply shall be clearly stated (e.g., specific levels of hardness, pH, or water temperature). Specific sampling requirements (e.g., location, frequency), if any, shall also be identified.

E. The data, testing procedures, and application (safety) factors used to develop specific criteria shall reflect the nature of the condition (e.g., persistency, bioaccumulation potential) and the most sensitive species associated with the wetland.

F. Each specific criterion shall be promulgated in rule 10 CSR 20-7.031. The public notice shall include a description of the affected wetland and the reasons for applying the proposed criterion. A public hearing may be held in the geographical vicinity of the affected wetland. Any specific criterion promulgated under these provisions is subject to U.S. EPA approval prior to becoming effective.

(B) Toxic Substances.

1. Water contaminants shall not cause the criteria in Tables A and B to be exceeded. Concentrations of these substances in bottom sediments or waters shall not harm benthic organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded. More stringent criteria may be imposed if there is evidence of additive or synergistic effects.

2. For compliance with this rule, metals shall be analyzed by the following methods:

A. Aquatic life protection and human-health protection—fish consumption.

(I) Mercury—total recoverable metals.

(II) All other metals—dissolved metals;

B. Drinking water supply—total recoverable metals; and

C. All other beneficial uses—total recoverable metals.

3. Other potentially toxic substances for which sufficient toxicity data are not available may not be released to waters of the state until safe levels are demonstrated through adequate bioassay studies.

4. Drinking water criteria, for substances which are rendered nontoxic by transformation processes in the surface water body, shall apply at water supply withdrawal points.

5. Site-specific alternative criteria for human health-fish consumption may be allowed. Designation of this site-specific criteria must follow the established variance request process.

6. Metals criteria for which toxicity is hardness dependent are in equation format in Table A.

7. Total ammonia nitrogen. For any given sample, the total ammonia nitrogen criteria shall be based on the pH and temperature of the water body measured at the time of each sample at the point of compliance.

A. The acute criteria shall not be exceeded at any time except in those waters for which the department has allowed a zone of initial dilution (ZID). The one (1)-day Q_{10} low flow condition will be used in determining acute total ammonia nitrogen criteria.

B. The chronic criteria shall not be exceeded except in water segments for which the department has allowed a mixing zone (MZ). The chronic criteria shall be based on a thirty (30)-day exposure period. Therefore, the thirty (30)-day Q_{10} low flow condition of the receiving water body will be used in determining chronic total ammonia nitrogen criteria.

C. Without sufficient and reliable data, it is assumed that early life stages are present and must be protected at all times of the year.

(I) Sufficient and reliable data shall include, but is not limited to, seasonal studies on the fish species distributions, spawning periods, nursery periods, duration of sensitive life stages, and water body temperature. Best professional judgement from fisheries biologists and other scientists will be considered as appropriate.

(II) The time frames during the year when early life stages are considered to be absent are those time periods when early life stages are present in numbers that, if chronic toxicity did occur, would not affect the long-term success of the populations.

(III) A source of information for determining the duration of early life stages is *The American Society for Testing and Materials (ASTM) Standard E-1241*, "Standard Guide for Conducting Early Life-Stage Toxicity Tests with Fishes."

(IV) Protection of early life stages should include the most sensitive species that have used a water body for spawning and rearing since November 28, 1975.

(C) Bacteria. Protection of whole body contact recreation is limited to classified waters designated for that use. Either of the following bacteria criterion shall apply until December 31, 2008; at which time, only *E. coli* criterion shall apply. The recreational season is from April 1 to October 31.

1. Fecal coliform bacteria—the fecal coliform count shall not exceed the criterion listed in Table A as a geometric mean during the recreational season in waters designated for whole body contact recreation. The fecal coliform count shall not exceed two hundred (200) per one hundred milliliters (100 mL) at any time in losing streams. For waters designated for secondary contact recreation, the fecal coliform count shall not exceed one thousand eight hundred (1,800) per one hundred milliliters (100 mL) as a geometric mean during the recreational season; or

2. *E. coli* bacteria—the *E. coli* count shall not exceed the criterion listed in Table A as a geometric mean during the recreational season in waters designated for whole body contact recreation. The *E. coli* count shall not exceed one hundred twenty-six (126) per one hundred milliliters (100 mL) at any time in losing streams. For waters designated for secondary contact recreation, the *E. coli* count shall not exceed one thousand one hundred thirty-four (1,134) per one hundred milliliters (100 mL) as a geometric mean during the recreational season.

(D) Temperature.

1. For general and limited warm-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of a stream more than five degrees Fahrenheit (5°F) or two and seven-ninths degrees Celsius (2 7/9°C). Water contaminant sources shall not cause or contribute to stream temperature in excess of ninety degrees Fahrenheit (90°F) or thirty-two and two-ninths degrees Celsius (32 2/9°C). However, site-specific ambient temperature data and requirements of sensitive resident aquatic species will be considered, when data are available, to establish alternative maxima or deviations from ambient temperatures.

2. For cool-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of a stream more than five degrees Fahrenheit (5°F) or two and seven-ninths degrees Celsius (2 7/9°C). Water contaminant sources shall not cause or contribute to stream temperature in excess of eighty-four degrees Fahrenheit (84°F) or twenty-eight and eight-ninths degrees Celsius (28 8/9°C).

3. For cold-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of the water body more than two degrees Fahrenheit (2°F) or one and one-ninth degrees Celsius (1 1/9°C). Water contaminant sources shall not cause or contribute to temperatures above sixty-eight degrees Fahrenheit (68°F) or twenty degrees Celsius (20°C).

4. Water contaminant sources shall not cause any measurable rise in the temperature of lakes. An increase is allowable for Lake Springfield, Thomas Hill Reservoir and Montrose Lake; however, discharges from these lakes must comply with temperature limits for streams.

5. For the Mississippi River Zones 1A and 2, the water temperature outside the mixing zone shall not exceed the maximum limits indicated in the following list during more than one percent (1%) of the time in any calendar year. In Zone 1B, limits may not be exceeded more than five percent (5%) of the time in a calendar year. At no time shall the river water temperature outside of the thermal mixing zone exceed the listed limits by more than three degrees Fahrenheit (3°F) or one and six-ninths degrees Celsius (1 6/9°C).

	A and B		C	
	(°F)	(°C)	(°F)	(°C)
January	45	7 2/9	50	10
February	45	7 2/9	50	10
March	57	13 8/9	60	15 5/9
April	68	20	70	21 1/9
May	78	25 5/9	80	26 6/9
June	86	30	87	30 5/9
July	88	31 1/9	89	31 6/9
August	88	31 1/9	89	31 6/9
September	86	30	87	30 5/9
October	75	23 8/9	78	25 5/9
November	65	18 3/9	70	21 1/9
December	52	11 1/9	57	13 8/9

A = Zone 1A—Des Moines River to Lock and Dam No. 25.
B = Zone 1B—Lock and Dam No. 25 to Lock and Dam No. 26.
C = Zone 2—Lock and Dam No. 26 to the Missouri-Arkansas state line.

6. Thermal mixing zones shall be limited to twenty-five percent (25%) of the cross-sectional area or volume of a river, unless biological surveys performed in response to section 316(a) of the federal Clean Water Act (or equivalent) indicate no significant adverse impact on aquatic life. Thermal plume lengths and widths within rivers, and all plume dimensions within lakes, shall be determined on a case-by-case basis and shall be based on physical and biological surveys when appropriate.

(E) pH. Water contaminants shall not cause pH to be outside of the range of 6.5 to 9.0 standard pH units.

(F) Taste- and Odor-Producing Substances. Taste- and odor-producing substances shall be limited to concentrations in the streams or lakes that will not interfere with beneficial uses of the water. For those streams and lakes designated for drinking water supply use, the taste- and odor-producing substances shall be limited to concentrations that will not interfere with the production of potable water by reasonable water treatment processes.

(G) Turbidity and Color. Water contaminants shall not cause or contribute to turbidity or color that will cause substantial visible contrast with the natural appearance of the stream or lake or interfere with beneficial uses.

(H) Solids. Water contaminants shall not cause or contribute to solids in excess of a level that will interfere with beneficial uses. The stream or lake bottom shall be free of materials which will adversely alter the composition of the benthos, interfere with the spawning of fish or development of their eggs or adversely change the physical or chemical nature of the bottom.

(I) Radioactive Materials. All streams and lakes shall conform with state and federal limits for radionuclides established for drinking water supply.

(J) Dissolved Oxygen. Water contaminants shall not cause the dissolved oxygen to be lower than the levels described in Table A or as indicated in paragraph (4)(A)3.

(K) Total Dissolved Gases. Operation of impoundments shall not cause the total dissolved gas concentrations to exceed one hundred ten percent (110%) of the saturation value for gases at the existing atmospheric and hydrostatic pressures.

(L) Sulfate and Chloride Limit for Protection of Aquatic Life.

1. Streams with seven (7)-day Q_{10} low flow of less than one (1) cubic foot per second. The concentration of chloride plus sulfate shall not exceed one thousand milligrams per liter (1000 mg/L). Table A includes additional chloride criteria.

2. Class P1, L1, L2 and L3 waters and streams with seven (7)-day Q_{10} low flow of more than one (1) cubic foot per second. The total chloride plus sulfate concentration shall not exceed the estimated natural background concentration by more than twenty percent (20%) at the sixty (60)-day Q_{10} low flow.

(M) Carcinogenic Substances. Carcinogenic substances shall not exceed concentrations in water which correspond to the 10^{-6} cancer risk rate. This risk rate equates to one (1) additional cancer case in a population of one (1) million with lifetime exposure. Derivation of this concentration assumes average water and fish consumption amounts. Assumptions are two (2) liters of water and 6.5 grams of fish consumed per day. Federally established final maximum contaminant levels for drinking water supply shall supersede drinking water supply criteria developed in this manner.

(N) All methods of sample collection, preservation and analysis used in applying criteria in these standards shall be in accord with those prescribed in the latest edition of *Standard Methods for the Examination of Water and Wastewater* or other procedures approved by the Environmental Protection Agency and the Missouri Department of Natural Resources.

(O) Criteria to protect designated uses are based on current technical literature, especially the Environmental Protection Agency's publication, *Quality Criteria for Water*, 1986. Criteria may be modified or expanded as additional information is developed or as needed to define narrative criteria for particular situations or locations.

(P) WET Chronic Tests. Chronic WET tests performed at the percent effluent at the edge of the mixing zone shall not be toxic to the most sensitive of at least two (2) representative, diverse species. Pollutant attenuation processes such as volatilization and biodegradation which may occur within the allowable mixing zone will be considered in interpreting results.

(Q) Biocriteria. The biological integrity of waters, as measured by lists or numeric diversity indices of benthic invertebrates, fish, algae or other appropriate biological indicators, shall not be significantly different from reference waters. Waters shall be compared to reference waters of similar size within an ecoregion. Reference water locations are listed in Table I.

(R) Site-Specific Criteria Development for the Protection of Aquatic Life. When water quality criteria in this regulation are either underprotective or overprotective of water quality due to natural, non-anthropogenic conditions for a given water body segment, a petitioner may request site-specific criteria. The petitioner must provide the department with sufficient documentation to show that the current criteria are not adequate and that the proposed site-specific criteria will protect all existing and/or potential uses of the water body.

1. Site-specific criteria may be appropriate where, but is not limited to the examples given in subparagraphs A. or B. of this paragraph:

A. The resident aquatic species of the selected water body have a different degree of sensitivity to a specific pollutant as compared to those species in the data set used to calculate the national or state criteria as described in either of the following parts:

(I) Natural adaptive processes have enabled a viable, balanced aquatic community to exist in waters where natural (non-anthropogenic) background conditions exceed the criterion (e.g., resident species have evolved a genetically based greater tolerance to high concentrations of a chemical); or

(II) The composition of aquatic species in a water body is different from those used in deriving a criterion (e.g., most of the species considered among the most sensitive, such as salmonids or the cladoceran, *Ceriodaphinia dubia*, which were used in developing a criterion, are absent from a water body).

B. The physical and/or chemical characteristics of the water body alter the biological availability and/or toxicity of the pollutant (e.g., pH, alkalinity, salinity, water temperature, hardness).

2. All petitioners seeking to develop site-specific criteria shall coordinate with the department early in the process. This coordination will insure the use of adequate, relevant, and quality data; proper analysis and testing; and defendable procedures. The department will provide guidance for establishing site-specific water quality criteria using scientific procedures including, but not limited to, those procedures described in the U. S. Environmental Protection Agency's *Water Quality Standards Handbook,* Second Edition, August 1994.

3. Site-specific criteria shall protect all life stages of resident species and prevent acute and chronic toxicity in all parts of a water body.

4. Site-specific criteria shall include both chronic and acute concentrations to better reflect the different tolerances of resident species to the inherent variability between concentrations and toxicological characteristics of a chemical.

5. Site-specific criteria shall be clearly identified as maximum "not to be exceeded" or average values, and if an average, the averaging period and the minimum number of samples. The conditions, if any, when the criteria apply shall be clearly stated (e.g., specific levels of hardness, pH, or water temperature). Specific sampling requirements (e.g., location, frequency), if any, shall also be identified.

6. The data, testing procedures, and application (safety) factors used to develop site-specific criteria shall reflect the nature of the chemical (e.g., persistency, bioaccumulation potential, and avoidance or attraction responses in fish) and the most sensitive resident species of a water body.

7. The size of a site may be limited to a single water segment, single water subsegment, or may cover a whole watershed depending on the particular situation for which the specific criterion is developed. A group of water bodies may be considered one site if their respective aquatic communities are similar in composition and have comparable water quality.

8. The department shall determine if a site-specific criterion is adequate and justifiable. Each site-specific criterion shall be promulgated into rule 10 CSR 20-7.031. The public notice shall include a description of the affected water body or water body segment and the reasons for applying the proposed criterion. If the department determines that there is significant public interest, a public hearing may be held in the geographical vicinity of the affected water body or water body segment. Any site-specific criterion promulgated under these provisions is subject to U.S. EPA approval prior to becoming effective.

(5) Groundwater.

(A) Water contaminants shall not cause or contribute to exceedence of Table A, groundwater limits in aquifers and caves. Table A values listed as health advisory levels shall be used in establishing management strategies and ground water cleanup criteria, until additional data becomes available to support alternative criteria or other standards are established. Substances not listed in Table A shall be limited so that drinking water, livestock watering and irrigation uses are protected.

(B) When criteria in for the protection of aquatic life or human health protection-fish comsumption in Table A are more stringent than groundwater criteria, appropriate criteria for the protection of aquatic life or human health protection-fish consumption shall apply to waters in caves and to aquifers which contribute an important part of base flow of surface waters designated for aquatic life protection. Other substances not listed in Table A shall be limited in these aquifers and caves so that the aquatic life use is protected.

(C) Groundwater and other criteria shall apply in any part of the aquifer, including the point at which the pollutant enters the aquifer. A specific monitoring depth requirement for releases to aquifers is included in 10 CSR 20-7.015(7)(A).

(D) For aquifers in which contaminant concentrations exceed groundwater criteria or other protection criteria, and existing and potential uses are not impaired, alternative site-specific criteria may be allowed. To allow alternative criteria, the management authority must demonstrate that alternative criteria will not impair existing and potential uses. The demonstration must consider the factors and be subject to the review requirements of 10 CSR 20-7.015(7)(F).

(6) Metropolitan No-Discharge Streams. No water contaminant except uncontaminated cooling water, permitted stormwater discharges in compliance with permit conditions and excess wet-weather bypass discharges not interfering with beneficial uses, shall be discharged to the watersheds of streams listed in Table F. Existing interim discharges may be allowed until interceptors are available within two thousand feet (2,000') or a distance deemed feasible by the department, or unless construction of outfalls to alternative receiving waters not listed in Table F is deemed feasible by the department. Existing discharges include wastewater volumes up to the design capacity of existing permitted treatment facilities, including phased increases in design capacity approved by the department prior to the effective date of this rule. Additional facilities may be constructed to discharge to these waters only if they are intended to be interim facilities in accordance with a regional wastewater treatment plan approved by the department.

(7) Outstanding National Resource Waters. Under section (2), antidegradation section of this rule, new releases to outstanding national resource waters from any source are prohibited and releases from allowed facilities are subject to special effluent limitations as required in 10 CSR 20-7.015(6). Table D contains a list of the outstanding national resource waters in Missouri.

(8) Outstanding State Resources Waters. The commission wishes to recognize certain high-quality waters that may require exceptionally stringent water-quality management requirements to assure conformance with the antidegradation policy. The degree of management requirements will be decided on an individual basis. To qualify for inclusion, all of the following criteria must be met. The waters listed in Table E must—

(A) Have a high level of aesthetic or scientific value;

(B) Have an undeveloped watershed; and

(C) Be located on or pass through lands which are state or federally owned, or which are leased or held in perpetual easement for conservation purposes by a state, federal, or private conservation agency or organization.

(9) Lake Taneycomo. The commission wishes to recognize the uniqueness of Lake Taneycomo with respect to its high water clarity, its importance as a trout fishery and as the central natural resource in the rapidly developing Branson area and threats to the lake's water quality imposed by development. An especially stringent antidegradation policy will be observed in the development of effluent rules, discharge permits and nonpoint-source management plans and permits to assure that the high visual quality and aquatic resources are maintained. The use of the best treatment technology for point- and non-point-source discharges in the lake's watershed between Table Rock Lake and Power Site Dam will be the guiding principle in establishing limitations.

(10) Compliance with Water Quality Based Limitations. Compliance with new or revised National Pollutant Discharge Elimination System (NPDES) or Missouri operating permit limitations based on criteria in this rule shall be achieved with all deliberate speed and no later than three (3) years from the date of issuance of the permit except where provided for otherwise in 10 CSR 20-7.015(9)(H).

(11) Losing Streams.

(A) Losing stream determinations will usually be made upon the first application for discharge to a specific water or location within a watershed for a wastewater treatment facility, subdivision development or animal waste management facility.

(B) Permits or other approvals for those applications will be processed in accordance with the determinations. Additional permits or approvals will be processed in accordance with the latest determination.

(C) For application purposes, any proposed facility within five (5) miles of a known losing stream segment should presume that facility's receiving stream segment is also losing until and unless a specific geologic evaluation is made of that stream and concludes the stream segment is gaining.

(D) Existing facilities operating under a state operating permit and new facilities being constructed under a construction permit in proximity to stream segments subsequently determined to be losing will be allowed to continue in operation at permitted or approved effluent limits for a period of time lasting the design life of the facility (usually twenty (20) years from the original construction completion), provided the facility is in compliance with its effluent limits and remains in compliance with those limits, and if neither of the following conditions is present:

1. If the discharge from such a facility can be eliminated by connection to a locally available facility, the facility shall be connected within three (3) years of the losing stream determination. A local facility shall be considered available if that facility or an interceptor is within two thousand feet (2000') or a distance deemed feasible by the department; and

2. If the discharge from such a facility is shown to cause pollution of groundwater, the facility shall be upgraded to appropriate effluent standards within three (3) years. The department shall include appropriate groundwater monitoring requirements in permits for any such facilities so that pollution, should it occur, would be detected.

(E) Any additional permits or approvals for increased treatment plant design capacity will be processed in accordance with the newest losing stream determination. No additional permits or approvals for any facilities shall be construed as lengthening the time for compliance with losing stream effluent limitations as established in subsection (11)(D).

(12) Severance. If a section, subsection, paragraph, sentence, clause, phrase or any part of this rule be declared unconstitutional or invalid for any reason, the remainder of this rule shall not be affected and shall remain in full force and effect.

(13) Effective Date. This rule becomes effective immediately upon adoption and compliance with the requirements of subsection 644.036.3, of the Missouri Clean Water Law and Chapter 536, RSMo.

Table A—Criteria for Designated Uses

WBC	=	Whole Body Contact Recreation
SCR	=	Secondary Contact Recreation
AQL	=	Protection of Aquatic Life
DWS	=	Drinking Water Supply
LWW	=	Livestock and Wildlife Watering
GRW	=	Groundwater

Pollutant (µg/L)	**AQL**
Chlorine (total residual)	
cold-water	2
warm-water chronic—	10
acute—	19
Cyanide (amenable to chlorination)	
chronic—	5
acute—	22
Hydrogen sulfide (un-ionized)	2

Pollutant (mg/L)	**AQL**	**DWS**	**LWW**	**GRW**
Chloride chronic—	230(+)	250		
acute—	860(+)			
Sulfate	(+)	250		
Fluoride		4	4	4
Nitrate-N		10		10
Dissolved oxygen (minimum)				
warm-water and cool-water fisheries	5			
cold-water fisheries	6			
Oil and grease	10			

+See 10 CSR 20-7.031(4)(L).

Pollutant (/100 mL)	**WBC-A**	**WBC-B**	**SCR**
Fecal Coliform Bacteria*	200		1800
E. coli Bacteria*	126	548	1134

*Geometric mean during the recreational season in waters designated for recreation or at any time in losing streams. The recreational season is from April 1 to October 31.

Pollutant	**AQL**	
Temperature (maximum)	°F	°C
warm-water	90	32 2/9
cool-water	84	28 8/9
cold-water	68	20
Temperature (maximum change)		
warm-water	5	2 7/9
cool-water	5	2 7/9
cold-water	2	16/9

Pollutant (percent saturation)	**AQL**
Total Dissolved Gases	110%

AQL = Protection of Aquatic Life
HHF = Human Health Protection-Fish Consumption
DWS = Drinking Water Supply
IRR = Irrigation
LWW = Livestock Wildlife Watering
GRW = Groundwater

Pollutant (μg/L)	**AQL**	**HHF**	**DWS**	**IRR**	**LWW**	**GRW**
Metals						
(Nonhardness Dependant)						
Aluminum (acute)	750					
Antimony		4,300	6			6
Arsenic	20		50	100		50
Barium			2,000			2,000
Beryllium	5		4	100		4
Boron				2,000		2,000
Cadmium	*		5			5
Chromium III	*		100	100		100
Chronmium VI						
chronic	10					
acute	15					
Cobalt					1000	1,000
Copper	*		1,300		500	1,300
Iron	1,000					300
Lead	*		15			15
Manganese						50
Mercury			2			2
chronic	0.5					
acute	2.4					
Nickel	*		100			100
Selenium	5		50			50
Silver	*		50			50
Thallium		6.3	2			2
Zinc	*		5,000			5,000

*See Metals (Hardness Dependent)

AQL = Protection of Aquatic Life

Pollutant (μg/L)		AQL
Metals (Hardness Dependent)		
Cadmium (μg/L)	Acute:	$e^{(1.0166*\ln(Hardness) - 3.062490)} * (1.136672 - (\ln(Hardness)*0.041838))$
	Chronic:	$e^{(0.7409*\ln(Hardness) - 4.719948)} * (1.101672 - (\ln(Hardness)*0.041838))$
Chromium III (μg/L)	Acute:	$e^{(0.8190*\ln(Hardness) + 3.725666)} * 0.316$
	Chronic:	$e^{(0.8190*\ln(Hardness) + 0.684960)} * 0.860$
Copper (μg/L)	Acute:	$e^{(0.9422*\ln(Hardness) - 1.700300)} * 0.960$
	Chronic:	$e^{(0.8845*\ln(Hardness) - 2.044953)} * 0.960$
Lead (μg/L)	Acute:	$e^{(1.273*\ln(Hardness) - 1.460448)} * (1.46203 - (\ln(Hardness)*0.145712))$
	Chronic:	$e^{(1.273*\ln(Hardness) - 4.704797)} * (1.46203 - (\ln(Hardness)*0.145712))$
Nickel (μg/L)	Acute:	$e^{(0.8460*\ln(Hardness) + 2.255647)} * 0.998$
	Chronic:	$e^{(0.8460*\ln(Hardness) + 0.058978)} * 0.997$
Silver (μg/L)	Acute:	$e^{(1.72*\ln(Hardness) - 6.588144)} * 0.850$
Zinc (μg/L)	Acute:	$e^{(0.8473*\ln(Hardness) + 0.884211)} * 0.978$
	Chronic:	$e^{(0.8473*\ln(Hardness) + 0.785271)} * 0.986$

	Hardness								
	50–74	75–99	100–124	125–149	150–174	175–199	200–224	225–249	250+
Cadmium									
Acute:	2.4	3.6	4.8	5.9	7.1	8.2	9.4	10.5	11.6
Chronic:	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
Chromium III									
Acute:	323	450	570	684	794	901	1,005	1,107	1,207
Chronic:	42	59	74	89	103	117	131	144	157
Copper									
Acute:	7	10	13	17	20	23	26	29	32
Chronic:	4	6	7	9	10	12	13	15	16
Lead									
Acute:	30	47	65	82	100	118	136	154	172
Chronic:	1	2	3	3	4	5	5	6	7
Nickel									
Acute:	261	367	469	566	660	752	842	930	1017
Chronic:	29	41	52	63	73	84	94	103	113
Silver									
Acute:	1.0	2.0	3.2	4.7	6.5	8.4	10.6	13.0	15.6
Zinc									
Acute:	65	92	117	142	165	188	211	233	255
Chronic:	59	84	107	129	151	172	193	213	233

AQL = Protection of Aquatic Life
HHF = Human Health Protection-Fish Consumption
DWS = Drinking Water Supply
GRW = Groundwater

Pollutant (μg/L)	AQL	HHF	DWS	GRW
Organics				
Acrolein		780	320	320
Bis-2-chloroisopropyl ether		4,360	1,400	1400
2, chlorophenol		400	.1	.1
2,4-dichlorophenol	7	790	93	93
2,4-dinitrophenol		14,000	70	70
2,4-dimethylphenol		2,300	540	540
2,4,5-trichlorophenol		9,800	2,600	2,600
2,4,6-trichlorophenol		6.5	2	2
2-methyl-4,6-dinitrophenol		765	13	13
Ethylbenzene	320		700	700
Hexachlorocyclopentadiene	.5		50	50
Isophorone		2,600	36	36
Nitrobenzene		1,900	17	17
Phenol	100		100	300
Dichloropropene		1,700	87	87
Para(1,4)-dichlorobenzene		2,600	75	75
Other Dichlorobenzenes		2,600	600	600
1,2,4-trichlorobenzene		940	70	70
1,2,4,5-tetrachlorobenzene		2.9	2.3	2.3
pentachlorobenzene		4.1	3.5	3.5
1,1,1-trichloroethane			200	200
1,1,2-trichloroethane		42	5	5
2,4-dinitrotoluene		9	.11	.04
1,2-diphenylhydrazine		.54	.04	.04
di (2-ethylhexyl) adipate			400	400
n-nitrosodiphenylamine		16	5	5
n-nitrosopyrrolidene		91.9		
2-chloronaphthalene	4,300			
n-nitrosodi-n-propylamine		1.4		

Pollutant (μg/L)	AQL	DWS	GRW
Pesticides			
Demeton	.1		
Endosulfan			
chronic—	.056		
acute—	0.11		
Guthion	.01		
Malathion	.1		
Parathion	.04		
2,4-D		70	70
2,4,5-TP		50	50
Chlorpyrifos	.04		
Alachlor		2	2
Atrazine		3	3
Carbofuran		40	40
Dalapon		200	200
Dibromochloropropane		.2	.2
Dinoseb		7	7
Diquat		20	20
Endothall		100	100
Ethylene dibromide		.05	.05
Oxamyl (vydate)		200	200
Picloram		500	500
Simazine		4	4
Glyphosate		700	700

AQL = Protection of Aquatic Life
HHF = Human Health Protection-Fish Consumption
DWS = Drinking Water Supply
GRW = Groundwater

Pollutant (μg/L)	AQL	HHF	DWS	GRW
Bioaccumulative, Anthropogenic Toxics (+)				
PCBs		.000045		.000045
4-4' dichlorodiphenyldichloroethane (DDT)		0.00059	0.00059	0.00059
4-4' dichlorodiphenyldichloroethylene (DDE)		0.00059	0.00059	0.00059
4-4' dichlorodiphenyldichloroethane (DDD)		0.00084	0.00083	0.00083
Endrin		.0023	2	2
Endrin aldehyde		.0023	.75	.75
Aldrin		.000079	.00013	.00013
Dieldrin		.000076	.00014	.00014
Heptachlor	.0038	.0002	0.4	0.4
Heptachlor epoxide		.00011	0.2	0.2
Methoxychlor	.03		40	40
Mirex	.001			
Toxaphene		.000073	3	3
Lindane (gamma-BHC)		.062	.2	.2
Alpha,beta,delta-BHC		.0074	.0022	.0022
Chlordane		.00048	2	2
Benzidine		.00053	.00012	.00012
2,3,7,8-tetrachlorodibenzo-p-dioxin (ng/L)* (TCDD or dioxin)		.000014	0.000013	0.000013
Pentachlorophenol**	3.2–pH 6.5 5.3–pH 7.0 8.7–pH 7.5 14.0–pH 8.0 23.0–pH 8.5	8	1	1

+Many of these values are below current detection limits; analyses will be determined by the 17th edition of *Standard Methods* or the most current methods approved by the Environmental Protection Agency.

*Units for dioxin are nanograms/liter (ng/L); 1 μg/L = 1000 ng/L.

**Toxic impurities may be present in technical-grade pentachlorophenol; monitoring and discharge control will assure that impurities are below toxic concentrations.

HHF = Human Health Protection-Fish Consumption
DWS = Drinking Water Supply
GRW = Groundwater

Pollutant (μg/L)	HHF	DWS	GRW
Anthropogenic Carcinogens(+)			
Acrylonitrile	.65	.058	.058
Hexachlorobenzene	.00074	1	1
Bis (2-chloroethyl) ether	1.4	.03	.03
Bis (chloromethyl) ether	0.00078	.00013	.00013
Hexachloroethane	8.7	1.9	1.9
3,3'-dichlorobenzidine	0.08	.04	.04
Hexachlorobutadiene	50	.45	.45
n-nitrosodimethylamine	8	.0007	.0007

(+) Some of these values are below current detection limits; analyses will be determined by the 17th edition of *Standard Methods* or the most current methods approved by the Environmental Protection Agency.

Pollutant (μg/L)	HHF	DWS	GRW
Volatile Organics			
Chlorobenzene	21,000	100	100
Carbon Tetrachloride	5	5	5
Trihalomethanes		80	80
Bromoform	360	4.3	4.3
Chlorodibromomethane	34	0.41	0.41
Dichlorobromoethane	46	0.56	0.56
Chloroform	470	5.7	5.7
Methyl Bromide	4,000	48	48
Methyl Chloride	470	5	5
Methylene Chloride	1,600	4.7	4.7
Dichlorodifluoromethane	570,000		
Trichlorofluoromethane	860,000		
1,2-dichloroethane	99	5	5
1,1,2,2-tetrachloroethane	11	.17	.17
1,1-dichloroethylene	3.2	7	7
1,2-trans-dichloroethylene	140,000	100	100
1,2-cis-dichloroethylene		70	70
Trichloroethylene	80	5	5
Tetrachloroethylene	8.85	0.8	0.8
Benzene	71	5	5
Toluene	200,000	1,000	1,000
Xylenes (total)		10,000	10,000
Vinyl chloride	525	2	2
Styrene		100	100
1,2-dichloropropane	39	0.52	0.52

Pollutant (Fibers/L)	DWS	GRW
Asbestos	7,000,000	

HHF = Human Health Protection-Fish Consumption
DWS = Drinking Water Supply
GRW = Groundwater

Pollutant (μg/L)	HHF	DWS	GRW
Polynuclear Aromatic Hydrocarbons			
Anthracene	110,000	9,600	9,600
Fluoranthene	370	300	300
Fluorene	14,000	1,300	1,300
Pyrene	11,000	960	960
Benzo(a)pyrene	.049	0.2	0.2
other polynuclear aromatic hydrocarbons*	.049	.0044	.0044
Acenaphthene	2,700	1,200	1,200

*This concentration is allowed for each of the following PAHs: benzo(a)anthracene, 3,4-benzofluoranthene, chrysene, dibenzo-(a,h)anthracene, indeno(1,2,3-cd)pyrene and benezo(k)fluoranthene. Higher values may be allowed if natural background concentrations exceed these values.

Pollutant (μg/L)	HHF	DWS	GRW
Phthalate Esters			
Bis(2-ethylhexyl) phthalate	5.9	6	6
Butylbenzyl phthalate	5,200	3,000	3,000
Diethyl phthalate	120,000	23,000	23,000
Dimethyl phthalate	2,900,000	313,000	313,000
Di-n-butyl phthalate	12,000	2,700	2,700

Health Advisory Levels

Pollutant (μg/L)	DWS	GRW
Ametryn	60	60
Baygon	3	3
Bentazon	20	20
Bis-2-chloroisopropyl ether	300	300
Bromacil	90	90
Bromochloromethane	90	90
Bromomethane	10	10
Butylate	350	350
Carbaryl	700	700
Carboxin	700	700
Chloramben	100	100
o-chlorotoluene	100	100
p-chlorotoluene	100	100
Chlorpyrifos	20	20
DCPA (dacthal)	4,000	4,000
Diazinon	0.6	0.6
Dicamba	200	200
Diisopropyl methylphosphonate	600	600
Dimethyl methylphosphonate	100	100
1,3-dinitrobenzene	1	1
Diphenamid	200	200
Diphenylamine	200	200
Disulfoton	0.3	0.3
1,4-dithiane	80	80
Diuron	10	10

DWS = Drinking Water Supply
GRW = Groundwater

Health Advisory Levels (continued)

Pollutant (μg/L)	**DWS**	**GRW**
Fenamiphos	2	2
Fluometron	90	90
Fluorotrichloromethane	2,000	2000
Fonofos	10	10
Hexazinone	200	200
Malathion	200	200
Maleic hydrazide	4,000	4000
MCPA	10	10
Methyl parathion	2	2
Metolachlor	70	70
Metribuzin	100	100
Naphthalene	20	20
Nitroguanidine	700	700
p-nitrophenol	60	60
Paraquat	30	30
Pronamide	50	50
Propachlor	90	90
Propazine	10	10
Propham	100	100
2,4,5-T	70	70
Tebuthiuron	500	500
Terbacil	90	90
Terbufos	0.9	0.9
1,1,1,2-Tetrachloroethane	70	70
1,2,3-trichloropropane	40	40
Trifluralin	5	5
Trinitroglycerol	5	5
Trinitrotoluene	2	2

Table B1. Acute Criteria for Total Ammonia Nitrogen (mg N/L)

pH	Cold-Water Fisheries (1)	Cool & Warm-Water Fisheries (2)
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.6	14.4
7.8	8.1	12.1
7.9	6.7	10.1
8.0	5.6	8.4
8.1	4.6	6.9
8.2	3.8	5.7
8.3	3.1	4.7
8.4	2.5	3.8
8.5	2.1	3.2
8.6	1.7	2.6
8.7	1.4	2.2
8.8	1.2	1.8
8.9	1.0	1.5
9.0	0.8	1.3

Table B2. Chronic Criteria for Total Ammonia Nitrogen (mg N/L): Early Life Stage absent(3)(4)

	Temperature (°C)															
pH	0-7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30
6.5	10.8	10.1	9.5	8.9	8.3	7.8	7.3	6.8	6.4	6.0	5.3	4.6	4.1	3.6	3.1	2.8	2.4
6.6	10.7	9.9	9.3	8.7	8.2	7.7	7.2	6.7	6.3	5.9	5.2	4.6	4.0	3.5	3.1	2.7	2.4
6.7	10.5	9.8	9.2	8.6	8.0	7.5	7.1	6.6	6.2	5.8	5.1	4.5	3.9	3.5	3.0	2.7	2.3
6.8	10.2	9.5	8.9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.0	4.4	3.8	3.4	3.0	2.6	2.3
6.9	9.9	9.3	8.7	8.1	7.6	7.2	6.7	6.3	5.9	5.5	4.8	4.3	3.7	3.3	2.9	2.5	2.2
7.0	9.6	9.0	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	4.7	4.1	3.6	3.2	2.8	2.4	2.1
7.1	9.2	8.6	8.0	7.5	7.1	6.6	6.2	5.8	5.4	5.1	4.5	3.9	3.5	3.0	2.7	2.3	2.0
7.2	8.7	8.2	7.6	7.2	6.7	6.3	5.9	5.5	5.2	4.9	4.3	3.7	3.3	2.9	2.5	2.2	1.9
7.3	8.2	7.7	7.2	6.7	6.3	5.9	5.6	5.2	4.9	4.6	4.0	3.5	3.1	2.7	2.4	2.1	1.8
7.4	7.6	7.2	6.7	6.3	5.9	5.5	5.2	4.8	4.5	4.3	3.7	3.3	2.9	2.5	2.2	1.9	1.7
7.5	7.0	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2	3.9	3.4	3.0	2.6	2.3	2.0	1.8	1.6
7.6	6.4	6.0	5.6	5.3	5.0	4.6	4.3	4.1	3.8	3.6	3.1	2.7	2.4	2.1	1.9	1.6	1.4
7.7	5.8	5.4	5.1	4.7	4.0	4.2	3.9	3.7	3.4	3.2	2.8	2.5	2.2	1.9	1.7	1.5	1.3
7.8	5.1	4.8	4.5	4.2	4.4	3.7	3.5	3.2	3.0	2.8	2.5	2.2	1.9	1.7	1.5	1.3	1.1
7.9	4.5	4.2	3.9	3.7	3.5	3.2	3.1	2.8	2.7	2.5	2.2	1.9	1.7	1.5	1.3	1.1	1.0
8.0	3.9	3.7	3.4	3.2	3.0	2.8	2.6	2.5	2.3	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.8
8.1	3.4	3.1	2.9	2.8	2.6	2.4	2.3	2.1	2.0	1.9	1.6	1.4	1.2	1.1	1.0	0.8	0.7
8.2	2.9	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.7	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6
8.3	2.4	2.3	2.1	2.0	1.9	1.7	1.6	1.5	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5
8.4	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.7	0.7	0.6	0.5	0.4
8.5	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4
8.6	1.4	1.4	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3
8.7	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2
8.8	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2
8.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
9.0	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1

Table B3. Chronic Criteria for Total Ammonia Nitrogen (mg N/L): Early Life Stages present (5)

	Temperature (°C)									
pH	0	14	16	18	20	22	24	26	28	30
6.5	6.6	6.6	6.0	5.3	4.6	4.1	3.6	3.1	2.8	2.4
6.6	6.5	6.5	5.9	5.2	4.6	4.0	3.5	3.1	2.7	2.4
6.7	6.4	6.4	5.8	5.1	4.5	3.9	3.5	3.0	2.7	2.3
6.8	6.2	6.2	5.7	5.0	4.4	3.8	3.4	3.0	2.6	2.3
6.9	6.1	6.1	5.5	4.8	4.3	3.7	3.3	2.9	2.5	2.2
7.0	5.9	5.9	5.3	4.7	4.1	3.6	3.2	2.8	2.4	2.1
7.1	5.6	5.6	5.1	4.5	3.9	3.5	3.0	2.7	2.3	2.0
7.2	5.3	5.3	4.9	4.3	3.7	3.3	2.9	2.5	2.2	1.9
7.3	5.0	5.0	4.6	4.0	3.5	3.1	2.7	2.4	2.1	1.8
7.4	4.7	4.7	4.3	3.7	3.3	2.9	2.5	2.2	1.9	1.7
7.5	4.3	4.3	3.9	3.4	3.0	2.6	2.3	2.0	1.8	1.6
7.6	3.9	3.9	3.6	3.1	2.7	2.4	2.1	1.9	1.6	1.4
7.7	3.5	3.5	3.2	2.8	2.5	2.2	1.9	1.7	1.5	1.3
7.8	3.1	3.1	2.8	2.5	2.2	1.9	1.7	1.5	1.3	1.1
7.9	2.8	2.8	2.5	2.2	1.9	1.7	1.5	1.3	1.1	1.0
8.0	2.4	2.4	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.8
8.1	2.1	2.1	1.9	1.6	1.4	1.2	1.1	1.0	0.8	0.7
8.2	1.7	1.7	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6
8.3	1.5	1.5	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5
8.4	1.2	1.2	1.1	1.0	0.9	0.7	0.7	0.6	0.5	0.4
8.5	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4
8.6	0.9	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3
8.7	0.7	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2
8.8	0.6	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2
8.9	0.5	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
9.0	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1

(1) *Salmonids present:* CMC = $[0.275 / (1+10^{7.204 ! pH})] + [39.0 / (1+10^{pH-7.204})]$

(2) *Salmonids absent:* CMC = $[0.411 / (1+10^{7.204 ! pH})] + [58.4 / (1+10^{pH-7.204})]$

(3) Without sufficient and reliable data, it is assumed that Early Life Stages are present and must be protected at all times of the year.

(4) Early Life Stages absent

CCC = $[0.0577 / (1+10^{7.688-pH})]+[2.487 / (1+10^{pH ! 7.688})] * 1.45 * 10^{0.028 * (25-MAX(T, 7))}$

(5) Early Life Stages present

CCC = $[0.0577 / (1+10^{7.688-pH})]+[2.487 / (1+10^{pH ! 7.688})] * MIN(2.85, 1.45 * 10^{0.028 * (25 ! T)})$

Table C
Waters Designated for Cold-Water Fishery

Water Body	Miles/Acres	From	To	County(ies)
Barren Fork	2	Mouth	20,31N,4W	Shannon
Bee Creek	1	Mouth	Hwy. 65	Taney
Bender Creek	0.7	Mouth	10,31N,9W	Texas
Bennett Springs Creek	2	Mouth	Bennett Springs	Laclede
Blue Springs Creek	4	Mouth	2,39N,3W	Crawford
Bryant Creek	1	3,23N,12W	34,24N,12W	Ozark
Bryant Creek	6	19,27N,14W	8,27N,15W	Douglas
Buffalo Creek	10	State line	5,23N,33W	McDonald
Bull Creek	5	Mouth	34,24N,21W	Taney
Bull Shoals Lake	9,000 ac.	21/34,20N,15W	— — —	Ozark
Capps Creek	4	Mouth	17,25N,28W	Newton-Barry
Cedar Creek	1	21,26N,32W	28,26N,32W	Newton
Center Creek	3	24,27N,29W	17,27N,28W	Lawrence
Chesapeake Creek	3	Mouth	29,28N,25W	Lawrence
Crane Creek	15	8,25N,23W	24,26N,25W	Stone-Lawrence
Current River	19	24,31N,6W	Montauk Spring	Shannon-Dent
Dogwood Creek	2.3	Mouth	State line	Stone
Dry Creek	4	Mouth	14,37N,3W	Crawford
Eleven Point River	33.5	State line	36,25N,4W	Oregon
Flat Creek	3	9,23N,27W	21,23N,27W	Barry
Goose Creek	4	Mouth	10,28N,25W	Lawrence
Greer Spring Branch	1	Mouth	36,25N,4W	Oregon
Hickory Creek	4.5	13,25N,31W	28,25N,31W	Newton
Hobbs Hollow	2.7	Mouth	State line	Stone
Horse Creek	2.2	Mouth	23,35N,8W	Dent
Hunter Creek	5	22,26N,15W	20,26N,14W	Douglas
Hurricane Creek	1.5	Mouth	30,24N,12W	Ozark
Hurricane Creek	3.2	Mouth	22,25N,3W	Oregon
Indian Creek	1.4	Mouth	17,21N,23W	Stone
Indian Creek	20	Mouth	36,39N,01W	Franklin-Washington
Johnson Creek	3	Mouth	36,29N,26W	Lawrence
Joyce Creek	1	17,24N,28W	16,24N,28W	Barry
L. Flat Creek	3.5	Mouth	25,25N,27W	Barry
L. Piney Creek	15	25,37N,9W	4,35N,8W	Phelps
L. Piney Creek	4	04,35N,08W	21,35N,08W	Phelps
L. Sinking Creek	2.2	Mouth	33,32N,4W	Dent
Lyman Creek	1	Mouth	30,40N,3W	Crawford
Maramec Spring Branch	1	Mouth	1,37N,6W	Phelps
Meramec River	10	22,38N,5W	Hwy. 8	Crawford
Mill Creek	1.5	Mouth	9,36N,18W	Dallas
Mill Creek	5	29,37N,9W	Yelton Spring	Phelps
Mill Creek	1.5	Mouth	11,40N,8W	Maries
N. Fork White River	23	09,22N,12W	34,25N,11W	Ozark
Niangua River	6	11,35N,18W	Bennett Sp. Creek	Dallas
Roaring River	7	Mouth	34,22N,27W	Barry
Roark Creek	3	Mouth	36,23N,22W	Taney
Roubidoux Creek	4	Mouth	25,36N,12W	Pulaski
S. Indian Creek	9	24,24N,31W	1,23N,30W	Newton-McDonald
Schafer Spring Creek	2	Mouth	20,32N,6W	Dent
Shoal Creek	1	Mouth	18,41N,17W	Morgan
Shoal Creek	7	09,25N,29W	16,22N,21W	Newton
Spring Branch	1	Mouth	18,41N,17W	Morgan
Spring Creek	6.5	Mouth	31,35N,9W	Phelps
Spring Creek	2.5	Mouth	4,41N,2W	Franklin
Spring Creek	5.5	Mouth	12,26N,24W	Stone
Spring Creek	6	Mouth	06,24N,13W	Douglas-Ozark
Spring Creek	2.5	Mouth	26,25N,11W	Douglas
Spring Creek	5	Mouth	14,23N,11W	Ozark
Spring Creek	4	Mouth	30,25N,4W	Oregon
Spring River	11.2	13,27N,27W	20,26N,26W	Lawrence
Stone Mill Spring Branch	0.2	Mouth	Spring	Pulaski
Taneycomo Lake	1,730 ac.	8,23N,20W	— — —	Taney
Terrell Creek	2	Mouth	2,27N,23W	Christian
Tory Creek	2.5	Mouth	27,26N,22W	Stone-Christian
Turkey Creek	2	Mouth	16,22N,21W	Taney
Turkey Creek	1	Mouth	17,23N,15W	Ozark
Turnback Creek	14	35,30N,26W	24,28N,25W	Dade-Lawrence
Warm Fork Spring River	3	6,22N,5W	30,23N,5W	Oregon
Whittenburg Creek	2.5	Mouth	Hwy. 8	Crawford
Williams Creek	1	Mouth	28,28N,27W	Lawrence
Woods Fork Bull Creek	1	15,25N,21W	15,25N,21W	Christian
Yadkin Creek	3	Mouth	9,37N,4W	Crawford
Yankee Branch	1	Mouth	10,36N,4W	Crawford

Table D
Outstanding National Resource Waters

Water Body	Location	County(ies)
Current River	Headwaters to Northern Ripley Co. Line Sec. 22,32N,07W to Sec. 15,25N,01E	Dent to Ripley
Jacks Fork River	Headwaters to Mouth Sec. 29,28N,07W to Sec. 9/15,29N,03W	Texas to Shannon
Eleven Point River	Headwaters to Hwy. 142 Sec. 32,25N,05W to Sec. 21,22N,02W	Oregon

Table E
Outstanding State Resource Waters

Water Body	Miles/Acres		Location	County(ies)
Baker Branch	4	mi.	Taberville Prairie	St. Clair
Bass Creek	1	mi.	in Three Creek Conservation Area	Boone
Big Buffalo Creek	1.5	mi.	Big Buffalo Creek Conservation Area	Benton-Morgan
Big Creek	5.3	mi.	Sam A. Baker State Park	Wayne
Big Sugar Creek	7	mi.	Cuivre River State Park	Lincoln
Big Lake Marsh	150	ac.	Big Lake State Park	Holt
Blue Springs Creek	4	mi.	Blue Spring Creek Conservation Area	Crawford
Bonne Femme Creek	2	mi.	Three Creeks Conservation Area	Boone
Brush Creek	0.7	mi.	Bonanza Conservation Area	Caldwell
Bryant Creek	1.5	mi.	Bryant Creek Natural Area in Rippee Conservation Area	Ozark/Douglas
Bull Creek	8	mi.	Mark Twain National Forest Sec. 24,25N,21W to Sec. 22,26N,20W	Christian
Cathedral Cave Branch	5	mi.	Onondaga Cave State Park	Crawford
Chariton River	9.8	mi.	Rebels Cove Conservation Area	Putnam-Schuyler
Chloe Lowry Marsh	40	ac.	Chloe Lowry Marsh Conservation Area	Mercer
Coakley Hollow	1.5	mi.	Lake of the Ozarks State Park	Camden
Coonville Creek	2	mi.	St. Francois State Park	St. Francois
Courtois Creek	12	mi.	Mouth to Hwy. 8	Crawford
Crabapple Creek	1.0	mi.	Bonanza Conservation Area	Caldwell
Devils Ice Box Cave Branch	1.5	mi.	Rock Bridge State Park	Boone
East Fork Black River	3	mi.	Johnson's Shut-Ins State Park	Reynolds
First Nicholson Creek (East Drywood Creek)	2	mi.	Prairie State Park	Barton
Gan's Creek	3	mi.	Rock Bridge State Park	Boone
Huzzah Creek	6	mi.	Mouth to Hwy. 8	Crawford
Indian Creek	17.5	mi.	Mark Twain National Forest	Douglas-Howell
Ketchum Hollow	1.5	mi.	Roaring River State Park	Barry
Little Piney Creek	25	mi.	Mouth to 21,35N,08W	Phelps
Little Black River	3	mi.	Mud Puppy Natural History Area S22,T24N,R3E to S25,T24N,R3E	Ripley
Log Creek	0.4	mi.	Bonanza Conservation Area	Caldwell
Meramec River	8	mi.	Adjacent to Meramac State Park	Crawford/Franklin
Meramec River	3	mi.	Adjacent to Onondaga and Huzzah State Forest	Crawford
Mill Creek	5	mi.	Mark Twain National Forest	Phelps
N. Fork White River	5.5	mi	Mark Twain National Forest	Ozark
Noblett Creek	5	mi.	Above Noblett Lake, Mark Twain National Forest	Douglas-Howell
Onondaga Cave Branch	0.6	mi.	Onondaga Cave State Park	Crawford
Pickle Creek	3	mi.	Hawn State Park	Ste. Genevieve
S. Prong L. Black River	2	mi.	In Little Black Conservation Area	Ripley
Shoal Creek	0.5	mi.	Bonanza Conservation Area	Caldwell
Spring Creek	17	mi.	Mark Twain National Forest	Douglas
Spring Creek	6.5	mi.	Mark Twain National Forest	Phelps
Taum Sauk Creek	5.5	mi.	Johnson's Shut-Ins State Park Addition S23,T33N,R2E to S5,T33N,R3E	Reynolds-Iron
Turkey Creek	4.6	mi.	In Three Creeks Conservation Area	Boone
Van Meter Marsh	80	ac.	Van Meter State Park	Saline
Whetstone Creek	5.1	mi.	Whetsone Creek Conservation Area	Callaway

Table F
Metropolitan No-Discharge Streams

St. Louis Area

Stream	Location
Gravois Creek	Entire length
Creve Coeur Creek	Creve Coeur Lake and stream above lake
Fee Fee Creek	Entire length
Coldwater Creek	Entire length
Dardenne Creek	Route DD—I-70 Highway—St. Charles County
Belleau Creek	Headwaters—0.1 mi. west of east edge of S22,T47N,R3E
Fishpot Creek	Entire length
Grand Glaize Creek	Entire length

Kansas City Area

Stream	Location
Indian Creek	Kansas state line to confluence with Blue River
Blue River	Kansas state line to 59th Street, Kansas City
Blue River (except combined sewer overflow from Brush Creek)	59th Street to Guinotte Dam
Little Blue River	Entire length

Springfield Area

Stream	Location
Pearson Creek	Entire length

Table G—Lake Classifications and Use Designations

NOTE: Fishing, swimming and livestock watering may not be allowed in some lakes by the local management authorities. The use designations refer only to the protection of water quality for those potential uses.

WATER BODY	CLASS	ACRES	LOCATION	COUNTY(IES)	LWW	AQL	CDF	WBC	SCR	DWS	IND
Adrian Lake	L1	26	03,41N,31W	Bates	X	X		B		X	
Agate Lake	L3	167	13,60N,06W	Lewis	X	X		A	X		
Aggrevation Lake	L3	40	31,42N,02E	Franklin	X	X		B	X		
Amarugia Highlands Lake	L3	55	10/11,43N,32W	Cass	X	X		B	X		
Anderson Lake	L3	20	36,28N,11E	Stoddard	X	X		B			
Annette Lake	L3	65	01,44N,33W	Cass	X	X		B	X		
Anthonies Mill Lake	L3	110	19,39N,01W	Washington	X	X		B	X		
Antimi Lake	L3	3	NENE,3,48N,12W	Boone	X	X		B			
Apollo Lake	L3	22	21,36N,05E	St. Francois	X	X		B	X		
Appleton City Lake	L1	36	12,39N,29W	Bates	X	X		B		X	
Archie Lake	L1	3.5	SESE,28,43N,31W	Cass	X	X		B		X	
Armstrong Lake	L1	12	28,52N,16W	Howard	X	X		B		X	
Arrow Rock Lake	L3	5	36,50N,19W	Saline	X	X		B	X		
Arrowhead, Lake	L3	150	18,54N,30W	Clinton	X	X		A	X		
Arrowhead, Lake	L3	25	05,41N,2E	Franklin	X	X		A	X		
Athens State Park Lake	L3	8	30,67N,07W	Clark	X	X		A	X		
Atkinson Lake	L3	355	NW SE06,37N,28W	St. Clair	X	X		A	X		
Atlanta Lake	L1	14	SE SW29,59N,14W	Macon	X	X		B		X	
Austin Community Lake	L3	22	30,29N,11W	Texas	X	X		A	X		
Baja Lake Assoc. Lake	L3	30	05,39N,01E	Washington	X	X		B	X		
Baring Country Club Lake	L1	81	SE SE26,63N,12W	Knox	X	X		A	X	X	
Bass Lake	L3	40	13,47N,08W	Callaway	X	X		A	X		
Bean Lake	L3	420	12,13,14,54N,37W	Platte	X	X		B	X		
Bear Creek Watershed Lake	L3	28	31,64N,09W	Clark	X	X		B	X		
Beaver Lake	L3	11	22,25N,04E	Butler	X	X		A			
Bee Tree Lake	L3	9	03,42N,06E	St. Louis	X	X		B	X		
Belcher Branch Lake	L3	55	08/17,55N,34W	Buchanan	X	X		B	X		
Belle City Lake	L3	3	20,41N,07W	Maries	X	X		B			
Ben Branch Lake	L3	45	15/14,44N,08W	Osage	X	X		B	X		
Bethany Lake #1	L1	18	02,63N,28W	Harrison	X	X		B		X	
Bethany Lake #2	L1	50	27,64N,28W	Harrison	X	X		B		X	
Bethany Reservoir	L3	78	SE27,64N,28W	Harrison	X	X		A	X		
Bevier Lake	L3	20	S SE,14,57N,15W	Macon	X	X		B			
Big Buffalo Wildlife Area L	L3	5	12,41N,20W	Benton	X	X		B			
Big Lake	L3	625	18&19,30,61N,39W	Holt	X	X		A	X		
Big Oak Tree S.P. Lake	L3	22	14,23N,16E	Mississippi	X	X		B			
Bilby Ranch Lake	L3	110	13/24,64N,38W	Nodaway	X	X		B	X		
Binder Lake	L3	127	SW SE36,45N,13W	Cole	X	X		B	X		
Birds Blue Hole	L3	8	29,27N,18E	Mississippi	X	X		B			
Blind Pony Lake	L3	195	NW SE18,49N,22W	Saline	X	X		B	X		
Bloodland Lake (Ft. Wood)	L3	45	04,34N,11W	Pulaski	X	X		B	X		
Blue Lake	L3	10	09,37N,08W	Phelps	X	X		B	X		
Blue Mountain Camp	L1	14	NW SE,09,33N,5E	Madison	X	X		B		X	
Blue Springs Lake	L3	720	03/04,48N,31W	Jackson	X	X		A	X		
Bluestem Lake	L3	15	22,47N,31W	Jackson	X	X		B	X		
Bocomo Lake	L3	140	NW NE10,49N,13W	Boone	X	X		B	X		
Bodarc Lake	L3	15	23,47N,31W	Jackson	X	X		B	X		
Bonne Ava Lake	L3	6	25,38N,04E	St. Francois	X	X		B			
Bonne Terre City Lake	L3	10	14,37N,04E	St. Francois	X	X		B			
Bowling Green Lake	L1	41	W NW29,53N,02W	Pike	X	X		B	X	X	

LWW—Livestock and Wildlife Watering
AQL—Protection of Warm Water Aquatic Life and Human Health-Fish Consumption
CDF—Cold-Water Fishery
WBC—Whole Body Contact Recreation
SCR—Secondary Contact Recreation
DWS—Drinking Water Supply
IND—Industrial

WATER BODY	CLASS	ACRES	LOCATION	COUNTY(IES)	LWW	AQL	CDF	WBC	SCR	DWS	IND
Bowling Green Lake (Old)	L1	7	NE NE30,53N,02W	Pike	X	X		B		X	
Bray Lake	L3	162	NE NW35,37N,08W	Phelps	X	X		B	X		
Breckenridge Lake	L1	80	NE SW3,57N,26W	Caldwell	X	X		B	X	X	
Briarwood, Lake	L3	103	SW NE33,40N,04E	Jefferson	X	X		A	X		
Brookfield Lake	L1	120	SE SE33,58N,19W	Linn	X	X		B		X	
Browning Lake	L3	120	10,11,12,57N,36W	Buchanan	X	X		B	X		
Bucklin Lake	L1	17	11,57N,18W	Linn	X	X		B		X	
Buffalo Bill Lake	L3	45	28,57N,31W	Dekalb	X	X		B	X		
Bull Shoals Lake	L2	9,000	21/34,20N,15W	Ozark	X	X	X	A	X		
Burlington Lake	L3	40	27,57N,30W	Clinton	X	X		B			
Busch W.A. #35	L3	51	NE NE30,46N,03E	St. Charles	X	X		B			
Busch W.A.—Kraut Run Lake	L3	182	NW NE23,46N,02E	St. Charles	X	X		B			
Bushwacker Lake	L3	159	27,34N,32W	Vernon	X	X		B	X		
Butler Lake	L1	67	NW NE14,40N,32W	Bates	X	X		B		X	
Butterfly Lake	L3	85	NW NE34,36N,07E	Ste. Genevieve	X	X		B			
Callaway Lake	L3	160	06,45N,02E	St. Charles	X	X		A	X		
Cameron Lake #1	L1	25	SW SW10,57N,30W	Dekalb	X	X		B	X	X	
Cameron Lake #2	L1	35	NW NW10,57N,30W	Dekalb	X	X		B	X	X	
Cameron Lake #3	L1	96	SE NE09,57N,30W	Dekalb	X	X		B	X	X	
Cameron Lake #4 (Grindtone Reservoir)	L1	180	05/08,57N,30W	Dekalb	X	X		B		X	
Camp Irondale Lake	L3	10	13,36N,01E	Washington	X	X		B	X		
Camp Solidarity Lake	L3	12	24,43N,02E	Franklin	X	X		B	X		
Carroll Reservoir	L3	65	SE NW07,52N,23W	Carroll	X	X		B	X		
Catclaw Lake	L3	42	14,47N,31W	Jackson	X	X		B	X		
Cedar Hill Lakes	L3	36	35,42N,03E	Jefferson	X	X		A	X		
Cedar Lake	L3	45	22,37N,05E	St. Francois	X	X		A	X		
Cedar Lake	L3	16	35,48N,13W	Boone	X	X		A	X		
Champetra, Lake	L3	60	NW13,45N,12W	Boone	X	X		A	X		
Charity Lake	L3	17	32,66N,41W-1,65N,41W	Atchison	X	X		B	X		
Clarence Lake #1	L1	20	15,57N,12W	Shelby	X	X		B	X	X	
Clarence Lake #2	L1	31	15,57N,12W	Shelby	X	X		B	X	X	
Clearwater Lake	L2	1,650	NW NE06,28N,03E	Wayne-Reynolds	X	X		A	X		
Cleveland Reservoir	L1	8	29,45N,33W	Cass	X	X		B		X	
Clever Dell Lake	L3	12	13,45N,22W	Pettis	X	X		B	X		
Cole County Park Lake	L3	7	17,44N,12W	Cole	X	X		B			
Cole Lake	L3	38	SE10,38N,04E	Jefferson	X	X		A	X		
Conner O. Fewell Lake	L3	10	32/29,43N,25W	Henry	X	X		B	X		
Contrary, Lake	L3	193	26,27,35,57N,36W	Buchanan	X	X		A	X		
Cooley Lake	L3	300	SE02,51N,30W	Clay	X	X		B			
Cool Valley Lake	L3	35	09,40N,02E	Franklin	X	X		B	X		
Coot Lake	L3	22	22,47N,31W	Jackson	X	X		B	X		
Corner Blue Hole Lake (34)	L3	9	25,25N,17E	Mississippi	X	X		B			
Cosmo-Bethel Lake	L3	6	NW,36,48N,13W	Boone	X	X		B			
Cottontail Lake	L3	27	14,47N,31W	Jackson	X	X		B	X		
Council Bluff Lake	L3	440	23,35N,01E	Iron	X	X		A	X		
Crane Lake	L3	50	W33,32N,04E	Iron	X	X		B	X		
Creighton Lake	L1	14	NW SE,14,43N,29W	Cass	X	X		B		X	
Crescent Lake	L3	10	02,42N,01W	Franklin	X	X		B	X		
Creve Couer Lake	L3	300	20,46N,05E	St. Louis	X	X		B	X		
Crooked Creek Lake	L3	3	07,36N,04W	Crawford	X	X		B			
Crowder St. Park Lake	L3	18	12,61N,25W	Grundy	X	X		A			
Crystal Lake	L3	122	NW SW32,53N,29W	Ray	X	X		A	X		X
Cut-off Lake	L3	80	01,12,57N,36W	Buchanan	X	X		B			
Cut-off Lake	L3	674	26,27,34,35,53N,19W	Chariton	X	X		B			
Dearborn Reservoir	L1	7	31,55N,34W	Buchanan	X	X		B	X	X	

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Deer Ridge Community Lake	L3	48	18,62N,08W	Lewis	X	X		B	X		
Dexter City Lake	L3	11	21,25N,10E	Stoddard	X	X		B			
Downing Lake	L1	18	SW NE17,66N,13W	Schuyler	X	X		B		X	
Drexel Lake #1	L1	28	32,43N,33W	Bates	X	X		B		X	
Drexel Lake #2	L1	51	SW NE06,42N,33W	Bates	X	X		B		X	
Duck Creek	L3	1,773	SW SW31,28N,09E	Wayne	X	X		B	X		
E A Pape Lake (Concordia)	L1	245	20,48N,24W	Lafayette	X	X		B	X	X	
Eagleville Lake	L1	40	33,66N,27W	Harrison	X	X		A	X	X	
Edina Lake	L1	11	07,62N,11W	Knox	X	X		B	X	X	
Edina Reservoir	L1	51	12,62N,11W	Knox	X	X		B	X	X	
Ella Ewing Community Lake	L3	15	21,64N,10W	Scotland	X	X		A			
Elsie Lake	L3	20	30,37N,02E	Washington	X	X		A	X		
Ethel Lake	L1	23	NE NW36,59N,17W	Macon	X	X		B		X	
Farmington City Lake	L3	8	SUR 2969,35N,05E	St. Francois	X	X		B			
Fawn Lake	L3	50	13,43N,02W	Franklin	X	X		B	X		
Fayette Lake #1	L3	10	NE NW15,50N,16W	Howard	X	X		B			
Fayette Lake #2	L3	60	NW NW4,50N,16W	Howard	X	X		B			
Fayette Lake #3 (Rogers)	L1	185	NW NW10,50N,16W	Howard	X	X		B		X	
Fellows Lake	L1	820	NW NE22,30N,21W	Greene	X	X		A	X	X	
Finger Lakes	L3	50	SW30,50N,12W	Boone	X	X		A			
Flight Lake	L3	100	26,36N,32W	Vernon	X	X		B			
Fond du Lac, Lake	L3	33	SUR 3011,43N,05E	Jefferson	X	X		A	X		
Forest Lake	L1	573	SE SW14,62N,16W	Adair	X	X		A		X	
Forest, Lake	L3	90	36,38N,07E	Ste. Genevieve	X	X		B			
Fort Westside Lake	L3	27	02,39N,04W	Crawford	X	X		A	X		
Fountain Grove Lakes	L3	—	35,57N,22W	Linn	X	X		B			
Fourche Lake	L3	49	22,23N,01W	Ripley	X	X		A	X		
Fox Valley Lake	L3	108	27,66N,08W	Clark	X	X		B	X		
Foxboro Lake	L3	25	14,42N,04W	Franklin	X	X		B	X		
Fredricktown City Lake	L1	158	SE SE06,33N,07E	Madison	X	X		B		X	
Freeman Lake	L1	13	SW SW18,44N,32W	Cass	X	X		B		X	
Frontier Lake	L3	62	NW NW35,30N,04E	Wayne	X	X		B	X		
Garden City Lake	L1	22	31,44N,29W	Cass	X	X		B		X	
Garden City New Lake	L1	46	NW,18,43N,29W	Cass	X	X		B		X	
Gerald City Lake	L3	5	12,42N,04W	Franklin	X	X		B			
Girardeau, Lake	L3	162	SW SW09,30N,11E	Cape Girardeau	X	X		B	X		
Glaus Lake	L3	30	17,27N,11E	Stoddard	X	X		B			
Glover Spring Lake	L3	80	13,47N,09W	Callaway	X	X		B			
Golden Eagle Lake	L3	141	SE SW16,48N,04W	Montgomery	X	X		B			
Goose Creek Lake	L3	62	NW NW26,38N,06E	St. Francois	X	X		A	X		
Gopher Lake	L3	42	23,47N,31W	Jackson	X	X		B	X		
Gower Lake	L1	14	03,55N,33W	Clinton	X	X		B		X	
Green City Lake	L1	57	SE NE16,63N,18W	Sullivan	X	X		B		X	
Green City Lake (Old)	L1	60	SE18,63N,18W	Sullivan	X	X		A		X	
HS Truman Lake	L2	55,600	07,40N,23W	Benton	X	X		A	X	X	
Hamilton Lake	L1	80	SW SW15,57N,28W	Caldwell	X	X		B	X	X	
Harmony Mission Lake	L3	96	15,38N,32W	Bates	X	X		B	X		
Harrison County Lake	L1	280	17/30,65N,28W	Harrison	X	X		B		X	
Harrisonville City Lake	L1	20	34,45N,31W	Cass	X	X		B	X	X	
Harrisonville, Lake	L1	385	SW SW26,46N,31W	Cass	X	X		B	X	X	
Hazel Creek Lake	L1	151	SW SW31,64N,15W	Adair	X	X		B		X	
Hazel Hill Lake	L3	71	28,47N,26W	Johnson	X	X		B	X		
Hematite (Bismarck) Lake	L3	210	SW NE19,35N,04E	St. Francois	X	X		B	X		
Henke Lake	L3	70	SE SE20,46N,09W	Callaway	X	X		B			
Henry Sever Lake	L3	158	NE NE14,60N,10W	Knox	X	X		A	X		

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Hermit Hollow Lake	L3	10	29,44N,02E	Franklin	X	X		B	X		
Herring Lake	L3	50	NW SW17,46N,09W	Callaway	X	X		B			
Higbee Lake	L1	15	SE SW09,52N,14W	Randolph	X	X		B		X	
Higginsville N. Lake	L1	40	NW SW09,49N,25W	Lafayette	X	X		B	X	X	
Higginsville S. Lake	L1	223	SW NE09,49N,25W	Lafayette	X	X		B	X	X	
HiPoint Lake	L3	3	24,39N,01E	Washington	X	X		B			
Holden Lake	L3	11	07,45N,27W	Johnson	X	X		B			
Holden Lake	L3	11	12,45N,28W	Johnson	X	X		B	X		
Holden Lake (New)	L1	380	29,46N,28W	Johnson	X	X		B	X	X	
Holiday Acres Lake	L3	250	SE SW17,55N,14W	Randolph	X	X		B			
Holiday Shores Lake	L3	47	12,36N,03E	Washington	X	X		A	X		
Horseshoe Lake	L3	80	15,56N,36W	Buchanan	X	X		B			
Hough Park Lake	L3	7	19,44N,11W	Cole	X	X		B			
Houston Lake	L3	22	NW 33,51N,33W	Platte	X	X		A	X		
Howell Mill Lake	L3	35	17,36N,01E	Washington	X	X		A	X		
Hunnewell Lake	L3	228	NW SW25,57N,09W	Shelby	X	X		B	X		
Hurdland Sever Lake	L3	16	36,62N,13W	Knox	X	X		A	X		
Indian Creek Lake	L3	192	15/27,59N,25W	Livingston	X	X		B	X		
Indian Hills Lake	L3	326	22,15,23,39N,05W	Crawford	X	X		A	X		
Innsbrook Lake	L3	51	NW SE06,46N,01W	Warren	X	X		B			
Iron Mtn Lake	L3	114	SE SW32,35N,04E	St. Francois	X	X		B	X		
Ironton Shepard Mountain Lake	L1	21	01,33N,03E	Iron	X	X		B	X	X	
Izaak Walton Lake	L3	7	32,36N,31W	Vernon	X	X		B	X		
Jackass Bend	L3	200	32,28,21–19,51N,29W	Ray-Jackson	X	X		B	X		X
Jackrabbit Lake	L3	31	15,47N,31W	Jackson	X	X		B	X		
Jacomo Lake	L3	970	NE NW11,48N,31W	Jackson	X	X		A	X		
Jamesport City Reservoir	L1	24	22,60N,26W	Daviess	X	X		B		X	
Jamesport Community Lake	L1	30	NE20,60N,26W	Daviess	X	X		A	X	X	
Jasper Lake	L3	35	13,60N,06W	Lewis	X	X		A	X		
Junge's Lake	L3	40	10,41N,21W	Benton	X	X		A	X		
Kahrs Boger Lake	L3	5	15,44N,20W	Pettis	X	X		B	X		
KC Angler's Club Lake	L3	25	SE18,46N,30W	Cass	X	X		B	X		
KC Southern Lake	L3	28	05,43N,33W	Cass	X	X		B	X		
Kellogg City Lake	L3	25	34,29N,31W	Jasper	X	X		A	X		
Killarney, Lake	L3	105	NW NW01,33N,04E	Iron	X	X		A	X		
King City Lake	L1	12	SW NE28,61N,32W	Gentry	X	X		B		X	
King City Lake	L1	34	28,61N,32W	Gentry	X	X		B		X	
King City Lake (South)	L1	32	SW SW34,61N,32W	Gentry	X	X		B		X	
King Lake	L3	231	12-13,60N,31W	Dekalb	X	X		A	X	X	
Kiwanis Lake	L3	4	SW23,51N,9W	Audrain	X	X		B			
Knob Noster St. Park Lakes	L3	24	29/30,46N,24W	Johnson	X	X		B			
L. Prairie Comm. Lake	L3	100	SE SE21,38N,7W	Phelps	X	X		B	X		
La Plata Lake (New)	L1	81	NW 14,60N,14W	Macon	X	X		B		X	
La Plata Lake (Old)	L1	19	09,60N,14W	Macon	X	X		B		X	
Labelle Lake #1	L1	17	16,61N,09W	Lewis	X	X		B	X	X	
Labelle Lake #2	L1	112	NW NE16,61N,09W	Lewis	X	X		B	X	X	
Lacawana, Lake	L3	10	13,38N,05E	St. Francois	X	X		B	X		
Lahweena, Lake	L3	60	24,47N,08W	Callaway	X	X		A	X		
Lakeview Lake	L3	25	SW35,51N,09W	Audrain	X	X		B			
Lakewood Lake	L3	107	NE NE07,48N,31W	Jackson	X	X		A	X		
Lamar City Lake	L1	180	SW NW32,32N,30W	Barton	X	X		B		X	
Lamine C.A. Lakes	L3	17	2-11-22-27,46N,19W	Cooper	X	X		B	X		
Lancaster City Lake (New)	L1	56	23,66N,15W	Schuyler	X	X		B		X	
Lancaster Lake (Old)	L1	10	SW NE14,66N,15W	Schuyler	X	X		B		X	
Lawson City Lake	L1	25	31,54N,29W	Ray	X	X		A	X	X	

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Leisure Lake	L3	50	NE SE05,61N,25W	Grundy	X	X		A			
Leisure Lake	L3	60	33,48N,08W	Callaway	X	X		A	X		
Lewis County #1 Lake (Ewing)	L1	43	06,60N,07W	Lewis	X	X		B	X	X	
Lewis Lake	L3	10	10,26N,11E	Stoddard	X	X		B			
Lewistown Lake	L1	29	NW SW08,61N,08W	Lewis	X	X		B	X	X	
Liberty Park Lake	L3	2	05,45N,21W	Pettis	X	X		B			
Limpp Lake	L3	30	29,61N,32W	Gentry	X	X		B	X		
Lincoln Lake-Cuivre River S.P.	L3	88	SW SE08,49N,01E	Lincoln	X	X		A	X		
Linneus Lake	L1	15	NE SW36,59N,21W	Linn	X	X		B	X	X	
Lions Lake	L3	10	16,44N,01W	Franklin	X	X		B	X		
Lions Lake	L3	5	26,46N,26W	Johnson	X	X		B	X		
Little Compton Lake	L3	40	29/32,55N,21W	Carroll	X	X		B	X		
Little Dixie Lake	L3	205	SW SE26,48N,11W	Callaway	X	X		B	X		
Loggers Lake	L3	25	10,15,31N,03W	Shannon	X	X		A	X		
Lone Jack Lake	L3	35	14,47N,30W	Jackson	X	X		B	X		
Lone Tree Lake	L3	22	15,46N,6W	Montgomery	X	X		B	X		
Long Branch Lake	L2	2,430	NW18,57N,14W	Macon	X	X		A	X	X	
Long Lake	L3	10	03,25N,12E	Stoddard	X	X		B			
Longview Lake	L2	930	04,47N,32W	Jackson	X	X		A	X		
Lorraine, Lake	L3	70	01,12,41N,04E	Jefferson	X	X		A	X		
Lost Valley Lake	L3	50	SE NE17,43N,04W	Gasconade	X	X		A	X		
Lotawana, Lake	L3	600	SE SE29,48N,30W	Jackson	X	X		A	X		
Lower Taum Sauk Lake	L3	200	33,33N,02E	Reynolds	X	X		B	X		
Lucky Clover Lake	L3	35	20,38N,04W	Crawford	X	X		A	X		
Luna Lake	L3	17	SE 34,45N,31W	Cass	X	X		B	X		
Mac Lake (Ziske)	L3	30	17,34N,05W	Dent	X	X		B	X		
Macon Lake	L3	200	SE NW17,57N,14W	Macon	X	X		B		X	
Malta Bend Comm. Lake	L3	40	25,51N,23W	Saline	X	X		B	X		
Manito Lake	L3	77	08,09,44N,17W	Moniteau	X	X		B	X		
Maple Leaf Lake	L3	140	04,48N,26W	Lafayette	X	X		B	X		
Marais Temps Clair	L3	500	19,48N,06E	St. Charles	X	X		B			
Marceline City Lake (New)	L1	200	SW SE14,56N,19W	Chariton	X	X		B		X	
Marceline Reservoir	L1	81	NW SW 28,57N,18W	Linn	X	X		B		X	
Marie, Lake	L3	60	NE NW 36,66N,24W	Mercer	X	X		A			
Mark Twain Lake	L2	18,600	26,55N,07W	Ralls	X	X		A	X	X	
Marshall Habilitation Center Lake	L3	12	11,50N,21W	Saline	X	X		B	X		
Martin Lakes	L3	30	11,26N,11E	Stoddard	X	X		B			
Maysville Lake	L1	12	NW NE03,58N,31W	Dekalb	X	X		B	X	X	
Maysville Lake	L1	27	SE SE33,59N,31W	Dekalb	X	X		B	X	X	
Maysville Lake #3	L1	53	NE04,58N,13W	Dekalb	X	X		B		X	
McCormick Lake	L3	11	08,09,25N,04W	Oregon	X	X		A	X		
McDaniel Lake	L1	300	NE SE26,30N,22W	Greene	X	X		B		X	
McGinness, Lake	L3	50	NW20,55N,30W	Clinton	X	X		B			
McKay Park Lake	L3	6	13,44N,12W	Cole	X	X		B			
Melody Lake	L3	35	15,42N,03W	Franklin	X	X		A	X		
Memphis Lake #1	L1	39	NE NE14,65N,12W	Scotland	X	X		B		X	
Memphis Lake #2	L1	250	15,65N,12W	Scotland	X	X		B		X	
Mercer Lake	L1	21	NE SW30,66N,23W	Mercer	X	X		B		X	
Middle Fork Water Comp.	L1	170	NW SW06,63N,31W	Gentry	X	X		B	X	X	
Milan Lake Elmwood	L1	235	NE NE35,63N,20W	Sullivan	X	X		B		X	
Milan Lake (New)	L1	15	SE SE,02,62N,20W	Sullivan	X	X		B		X	
Milan Lake (Old)	L1	13	SE SE02,62N,20W	Sullivan	X	X		B		X	
Mineral Lake	L3	20	01,42N,03W	Franklin	X	X		B	X		
Mingo Lakes	L3	1,045	30,27N,08E	Stoddard	X	X		B			
Moberly Park Lake	L1	35	SE NE03,53N,14W	Randolph	X	X		B		X	

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Moberly Rothwell Lake	L3	25	03,53N,14W	Randolph	X	X		B			
Monroe City Lake	L1	94	SW,NE,34,56N,07W	Ralls	X	X		A	X	X	
Monroe City Lake A	L1	17	NW NW13,56N,08W	Monroe	X	X		B		X	
Monroe City Lake B	L1	55	30,56N,07W	Monroe	X	X		B	X	X	
Montonese Lake	L3	45	27,43N,04E	Jefferson	X	X		A	X		
Montrose Lake	L3	1,568	NE NW33,41N,27W	Henry	X	X		B			X
Mozingo Lake	L1	1,000	19,65N,34W	Nodaway	X	X		B		X	
Mud Lake	L3	100	16,18,20,56N,36W	Buchanan	X	X		B			
Nehai Tonkayea Lake	L3	149	NW NE11,55N,18W	Chariton	X	X		A			
Nell Lake	L3	31	15,47N,31W	Jackson	X	X		B	X		
New Cambria Lake	L1	7	SW NE07,57N,16W	Macon	X	X		B		X	
Niangua Lake	L3	360	35,37N,18W	Camden	X	X		A	X		
Nims Lake	L3	253	SW SW24,34N,06E	Madison	X	X		A			
Noblett Lake	L3	26	25,26N,11W	Douglas	X	X		A			
Nodaway Lake	L3	73	SW NE20,65N,35W	Nodaway	X	X		B	X		
Norfork Lake	L2	1,000	21N,12W	Ozark	X	X		A	X		
North Lake	L3	51	NW NE28,45N,31W	Cass	X	X		B	X		
North Sever Lake	L3	20	20,63N,13W	Knox	X	X		B	X		
Northwoods, Lake	L3	120	SE NE33,43N,05W	Gasconade	X	X		A			
O’Brian Lake	L3	50	NW NW19,47N,01E	St. Charles	X	X		B			
Oaks, Lake of the	L3	53	SE SW07,63N,06W	Clark	X	X		A	X		
Odessa Lake	L1	90	NW NE15,48N,28W	Lafayette	X	X		B	X	X	
Odessa Lake (Old)	L1	19	NW NW14,48N,28W	Lafayette	X	X		B		X	
Old Plattsburg Lake	L1	20	13,55N,32W	Clinton	X	X		B		X	
Opossum Hollow Lake	L3	70	SW NE29,39N,03W	Crawford	X	X		A	X		
Oscie Ora Acres	L3	50	SE NW10,28N,33W	Jasper	X	X		B			
Otter Slough	L3	250	17,24N,09E	Stoddard	X	X		B			
Ozarks, Lake of the	L2	59,520	SE SE19,40N,15W	Camden	X	X		A	X		
Paho, Lake	L3	273	NE SE25,65N,25W	Mercer	X	X		B			
Painted Rock Lake	L3	4	11,42N,11W	Osage	X	X		B			
Palmer Lake	L3	93	22,36N,01E	Washington	X	X		A	X		
Panther Creek C-2 Lake	L3	20	32,65N,27W	Harrison	X	X		B			
Parker Lake #1	L3	20	NE SW32,35N,09E	Perry	X	X		A			
Parker Lake #2	L3	80	NE SW32,35N,09E	Perry	X	X		A			
Parole Lake	L3	35	07,36N,01E	Washington	X	X		A	X		
Peabody Wildlife Area Lake	L3	36	04/09,38N,32W	Bates	X	X		B	X		
Peaceful Valley Lake	L3	170	NE NE25,42N,06W	Gasconade	X	X		A			
Peculiar Lake	L1	25	SE SW22,45N,32W	Cass	X	X		B		X	
Penn’s Pond Lake	L3	12	06,34N,11W	Pulaski	X	X		B	X		
Perry County Community Lake	L3	103	SW NE22,35N,10E	Perry	X	X		B			
Perry Lake #1	L1	18	NW NW34,54N,07W	Ralls	X	X		B		X	
Perry Lake #2	L1	7	NW34,54N,07W	Ralls	X	X		B		X	
Perry C.A. Lakes	L3	4	02,47N,24W	Johnson	X	X		B	X		
Pershing St. Park Lake	L3	12	11,57N,21W	Linn	X	X		A			
Pike Lake	L3	20	02,59N,25W	Livingston	X	X		A	X		
Pinewoods Lake	L3	30	07,26N,03E	Carter	X	X		B	X		
Pinnacle Lake	L3	130	SE NE24,47N,05W	Montgomery	X	X		A			
Plattsburg 6 Mi. Lane Lk.	L3	57	SW SE11,55N,32W	Clinton	X	X		B		X	
Pleasant Hill Lake	L1	115	SW SE01,46N,31W	Cass	X	X		B	X	X	
Plover Lake	L3	15	15,47N,31W	Jackson	X	X		B	X		
Poague Wildlife Area Lake	L3	77	19,42N,26W	Henry	X	X		B	X		
Pomme de Terre Lake	L2	7,820	SW NE2,36N,22W	Hickory	X	X		A			
Pony Express Lake	L3	240	NE35,58N,31W	Dekalb	X	X		A	X		
Port Hudson Lake	L3	55	16,43N,03W	Franklin	X	X		B	X		
Port Perry Lake	L3	200	NE SE08,34N,09E	Perry	X	X		B			

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WATER BODY	CLASS	ACRES	LOCATION	COUNTY(IES)	LWW	AQL	CDF	WBC	SCR	DWS	IND
Potosi Lake Village	L3	40	27,37N,03E	Washington	X	X		A	X		
Prairie Lee Lake	L3	150	NE NW27,48N,31W	Jackson	X	X		A	X		
Prairie Home C.A. Lakes	L3	25	25,46N,15W	Cooper/ Moniteau	X	X		B		X	
Primrose Lake	L3	100	23,38,04E	St. Francois	X	X		B	X		
Proctor Park Lake	L3	6	34,45N,15W	Moniteau	X	X		B	X		
Purko Lake	L3	25	SW SE07,34N,10E	Perry	X	X		B			
Radio Springs Lake	L3	8	08,35N,31W	Vernon	X	X		B	X		
Railroad Lake	L3	20	25,51N,09W	Audrain	X	X		B			
Raintree Lake	L3	300	06,46N,31W	Cass	X	X		A	X		
Raintree Lake	L3	126	30,41N,04E	Jefferson	X	X		A	X		
Ray County Community Lake	L3	25	13,52N,28W	Ray	X	X		A	X		
Rice Lake	L3	40	09,27N,11E	Stoddard	X	X		B			
Ridgeway (Rockhouse) Lake	L1	67	SW SE36,65N,27W	Harrison	X	X		A	X	X	
Rinquelin Trail Community Lake	L3	30	NW29,39N,11W	Maries	X	X		B	X		
Ripley Co. Lake	L3	20	10,23N,01E	Ripley	X	X		A	X		
Riss Lake	L3	134	SW SW25,51N,33W	Platte	X	X		B	X		
Roach Lake	L3	2	30,57N,23W	Livingston	X	X		A	X		
Roby Lake	L3	21	34/35,33N,11W	Texas	X	X		A	X		
Rocky Fork Lake	L3	53	NW SE31,50N,12W	Boone	X	X		B			
Rocky Hollow Lake	L3	20	SE33,53N,30W	Clay	X	X		B	X		
Salisbury City Lake (Pine Ridge Lake)	L3	25	15,53N,17W	Chariton	X	X		B	X		
Savannah City Reservoir	L1	17	07,59N,35W	Andrew	X	X		A	X	X	
Sayersbrook Lake	L3	70	NE SE28,38N,01E	Washington	X	X		B			
Schell-Osage W.A.—Levee 3	L3	461	SE NE06,37N,28W	St. Clair	X	X		A	X		
Scioto Lake	L3	3	29,38N,06W	Phelps	X	X		B			
Schuman Park Lake	L3	5	02,37N,08W	Phelps	X	X		B			
Schuyler Co. PWSD #1 Lake	L1	29	SE SE04,64N,015W	Schuyler	X	X		B		X	
Scrivner Lake	L3	8	18,43N,13W	Cole	X	X		B			
Sears Community Lake	L3	19	18,63N,19W	Sullivan	X	X		A	X		
Seetal Lake	L3	45	SE NW01,45N,05W	Gasconade	X	X		B			
Seqiuota Park Lake	L3	3	09,28N,21W	Greene	X	X		B			
Serene, Lake	L3	59	NW NE03,42N,02E	Franklin	X	X		A	X		
Settles Ford C.A. Lakes	L3	110	09-10,42N,29W	Bates	X	X		B	X		
Seven Springs Lake	L3	35	23-24,36N,06W	Phelps	X	X		A	X		
Shawnee Lake (Turner)	L3	17	17,34N,05W	Dent	X	X		B	X		
Shelbina Lake	L1	45	NE SW20,57N,10W	Shelby	X	X		B	X	X	
Shelbyville Lake	L1	32	SW SE19,58N,10W	Shelby	X	X		B	X	X	
Sherwood, Lake	L3	120	SW SE11,45N,01W	Warren	X	X		A			
Silver Lake	L3	59	SW SW16,46N,32W	Cass	X	X		B	X		
Silver Lake—Levee 3	L3	2,464	06,55N,20W	Chariton	X	X		B			
Sims Valley Community Lake	L3	38	17,20,27N,08W	Howell	X	X		A	X		
Smithville City Lake	L1	8	26,53N,33W	Clay	X	X		B		X	
Smithville Lake	L2	7,190	E SW13,53N,33W	Clay	X	X		A	X	X	
Snow Hollow Lake	L3	38	26/27,34N,03E	Iron	X	X		B	X		
South Pool—Levee 3	L3	1,151	35,56N,21W	Chariton	X	X		B			
Spencer Lake	L3	8	NW19,66N,14W	Schuyler	X	X		B			
Spring Fork Lake	L1	178	NE SW21,44N,21W	Pettis	X	X		B	X	X	
Spring Lake	L3	100	NW SW20,61N,16W	Adair	X	X		A			
Springfield, Lake	L3	360	19,28N,21W	Greene	X	X		B	X		X
Squaw Creek—Main Pool	L3	615	36,61N,39W	Holt	X	X		B			
St. Clair #1 Lake	L3	54	SW SE02,41N,01W	Franklin	X	X		A	X		
St. Joe Park Lakes	L3	70	20,21,36N,05E	St. Francois	X	X		A	X		
St. Louis, Lake	L3	525	NE SW26,47N,02E	St. Charles	X	X		A			
Ste. Louise, Lake	L3	87	SW SW27,47N,02E	St. Charles	X	X		A			
Sterling Price Community Lake	L3	35	17,53N,17W	Chariton	X	X		A	X		

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WATER BODY	CLASS	ACRES	LOCATION	COUNTY(IES)	LWW	AQL	CDF	WBC	SCR	DWS	IND
Stockton Lake	L2	23,680	NE NE15,34N,26W	Cedar	X	X		A		X	
Stokes Lake #1 (Arrowhead Lakes)	L3	60	SW SE18,23N,08W	Howell	X	X	X	A			
Stokes Lake #2 (Arrowhead Lakes)	L3	80	18,23N,08W	Howell	X	X	X	B	X		
Strobel Lake	L3	50	01,27N,09E	Stoddard	X	X		B			
Sugar Creek Lake	L1	346	NE SW16,54N,14W	Randolph	X	X		B		X	
Sugar Lake	L3	317	27,28,33,55N,37W	Buchanan	X	X		A	X		
Sullivan City Lake	L3	5	17,40N,02W	Crawford	X	X		B			
Summerset Lake	L3	75	NE SW15,39N,04E	Jefferson	X	X		A	X		
Sunfish Lake (Spanish L Pk)	L3	34	47N,07E	St. Louis	X	X		B	X		
Sunnen Lake	L3	198	SW SE04,37N,01E	Washington	X	X		A			
Sunrise Lakes	L3	46	36,39N,04E	Jefferson	X	X		A	X		
Sunset Lake	L3	60	NW SE33,39N,07E	Ste. Genevieve	X	X		B			
Sunshine Lake	L3	500	19,29,32,51N,27W	Ray	X	X		A	X		X
Swan Lake—Levee 5	L3	1,425	10,55N,21W	Chariton	X	X		B			
Swiss Lake Development Lake	L3	40	21-28,44N,05W	Gasconade	X	X		B	X		
Table Rock Lake	L2	43,100	SW NW22,22N,22W	Stone	X	X		A	X		
Taneycomo, Lake	L2	1,730	SW NE8,23N,20W	Taney	X	X	X	A	X	X	
Tapawingo, Lake	L3	76	NE NE34,49N,31W	Jackson	X	X		A	X		
Tarsney Lake	L3	17	SE SE22,48N,30W	Jackson	X	X		A	X		
Tea Lake	L3	25	08,41N,04W	Gasconade	X	X		B	X		
Teal Lake	L3	76	NE SW36,51N,09W	Audrain	X	X		B	X		
Tebo Freshwater Lake	L3	300	SW SW25,43N,25W	Henry	X	X		B			
Ten Mile Pond	L3	70	07,04,03,24N,16E	Mississippi	X	X		B			
Terre Du Lac Lakes	L3	190	18,19,37N,04E	St. Francois	X	X		A	X		
Thomas Hill Reservoir	L2	4,400	NE SE24,55N,16W	Randolph	X	X		A		X	X
Thunderbird, Lake	L3	45	06,41N,01E	Franklin	X	X		A	X		
Timberline Lake	L3	13	32,37N,01W	Washington	X	X		A	X		
Timberline Lakes	L3	119	23,24,38N,04E	St. Francois	X	X		A	X		
Timberridge, Lake	L3	50	20,43N,06W	Gasconade	X	X		A	X		
Tishomingo, Lake	L3	115	NE SE5,41N,04E	Jefferson	X	X		A	X		
Tobacco Hills, Lake	L3	17	NW,11,53N,35W	Platte	X	X		B	X		
Tom Sawyer Lake (Mk. Twain SP)	L3	5	09,54N,08W	Monroe	X	X		A			
Torino Lake	L3	10	20,42N,02E	Franklin	X	X		B	X		
Trenton Lower Lake	L1	103	NE SE15,61N,24W	Grundy	X	X		B		X	
Trenton Upper Lake	L1	68	NE SE15,61N,24W	Grundy	X	X		B		X	
Twin Borrow Pits	L3	18	13,19N,13E	Pemiscot	X	X		B			
Twin Lake	L3	70	NW NW31,66N,23W	Mercer	X	X		B			
Twin Lake	L3	18	SW SW,22,48N,13W	Boone	X	X		B	X		
Tywappity Community Lake	L3	55	SW SE08,29N,13E	Scott	X	X		A			
Union City Lake	L3	5	27,43N,01W	Franklin	X	X		B			
Unionville Lake (Thunderhead, Lake)	L1	1,015	NE NE15,66N,19W	Putnam	X	X		A	X	X	
Unionville (New) Lake	L3	70	27,66N,19W	Putnam	X	X		B			
Unionville (Old) Lake	L1	15	34,66N,19W	Putnam	X	X		A	X	X	
Unity Village Lake #1	L1	15	25,48N,32W	Jackson	X	X		B	X	X	
Unity Village Lake #2	L1	23	24,48N,32W	Jackson	X	X		B	X	X	
Upper Big Lake	L3	110	25,27N,16E	Mississippi	X	X		B			
Valle Lake	L3	100	31,39N,05E	Jefferson	X	X		A	X		
Van Meter St. Park Lake	L3	8	24,52N,22W	Saline	X	X		A	X		
Vandalia Community Lake	L3	44	SE35,52N,06W	Audrain	X	X		B			
Vandalia Lake	L1	37	NE NE12,53N,05W	Pike	X	X		B	X	X	
Viking, Lake	L1	550	09,59N,28W	Daviess	X	X		A	X	X	
Wahoo Lake	L3	25	14,38N,04E	St. Francois	X	X		B	X		
Wakonda Lake	L3	78	NW NE13,60N,06W	Lewis	X	X		A	X		
Wallace SP Lake	L3	6	NE,24,56N,30W	Clinton	X	X		A	X		

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Walt Disney Lake	L3	18	05,57N,18W	Linn	X	X		A			
Wanda Lee, Lake	L3	220	02,37N,70E	Ste. Genevieve	X	X		A			
Wapappello, Lake	L2	8,200	SE NE3,26N,03E	Wayne	X	X		A	X		
Watkins Mill Lake	L3	126	NW 22,53N,30W	Clay	X	X		A	X		
Waukomis Lake	L3	82	NE NW17,51N,33W	Platte	X	X		A	X		
Wauwanoka, Lake	L3	86	SE NW01,40N,04E	Jefferson	X	X		A	X		
Weatherby Lake	L3	194	SW SE15,51N,34W	Platte	X	X		A	X		
Wellsville Lake	L1	10	33,50N,06W	Montgomery	X	X		B		X	
Wellsville Quarry	L1	1.3	NE SE,04,49N,06W	Montgomery	X	X		B		X	
Whetstone Creek W.A. Lake	L3	26	08,48N,07W	Callaway	X	X		B	X		
Whispering Valley Lakes	L3	30	02,43N,03W	Franklin	X	X		A	X		
White Area Lake (Lake Whiteside)	L3	28	SW SUR 1686,51N,01W	Lincoln	X	X		B	X		
Wildwood Lake	L3	17	NE09,48N,32W	Jackson	X	X		B			
Willow Lake	L3	29	27-34,34N,32W	Vernon	X	X		B	X		
Willowwood Lake	L3	100	35,48N,05E	St. Charles	X	X		B			
Windsor City Lake	L3	20	06,43N,23W	Pettis	X	X		B			
Winnebago, Lake	L3	350	NE NW09,46N,31W	Cass	X	X		A	X		
Wolf Bayou	L3	35	04,19N,13E	Pemiscot	X	X		B			
Woods, Lake of the	L3	3	NE,02,48N,12W	Boone	X	X		B			
Worth County Lake	L3	20	29,32,65N,32W	Worth	X	X		B	X		
Wyaconda Lake	L1	8	NW NW33,65N,09W	Clark	X	X		B	X	X	

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MDNR Regulations

Title 10

Division 60 – Public Drinking Water Program

Chapter 15 – Lead and Copper

Date: 03/31/2002

Rules of
Department of Natural Resources
Division 60—Public Drinking Water Program
Chapter 15—Lead and Copper

Title **Page**

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 60—Public Drinking Water Program
Chapter 15—Lead and Copper

10 CSR 60-15.010 General Requirements

PURPOSE: This rule gives an overview of requirements covered in the national primary drinking water regulations for lead and copper.

(1) Applicability and Effective Dates. The requirements of this chapter constitute the Missouri public drinking water rules for lead and copper. Unless otherwise indicated, each of the provisions of this chapter applies to community water systems and nontransient noncommunity water systems (after this referred to as water systems or systems).

(2) Scope. These rules establish a treatment technique that includes requirements for corrosion control treatment, source water treatment, lead service line replacement and public education. These requirements are triggered, in some cases, by lead and copper action levels measured in samples collected at consumers' taps.

(3) Lead and Copper Action Levels.

(A) The lead action level is exceeded if the concentration of lead in more than ten percent (10%) of tap water samples collected during any monitoring period conducted in accordance with 10 CSR 60-15.070 is greater than 0.015 milligrams/liter (mg/l) (that is, if the ninetieth percentile lead level is greater than 0.015 mg/l).

(B) The copper action level is exceeded if the concentration of copper in more than ten percent (10%) of tap water samples collected during any monitoring period conducted in accordance with 10 CSR 60-15.070 is greater than 1.3 mg/l (that is, if the ninetieth percentile copper level is greater than 1.3 mg/l).

(C) The ninetieth percentile lead and copper levels shall be computed as follows:

1. The results of all lead or copper samples taken during a monitoring period shall be placed in ascending order from the sample with the lowest concentration to the sample with the highest concentration. Each sampling result shall be assigned a number, ascending by single integers beginning with the number one (1) for the sample with the lowest contaminant level. The number assigned to the sample with the highest contaminant level shall be equal to the total number of samples taken;

2. The number of samples taken during the monitoring period shall be multiplied by 0.9;

3. The contaminant concentration in the numbered sample yielded by the calculation in paragraph (3)(C)2. is the ninetieth percentile contaminant level; and

4. For water systems serving fewer than one hundred (100) people that collect five (5) samples per monitoring period, the ninetieth percentile is computed by taking the average of the highest and second highest concentrations.

(4) Corrosion Control Treatment Requirements.

(A) All water systems shall install and operate optimal corrosion control treatment as defined in 10 CSR 60-15.030.

(B) Any water system that complies with the applicable corrosion control treatment requirements specified by the state under 10 CSR 60-15.020 and 10 CSR 60-15.030 shall be deemed in compliance with the treatment requirement contained in subsection (4)(A).

(5) Source Water Treatment Requirements. Any system exceeding the lead or copper action level shall implement all applicable source water treatment requirements specified by the state under 10 CSR 60-15.040.

(6) Lead Service Line Replacement Requirements. Any system exceeding the lead action level after implementation of applicable corrosion control and source water treatment requirements shall complete the lead service line replacement requirements contained in 10 CSR 60-15.050.

(7) Public Education Requirements. Any system exceeding the lead action level shall implement the public education requirements contained in 10 CSR 60-15.060.

(8) Monitoring and Analytical Requirements. Tap water monitoring for lead and copper, monitoring for water quality parameters, source water monitoring for lead and copper and analyses of the monitoring results under this section shall be completed in compliance with 10 CSR 60-15.070, 10 CSR 60-15.080, 10 CSR 60-15.090 and 10 CSR 60-5.010(1).

(9) Reporting Requirements. Systems shall report to the state any information required by the treatment provisions of this section and 10 CSR 60-7.020.

(10) Recordkeeping Requirements. Systems shall maintain records in accordance with 10 CSR 60-9.010.

(11) Violation of National Primary Drinking Water Regulations. Failure to comply with the applicable requirements of 10 CSR 60-15.010–10 CSR 60-15.090, 10 CSR 60-5.010, 10 CSR 60-7.020 and 10 CSR 60-9.010, including requirements established by the state pursuant to these provisions, shall constitute a violation of the state public drinking water rules for lead, copper, or both.

AUTHORITY: section 640.100, RSMo Supp. 1989. Original rule filed Aug. 4, 1992, effective May 6, 1993.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989.*

10 CSR 60-15.020 Applicability of Corrosion Control Treatment Steps to Small, Medium-Size and Large Water Systems

PURPOSE: This rule establishes deadlines for public water systems to complete corrosion control treatment required in 10 CSR 60-15.030 and to conduct associated monitoring.

(1) A large system (serving more than fifty thousand (50,000) persons) shall complete the corrosion control treatment steps as follows unless it is deemed to have optimized corrosion control under paragraph (1)(B)1. or 2.

(A) Treatment Steps and Deadlines for Large Systems.

1. The system shall conduct initial monitoring (10 CSR 60-15.070(4)(A) and 10 CSR 60-15.080(2)) during two (2) consecutive six (6)-month monitoring periods by January 1, 1993.

2. The system shall complete corrosion control studies (10 CSR 60-15.030(3)) by July 1, 1994.

3. The department shall designate optimal corrosion control treatment (10 CSR 60-15.030(4)) by January 1, 1995.

4. The system shall install optimal corrosion control treatment (10 CSR 60-15.030(6)) by January 1, 1997.

5. The system shall complete follow-up sampling (10 CSR 60-15.070(4)(B) and 10 CSR 60-15.080(3)) by January 1, 1998.

6. The department shall review installation of treatment and designate optimal water quality control parameters (10 CSR 60-15.030(7)) by July 1, 1998.

7. The system shall operate in compliance with the department-specified optimal water quality control parameters (10 CSR 60-15.030(8)) and continue to conduct tap

sampling (10 CSR 60-15.070(4)(C) and 10 CSR 60-15.080(4)).

(B) A large system is deemed to have optimized corrosion control and is not required to complete the applicable corrosion control treatment steps identified in this section if the system satisfies one (1) of the following criteria. Any such large system deemed to have optimized corrosion control, and which has treatment in place, shall continue to operate and maintain optimal corrosion control treatment and meet any requirements that the department determines appropriate to ensure optimal corrosion control treatment is maintained.

1. The system demonstrates to the satisfaction of the department that it has conducted activities equivalent to the corrosion control steps applicable to large systems. If the department makes this determination, it shall provide the system with written notice explaining the basis for its decision and shall specify the water quality control parameters representing optimal corrosion control in accordance with 10 CSR 60-15.030(7). Water systems deemed to have optimized corrosion control shall operate in compliance with the department-designated optimal water quality control parameters in accordance with 10 CSR 60-15.030(8) and continue to conduct lead and copper tap and water quality parameter sampling in accordance with 10 CSR 60-15.070(4)(C) and 10 CSR 60-15.080(4). A system shall provide the department with the following information in order to support this determination:

A. The results of all test samples collected for each of the water quality parameters in 10 CSR 60-15.030(3)(C);

B. A report explaining the test methods used by the water system to evaluate the corrosion control treatments listed in 10 CSR 60-15.030(3)(A), the results of all tests conducted and the basis for the system's selection of optimal corrosion control treatment;

C. A report explaining how corrosion control has been installed and how it is being maintained to insure minimal lead and copper concentrations at consumers' taps; and

D. The results of tap water samples collected in accordance with 10 CSR 60-15.070 at least once every six (6) months for one (1) year after corrosion control has been installed.

2. The water system submits results of tap water monitoring conducted in accordance with 10 CSR 60-15.070 and source water monitoring conducted in accordance with 10 CSR 60-15.090 that demonstrates for two (2) consecutive six (6)-month monitoring periods that the difference between the ninetieth percentile tap water lead level, computed under 10 CSR 60-15.010(3)(C), and the highest source water lead concentration is less than the practical quantitation level for lead specified in 10 CSR 60-5.010(5)(H).

A. Those systems whose highest source water lead level is below the method detection limit may also be deemed to have optimized corrosion control under this paragraph if the ninetieth percentile tap water lead level is less than or equal to the practical quantitation level for lead for two (2) consecutive six (6)-month monitoring periods.

B. Any water system deemed to have optimized corrosion control in accordance with this paragraph (1)(B)2. shall continue monitoring for lead and copper at the tap no less frequently than once every three (3) calendar years using the reduced number of sites specified in 10 CSR 60-15.070(3) and collecting the samples at times and locations specified in 10 CSR 60-15.070(4)(D)4.

C. Any water system deemed to have optimized corrosion control pursuant to this paragraph (1)(B)2. shall notify the department in writing pursuant to 10 CSR 60-7.020(1)(C) of any change in treatment or the addition of a new source. The department may require any such system to conduct additional monitoring or to take other action the department deems appropriate to ensure that such system maintains minimal levels of corrosion in the distribution system.

D. A system is not deemed to have optimized corrosion control pursuant to this paragraph (1)(B)2., and shall implement corrosion control treatment pursuant to subparagraph (1)(B)2.E. of this rule unless it meets the copper action level.

E. Any system triggered into corrosion control because it is no longer deemed to have optimized corrosion control under paragraph (1)(B)2. shall implement corrosion control treatment in accordance with the deadlines in subsection (2)(A) of this rule. Any such large system shall adhere to the schedule specified in subsection (2)(A) of this rule for medium-size systems, with the time periods for completing each step being triggered by the date the system is no longer deemed to have optimized corrosion control under paragraph (1)(B)2. of this rule.

(2) A small system (serving fewer than three thousand three hundred (3,300) persons) and a medium-size system (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) shall complete the corrosion control treatment steps specified as follows unless it is deemed to have optimized corrosion control under paragraph (2)(B)1., 2. or 3. of this rule:

(A) Treatment Steps and Deadlines for Small and Medium-Size Systems.

1. The system shall conduct initial tap sampling (10 CSR 60-15.070(4)(A) and 10 CSR 60-15.080(2)) until the system either exceeds the lead or copper action level or becomes eligible for reduced monitoring under 10 CSR 60-15.070(4)(D). A system exceeding the lead or copper action level shall recommend optimal corrosion control treatment (10 CSR 60-15.030(1)) within six (6) months after it exceeds one (1) of the action levels.

2. Within twelve (12) months after a system exceeds the lead or copper action level, the department may require the system to perform corrosion control studies (10 CSR 60-15.030(2)). If the department does not require the system to perform these studies, the department shall specify optimal corrosion control treatment (10 CSR 60-15.030(4)) within the following time frames:

A. For medium-size systems, within eighteen (18) months after that system exceeds the lead or copper action level; or

B. For small systems, within twenty-four (24) months after that system exceeds the lead or copper action level.

3. If the department requires a system to perform corrosion control studies under paragraph (2)(A)2. of this rule, the system shall complete the studies (10 CSR 60-15.030(3)) within eighteen (18) months after the department requires that those studies be conducted.

4. If the system has performed corrosion control studies under paragraph (2)(A)2. of this rule, the department shall designate optimal corrosion control treatment (10 CSR 60-15.030(4)) within six (6) months after completion of paragraph (2)(A)3. of this rule.

5. The system shall install optimal corrosion control treatment (10 CSR 60-15.030(6)) within twenty-four (24) months after the department designates that treatment.

6. The system shall complete follow-up sampling (10 CSR 60-15.070(4)(B) and 10 CSR 60-15.080(3)) within thirty-six (36) months after the department designates optimal corrosion control treatment.

7. The department shall review the system's installation of treatment and designate optimal water quality control parameters (10 CSR 60-15.030(7)) within six (6) months after completion of paragraph (2)(A)6. of this rule.

8. The system shall operate in compliance with the department-designated optimal

water quality control parameters (10 CSR 60-15.030(8)) and continue to conduct tap sampling as specified in 10 CSR 60-15.070(4)(C) and 10 CSR 60-15.080(4);

(B) A small- or medium-size water system is deemed to have optimized corrosion control and is not required to complete the applicable corrosion control treatment steps identified in this section if the system satisfies one (1) of the following criteria. Any such system deemed to have optimized corrosion control, and which has treatment in place, shall continue to operate and maintain optimal corrosion control treatment and meet any requirements that the department determines appropriate to ensure optimal corrosion control treatment is maintained.

1. The system meets the lead and copper action levels during each of two (2) consecutive six (6)-month monitoring periods conducted in accordance with 10 CSR 60-15.070.

2. The system demonstrates to the satisfaction of the department that it has conducted activities equivalent to the corrosion control steps applicable to medium-size or small systems under this section. If the department makes this determination, it shall provide the system with written notice explaining the basis for its decision and shall specify the water quality control parameters representing optimal corrosion control in accordance with 10 CSR 60-15.030(7). Water systems deemed to have optimized corrosion control under this paragraph shall operate in compliance with the department-designated optimal water quality control parameters in accordance with 10 CSR 60-15.030(8) and shall continue to conduct lead and copper tap and water quality parameter sampling in accordance with 10 CSR 60-15.070(4)(C) and 10 CSR 60-15.080(4). The system shall provide the department with the following information in order to support a determination:

A. The results of all test samples collected for each of the water quality parameters in 10 CSR 60-15.030(3)(C);

B. A report explaining the test methods used by the water system to evaluate the corrosion control treatments listed in 10 CSR 60-15.030(3)(A), the results of all tests conducted and the basis for the system's selection of optimal corrosion control treatment;

C. A report explaining how corrosion control has been installed and how it is being maintained to insure minimal lead and copper concentrations at consumers' taps; and

D. The results of tap water samples collected in accordance with 10 CSR 60-15.070 at least once every six (6) months for one (1) year after corrosion control has been installed.

3. Any water system is deemed to have optimized corrosion control if it submits results of tap water monitoring conducted in accordance with 10 CSR 60-15.070 and source water monitoring conducted in accordance with 10 CSR 60-15.090 that demonstrates for two (2) consecutive six (6)-month monitoring periods that the difference between the ninetieth percentile tap water lead level computed under 10 CSR 60-15.010(3)(C) and the highest source water lead concentration is less than the practical quantitation level for lead specified in 10 CSR 60-5.010(5)(H).

A. Those systems whose highest source water lead level is below the method detection limit may also be deemed to have optimized corrosion control under this paragraph if the ninetieth percentile tap water lead level is less than or equal to the practical quantitation level for lead for two (2) consecutive six (6)-month monitoring periods.

B. Any water system deemed to have optimized corrosion control in accordance with this paragraph (2)(B)3. shall continue monitoring for lead and copper at the tap no less frequently than once every three (3) calendar years using the reduced number of sites specified in 10 CSR 60-15.070(3) and collecting the samples at times and locations specified in 10 CSR 60-15.070(4)(D)4.

C. Any water system deemed to have optimized corrosion control pursuant to this paragraph (2)(B)3. shall notify the department in writing pursuant to 10 CSR 60-7.020(1)(C) of any change in treatment or the addition of a new source. The department may require any such system to conduct additional monitoring or to take other action the department deems appropriate to ensure that such systems maintain minimal levels of corrosion in the distribution system.

D. A system is not deemed to have optimized corrosion control pursuant to this paragraph (2)(B)3., and shall implement corrosion control treatment pursuant to subparagraph (2)(B)3.E. of this rule unless it meets the copper action level.

E. Any system triggered into corrosion control because it is no longer deemed to have optimized corrosion control under paragraph (2)(B)3. shall implement corrosion control treatment in accordance with the deadlines in subsection (2)(A) of this rule. Any such large system shall adhere to the schedule specified in subsection (2)(A) of this rule for medium-size systems, with the time periods for completing each step being triggered by the date the system is no longer deemed to have optimized corrosion control under paragraph (2)(B)3. of this rule; and

(C) Any small- or medium-size water system that is required to complete the corrosion control steps due to its exceedance of the lead or copper action level may cease completing the treatment steps whenever the system meets both action levels during each of two (2) consecutive monitoring periods conducted pursuant to 10 CSR 60-15.070 and submits the results to the department. If any such water system after that exceeds the lead or copper action level during any monitoring period, the system (or the department, as the case may be) shall recommence completion of the applicable treatment steps, beginning with the first treatment step which was not previously completed in its entirety. The department may require a system to repeat treatment steps previously completed by the system where the department determines that this is necessary to implement properly the treatment requirements of this section. The department shall notify the system in writing of the determination and explain the basis for its decision. The requirement for any small- or medium-size system to implement corrosion control treatment steps (including systems deemed to have optimized corrosion control) is triggered whenever any small- or medium-size system exceeds the lead or copper action level.

AUTHORITY: section 640.100, RSMo 2000. Original rule filed Aug. 4, 1992, effective May 6, 1993. Amended: Filed Aug. 14, 2001, effective April 30, 2002.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-15.030 Description of Corrosion Control Treatment Requirements

PURPOSE: This rule describes the corrosion control treatment requirements which are applicable to all water systems under 10 CSR 60-15.020.

(1) Based upon the results of lead and copper tap monitoring and water quality parameter monitoring, small- (serving fewer than three thousand three hundred (3,300) persons) and medium-size (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) water systems exceeding the lead or copper action level shall recommend installation of one (1) or more of the corrosion control treatments listed in subsection (3)(A), which the system believes constitutes optimal corrosion control for that system. The department may require the system to conduct additional water quality parameter monitoring in

accordance with 10 CSR 60-15.080(2) and perform corrosion control studies as described in this rule to assist the department in reviewing the system's recommendations.

(2) The department may require any small- or medium-sized systems that exceed the lead or copper action level to perform corrosion control studies under section (3) of this rule to identify optimal corrosion control treatment for the system.

(3) Performance of Corrosion Control Studies.

(A) Any public water system performing corrosion control studies shall evaluate the effectiveness of each of the following treatments and, if appropriate, combinations of the following treatments to identify the optimal corrosion control treatment for that system:

1. Alkalinity and pH adjustment;
2. Calcium hardness adjustment; and
3. The addition of a phosphate or silicate based corrosion inhibitor at a concentration sufficient to maintain an effective residual concentration in all test tap samples.

(B) The water system shall evaluate each of the corrosion control treatments using either pipe rig/loop tests, metal coupon tests, partial-system tests or analyses based on documented analogous treatments with other systems of similar size, water chemistry and distribution system configuration.

(C) The water system shall measure the following water quality parameters in any tests conducted under this section before and after evaluating the corrosion control treatments listed in paragraph (3)(A)1. of this rule:

1. Lead;
2. Copper;
3. pH;
4. Alkalinity;
5. Calcium;
6. Conductivity;
7. Orthophosphate (when an inhibitor containing a phosphate compound is used);
8. Silicate (when an inhibitor containing a silicate compound is used); and
9. Water temperature.

(D) The water system shall identify all chemical or physical constraints that limit or prohibit the use of a particular corrosion control treatment and document these constraints with at least one (1) of the following:

1. Data and documentation showing that a particular corrosion control treatment has adversely affected other water treatment processes when used by another water system with comparable water quality characteristics; or
2. Data and documentation demonstrating that the water system has previously attempted to evaluate a particular corrosion control treatment and has found that the treatment is ineffective or adversely affects other water quality treatment processes.

(E) The water system shall evaluate the effect of the chemicals used for corrosion control treatment on other water quality treatment processes.

(F) On the basis of an analysis of the data generated during each evaluation, the water system shall recommend to the department, in writing, the treatment option that the corrosion control studies indicate constitutes optimal corrosion control treatment for that system. The water system shall provide a rationale for its recommendation along with all supporting documentation specified in this section.

(4) Based upon consideration of available information including, where applicable, studies performed under section (3) of this rule and a system's recommended treatment alternative, the department shall either approve the corrosion control treatment option recommended by the system or designate alternative corrosion control treatment(s) from among those listed in subsection (3)(A) of this rule. When designating optimal treatment, the department shall consider the effects that additional corrosion control treatment will have on the water quality parameters and on other water quality treatment processes.

(5) The department, in writing, shall notify the system of its decision on optimal corrosion control treatment and explain the basis for this determination. If the department requests additional information to aid its review, the water system shall provide the information.

(6) Each system shall properly install and operate throughout its distribution system the optimal corrosion control treatment designated by the department.

(7) The department shall evaluate the results of all lead and copper tap samples and water quality parameter samples submitted by the water system and determine whether the system has properly installed and operated the optimal corrosion control treatment designated by the department. Upon reviewing the results of tap water and water quality parameter monitoring by the system, both before and after the system installs optimal corrosion control treatment, the department shall designate—

(A) A minimum value or a range of values for pH measured at each entry point to the distribution system;

(B) A minimum pH value measured in all tap samples. That value shall be equal to or greater than 7.0, unless the department determines that meeting a pH level of 7.0 is not technologically feasible or is not necessary for the system to optimize corrosion control;

(C) If a corrosion inhibitor is used, a minimum concentration or a range of concentrations for the inhibitor measured at each entry point to the distribution system and in all tap samples, that the department determines is necessary to form a passivating film on the interior walls of the pipes of the distribution system;

(D) If alkalinity is adjusted as part of optimal corrosion control treatment, a minimum concentration or a range of concentrations for alkalinity, measured at each entry point to the distribution system and in all tap samples;

(E) If calcium carbonate stabilization is used as part of corrosion control, a minimum concentration or a range of concentrations for calcium, measured in all tap samples.

(F) The values for the applicable water quality control parameters listed in this section shall be those that the department determines to reflect optimal corrosion control treatment for the system. The department may designate values for additional water quality control parameters determined by the department to reflect optimal corrosion control for the system. The department shall notify the system, in writing, of these determinations and explain the basis for its decisions.

(8) All systems optimizing corrosion control shall continue to operate and maintain optimal corrosion control treatment, including maintaining water quality parameters at or above minimum values or within ranges designated by the department under section (7) of this rule for all samples collected under 10 CSR 60-15.080(4)–(6). Compliance with this section shall be determined every six (6) months, as specified under 10 CSR 60-15.080(4). A water system is out of compliance with the requirements of this section (8) for a six (6)-month period if it has excursions for any department-specified parameter on more than nine (9) days during the period. An excursion occurs whenever the daily value for one (1) or more of the water quality parameters measured at a sampling location is below the minimum value or outside the range designated by the department. Daily values are calculated as follows. The department shall have discretion to delete results of obvious sampling errors from this calculation.

(A) On days when more than one (1) measurement for the water quality parameter is collected at the sampling location, the daily value shall be the average of all results collected during the day regardless of whether they are collected through continuous monitoring, grab sampling, or a combination of both.

(B) On days when only one (1) measurement for the water quality parameter is collected at the sampling location, the daily value shall be the result of that measurement.

(C) On days when no measurement is collected for the water quality parameter at the sampling location, the daily value shall be the daily value calculated on the most recent day on which the water quality parameter was measured at the sample site.

(9) The department, upon its own initiative or in response to a request by a water system or other interested party, may modify its determination of the optimal corrosion control treatment or optimal water quality control parameters. A request for modification by a system or other interested party shall be in writing, explain why the modification is appropriate and provide supporting documentation. The department may modify its determination where it concludes that the change is necessary to ensure that the system continues to optimize corrosion control treatment. A revised determination shall be made in writing, setting forth the new treatment requirements, explaining the basis for the department's decision and providing an implementation schedule for completing the treatment modifications.

AUTHORITY: section 640.100, RSMo 2000. Original rule filed Aug. 4, 1992, effective May 6, 1993. Amended: Filed Aug. 14, 2001, effective April 30, 2002.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-15.040 Source Water Treatment Requirements

PURPOSE: This rule describes the required corrosion control treatment steps for a system's source water and establishes treatment requirement deadlines.

(1) The following are deadlines for completing source water treatment steps:

(A) A system exceeding the lead or copper action level shall complete lead and copper source water monitoring under 10 CSR 60-15.090(2) and make a treatment recommendation to the department within six (6) months after exceeding the lead or copper action level;

(B) The department shall make a determination regarding source water treatment within six (6) months after submission of monitoring results under subsection (1)(A) of this rule;

(C) If the department requires installation of source water treatment, the system shall install the treatment within twenty-four (24) months after the completion of subsection (1)(B) of this rule;

(D) The system shall complete follow-up tap water monitoring and source water monitoring within thirty-six (36) months after completion of subsection (1)(B) of this rule;

(E) The department shall review the system's installation and operation of source water treatment and specify maximum permissible source water levels within six (6) months after completion of subsection (1)(D) of this rule;

(F) The system shall operate in compliance with the department-specified maximum permissible lead and copper source water levels and continue source water monitoring.

(2) Any system which exceeds the lead or copper action level shall recommend in writing to the department the installation and operation of one (1) of the source water treatments listed in the following subsections. A system may recommend that no treatment be installed based upon a demonstration that source water treatment is not necessary to minimize lead and copper levels at users' taps:

(A) The department shall complete an evaluation of the results of all source water samples submitted by the water system to determine whether source water treatment is necessary to minimize lead or copper levels in water delivered to users' taps. If the department determines that treatment is needed, the department shall either require installation and operation of the source water treatment recommended by the system, if any, or require the installation and operation of another source water treatment from the following: ion exchange, reverse osmosis, lime softening or coagulation/filtration. If the department requests additional information to aid in its review, the water system shall provide the information by the date specified by the department in its request. The department shall notify the system in writing of its determination and set forth the basis for its decision;

(B) Each system shall properly install and operate the source water treatment designated by the department;

(C) The department shall review the source water samples taken by the water system both before and after the system installs source water treatment, and determine whether the system has properly installed and operated the source water treatment designated by the department. Based upon its review, the department shall designate the maximum permissible lead and copper concentrations for finished water entering the distribution system. These levels shall reflect the contaminant removal capability of the treatment properly operated and maintained. The department shall notify the system in writing and explain the basis for its decision;

(D) Each water system shall maintain lead and copper levels below the maximum permissible concentrations designated by the department at each sampling point monitored in accordance with 10 CSR 60-15.090. The system is out of compliance if the level of lead or copper at any of the sampling points are greater than the maximum permissible concentration designated by the department; or

(E) The department, upon its own initiative or in response to a request by a water system or other interested party, may modify its determination of the source water treatment or maximum permissible lead and copper concentrations for finished water entering the distribution system. A request for modification by a system or other interested party shall be in writing, explain why the modification is appropriate and provide supporting documentation. The department may modify its determination where it concludes that the change is necessary to ensure that the system continues to minimize lead and copper concentrations in the source water. A revised determination shall be made in writing, set forth the new treatment requirements, explain the basis for the department's decision and provide an implementation schedule for completing the treatment modifications.

AUTHORITY: section 640.100, RSMo Supp. 1989. Original rule filed Aug. 4, 1992, effective May 6, 1993.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989.*

10 CSR 60-15.050 Lead Service Line Replacement Requirements

PURPOSE: This rule sets forth requirements for the removal of lead service lines if lead action levels are exceeded, and corrosion control efforts and source water treatment are unsuccessful in lowering the lead concentration levels in tap samples.

(1) Systems that fail to meet the lead action level in tap samples taken pursuant to 10 CSR 60-15.070(4)(B), after installing corrosion control, source water treatment, or both (whichever sampling occurs later), shall replace lead service lines in accordance with the requirements of this section. If a system is in violation of 10 CSR 60-15.020 or 10 CSR 60-15.040 for failure to install source water or corrosion control treatment, the department may require the system to commence lead service line replacement under this section after the date by which the system was required to conduct monitoring under 10 CSR 60-15.070(4)(B) has passed.

(2) A water system shall replace annually at least seven percent (7%) of the initial number of lead service lines in its distribution system. The initial number of lead service lines is the number of lead lines in place at the time the replacement program begins. The system shall identify the initial number of lead service lines in its distribution system, including an identification of the portion(s) owned by the system, based upon a materials evaluation, including the evaluation required under 10 CSR 60-15.070(1) and relevant legal authorities (e.g., contracts, local ordinances) regarding the portion owned by the system. The first year of lead service line replacement shall begin on the date the action level was exceeded in tap sampling referenced in section (1) of this rule.

(3) A system is not required to replace an individual lead service line if the lead concentration in all service line samples from that line, taken pursuant to 10 CSR 60-15.070(2)(C), is less than or equal to 0.015 milligrams per liter (mg/l).

(4) A water system shall replace that portion of the lead service line that it owns. In cases where the system does not own the entire lead service line, the system shall notify the owner of the line, or the owner's authorized agent, that the system will replace the portion of the service line that it owns and shall offer to replace the owner's portion of the line. A system is not required to bear the cost of replacing the privately-owned portion of the line, nor is it required to replace the privately-owned portion where the owner chooses not to pay the cost of replacing the privately-owned portion of the line, or where replacing the privately-owned portion would be precluded by department, local or common law. A water system that does not replace the entire length of the service line also shall complete the following tasks:

(A) At least forty-five (45) days prior to commencing with the partial replacement of a lead service line, the water system shall provide notice to the resident(s) of all buildings served by the line explaining that they may experience a temporary increase of lead levels in their drinking water, along with guidance on measures consumers can take to minimize their exposure to lead. The department may allow the water system to provide this notice less than forty-five (45) days prior to commencing partial lead service line replacement where such replacement is in conjunction with emergency repairs. In addition, the water system shall inform the resident(s) served by the line that the system will, at the system's expense, collect a sample from each partially-replaced lead service line that is representative of the water in the service line for analysis of lead content, as prescribed under 10 CSR 60-15.070(2)(C), within seventy-two (72) hours after the completion of the partial replacement of the service line. The system shall collect the sample and report the results of the analysis to the owner and the resident(s) served by the line within three (3) business days of receiving the results. Mailed notices postmarked within three (3) business days of receiving the results shall be considered "on time"; and

(B) The water system shall provide the information required by subsection (4)(A) of this rule to the residents of individual dwellings by mail or by other methods approved by the department. In instances where multi-family dwellings are served by the line, the water system shall have the option to post the information at a conspicuous location.

(5) The department shall require a system to replace lead service lines on a shorter time schedule than that required by this section, taking into account the number of lead service lines in the system, where such a shorter replacement schedule is feasible. The department shall make this determination in writing and notify the system of its finding within six (6) months after the system is triggered into lead service line replacement based on monitoring referenced in section (1) of this rule.

(6) Any system may cease replacing lead service lines whenever first-draw tap samples collected pursuant to 10 CSR 60-15.070(4)(C) meet the lead action level during each of two (2) consecutive monitoring periods and the system submits the results to the department. If the first-draw tap samples in any such water system after that exceed the lead action level, the system shall recommence replacing lead service lines, pursuant to section (2) of this rule.

(7) To demonstrate compliance with sections (1)–(4) of this rule, a system shall report to the department the information specified in 10 CSR 60-7.020(5).

AUTHORITY: section 640.100, RSMo 2000. Original rule filed Aug. 4, 1992, effective May 6, 1993. Amended: Filed Aug. 14, 2001, effective April 30, 2002.*

*Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.

10 CSR 60-15.060 Public Education and Supplemental Monitoring Requirements

PURPOSE: This rule sets forth the content and mode of delivery of written and broadcast materials to be used by water systems when action levels have been exceeded. It also addresses supplemental monitoring and notification of results for any customer who requests that monitoring.

(1) Content of Written Materials.

(A) Community Water Systems. A community water system shall include the following text in all of the printed materials it distributes through its lead public education program. Systems may delete information pertaining to lead service lines, upon approval by the department, if no lead service lines exist anywhere in the water system service area. Public education language at parts (1)(A)4.B.(V) and (1)(A)4.D.(II) of this rule may be modified regarding building permit record availability and consumer access to these records, if approved by the department. Any additional information presented by a system shall be consistent with the information in this rule and be in plain English that can be understood by lay persons. A water system that exceeds the lead action level based on tap water samples collected in accordance with 10 CSR 60-15.070 shall deliver the public education materials contained in sections (1) and (2) of this rule in accordance with the requirements in section (3) of this rule.

1. Introduction. "The Missouri Department of Natural Resources (DNR) and *(insert name of water supplier)* are concerned about lead in your drinking water. Although most homes have very low levels of lead in their drinking water, some homes in the community have lead levels above the DNR action level of 15 parts per billion (ppb) or 0.015 milligrams of lead per liter of water (mg/l).

Under federal and state law we are required to have a program in place to minimize lead in your drinking water by *(insert date when corrosion control will be completed for your system)*. This program includes corrosion control treatment, source water treatment and public education. We are also required to replace the portion of each lead service line that we control if the line contributes lead concentrations of more than 15 ppb after we have completed the comprehensive treatment program. If you have any questions about how we are carrying out the requirements of the lead rule please give us a call at *(insert water system's phone number)*. This brochure explains the simple steps you can take to protect you and your family by reducing your exposure to lead in drinking water."

2. Health Effects of Lead. "Lead is a common metal found throughout the environment in lead-based paint, air, soil, household dust, food, certain types of pottery porcelain and pewter, brass fixtures and water. Lead can pose a significant risk to your health if too much of it enters your body. Lead builds up in the body over many years and can cause damage to the brain, red blood cells and kidneys. The greatest risk is to young children and pregnant women. Amounts of lead that will not hurt adults can slow down normal mental and physical development of growing bodies. In addition, a child at play often comes into contact with sources of lead contamination, like dirt and dust, that rarely affect an adult. It is important to wash children's hands and toys often, and to try to make sure they only put food in their mouths."

3. Lead in Drinking Water.

A. "Lead in drinking water, although rarely the sole cause of lead poisoning, can significantly increase a person's total lead exposure, particularly the exposure of infants who drink baby formulas and concentrated juices that are mixed with water. The DNR estimates that drinking water can make up 20 percent or more of a person's total exposure to lead.

B. "Lead is unusual among drinking water contaminants in that it seldom occurs naturally in water supplies like rivers and lakes. It is also rare in groundwater, even in Missouri's lead belt. Lead enters drinking water primarily as a result of the corrosion, or wearing away, of materials containing lead in the water distribution system and household plumbing. These materials include lead-based solder used to join copper pipe, brass and chrome-plated brass faucets, and, in some cases, pipes made of lead that connect your house to the water main (service lines). In 1986, Congress banned the use of lead solder containing greater than 0.2 percent lead and restricted the lead content of faucets, pipes and other plumbing materials to 8.0 percent. Missouri rule 10 CSR 60-10.040 requires that as of January 1, 1989, all materials used in the construction, expansion, modification or improvement of a public water system or customer water system shall be lead-free. This does not apply to leaded joints necessary for the repair of cast iron pipes. In addition, any customer water system constructed, expanded, modified or repaired after January 1, 1989, that is connected to a public water system and later is found to contain materials that are not lead-free, shall have the water meter removed or otherwise have the service line severed from the public water system when the supplier of water is so ordered by the appropriate local government authority (if one exists) or by the department. This requirement does not apply to any customer water system previously served by a water system other than a public water system.

C. "When water stands in lead pipes or plumbing systems containing lead for several hours or more, the lead may dissolve into your drinking water. This means the first water drawn from the tap in the morning or later in the afternoon after returning from work or school can contain fairly high levels of lead."

4. Steps You Can Take in the Home to Reduce Exposure to Lead in Drinking Water.

A. "Despite our best efforts mentioned earlier to control water corrosivity and remove lead from the water supply, lead levels in some homes or buildings can be high. To find out whether you need to take action in your own home, have your drinking water tested to determine if it contains excessive concentrations of lead. Testing the water is essential because you cannot see, taste or smell lead in drinking water. Some local laboratories that can provide this service are listed at the end of this booklet. For more information on having your water tested, please call *(insert phone number of water system)*.

B. "If a water test indicates that the drinking water drawn from a tap in your home contains lead above 15 ppb, then you should take the following precautions:

(I) "Let the water run from the tap before using it for drinking or cooking any time the water in a faucet has gone unused for more than six hours. The longer water resides in your home's plumbing the more lead it may contain. Flushing the tap means running the cold water faucet until the water gets noticeably colder, usually about 15–30 seconds. If your house has a lead service line to the water main, you may have to flush the water for a longer time, perhaps one minute, before drinking. Although toilet flushing or showering flushes water through a portion of your home's plumbing system, you still need to flush the water in each faucet before using it for drinking or cooking. Flushing tap water is a simple and inexpensive measure you can take to protect your family's health. It usually uses less than one or two gallons of water and costs less than *(insert a cost estimate based on flushing two times a day for* 30 *days)* per month. To conserve water, fill a couple of bottles for drinking water after flushing the tap and whenever possible use the first flush water to wash the dishes or water the plants. If you live in a high-rise building, letting the water flow before using it may not work to lessen your risk from lead. The plumbing systems have more, and sometimes larger pipes than smaller buildings. Ask your landlord for help in locating the source of the lead and for advice on reducing the lead level;

(II) "Try not to cook with or drink water from the hot water tap. Hot water can dissolve more lead more quickly than cold water. If you need hot water, draw water from the cold tap and heat it on the stove;

(III) "Remove loose lead solder and debris from the plumbing materials installed in newly constructed homes, or homes in which the plumbing has recently been replaced, by removing the faucet strainers from all taps and running the water from three to five minutes. After that, periodically remove the strainers and flush out any debris that has accumulated over time;

(IV) "If your copper pipes are joined with lead solder that has been installed illegally since it was banned in 1989, notify the plumber who did the work and request that s/he replace the lead solder with lead-free solder. Lead solder looks dull gray and when scratched with a key looks shiny. In addition, notify the Public Drinking Water Program of the Missouri Department of Natural Resources at (800) 334-6946 about the violation;

(V) "Determine whether or not the service line that connects your home or apartment to the water main is made of lead. The best way to determine if your service line is made of lead is by either hiring a licensed plumber to inspect the line or by contacting the plumbing contractor who installed the line. You can identify the plumbing contractor by checking the city's record of building permits which should be maintained in the files of the *(insert name of department that issues building permits)*. A licensed plumber at the same time can check to see if your home's plumbing contains lead solder, lead pipes or pipe fittings that contain lead. The public water system that delivers water to your home should also maintain records of the materials located in the distribution system. If the service line that connects your dwelling to the water main contributes more than 15 ppb to drinking water, after our comprehensive treatment program is in place, we are required to replace the portion of the line we own. If the line is only partially controlled by the *(insert name of the city, county or water system that controls the line)*, we are required to provide the owner of the privately-owned portion of the line with information on how to replace the privately-owned portion of the service line, and offer to replace that portion of the line at the owner's expense. If we replace only the portion of the line that we own, we also are required to notify you in advance and provide you with information on the steps you can take to minimize exposure to any temporary increase in lead levels that may result from the partial replacement, to take a follow-up sample at our expense from the line within 72 hours after the partial replacement, and to mail or otherwise provide you with the results of that sample within three business days of receiving the results. Acceptable replacement alternatives include copper, steel, iron and plastic pipes; and

(VI) "Have an electrician check your wiring. If grounding wires from the electrical system are attached to your pipes, corrosion may be greater. Check with a licensed electrician or your local electrical code to determine if your wiring can be grounded elsewhere. Do not attempt to change the wiring yourself because improper grounding can cause electrical shock and fire hazards.

C. "The steps described above will reduce the lead concentrations in your drinking water. However, if a water test indicates that the drinking water coming from your tap contains lead concentrations in excess of 15 ppb after flushing, or after we have completed our actions to minimize lead levels, then you may want to take the following additional measures:

(I) "Purchase or lease a home treatment device. Home treatment devices are limited in that each unit treats only the water that flows from the faucet to which it is connected, and all of the devices require periodic maintenance and replacement. Devices, such as reverse osmosis systems or distillers, can effectively remove lead from your drinking water. Some activated carbon filters may reduce lead levels at the tap; however, all lead reduction claims should be investigated. Be sure to check the actual performance of a specific home treatment device before and after installing the unit; and

(II) "Purchase bottled water for drinking and cooking.

D. "You can consult a variety of sources for additional information. Your family doctor or pediatrician can perform a blood test for lead and provide you with information about the health effects of lead. State and local government agencies that can be contacted include:

(I) "*(Insert the name of city or county department of public utilities)* at *(insert phone number)* can provide you with information about your community's water supply and a list of local laboratories that have been certified by DNR for testing water quality;

(II) "*(Insert the name of city or county department that issues building permits)* at *(insert phone number)* can provide you with information about building permit records that should contain the names of plumbing contractors that plumbed your home; and

(III) "The Missouri Department of Health at (800) 392-7245 or the *(insert the name of the city or county health department)* at *(insert phone number)* can provide you with information about the health effects of lead and how you can have your child's blood tested.

E. "The following is a list of some state-approved laboratories in your area that you can call to have your water tested for lead: *(insert names and phone numbers of at least two (2) laboratories)*."

(B) Nontransient Noncommunity Water Systems. A nontransient noncommunity water system shall either include the text specified in subsection (1)(A) of this rule or shall include the following text in all of the printed materials it distributes through its lead public education program. Water systems may delete information pertaining to lead service lines upon approval by the department if no lead service lines exist anywhere in the water system service area. Any additional information presented by a system shall be consistent with the information below and be in plain English that can be understood by lay people.

1. Introduction. "The Missouri Department of Natural Resources (DNR) and *(insert name of water supplier)* are concerned about lead in your drinking water. Some drinking water samples taken from this facility have lead levels above the DNR action level of 15 parts per billion (ppb), or 0.015 milligrams of lead per liter of water (mg/l). We are required to have a program in place to minimize lead in your drinking water by *(insert date when corrosion control will be completed for your system)*. This program includes corrosion control treatment, source water treatment, and public education. We are also required to replace the portion of each lead service line that we own if the line contributes lead concentrations of more than 15 ppb after we have completed the comprehensive treatment program. If you have any questions about how we are carrying out the requirements of the lead regulation please give us a call at *(insert water system's phone number)*. This brochure explains the simple steps you can take to protect yourself by reducing your exposure to lead in drinking water."

2. Health effects of lead. "Lead is found throughout the environment in lead-based paint, air, soil, household dust, food, certain types of pottery porcelain and pewter, and water. Lead can pose a significant risk to your health if too much of it enters your body. Lead builds up in the body over many years and can cause damage to the brain, red blood cells and kidneys. The greatest risk is to young children and pregnant women. Amounts of lead that won't hurt adults can slow down normal mental and physical development of growing bodies. In addition, a child at play often comes into contact with sources of lead contamination—like dirt and dust—that rarely affect an adult. It is important to wash children's hands and toys often, and to try to make sure they only put food in their mouths."

3. Lead in drinking water.

A. "Lead in drinking water, although rarely the sole cause of lead poisoning, can significantly increase a person's total lead exposure, particularly the exposure of infants who drink baby formulas and concentrated juices that are mixed with water. The EPA estimates that drinking water can make up 20 percent or more of a person's total exposure to lead.

B. "Lead is unusual among drinking water contaminants in that it seldom occurs naturally in water supplies like rivers and lakes. Lead enters drinking water primarily as a result of the corrosion, or wearing away, of materials containing lead in the water distribution system and household plumbing. These materials include lead-based solder used to join copper pipe, brass and chrome-plated brass faucets, and in some cases, pipes made of lead that connect houses and buildings to water mains (service lines). In 1986, Congress banned the use of lead solder containing greater than 0.2 percent lead, and restricted the lead content of faucets, pipes and other plumbing materials to 8.0 percent.

C. "When water stands in lead pipes or plumbing systems containing lead for several hours or more, the lead may dissolve into your drinking water. This means the first water drawn from the tap in the morning, or later in the afternoon if the water has not been used all day, can contain fairly high levels of lead."

4. Steps you can take to reduce exposure to lead in drinking water.

A. "Let the water run from the tap before using it for drinking or cooking any time the water in a faucet has gone unused for more than six hours. The longer water resides in plumbing the more lead it may contain. Flushing the tap means running the cold water faucet for about 15–30 seconds. Although toilet flushing or showering flushes water through a portion of the plumbing system, you still need to flush the water in each faucet before using it for drinking or cooking. Flushing tap water is a simple and inexpensive measure you can take to protect your health. It usually uses less than one gallon of water.

B. "Do not cook with, or drink water from the hot water tap. Hot water can dissolve more lead more quickly than cold water. If you need hot water, draw water from the cold tap and then heat it.

C. "The steps described above will reduce the lead concentrations in your drinking water. However, if you are still concerned, you may wish to use bottled water for drinking and cooking.

D. "You can consult a variety of sources for additional information. Your family doctor or pediatrician can perform a blood test for lead and provide you with information about the health effects of lead. State and local government agencies that can be contacted include: *(insert the name or title of facility official if appropriate)* at *(insert phone number)* can provide you with information about your facility's water supply."

(C) "The Missouri Department of Health at (800) 392-7245 or the *(insert the name of the city or county health department)* at *(insert phone number)* can provide you with information about the health effects of lead."

(2) Content of Broadcast Materials. A water system shall include the following information in all public service announcements submitted under its lead public education program to television and radio stations for broadcasting:

"Why should everyone want to know the facts about lead and drinking water? Because unhealthy amounts of lead can enter drinking water through the plumbing in your home. That's why I urge you to do what I did. I had my water tested for *(insert free or $ per sample)*. You can contact the *(insert the name of the city or water system)* for information on testing and on simple ways to reduce your exposure to lead in drinking water.

To have your water tested for lead or to get more information about this public health concern please call *(insert the phone number of the city or water system)*."

(3) Delivery of a Public Education Program.

(A) In communities where a significant proportion of the population speaks a language other than English, public education materials shall be communicated in the appropriate language(s).

(B) A community water system that exceeds the lead action level on the basis of tap water samples collected in accordance with 10 CSR 60-15.070, and that is not already repeating public education tasks pursuant to subsection (3)(C), (3)(G) or (3)(H) of this rule within sixty (60) days shall—

1. Insert notices in each customer's water utility bill containing the information in section (1) of this rule, along with the following alert on the water bill itself in large print: "SOME HOMES IN THIS COMMUNITY HAVE ELEVATED LEAD LEVELS IN THEIR DRINKING WATER. LEAD CAN POSE A SIGNIFICANT RISK TO YOUR HEALTH. PLEASE READ THE ENCLOSED NOTICE FOR FURTHER INFORMATION." A community water system having a billing cycle that does not include a billing within sixty (60) days of exceeding the action level, or that cannot insert information in the water utility bill without making major changes to its billing system, may use a separate mailing to deliver the information in subsection (1)(A) of this rule as long as the information is delivered to each customer within sixty (60) days of exceeding the action level. Such water systems shall also include the "alert" language specified in this paragraph.

2. Submit the information in subsection (1)(A) of this rule to the editorial departments of the major daily and weekly newspapers circulated throughout the community;

3. Deliver pamphlets or brochures, or both, that contain the public education materials in paragraphs (1)(A)2. and 4. of this rule to facilities and organizations, including the following:

A. Public schools or local school boards, or both;

B. City or county health department;

C. Women, Infants and Children (WIC), Head Start Program(s), or both, whenever available;

D. Public and private hospitals or clinics, or both;

E. Pediatricians;

F. Family planning clinics;

G. Local welfare agencies; and

4. Submit the public service announcement in section (2) of this rule to at least five (5) of the radio and television stations with the largest audiences that broadcast to the community served by the water system.

(C) A community water system shall repeat the tasks contained in paragraphs (3)(B)1.—3. of this rule every twelve (12) months and the tasks contained in paragraph (3)(B)4. of this rule every six (6) months for as long as the system exceeds the lead action level.

(D) Within sixty (60) days after it exceeds the lead action level (unless it already is repeating public education tasks pursuant to subsection (3)(E) of this rule) a nontransient noncommunity water system shall deliver the public education materials contained in subsections (1)(A) or (B) of this rule as follows:

1. Post informational posters on lead in drinking water in a public place or common area in each of the buildings served by the system; and

2. Distribute informational pamphlets, brochures, or both, on lead in drinking water to each person served by the nontransient noncommunity water system. The system may utilize electronic transmission in lieu of or combined with printed materials as long as it achieves at least the same coverage.

(E) A nontransient noncommunity water system shall repeat the tasks contained in subsection (3)(D) of this rule at least once during every twelve (12) months in which the system exceeds the lead action level.

(F) A water system may discontinue delivery of public education materials if the system has met the lead action level during the most recent six (6)-month monitoring period conducted pursuant to 10 CSR 60-15.070. Such a system shall recommence public education in accordance with this section if it subsequently exceeds the lead action level during any monitoring period.

(G) A community water system may use the text specified in subsection (1)(B) of this rule instead of the text in subsection (1)(A) of this rule and may perform the tasks listed in subsections (3)(D) and (3)(E) of this rule instead of the tasks in subsections (3)(B) and (3)(C) of this rule if:

1. The system is a facility, such as a prison or a hospital, where the population served is not capable of or is prevented from making improvements to plumbing or installing point-of-use treatment devices; and

2. The system provides water as part of the cost of services provided and does not separately charge for water consumption.

(H) A community water system serving three thousand three hundred (3,300) or fewer people may omit the task contained in paragraph (3)(B)4. of this rule. As long as it distributes notices containing the information contained in paragraph (1)(A)1. of this rule to every household served by the system, such systems may further limit their public education programs as follows:

1. Systems serving five hundred (500) or fewer people may forego the task contained in paragraph (3)(B)2. of this rule. Such a system may limit the distribution of the public education materials required under paragraph (3)(B)3. of this rule to facilities and organizations served by the system that are most likely to be visited regularly by pregnant women and children, unless it is notified by the department in writing that it must make a broader distribution. A community water system serving three thousand three hundred (3,300) or fewer people that delivers public education in accordance with this paragraph shall repeat the required public education tasks at least once during each calendar year in which the system exceeds the lead action level.

2. If approved by the department in writing, a system serving five hundred one to three thousand three hundred (501–3,300) people may omit the task in paragraph (3)(B)2. of this rule and/or limit the distribution of the public education materials required under paragraph (3)(B)3. of this rule to facilities and organizations served by the system that are most likely to be visited regularly by pregnant women and children.

(I) A community water system serving three thousand three hundred (3,300) or fewer people that delivers public education in accordance with subsection (3)(H) of this rule shall repeat the required public education tasks at least once during each calendar year in which the system exceeds the action level.

(4) Supplemental Monitoring and Notification of Results. A water system that fails to meet the lead action level on the basis of tap samples collected in accordance with 10 CSR 60-15.070 shall offer to sample the tap water of any customer who requests it. The system is not required to pay for collecting or analyzing the sample nor is the system required to collect and analyze the sample itself.

AUTHORITY: section 640.100, RSMo 2000. Original rule filed Aug. 4, 1992, effective May 6, 1993. Amended: Filed Aug. 14, 2001, effective April 30, 2002.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-15.070 Monitoring Requirements for Lead and Copper in Tap Water

PURPOSE: This rule establishes the monitoring requirements which are applicable to lead and copper in drinking water.

(1) Sample Site Location. A water system shall use the information on lead, copper and galvanized steel that it is required to collect under this section when conducting a materials evaluation. When an evaluation of the information collected pursuant to this section is insufficient to locate the requisite number of lead and copper sampling sites that meet the targeting criteria in subsection (1)(A) of this rule, the water system shall review the sources of information listed in this rule in order to identify a sufficient number of sampling sites. In addition, the system shall seek to collect that information where possible in the course of its normal operations (for example, checking service line materials when reading water meters or performing maintenance activities); all plumbing codes, permits and records in the files of the building department(s) which indicate the plumbing materials that are installed within publicly- and privately-owned structures connected to the distribution system; all inspections and records of the distribution system that indicate the material composition of the service connections that connect a structure to the distribution system; and all existing water quality information, which includes the results of all prior analyses of the system or individual structures connected to the system, indicating locations that may be particularly susceptible to high lead or copper concentrations.

(A) By the applicable date for commencement of monitoring under subsection (4)(A) of this rule, each water system shall complete a materials evaluation of its distribution system in order to identify a pool of targeted sampling sites that meets the requirements of this section and which is sufficiently large to ensure that the water system can collect the number of lead and copper tap samples required in section (3) of this rule. All sites from which first-draw samples are collected shall be selected from this pool of targeted sampling sites. Sampling sites may not include faucets that have point-of-use or point-of-entry treatment devices designed to remove inorganic contaminants.

(B) Community water supply systems shall identify whether the following construction materials are present in their distribution system:

1. Lead from piping, solder caulking, interior lining of distribution mains, alloys and home plumbing;
2. Copper from piping and alloys, service lines and home plumbing;
3. Ferrous piping materials, such as cast iron and steel;
4. Asbestos cement pipe;
5. Vinyl-lined asbestos cement pipe; and
6. Coal tar-lined pipes and tanks.

(C) The sampling sites selected for a community water system's sampling pool (tier 1 sampling sites) shall consist of single-family structures that contain copper pipes with lead solder installed after 1982, or contain lead pipes, or are served by a lead service line, or a combination of these. When multiple-family residences comprise at least twenty percent (20%) of the structures served by a water system, the system may include these types of structures in its sampling pool.

(D) Any community water system with insufficient tier 1 sampling sites shall complete its sampling pool with tier 2 sampling sites, consisting of buildings, including multiple-family residences, that contain copper pipes with lead solder installed after 1982, or contain lead pipes, or are served by a lead service line, or a combination of these.

(E) Any community water system with insufficient tier 1 and tier 2 sampling sites shall complete its sampling pool with tier 3 sampling sites, consisting of single-family structures that contain copper pipes with lead solder installed before 1983. A community water system with insufficient tier 1, tier 2, and tier 3 sampling sites shall complete its sampling pool with representative sites throughout the distribution system. A representative site is a site in which the plumbing materials used at that site would be commonly found at other sites served by the water system.

(F) The sampling sites selected for a nontransient noncommunity water system (tier 1 sampling sites) shall consist of buildings that contain copper pipes with lead solder installed after 1982, or contain lead pipes, or are served by a lead service line, or a combination of these.

(G) A nontransient noncommunity water system with insufficient tier 1 sites that meet the targering criteria in subsection (1)(F) of this rule shall complete its sampling pool with sampling sites that contain copper piper with lead solder installed before 1983. If additional sites are needed to complete the sampling pool, the nontransient noncommunity water system shall use representative sites throughout the distribution system. A representative site is a site in which the plumbing materials used at that site would be commonly found at other sites served by the water system.

(H) Any water system whose distribution system contains lead service lines shall draw fifty percent (50%) of the samples it collects during each monitoring period from sites that contain lead pipes or copper pipes with lead solder and fifty percent (50%) of those samples from sites served by a lead service line. A water system that cannot identify a sufficient number of sampling sites served by a lead service line shall collect first-draw samples from all of the sites identified as being served by these lines.

(2) Sample Collection Methods.

(A) All tap samples for lead and copper collected in accordance with this rule, with the exception of lead service line samples collected under 10 CSR 60-15.050(3) and samples collected under subsection (2)(E) of this rule, shall be first-draw samples.

(B) Each first-draw tap sample for lead and copper shall be one (1) liter in volume and have stood motionless in the plumbing system of each sampling site for at least six (6) hours. First-draw samples from residential housing shall be collected from the cold-water kitchen tap or bathroom sink tap. First-draw samples from a nonresidential building shall be one (1) liter in volume and shall be collected at an interior tap from which water is typically drawn for consumption. Non-first-draw samples collected in lieu of first-draw samples pursuant to subsection (2)(E) of this rule shall be one (1) liter in volume and shall be collected at an interior tap from which water is typically drawn for consumption. First-draw samples may be collected by the system or the system may allow residents to collect first-draw samples after instructing the residents of the sampling procedures specified in this section. To avoid problems of residents handling nitric acid, acidification of first-draw samples may be done up to fourteen (14) days after the sample is collected. After acidification to resolubilize the metals, the sample must stand in the original container for the time specified in the approved United States Environmental Protection Agency (U.S. EPA) method before the sample can be analyzed. If a system allows residents to perform sampling, the system may not challenge, based on alleged errors in sample collection, the accuracy of sampling results.

(C) Each service line sample shall be one (1) liter in volume and have stood motionless in the lead service line for at least six (6) hours. Lead service line samples shall be collected in one (1) of the following three (3) ways:

1. At the tap after flushing the volume of water between the tap and the lead service line. The volume of water shall be calculated based on the interior diameter and length of the pipe between the tap and the lead service line;

2. Tapping directly into the lead service line; or

3. If the sampling site is a building constructed as a single-family residence, allowing the water to run until there is a significant change in temperature which would be indicative of water that has been standing in the lead service line.

(D) A water system shall collect each first-draw tap sample from the same sampling site from which it collected a previous sample. If, for any reason, the water system cannot gain entry to a sampling site in order to collect a follow-up tap sample, the system may collect the follow-up tap sample from another sampling site in its sampling pool as long as the new site meets the same targeting criteria and is within reasonable proximity of the original site.

(E) A nontransient noncommunity water system, or a community water system that meets the criteria of 10 CSR 60-15.060, that does not have enough taps that can supply first-draw samples as defined in 10 CSR 60-2.015 may, with department approval, apply substitute non-first-draw samples. Such systems shall collect as many first-draw samples from appropriate taps as possible and identify sampling times and locations that would likely result in the longest standing time for the remaining sites.

(3) Number of Samples. Water systems shall collect at least one (1) sample during each monitoring period specified in subsection (4)(D) of this rule from the number of sites listed in the second column ("Standard Monitoring") of Table 1. A system conducting reduced monitoring under subsection (4)(D) of this rule shall collect at least one (1) sample from the number of sites specified in the third column ("Reduced Monitoring") of Table 1 during each monitoring period specified in subsection (4)(D) of this rule. Such reduced monitoring sites shall be representative of the sites required for standard monitoring. The department may specify sampling locations when a system is conducting reduced monitoring.

Table 1.

System Size (# People Served)	Number of Sites (Standard Monitoring)	Number of Sites (Reduced Monitoring)
>100,000	100	50
10,001–100,000	60	30
3,301–10,000	40	20
501– 3,300	20	10
101–500	10	5
≤100	5	5

(4) Timing of Monitoring.

(A) Initial Tap Sampling. The first six (6)-month monitoring period for small (serving less than or equal to three thousand three hundred (3,300) persons), medium-size (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) and large (serving more than fifty thousand (>50,000) persons) systems shall begin on the following dates:

System Size (# People Served)	First Six (6)-Month Monitoring Period Begins On
>50,000	January 1, 1992
3,301–50,000	July 1, 1992
≤3,300	July 1, 1993

1. All large systems shall monitor during two (2) consecutive six (6)-month periods.

2. All small- and medium-size systems shall monitor during each six (6)-month monitoring period until the system—

A. Exceeds the lead or copper action level and is therefore required to implement the corrosion control treatment requirements under 10 CSR 60-15.020, in which case the system shall continue monitoring in accordance with subsection (4)(B) of this rule; or

B. Meets the lead and copper action levels during two (2) consecutive six (6)-month monitoring periods, in which case the system may reduce monitoring in accordance with subsection (4)(D) of this rule.

(B) Monitoring After Installation of Corrosion Control and Source Water Treatment.

1. Any large system which installs optimal corrosion control treatment pursuant to 10 CSR 60-15.020(1)(A)4. shall monitor during two (2) consecutive six (6)-month monitoring periods by the date specified in 10 CSR 60-15.020(1)(A)5.

2. Any small- or medium-size system which installs optimal corrosion control treatment pursuant to 10 CSR 60-15.020(2)(A)5. shall monitor during two (2) consecutive six (6)-month monitoring periods by the date specified in 10 CSR 60-15.020(2)(A)6.

3. Any system which installs source water treatment pursuant to 10 CSR 60-15.040(1)(C) shall monitor during two (2) consecutive six (6)-month monitoring periods by the date specified in 10 CSR 60-15.040(1)(D).

(C) After the department specifies the values for water quality control parameters under 10 CSR 60-15.030(6), the system shall monitor during each subsequent six (6)-month monitoring period, with the first monitoring period to begin on the date the department specifies the optimal values under 10 CSR 60-15.030(6).

(D) Reduced Monitoring.

1. A small- or medium-size water system that meets the lead and copper action levels during each of two (2) consecutive six (6)-month monitoring periods may reduce the number of samples in accordance with section (3) of this rule and reduce the frequency of sampling to once per year.

2. Any water system that maintains the range of values for the water quality control parameters reflecting optimal corrosion control treatment specified under 10 CSR 60-15.030(7) during each of two (2) consecutive six (6)-month monitoring periods may reduce the number of lead and copper samples in accordance with section (3) of this rule. The department shall review monitoring, treatment and other relevant information submitted by the water system in accordance with 10 CSR 60-7.020, and shall notify the system in writing when it determines the system is eligible to commence reduced monitoring. The department shall review and, where appropriate, revise its determination when the system submits new monitoring or treatment data or when other data relevant to the number and frequency of tap sampling becomes available.

3. A small- or medium-size water system that meets the lead and copper action levels during three (3) consecutive years of monitoring may reduce the frequency of monitoring for lead and copper from annually to once every three (3) years. Any water system that maintains the range of values for the water quality control parameters reflecting optimal corrosion control treatment specified by the department under 10 CSR 60-15.030(6) during three (3) consecutive years of monitoring may reduce the frequency of monitoring from annually to once every three (3) years if it receives written approval from the department. The department shall review monitoring, treatment, and other relevant information submitted by the water system in accordance with 10 CSR 60-7.020 and shall notify the system in writing when it determines the system is eligible to reduce the frequency of monitoring to once every three (3) years. The department shall review and, where appropriate, revise its determination when the system submits new monitoring or treatment data or when other data relevant to the number and frequency of tap sampling becomes available.

4. A water system that reduces the number and frequency of sampling shall collect these samples from representative sites included in the pool of targeted sampling sites identified in section (1) of this rule. Systems sampling annually or less frequently shall conduct the lead and copper tap sampling during the months of June, July, August or September unless the department has approved a different sampling period.

A. The department, at its discretion, may approve a different period for conducting the lead and copper tap sampling for systems collecting a reduced number of samples. Such a period shall be no longer than four (4) consecutive months and must represent a time of normal operation where the highest levels of lead are most likely to occur. For a nontransient noncommunity water system that does not operate during the months of June through September, and for which the period of normal operation where the highest levels of lead are most likely to occur is not known, the department shall designate a period that represents a time of normal operation for the system.

B. Systems monitoring annually, that have been collecting samples during the months of June through September and that receive department approval to alter their sample collection period, must collect their next round of samples during a time period that ends no later than twenty-one (21) months after the previous round of sampling. Systems monitoring triennially that have been collecting samples during the months of June through September and receive department approval to alter the sampling collection period, must collect their next round of samples during a time period that ends no later than forty-five (45) months after the previous round of sampling. Subsequent rounds of sampling must be collected annually or triennially, as required by this section. Small systems with waivers, granted pursuant to section (6) of this rule, that have been collecting samples during the months of June through September and receive department approval to alter their sample collection period must collect their next round of samples before the end of the nine (9)-year period.

5. A small- or medium-size water system subject to reduced monitoring that exceeds the lead or copper action level shall resume sampling in accordance with subsection (4)(C) of this rule and collect the number of samples specified for standard monitoring under section (3) of this rule. This system also shall conduct water quality parameter monitoring in accordance with 10 CSR 60-15.080(3) or (4) (as appropriate) during the monitoring period in which it exceeded the action level. Any such system may resume annual monitoring for lead and copper at the tap at the reduced number of sites specified in section (3) of this rule after it has completed two (2) subsequent consecutive six (6)-month rounds of monitoring that meet the criteria of paragraph (4)(D)1. of this rule and/or may resume triennial monitoring for lead and copper at the reduced number of sites after it demonstrates through subsequent rounds of monitoring that it meets the criteria of either paragraph (4)(D)3. or (4)(D)5. of this rule.

6. Any water system that demonstrates for two (2) consecutive six (6)-month monitoring periods that the tap water lead level computed under 10 CSR 60-15.010(3)(C) is less than or equal to 0.005 mg/l and the tap water copper level computed under 10 CSR 60-15.010(3)(C) is less than or equal to 0.65 mg/l may reduce the number of samples in accordance with section (3) of this rule and reduce the frequency of sampling to once every three (3) calendar years.

7. Any water system subject to the reduced monitoring frequency that fails to operate at or above the minimum value or within the range of values for the water quality parameters specified by the department under 10 CSR 60-15.030(6) for more than nine (9) days in any six (6)-month period specified in 10 CSR 60-15.080(4) shall conduct tap water sampling for lead and copper at the frequency specified in subsection (4)(C) of this rule, collect the number of samples specified for standard monitoring under section (3) of this rule, and shall resume monitoring for water quality parameters within the distribution system in accordance with 10 CSR 60-15.030(4). Such a system may resume reduced monitoring for lead and copper at the tap and for water quality parameters within the distribution system under the following conditions:

A. The system may resume annual monitoring for lead and copper at the tap at the reduced number of sites specified in section (3) of this rule after it has completed two (2) subsequent six (6)-month rounds of monitoring that meet the criteria of paragraph (4)(D)2. of this rule and the system has received written approval from the department that it is appropriate to resume reduced monitoring on an annual frequency;

B. The system may resume triennial monitoring for lead and copper at the tap at the reduced number of sites after it demonstrates through subsequent rounds of monitoring that it meets the criteria of either paragraph (4)(D)3. or (4)(D)5. of this rule and the system has received written approval from the department that it is appropriate to resume triennial monitoring; and

C. The system may reduce the number of water quality parameter tap water samples required in accordance with 10 CSR 60-15.080(5)(A) and the frequency with which it collects such samples in accordance with 10 CSR 60-15.080(5)(B). Such a system may not resume triennial monitoring for water quality parameters at the tap until it demonstrates, in accordance with the requirements of 10 CSR 60-15.080(5)(B)2., that it has requalified for triennial monitoring.

8. Any water system subject to a reduced monitoring frequency under subsection (4)(D) of this rule that either adds a new source of water or changes any water treatment shall inform the department in writing in accordance with 10 CSR 60-7.020(1)(C). The department may require the system to resume sampling in accordance with subsection (4)(C) of this rule and collect the number of samples specified for standard monitoring in Table 1 of section (3) of this rule or take other appropriate steps such as increased water quality parameter monitoring or reevaluation of its corrosion control treatment given the potentially different water quality considerations.

(5) The results of any monitoring conducted, in addition to the minimum requirements of this section, shall be considered by the system and the department in making any determinations (that is, calculating the ninetieth percentile lead or copper level) under this rule.

(6) Invalidation of Lead or Copper Tap Water Samples. A sample invalidated under this section does not count toward determining lead or copper ninetieth percentile levels under 10 CSR 60-15.010(3)(C) or toward meeting the minimum monitoring requirements of Table 1 in section (3) of this rule.

(A) The department may invalidate a lead or copper tap water sample if one (1) of the following conditions is met:

1. The laboratory establishes that improper sample analysis caused erroneous results;

2. The department determines that the sample was taken from a site that did not meet the site selection criteria of this rule;

3. The sample container was damaged in transit; or

4. There is substantial reason to believe that the sample was subject to tampering.

(B) The system must report the results of all samples to the department and all supporting documentation for samples the system believes should be invalidated.

(C) To invalidate a sample under subsection (6)(A) of this rule, the decision and the rationale for the decision must be documented in writing. The department shall not invalidate a sample solely on the grounds that a follow-up sample result is higher or lower than that of the original sample.

(D) The water system must collect replacement samples for any samples invalidated under this section if, after the invalidation of one (1) or more samples, the system has too few samples to meet the minimum requirements of section (3) of this rule. Any such replacement samples must be taken as soon as possible, but no later than twenty (20) days after the date the department invalidates the sample or by the end of the applicable monitoring period, whichever occurs later. Replacement samples taken after the end of the applicable monitoring period shall not also be used to meet the monitoring requirements of a subsequent monitoring period. The replacement samples shall be taken at the same locations as the invalidated samples or, if that is not possible, at locations other than those already used for sampling during the monitoring period.

(7) Monitoring Waivers for Small Systems. Any small system that meets the criteria of this section may apply to the department to reduce the frequency of monitoring for lead and copper under this section to once every nine (9) years (that is, a "full waiver") if it meets all of the materials criteria specified in subsection (7)(A) of this rule and all of the monitoring criteria specified in subsection (7)(B) of this rule. Any small system that meets the criteria in subsection (7)(A) and (B) of this rule only for lead, or only for copper, may apply to the department for a waiver to reduce the frequency of tap water monitoring to once every nine (9) years for that contaminant only (that is, a "partial waiver").

(A) Materials Criteria. The system must demonstrate that its distribution system and service lines and all drinking water supply plumbing, including plumbing conveying drinking water within all residences and buildings connected to the system, are free of lead-containing materials and/or copper-containing materials, as those terms are defined here, as follows:

1. Lead. To qualify for a full waiver, or a waiver of the tap water monitoring requirements for lead (that is, a "lead waiver"), the water system must provide certification and supporting documentation to the department that the system is free of all lead-containing materials, as follows:

A. It contains no plastic pipes which contain lead plasticizers, or plastic service lines which contain lead plasticizers; and

B. It is free of lead service lines, lead pipes, lead soldered pipe joints, and leaded brass or bronze alloy fittings and fixtures, unless such fittings and fixtures meet the specifications of any standard established pursuant to 42 U.S.C. 300g–6(e) (SDWA section 1417(e)).

2. Copper. To qualify for a full waiver, or a waiver of the tap water monitoring requirements for copper (that is, a "copper waiver"), the water system must provide certification and supporting documentation to the department that the system contains no copper pipes or copper service lines.

(B) Monitoring Criteria for Waiver Issuance. The system must have completed at least one (1) six (6)-month round of standard tap water monitoring for lead and copper at sites approved by the department and from the number of sites required by Table 1 of section (3) of this rule and demonstrate that the ninetieth percentile levels for any and all rounds of monitoring conducted since the system became free of all lead-containing and/or copper-containing materials, as appropriate, meet the following criteria.

1. Lead levels. To qualify for a full waiver, or a lead waiver, the system must demonstrate that the ninetieth percentile lead level does not exceed 0.005 mg/l.

2. Copper levels. To qualify for a full waiver, or a copper waiver, the system must demonstrate that the ninetieth percentile copper level does not exceed 0.65 mg/l.

(C) Department Approval of Waiver Application. The department shall notify the system of its waiver determination, in writing, setting forth the basis of its decision and any condition of the waiver. As a condition of the waiver, the department may require the system to perform specific activities (e.g., limited monitoring, periodic outreach to customers to remind them to avoid installation of materials that might void the waiver) to avoid the risk of lead or copper concentration of concern in tap water. The small system must continue monitoring for lead and copper at the tap as required by subsections (4)(A)–(D) of this rule, as appropriate, until it receives written notification from the department that the waiver has been approved.

(D) Monitoring Frequency for Systems with Waivers.

1. A system with a full waiver must conduct tap water monitoring for lead and copper

in accordance with paragraph (4)(D)4. of this rule at the reduced number of sampling sites identified in Table 1 of section (3) of this rule at least once every nine (9) years and provide the materials certification specified in subsection (7)(A) of this rule for both lead and copper to the department along with the monitoring results.

2. A system with a partial waiver must conduct tap water monitoring for the waived contaminant in accordance with paragraph (4)(D)4. of this rule at the reduced number of sampling sites specified in Table 1 of section (3) of this rule at least once every nine (9) years and provide the materials certification specified in subsection (7)(A) of this rule pertaining to the waived contaminant along with the monitoring results. Such a system also must continue to monitor for the non-waived contaminant in accordance with requirements of subsection (4)(A) through (4)(D) of this rule, as appropriate.

3. If a system with a full or partial waiver adds a new source of water or changes any water treatment, the system must notify the department in writing in accordance with 10 CSR 60-7.020(1)(C). The department may require the system to add or modify waiver conditions (e.g., require recertification that the system is free of lead-containing and/or copper-containing materials, require additional round(s) of monitoring), if it deems such modifications are necessary to address treatment or source water changes at the system.

4. If a system with a full or partial waiver becomes aware that it is no longer free of lead-containing or copper-containing materials (for example, as a result of new construction or repairs), the system shall notify the department in writing no later than sixty (60) days after becoming aware of such a change.

(E) Continued Eligibility. If the system continues to satisfy the requirements of subsection (7)(D) of this rule, the waiver will be renewed automatically, unless any of the conditions listed in paragraph (7)(E)1.–3. of this rule occurs. A system whose waiver has been revoked may reapply for a waiver at such time as it again meets the appropriate materials and monitoring criteria of subsections (7)(A) and (7)(B) of this rule.

1. A system with a full waiver or a lead waiver no longer satisfies the materials criteria of paragraph (7)(A)1. of this rule or has a ninetieth percentile lead level greater than 0.005 mg/l.

2. A system with a full waiver or a copper waiver no longer satisfies the materials criteria of paragraph (7)(A)2. of this rule or has a ninetieth percentile copper level greater than 0.65 mg/l.

3. The department notifies the system, in writing, that the waiver has been revoked, setting forth the basis of its decision.

(F) Requirements Following Waiver Revocation. A system whose full or partial waiver has been revoked by the department is subject to the corrosion control treatment and lead and copper tap water monitoring requirements, as follows:

1. If the system exceeds the lead and/or copper action level, the system must implement corrosion control treatment in accordance with the deadlines specified in 10 CSR 60-15.010(5), and any other applicable requirements of this subpart.

2. If the system meets both the lead and the copper action level, the system must monitor for lead and copper at the tap no less frequently than once every three (3) years using the reduced number of sample sites specified in Table 1 of section (3) of this rule.

(G) Pre-existing Waivers. Small system waivers approved by the department in writing prior to April 11, 2000 shall remain in effect under the following conditions:

1. If the system has demonstrated that it is both free of lead-containing and copper-containing materials, as required by subsection (7)(A) of this rule and that its ninetieth percentile lead levels and ninetieth percentile copper levels meet the criteria of subsection (7)(B) of this rule, the waiver remains in effect so long as the system continues to meet the waiver eligibility criteria of subsection (7)(E) of this rule. The first round of tap water monitoring conducted pursuant to subsection (7)(D) of this rule shall be completed no later than nine (9) years after the last time the system has monitored for lead and copper at the tap.

2. *Reserved.*

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**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-15.080 Monitoring Requirements for Water Quality Parameters

PURPOSE: This rule sets forth the procedures and requirements for monitoring drinking water to determine how corrosive the water is to the distribution system.

(1) General Requirements. All large (serving more than fifty thousand (>50,000) persons) water systems and all small-(serving less than or equal to three thousand three hundred (≤3,300) persons) and medium-size (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) systems that exceed the lead or copper action level shall monitor water quality parameters in addition to lead and copper in accordance with this rule. The requirements of this rule are summarized in the table at the end of this rule.

(A) Sample Collection Methods.

1. Tap samples shall be representative of water quality throughout the distribution system taking into account the number of persons served, the different sources of water, the different treatment methods employed by the system and seasonal variability. Tap sampling under this rule is not required to be conducted at taps targeted for lead and copper sampling under 10 CSR 60-15.070(1). (Note: Systems may find it convenient to conduct tap sampling for water quality parameters at sites used for coliform sampling under 10 CSR 60-4.020(1)(A).)

2. Samples collected at the entry point(s) to the distribution system shall be from locations representative of each source after treatment. If a system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions (that is, when water is representative of all sources being used).

(B) Number of Samples.

1. Systems shall collect two (2) tap samples for applicable water quality parameters during each monitoring period specified under sections (2)–(5) of this rule from the following number of sites:

System Size (# People Served)	Sites for Water Quality Parameters (Number)
>100,000	25
10,001–100,000	10
3,301–10,000	3
501–3,300	2
101–500	1
≤100	1

2. Except as provided in subsection (3)(C) of this rule, Systems shall collect two (2) samples for each applicable water quality parameter at each entry point to the distribution system during each monitoring period specified in section (2) of this rule. During each monitoring period specified in sections (3)–(5) of this rule, systems shall collect one (1) sample for each applicable water quality parameter at each entry point to the distribution system.

(2) Initial Sampling. All large (serving more than fifty thousand (>50,000) persons) water systems shall measure the applicable water quality parameters as specified in this rule at taps and at each entry point to the distribution system during each six (6)-month monitoring period specified in 10 CSR 60-15.070(4)(A). All small (serving less than or equal to three thousand three hundred (≤3,300) persons) and medium-size (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) systems shall measure the applicable water quality parameters at the locations specified as follows during each six (6)-month monitoring period specified in 10 CSR 60-15.070(4)(A). during which the system exceeds the lead or copper action level:

(A) At taps—

1. pH;
2. Alkalinity;
3. Orthophosphate, when an inhibitor containing a phosphate compound is used;
4. Silica, when an inhibitor containing a silicate compound is used;
5. Calcium;
6. Conductivity; and
7. Water temperature; and

(B) At each entry point to the distribution system, all of the applicable parameters listed in subsection (2)(A) of this rule.

(3) Monitoring After Installation of Corrosion Control. Any large system which installs optimal corrosion control treatment pursuant to 10 CSR 60-15.020(1)(A)4. shall measure the water quality parameters at the locations and frequencies specified in this section during each six (6)-month monitoring period specified in 10 CSR 60-15.070(4)(B)1. Any small- or medium-size system which installs optimal corrosion control treatment shall conduct monitoring during each six (6)-month monitoring period as specified in 10 CSR 60-15.070(4)(B)2. in which the system exceeds the lead or copper action level.

(A) At taps, two (2) samples for—

1. pH;
2. Alkalinity;
3. Orthophosphate, when an inhibitor containing a phosphate compound is used;
4. Silica, when an inhibitor containing a silicate compound is used; and
5. Calcium, when calcium carbonate stabilization is used as part of corrosion control.

(B) Except as provided in subsection (3)(C) of this rule, at each entry point to the distribution system, at least one (1) sample no less frequently than every two (2) weeks (bi-weekly)—

1. For pH;
2. When alkalinity is adjusted as part of optimal corrosion control, a reading of the dosage rate of the chemical used to adjust alkalinity and the alkalinity concentration; and
3. When a corrosion inhibitor is used as part of optimal corrosion control, a reading of the dosage rate of the inhibitor used and the concentration of orthophosphate or silica (whichever is applicable).

(C) Any groundwater system can limit entry point sampling described in subsection (3)(B) of this rule to those entry points that are representative of water quality and treatment conditions throughout the system. If water from untreated groundwater sources mixes with water from treated groundwater sources, the system must monitor for water quality parameters both at representative entry points receiving treatment and representative entry points receiving no treatment. Prior to the start of any monitoring under this subsection, the system shall provide to the department written information identifying the selected entry points and documentation, including information on seasonal variability, sufficient to demonstrate that the sites are representative of water quality and treatment conditions throughout the system.

(4) Monitoring After Department Specifies Water Quality Parameter Values For Optimal Corrosion Control. After the department specifies the values for applicable water quality control parameters reflecting optimal corrosion control treatment under 10 CSR 60-15.030(7), all large (serving more than fifty thousand (>50,000) persons) systems shall measure the applicable water quality parameters in accordance with section (3) of this rule and determine compliance with the requirements of 10 CSR 60-15.030(8) every six (6) months with the first six (6)-month period to begin on the date the department specifies the optimal values under 10 CSR 60-15.030(7). Any small- (serving less than three thousand three hundred (<3,300) persons) or medium-size (serving three thousand three hundred one to fifty thousand (3,301–50,000) persons) system shall conduct such monitoring during each six (6)-month period specified in 10 CSR 60-15.070(4)(C) in which the system exceeds the lead or copper action level. For any such small- and medium-size system that is subject to a reduced monitoring frequency pursuant to 10 CSR 60-15.070(4)(D) at the time of the action level exceedance, the end of the applicable six (6)-month period under this section shall coincide with the end of the applicable monitoring period under 10 CSR 60-15.070(4)(D). Compliance with department-designated optimal water quality parameter values shall be determined as specified under 10 CSR 60-15.030(8).

(5) Reduced Monitoring.

(A) Any water system that maintains the range of values for the water quality parameters reflecting optimal corrosion control treatment during each of two (2) consecutive six (6)-month monitoring periods under section (4) of this rule shall continue monitoring at the entry point(s) to the distribution system as specified in subsection (3)(B) of this rule. That system may collect two (2) tap samples for applicable water quality parameters from the following reduced number of sites during each six (6)-month monitoring period.

System Size (# People Served)	Sites for Water Quality Parameters (Reduced Number)
>100,000	10
10,001–100,000	7
3,301–10,000	3
501–3,300	2
101–500	1
≤100	1

(B) Any water system that maintains the range of values for the water quality parameters reflecting optimal corrosion control treatment specified by the department under 10 CSR 60-15.030(6) during three (3) consecutive years of annual monitoring under this subsection may reduce the frequency with which it collects the number of tap samples for applicable water quality parameters specified in subsection (5)(A) of this rule from annually to every three (3) years. A water system may reduce the frequency with which it collects tap samples for applicable water quality parameters specified in subsection (5)(A) of this rule to every three (3) years if it demonstrates during two (2) consecutive monitoring periods that its tap water lead level at the ninetieth percentile is less than or equal to the PQL for lead specified in 10 CSR 60-5.010(5)(H), that its tap water copper level at the ninetieth percentile is less than or equal to 0.65 mg/l for copper, and that it also has maintained the range of values for the water quality parameters reflecting optimal corrosion control treatment specified by the department under 10 CSR 60-15.030(7).

(C) A water system that conducts sampling annually shall collect these samples evenly throughout the year so as to reflect seasonal variability.

(D) Any water system subject to the reduced monitoring frequency that fails to operate at or above the minimum value or within the range of values for the water quality parameters specified by the department in 10 CSR 60-15.030(7) for more than nine (9) days in any six (6)-month period specified in 10 CSR 60-15.030(8) shall resume distribution system tap water sampling in accordance with the number and frequency requirements in section (4) of this rule. Such a system may resume annual monitoring for water quality parameters at the tap at the reduced number of sites specified in subsection (5)(A) of this rule after it has completed two (2) subsequent consecutive six (6)-month rounds of monitoring that meet the criteria of that paragraph and/or may resume triennial monitoring for water quality parameters at the tap at the reduced number of sites after it demonstrates through subsequent rounds of monitoring that it meets the criteria of either paragraph (5)(B)1. or (5)(B)2. of this rule.

(6) Additional Monitoring by Systems. The results of any monitoring conducted in addition to the minimum requirements of this rule shall be considered by the system and the department in making any determinations (that is, determining concentrations of water quality parameters) under this rule or 10 CSR 60-15.030.

Summary of Monitoring Requirements for Water Quality Parameters[1]

Monitoring Period	Parameters[2]	Location	Frequency
Initial monitoring	pH, alkalinity, orthophosphate or silica[3], calcium, conductivity, temperature	Taps and at entry point(s) to the distribution system	Every six (6) months
After installation of corrosion control	pH, alkalinity, orthophosphate or silica[3], calcium[4]	Taps	Every six (6) months
	pH, alkalinity dosage rate and concentration (if alkalinity adjusted as part of corrosion control), inhibitor dosage rate and inhibitor residual[5]	Entry point(s) to distribution system[6]	No less frequently than every two (2) weeks
After department specifies parameter values for optimal corrosion control	pH, alkalinity, orthophosphate or silica[3], calcium[4]	Taps	Every six (6) months’
	pH, alkalinity dosage rate and concentration (if alkalinity adjusted as part of corrosion control), inhibitor dosage rate and inhibitor residual[5]	Entry point(s) to the distribution system[6]	No less frequently than every two (2) weeks
Reduced Monitoring	pH, alkalinity, orthophosphate or silica[3], calcium[4]	Taps	Every six (6) months, annually[7] or every three (3) years[8] at a reduced number of sites
	pH, alkalinity dosage rate and concentration (if alkalinity adjusted as part of corrosion control), inhibitor dosage rate and inhibitor residual[5]	Entry point(s) to the distribution system[6]	No less frequently than every two (2) weeks

[1]Table is for illustrative purposes; consult the text of this rule for precise regulatory requirements.

[2]Small- and medium-size systems have to monitor for water quality parameters only during monitoring periods in which the system exceeds the lead or copper action level.

[3]Orthophosphate must be measured only when an inhibitor containing a phosphate compound is used. Silica must be measured only when an inhibitor containing silicate compound is used.

[4]Calcium must be measured only when calcium carbonate stabilization is used as part of corrosion control.

[5]Inhibitor dosage rates and inhibitor residual concentrations (orthophosphate or silica) must be measured only when an inhibitor is used.

[6]Groundwater systems may limit monitoring to representative locations throughout the system.

[7]Water systems may reduce frequency of monitoring for water quality parameters at the tap from every six (6) months to annually if they have maintained the range of values for water quality parameters reflecting optimal corrosion control during three (3) consecutive years of monitoring.

[8]Water systems may further reduce the frequency of monitoring for water quality parameters at the tap from annually to once every three (3) years if they have maintained the range of values from water quality parameters reflecting optimal corrosion control during three (3) consecutive years of annual monitoring. Water systems may accelerate to triennial monitoring for quality parameters at the tap if they have maintained ninetieth percentile lead levels less than or equal to 0.005 mg/l, ninetieth percentile copper levels less than or equal to 0.65 mg/l, and the range of water quality parameters designated by the department under 10 CSR 60-15.030(7) as representing optimal corrosion control during two (2) consecutive six (6)-month monitoring periods.

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**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

10 CSR 60-15.090 Monitoring Requirements for Lead and Copper in Source Water

PURPOSE: This rule establishes monitoring requirements for lead and copper in source waters.

(1) Sample Location, Collection Methods and Number of Samples.

(A) A water system that fails to meet the lead or copper action level on the basis of tap samples collected in accordance with 10 CSR 60-15.070 shall collect lead and copper source water samples in accordance with the following requirements regarding sample location, number of samples and collection methods:

1. Groundwater systems shall take a minimum of one (1) sample at every entry point to the distribution system which is representative of each well after treatment (hereafter called a sampling point). The system shall take one (1) sample at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant;

2. Surface water systems shall take a minimum of one (1) sample at every entry point to the distribution system after any application of treatment or in the distribution system at a point which is representative of each source after treatment (hereafter called a sampling point). The system shall take each sample at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant (Note: For the purposes of this requirement, surface water systems include systems with a combination of surface and ground sources);

3. If a system draws water from more than one (1) source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions (that is, when water is representative of all sources being used); and

4. The department may reduce the total number of samples which must be analyzed by allowing the use of compositing. Compositing of samples must be done by certified laboratory personnel. Composite samples from a maximum of five (5) samples are allowed, provided that if the lead concentration in the composite sample is greater than or equal to 0.001 mg/l or the copper concentration is greater than or equal to 0.160 mg/l, then either:

A. A follow-up sample shall be taken and analyzed within fourteen (14) days at each sampling point included in the composite; or

B. If duplicates of or sufficient quantities from the original samples from each sampling point used in the composite are available, the system may use these instead of resampling.

(B) Where the results of sampling indicate an exceedance of maximum permissible source water levels established under 10 CSR 60-5.040(2)(C), the department may require that one (1) additional sample be collected as soon as possible after the initial sample was taken (but not to exceed two (2) weeks) at the same sampling point. If the department-required confirmation sample is taken for lead or copper, then the results of the initial and confirmation sample shall be averaged in determining compliance with maximum permissible levels. Any sample value below the detection limit shall be considered to be zero (0). Any value above the detection limit but below the practical quantification level (PQL) shall be as the measured value or be considered one-half (1/2) PQL.

(2) Monitoring Frequency After System Exceeds Tap Water Action Level. Any system which exceeds the lead or copper action level at the tap shall collect one (1) source water sample from each entry point to the distribution system within six (6) months after the exceedance.

(3) Monitoring Frequency After Installation of Source Water Treatment. Any system which installs source water treatment pursuant to 10 CSR 60-15.040 shall collect an additional source water sample from each entry point to the distribution system during two (2) consecutive six (6)-month monitoring periods by the deadline specified in 10 CSR 60-15.040(1)(D).

(4) Monitoring Frequency after the Department Specifies Maximum Permissible Source Water Levels or Determines that Source Water Treatment Is Not Needed.

(A) A system shall monitor at the following specified frequency in cases where the department specifies maximum permissible source water levels under 10 CSR 60-15.040(2)(C) or determines that the system is not required to install source water treatment under 10 CSR 60-15.040(2)(A):

1. A water system using only groundwater shall collect samples once during the three (3)-year compliance period in effect when the applicable department determination under subsection (4)(A) of this rule is made. Those systems shall collect samples once during each subsequent compliance period; and

2. A water system using surface water (or a combination of surface and ground water) shall collect samples once during each year, the first annual monitoring period to begin on the date on which the applicable department determination is made under subsection (4)(A) of this rule.

(B) A system is not required to conduct source water sampling for lead, copper, or both, if the system meets the action level for the specific contaminant in tap water samples during the entire source water sampling period applicable to the system under subsection (4)(A) of this rule.

(5) Reduced Monitoring Frequency.

(A) A water system using only groundwater may reduce the monitoring frequency for lead and copper in source water to once during each nine (9)-year compliance cycle if the system meets any one (1) of the following criteria:

1. The system demonstrates that finished drinking water entering the distribution system has been maintained below the maximum permissible lead and copper concentrations specified in 10 CSR 60-15.040(2)(C) during at least three (3) consecutive compliance periods under subsection (4)(A) of this rule; or

2. The department has determined that source water treatment is not needed and the system demonstrates that, during at least three (3) consecutive compliance periods in which sampling was conducted under subsection (4)(A) of this rule, the concentration of lead in source water was less than or equal to 0.005 mg/l and the concentration of copper in source water was less than or equal to 0.65 mg/l.

(B) A water system using surface water (or a combination of surface and ground waters) may reduce the monitoring frequency in paragraph (4)(A)2. of this rule to once during each nine (9)-year compliance cycle if the system meets one (1) of the following criteria:

1. The system demonstrates that finished drinking water entering the distribution system has been maintained below the maximum permissible lead and copper concentrations specified in 10 CSR 60-15.040(2)(C) for at least three (3) consecutive years; or

2. The department has determined that source water treatment is not needed and the system demonstrates that, during at least three (3) consecutive years, the concentration of lead in source water was less than or equal to 0.005 mg/l and the concentration of copper in source water was less than or equal to 0.65 mg/l.

(C) A water system that uses a new source of water is not eligible for reduced monitoring for lead, copper, or both, until concentrations in samples collected from the new source during three (3) consecutive monitoring periods are below the maximum permissible lead and copper concentrations.

AUTHORITY: section 640.100, RSMo 2000. Original rule filed Aug. 4, 1992, effective May 6, 1993. Amended: Filed Aug. 14, 2001, effective April 30, 2002.*

**Original authority: 640.100, RSMo 1939, amended 1978, 1981, 1982, 1988, 1989, 1992, 1993, 1995, 1996, 1998, 1999.*

ATTACHMENT 3

PACE ANALYTICAL SERVICES, LLC ACCREDITATION FOR CERTIFICATION

The Kansas Department of Health and Environment encourages all clients and data users to verify the most current scope of accreditation for certification number E-10177

The analytes tested and the corresponding matrix and method which a laboratory is authorized to perform at any given time will be those indicated in the most recently issued scope of accreditation. The most recent scope of accreditation supersedes all previously issued scopes of accreditation. It is the certified laboratory's responsibility to review this document for any discrepancies. This scope of accreditation will be recalled in the event that your laboratory's certification is revoked.

Accreditation Start: 7/25/2019 Accreditation End: 4/30/2020

EPA Number: ***IN00043*** **Scope of Accreditation for Certification Number: E-10177**

Pace Analytical Services, Inc - Indianapolis IN **Primary AB**

Program/Matrix: ***CWA (Non Potable Water)***

Method ASTM D516-07

Sulfate	KS

Method ASTM D516-11

Sulfate	KS

Method EPA 120.1

Conductivity	KS

Method EPA 1631E

Mercury	KS

Method EPA 1664A

Oil & Grease	KS

Method EPA 180.1

Turbidity	KS

Method EPA 200.7

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS

Program/Matrix: ***CWA (Non Potable Water)***

Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Strontium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 200.8

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Lead	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Selenium	KS
Silver	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 245.1

Mercury	KS

Method EPA 300.0

Bromide	KS
Chloride	KS
Fluoride	KS
Nitrate	KS
Nitrate-nitrite	KS
Nitrite	KS
Sulfate	KS

Program/Matrix: ***CWA (Non Potable Water)***

Method EPA 335.4	
Amenable cyanide	KS
Cyanide	KS
Method EPA 350.1	
Ammonia as N	KS
Method EPA 351.2	
Total Kjeldahl Nitrogen (TKN)	KS
Method EPA 351.2 minus EPA 350.1	
Organic nitrogen	KS
Method EPA 353.2	
Nitrate	KS
Nitrate-nitrite	KS
Nitrite	KS
Method EPA 365.1	
Phosphorus	KS
Method EPA 410.4	
Chemical oxygen demand	KS
Method EPA 420.4	
Total phenolics	KS
Method EPA 6010B	
Arsenic	KS
Cadmium	KS
Copper	KS
Lead	KS
Lithium	KS
Molybdenum	KS
Nickel	KS
Selenium	KS
Strontium	KS
Total chromium	KS
Zinc	KS
Method EPA 6020	
Arsenic	KS
Cadmium	KS
Copper	KS
Lead	KS
Molybdenum	KS
Nickel	KS
Selenium	KS
Total chromium	KS
Zinc	KS
Method EPA 608.3 GC-ECD	
4,4'-DDD	KS
4,4'-DDE	KS

Program/Matrix: ***CWA (Non Potable Water)***

4,4'-DDT	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS
Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS
Heptachlor	KS
Heptachlor epoxide	KS
Methoxychlor	KS
Toxaphene (Chlorinated camphene)	KS

Method EPA 624.1

1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3-Dichlorobenzene	KS
1,4-Dichlorobenzene	KS
2-Chloroethyl vinyl ether	KS
Acrolein (Propenal)	KS
Acrylonitrile	KS
Benzene	KS
Bromodichloromethane	KS
Bromoform	KS
Carbon tetrachloride	KS
Chlorobenzene	KS
Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS

Program/Matrix: ***CWA (Non Potable Water)***

cis-1,3-Dichloropropene	KS
Ethylbenzene	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methylene chloride (Dichloromethane)	KS
Naphthalene	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl chloride	KS
Xylene (total)	KS

Method EPA 625.1

1,2,4-Trichlorobenzene	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,3-Dichlorobenzene	KS
1,4-Dichlorobenzene	KS
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	KS
2,4,6-Trichlorophenol	KS
2,4-Dichlorophenol	KS
2,4-Dimethylphenol	KS
2,4-Dinitrophenol	KS
2,4-Dinitrotoluene (2,4-DNT)	KS
2,6-Dinitrotoluene (2,6-DNT)	KS
2-Chloronaphthalene	KS
2-Chlorophenol	KS
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	KS
2-Nitrophenol	KS
3,3'-Dichlorobenzidine	KS
4-Bromophenyl phenyl ether	KS
4-Chloro-3-methylphenol	KS
4-Chlorophenyl phenylether	KS
4-Nitrophenol	KS
Acenaphthene	KS
Acenaphthylene	KS
Anthracene	KS
Benzidine	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
bis(2-Chloroethoxy)methane	KS
bis(2-Chloroethyl) ether	KS

Program/Matrix: ***CWA (Non Potable Water)***

Butyl benzyl phthalate	KS
Chrysene	KS
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	KS
Dibenz(a,h) anthracene	KS
Diethyl phthalate	KS
Dimethyl phthalate	KS
Di-n-butyl phthalate	KS
Di-n-octyl phthalate	KS
Fluoranthene	KS
Fluorene	KS
Hexachlorobenzene	KS
Hexachlorobutadiene	KS
Hexachloroethane	KS
Indeno(1,2,3-cd) pyrene	KS
Isophorone	KS
Naphthalene	KS
Nitrobenzene	KS
n-Nitrosodimethylamine	KS
n-Nitrosodi-n-propylamine	KS
n-Nitrosodiphenylamine	KS
Pentachlorophenol	KS
Phenanthrene	KS
Phenol	KS
Pyrene	KS

Method **EPA 7470A**

Mercury	KS

Method **EPA 7471A**

Mercury	KS

Method **EPA 8015D**

Propylene glycol	KS

Method **EPA 8260C**

1,1,2-Trichloro-1,2,2-trifluoroethane	KS
1,3,5-Trichlorobenzene	KS

Method **EPA 8270C**

1-Methylnaphthalene	KS
Carbazole	KS

Method **EPA RSK-175 (GC/FID)**

Ethane	KS
Ethene	KS
Methane	KS

Method **OIA 1677-09**

Available Cyanide	KS
Free cyanide	KS

Method **SM 2310 B-2011**

Acidity, as CaCO3	KS

Program/Matrix: ***CWA (Non Potable Water)***

Method SM 2320 B-2011	
Alkalinity as CaCO3	KS
Method SM 2340 B-2011	
Hardness	KS
Method SM 2510 B-2011	
Conductivity	KS
Method SM 2540 B-2011	
Residue-total	KS
Method SM 2540 C-2011	
Residue-filterable (TDS)	KS
Method SM 2540 D-2011	
Residue-nonfilterable (TSS)	KS
Method SM 2540 F-2011	
Residue-settleable	KS
Method SM 3500-Cr B-2011	
Chromium VI	KS
Method SM 4500-Cl G-2011	
Total residual chlorine	KS
Method SM 4500-Cl^{-} E-2011	
Chloride	KS
Method SM 4500-CN^{-} C-2011	
Cyanide	KS
Method SM 4500-CN^{-} E-2011	
Cyanide	KS
Method SM 4500-CN^{-} G-2011	
Amenable cyanide	KS
Method SM 4500-F^{-} C-2011	
Fluoride	KS
Method SM 4500-H+ B-2011	
pH	KS
Method SM 4500-NH3 G-2011	
Ammonia as N	KS
Method SM 4500-P E-2011	
Orthophosphate as P	KS
Method SM 4500-S2^{-} D-2000	
Sulfide	KS
Method SM 4500-S2^{-} D-2011	
Sulfide	KS
Method SM 5210 B-2011	
Biochemical oxygen demand	KS
Carbonaceous BOD, CBOD	KS
Method SM 5310 C-2011	

Program/Matrix: ***CWA (Non Potable Water)***

Total organic carbon	KS
Method SM 5540 C-2011	
Surfactants - MBAS	KS
Method TKN-NH3-CAL	
Organic nitrogen	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Method EPA 1010A	
Ignitability	KS
Method EPA 1311	
Toxicity Characteristic Leaching Procedure (TCLP)	KS
Method EPA 1312	
Synthetic Precipitation Leaching Procedure (SPLP)	KS
Method EPA 6010B	
Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Strontium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS
Method EPA 6020	
Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Cadmium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Lead	KS
Manganese	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Nickel	KS
Selenium	KS
Silver	KS
Thallium	KS
Vanadium	KS
Zinc	KS
Method EPA 7196A	
Chromium VI	KS
Method EPA 7470A	
Mercury	KS
Method EPA 7471A	
Mercury	KS
Method EPA 8011	
1,2-Dibromo-3-chloropropane (DBCP)	KS
1,2-Dibromoethane (EDB, Ethylene dibromide)	KS
Method EPA 8015D	
Diesel range organics (DRO)	KS
Ethanol	KS
Ethylene glycol	KS
Gasoline range organics (GRO)	KS
Isobutyl alcohol (2-Methyl-1-propanol)	KS
Isopropyl alcohol (2-Propanol, Isopropanol)	KS
Methanol	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Propanol (1-Propanol)	KS
Propylene glycol	KS
Method EPA 8081B	
4,4'-DDD	KS
4,4'-DDE	KS
4,4'-DDT	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
alpha-Chlordane, cis-Chlordane	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS
Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
Endrin ketone	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS
gamma-Chlordane	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Heptachlor	KS
Heptachlor epoxide	KS
Methoxychlor	KS
Toxaphene (Chlorinated camphene)	KS

Method **EPA 8082A**

Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS

Method **EPA 8141B**

Atrazine	KS
Azinphos-methyl (Guthion)	KS
Chlorpyrifos	KS
Chlorpyrifos-methyl	KS
Demeton-o	KS
Demeton-s	KS
Diazinon	KS
Dichlorovos (DDVP, Dichlorvos)	KS
Dimethoate	KS
Disulfoton	KS
Famphur	KS
Malathion	KS
Merphos	KS
Methyl parathion (Parathion, methyl)	KS
Naled	KS
Parathion, ethyl	KS
Phorate	KS
Ronnel	KS
Simazine	KS
Terbufos	KS
Tetrachlorvinphos (Stirophos, Gardona) E-isomer	KS

Method **EPA 8151A**

2,4,5-T	KS
2,4-D	KS
2,4-DB	KS
3,5-Dichlorobenzoic acid	KS
Acifluorfen	KS
Bentazon	KS
Chloramben	KS
Dalapon	KS
DCPA di acid degradate	KS
Dicamba	KS
Dichloroprop (Dichlorprop)	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	KS
MCPA	KS
MCPP	KS
Pentachlorophenol	KS
Picloram	KS
Silvex (2,4,5-TP)	KS

Method EPA 8260C

1,1,1,2-Tetrachloroethane	KS
1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloro-1,2,2-trifluoroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,1-Dichloropropene	KS
1,2,3-Trichlorobenzene	KS
1,2,3-Trichloropropane	KS
1,2,4-Trichlorobenzene	KS
1,2,4-Trimethylbenzene	KS
1,2-Dibromo-3-chloropropane (DBCP)	KS
1,2-Dibromoethane (EDB, Ethylene dibromide)	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3,5-Trichlorobenzene	KS
1,3,5-Trimethylbenzene	KS
1,3-Dichlorobenzene	KS
1,3-Dichloropropane	KS
1,4-Dichlorobenzene	KS
1,4-Dioxane (1,4- Diethyleneoxide)	KS
2,2-Dichloropropane	KS
2-Butanone (Methyl ethyl ketone, MEK)	KS
2-Chloroethyl vinyl ether	KS
2-Chlorotoluene	KS
2-Hexanone	KS
4-Chlorotoluene	KS
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	KS
4-Methyl-2-pentanone (MIBK)	KS
Acetone	KS
Acetonitrile	KS
Acrolein (Propenal)	KS
Acrylonitrile	KS
Allyl chloride (3-Chloropropene)	KS
Benzene	KS
Bromobenzene	KS
Bromochloromethane	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Bromodichloromethane	KS
Bromoform	KS
Carbon disulfide	KS
Carbon tetrachloride	KS
Chlorobenzene	KS
Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS
cis-1,2-Dichloroethylene	KS
cis-1,3-Dichloropropene	KS
Dibromomethane (Methylene bromide)	KS
Dichlorodifluoromethane (Freon-12)	KS
Diethyl ether	KS
Ethyl acetate	KS
Ethyl methacrylate	KS
Ethylbenzene	KS
Hexachlorobutadiene	KS
Iodomethane (Methyl iodide)	KS
Isopropylbenzene	KS
Methacrylonitrile	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methyl methacrylate	KS
Methyl tert-butyl ether (MTBE)	KS
Methylene chloride (Dichloromethane)	KS
m-Xylene	KS
Naphthalene	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Butylbenzene	KS
n-Propylbenzene	KS
o-Xylene	KS
Propionitrile (Ethyl cyanide)	KS
p-Xylene	KS
sec-Butylbenzene	KS
Styrene	KS
tert-Butyl alcohol	KS
tert-Butylbenzene	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
trans-1,4-Dichloro-2-butene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl acetate	KS
Vinyl chloride	KS
Xylene (total)	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Method EPA 8270C

1,2,4,5-Tetrachlorobenzene	KS
1,2,4-Trichlorobenzene	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Diphenylhydrazine	KS
1,3-Dichlorobenzene	KS
1,3-Dinitrobenzene (1,3-DNB)	KS
1,4-Dichlorobenzene	KS
1,4-Naphthoquinone	KS
1,4-Phenylenediamine	KS
1-Methylnaphthalene	KS
1-Naphthylamine	KS
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	KS
2,3,4,6-Tetrachlorophenol	KS
2,4,5-Trichlorophenol	KS
2,4,6-Trichlorophenol	KS
2,4-Dichlorophenol	KS
2,4-Dimethylphenol	KS
2,4-Dinitrophenol	KS
2,4-Dinitrotoluene (2,4-DNT)	KS
2,6-Dichlorophenol	KS
2,6-Dinitrotoluene (2,6-DNT)	KS
2-Acetylaminofluorene	KS
2-Chloronaphthalene	KS
2-Chlorophenol	KS
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	KS
2-Methylaniline (o-Toluidine)	KS
2-Methylnaphthalene	KS
2-Methylphenol (o-Cresol)	KS
2-Naphthylamine	KS
2-Nitroaniline	KS
2-Nitrophenol	KS
2-Picoline (2-Methylpyridine)	KS
3,3'-Dichlorobenzidine	KS
3,3'-Dimethylbenzidine	KS
3-Methylcholanthrene	KS
3-Methylphenol (m-Cresol)	KS
3-Nitroaniline	KS
4-Aminobiphenyl	KS
4-Bromophenyl phenyl ether	KS
4-Chloro-3-methylphenol	KS
4-Chloroaniline	KS
4-Chlorophenyl phenylether	KS
4-Dimethyl aminoazobenzene	KS
4-Methylphenol (p-Cresol)	KS
4-Nitroaniline	KS

Program/Matrix: ***RCRA (Non Potable Water)***

4-Nitrophenol	KS
4-Nitroquinoline 1-oxide	KS
5-Nitro-o-toluidine	KS
7,12-Dimethylbenz(a) anthracene	KS
a-a-Dimethylphenethylamine	KS
Acenaphthene	KS
Acenaphthylene	KS
Acetophenone	KS
Aniline	KS
Anthracene	KS
Aramite	KS
Benzidine	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
Benzoic acid	KS
Benzyl alcohol	KS
bis(2-Chloroethoxy)methane	KS
bis(2-Chloroethyl) ether	KS
Butyl benzyl phthalate	KS
Carbazole	KS
Chlorobenzilate	KS
Chrysene	KS
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	KS
Diallate	KS
Dibenz(a,h) anthracene	KS
Dibenzofuran	KS
Diethyl phthalate	KS
Dimethoate	KS
Dimethyl phthalate	KS
Di-n-butyl phthalate	KS
Di-n-octyl phthalate	KS
Diphenylamine	KS
Disulfoton	KS
Ethyl methanesulfonate	KS
Famphur	KS
Fluoranthene	KS
Fluorene	KS
Hexachlorobenzene	KS
Hexachlorobutadiene	KS
Hexachlorocyclopentadiene	KS
Hexachloroethane	KS
Hexachlorophene	KS
Hexachloropropene	KS
Indeno(1,2,3-cd) pyrene	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Isodrin	KS
Isophorone	KS
Isosafrole	KS
Kepone	KS
Methapyrilene	KS
Methyl methanesulfonate	KS
Methyl parathion (Parathion, methyl)	KS
Naphthalene	KS
Nitrobenzene	KS
n-Nitrosodiethylamine	KS
n-Nitrosodimethylamine	KS
n-Nitroso-di-n-butylamine	KS
n-Nitrosodi-n-propylamine	KS
n-Nitrosodiphenylamine	KS
n-Nitrosomethylethalamine	KS
n-Nitrosomorpholine	KS
n-Nitrosopiperidine	KS
n-Nitrosopyrrolidine	KS
o,o,o-Triethyl phosphorothioate	KS
Parathion, ethyl	KS
Pentachlorobenzene	KS
Pentachloronitrobenzene	KS
Pentachlorophenol	KS
Phenacetin	KS
Phenanthrene	KS
Phenol	KS
Phorate	KS
Pronamide (Kerb)	KS
Pyrene	KS
Pyridine	KS
Safrole	KS
Sulfotep (Tetraethyl dithiopyrophosphate)	KS
Thionazin (Zinophos)	KS

Method EPA 8270C SIM

1-Methylnaphthalene	KS
2-Methylnaphthalene	KS
Acenaphthene	KS
Acenaphthylene	KS
Anthracene	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
Chrysene	KS
Dibenz(a,h) anthracene	KS

	Primary AB
Program/Matrix: ***RCRA (Non Potable Water)***	
Fluoranthene	KS
Fluorene	KS
Indeno(1,2,3-cd) pyrene	KS
Naphthalene	KS
Phenanthrene	KS
Pyrene	KS
Method EPA 9012A	
Amenable cyanide	KS
Cyanide	KS
Method EPA 9038	
Sulfate	KS
Method EPA 9056A	
Bromide	KS
Chloride	KS
Fluoride	KS
Nitrate	KS
Nitrite	KS
Sulfate	KS
Method EPA 9066	
Total phenolics	KS
Method EPA 9095B	
Paint Filter Test	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Method EPA 1010A

Ignitability	KS

Method EPA 1311

Toxicity Characteristic Leaching Procedure (TCLP)	KS

Method EPA 1312

Synthetic Precipitation Leaching Procedure (SPLP)	KS

Method EPA 6010B

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Strontium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 6020

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Cadmium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Lead	KS
Manganese	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Nickel	KS
Selenium	KS
Silver	KS
Thallium	KS
Vanadium	KS
Zinc	KS

Method EPA 7196A

Chromium VI	KS

Method EPA 7470A

Mercury	KS

Method EPA 7471A

Mercury	KS

Method EPA 8015D

Diesel range organics (DRO)	KS
Ethanol	KS
Ethylene glycol	KS
Gasoline range organics (GRO)	KS
Isobutyl alcohol (2-Methyl-1-propanol)	KS
Isopropyl alcohol (2-Propanol, Isopropanol)	KS
Methanol	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Propanol (1-Propanol)	KS
Propylene glycol	KS

Method EPA 8081B

4,4'-DDD	KS
4,4'-DDE	KS
4,4'-DDT	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
alpha-Chlordane, cis-Chlordane	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS
Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
Endrin ketone	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS
gamma-Chlordane	KS
Heptachlor	KS
Heptachlor epoxide	KS
Methoxychlor	KS
Toxaphene (Chlorinated camphene)	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Method EPA 8082A

Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS

Method EPA 8141B

Atrazine	KS
Azinphos-methyl (Guthion)	KS
Chlorpyrifos	KS
Chlorpyrifos-methyl	KS
Demeton-o	KS
Demeton-s	KS
Diazinon	KS
Dichlorovos (DDVP, Dichlorvos)	KS
Dimethoate	KS
Disulfoton	KS
Famphur	KS
Malathion	KS
Merphos	KS
Methyl parathion (Parathion, methyl)	KS
Naled	KS
Parathion, ethyl	KS
Phorate	KS
Ronnel	KS
Simazine	KS
Terbufos	KS
Tetrachlorvinphos (Stirophos, Gardona) E-isomer	KS

Method EPA 8151A

2,4,5-T	KS
2,4-D	KS
2,4-DB	KS
3,5-Dichlorobenzoic acid	KS
Acifluorfen	KS
Bentazon	KS
Dalapon	KS
DCPA di acid degradate	KS
Dicamba	KS
Dichloroprop (Dichlorprop)	KS
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	KS
MCPA	KS
MCPP	KS
Pentachlorophenol	KS
Picloram	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Silvex (2,4,5-TP)	KS

Method EPA 8260C

1,1,1,2-Tetrachloroethane	KS
1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloro-1,2,2-trifluoroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,1-Dichloropropene	KS
1,2,3-Trichlorobenzene	KS
1,2,3-Trichloropropane	KS
1,2,4-Trichlorobenzene	KS
1,2,4-Trimethylbenzene	KS
1,2-Dibromo-3-chloropropane (DBCP)	KS
1,2-Dibromoethane (EDB, Ethylene dibromide)	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3,5-Trichlorobenzene	KS
1,3,5-Trimethylbenzene	KS
1,3-Dichlorobenzene	KS
1,3-Dichloropropane	KS
1,4-Dichlorobenzene	KS
1,4-Dioxane (1,4- Diethyleneoxide)	KS
2,2-Dichloropropane	KS
2-Butanone (Methyl ethyl ketone, MEK)	KS
2-Chloroethyl vinyl ether	KS
2-Chlorotoluene	KS
2-Hexanone	KS
4-Chlorotoluene	KS
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	KS
4-Methyl-2-pentanone (MIBK)	KS
Acetone	KS
Acetonitrile	KS
Acrolein (Propenal)	KS
Acrylonitrile	KS
Allyl chloride (3-Chloropropene)	KS
Benzene	KS
Bromobenzene	KS
Bromochloromethane	KS
Bromodichloromethane	KS
Bromoform	KS
Carbon disulfide	KS
Carbon tetrachloride	KS
Chlorobenzene	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS
cis-1,2-Dichloroethylene	KS
cis-1,3-Dichloropropene	KS
Dibromomethane (Methylene bromide)	KS
Dichlorodifluoromethane (Freon-12)	KS
Diethyl ether	KS
Ethyl acetate	KS
Ethyl methacrylate	KS
Ethylbenzene	KS
Hexachlorobutadiene	KS
Iodomethane (Methyl iodide)	KS
Isopropylbenzene	KS
Methacrylonitrile	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methyl methacrylate	KS
Methyl tert-butyl ether (MTBE)	KS
Methylene chloride (Dichloromethane)	KS
m-Xylene	KS
Naphthalene	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Butylbenzene	KS
n-Propylbenzene	KS
o-Xylene	KS
Propionitrile (Ethyl cyanide)	KS
p-Xylene	KS
sec-Butylbenzene	KS
Styrene	KS
tert-Butyl alcohol	KS
tert-Butylbenzene	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
trans-1,4-Dichloro-2-butene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl acetate	KS
Vinyl chloride	KS
Xylene (total)	KS

Method **EPA 8270C**

1,2,4,5-Tetrachlorobenzene	KS
1,2,4-Trichlorobenzene	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

1,2-Diphenylhydrazine	KS
1,3-Dichlorobenzene	KS
1,3-Dinitrobenzene (1,3-DNB)	KS
1,4-Dichlorobenzene	KS
1,4-Naphthoquinone	KS
1,4-Phenylenediamine	KS
1-Methylnaphthalene	KS
1-Naphthylamine	KS
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	KS
2,3,4,6-Tetrachlorophenol	KS
2,4,5-Trichlorophenol	KS
2,4,6-Trichlorophenol	KS
2,4-Dichlorophenol	KS
2,4-Dimethylphenol	KS
2,4-Dinitrophenol	KS
2,4-Dinitrotoluene (2,4-DNT)	KS
2,6-Dichlorophenol	KS
2,6-Dinitrotoluene (2,6-DNT)	KS
2-Acetylaminofluorene	KS
2-Chloronaphthalene	KS
2-Chlorophenol	KS
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	KS
2-Methylaniline (o-Toluidine)	KS
2-Methylnaphthalene	KS
2-Methylphenol (o-Cresol)	KS
2-Naphthylamine	KS
2-Nitroaniline	KS
2-Nitrophenol	KS
2-Picoline (2-Methylpyridine)	KS
3,3'-Dichlorobenzidine	KS
3,3'-Dimethylbenzidine	KS
3-Methylcholanthrene	KS
3-Methylphenol (m-Cresol)	KS
3-Nitroaniline	KS
4-Aminobiphenyl	KS
4-Bromophenyl phenyl ether	KS
4-Chloro-3-methylphenol	KS
4-Chloroaniline	KS
4-Chlorophenyl phenylether	KS
4-Dimethyl aminoazobenzene	KS
4-Methylphenol (p-Cresol)	KS
4-Nitroaniline	KS
4-Nitrophenol	KS
4-Nitroquinoline 1-oxide	KS
5-Nitro-o-toluidine	KS
7,12-Dimethylbenz(a) anthracene	KS
a-a-Dimethylphenethylamine	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***	**Primary AB**
Acenaphthene	KS
Acenaphthylene	KS
Acetophenone	KS
Aniline	KS
Anthracene	KS
Aramite	KS
Benzidine	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
Benzoic acid	KS
Benzyl alcohol	KS
bis(2-Chloroethoxy)methane	KS
bis(2-Chloroethyl) ether	KS
Butyl benzyl phthalate	KS
Carbazole	KS
Chlorobenzilate	KS
Chrysene	KS
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	KS
Diallate	KS
Dibenz(a,h) anthracene	KS
Dibenzofuran	KS
Diethyl phthalate	KS
Dimethoate	KS
Dimethyl phthalate	KS
Di-n-butyl phthalate	KS
Di-n-octyl phthalate	KS
Diphenylamine	KS
Disulfoton	KS
Ethyl methanesulfonate	KS
Famphur	KS
Fluoranthene	KS
Fluorene	KS
Hexachlorobenzene	KS
Hexachlorobutadiene	KS
Hexachlorocyclopentadiene	KS
Hexachloroethane	KS
Hexachlorophene	KS
Hexachloropropene	KS
Indeno(1,2,3-cd) pyrene	KS
Isodrin	KS
Isophorone	KS
Isosafrole	KS
Kepone	KS
Methapyrilene	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Methyl methanesulfonate	KS
Methyl parathion (Parathion, methyl)	KS
Naphthalene	KS
Nitrobenzene	KS
n-Nitrosodiethylamine	KS
n-Nitrosodimethylamine	KS
n-Nitroso-di-n-butylamine	KS
n-Nitrosodi-n-propylamine	KS
n-Nitrosodiphenylamine	KS
n-Nitrosomethylethalamine	KS
n-Nitrosomorpholine	KS
n-Nitrosopiperidine	KS
n-Nitrosopyrrolidine	KS
o,o,o-Triethyl phosphorothioate	KS
Parathion, ethyl	KS
Pentachlorobenzene	KS
Pentachloronitrobenzene	KS
Pentachlorophenol	KS
Phenacetin	KS
Phenanthrene	KS
Phenol	KS
Phorate	KS
Pronamide (Kerb)	KS
Pyrene	KS
Pyridine	KS
Safrole	KS
Sulfotep (Tetraethyl dithiopyrophosphate)	KS
Thionazin (Zinophos)	KS

Method **EPA 8270C SIM**

1-Methylnaphthalene	KS
2-Methylnaphthalene	KS
Acenaphthene	KS
Acenaphthylene	KS
Anthracene	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
Chrysene	KS
Dibenz(a,h) anthracene	KS
Fluoranthene	KS
Fluorene	KS
Indeno(1,2,3-cd) pyrene	KS
Naphthalene	KS
Phenanthrene	KS

	Primary AB
Program/Matrix: ***RCRA (Solid & Hazardous Material)***	
Pyrene	KS
Method EPA 9012A	
Amenable cyanide	KS
Cyanide	KS
Method EPA 9045C	
pH	KS
Method EPA 9066	
Total phenolics	KS
Method EPA 9095B	
Paint Filter Test	KS

End of Scope of Accreditation

APPENDIX B

REMEDIAL DESIGN SAMPLING AND ANALYSIS PLAN

REMEDIAL DESIGN
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
(RD SAP)

APPENDIX B TO REMEDIAL DESIGN WORK PLAN

WEST LAKE LANDFILL SUPERFUND SITE
OPERABLE UNIT 2 (OU-2)
BRIDGETON, MISSOURI

Prepared For:

Bridgeton Landfill LLC

BRIDGETON LANDFILL, LLC

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PHOENIX, ARIZONA

CEC PROJECT 191-750

MARCH 23, 2020
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1.0 INTRODUCTION

This Remedial Design Sampling and Analysis Plan (RD SAP) has been prepared by Civil & Environmental Consultants, Inc. (CEC) to provide guidance for field sample collection and measurements that will be conducted under the Remedial Design Work Plan (RD Work Plan) for West Lake Landfill Operable Unit 2 (OU-2) activities. **Figure B-1** provides the location of the Inactive Sanitary Landfill (ISL) portion of OU-2, where the field sample collection and measurements will be performed. This RD SAP provides the procedural, documentation, and analytical requirements for each of the proposed field investigations described in the RD Work Plan. Not all sections of this RD SAP apply to or are relevant to all of the proposed field investigations.

Existing conditions at the ISL portion of the West Lake Landfill have been previously defined by past studies, including:

- *Draft Report – Inactive Landfill Cap Investigation, West Lake Site*; Golder Associates Inc., August 25, 1995
- *Remedial Investigation Report, West Lake Landfill Operable Unit 2*; Herst & Associates, Inc., September 2005.
- *Feasibility Study Report, West Lake Landfill Operable Unit 2, Bridgeton, Missouri – Revision 1*; Herst & Associates, Inc., June 2006

Existing facility features, including monitoring wells and the boundary of the ISL, are shown in **Figure B-2**. Activities described in this RD SAP are intended to enhance the decision-making process for the Remedial Design (RD) by providing an updated assessment of environmental conditions in the vicinity of the ISL portion of OU-2.

2.0 SAMPLING OBJECTIVES

As stated in the RD Work Plan and the 2008 United States Environmental Protection Agency Record of Decision (USEPA ROD), the general objective of the OU-2 remedial activities is to "protect public health and the environment by preventing actual or potential human exposure to the Site's contaminants and by preventing or mitigating contaminant migration." The specific OU-2 Remedial Action objectives are:

- Prevent direct contact with landfill contents;
- Minimize infiltration and resulting contaminant leaching to groundwater;
- Control surface water runoff and erosion; and
- Control and treat landfill gas.

To assist in achieving these objectives, the following field sampling activities are proposed:

- Complete a geotechnical evaluation and estimate volumes for potential borrow areas for ISL;
- Install and monitor temporary landfill gas perimeter monitoring wells[1] to determine if landfill gas is present at greater than 2.5 percent (%);
- Collect soil samples from the existing ISL cover to evaluate cover thickness and assess selected geotechnical soil properties;
- *Slope* A *Stability Evaluation Plan* will be submitted in the future to detail the planed investigation of existing slope stability along the ISL and other steep slopes greater than 25% per the Missouri Department of Natural Resource (MDNR) code of state regulations 10 CSR 80-3.010(17)(B)3. Even with such demonstration, no active, immediate, or final slope shall exceed 33 1/3%" per MDNR 10 CSR 80-3.010(17)(C)3. Additionally, MDNR 10 CSR 80-3.010(17)(C)5, requires provisions for slope stability for installation of final cover systems. The slope on the western portion of the ISL has been in place for over 30 years and visually has shown to be stable and therefore an analysis of the slope will be performed as part of the RD;
- Evaluate subsurface characterization to evaluate waste separation between the ISL and the South Quarry portion of the Bridgeton Landfill; and

[1] *The term "gas monitoring well" is being used throughout this document per EPA comment and at the recommendation of MDNR. Please note that such gas monitoring "wells" being installed and sampled as part of the OU-2 investigation will be installed outside of the waste boundary and will not be attached to a gas collection and control system. The "wells" will serve as what have traditionally been identified by Bridgeton Landfill as gas monitoring "probes" to monitor if landfill gas is migrating off-site.

- Collect water samples and groundwater flow data from select groundwater wells for analysis as part of the proposed long-term performance groundwater monitoring program for the ISL.

Each of the above-referenced tasks is described in the following sections.

Data from these sampling efforts will be used to evaluate current subsurface gas and groundwater quality conditions in the vicinity of the OU-2 facility, and to evaluate the current cover thickness and slope stability on the ISL.

This RD SAP was developed to provide consistency in the field sampling and monitoring efforts, including the collection, documentation and verification of groundwater quality, landfill gas, and geotechnical samples. Use of this RD SAP, and the associated RD Quality Assurance Project Plan (RD QAPP), will ensure that the data collected and analyzed meet specific project and regulatory requirements. The Data Quality Objectives (DQOs) for each field effort proposed in the RD Work Plan are presented and discussed in detail in Section 2.0 of the RD QAPP, Appendix A of the RDWP.

3.0 GEOTECHNICAL TESTING OF POTENTIAL BORROW AREAS

A separate plan, the *Soil Borrow Area Investigation Plan*, for the geotechnical testing of potential borrow area sources will be prepared and submitted to the USEPA for review and approval. The *Soil Borrow Area Investigation Plan* will provide additional details regarding proposed field work and sampling efforts needed to support the RD, including the proposed types, numbers, and locations for sample collection, and the evaluation criteria associated with the work.

4.0 INSTALLATION AND MONITORING OF TEMPORARY LANDFILL GAS PERIMETER MONITORING WELLS

To assess the status of subsurface decomposition gases in the vicinity of the ISL portion of OU-2, temporary landfill gas perimeter monitoring wells* are proposed to be installed. As described in the RD Work Plan and RD QAPP, six (6) temporary landfill gas monitoring wells* are proposed (**Figure B-3**) allowing monitoring of the western perimeter of the landfill.

Following the installation of the landfill gas perimeter monitoring wells*, weekly, monthly and quarterly measurements for methane will be performed. The monitoring will be conducted pursuant to the project schedule (Section 8.0 of the RD Work Plan) and in general accordance with procedures described by the MDNR 1999 technical bulletin *Sampling of Landfill Gas Monitoring Wells*. The duration of sampling, including criteria for modification or termination of measurements, will be consistent with protocol set forth in the *Explosive Gas Monitoring Plan* that will be prepared and established for the facility.

5.0 EXISTING THICKNESS AND MATERIAL EVALUATION OF INACTIVE SANITARY LANDFILL COVER

Sampling of existing cover materials from the ISL will be conducted to evaluate cover thickness and assess select geotechnical soil properties, including moisture content, unit weight, grain size distribution, Atterberg limits, and hydraulic conductivity. The assessments will provide an estimate of the volume of materials needed for construction of the final cover and the suitability of using the existing material as final landfill cover.

Sampling of the landfill cover materials will indicate and confirm where excess cover materials are available within portions of the ISL and where additional material needs to be added. Areas needing additional cover material or possessing excess cover material will be detailed in the 30%, 60% (if required), 90%, and Final Remedial Design Report Submissions.

The landfill cover thickness sampling program will include the collection of samples at approximate 150-foot grid sampling locations across the ISL. Sampling locations do not include the steep slope areas on the west side of the ISL due to access limitations for equipment. Samples immediately adjacent to the west slope of the ISL are assumed to be representative of the steep slope area. **Figure B-4** displays the approximate sampling grid and sample locations.

Each sampling location will be initially surveyed for northing, easting, and ground surface elevation. The thickness of the cover will be determined by a full depth sampling of the cover material. Each location will be sampled using a direct push drill rig to push a tube sampler lined with clear polyethylene liners a minimum of three (3) feet and up to five (5) feet, if soil conditions allow. Each sampler will be brought to the surface, the liner opened, and the soils visually examined to distinguish materials and measure corresponding material thicknesses. Sampled materials will be placed back into the borehole. The field engineer will develop a log of the soil conditions encountered in each drill hole. Field activity descriptions and field data will be entered onto appropriate field forms.

5.1 EXISTING MATERIAL EVALUATION

In addition to the cap thickness samples, described in Section 5.0 above, Shelby Tube samples of the in-situ cap materials will also be collected. A minimum of ten (10) Shelby Tube samples will be collected in accordance with ASTM D1587 at locations immediately adjacent to previous cap sampling locations. The sampling locations were spaced to provide representative coverage across the existing cap area at a frequency in excess of one (1) per every five (5) acres of cap material placed. At this frequency, the material will be sampled once per every 30,000 tons of material (assuming a three (3)-foot thickness and 120 pounds per square foot [lbs/cf]). Assuming the compacted clay material is fairly homogeneous, this testing frequency will provide representative results for the in-place compacted clay cover. If it is observed during the cap sampling procedures that the materials are heterogeneous, additional samples will be collected at the discretion of the Design Manager.

Undisturbed soil samples will be collected for material classification and hydraulic conductivity testing purposes. The Shelby Tube samples will be submitted to a qualified testing laboratory where the tubes will be extruded and logged with representative portions of each tube tested using the ASTM methods identified in Section 8.0 of the RD QAPP. Sampling locations, penetrating the landfill cover, will be sealed with hydrated bentonite or other appropriate means [MDNR Code of State Regulations (CSR) for Well Installation, Test Hole Construction (10 CSR 23-6.050)] for plugging of test holes.

6.0 SLOPE STABILITY VERIFICATION ALONG THE WESTERN PORTION OF THE INACTIVE SANITARY LANDFILL

The existing slope along the western perimeter of the ISL portion of OU-2 was established in the mid-1990s. **Figures B-5A and B-5B** display the location, contour details, and a cross-section of the western slope. Based on visual observations during a site visit, conducted by the Landfill Design team on November 11, 2008, as well as more recent site visits, and by years of observations by onsite personnel, the existing slope appears to be stable. This statement is based on the lack of observed signs of instability at the surface (i.e., no observed stress fractures/fissures in the surface, no slumping of the surface soil, no soil mounding at the toe of slope, etc.).

A *Slope Stability Evaluation Plan* will be submitted as a future design investigation planning document.

7.0 WASTE SEPARATION EVALUATION

A minimum of 3 sonic borings will be performed for the full thickness of in-place soil materials at locations between the ISL and the South Quarry portion of the Bridgeton Landfill. Borings will be performed with sonic drilling techniques using a four inch hollow drilling tool. Sonic drilling will be performed until the drill rig bit reaches a bedrock layer. Rock coring will be performed for an additional 5 feet to confirm that material encountered is bedrock. The soil borings are proposed to determine whether municipal solid waste (MSW) is present between the ISL and South Quarry portion of the Bridgeton Landfill cells. Materials returned to the surface will be visually evaluated and photographed for the presence of MSW materials. Field activity descriptions and field data will be entered onto appropriate field forms. Refer to **Figure B-7** for proposed soil boring locations. Historic placement of waste will also be investigated through review of aerial photos, drawings, and site files. The results of the waste separation boring program, along with the review of historical documents/photos, will be provided in the *Waste Separation Evaluation Report*.

8.0 LONG-TERM PERFORMANCE GROUNDWATER MONITORING

The objectives of the proposed long-term performance groundwater monitoring program for the ISL portion of the OU-2 are: 1) characterize the existing groundwater conditions and water quality; 2) protect groundwater from ongoing or future impacts from the ISL; and 3) demonstrate that the Selected Remedy performs, as required, over the post-closure period (USEPA ROD, 2008).

The OU-2 long-term performance groundwater monitoring program will consist of 2 phases:

- Baseline groundwater monitoring – to be conducted in accordance with 10 CSR 80-3.010 (11)(C)3, quarterly, but not to exceed 8 quarters of monitoring. The objective of the baseline groundwater monitoring is to establish current or existing groundwater quality and groundwater conditions prior to closure of the ISL.

- Detection groundwater monitoring – to begin after baseline groundwater monitoring and be conducted in accordance with 10 CSR 80-3.010(11)(C)4. Additional details regarding sampling frequency, locations, and evaluation approach will be included in the *Groundwater Monitoring Plan* submitted as part of the *Intermediate Design Report*. The objective of the detection groundwater monitoring program is to monitor for a change in groundwater conditions that could indicate a potential impact to the groundwater from the landfill.

Baseline and detection groundwater monitoring for the ISL will be coordinated and conducted in conjunction with the implementation of the OU-3 Remedial Investigation/Feasibility Study (RI/FS) groundwater monitoring program currently under USEPA review. At this time, it is anticipated that the OU-3 RI/FS Work Plan will be approved by the USEPA, and the proposed additional OU-3 monitoring wells will be installed during the third and fourth quarters of 2020. Therefore, the baseline phase of the proposed OU-2 groundwater monitoring program would begin in the fourth quarter of 2020. The actual date is contingent upon approval of the OU-3 RI/FS Work Plan by the USEPA.

The baseline monitoring well network is proposed to consist of nineteen (19) groundwater wells. The 19 wells are comprised of 13 existing groundwater monitoring wells plus six (6) to-be-constructed groundwater wells proposed as part of the OU-3 RI/FS. Each of these wells will be monitored quarterly. Locations of the 19 wells are presented on **Figure B-8**.

These 19 monitoring wells were selected based on their geographic/spatial location to each other along the western, southwestern, and southeastern boundaries of the ISL and availability to monitor various hydrogeologic zones of the alluvial aquifer. The proposed monitoring wells are spaced at between 50 feet to 600 feet from each other. Of the 19 proposed wells, 6 are/will be screened in the shallow alluvial aquifer, 7 are/will be screened in the intermediate portion of the alluvial aquifer, and 6 will be/are screened in the deep portion of the alluvial aquifer. Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells. The locations of the 19 wells are shown on **Figure B-8** of this RD SAP.

The 19 wells will be monitored for static water level and those parameters listed in 10 CSR 80-3 Appendix I, which includes various general water quality parameters, metals, and organic constituents. Section 8.1 below discusses the applicable or relevant and appropriate water quality standard requirements. **Table B-1** lists all the groundwater parameters that will be analyzed for this program, the analytical methods, required containers, preservatives, and holding times. **Table B-2** lists the parameters to be analyzed and their respective numeric water quality standards, if applicable.

The laboratory will be instructed to use the lowest practical quantitation limit that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions (10 CSR 80-3.010 (11)(C)5.J.(V)).

The 8 quarters of baseline monitoring data will be used to calculate and establish background values in accordance with 10 CSR 80-8.010(11)(C)3. Statistical analyses will be performed in accordance with MDNR 10 CSR 80-3.010(11)(C)5 and documented in the annual reports. Applicable or relevant and appropriate requirements (ARARs) that will be used for comparison purposes of the groundwater quality samples include:

1) Federal Primary Drinking Water Regulations, as specified in the Code of Federal Regulations, Title 40 (40 CFR), Part 141, Subpart B, Maximum Contaminant Levels (MCLs);

2) MDNR 10 CSR 60-4.010 through 4.110; and

3) MDNR 10 CSR 20-7.031(5), including Table A.

If, during the detection monitoring phase, a parameter in a well shows a statistically significant increase over the background value, notification, along with the well data, will be submitted to the USEPA and MDNR and the well will be resampled in accordance with MDNR 10 CSR 80-3.010 (11)(C)6.

Groundwater data obtained during the remedial activities will be validated in general accordance with the USEPA guidelines for Level IV data validation review as discussed in Section 14 of the

RD QAPP. Unvalidated groundwater quality analytical data will be provided to the USEPA and MDNR as part of the monthly progress reports.

Groundwater level, water quality data, and updated potentiometric maps will be summarized and presented in *Quarterly Groundwater Monitoring Reports*. *Annual Groundwater Monitoring Reports* will also include trend analyses, tri-linear plots, and relevant maps and figures of the groundwater quality data. During detection monitoring, the *Annual Groundwater Monitoring Reports* will also include statistical analyses. The groundwater monitoring reports will include the *Data Validation Report*, which will present and summarize the data verification and validation results. All laboratory data will be validated on an individual laboratory report basis within 60 days of receipt from the laboratory. The validated data will be submitted to the USEPA and MDNR with 30 days after the data has been validated (or within 90 days of receipt of the laboratory data.)

Upon completion of the OU-2 RD work, the OU-2 groundwater monitoring plan program may be modified pending discussions with USEPA and MDNR. Modifications may include revising or eliminating monitoring locations, reducing monitoring frequency and/or the parameters monitored to increase the effectiveness of the monitoring program.

8.1 GROUNDWATER SAMPLE COLLECTION PROCEDURES

This section provides the general procedures, methods, and considerations that will be used when collecting groundwater quality samples for laboratory analysis and supporting data for the long-term performance groundwater monitoring program (both the baseline and detection monitoring phases).

The selected analytical laboratory for the groundwater samples is Pace Analytical Services, LLC. The Pace Analytical Services' Quality Manual is provided in Attachment 1 of the RD QAPP.

Groundwater monitoring will be conducted in coordination with the OU-1 and OU-3 groundwater monitoring consultants/teams.

8.1.1 General Groundwater Sampling Procedures

Before embarking on a groundwater sampling event, necessary supplies and equipment will be reviewed to ensure they are in working order, calibrated, and ready for use. General sampling supplies should include, but not be limited to, the following:

- Field logs, notebook, well field log, and/or field computer with appropriate software;
- Laboratory chain of custody (COC) form(s);

- Water quality meters (for pH, temperature, conductivity, dissolved oxygen [DO], oxidation/reduction potential [ORP], and turbidity);
- Water level sounder;
- Well keys;
- Map or Geoportal access;
- Waterproof pens;
- Watch;
- Clean, pre-preserved laboratory-provided sample bottles;
- 500 milliliter (or more) clean, pouring beaker;
- Distilled water;
- Ice;
- Cooler;
- Plastic Ziploc bags;
- Trash bags;
- Scissors and/or knife;
- Pipe wrench;
- Multiple 5-gallon plastic buckets;
- Paper towels;
- Disposable nitrile or latex gloves (powder free);
- Alconox™ (or other) non-phosphate detergent;
- Tap water;
- Cell phone or field radio; and
- Camera.

The development of a sampling equipment checklist will expedite the preparation process. In addition, the sampler(s) must be familiar with the parameters to be analyzed and associated sampling requirements. The laboratory should be contacted prior to the field sampling date so a sufficient number of appropriately sized and preserved sample bottles are ordered and picked up/delivered. Additionally, laboratory personnel should be notified when bottles will be picked up and when to expect the samples to be delivered. Clean, unused, pre-preserved laboratory-provided sample bottles must be used for sampling.

Field water quality meters should be calibrated the morning of, or evening prior to, sample collection. See Section 8.1.4 regarding calibration procedures.

Equipment used to collect groundwater samples must be appropriately cleaned and decontaminated prior to measurements or sample collection (see Section 8.1.9).

Individual sample containers will be filled in order of decreasing sensitivity to potential volatilization of the analytical constituents. Groundwater will be transferred directly into the appropriate sample containers with preservative, if required. The groundwater samples will be placed into a clean trash bag that will be placed into a cooler with ice and then processed for shipment to the laboratory.

Special care will be taken not to contaminate the groundwater samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample, such as elevated temperatures. Sample containers will only be opened immediately prior to filling. Appropriate disposable, powderless gloves will be worn; a new pair will be worn each time a different location is sampled or for a different sampling event at the same location.

Laboratory-provided chain-of-custody forms must be completed and provided to the laboratory upon delivery of the samples. The samples will be delivered to the laboratory as soon as feasibly possible.

Lists of the specific parameters to be analyzed, analytical methods, recommended container type and size, required preservation, as well as the holding times for each parameter, are provided in **Table B-1** of this RD SAP.

Laboratory detection and reporting limits for each parameter must be at or below the applicable water quality standard for that parameter. **Table B-2** of this RD SAP provides the applicable water quality standard for each required parameter. The laboratory will be instructed to use the lowest practical quantitation limit that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions (10 CSR 80-3.010 (11)(C)5.J.(V)).

Critical information of the field sampling work (i.e., sample locations, date/time, samplers' names, weather, etc.), as well as field water quality stability parameters, purging details, deviations from planned sampling, and other pertinent information, must be documented on the field sample collection form or the well field log.

8.1.2 Wells To Be Sampled

Nineteen (19) monitoring wells have been selected for the long-term performance groundwater monitoring program. Locations of the proposed monitoring wells are shown on **Figure B-8**. The 19 wells include the following 13 existing wells:

• MW-103	PZ-302-AS	PZ-304-AS	D-93
• D-81	PZ-303-AS	PZ-205-AS	I-9
• PZ-302-AI	PZ-304-AI	S-82	I-73
• D-89			

Three (3) of the 19 wells are located hydraulically upgradient and will function as background monitoring wells. Those 3 wells are: I-73, PZ-205-AS, and D-89.

Additionally, six (6) wells currently proposed as part of the OU-3 Groundwater Monitoring Plan for the OU-3 RI will be incorporated into the OU-2 groundwater monitoring program upon their installation. Those six (6) wells are:

• MW-302-AD	MW-303-AD	MW-304-AD
• MW-303-AI	MW-306-AD	MW-306-AI

Because the groundwater monitoring program proposes to utilize six (6) yet-to-be-constructed OU-3 wells, the proposed groundwater monitoring well network is contingent upon coordination and approval of OU-3 RI/FS activities.

8.1.3 Water Level Measurements

A depth to static groundwater measurement will be collected at each of the 19 groundwater monitoring wells prior to purging. Static groundwater elevation will be determined for each well by subtracting the measured depth to static groundwater from the surveyed elevation of the top of the well riser (inner casing). An electronic water level probe, accurate to the nearest 0.01 foot, will be used to measure depth-to-water in each well. The groundwater level measurement will be hand-written on a field sampling form/worksheet.

The electronic water level probe will be cleaned with a non-phosphate detergent and then rinsed with deionized water prior to measuring each well.

8.1.4 Well Purging

Before the collection of groundwater samples, the well will be purged of standing water to remove stagnant or thermally stratified groundwater from the well casing and sand pack that may not be representative of groundwater within the aquifer.

Seven (7) of the 13 existing wells have Waterra pumps (inertia pumps with foot valves) installed, two (2) existing wells have dedicated bladder pumps, and the remaining four (4) existing wells do not have any dedicated pumps. It is planned to remove the Waterra pumps (where applicable) and install dedicated bladder pumps in each of the six (6) existing wells and the six (6) proposed wells prior to beginning baseline monitoring. Low-flow purging is the recommended method of pump purging for all groundwater sampling at the ISL. During low-flow purging via pump, pumping rates will be regulated or controlled to minimize turbulent flow, prevent damage to monitoring well components, and minimize the introduction of sediments into the well.

A minimum groundwater volume will be purged from the well, equal to two (2) times the volume of the pump and its associated tubing. Field parameter measurements will be recorded at regular time intervals (ideally every 5 minutes) until measurements of the field indicator parameters (pH, specific conductance, temperature, DO, turbidity, and ORP) indicate equilibrium as defined in Section 8.1.4 below. A flow-through cell will be used for field parameter measurements.

If a well is purged dry prior to the achievement of field parameter equilibrium, the well will be permitted to recover and then sampled within 24 hours of the completion of purging.

Purged water will be containerized and stored on-site within a temporary tank pending analyses. Upon receipt of analytical results, the purged water will be disposed of properly.

Pumping rate(s), approximate volume of water purged, and field stability parameter measurements will be recorded on the field sample collection form or the well field log.

8.1.5 Calibration of Water Sample Instruments

All water monitoring instruments, including water-level meters and water quality instruments, will be tested and calibrated prior to each sampling trip and periodically during sampling (i.e., every tenth sample). Water-level meters will be tested according the manufacturer's recommendations. For pH, meters must be calibrated with 3 buffer solutions: 4.0, 7.0, and 10.0. Conductivity must be calibrated with a standard that is similar to the expected conductivity range of the water that will be sampled. The temperature probe must be calibrated once a year with a NIST-certified thermometer.

Calibration of the DO probe and the ORP probe must be conducted in accordance with the respective manufacturer's instructions.

Calibration information, such as the date/time, standard(s), etc., must be recorded in the instrument log book and/or groundwater sampling field form.

If, at any time, instrument readings seem inaccurate based on historical data or professional judgment, the instrument calibration will be checked and the instrument recalibrated, if necessary. If the instrument continues to malfunction, the field sampler(s) may trade the malfunctioning instrument for a new or another functioning instrument.

8.1.6 Measurement of Field Indicator Parameters

Measurement of field indicator parameters must be performed in situ or using a separate sub-sample, which is then discarded once the measurement has been made. Field measurements should never be made on the same water sample that is going to be submitted to an analytical laboratory for analyses.

Measurement of field indicator parameters (pH, temperature, specific conductivity, DO, ORP, and turbidity) will be collected every 5 minutes during purging and within 15 minutes of sample collection. All field indicator parameters, as well as the date, time, and sampler's initials, will be recorded on the field sampling worksheet and/or field computer.

Stabilization of the purging process, or field parameter equilibrium, is considered to be achieved when three (3) consecutive readings are within the following limits:

- pH: +/- 0.1 unit
- Temperature: +/- 3%
- Specific Conductance: +/- 3%
- DO: +/- 10% for values greater than 0.5 mg/L; if 3 DO values are less than 0.5 mg/L, consider the values as stabilized
- ORP: +/- 10 millivolts
- Turbidity: +/- 10% for values greater than 5 NTU; if 3 Turbidity values are less than 5 NTU, consider the values as stabilized

Groundwater samples may be collected as soon as the field parameters have stabilized, or if purged to dry, as soon as the well has recovered sufficiently.

8.1.7 Collection of Volatile Organic Compounds (VOCs)

Water samples to be analyzed for volatile organic compounds (VOCs), which are listed on **Table B-1** of this RD SAP, must be collected in 40-milliliter (ml) glass vials with Teflon® septa. Water samples collected for VOCs should be collected with as little agitation or disturbance as possible. The vial should be filled such that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. VOC samples have a 14-day holding time.

8.1.8 Sample Handling and Transportation

The type of analysis for each sample collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples will be collected directly from the pump tubing into the appropriate laboratory-cleaned bottles. Sample identification, date and time, and analysis requested must be written, with a waterproof pen, on each sample bottle.

Samples must be maintained at a temperature of 4° Celsius (or less) until they are delivered to the laboratory.

Immediately after collection, all water samples will be placed into a clean, large trash bag. Ice will be added to the trash bag then the trash bag will be sealed. The trash bag with samples will then be placed into a cooler. The cooler will be wrapped with duct tape. Samples must be transported to the analytical laboratory as soon as possible to ensure holding times are met.

The tracking numbering system for groundwater samples will use the prefix: OU2-GW.

8.1.9 Decontamination of Field Sampling Equipment

All field sampling equipment must be properly cleaned before use. Equipment should be cleaned in an area protected from airborne contaminants or other sources of contamination. The cleaning procedure used depends on the type(s) of water samples that will be collected and processed. The following cleaning procedures are appropriate:

- Rinse the sampling equipment with tap water to remove the majority of solids;
- Using a plastic brush or sponge and low-phosphate lab detergent (e.g. Alconox™ or other phosphate-free, biodegradable liquid detergent), scrub the equipment to remove all residues;
- After scrubbing, rinse the equipment with tap water;
- For the final rinse, rinse with distilled or deionized water; and
- Place the cleaned equipment into sealable plastic bags.

8.1.10 Documentation

Document control procedures will be followed to ensure the reliability and interpretability of the collected data. A field sampling form will be filled out for each monitoring well, and for each sampling event. In general, data obtained from each sampling event should contain the following information:

- Sampling location ID (i.e., well number) with coordinates or other relevant information;
- Details of sampling point (i.e., end of discharge tubing, sampling port, etc.);
- Date/time of sample collection;
- Site/weather conditions;
- Name(s) of sampling personnel;
- Visual observation of sample appearance;
- Field indicator parameters collected in the field; and
- Any information that may affect the results of the analysis.

All entries must be legible, written in waterproof ink, with the date and time of entry. Photographs taken at a location, if any, should be noted on the field sampling form.

A laboratory chain-of-custody form must be completed for each sampling event. At a minimum, the chain-of-custody form will include:

- The project name;
- Sampler(s) names;
- Analytical laboratory name, address, and phone number;
- Type of analysis requested;
- Date/time of shipment or delivery; and
- Signature of person involved in shipment/delivery of samples.

The form is to be completed by the sampling team, and after signing and relinquishing custody of the samples to the laboratory, the sampler retains the bottom copy. The other copies are retained by the laboratory.

8.2 GROUNDWATER FIELD AND LABORATORY QUALITY CONTROL (QC) SAMPLES

The following field QC samples and sample frequencies (per standard professional protocols) will be collected for analysis during the proposed groundwater monitoring event:

- Field Duplicate samples – 1 field duplicate groundwater sample to be collected per 10 primary groundwater samples;
- Field Blank samples – 1 field blank sample to be collected per sampling event;
- Equipment Blank samples – 1 equipment blank sample to be collected per sampling event if a non-dedicated pump is utilized for purging and sampling; and
- Trip Blank samples – 1 trip blank sample (provided by the laboratory) to be included with each sample shipment containing samples for analysis of VOCs.

The following laboratory quality control samples and sample frequencies are proposed to be analyzed concurrently with groundwater samples:

- Method Blank samples – 1 method blank sample to be analyzed per 20 samples analyzed in the batch;
- Laboratory Control Samples (LCS) – 1 LCS to be analyzed per 20 analyzed samples in the batch; and
- Matrix Spike / Matrix Spike Duplicate (MS / MSD) samples – 1 MS / MSD sample pair to be analyzed per 20 samples analyzed in the batch.

8.2.1 Collection of Field Quality Control Samples

Field duplicate samples are independent samples collected at the same location, at the same time, and analyzed for the same parameters of interest as the regular groundwater sample. Field duplicate samples are used to check the precision of field collection or laboratory analyses. The sample bottles for regular and duplicate analyses will be filled in alternate succession for each required analysis (i.e. fill the metals sample bottle, then the metals duplicate bottle). The sample and duplicate bottles will then be labeled as separate samples and placed in the trash bag with ice. Field duplicates will be "blind" so the analytical laboratory does not know from which well(s) they were collected.

Field blanks are used to evaluate possible cross-contamination of samples from the field conditions that are present at the sampling location. Field blanks must be analyzed for the same parameters for which the groundwater samples will be analyzed. Field blanks will be prepared at a specified well site by pouring deionized water into the appropriate sample bottles and vials in the same quantities (same sample bottle set) as the groundwater samples. The field blank bottles will be placed on a cooler and left open during the well purging, and then sealed prior to sampling the well. The field blank will be labelled and shipped to the laboratory with the groundwater samples.

Equipment blanks are used to determine the adequacy of the decontamination procedures used for the reusable sampling equipment. The equipment blank is collected by pouring deionized water onto or into the sampling equipment (i.e., non-dedicated pump or tubing) after the equipment has been decontaminated, and then collecting the rinsate water in the same sample bottle set as the wells. The equipment blank bottles will be labelled and placed in the trash bag with ice along with the well water sample bottles. The equipment blank will be submitted for the same analysis as the well samples. An equipment blank will only be collected if non-dedicated purging/sampling equipment, such as a non-dedicated bladder pump, is used.

Trip blanks will accompany samples to be analyzed for volatile analysis. Trip blanks are prepared by the laboratory and are used to establish that the sample has not been contaminated by external sources during the transport of sample bottles to and from the field. Trip blanks are of reagent-grade water, properly preserved in a controlled environment prior to field mobilization by the laboratory. The trip blank will be kept with the sample containers through the sampling process and returned to the laboratory with the other samples. The trip blank will be submitted for the same analysis as the well samples. All trip blanks will be labeled and included on the COC.

8.3 REQUESTED ANALYSIS

The 19 wells will be monitored for static water level and those parameters listed in 10 CSR 80-3 Appendix I, which includes various general water quality parameters, metals, and organic constituents. **Table B-1** lists the specific parameters to be analyzed, as well as the sample bottle size, required preservation, and holding time for each parameter.

Metals listed in **Table B-1** will be analyzed as total metals (i.e., not field filtered), in accordance with 10 CSR 20-7.031(5)(B)2.B.

Laboratory detection and reporting limits for each parameter must be at or below the applicable water quality standard for that parameter. **Table B-2** of this RD SAP provides the applicable water quality standard for each required parameter. The laboratory will be instructed to use the lowest practical quantitation limit that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions (10 CSR 80-3.010 (11)(C)5.J.(V)).

8.4 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The applicable or relevant and appropriate numeric water quality standards for the OU-2 RD Work Plan performance groundwater monitoring program consist of those water quality standards as promulgated, revised, and published by the MDNR and USEPA. Applicable or relevant and appropriate water quality standards that will be used for comparison purposes for this project are:

- 40 CFR Part 141, Subpart B, Federal Primary Safe Drinking Water Act Maximum Contaminant Levels (MCLs);
- Missouri State regulations 10 CSR 60-4.010 through 4.110; and
- Missouri State regulations 10 CSR 20-7 Table A.

9.0 REFERENCES

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Herst & Associates, Inc., 2006. *Feasibility Study Report, West Lake Landfill Operable Unit 2, Bridgeton, Missouri*. Revision 1. June 2006.

Herst & Associates, Inc., 2005. *Remedial Investigation Report, West Lake Landfill Operable Unit 2*. Consultant Report. Revised September 2005.

Missouri Department of Natural Resources (MDNR), 1999. *Sampling of Landfill Gas Monitoring Wells*. Technical Bulletin 9/1999. Division of Environmental Quality, Solid Waste Management Program.

TABLES

TABLE B-1 PARAMETERS, ANALYTICAL METHODS, SAMPLE CONTAINER TYPES, PRESERVATION METHODS, AND HOLDING TIMES FOR GROUNDWATER SAMPLES					
Regulatory Citation	**Parameter**	**Method**	**Container**	**Preservative**	**Holding Time**
None	pH - field	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Temperature - field	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Specific conductance - field (Conductivity)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Dissolved Oxygen (DO)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
None	Oxidation/Reduction Potential (ORP)	N/A	N/A	N/A	Analyze within 15 minutes of sample collection
Missouri 10 C.S.R. 80-3.010 Appendix I	**General Parameters and Inorganics**				
	pH - laboratory	SM 4500 H B	1 x 250 mL P	Cool to < 4° C	15 minutes of sample collection
	Total dissolved solids (TDS; mg/L)	SM 2540 D	1 x 500 mL P	Cool to < 4° C	7 days
	Chemical oxygen demand (COD; mg/L), dissolved	EPA 410.4	1 x 250 mL P	Cool to < 4° C; H2SO4 to pH <2	28 days
	Chloride (CL; mg/l) dissolved	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Specific conductance- laboratory (25° C; umho/cm)	SM 2510B	1 x 250 mL P	Cool to < 4° C	28 days
	Ammonia (NH3 as N, mg/L)	EPA 350.1	1 x 250 mL P	Cool to < 4° C; H2SO4 to pH <2	28 days
	Total Organic Carbon (TOC, mg/L)	SM 5310 B	1 x 250 mL P	Cool to < 4° C; H2SO4 to pH <2	28 days
	Fluoride (F, ug/L)	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Hardness (calculated, mg/L)	SM 2340 B	1 x 250 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Nitrate/Nitrite (NO3/NO2, mg/L)	EPA 353.2	1 x 250 mL P	Cool to < 4° C; H2SO4 to pH <2	28 days
	Phosphorus (total P, mg/L)	EPA 365.1	1 x 250 mL P	Cool to < 4° C; H2SO4 to pH <2	28 days
	Sulfate (SO4, mg/L)	EPA 300.0	1 x 250 mL P	Cool to < 4° C	28 days
	Metals - to be analyzed for Total Metals				
	Antimony (Sb, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Arsenic (As, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Barium (Ba, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Beryllium (Be, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Boron (B, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Cadmium (Cd, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Calcium (Ca, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Chromium (Cr, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Cobalt (Co, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Copper (Cu, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Lead (Pb, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Magnesium (Mg, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Manganese (Mn, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Mercury (Hg, mg/L	SW-846 7470A	1 x 250 mL P	Cool to < 4° C; HNO3 to pH <2	28 days
	Nickel (Ni, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Selenium (Se, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Silver (Ag, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Sodium (Na, mg/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Thallium (Tl, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Vanadium (V, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
	Zinc (Zn, ug/L)	SW-846 6010B	2 x 500 mL P	Cool to < 4° C; HNO3 to pH <2	6 months
Missouri 10 C.S.R. 80-3.010 Appendix I	**Organic Constituents**				
	Acetone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Acrylonitrile	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Benzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromochloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromodichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Bromoform; Tribromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Carbon disulfide	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Carbon tetrachloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chloroethane; Ethyl chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Chloroform; Trichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Dibromochloromethane; Chlorodibromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dibromo-3-chloropropane; DBCP	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dibromoethane; Ethylene dibromide; EDB	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	o-Dichlorobenzene; 1,2-Dichlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	p-Dichlorobenzene; 1,4-Dichlorobenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,4-Dichloro-2-butene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved

TABLE B-1 PARAMETERS, ANALYTICAL METHODS, SAMPLE CONTAINER TYPES, PRESERVATION METHODS, AND HOLDING TIMES FOR GROUNDWATER SAMPLES					
Regulatory Citation	**Parameter**	**Method**	**Container**	**Preservative**	**Holding Time**
	1,1-Dichloroethane; Ethylidene chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dichloroethane; Ethylene dichloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2-Dichloropropane; Propylene dichloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	cis-1,3-Dichloropropene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	trans-1,3-Dichloropropene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Ethylbenzene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	2-Hexanone; Methyl butyl ketone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl bromide; Bromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl chloride; Chloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methylene bromide; Dibromomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methylene chloride; Dichloromethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl ethyl ketone; MEK; 2-Butanone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Methyl iodide; Iodomethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	4-Methyl-2-pentanone; Methyl isobutyl ketone	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Styrene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,1,2-Tetrachloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,2,2-Tetrachloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Toluene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,1-Trichloroethane; Methylchloroform	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,1,2-Trichloroethane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Trichloroethylene; Trichloroethene	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Trichlorofluoromethane; CFC-11	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	1,2,3-Trichloropropane	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Vinyl acetate	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Vinyl chloride	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved
	Xylenes	SW846 8260C	3 x 40mL glass	Cool to < 4° C; HCl to pH < 2	14 days preserved; 7 days unpreserved

All metals will be analyzed for total (unfiltered samples) metals analyses.
N/A = not applicable; samples not submitted to laboratory
ug/L = micrograms per liter
mg/L = milligrams per liter
P = plastic, polypropylene, polyethylene
4° C = 39.2° Fahrenheit

TABLE B-2 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS
-FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
None	pH - field	NNS	6.5-8.5 [2]
None	Temperature - field	NNS	NNS
None	Specific conductance - field (Conductivity)	NNS	NNS
None	Dissolved Oxygen (DO)	NNS	NNS
None	Oxidation/Reduction Potential (ORP)	NNS	NNS
	General Parameters and Inorganics		
Missouri 10 C.S.R. 80-3.010 Appendix I	pH - laboratory	NNS	6.5-8.5
	Total dissolved solids (TDS; mg/L)	NNS	500 [2]
	Chemical oxygen demand (COD; mg/L), dissolved	NNS	NNS
	Chloride (CL; mg/l) dissolved	NNS	250 [2]
	Specific conductance- laboratory (25° C; umho/cm)	NNS	NNS
	Ammonia (NH3 as N, mg/L)	NNS	NNS
	Total Organic Carbon (TOC, mg/L)	NNS	NNS
	Fluoride (F, mg/L)	4.0	4.0
	Hardness (calculated, mg/L)	NNS	NNS
	Nitrate (as NO_3, mg/L)	10.0	10.0
	Nitrite (as NO_2, mg/L)	1.0	1.0
	Total Nitrate + Nitrite	10.0	10.0
	Phosphorus (total P, mg/L)	NNS	NNS
	Sulfate (SO4, mg/L)	NNS	250 [2]
	Metals - to be analyzed for Total Metals		
	Antimony (Sb, mg/L)	0.006	0.006
	Arsenic (As, mg/L)	0.01	0.01
	Barium (Ba, mg/L)	2.0	2.0
	Beryllium (Be, mg/L)	0.004	0.004
	Boron (B, mg/L)	NNS	NNS
	Cadmium (Cd, mg/L)	0.005	0.005
	Calcium (Ca, mg/L)	NNS	NNS
	Chromium (Cr, mg/L)	0.10	0.10
	Cobalt (Co, mg/L)	NNS	NNS
	Copper (Cu, mg/L)	1.3	1.0 [2]
	Lead (Pb, mg/L)	0.015	0.015
	Magnesium (Mg, mg/L)	NNS	NNS
	Manganese (Mn, mg/L)	NNS	0.05 [2]
	Mercury (Hg, mg/L	0.002	0.002
	Nickel (Ni, mg/L)	NNS	NNS
	Selenium (Se, mg/L)	0.05	0.05
	Silver (Ag, mg/L)	NNS	0.10 [2]
	Sodium (Na, mg/L)	NNS	NNS
	Thallium (Tl, mg/L)	0.002	0.002
	Vanadium (V, mg/L)	NNS	NNS
	Zinc (Zn, mg/L)	NNS	5.0 [2]

TABLE B-2 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS
-FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
	Organic Constituents (mg/L)		
Missouri 10 C.S.R. 80-3.010 Appendix I	Acetone	NNS	NNS
	Acrylonitrile	NNS	NNS
	Benzene	0.005	0.005
	Bromochloromethane	NNS	NNS
	Bromodichloromethane	NNS	NNS
	Bromoform; Tribromomethane	NNS	NNS
	Carbon disulfide	NNS	NNS
	Carbon tetrachloride	0.005	0.005
	Chlorobenzene	0.10	0.10
	Chloroethane; Ethyl chloride	NNS	NNS
	Chloroform; Trichloromethane	NNS	NNS
	Dibromochloromethane; Chlorodibromomethane	0.06	NNS
	1,2-Dibromo-3-chloropropane; DBCP	0.0002	0.0002
	1,2-Dibromoethane; Ethylene dibromide; EDB	0.00005	0.00005
	o-Dichlorobenzene; 1,2-Dichlorobenzene	0.60	0.60
	p-Dichlorobenzene; 1,4-Dichlorobenzene	0.075	0.075
	trans-1,4-Dichloro-2-butene	NNS	NNS
	1,1-Dichloroethane; Ethylidene chloride	NNS	NNS
	1,2-Dichloroethane; Ethylene dichloride	0.005	0.005
	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	0.007	0.007
	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	0.07	0.07
	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	0.10	0.10
	1,2-Dichloropropane; Propylene dichloride	0.005	0.005
	cis-1,3-Dichloropropene	NNS	NNS
	trans-1,3-Dichloropropene	NNS	NNS
	Ethylbenzene	0.70	0.70
	2-Hexanone; Methyl butyl ketone	NNS	NNS
	Methyl bromide; Bromomethane	NNS	NNS
	Methyl chloride; Chloromethane	NNS	NNS
	Methylene bromide; Dibromomethane	NNS	NNS
	Methylene chloride; Dichloromethane	0.005	0.005
	Methyl ethyl ketone; MEK; 2-Butanone	NNS	NNS
	Methyl iodide; Iodomethane	NNS	NNS
	4-Methyl-2-pentanone; Methyl isobutyl ketone	NNS	NNS
	Styrene	0.10	0.10
	1,1,1,2-Tetrachloroethane	NNS	NNS
	1,1,2,2-Tetrachloroethane	NNS	NNS
	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	0.005	0.005
	Toluene	1.0	1.0

TABLE B-2 PARAMETERS AND APPLICABLE WATER QUALITY STANDARDS
-FOR COMPARISON PURPOSES ONLY

Regulatory Citation	Parameter	40 CFR Part 141 [1] Primary MCL	Missouri 10 CSR [1] 60-4.010 - 4.110 (mg/L)
	1,1,1-Trichloroethane; Methylchloroform	0.20	0.20
	1,1,2-Trichloroethane	0.005	0.005
	Trichloroethylene; Trichloroethene	0.005	0.005
	Trichlorofluoromethane; CFC-11	NNS	NNS
	1,2,3-Trichloropropane	NNS	NNS
	Vinyl acetate	NNS	NNS
	Vinyl chloride	0.002	0.002
	Xylenes	10	10

All metals will be analyzed for total (unfiltered samples) metals analyses.

NNS = No numeric water quality standard

ug/L = micrograms per liter

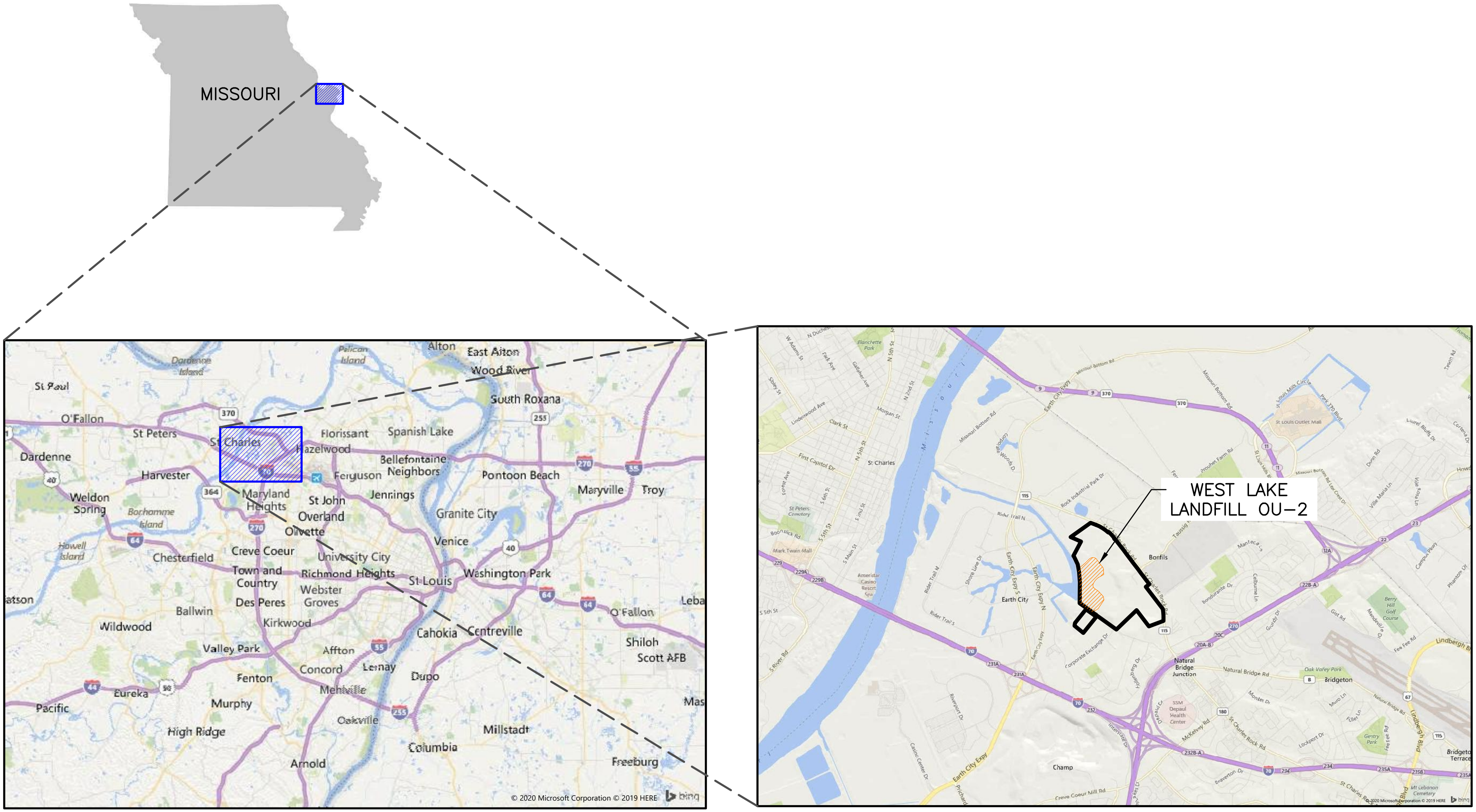
mg/L = milligrams per liter

[1]: Water quality standards in effect at time of ROD signing (2008)

[2]: Secondary MCL (10 CSR 60-4.070): Secondary MCLs are non-enforceable guidelines regulating contaminants that may cause aesthetic effects (such as taste, odor, or color) in drinking water.

FIGURES

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Site Location Map.dwg{8X11} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:32 PM



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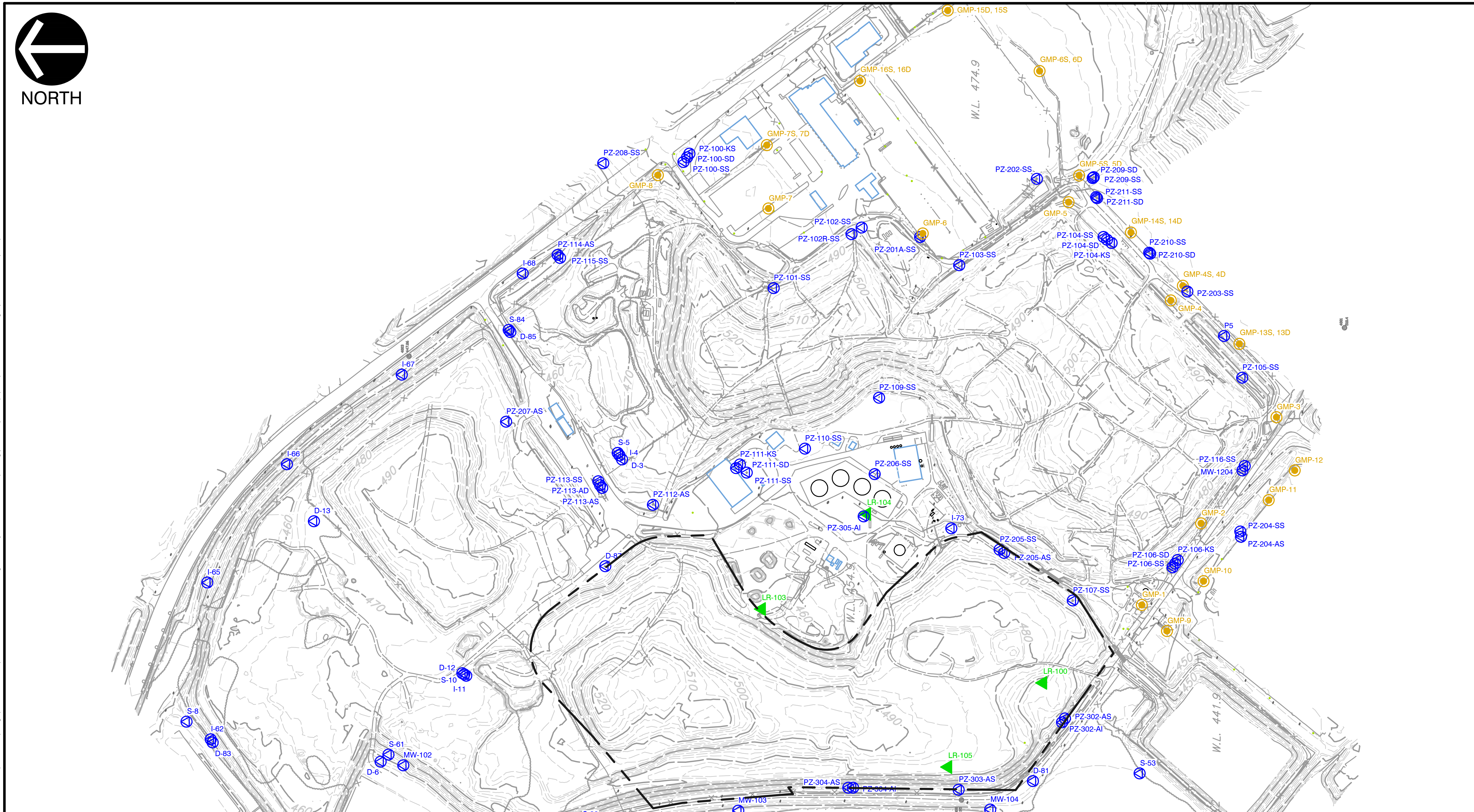
ST. LOUIS COUNTY

SITE LOCATION MAP

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.: B-1
DATE: FEB. 2020	DWG SCALE: N.T.S.	PROJECT NO: 191-750	

*HAND SIGNATURE ON FILE



LEGEND

— — —	OU-2 BOUNDARY
— 500 —	EXISTING CONTOUR MAJOR
- - -	EXISTING CONTOUR MINOR
△	MONITORING WELL
◉	GAS WELL
▲	LEACHATE RISER

SCALE IN FEET

0 400 800

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EXISTING FACILITY FEATURES MAP

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=400'	PROJECT NO: 191-750	B-2

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Existing Facility Features Map.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:29 PM

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LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

GW-## PROPOSED GAS WELL

GMW-16S EXISTING GAS WELL

SCALE IN FEET

0 200 400

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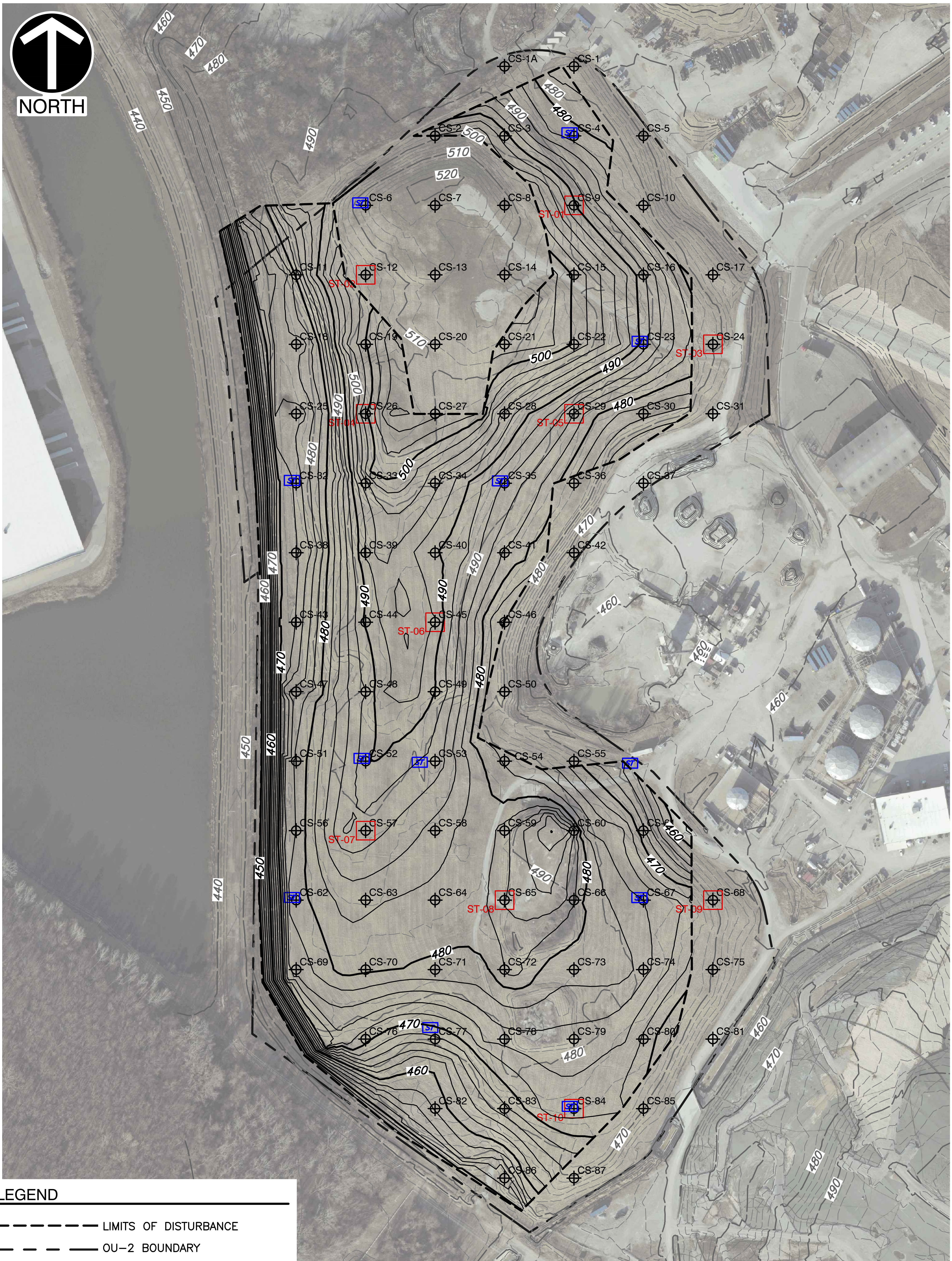
PROPOSED GAS WELL LOCATIONS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	B-3
DATE:	APR. 2020	DWG SCALE:	1"=200'	PROJECT NO:	191-750		

P:\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Cap Sampling Locations.dwg{11X17} LS:(3/19/2020 - cnagel) - LP: 3/19/2020 12:40 PM



LEGEND

LIMITS OF DISTURBANCE

OU-2 BOUNDARY

500 TOP OF WASTE CONTOUR MAJOR

TOP OF WASTE CONTOUR MINOR

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

CS-89 SAMPLING LOCATIONS

ST-## SHELBY TUBE SAMPLING LOCATIONS

ST PREVIOUS SHELBY TUBE SAMPLING LOCATIONS

SCALE IN FEET

0 200 400

NOTE

1. ADDITIONAL CAP OR SHELBY TUBE SAMPLING LOCATIONS MAY BE UTILIZED FOR IRREGULARITIES OBSERVED DURING THE INACTIVE SANITARY LANDFILL EXISTING CAP EVALUATION

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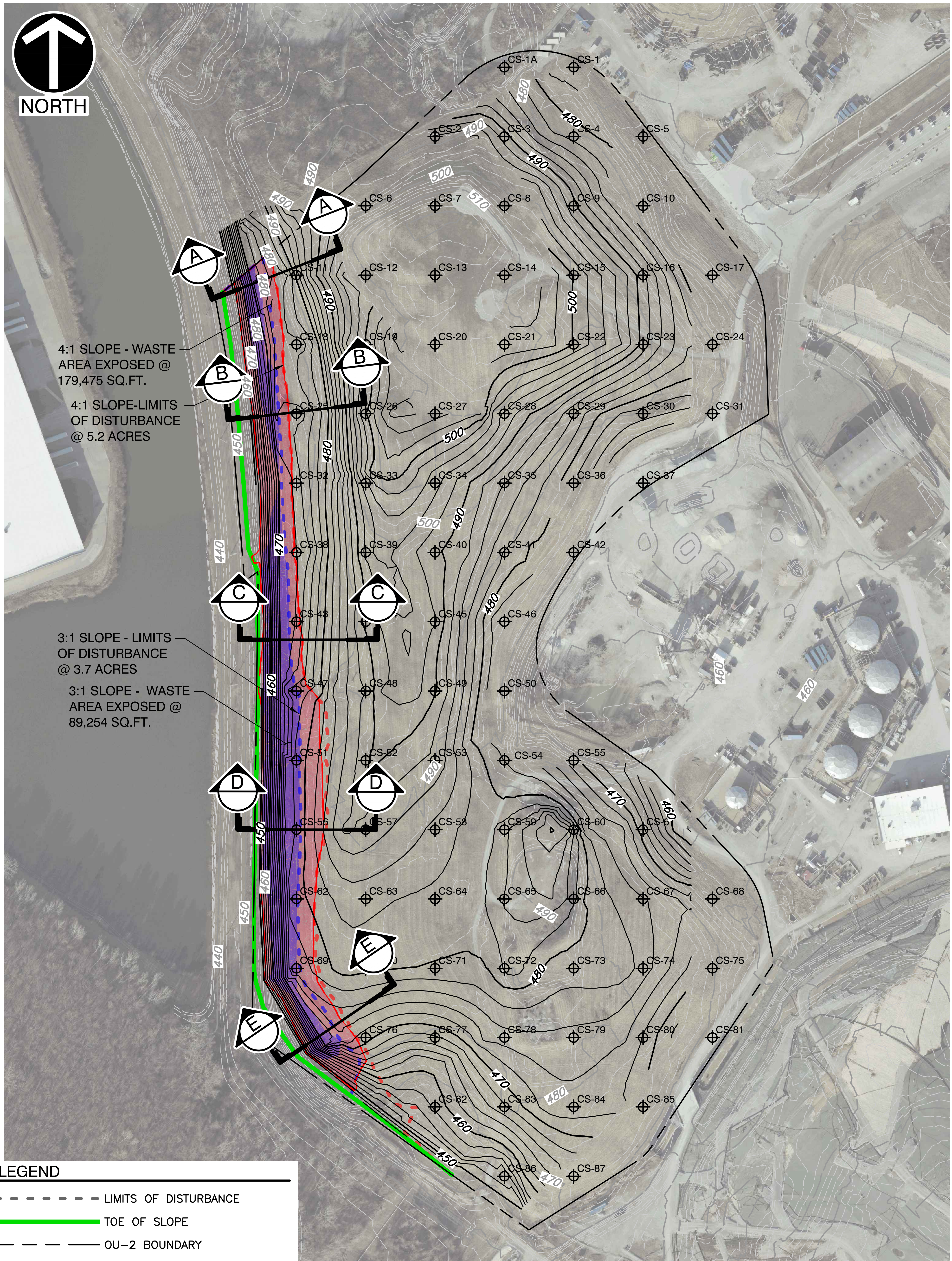
CAP SAMPLING LOCATIONS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	B-4
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Existing Western Slope OU-2.dwg{PLAN VIEW- 11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 5:03 PM



LEGEND

- LIMITS OF DISTURBANCE
- TOE OF SLOPE
- OU-2 BOUNDARY
- 500 TOP OF WASTE CONTOUR MAJOR
- TOP OF WASTE CONTOUR MINOR
- 500 EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- CS-89 SAMPLING LOCATIONS
- WASTE REVEAL AT 3:1
- WASTE REVEAL AT 4:1

SCALE IN FEET

0 200 400

REFERENCE

1. WASTE SURFACE EXPOSED ACCOUNTS FOR THE 3' CAP REQUIRED
2. TOP OF WASTE SURFACE IS APPROXIMATED BASED UPON SAMPLING LOCATIONS AND PROJECTED TO BASE OF SLOPE

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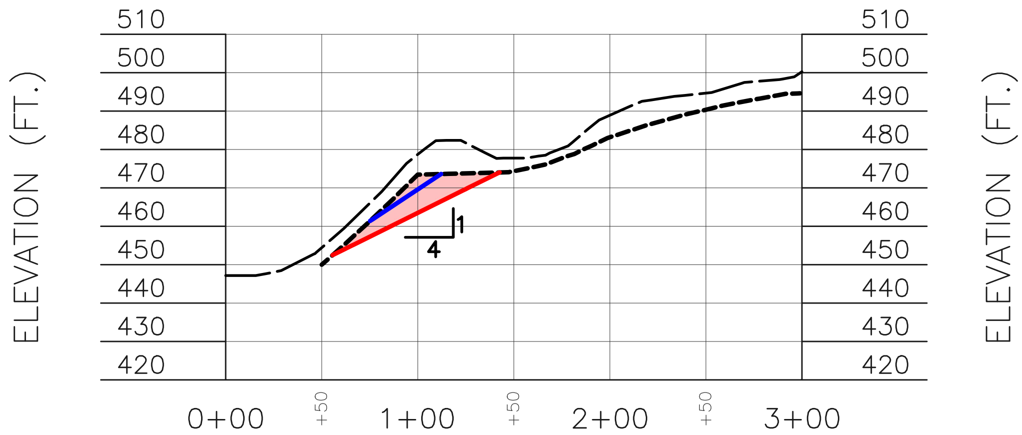
EXISTING WESTERN SLOPE OF OU-2

DRAWN BY: CAC	CHECKED BY: KTK	APPROVED BY: TDM*	FIGURE NO.: B-5A
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Existing Western Slope OU-2.dwg{SECTIONS- 11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 4:41 PM

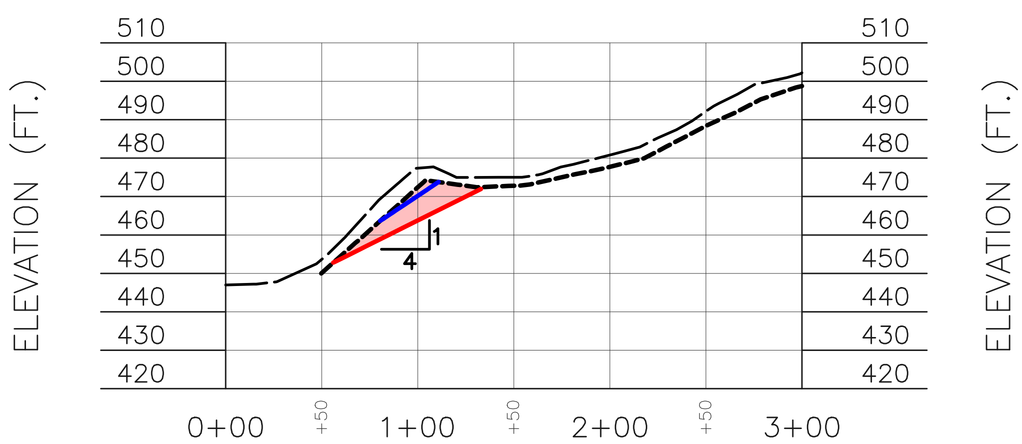
NORTH

STATISTICS	SLOPES	
	3:1	4:1
DISTURBED WASTE 3D AREA	89,254 FT^2	179,475 FT^2
DISTURBED WASTE VOLUME	8,569 YD^3	34,300 YD^3
LIMITS OF DISTURBANCE	3.7 AC	5.2 AC



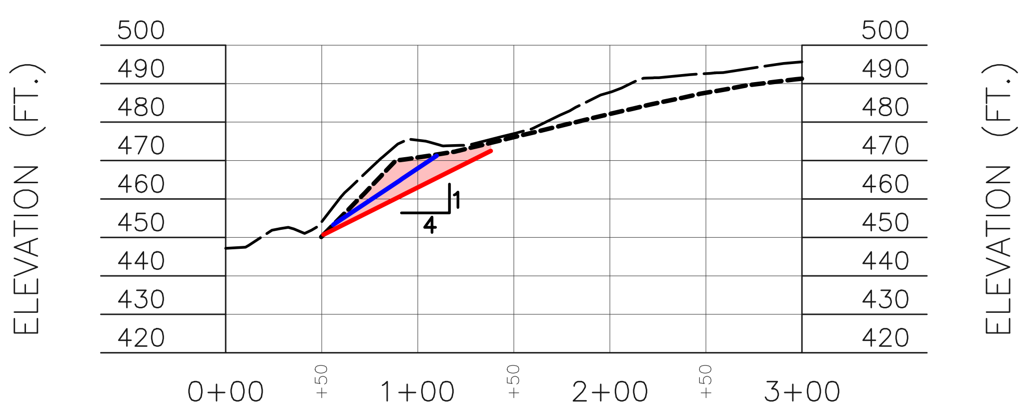
A-A'

SCALE H:1"=100'; V:1"=50'



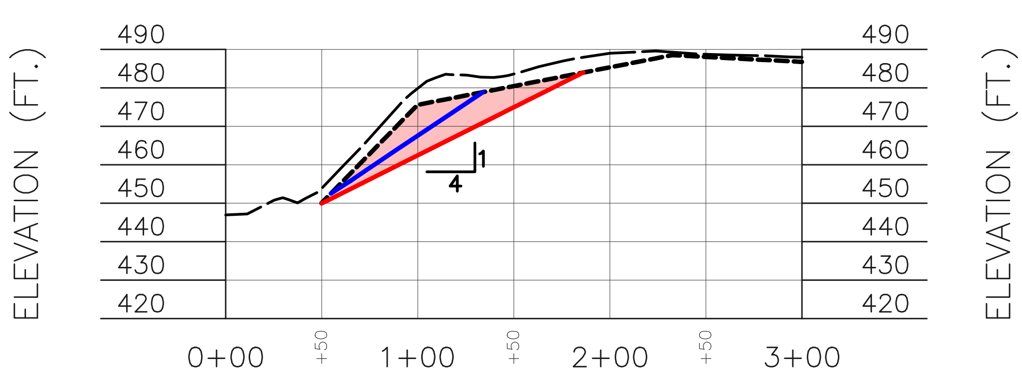
B-B'

SCALE H:1"=100'; V:1"=50'



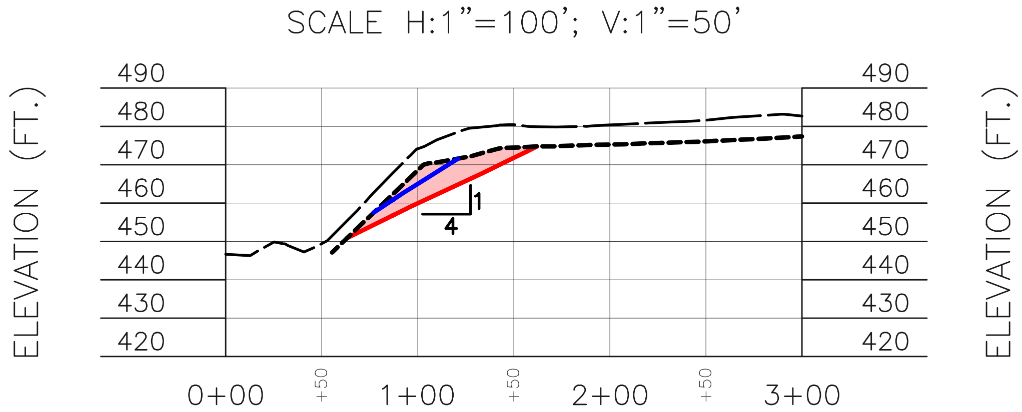
C-C'

SCALE H:1"=100'; V:1"=50'



D-D'

SCALE H:1"=100'; V:1"=50'



E-E'

SCALE H:1"=100'; V:1"=50'

LEGEND

- EXISTING SURFACE
- TOP OF WASTE (SUB-SURFACE)
- DENOTES 3:1 CUT SLOPE W/ WASTE
- DENOTES 4:1 CUT SLOPE W/ WASTE
- 4:1 CUT SLOPE W/ WASTE – FILL

REFERENCE

1. WASTE SURFACE EXPOSED ACCOUNTS FOR THE 3' CAP REQUIRED
2. TOP OF WASTE SURFACE IS APPROXIMATED BASED UPON SAMPLING LOCATIONS AND PROJECTED TO BASE OF SLOPE

HORIZONTAL SCALE IN FEET

0 100 200

VERTICAL SCALE IN FEET

0 50 100

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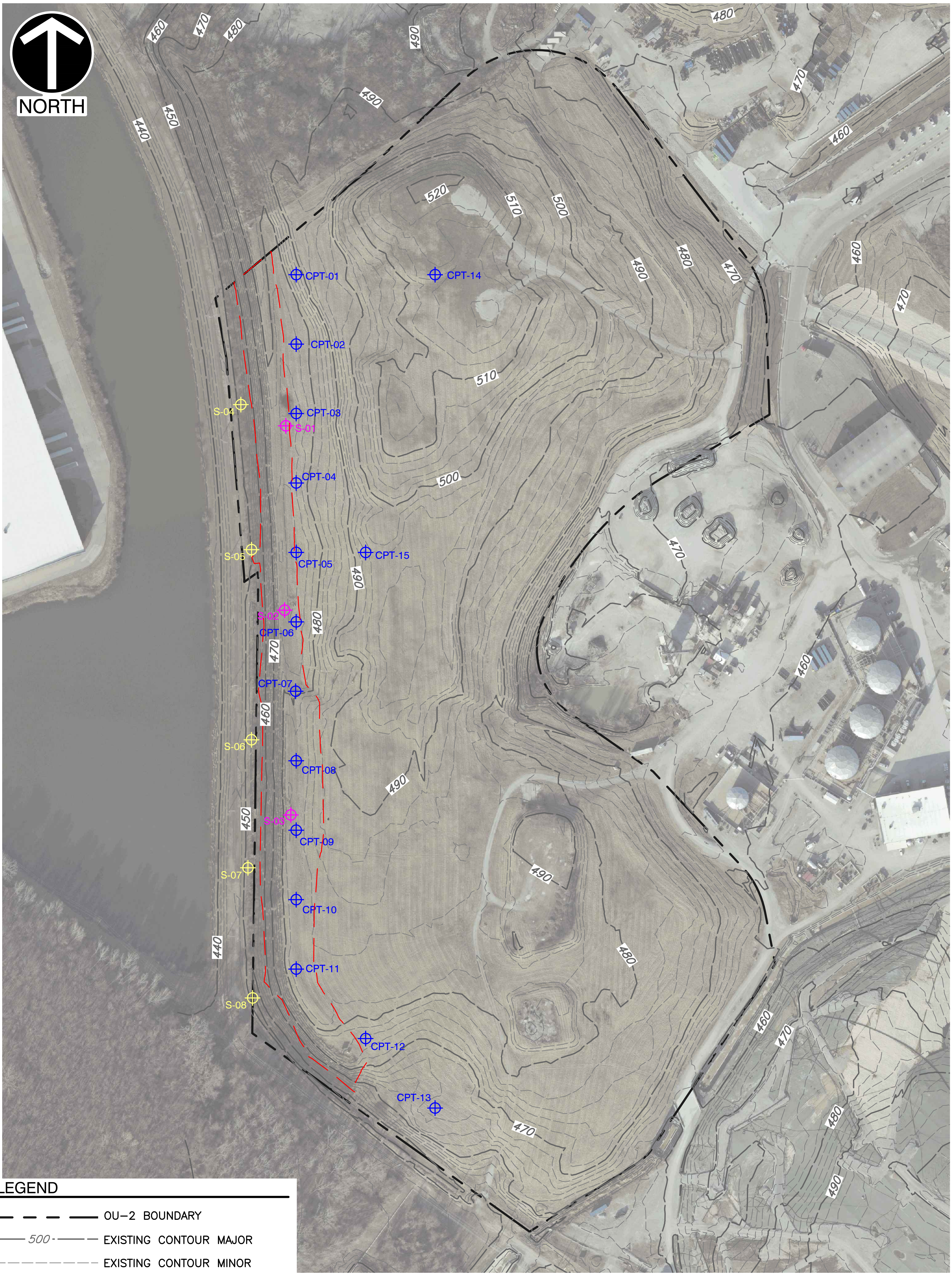
EXISTING WESTERN SLOPE
SECTIONS OF OU-2

DRAWN BY: CAC	CHECKED BY: KTK	APPROVED BY: TDM*	FIGURE NO.: B-5B
DATE: FEB. 2020	DWG SCALE: 1"=100	PROJECT NO: 191-750	

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 CPT and Sonic Drilling Locations.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 12:31 PM



LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

CPT-## PROPOSED CPT LOCATIONS

S-## PROPOSED GEOTECHNICAL EVALUATION BOREHOLE

S-## PROPOSED WASTE PROPERTIES SONIC DRILLING LOCATIONS

NOTE

1. SONIC BORING LOCATIONS IN THE WASTE MASS SHALL BE LOCATED BASED ON THE CPT RESULTS. LOCATIONS SHOWN ARE ONLY FOR DISCUSSION.

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SCALE IN FEET

0 200 400

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PROPOSED CPT AND SONIC DRILLING LOCATIONS

DRAWN BY: MAK	CHECKED BY: RFB	APPROVED BY: TDM*	FIGURE NO.:
DATE: FEB. 2020	DWG SCALE: 1"=200	PROJECT NO: 191-750	B-6

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU1\191750-CV01 Proposed Waste Separation Demonstration Boreholes.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 2/14/2020 5:23 PM

LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

BH-# PROPOSED WASTE SEPARATION BOREHOLES

*HAND SIGNATURE ON FILE

SCALE IN FEET

0 200 400

CEC

Civil & Environmental Consultants, Inc.

4848 Park 370 Blvd., Suite F - Hazelwood, MO 63042
314-656-4566 · 866-250-3679
www.cecinc.com

WESTLAKE LANDFILL OU-2
13570 ST. CHARLES ROCK RD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

PROPOSED WASTE SEPARATION DEMONSTRATION BOREHOLES

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	B-7
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

P:\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Proposed OU2 Performance Groundwater Wells.dwg{11X17} LS:(2/14/2020 - cnagel) - LP: 5/19/2020 4:56 PM

LEGEND

OU-2 BOUNDARY

500 EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

XX-## PROPOSED WELLS FOR OU-2 RD WORK PLAN (EXISTING)

MW-###-XX PROPOSED WELLS FOR OU-2 RD WORK PLAN AND OU-3 GROUNDWATER MONITORING (TO BE CONSTRUCTED)

XX-## OTHER MONITORING WELLS (EXISTING AND TO BE CONSTRUCTED)

*HAND SIGNATURE ON FILE

SCALE IN FEET

0 200 400

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13570 ST. CHARLES ROCK RD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

PROPOSED OU-2 PERFORMANCE GROUNDWATER MONITORING WELLS

DRAWN BY:	MAK	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.:	B-8
DATE:	FEB. 2020	DWG SCALE:	1"=200	PROJECT NO:	191-750		

APPENDIX C

REMEDIAL DESIGN HEALTH AND SAFETY PLAN

REMEDIAL DESIGN
HEALTH & SAFETY PLAN

WEST LAKE LANDFILL SITE
OPERABLE UNIT 2 (OU-2
BRIDGETON, MISSOURI

Prepared For:

Bridgeton Landfill LLC

BRIDGETON LANDFILL, LLC

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PHOENIX, ARIZONA

CEC Project 191-750

MAY 22, 2020

TABLE OF CONTENTS

FIGURES

1.0 INTRODUCTION

This document is the Health and Safety Plan (HASP) for remedial design activities for West Lake Operable Unit 2, Bridgeton, Missouri.

The purpose of this document is to establish standard health and safety procedures for the Contractor and Subcontractor employees during field activities at and near the facility. The provisions of this plan aim to eliminate exposure to hazardous materials or activities.

The following paragraphs of Section 1 of the HASP outline general health and safety considerations to be utilized when conducting field activities for the project. Section 2 details the scope of work and potential hazards. Site monitoring and action levels are presented in Section 3. Contingency and emergency response plans are presented in Section 4.

1.1 GENERAL CONSIDERATIONS

The levels of protection and the procedures specified in this HASP are based on information available at this time and represent the minimum health and safety requirements to be observed by all Contractor and Subcontractor employees while engaged in this project. Unforeseeable site conditions may warrant the use of higher levels of protection. The content of this HASP may change or undergo revision as additional information is obtained during the field activities. Any changes to this HASP must be reviewed by Health and Safety Officer and are subject to approval by the Environmental Project Manager.

The safety of all on-site personnel is ultimately the responsibility of each employee and his or her respective employer. Subcontractors are required to provide the necessary safety equipment, medical monitoring, and safety training to their personnel in compliance with the Occupational Safety and Health Administration (OSHA) regulations provided in 29 CFR 1910.120.

Field personnel must read this document carefully. If you have any questions or concerns that you feel are not adequately addressed, ask the Health and Safety Officer. Follow the designated health and safety procedures, be alert to the hazards associated with working on any construction site in close proximity to heavy equipment, and above all else, use common sense and exercise reasonable caution at all times. Contractors are required to watch a health and safety video prior to working on-site, and should attend daily safety ‘tailgate’ meetings.

1.2 SAFETY PERSONNEL & CHAIN OF COMMAND

Contractor personnel responsible for health and safety on this project will include the Project Health and Safety Coordinator, the Project Manager, and the field team leader / on-site Health and Safety Officer. The Project Health and Safety Coordinator will have overall responsibility for establishing appropriate health and safety procedures for the project (as presented in this Health and Safety Plan) and shall have the authority to implement those procedures. The field team leader / on-site Health and Safety Officer will be responsible for assuring that the procedures designated in this Health and Safety Plan are implemented in the field. Both the Project Health and Safety Coordinator and field team leader / on-site Health and Safety Officer have the authority to temporarily shut down the project for health and safety reasons. The Project Manager will have overall responsibility for project health and safety and has the authority to take whatever actions may be necessary to provide a safe working environment for all Contractor and Subcontractor personnel. The personnel fulfilling these responsibilities are listed in Table 1.1.

Table 1.1 Project Personnel

Project Personnel Contact Information West Lake Landfill OU-2 Facility Bridgeton, Missouri			
Name	**Affiliation**	**Title**	**Telephone Number**
Keith Robinson	Civil & Environmental Consultants, Inc.	Site Health and Safety Officer	(614) 364-0704
Randal Bodnar, P.E.	Civil & Environmental Consultants, Inc.	Project Health and Safety Coordinator	(602) 760-2324
Kevin Kamp, P.E.	Civil & Environmental Consultants, Inc.	Project Manager	(314) 656-4566

As discussed above, the ultimate responsibility for the health and safety of the individual employee rests with the employee and his or her colleagues. Each employee is responsible for exercising the utmost care and good judgement in protecting his or her own health and safety, and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel.

Should an employee find himself or herself in a potentially hazardous situation, the employee shall immediately discontinue the hazardous procedure(s) and personally take appropriate preventative or corrective action, and immediately notify the Site Health and Safety Officer or Project Manager of the nature of the hazard. In the event of an immediately dangerous or life-threatening situation, the employee automatically has “stop work” authority.

At least two workers on-site will have current First Aid and CPR certifications during field work associated with the RD. In the event of inclement weather, all field crews shall rally at the blue Republic Building located just southwest of the main entrance to St. Charles Rock Road.

1.3 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by Contractor and Subcontractor employees at all times.

- The “buddy system” will be used when conducting all field activities;
- A multipurpose dry chemical fire extinguisher, a complete field first aid kit, and a bottle of emergency eye wash solution will be immediately available to project field personnel. For example, field support vehicles will be stocked with these items when conducting drilling operations;
- Eating, drinking, smoking, taking medications, chewing gum or tobacco, etc. is prohibited in the immediate vicinity of the drilling operation;
- Thoroughly wash hands and, if necessary, face before eating or putting anything in your mouth (i.e., avoid hand-to-mouth contamination);
- Stand upwind of sample locations whenever possible;
- Be alert to potentially changing exposure conditions as evidenced by perceptible odors, unusual appearance of excavated soils, oily sheen on water, etc.;
- Be alert to the symptoms or fatigue and heat/cold stress, and their effect on the normal caution and judgement of personnel;
- Establish prearranged hand signals or other means of emergency communication when wearing respiratory equipment, since this equipment seriously impairs speech communications;
- Noise may pose a health and safety hazard during drilling and construction activities. A good rule of thumb to follow is that if you have to shout in order to communicate a distance of three

(3) feet in steady state (continuous) noise, you should be wearing hearing protection. Likewise, any impact noise from activities such as driving casing during drilling which is loud enough to cause discomfort would also indicate the need for hearing protection;

- Stay clear of heavy machinery/drilling equipment, especially in the vicinity of the transfer station and asphalt operations in the vicinity, which often has truck traffic; and

- Always wear an appropriate level of personal protection (Level D is the minimum level required). Lesser levels of protection can result in preventable exposure; excessive levels of safety equipment can impair efficiency and increase the potential for accidents to occur.

1.4 SITE CONTROL PROCEDURES

All project personnel will check in with the Field Team Leader on a daily basis. Authorized personnel will accompany any visitors to the work site.

1.5 SITE SAFETY BRIEFING

Prior to commencement of field investigative activities, field personnel will attend an on-site safety orientation. This orientation will include, at a minimum, the following topics:

- A discussion of the scope of work for the project;
- Locations of site emergency equipment and contacts;
- Personnel protective equipment requirements and action levels;
- Site specific H&S concerns; and
- Site safety procedures.

This briefing will be repeated for new employees and supported with weekly "tailgate" health and safety briefings and daily morning meetings. The weekly briefings will be conducted by CEC personnel according to a schedule established by the Field Team Leader and will be supplemented with additional briefings if site conditions change or are different than anticipated by this HASP. Daily morning tailgate meetings are typically conducted by Bridgeton Landfill personnel.

All personnel in attendance must sign a safety briefing attendance sheet. No employee shall be permitted to begin field activities until they have received and acknowledged such a briefing.

1.6 HEALTH & SAFETY PLAN APPLICABILITY

This Health and Safety Plan applies specifically to the field activities performed as part of the remedial design activities. It has been prepared specifically for this project.

2.0 SCOPE OF WORK AND POTENTIAL HAZARDS

2.1 WORK TASKS

The site field tasks identified for the project are:

- Field surveying for topography within and near OU-2 areas.
- Drilling and installation of perimeter landfill gas wells.
- Monitoring well sampling.

This HASP describes health and safety concerns associated with these field tasks.

2.2 POTENTIAL HAZARDS

A recent study by the National Safety Council indicated that the greatest risk to workers at hazardous waste sites is from traumatic injury from heavy equipment (such as drilling rigs or construction equipment) rather than from exposure to hazardous materials. Potential hazards anticipated at the facility include physical and chemical hazards, such as inhalation of vapors and dusts, absorption of chemicals through the skin, ingestion of chemicals, injury from falling objects during drilling activities, hearing loss during drilling activities, and weather-related stress. To prevent these potential hazards from affecting worker performance, the Health and Safety Plan incorporates various levels of protection to be followed. However, it is recognized the guidelines to be followed cannot replace worker common sense and experience.

2.3 ASSESSMENT & MITIGATION OF POTENTIAL HAZARDS

2.3.1 Inhalation

Inhalation of vapors is a potential hazard during field activities, although it is most likely to occur during borehole drilling for well installation. Methane is generally associated with municipal landfills. Release of these gases may occur during borehole drilling. Site history is a valuable aid in determining the type of chemical hazards that may be encountered. It is important to know and understand the physical and chemical properties of the anticipated compounds of concern at the site and evaluate the potential hazards that may be encountered.

2.3.2 Absorption

Absorption of chemicals can occur whenever chemicals contact the skin or clothing of the worker. Absorption of chemicals is most likely to occur during drilling activities, but could also occur during groundwater sampling. To reduce the likelihood of absorption, all workers will be required to wear gloves when handling soil cuttings generated during drilling activities and while conducting groundwater sampling.

2.3.3 Ingestion

Ingestion of chemicals generally occurs only when workers do not follow proper decontamination procedures prior to eating.

2.3.4 Biologic Hazards

Sanitary landfills receiving waste prior to 1980 (pre-RCRA), should particularly be considered suspect for the presence of biologic hazards. Biological hazards including hospital and laboratory materials may be encountered at sanitary landfills. These materials may contain microorganisms which cause hepatitis and influenza as well as other viral and bacterial diseases. Plants such as poison ivy, oak, and sumac that elicit allergic skin reactions in sensitive individuals are also biologic hazards. Even when not transmitting disease or producing allergic reactions, insects and other invertebrates such as bees and wasps, fire ants, and biting flies which produce painful irritations should be considered hazardous. Awareness of the potential biological hazards that may be encountered at the facility is important to avoid potentially harmful situations.

2.3.5 Injury from Falling Objects

Injury from falling objects, such as hammers, can occur whenever work activities are performed above the worker (e.g., on a drill rig). To prevent such injuries, all workers are required to wear protective headgear (i.e., hard hat) at all times when on-site.

2.3.6 Hearing Loss

Hearing loss can occur whenever the worker is exposed to excessive noise levels. To prevent this type of injury, all workers will be supplied with earplugs to be worn when necessary. A good rule-of-thumb is that if workers must shout to be heard when standing only a few feet from each other, earplugs should be used. Furthermore, all noise producing equipment (i.e., drill rigs) will be maintained in peak operating condition to reduce their noise levels.

2.3.7 Weather Related Stress

Weather related stress can occur from both heat and cold, and can cause decreased motor skills and impaired judgement, which in turn can lead to injuries through impaired judgement or physical trauma.

Work will be stopped when lightning is in the vicinity for a minimum of 30 minutes from the last observed lighting before work may resume. The 'clock' restarts if additional lightning is observed.

2.3.7.1 Cold Stress

The American Conference of Governmental Industrial Hygienists (ACGIH) has developed threshold limit values (TLVs) in the form of work/warm up schedules for working in ambient air temperatures below -15°F. The ACGIH has also developed criteria to describe exposures to cold working conditions under which nearly all workers can be repeatedly exposed without adverse health effects.

If work is performed continuously in an equivalent chill temperature of 20°F or less workers will be encouraged to use heated warming shelters at regular intervals, the frequency depending on the severity of the environmental exposure. When entering the heated shelter, the outer layer of clothing will be removed and the remainder of the clothing loosened to permit sweat evaporation. Workers will be encouraged to drink warm liquids to prevent dehydration, although the intake of coffee or other caffeinated beverages should be limited.

For work activities at or below an equivalent chill temperature of 10°F, workers will be under constant supervision and heavy sweating must be avoided. All workers will be trained in:

- Proper rewarming procedures;
- Appropriate first aid treatments;
- Proper clothing practices;
- Proper eating and drinking habits;
- Recognition of impending frostbite;
- Recognition signs and symptoms of impending hypothermia; and
- Safe work practices.

Tinted eye protection for all workers will be provided when a glare potential (snow or ice) is present. Air temperature and wind speed monitoring and recording are required every four hours when the temperature falls below 30°F.

2.3.7.2 Heat Stress

Experience has shown that the most effective heat stress deterrent is worker awareness and physiological monitoring. When working in Level C or B protection in ambient temperatures greater than 65°F, employees will use the "buddy system" to monitor each other's pulse rate at the start of each test period. If the pulse rate exceeds 110 beats per minute, the employee will take a 10-minute rest period. The pulse rate shall be monitored again at the beginning of the next rest period and if the pulse rate exceeds 110 beats per minute, the work period shall be shortened by one-third, until the pulse rate does not exceed 110 beats per minute.

All employees are to be alert to the possibility and symptoms of heat stress. Should any of the following symptoms occur (extreme fatigue, cramps, dizziness, headache, nausea, profuse sweating, or pale clammy skin), the employee is to leave the work area, rest, cool off, and drink plenty of water or other rehydrating liquids. If the symptoms do not subside after a reasonable rest period, the employee shall notify the Contractor Project Manager or Project Health and Safety Officer and seek medical assistance.

2.4 JOB SAFETY ANALYSIS

A Job Safety Analysis (JSA) will be provided for each specific task. A JSA is a procedure, which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. A JSA may be required are for tasks such as mobilization, demobilization, surveying, drilling, sampling, investigation derived waste (IDW), working around heavy equipment.

2.5 RADIOACTIVE & HAZARDOUS MATERIALS

There is no concerns of encountering radioactive materials during performance of OU-2 RD field work. OU-2 RD field work will not be conducted near the known boundary until OU-1 confirms that boundary. If suspected hazardous waste is encountered during excavation, it will be evaluated for RCRA hazardous characteristics per 40 CFR 261.21 through 262.24. If the waste is determined to be a characteristic hazardous waste, then it will be disposed of off-site at a RCRA Subtitle C landfill if the waste is not above that facility's permit limits for radioactivity. If the radioactivity is in excess of the Subtitle C facility permit limits, then it will be disposed at a landfill permitted to receive both radioactive and hazardous waste materials.

2.6 SAFETY DATA SHEETS

The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) each hazardous chemical to downstream users to communicate information on these hazards. The SDSs provides guidance to help workers who handle hazardous chemicals to become familiar with the format and understand the contents of the SDSs.

The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. The information contained in the SDS must be in English. In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200. The SDS preparers may also include additional information in various section(s).

Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures. This information should be helpful to those that need to get the information quickly. Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element. The SDS must also contain Sections 12 through 15, to be consistent with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS). A list of all 16 sections is presented below:

Section 1: Identification
Section 2: Hazard(s) Identification
Section 3: Composition/Information on Ingredients
Section 4: First-Aid Measures
Section 5: Fire-Fighting Measures
Section 6: Accidental Release Measures
Section 7: Handling and Storage
Section 8: Exposure Controls/Personal Protection
Section 9: Physical and Chemical Properties
Section 10: Stability and Reactivity
Section 11: Toxicological Information
Section 12: Ecological Information
Section 13: Disposal Considerations
Section 14: Transport Information
Section 15: Regulatory Information
Section 16: Other Information

2.7 REPORTING INCIDENCES AND TAILGATE MEETINGS

All incidences and/or accidences shall be reported immediately to the Health and Safety Officer. All personal involved in an incident and/or accident shall compete the form shown in **Figure 2 –**

Incident Report. All "near misses" shall be reported using the form shown in **Figure 3 – Close Call Report**. To help reduce the risk of injuries, daily safety briefings shall take place every morning prior to commencement of work. The daily safety briefings shall be logged using the form shown in **Figure 4 – Tailgate Meeting Log.** All employees must sign this log daily to prove attendance. The tailgate meeting logs shall be kept by the Health and Safety Officer.

3.0 SITE MONITORING AND ACTION LEVELS

Monitoring for potentially toxic vapors will be performed in all areas with a potential for the presence hazardous airborne substances.

All health and safety monitoring readings will be recorded in field document and will include the date, time, weather conditions, and location of the reading. In addition, on a daily basis background readings will be measured. Table 3-1 and the following paragraphs describe air monitoring for VOCs and oxygen.

The vicinity of a waste disposal site may contain isolated quantities of a variety of potentially hazardous substances. Substances that are of most concern from an inhalation or asphyxiation standpoint are those that are relatively volatile and are moderately to highly toxic, having odor thresholds higher than the corresponding TLV (many organic solvents fall into this category), and methane.

Field personnel shall use a photoionization detector (RAE Systems MiniRAE 2000, Thermo Environmental 580B Organic Vapor Meter, etc.) and a combustible gas indicator equipped with an oxygen sensor to conduct air monitoring during drilling activities. Background levels must be established well upwind of the drilling locations.

Prior to initiation of drilling, all utilities will be clearly staked by utility representatives. During drilling, workers will be aware of the location of overhead lines as well as any changes in drilling that might indicate the presence of a buried utility line. If it is believed that a utility line has been drilled into, drilling should immediately cease and the Project Health and Safety Officer will be notified.

The following paragraphs describe air monitoring for combustible gases. Action level information is summarized in Table 3.1.

Table 3.1 Air Monitoring Action Levels

Instrument	Parameter	Action level	Specific Response
Photoionization Detector (PID)	Volatile Organic Compounds (VOCs)	Above background in breathing zone for more than 5 minutes OR >5 ppm in breathing zone (other than a peak) OR >10 but <100 ppm peak.	Ventilate and increase monitoring.
		>10 but <100 ppm in breathing zone for more than 5 minutes OR	Temporarily cease operations.

Instrument	Parameter	Action level	Specific Response
		>25 ppm in breathing zone (other than a peak) OR >50 ppm	
Combustible Gas Indicator (CGI)	Methane Gas	10% LEL in breathing zone 25% LEL 1 foot above hole or casing, or 25% LEL in work zone	Increased monitoring Temporarily cease operations.

Any VOC reading consistently greater than 10 ppm above background (but less than 100 ppm) for 5 minutes, greater than 25 ppm other than for a brief peak, or any peak reading greater than 50 ppm in the breathing zone will be the action level for temporarily ceasing operations.

Methane gas generated by the decomposition of organic matter is commonly associated with invasive work on and near sanitary landfills. Combustible gas monitoring will be performed when drilling all boreholes.

The CGI will be used to monitor the work area for combustible gas levels. Steady-state readings in the immediate work area in excess of 10 percent LEL shall be the action level for increased vigilance, extreme caution, and a careful assessment of overall conditions for potential explosion hazards. Readings in excess of 50 percent LEL 1 to 2 feet above (and slightly downwind of) the mouth of the borehole or 25 percent LEL in the work area shall be the action level to temporarily cease operations and evacuate the exclusion zone. Such conditions may require active corrective measures such as general site ventilation, passive measure (i.e., allowing the hole to vent), or as a last resort, abandoning the hole.

4.0 CONTINGENCY PLANS

The following procedures have been established to deal with emergency situations that might occur during drilling or sampling operations. Field personnel should familiarize themselves with the location of the nearest phone and medical facilities. In the event of an emergency situation, field personnel shall follow the procedures specified below. When help arrives, Contractor employees shall defer all emergency response authority to appropriate responding agency personnel.

If an unanticipated, potentially hazardous situation arises as indicated by instrument readings, visible contamination, unusual or excessive odors, etc., field personnel shall temporarily cease operations, move away to a safe area, and contact the Contractor Health and Safety Coordinator. In the event of a serious emergency situation, field personnel shall contact the local fire department or paramedics, as appropriate, and inform them of the nature of the emergency, and then notify Contractor Health and Safety personnel as well as the Site Health and Safety Officer.

A cellular phone will be on site during all site activities. Emergency response telephone numbers are as follows:

Hospital:	SSM DePaul Health Center
Address:	12303 DePaul Drive
	St. Louis, MO 63044-2588
Telephone:	(314) 344-6000
Ambulance	911
Fire:	911
Police:	911

Directions to DePaul Hospital from the West Lake OU-2 Facility site:

Start out going SOUTHEAST on ST CHARLES ROCK RD/MO-115 toward TAUSSIG RD. Continue to follow ST CHARLES ROCK RD. Turn RIGHT onto MCKELVEY RD. T urn RIGHT onto DE PAUL DR. Turn LEFT to stay on DE PAUL DR. End at 12303 De Paul Dr. Bridgeton, MO 63044-2512.

The attached **Figure 1** illustrates the route to the hospital from the site.

4.1 MEDICAL EMERGENCY RESPONSE PLAN

Employees shall have walkie-talkies or CB radios on site, or be within the immediate vicinity of a cellular phone, at all times. Employees should familiarize themselves with the location of the nearest phone and medical facilities. In the event of an emergency situation, employees shall follow the general procedures specified below. Specific emergency procedures must be either posted at the work location or available in the vehicle.

Should any person visiting or working at the site be injured or become ill, notify the on-site Health and Safety Officer and Bridgeton Landfill management, and initiate the following emergency response plan.

If able, the injured person should proceed to the nearest available source of first aid. If the injured party is extremely muddy, remove outer garments and if necessary, wash the injured area with soap and water. If the "injury" involves a potential overexposure to hazardous gases or vapors, (headache, dizziness, nausea, disorientation), get the victim to fresh air and take him or her to a doctor for a complete physical examination as soon as possible.

If the injury involves foreign material in the eyes, immediately flush the eyes with emergency eye wash solution and rinse with copious amounts of water at the nearest emergency eye wash station. Obtain or administer first aid as required. If further medical treatment is required, seek medical assistance as discussed below.

If the victim is unable to walk but is conscious and there is no evidence of spinal injury, escort or transport the injured person to the nearest first aid facility. If the victim cannot be moved without causing further injury such as in the case of a severe compound fracture, take necessary emergency steps to control bleeding and immediately call for medical assistance as discussed below.

If the victim is unconscious or unable to move, do not move the injured person unless absolutely necessary to save his or her life, until the nature of the injury has been determined.

If there is any evidence of spinal injury do not move the victim unless absolutely necessary to save his or her life. Administer rescue breathing if the victim is not breathing, control severe bleeding and immediately seek medical assistance.

4.2 FIRE AND EXPLOSIONS

Dry chemical fire extinguishers are effective for fires involving ordinary combustibles such as wood, grass, etc., flammable liquids, and electrical equipment. They are appropriate for small, localized fires such as a drum of burning refuse, a small burning gasoline spill, a vehicle engine fire, etc. No attempt should be made to use the provided extinguishers for well-established fires or large areas or volumes of flammable liquids.

Regarding fire, prevention is the best contingency plan. There should be no smoking in the vicinity of a well-head and smoking materials, where permitted, should be extinguished with care.

In the event of a fire or explosion:

- If the situation can be readily controlled with available resources without jeopardizing the health and safety of yourself or other site personnel, take immediate action to do so. If not:
    - Isolate the fire to prevent spreading if possible.
    - Clear the area of all personnel working in the immediate vicinity.
    - Immediately notify site emergency personnel and the local fire department, as well as Bridgeton Landfill management.

4.3 UNFORESEEN CIRCUMSTANCES

The Health and Safety procedures specified in this plan are based on the best information available at the time. Unknown conditions may exist and known conditions may change. This plan cannot possibly account for every unknown or anticipate every contingency. Should substantially higher levels of contamination be encountered in the soil or groundwater, or should any situation arise which is obviously beyond the scope of the monitoring, respiratory protection, and decontamination procedures specified herein, work activities shall be modified (such as moving to another location) or halted pending discussion with the Contractor Health and Safety Coordinator and implementation of appropriate protective measures.

All equipment, tools and materials used in drilling, well installation and well development shall be decontaminated (cleaned) before being used at any hole or well on site and between holes or wells on site. Water used for decontamination shall be stored, pumped or otherwise maintained so that it remains free of deleterious substances.

1. The condition of the equipment shall be such that contamination is not created. Leaking seals or leaking tanks containing fluids other than water shall not be permitted.

2. Distilled water is preferred for use for decontamination so that no metals, chloride, etc. from a potable water source are introduced. If distilled water is not available, the water used for decontamination may be from a municipal water supply or other uncontaminated potable water source.

3. All equipment shall be degreased upon arrival at the site. Any lubrication of equipment after degreasing will be with vegetable oil.

4. Cleaning operations, including disposal of fluids and trash generated, will be done in accordance with the site's safety procedures and material handling policies.

5. Drill rods, augers, casing, soil samplers, pipe wrenches, etc., shall be placed on horses or other supports and cleaned until all visible signs of grease, oil, mud, etc., are removed. Brushes shall be used as required.

6. Latex gloves or new clean cotton work gloves shall be used for handling cleaned equipment.

7. Clean hose shall be used for transferring the cleaning water. Water tanks, pumps and mud pans, including tanks used to transfer water from sources to drill rig tank (e.g., pickup truck water tanks) shall be clean.

8. Petroleum-based lubricants shall not be used. Fittings on the drilling equipment may be lubricated with vegetable oil and fluids may be added to the equipment with care after cleaning.

9. Only cement in bags, powdered or granulated bentonite in bags, and bentonite pellets in sealed containers shall be used. All materials shall be free of additives.

10. Riser pipe and well screen will be provided in a cleaned condition. Workers shall use clean cotton gloves or new latex gloves when handling riser pipe and well screen.

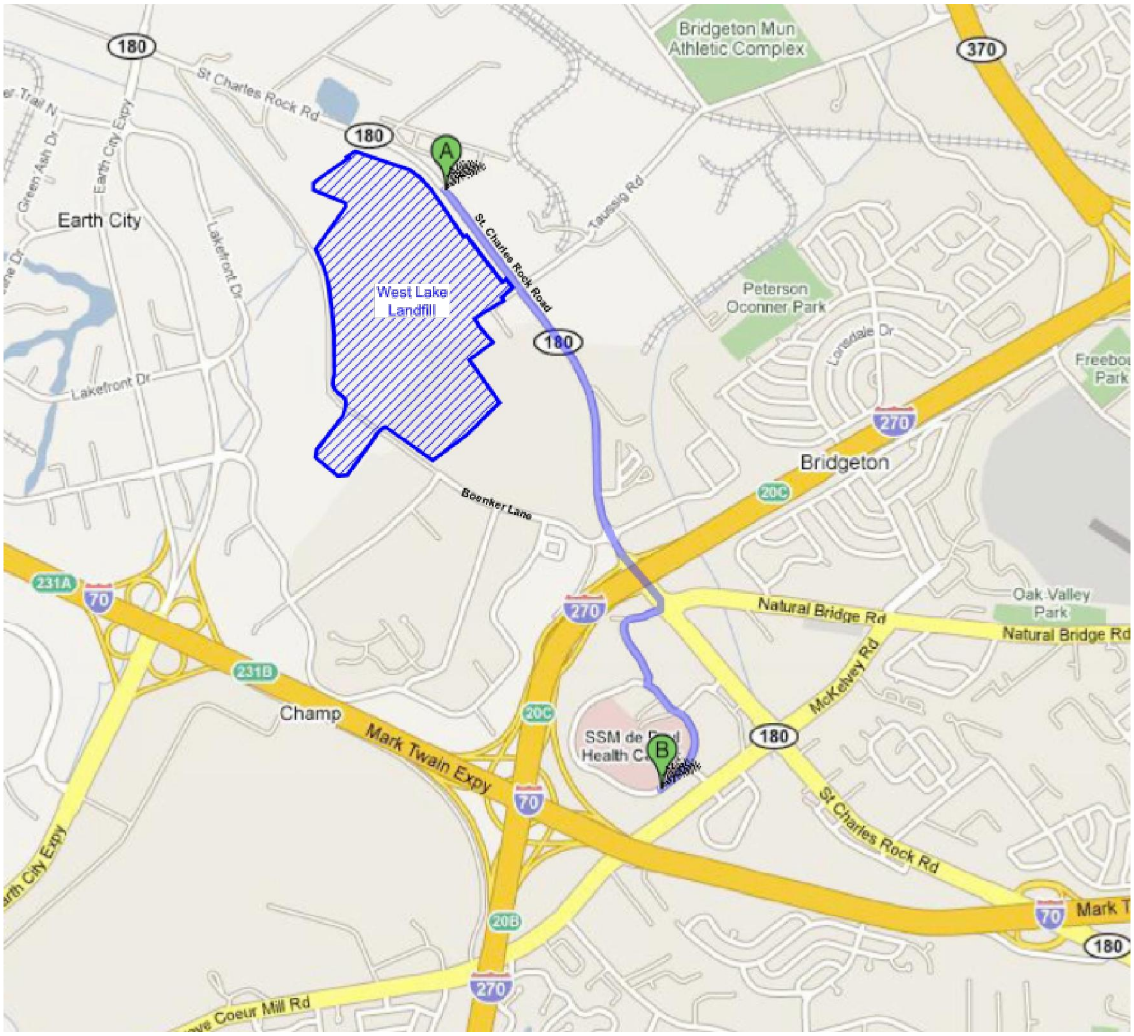
11. Riser pipe, well screen and other materials for well construction shall be stored in such a manner to prevent damage or contamination.

12. The protective casing and any other casing pipe used shall be steam cleaned.

13. Boreholes shall not be left open for extended periods of time or during periods of precipitation. The boreholes shall be covered with plastic on these occasions to protect the inside of the well bore from contamination.

FIGURES

NORTH



1. Head northeast toward St Charles Rock Rd
   Restricted usage road
   0.1 mi
2. Turn right onto St Charles Rock Rd
   1.2 mi
3. Turn right onto Mareschal Ln
   0.1 mi
4. Mareschal Ln turns slightly left and becomes De Paul Ln
   0.2 mi
5. Turn left to stay on De Paul Ln
   0.1 mi
6. Slight right onto De Paul Dr
   0.4 mi
7. Turn right
   Destination will be on the left
   0.1 mi

12303 De Paul Dr
Bridgeton, MO 63044

*HAND SIGNATURE ON FILE

CEC
Civil & Environmental Consultants, Inc.
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WESTLAKE LANDFILL OU-2
13570 ST. CHARLES ROCK RD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

DIRECTIONS TO NEAREST HOSPITAL

DRAWN BY:	CAN	CHECKED BY:	RFB	APPROVED BY:	TDM*	FIGURE NO.: 1
DATE:	FEB. 2020	DWG SCALE:	N.T.S.	PROJECT NO:	191-750	

\\Svr-stlouis\projects\2019\191-750.0006\-CADD\Dwg\CV01-OU2\191750-CV01 Hospital Directions.dwg{8X11} LS:(2/18/2020 - cnagel) - LP: 2/18/2020 9:30 AM

Figure 2 - INCIDENT REPORT

PROJECT: BRIDGETON LANDFILL

Person Completing this Report ______________________ Phone Number (____)____________

Date of Report________________________ Date of Incident ____________________________

month/day/year month/day/year

Employee's Information:

Name_______________________________ Home Office ______________________________

Occupation/Job Title ____

Where did the incident occur?

____

____

____

What was the employee doing when the incident occurred?

____

____

____

What was the type of injury or illness?

____

____

____

____

What object or substance directly harmed the employee?

____

____

Figure 3 - Close Call Report

Project: Bridgeton Landfill

Please complete this form after the occurrence of a Close Call (incident causing injury or property damage that almost happened, or could have been worse).

Description of Close Call (who, what, where, when, how):

What went right? What could have been done differently?

Safe Start Assessment. Did the incident involve:	**Critical error that contributed to incident:**
☐ **Rushing**	☐ **Eyes not on task**
☐ **Frustration**	☐ **Mind not on task**
☐ **Fatigue**	☐ **Line of fire**
☐ **Complacency**	☐ **Balance/traction/grip**

Reported by (optional): **Today's Date:**

Project (optional): **Project Manager (optional):**

Figure 4 - Tailgate Meeting Log

REPUBLIC SERVICES

Training Attendance Roster

Division: Bridgeton Landfill, LLC **Date / time: ____ / ____ / ______ @ ____:____**

Trainer's Name: ____

Tailgate Safety Topic: ____

____

____

Safety briefing on any other current activities: ____________________________

____

____

Discussion of known issues: ____

____

____

Discussion of overnight events: ____

____

____

Assignment of daily tasks: Tasks are assigned your Employee Inbox in the Operations Manager's office.

Acknowledgement: I have attended the daily tailgate meeting to receive assignments, have safety briefing, and discuss known issues and overnight events. I have had the opportunity to ask questions and receive answers on the content of the training presented by the Company. I understand the training and agree to abide by the standards presented therein.

Employee Name	Employee Signature	Time

Figure 4 - Tailgate Meeting Log

Employee Name	Employee Signature	Time