June 11, 2019

Mr. Justin Barker
Remedial Project Manager
US Environmental Protection Agency – Region 7
Site Remediation Branch – Superfund Division
11201 Renner Boulevard
Lenexa, KS 66219

Dear Mr. Barker:

Re: Responses to Missouri Department of Natural Resources and US Environmental Protection Agency Comments on the Remedial Design Work Plan and Associated Documents
West Lake Landfill Operable Unit 2

On December 16, 2008 a Remedial Design Work Plan (Work Plan), Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan for the West Lake Landfill Operable Unit 2 (OU-2) were provided to the United States Environmental Protection Agency (USEPA), with copy to the Missouri Department of Natural Resources (MDNR). On April 2, 2009 MDNR provided comments on the Work Plan and associated documents via email. USEPA then followed with comments provided via email on April 8, 2009. Subsequently, before a response to these comments could be addressed and an updated Work Plan could be completed, all work on OU-2 was discontinued while awaiting the remedy for OU-1 to commence

On March 14, 2019, USEPA issued a letter stating that work on OU-2 should recommence and that the submitted draft Work Plan should be updated and submitted to the agency consistent with the direction provided in the letter, developed per the OU-2 Scope of Work dated October 7, 2008 and as described in the Third Amendment to the Administrative Settlement Agreement and Order on Consent (RD ASAOC), Docket No. VII-94-F-0025.

Further, the March 14, 2019 letter asked that several other issues be addressed as part of the update to the Work Plan. These items are discussed briefly here.

1- Subsurface heating event (SSHE) to be accounted for in updated RDWP

There is very little chance that the subsurface reaction (SSR) is going to reach the Inactive Sanitary and Closed Demolition Landfill portions of OU-2 and previous studies have shown little risk associated with the construction and maintenance of a cap in the affected areas. These areas are separated by native soil areas (landfill access road, transfer station and plant area) from the Bridgeton Landfill. It is envisioned that the Bridgeton Landfill, where the reaction has occurred, will continue to be managed according to the obligations outlined in the June 29,

2018, Final Consent Judgment and the Operation, Maintenance, and Monitoring Plan (OM&M Plan).

2- OU-2 remedy at Closed Demolition and Bridgeton Landfills (timeline and process)

As stated above, the Closed Demolition and Bridgeton Landfills will continue to be managed according to their respective permit requirements and should not be subject to further requirements as described in the OU-2 ROD. Therefore, they should not be incorporated into the remedial design work plan (RDWP) for OU-2.

3- Effects of OU-1 RD/RA process on OU-2 Remedy

Because the OU-1 RD/RA is not complete, it cannot yet be incorporated into the Work Plan. However, the OU-2 design team is in contact with and coordinating with the OU-1 design team regarding aspects such as slope and cover termination, stormwater management, etc. that require integration between the designs. The OU-2 design team plans to optimize the OU-2 remedy with the remedial action taken at OU-1.

4- Effects of OU-3 RI/FS process on OU-2 Remedy

See answer for comment 3 above. However, since many groundwater issues were addressed in the OU-2 Work Plan, we can eliminate these questions/responses and defer them to the OU-3 RI/FS process.

5- Implementation of previous MDNR/USEPA comments from April 2009

These comments will be addressed in the Work Plan but several will be deferred to the OU-3 RI/FS process.

6- Implementation of 2008 SOW Schedule (following submittal of updated draft OU-2 RDWP by June 12, 2019)

Some of this timeline will be dependent on the OU-1 and OU-3 resolutions and will need to be refined later as timelines become clearer.

The original MDNR and USEPA comments are reiterated verbatim below and are followed by detailed responses.

MDNR COMMENTS

General Comment No. 1 – Groundwater Monitoring

a. Section 2.2.2 of the Remedial Design Work Plan is vague in its explanation of the groundwater monitoring that will occur. It would be beneficial to reference where in the document that the list of wells to be sampled, sampling frequency, and the parameters/contaminants to be analyzed can be found. The department understands the approach presented in the work plan to sample wells that were included in the 2003/2004 supplemental groundwater sampling event for comparative analysis; however, this event should also include other existing wells that will provide information in order to design the long-term monitoring program for the site. The department recommends investigating additional wells that were not included in the 2003/2004 sampling event but may be beneficial to include for the design of the long-term groundwater monitoring program to meet the objectives stated in Section 2.2.2 of the work plan.

Response: *Consistent with the discussion earlier in this letter, groundwater issues and monitoring for OU-2 will be deferred to the OU-3 RI/FS Process and will not be addressed as part of this Work Plan.*

b. The department would like to see more elaboration on the long-term monitoring objectives within the RD work plan to aid the development of the long-term monitoring plan.

Response: *Consistent with the discussion earlier in this letter, groundwater issues and monitoring for OU-2 will be deferred to the OU-3 RI/FS Process and will not be addressed as part of this Work Plan.*

General Comment No. 2 – Gas Monitoring

a. The Missouri Solid Waste Management Regulations require owners to choose monitoring well locations based in part on the existence of any features that may transmit gas from the landfill (preferential migration pathways). These could be buried utility or communication lines such as the fiber optic line identified in the work plan. The department recommends that the design team include a provision for identifying any man-made preferential pathways at the site and determining how they were constructed (e.g., did they utilize granular bedding material or backfill?).

Response: *The utility companies will be contacted for the locations of the buried utility or communication lines and an attempt will be made to determine how these lines were constructed.*

b. Please elaborate on the purpose of two screened intervals for the gas monitoring wells and also explain the decision to construct to a depth of 35 feet.

Response: *Two screened intervals were selected in order to allow more accurate interpretation of results. Should landfill gas be detected in a gas monitoring well, the Respondent would like to better identify whether the migration is occurring near surface or at depth, since there may be different approaches to addressing the issue depending on the depth intervals over which the gas is being*

detected. A depth of 35 feet is considered extremely conservative, since historic information for the Inactive Landfill indicates that it was constructed on top of pre-existing ground surface and on top of quarry materials that were excavated in what subsequently became the Active Sanitary Landfill (please refer to the OU-2 RI/FS Work Plan for more details). Missouri regulations require that landfill gas monitoring probes extend at least to the base of the landfill, which in this case would be at ground surface. Therefore, a depth of 35 feet is conservative and exceeds regulatory requirements.

c. QAPP states that gas monitoring will be performed on a quarterly basis, but Figure 8-1 seems to indicate the gas sampling will last for 46 days. Please update the sampling frequency with that discussed during the January 22, 2009, meeting (sample every 2 weeks for 2 months, then every month for 4 months and then quarterly thereafter).

Response: *The text of the QAPP has been revised to indicate a perimeter landfill gas monitoring frequency of every two weeks for two months, then every month for four months, then quarterly thereafter. Figure 8-1 has been revised accordingly.*

d. The work plan repeatedly refers to the gas monitoring wells as "temporary". It is our understanding that the gas monitoring wells will be installed to permanent well construction standards. Please omit the word "temporary" in all instances from the document. Also, the Missouri Solid Waste Management Regulations refer to these types of installations as "wells" not "probes". Please revise the document to be consistent with the regulation language.

Response: *As discussed with MDNR during the January 2009 meeting, the gas monitoring wells will be installed to permanent standards but will likely be decommissioned prior to landfill cap construction activities. It is likely that heavy equipment needed for landfill cap construction will otherwise damage or unintentionally destroy perimeter monitoring locations. The Respondent prefers to properly decommission the wells and then replace them upon completion of cap construction activities. For this reason, the Respondent believes the use of "temporary" is appropriate when referring to the RD perimeter landfill gas wells. The text of the Work Plan, QAPP, and SAP has been revised to refer to the installations as "wells".*

e. The Remedial Design Sampling and Analysis Plan (SAP) indicates that the gas wells will be sampled in accordance with the department's technical bulletin on sampling of gas monitoring wells, but references a September 1999 revision of the bulletin. The most recent revision is dated June 2006, and can be obtained from the department's website. Please revise the QAPP to address this as well. Also, please revise the QAPP to discuss the monitoring equipment and procedures that will be used to sample the methane monitoring probes, as well as the monitoring parameters. Though it isn't listed as a monitoring parameter in the technical bulletin, the department recommends checking relative pressure in each gas well during each sampling event.

Response: *The text of the QAPP has been revised to refer to the May 2017 Methane Gas Policy. The text has been revised to discuss the monitoring equipment and procedures that will be used to sample for methane. The Respondent will consider the merits of monitoring for relative pressure as well.*

General Comment No. 3 – Cover System

a. The department would like to see more detail in the work plan on how the cover system for the two Operable Units will interact. It is our understanding that OU-1 will precede OU-2 and that the OU-2 RD documents will describe the relationship in the design. If this is the case, please describe this relationship in the work plan.

Response: *OU-1 field activities are likely to precede the OU-2 field activities, therefore, OU-2 does not have the benefit of final OU-1 cap contours, stormwater drainage, letdowns, etc. to incorporate into the OU-2 Work Plan. The design teams for both operable units have met and discussed the design concepts for this transition/demarcation line between the two remedies and currently conceptualize this area as a common surface water facility, however, because neither OU-1 nor OU-2 have been approved or constructed, there may be changes in the future. This coordination effort has been added to the work plans of both OU-2 and OU-1.*

b. It is recommended that alternative methods for in situ testing of hydraulic conductivity such as sealed double ring infiltrometers or two stage borehole tests if the conditions meet the requirements specified in the test procedures (primarily thickness and degree of saturation). (See Specific Comment #9).

Response: *As discussed in several follow up meetings with the agencies, alternatives to the permeability testing program outlined in the first draft of the work plan were revised to indicate the collection of 10 Shelby Tube samples that will be used along with two (2) Sealed Double Ring Infiltrometer tests. In situ hydraulic conductivity testing results are included in Appendix F of the Work Plan. The results of these tests will be incorporated into the Remedial Design effort.*

Specific Comment No. 1 – Section 2.0, REMEDY DESCRIPTION, page 2.

The first page reads, "The remedy will be designed to meet the performance standards, criteria, and specifications set forth in the OU-2 Record of Decision (ROD), *this SOW* and the AOC…" Should "this" be replaced with "the" or SOW be replaced with Remedial Design Work Plan?

Response: *The text of Section 2.0 has been revised to replace "this" with "the".*

Specific Comment No. 2 – Section 2.2.5, Institutional Controls, page 3.

The department would like to see language similar to that in the ROD that states, "proprietary controls will be used because they generally run with the land and are enforceable." Mention can also be made that the Missouri Environmental Covenants Act (MECA) is the preferred instrument for the site (also similar language found in the ROD).

Response: *Language similar to that in the ROD has been incorporated. The respondent has already put certain expected institutional controls in place.*

Specific Comment No. 3 – Section 5.5, Missouri Well Construction Code, page 10.

The last paragraph is missing a word. Should this read, "MDNR has also established regulations on monitoring well construction…"?

Response: *Section 5.5 has been revised to include the word "regulations".*

Specific Comment No. 4 – Section 6.0, CONCEPTUAL DESIGN AND DESIGN CRITERIA, page 11.

The second last sentence of the first paragraph gives the permeability requirement of 10^{-5} cm/sec. The department suggests adding the phrase "or less" after this number.

Response: *The suggested addition of text has been implemented.*

Specific Comment No. 5 – Section 6.1, Conceptual Design, page 11.

This section focuses on the regrading of waste to achieve final grades. The department would like to see a comprehensive explanation of the entire design added to this section. This should include discussions on final cover construction, stormwater management, monitoring systems, etc. All of the parameters listed in Table 6-1: Design Basis and Design Criteria should be covered under this section.

Response: *As described in response to General Comment No. 1, USEPA guidance prescribes that the Work Plan is to provide a general overview of project activities, goals, etc., while specific information is to be provided in the QAPP and SAP. The West Lake OU-2 Work Plan, QAPP, and SAP were prepared consistent with USEPA guidance. Text revisions have been made that indicate waste relocation is not anticipated at this phase of the conceptual plan but that details are included in the SAP and the QAPP as to how this is to be validated through implementation of the Work Plan. Further details of materials and construction methods will be outlined in later submittals of the design reports.*

Specific Comment No. 6 – Figure 3-1, Project Organization Chart.

Please replace Larry Erickson with Branden Doster.

Response: *Given the many changes that have occurred since the last submittal, the Project Organization Chart has been revised accordingly.*

Specific Comment No. 7 – QAPP, Section A6.1, Ground and Aerial Topographic Survey and Base Map Preparation, page 3.

The department suggests that a sentence be added that states that the ground survey will be conducted by a registered surveyor.

Response: *The text of Section A6.1 has been revised to include a sentence stating that the ground survey will be conducted by a registered surveyor.*

Specific Comment No. 8 – QAPP, Section A6.2, Testing of Potential Borrow Areas, page 3.

The department suggests adding testing methods for soil classification (e.g., sieve analysis and Atterberg Limits tests).

Response: *The text of Section A6.2 has been revised to include testing methods for soil classification (e.g., sieve analysis and Atterberg Limit tests) as well as the frequency and intervals at which these parameters are obtained and measured.*

Specific Comment No. 9 – QAPP, Section A6.4, Existing Thickness and Material Evaluation of Inactive Sanitary Landfill Cover, page 4.

The department's Solid Waste Management Program has presented methods suitable for evaluation the existing landfill cover. These include sealed double ring infiltrometers (SDRI) testing for permeability along with Shelby Tube samples for thickness verification. The number of Shelby Tube samples may be decreased if the SDRI is used. (See General Comment 3.b.)

Response: *As discussed in several follow up meetings with the agencies, alternatives to the permeability testing program outlined in the first draft of the work plan were revised to indicate the collection of 10 Shelby Tube samples that will be used along with two (2) Sealed Double Ring Infiltrometer tests. In situ hydraulic conductivity testing results are included in Appendix F of the Work Plan. The results of these tests will be incorporated into the Remedial Design effort.*

Specific Comment No. 10 – QAPP, Section A6.5, Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures, pages 4-5.

This section states that the existing leachate pumping well will be evaluated for structural design and functionality. The department would like to see more details on what type of parameters the leachate pumping system will be evaluated for.

Response: *The primary focus will be on understanding the history of this system, if such information is available. The secondary focus will be on determining whether or not this system or another system will be needed after the RD has been implemented. This will be based on leachate generation volumes attributable to OU-2 and whether or not those volumes would warrant the continued or expanded use of such systems. Additional detail has been added to the text to address this concern.*

Specific Comment No. 11 – QAPP, Section A7, DATA QUALITY OBJECTIVES AND CRITERIA, page 7.

The last paragraph on this page lists the Groundwater Protection Standards (GPSs) that will be used to evaluate groundwater quality. The department suggests adding the National Primary Drinking

Water Standards, 40 CFR 141 (MCLs) and Missouri regulations (10 CSR 60-4) to this list for comparative purposes.

Response: *The OU-2 Record of Decision (ROD), Section 12.2.1, specifies the GPSs that apply to OU-2. The ROD specifies that groundwater protection standards will be consistent with the requirements found in Missouri Solid Waste Rules for Sanitary landfills (10 CSR 80-3.010(11)]. 10 CSR 80-3.010(11) incorporates 40 CFR 141 by reference.*

10 CSR 60-4, part 1 states, "The rules in this chapter contain maximum contaminant levels (MCLs) permissible in public water systems…" The groundwater within the OU-2 area is not a public water system. 10 CSR 60-4 therefore is not applicable.

The text of Section A7 has been revised to indicate that the GPSs for OU-2 are based on 10 CSR 80-3.010(11), which in turn incorporates 40 CFR 141 by reference.

Specific Comment No. 12 – QAPP, Section B1.4, Existing Thickness and Material Evaluation of Inactive Sanitary Landfill, page 11.

See Comment #9 above.

Response: *No response necessary.*

Specific Comment No. 13 – QAPP, Section B2.4, Existing Thickness and Materials Evaluation of Inactive Sanitary landfill, page 12-13.

See Comment #9 above.

Response: *No response necessary.*

Specific Comment No. 14 – QAPP, Section B2.6, Sampling and Analyses of Selected Groundwater Monitoring Wells, page 13.

This first bulleted item states, "Containerization of purged groundwater and equipment decontamination is required. Containerized water will be disposed of in leachate sump K-128, associated with the adjacent closed sanitary landfill." The department would like more explanation on what types of chemicals are acceptable to dump in the leachate sump, especially regarding radiological contamination.

Response: *The discharge of groundwater sampling purge water or equipment decontamination water will be done in accordance with the permit requirements for discharge for the leachate treatment system including limits on radiological constituents. By definition, there are no radiological constituents in OU-2.*

Specific Comment No. 15 – QAPP, Section B5.6, Sampling and Analysis of Selected Groundwater Monitoring Wells, page 17.

The first bulleted item in this section indicates that one field duplicate soil sample is to be taken every 10 soil samples. These samples should refer to water not soil.

Response: *The RI/FS associated with OU-3 will address groundwater issues for OU-2 as well. Therefore, the sampling and analysis of groundwater will be eliminated from the QAPP.*

Specific Comment No. 16 – QAPP, Figure B-1: Example of Temporary Gas Probe Construction.

Please revise Figure B-1 to indicate what filter pack material will be used in the methane monitoring probes. Also, we believe this figure should be labeled as C-1.

Response: *The filter pack material will be pea gravel.*

Specific Comment No. 17 – QAPP, Figure A-5: Location of Potential Borrow Areas.

The department recommends that all borrow material be screened for common contaminants prior to bringing on site. In particular, Figure A-5 denotes the former leachate pond area as Potential Borrow Area #3. The department requests that this material be sampled for contaminants associated with the landfill waste, in addition to geotechnical testing, if this area is to be used for borrow.

Response: *The three potential borrow areas identified in Figure A-5 in the original plan are no longer available and new sources will need to be identified.*

Specific Comment No. 18 – SAP, Section 4.0, SAMPLING AND ANALYSIS OF SELECTED GROUNDWATER MONITORING WELLS, page 2. (Same as comment #14 above)

This first bulleted item states, "Containerization of purged groundwater and equipment decontamination is required. Containerized water will be disposed of in leachate sump K-128, associated with the adjacent closed sanitary landfill." The department would like more explanation on what types of chemicals are acceptable to dump in the leachate sump, especially regarding radiological contamination.

Response: *Please refer to the response to Specific Comment No. 14 above.*

Specific Comment No. 19 – SAP, Section 6.2, Existing Material Evaluation, page 4.

See comment #9 above.

Response: *Please refer to the response to Specific Comment No. 9 above.*

Specific Comment No. 20 – SAP, Section 8.0, GEOTECHNICAL TESTING OF POTENTIAL BORROW AREAS, pages 5-6.

The testing frequency for each parameter discussed in this section should be identified.

Response: *As mentioned in the response to Specific Comment No. 8 above, testing methods for soil classification (e.g., sieve analysis and Atterberg Limit tests) as well as the frequency and intervals at which these parameters are obtained and measured have been addressed in the revision of the text of Section A6.2.*

Specific Comment No. 21 – Standard Operating Procedures for Purging and Collection of Samples from Groundwater Monitoring Wells, Appendix A of SAP.

This section describes field quality control procedures, but does not mention equipment calibration. Please revise this section to address this.

Response: *The RI/FS associated with OU-3 will address groundwater issues for OU-2 as well. Therefore, the sampling and analysis of groundwater will be eliminated from the QAPP.*

Specific Comment No. 22 – Standard Operating Procedures for Purging and Collection of Samples from Groundwater Monitoring Wells, Section 3.3, Bailer Purging, pages 3-4.

This section indicates that bailers will be used to purge wells. The department recommends using low flow purging as described in Section 3.1 as the primary technique. Also, impeller type pumps should be avoided when sampling for volatiles.

Response: *The RI/FS associated with OU-3 will address groundwater issues for OU-2 as well. Therefore, the sampling and analysis of groundwater will be eliminated from the QAPP.*

USEPA COMMENTS

Comment No. 1 – The plan should further develop the implementation of institutional controls, i.e., describe some of the steps that will be part of the implementation plan.

Response: *The RD will provide for the design and implementation of institutional controls meeting the land and resource use requirements and objectives identified in the OU-2 ROD Section 12.2.2. Proprietary controls will be used because they generally run with the land and are enforceable. Missouri Environmental Covenants Act (MECA) is the preferred instrument for this site. The respondent has already put certain expected institutional controls in place.*

Comment No. 2 – OU-1/OU-2 interaction – The plan should describe overlap issues and be more instructive on sequencing and coordination. As discussed, the major areas of interest are 1) surface water runoff management; 2) landfill cover intersections, and; 3) groundwater monitoring.

Response: *The coordination effort and conceptual interaction between the two remedies are outlined in the response to MDNR General Comment number three. With regard to groundwater monitoring, please refer to the response to MDNR General Comment number one.*

Comment No. 3 – Since both OUs affect the same groundwater system, EPA sees advantages to an integrated groundwater monitoring program with a single groundwater monitoring report. This approach should help to provide a complete interpretation of potentiometric surfaces, groundwater flows, water quality, etc. In addition, this approach should help economize on the number of necessary wells.

Response: *The RI/FS associated with OU-3 will address groundwater issues for OU-2 as well. Therefore, the sampling and analysis of groundwater will be eliminated from the QAPP.*

Comment No. 4 – The objective of the groundwater sampling and analysis is to update groundwater conditions at locations monitoring during the RI/FS. EPA would like to see consideration of monitoring locations or objectives that could provide information useful to the design of the long-term groundwater monitoring plan.

Response: *Please refer to the response to MDNR General Comment No. 1.*

Comment No. 5 – While EPA is deferring to MDNR regarding the closure of permitted areas, these closures will need to be accounted for in the RD/RA documentation process for the impacted operable unit. The final RA report will need to confirm that the permitted were properly closed or otherwise resolved.

Response: *No response necessary.*

Sincerely,

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.

Randal F. Bodnar, P.E.
Vice President

Cc: Ryan Seabaugh – MDNR
Victoria Warren – Republic Services, Inc.
Erin Fanning – Bridgeton Landfill, LLC
Dana Sincox – Bridgeton Landfill, LLC
Cynthia Teel – Lathrop Gage
Paul Rosasco – EMSI

Attachment: Updated Remedial Design Work Plan (June 11, 2019)

ATTACHMENT

UPDATED REMEDIAL DESIGN WORK PLAN

REMEDIAL DESIGN WORK PLAN

WEST LAKE LANDFILL 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

JUNE 11, 2019

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APPENDICES

1.0 INTRODUCTION

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

This Work Plan and the associated documents including the Quality Assurance Project Plan (QAPP), Sampling and Analysis Plan (SAP), and Health and Safety Plan (HSP) 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 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.

Discussion of Updates to the December 2008 Draft OU-2 Work Plan

- Subsurface Reaction (SSR)
  There is very little chance that the SSR is going to reach the Inactive Sanitary and Closed Demolition Landfill portions of OU-2 and previous studies have shown little risk associated with the construction and maintenance of a cap in the SSR affected areas. It is envisioned that the Bridgeton Landfill, where the reaction has occurred, will continue to be managed according to the obligations outlined in its MDNR permit requirements.

- OU-2 Remedy at Closed Demolition and Bridgeton Landfills (Timeline and Process)
  - As stated above, the Closed Demolition and Bridgeton Landfills will continue to be managed according to their respective permit requirements and should not be subject to further CERCLA action as outlined in the OU-2 ROD.

- Effects of OU-1 RD/RA Process on OU-2 Remedy
  - Because the OU-1 RD/RA is not complete, it cannot yet be incorporated into the Work Plan.

- Effects of OU-3 RI/FS process on OU-2 Remedy
  - Because the OU-1 RD/RA is not complete, it cannot yet be incorporated into the Work

Plan. However, some groundwater issues that have been addressed can be deferred to the OU-3 RI/FS process.

- Implementation of previous MDNR/USEPA comments from April 2009
  - These comments will be addressed in the Work Plan but several will be deferred to the OU-3 RI/FS process.

- Implementation of 2008 SOW Schedule (following submittal of updated draft OU-2 RDWP by June 12, 2019)
  - This schedule will be dependent on the OU-1 and OU-3 RD/RA.

1.1 PURPOSE AND SCOPE

This 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 Work Plan.

The requirements of other environmental regulations determined to be applicable or relevant and appropriate to the design and implementation of the remedy are included. In addition, this Work Plan presents preliminary design criteria upon which the RD will be based.

1.2 ORGANIZATION

This Work Plan includes the following sections:

1.0 Introduction
2.0 Remedy Description
3.0 Team Composition
4.0 Design Investigations
5.0 ARARs Identification
6.0 Conceptual Design and Design Criteria
7.0 Progress Reporting
8.0 Project Schedule for RD

This Work Plan also includes the following appendices:

Appendix A:	Conceptual Design Drawings
Appendix B:	Photographs of Conditions at OU-2
Appendix C:	Quality Assurance Project Plan (QAPP)
Appendix D:	Sampling and Analysis Plan (SAP)
Appendix E:	Health and Safety Plan (HSP)
Appendix F:	Shelby Tube Sample Results

2.0 REMEDY DESCRIPTION

The remedy will be designed to meet the performance standards, criteria and specifications set forth in the OU-2 Record of Decision (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 applicable or relevant and appropriate requirements (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 with relevant and appropriate closure and post-closure care requirements for the landfilled waste materials. The containment and post-closure care methods prevent human receptors from contacting the waste material and control contaminant migration to air or groundwater and include:

1. Install landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills.

2. Apply groundwater monitoring and protection standards consistent with requirements for sanitary landfills. However, groundwater issues and monitoring for OU-2 will be deferred to the OU-3 RI/FS Process and will not be addressed as part of this Work Plan.

3. Surface water runoff control.

4. Landfill 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.

6. Long term surveillance and maintenance of the remedy.

2.2 PERFORMANCE STANDARDS FOR THE SELECTED REMEDY

The Respondents will design the remedy 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. 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 Cap

The landfill cover system will be designed to meet, at a minimum, the State of Missouri closure requirements for sanitary landfills. Consistent with the OU-2 ROD, these requirements are identified below:

- The Missouri Department of Natural Resources (MDNR) rules for sanitary landfill caps are in 10 CSR 80-3.010(17). These rules require that the final cover shall consist of at least two feet of compacted clay with a coefficient of permeability of $1x10^{-5}$ cm/sec or less and overlaid by at least one foot of soil capable of sustaining vegetative growth. The minimum sloping requirement of 5% shall be incorporated into the design, which will also include provisions for slope stability, proper run-off and erosion control. The maximum sloping requirement of 25% will be met unless the stability of steeper slopes can be demonstrated; however, in no case will the slopes exceed 33 1/3%.

- The design will incorporate plans for decomposition gas monitoring and control consistent with 10 CSR 80-3.010(14).

2.2.2 Groundwater Monitoring

Groundwater issues and monitoring for OU-2 are being handled pursuant to OU-3 and will not be addressed as part of this Work Plan.

2.2.3 Surface Water Runoff Controls

Surface water runoff controls may include surface water diversion channels, inlet structures, underground conveyance systems, and surface water detention basins. These features will be designed to accommodate the 24-hour, 25-year storm as required by the MDNR Solid Waste Regulations (10 CSR 80-3.010(8)(B)1.F.(III) and as may be required by the Missouri Clean Water Law and

corresponding rules and the state National Pollutant Discharge Elimination System (NPDES) permit for the Site.

2.2.4 Landfill Gas Monitoring and Control

Characterization of landfill gas occurrences and concentrations will be conducted as part of the Remedial Design investigations. The MDNR Solid Waste Regulations [10 CSR 80-3.010(14)(C)(2)B.] state that decomposition gases shall 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. In the event that landfill gas occurs, or may reasonably be expected to occur after construction of the new landfill cover, at levels greater than those allow by the MDNR Solid Waste Regulations, then an active or passive landfill gas control system will be installed.

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 the OU-2 ROD Section 12.2.2. Proprietary controls will be used because they generally run with the land and are enforceable. Missouri Environmental Covenants Act (MECA) is the preferred instrument for this site.

2.2.6 Surveillance and Maintenance

The RD will provide for surveillance and maintenance of the remedy. Plans will be developed 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 land and groundwater use restrictions.

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 Coordinator. Having previously been responsible for the Remedial Investigation (RI) and Feasibility Study (FS) for OU-2, CEC personnel are familiar with the various aspects of the project and 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 Work Plan;
- Coordination of the development of design criteria;
- Development of the Institutional Controls Plan for OU-2;
- Coordination and preparation of the Preliminary Design submittal;
- Coordination and preparation of the Intermediate Design submittal (if necessary);
- Coordination and preparation of the Pre-Final Design submittal;
- Coordination and preparation of the Final Design submittal;
- Coordination and preparation of the O&M Plan;
- Coordination and preparation of the Contingency Plan;
- Preparation of the Community Relations Plan; and
- Preparation of monthly project status reports to USEPA and for scheduling and coordination of meetings and interactions with USEPA and MDNR.

CEC will provide design services and will be responsible for development of the RD drawings and specifications. CEC has extensive experience designing and permitting solid waste landfills and

Subtitle D covers similar to that required for OU-2. CEC will be responsible for the following RD activities:

- Supervision of RD site surveying and base map development;
- Identification and geotechnical testing of potential construction materials (rock, low permeability layer and vegetative layer);
- Development of grading and cut and fill plans for waste relocation (if needed);
- Design and preparation of the construction drawings and specifications for the landfill cover;
- Design and preparation of the construction drawings and specifications for the surface water runoff control system;
- Design and preparation of the construction drawings and specifications for the landfill gas control system (if necessary);
- Preparation of the Construction Quality Assurance (CQA) Plan;
- Preparation of a construction schedule; and
- Preparation of construction cost estimate.

CEC will also be responsible for the following RD activities:

- Preparation of the QAPP, SAP, and the HASP included with this Work Plan;
- Conducting the additional site investigations required to support the RD;
- Installation and testing of landfill gas wells to assess the presence and extent of occurrences of landfill gases along the outer (property) boundaries of Inactive Sanitary Landfill;
- The health and safety program utilized during performance of the design investigations;

- Design of the environmental monitoring (stormwater and landfill gas) program portion of the RD;
- Preparation of the construction Field Sampling Plan; and
- Preparation of the Spill Prevention, Control and Countermeasure Plan portion of the Contingency Plan.

Figure 3-1 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

Most of the site characterization was completed as part of the RI (Herst, 2005) and supplemental investigations completed in conjunction with the FS (Herst, 2006); however, some additional data are needed to prepare the RD. The additional data needed to complete the RD include the following:

1. During the RD, a more detailed ground survey will be conducted, with the goal of yielding ground surface elevations accurate to within 0.25 feet throughout the Inactive Sanitary Landfill. The ground survey will be combined with a more recent aerial flyover and photography to provide the level of detail sufficient for calculating necessary material volumes to achieve planned final grades. Field activities associated with the topographic survey will include, but not necessarily be limited to, surveying ground surface elevations and, if possible, establishing the routing and discharge points of the existing surface water controls;

2. Nature and concentration of explosive gases, if any, that are coincident with the landfill property boundaries to determine if landfill gas is present at levels above 50% of the lower explosive limit (LEL), which is equivalent to 2.5% methane by volume, such that a landfill gas control system will be required;

3. Cover thickness testing and geotechnical testing (Atterberg Limits, grain size distribution and permeability) will be performed during the RD with the intent of optimizing the use of 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 the volume of materials needed for construction of the final cover and the suitability of using the existing material as landfill cover. The collection of ten (10) Shelby Tube samples has been completed and will be used along with the results of two (2) Sealed Double Ring Infiltrometer tests that have yet to be completed. The results of this testing are included in Appendix F, and will be incorporated into the RD effort;

4. The existing slope along the western perimeter of OU-2 was established in the mid-1990's. Based on observations during a site walkover conducted by the Landfill Design team on November 11, 2008, and more recently on May 14, 2019, the existing slope appeared to be stable. One of the RD tasks is to further document the history and stability of the existing slope. To meet this objective, a series of thirteen (13) survey pins will be installed in the western slope. These pins will be surveyed on a monthly basis during the RD phase to document movement and stability of the slope. If additional documentation of slope stability

is warranted, an on-site biological assessment of existing vegetation along the western slope or a geotechnical sampling investigation may be implemented.

5. As part of the RD, 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 excavated in each of the proposed borrow areas. The testing program will include natural moisture content, Atterberg Limits, Standard proctor dry density determination, and recompacted permeability. The resultant data are needed for approval of the borrow soils before construction and will be identified in the RA construction specifications that are developed following completion of the RD phase of this project;

6. Several issues were noted during the site walkover performed on November 11, 2008, and more recently on May 14, 2019, and will also need to be investigated as part of the RD. Photographs from the site walkovers are provided in Appendix B. Issues requiring further investigation include the following:

    - Presence of apparent stormwater "drains" on the west slope that drain stormwater trapped in the channel. It is uncertain where the conveyances discharge and one of the two was covered and not recognizable on the day of the 2008 visit.

    - There are two concrete standpipes that rise approximately 20 feet above the ground surface on the west side of OU-2. It is uncertain what these structures were designed for or if they will be needed long-term at the site.

    - There are fiber optic lines at the base of the steep west slope that may need to be addressed depending on the design of the cap.

    - The leachate pumping system at the southeast corner of the site also requires additional investigation. Discussions will need to be coordinated with MDNR/USEPA to determine whether continued pumping of leachate will be required based on previous leachate characterization details.

More detailed information and drawings regarding the sampling and analysis protocols, data needs and data quality objectives for the RD investigations are presented in the SAP and QAPP (Appendix C and Appendix D to this Work Plan, respectively).

5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section describes the ARARs or other regulations as identified in Section 13.2 of the ROD for OU-2.

5.1 MISSOURI SOLID WASTE RULES FOR SANITARY LANDFILLS

Missouri is a USEPA-approved state for providing regulations for landfills under the Resource Conservation and Recovery Act 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 OU-2, 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 feet of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less overlaid by at least one foot of soil capable of sustaining vegetative growth [10 CSR 80-3.010(17)(C)(4)]. These requirements are considered to be the design criteria for the RD for OU-2. 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 clay 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 [10 CSR 80-3.010(17)(B)(7)]. MDNR regulations also require that the maximum slopes be less than 25 percent 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 a demonstration, no active, intermediate, or final slope shall exceed 33 1/3 %. The objective of these requirements is to promote maximum runoff without excessive erosion and to account for potential differential settlement. Because the landfilling of OU-2 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 minimum sloping requirement is greater than necessary and may not be optimal in this case. Therefore, the five percent

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. It is anticipated that a two percent 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 increased erosion potential. The 2% minimum slope and 25% maximum slope (or alternatively up to a 33 1/3% maximum slope as supported by a geotechnical evaluation) will be included as design criteria in the RD and therefore the minimum and maximum sloping requirements of the MDNR regulations will be met. These requirements may need to be looked at for the disturbed area only. The existing Western slope exceeds these requirements, but as described above appears to be stable by observation. Removing this slope would cause more harm than leaving the slope intact.

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.

While the requirements for a groundwater monitoring program in 10 CSR 80-3.010(11) are considered relevant and appropriate, and monitoring of groundwater for the landfill is ongoing, all groundwater monitoring has been placed into OU-3.

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 substantive provisions provide a useful framework for O&M 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 on developing robust O&M and long-term monitoring plans. These requirements will be addressed in the development of an O&M 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 will involve grading, compaction, and other soil-related activities, NAAQS for PM10 are

potentially relevant and appropriate requirements during implementation of the RA. As a result, perimeter air monitoring may be conducted during implementation of the RA at OU-2. Site health and safety plans will address protection of on-site personnel.

5.3 CLEAN WATER ACT

The Clean Water Act sets standards for ambient water quality and incorporates chemical specific standards including federal water quality criteria and state water quality standards. The substantive requirements for stormwater runoff are relevant and appropriate. Therefore, these standards will be identified in the stormwater monitoring plan as appropriate.

5.4 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) prohibits the placement of a well within 300 feet of a landfill. These rules should provide protection against the placement of wells on or near the Site and will be incorporated as appropriate into the Institutional Controls Plan for the Site.

MDNR has also established regulations on monitoring well construction (10 CSR 23-4) that will apply to the construction of new or replacement monitoring wells at the Site.

6.0 CONCEPTUAL DESIGN AND DESIGN CRITERIA

The solid waste materials in OU-2 will be regraded, where needed, to meet the minimum and maximum slope requirements established by the MDNR solid waste regulations as discussed above, and then will be covered with a landfill cover that meets the MDNR solid waste requirements. The final cover for OU-2 will consist of a minimum of 2-ft of clay, silt, or sandy clay compacted to a density that should result in a factor of permeability for this layer of 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 1 ft of uncompacted soil suitable to support development of grassy vegetation, again optimizing the existing cover.

6.1 CONCEPTUAL DESIGN

The design team has developed preliminary grading plans for the regraded landfill cover (Appendix A, **Figure A-1**) that meet the minimum and maximum slope requirements of the MDNR Solid Waste Regulations for the area to be disturbed in creating the final closure cap. The proposed regrading plan was developed based on general topographic elevations of the landfill surface which may not accurately reflect current conditions. The proposed regrading plan was also developed based on trying to limit the amount of fill that needs to be trucked on-site by locating areas within the Inactive Sanitary Landfill 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 that regrading of the waste surface will be minimal. This will be achieved only if the existing western slope can be maintained in its current condition. If this slope needs to be cut back, significant regrading of waste will be required. Waste relocation is not anticipated at this phase of the conceptual plan. However, details are included in the SAP and the QAPP as to how this is to be validated through implementation of the Work Plan. Further details of materials and construction methods will be outlined in later submittals of the design reports.

6.2 DESIGN CRITERIA

The design criteria to be used as a basis for the design of the remedy were identified based on the requirements of the ARARs presented in Section 5 and based on professional engineering judgment. The design criteria and the basis of the design criteria are summarized in Table 6-1.

7.0 PROGRESS REPORTS

On behalf of the Respondents, CEC will prepare and submit monthly progress reports 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 data received by the Respondents during the prior month;

3. A description of the work planned for the next two months; and

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.

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

8.0 PROJECT SCHEDULE FOR REMEDIAL DESIGN

Figure 8-1 presents potential durations and a critical path schedule for the various RD activities. The actual schedule will be affected by the OU-1 RD/RA process, weather conditions during performance of the RD site investigations, the possible need for follow-up investigations based on the results of the proposed investigations, and the actual length of agency review periods.

9.0 REFERENCES

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

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

Herst & Associates, Inc., Feasibility Study Report, West Lake Landfill Operable Unit 2, June, 2006.

Missouri Department of Natural Resources (MDNR), Landfill Closure Guidance, Publication 187, July, 2003.

U.S. Environmental Protection Agency (EPA), 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.

U.S. EPA, Record of Decision, West Lake Landfill Site, Bridgeton, Missouri Operable Unit 2, July, 2008.

TABLE

Table 6-1
Design Basis and Design Criteria
West Lake Landfill OU-2

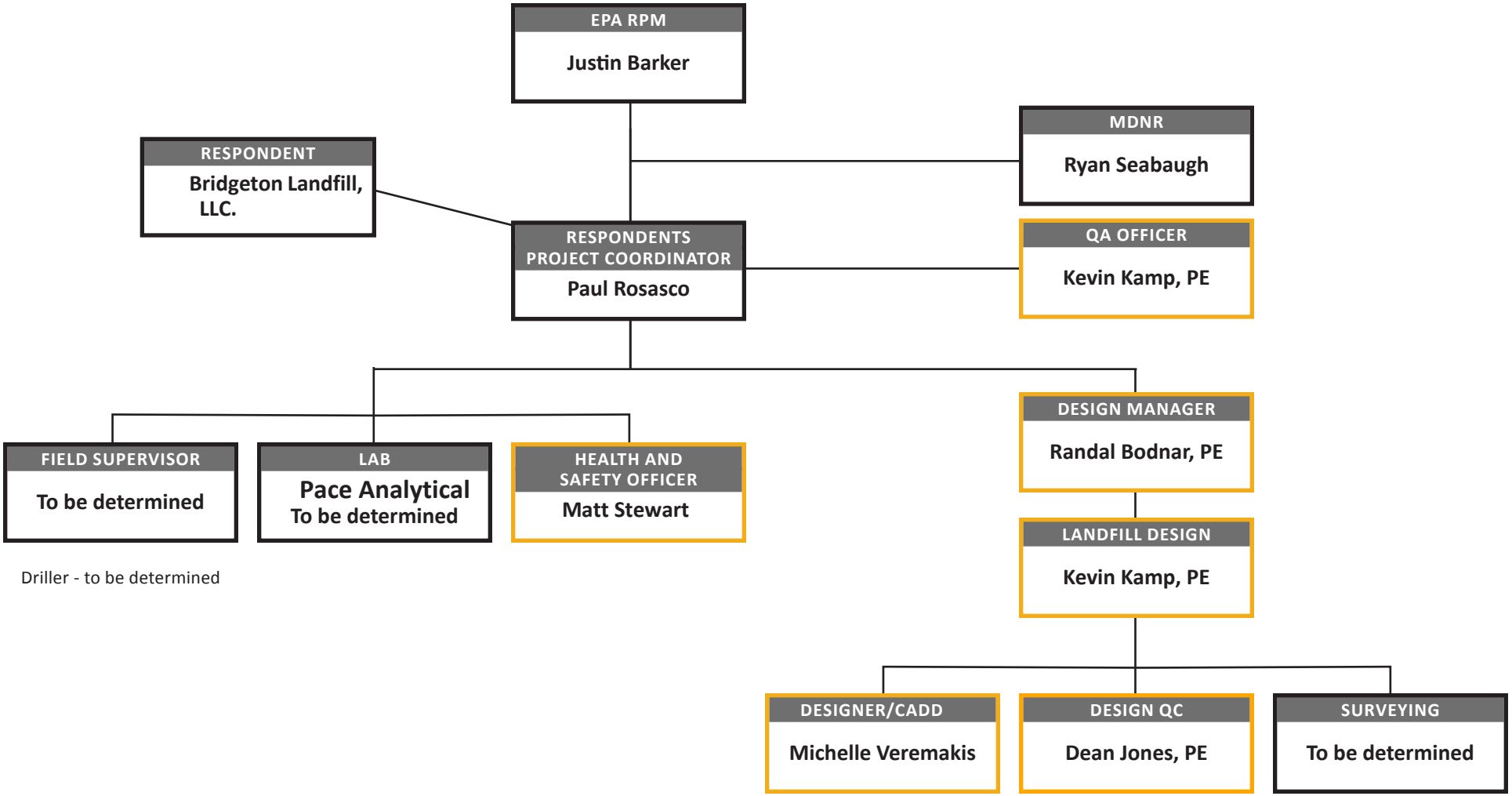
Parameter or Criteria	Design Basis	Design Criteria
Final Landfill slopes	MDNR Solid Waste Regulations 10 CSR 80-3 (17) (B) 7 and 8 and (C) 3 and the Record of Decision	Minimum 2% Maximum 25% (or 33 1/3% subject to a geotechnical investigation of slope stability)
Landfill Cover		
Rock Layer	Record of Decision	2 ft of 8” minus pit run quarry rock (limestone)
Low permeability layer	MDN Solid Waste Regulations 10 CSR 80-3 (17) (C) 4 A	2 ft of compacted clay, silt or sandy clay with a permeability of 1 x 10^{-5} cm/sec or less
	Radon NESHAP 40 CFR 61 Subpart T	Rn-222 emissions should not exceed 20 pCi/m^2s on average
Vegetative layer	MDNR Solid Waste Regulations 10 CSR 80-3 (17) (C) 4 A	1 ft minimum of soil capable of sustaining vegetative growth
Landfill Gas		
Decision as to whether a landfill gas system is necessary	MDNR Solid Waste Regulations 10 CSR 80-3 (14) (C) 2 B	Landfill decomposition gases shall not be allowed to concentrate above 50% of the LEL or 2.5% by volume of methane in soil at the property boundary
Design of a landfill gas system, if necessary	MDNR Solid Waste Regulations 10 CSR 80-3 (14)	Identifies the specific requirements for design of a landfill gas control system.

Table 6-1
Design Basis and Design Criteria
West Lake Landfill OU-2

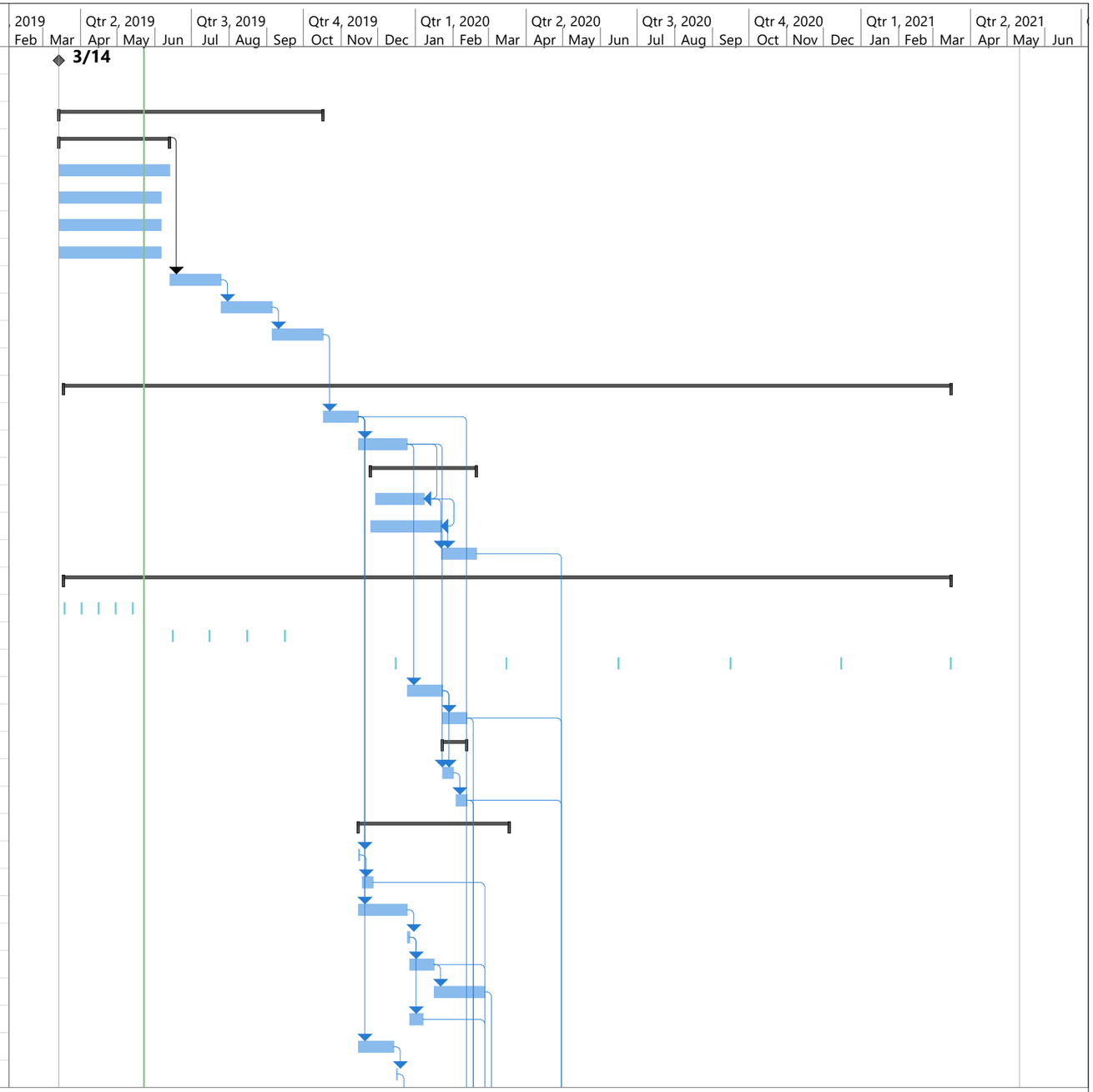
Parameter or Criteria	Design Basis	Design Criteria
Stormwater	MDNR Solid Waste Regulations 10 CSR 80-3 (8) F	On-site drainage structures and channels shall be designed to collect at least the water volume resulting from a 24-hour, 25-year storm
Groundwater Monitoring		
	MDNR Solid Waste Regulations 10 CSR 80-3 (11)	Identifies the specific requirements for design, implementation and operation of a groundwater monitoring program and for a solid waste landfill and establishes groundwater protection standards for landfill related constituents
	Missouri Well Construction Code 10 CRS 23-4	Specifies requirements for design and construction of groundwater monitoring wells

FIGURES

Figure 3-1
Project Organization Chart



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		AOC Amendment No. 3	0 days	Thu 3/14/19	Thu 3/14/19	
2						
3		RD Work Plan	155 days	Thu 3/14/19	Wed 10/16/19	
4		Draft RD Work Plans	65 days	Thu 3/14/19	Wed 6/12/19	
5		Draft RD Work Plan	65 days	Thu 3/14/19	Wed 6/12/19	
6		Draft RD QAPP	60 days	Thu 3/14/19	Wed 6/5/19	
7		Draft RD SAP	60 days	Thu 3/14/19	Wed 6/5/19	
8		Draft RD HASP	60 days	Thu 3/14/19	Wed 6/5/19	
9		EPA Review of Draft RD Plans	30 days	Thu 6/13/19	Wed 7/24/19	4
10		Final RD Work Plans	30 days	Thu 7/25/19	Wed 9/4/19	9
11		EPA Review and Approval of Final Plans	30 days	Thu 9/5/19	Wed 10/16/19	10
12						
13		Remedial Design Investigations	521 days	Mon 3/18/19	Mon 3/15/21	
14		Contracting and Mobilization	21 days	Thu 10/17/19	Thu 11/14/19	11
15		Clearing and Grubbing	28 days	Fri 11/15/19	Tue 12/24/19	14
16		Surveying	63 days	Mon 11/25/19	Wed 2/19/20	
17		Ground Surveying	28 days	Fri 11/29/19	Tue 1/7/20	15FF+10 days
18		Aerial Photography	42 days	Mon 11/25/19	Tue 1/21/20	17FF+10 days
19		Base Map Preparation	21 days	Wed 1/22/20	Wed 2/19/20	18,17
20		Landfill Gas Investigation	521 days	Mon 3/18/19	Mon 3/15/21	
21		**B-Weekly Landfill Gas Sampling**	**41 days**	**Mon 3/18/19**	**Mon 5/13/19**	
27		**Monthly Landfill Gas Sampling**	**65 days**	**Sat 6/15/19**	**Sun 9/15/19**	**21**
32		**Quarterly Landfill Gas Sampling**	**326 days**	**Sun 12/15/19**	**Mon 3/15/21**	**27**
39		Geoprobe Soil Gas Sampling	21 days	Wed 12/25/19	Wed 1/22/20	15
40		Summary of Soil Gas Results	14 days	Thu 1/23/20	Tue 2/11/20	39
41		**Investigation of Existing Clay Cap**	**14 days**	**Thu 1/23/20**	**Tue 2/11/20**	
42		Geoprobe Investigation	7 days	Thu 1/23/20	Fri 1/31/20	15,39
43		Summary of Geoprobe Results	7 days	Mon 2/3/20	Tue 2/11/20	42
44		Import Materials Testing	88 days	Fri 11/15/19	Tue 3/17/20	
45		Pit Run Material Sampling	1 day	Fri 11/15/19	Fri 11/15/19	14
46		Pit Run Material Density Testing	7 days	Mon 11/18/19	Tue 11/26/19	45
47		Low Perm Material Source ID	28 days	Fri 11/15/19	Tue 12/24/19	14
48		Low Perm Material Sampling	2 days	Wed 12/25/19	Thu 12/26/19	47
49		Low Perm Material Compaction Testing	14 days	Fri 12/27/19	Wed 1/15/20	48
50		Low Perm Material Testing	30 days	Thu 1/16/20	Wed 2/26/20	49
51		Low Perm Material Density Testing	7 days	Fri 12/27/19	Mon 1/6/20	48
52		Topsoil Material Source ID	21 days	Fri 11/15/19	Fri 12/13/19	14
53		Topsoil Material Sampling	1 day	Mon 12/16/19	Mon 12/16/19	52

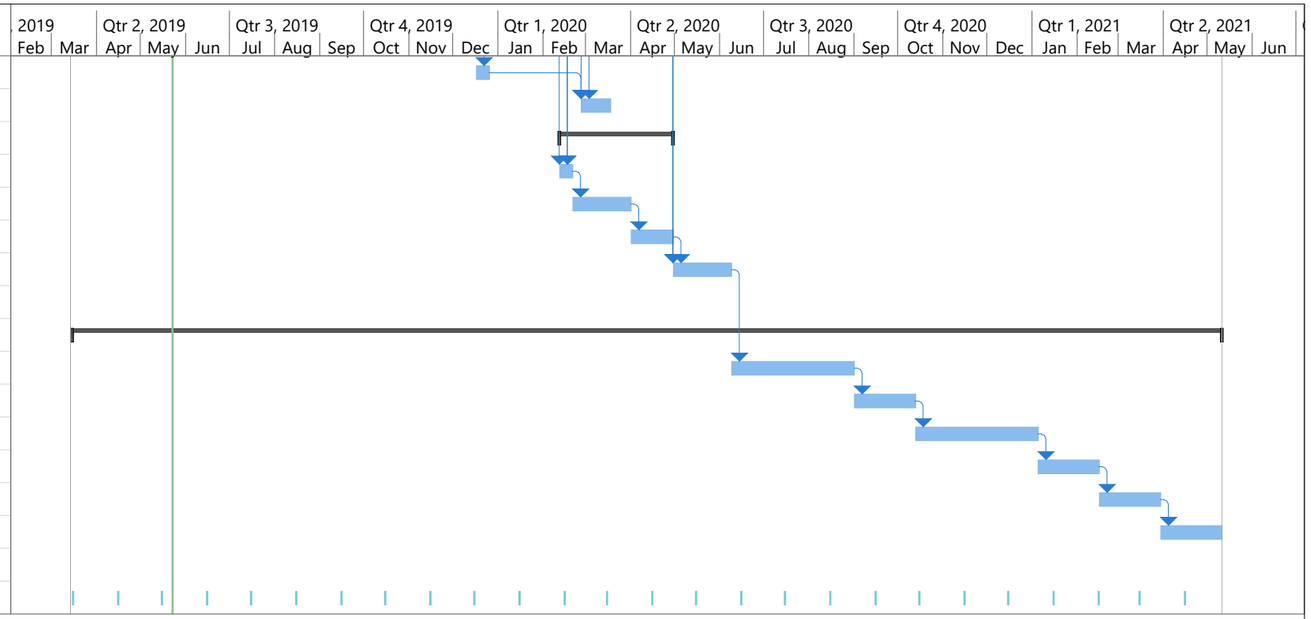


Project: Remedial Design Sched
Date: Tues 6/11/19

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		

Figure 8-1: Remedial Design Schedule - West Lake Landfill Operable Unit - 2

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
54		Topsoil Material Density Testing	7 days	Tue 12/17/19	Wed 12/25/19	53
55		Summary of Materials Testing	14 days	Thu 2/27/20	Tue 3/17/20	46,49,50,51,54
56		Groundwater Monitoring	56 days	Wed 2/12/20	Wed 4/29/20	
57		Groundwater Sample Collection	7 days	Wed 2/12/20	Thu 2/20/20	14,40,43
58		Groundwater Sample Analysis	28 days	Fri 2/21/20	Tue 3/31/20	57
59		Groundwater Analysis Data Review	21 days	Wed 4/1/20	Wed 4/29/20	58
60		Data Evaluation Summary Report	28 days	Thu 4/30/20	Mon 6/8/20	19,40,43,59
61						
62		Remedial Design	562 days	Fri 3/15/19	Mon 5/10/21	
63		Preliminary Design Report	60 days	Tue 6/9/20	Mon 8/31/20	60
64		EPA Review of Preliminary Design Report	30 days	Tue 9/1/20	Mon 10/12/20	63
65		Pre-Final Design Report	60 days	Tue 10/13/20	Mon 1/4/21	64
66		EPA Review of Pre-Final Design	30 days	Tue 1/5/21	Mon 2/15/21	65
67		Final Design Reprt	30 days	Tue 2/16/21	Mon 3/29/21	66
68		EPA Approval of Final Design	30 days	Tue 3/30/21	Mon 5/10/21	67
69						
70		**Monthly Progress Reports**	**545 days**	**Fri 3/15/19**	**Thu 4/15/21**	



Project: Remedial Design Sched
Date: Tues 6/11/19

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	

Figure 8-1: Remedial Design Schedule - West Lake Landfill Operable Unit - 2

APPENDIX A

CONCEPTUAL DESIGN DRAWING

G:\PROJECTS\2008\081-926\DWG\081926-C000.DWG (LPALMER) - DEC 11, 2008 - 11:26:5

DESIGN INTENT IS TO MATCH GRADES PROPOSED WITH OU-1 REMEDY

LEGEND

- OU-2 BOUNDARY
- FINISHED GRADES — 480
- EX. LEACHATE WELL & PUMP
- EX. CONC. STAND PIPE
- PROPOSED STORM PIPE — ST
- PROPOSED ROCK SWALE

PROPOSED SURFACRE WATER INLET

PROPOSED SURFACE WATER MH

PROPOSED SURFACE WATER MH

NPDES OUTFALL 003

NORTH

SCALE IN FEET

0 200 400

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 ROAD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

CONCEPTUAL DESIGN PLAN

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926	A-1

APPENDIX B

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.

CEC
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

APPENDIX C

REMEDIAL DESIGN QUALITY ASSURANCE PROJECT PLAN

REMEDIAL DESIGN ENVIRONMENTAL QUALITY ASURANCE PROJECT PLAN (RD-QAPP)

WEST LAKE LANDFILL 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

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REMEDIAL DESIGN ENVIRONMENTAL
QUALITY ASSURANCE PROJECT PLAN (QAPP)

WEST LAKE LANDFILL OU-2 FACILITY

SIGNATURE / APPROVAL PAGE

Approved by:

Justin Barker – USEPA Project Manager	Date
Paul Rosasco – Project Coordinator	Date
Kevin Kamp – Project QA Officer	Date
Randal Bodnar – Design Manager	Date

DISTRIBUTION LIST

The following individuals will receive copies of the approved Remedial Design Environmental Quality Assurance Project Plan (RD QAPP) and subsequent revisions:

Justin Barker, RPM - US EPA Region 7
Ryan Seabaugh - Missouri Department of Natural Resources
Paul Rosasco, Project Coordinator - CEC, Inc.
Kevin Kamp, PE, Project QA Officer - CEC, Inc.
Randal Bodnar, PE, Design Manager - CEC, Inc.

Courtesy copies will be provided to others, including Respondent and Respondent's individual contractors.

PROJECT / TASK ORGANIZATION

A project organization chart is provided as **Figure A-1**. Contact information for the individuals listed below is provided in **Table A-1**. The individuals participating in the project and their roles and responsibilities are discussed below:

Paul Rosasco, Project Coordinator, Engineering Management Support, Inc. (EMSI)

> Mr. Rosasco will have overall responsibility for successful project completion and will provide the interface between the USEPA and MDNR, the Respondent, and the Remedial Design Group.

Kevin Kamp, PE, Project Quality Assurance Officer/Landfill Design, CEC, Inc.

> Mr. Kamp will have overall responsibility for project quality assurance and landfill design activities.

Randal Bodnar, PE, Design Manager, CEC, Inc.

Mr. Bodnar will have overall responsibility for engineering design activities.

Laboratory Quality Assurance Officer (TBD), CEC, Inc.

The Laboratory Quality Assurance Officer will be responsible for coordination between the field sampling teams and the analytical laboratory and will be responsible for data validation activities.

Field Supervisor (TBD), CEC, Inc.

The Field Supervisor will be responsible for day-to-day oversight of field sampling teams and field sampling equipment.

Health and Safety Officer, Matt Stewart, Bridgeton Landfill, LLC

Mr. Stewart 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 laboratory analytical report preparation. The Quality Assurance Manual for Pace Analytical Services, LLC is included in Appendix B.

PROBLEM DEFINITION / BACKGROUND

Environmental conditions at the West Lake Landfill OU-2 facility (**Figure A-2**) have been previously defined by past studies. Existing facility features, including monitoring wells and other environmental monitoring locations near OU-2, are provided in **Figure A-3**. Proposed activities described in this RD QAPP are intended to enhance the decision-making process for the RD Work Plan by providing an updated assessment of environmental conditions in the vicinity of the West Lake Landfill OU-2 facility.

1.0 PROJECT / TASK DESCRIPTION AND SCHEDULE

Work to be performed in accordance with this RD QAPP consists of:

- Ground and aerial 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 probes;
- Collection and evaluation of existing cover thickness and material samples from OU-2;
- Evaluation of stormwater conveyance and leachate pumping well structures within and near the boundaries of the Inactive Sanitary Landfill;
- Level 4 validation of soil sampling laboratory analytical results;
- Verification of slope stability along western side of the Inactive Sanitary Landfill;
- Confirmation of property ownership extent along Old St. Charles Rock Road; and
- Report preparation and submittal to the USEPA and the MDNR.

Groundwater investigation and monitoring for OU-2 will be deferred to the OU-3 RI/FS process and will not be addressed as part of the RD Work Plan.

Each of the above-referenced tasks is briefly described below.

1.1 Ground and Aerial 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 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 West Lake Landfill OU-2 remedy (i.e., cover placement). Accordingly, during the RD phase of the project a more detailed ground survey will be conducted, with the goal of yielding ground surface elevations accurate to with 0.25 feet throughout the Inactive Sanitary Landfill. The ground survey will be conducted by a registered surveyor. The ground survey will be combined with a more recent aerial flyover and photography to provide the level of detail sufficient for calculating necessary material volumes to achieve planned final grades. This data will then be used to create a more accurate base map of the existing topographic conditions.

1.2 Testing of Potential Borrow Areas

As part of the West Lake Landfill OU-2 remedy, various materials will be placed and compacted within the Inactive Sanitary Landfill to achieve planned final grades. In order to accurately estimate needed volumes of materials, it is necessary to identify the density of materials in their current location and then conduct testing to quantify the achievable density of those same materials after undergoing excavation, transport, placement, and compaction. As part of the RD phase of the project, testing will be conducted on various potential sources of materials to yield this critical information. Testing methods for soil classification will include sieve analysis and Atterberg Limits. The frequency and intervals at which these parameters are obtained and measured will be determined by the Laboratory Quality Assurance Officer in consultation with USEPA and MDNR.

In addition, any soils that may be used for final cover must meet permeability specifications. As part of the RD phase of this project, laboratory testing will be conducted on potential sources of low-permeable final cover soils, with particular attention to the relationship between moisture content, compaction, and permeability. The resultant data are critical for construction and will be identified in the Remedial Action (RA) construction specifications to be developed after completion of the RD phase of the project. The potential borrow areas that are displayed in **Figure A-5**, are no longer available and new sources will need to be identified.

1.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

For the purposes of the assessment of environmental conditions to support the RD Work Plan, temporary landfill gas perimeter monitoring probes are proposed to be installed at the West Lake Landfill OU-2 facility. Two (2) temporary landfill gas monitoring probe screened intervals are proposed to be installed at each location to allow monitoring of discrete zones. The upper zone probe at each location will be screened from approximately five (5) feet to approximately twenty (20) feet below ground surface and the lower zone probe at each location will be screened from approximately twenty-five (25) to approximate thirty- five (35) feet below ground surface. Temporary landfill gas perimeter monitoring probes are proposed to be installed at the approximate locations presented in **Figure A-4.**

Results of the temporary perimeter landfill gas monitoring probe installation activities will be provided in the Data Evaluation Summary Report.

It is anticipated that some of the temporary landfill gas perimeter monitoring probes could be damaged during construction activities or would otherwise need to be removed to facilitate construction

activities. To the extent that temporary landfill gas perimeter monitoring probes remain viable after construction, it is proposed that they remain available for use as long-term monitoring locations, if determined to be necessary after the landfill gas investigation of the Inactive Sanitary Landfill.

Quarterly methane monitoring will be performed on temporary perimeter landfill gas monitoring probes once they have been installed.

Results of the quarterly methane monitoring are expected to be used during the RD process to assess the composition of decomposition gases in the West Lake Landfill OU-2 facility. Quarterly methane 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

The Feasibility Study in 2008 included an estimate of the volumes of materials to be needed for final cover on the Inactive Sanitary Landfill. The estimate was based on existing cover thickness data collected in 1995. To help refine the volume estimate, and in conjunction with the planned aerial flyover and topographic survey to be conducted, supplemental cover thickness testing will be performed during the RD. The program will include collecting cover thickness samples on a surveyed grid pattern of approximately 150 feet across the Inactive Sanitary Landfill, as illustrated on **Figure A-6.**

Each sampling point will initially be surveyed for northing, easting, and ground surface elevation. Clear polyethylene tube samplers (or similar type of sampler) will then be pushed to depth through the existing cover at each sampling location. Each sampler will be brought to the surface and visually examined to distinguish materials and measure corresponding material thicknesses.

In addition, approximately thirty (30) Shelby Tube samples will be collected adjacent to selected sampling locations for permeability testing at an off-site laboratory. These samples will also 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. The average thickness of the topsoil to be removed and reinstalled after construction will be established.

1.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

During a recent site walkover of the Inactive Sanitary Landfill to confirm current conditions, the Landfill Design team noted the presence of various grates along the western portion of OU-2 that appear to represent stormwater conveyance structures. In addition, a leachate pumping well was observed to the east of OU-2. These features are displayed in **Figure A-7**.

At least one of the inferred stormwater conveyance structures appears to be completely silted-in. The outlets for the inferred stormwater conveyance structures could not be located due to vegetation growth on the Inactive Sanitary Landfill. Because proper stormwater conveyance is a key goal for the OU-2 remedy, an evaluation of the inferred stormwater conveyance structures will be performed as part of the RD phase.

Initially, the locations of the presumed stormwater grates will be plotted on the survey base map previously described in Section A6.1. Structural details will also be acquired. A geophysical survey or sewer inspection camera will then be utilized to establish the routing and discharge points of the stormwater conveyance lines. The surveyors will locate the routing and discharge points for subsequent use in the design of the OU-2 remedy. If the conveyance lines are completely silted in or are otherwise unusable, the lines will likely be abandoned. A functional stormwater conveyance system will then need to be incorporated as part of the RD.

In addition, an evaluation of the existing leachate pumping well will also be conducted. The location of the existing leachate pumping well will be similarly plotted on the survey base map. Detailed information regarding its structural design and functionality will then be acquired from the landfill operators. The resulting information will be evaluated to determine whether the pumping well can be incorporated into the OU-2 RD or if a separate leachate system needs to be designed. The primary focus of the leachate pumping well evaluation will be on understanding the history of this system, if such information is available. The secondary focus will be on determining whether or not this system or another system will be needed after the RD has been implemented. This will be based on leachate generation volumes attributable to OU-2 and whether or not those volumes would warrant the continued or expanded use of such systems.

1.6 Validation of Laboratory Analytical Results

All laboratory analytical results for soil samples will be validated in accordance with the requirements of a Level 4 validation program.

Data validation summary reports will be provided to the USEPA and the MDNR as part of the Data Evaluation Report.

1.7 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

The 2008 OU-2 Feasibility Study Report noted that slopes along the western portion of the Inactive Sanitary Landfill near Old St. Charles Rock Road were reportedly re-graded in 1992 with a goal of achieving a 3:1 or less slope (instead of its prior 2:1 ratio). Based on a recent site walkover completed by the Landfill Design team and a review of the 2005 topography available for the Inactive Sanitary Landfill, CEC has concluded that portions of the western slope of the Inactive Sanitary Landfill may not currently meet 3:1 or 2:1. **Figure A-8** displays the location and contour details of the western slope.

During the recent site walkover, there was no evidence of movement of the fence that was installed along the western slope, reportedly in the mid-1990's. The existing slopes were also well-vegetated. The alignment of the fencing and the vegetation indicate that the current slope is stable.

As one of the RD tasks, an evaluation will be conducted to further document the history and stability of the existing slope. A detailed assessment of the western slopes will be performed upon completion of the ground and aerial topographic survey previously described in Section A6.1. In addition, a series of thirteen (13) survey pins will be installed in the western slope. The approximate pin locations are displayed in **Figure A-8**. These pins will be surveyed on a monthly basis during the RD phase to document slope stability.

If additional documentation of slope stability is warranted, an on-site assessment of existing vegetation along the western slope may be implemented. Derived conclusions would be documented to further substantiate the stability control provided by existing vegetation.

If noticeable slope movement occurs during the RD phase, a geotechnical sampling investigation may be implemented. Such an evaluation would require a significant number of soil borings to identify any potential failure planes or unstable portions of the western slope.

1.8 Confirmation of Property Ownership Along Old St. Charles Rock Road

The extent of property ownership is obviously a key component to a proper RD. With regard to OU-2, the extent of property ownership along Old St. Charles Rock Road is particularly important due to planned installation of perimeter landfill gas monitoring probes and as far as final cover slope and extent on the Inactive Sanitary Landfill. Anecdotal information suggests that property ownership may extend some distance into what was formerly Old St. Charles Rock Road but has now reportedly been abandoned. Given the presence of a high-capacity fiber-optic line along the toe of the Inactive Sanitary Landfill near Old St. Charles Rock Road, drilling of perimeter landfill gas monitoring probes described earlier in Section A.6 may be problematic and will at the least require careful delineation of the fiber-optic line location. If property ownership extends some distance into Old St. Charles Rock Road, perimeter landfill gas probes can be located some distance away from the fiber- optic line while still meeting the goal of obtaining landfill gas data at the property boundary.

2.0 DATA QUALITY OBJECTIVES AND CRITERIA

Valid data of known and documented quality are required for the RD decision making process.

The ground and aerial topographic survey and base map preparation is intended to address an identified need for a more accurate ground surface topography within the Inactive Sanitary Landfill. The increased ground surface elevation accuracy will be used to refine the material volume estimates.

The testing of potential borrow areas is intended to address an identified need for materials density both at the source and after excavation, transport, placement, and compaction. This task is also intended to address an identified need for quantification of permeability for potential final cover soils, along with moisture/density relationships of the potential final cover soils. These testing activities are expected to provide data which can be used to address these data needs, which in turn will allow refinement of materials volume calculations and costs, as well as eventual development of construction specifications for use during the RA.

Landfill gas perimeter probe installation and monitoring are intended to address an identified data need for determining the current gas generation and movement the perimeter of the Inactive Sanitary Landfill. Results of the temporary landfill gas perimeter probe monitoring will be utilized to assist RD decision making concerning the potential incorporation of a landfill gas management system in the West Lake Landfill OU-2 facility.

The evaluation of existing cover thickness and material is intended to address an identified need to verify the thickness of existing soil and low-permeability cover materials within the boundaries of the Inactive Sanitary Landfill, as well as to refine the previous thickness estimates based on 200-foot spacing through collection of data on a closer grid spacing. Results of the cover thickness and material evaluation are expected to be utilized to assist in scoping cover placement activities necessary during the RA as well as refining the estimate of material volumes needed to achieve final cover goals.

The evaluation of stormwater conveyance and leachate pumping well structures is intended to address an identified need to verify the ability of existing stormwater conveyance structures within the Inactive Sanitary Landfill to pass rainfall / runoff. The results of the evaluation are expected to yield data that can be incorporated into an overall stormwater management plan for the Inactive Sanitary Landfill during and after the RA. A similar evaluation will be conducted to assess the functionality of an existing leachate pumping well and its potential incorporation into the OU-2 RD.

The verification of slope stability along the western portion of the Inactive Sanitary Landfill is intended to address an identified need for comparing the existing slope to ARARs. The results of the slope stability verification program are intended to be used to meet the goals of a stability demonstration, or alternatively, identify the need for a modified slope along the western portion of the Inactive Sanitary Landfill.

The property ownership confirmation evaluation along Old St. Charles Rock Road is intended to provide verification of property ownership from which RD and RA decisions can be based. For example, if Bridgeton Landfill, LLC property ownership is determined to extend some distance into Old St. Charles Rock Road that has been abandoned, placement of perimeter landfill gas monitoring probes can be adjusted to provide increased confidence of avoiding fiber-optic lines present at the base of the Inactive Sanitary Landfill while still meeting the goal of obtaining landfill gas data at the property boundary.

3.0 SPECIAL TRAINING / CERTIFICATION

Specialized training for field activities off-site analyses (performed by the analytical laboratory), and data validation have not been identified as necessary during the planning of this project. The proposed activities are part of routine activities performed by competent, knowledgeable, and experienced professionals in the fields of environmental science and engineering. The CEC, Inc. field team leader will be responsible for ensuring that all members of the field team have valid and current specialized training required by OSHA regulations.

4.0 DOCUMENTS AND RECORDS

Records for this project will include miscellaneous correspondence, field logs, field data worksheets, laboratory analytical reports, maps/figures, data validation reports, and a final report. Sampling sheets, chains of custody, analytical data, and a summary will be submitted to the USEPA Project Manager and to the MDNR Project Manager as part of the Data Evaluation Report. Field information logs for perimeter landfill gas probe 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.

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 Ground and Aerial Topographic Survey and Base Map Preparation

There are no specific sampling process design needs associated with the ground and aerial topographic survey and 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 0.25 feet vertical ground elevation throughout the Inactive Sanitary Landfill.

5.2 Testing of Potential Borrow Areas

To meet the objectives of this task, a sufficient number of samples will be collected and tested from each potential source that the Landfill Design Manager can attest with confidence that the data are sufficiently detailed to meet the data quality objectives. It is likely that a minimum of three (3) to five (5) samples will be required from each potential source. The Landfill Design Manager will have final authority for determining the appropriate number of samples, type of sampling, and testing to be conducted.

5.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

Temporary landfill gas perimeter monitoring probes are proposed to be installed near the Inactive Sanitary Landfill portion of the West Lake Landfill OU-2 facility. These probes will assist in the assessment of subsurface conditions to support the RD. Temporary probes are proposed for gas monitoring because the facility believes that use of heavy equipment during subsequent RA activities (cap construction) will likely result in severe damage or the destruction of some of the landfill gas perimeter monitoring probes. If required, permanent landfill gas perimeter monitoring probes will be installed after RA construction activities are completed.

Temporary landfill gas perimeter monitoring probes are proposed to be installed at the approximate locations presented in **Figure A-4**. Temporary landfill gas perimeter monitoring probe installation activities will be performed by a Missouri-licensed well driller supervised by CEC, Inc. personnel, who will asbestos certification. Approximate locations of the proposed temporary landfill gas

perimeter monitoring probes were selected on a 500-foot spacing around the boundaries of Inactive Sanitary Landfill in accordance with Missouri regulations provided in Division 80 of Title 10 of the Missouri Code of State Regulations [10 CSR 80-3.010(14)(B)(1)(C)].

Two (2) temporary landfill gas monitoring probe screened intervals (upper and lower) are proposed to be installed at each location to allow monitoring of discrete zones. The upper zone probe at each location will be screened from approximately five (5) feet to approximately twenty (20) feet below ground surface and the lower zone probe at each location will be screened from approximately twenty-five (25) to approximate thirty-five (35) feet below ground surface. **Figure B-1** provides a proposed as-built monitoring diagram of the proposed upper and lower temporary landfill gas perimeter monitoring probe configuration.

Each temporary perimeter landfill gas monitoring probe 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 temporary perimeter landfill gas monitoring probe survey will be provided in the Data Summary Evaluation Report.

Quarterly methane monitoring will be performed at the installed temporary landfill gas perimeter monitoring probes, as required by 10 CSR 80-3.010(14)(C)(4). Quarterly monitoring of these probes will continue until immediately prior to the commencement of RA construction activities.

Heavy equipment activities are expected to result in severe damage to the temporary probes or the destruction of the temporary probes. Those temporary probes that are identified as requiring decommissioning to facilitate the RA will be abandoned in accordance with applicable Missouri regulations prior to initiation of RA construction activities. Any temporary probes that remain intact 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 the collection of approximately ninety (90) samples at 150- ft intervals from a surveyed grid across the Inactive Sanitary Landfill to evaluate the existing cover thickness. **Figure A-6** displays the approximate sampling grid and sample locations. This sampling task will be coordinated with the aerial flyover and topographic survey.

After completing the ninety (90) initial sampling locations, thirty (30) Shelby Tube samples will be collected in accordance with ASTM D1587 at locations immediately adjacent to selected sampling locations to further investigate the material properties of the existing cover. Undisturbed soil samples will be collected for material classification and permeability testing purposes.

5.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

There are no specific sampling process design needs associated with this task.

5.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

As one of the RD tasks, an evaluation will be conducted to further document the history and stability of the existing western slope. A series of thirteen (13) survey pins will be installed in the western slope. The pin locations are displayed in **Figure A-8**. These pins will be surveyed on a monthly basis during the RD phase to document movement and stability of the existing slope.

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 Ground and Aerial 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

Once potential borrow areas are identified, the Project Quality Assurance Officer will coordinate test pits to obtain sufficient samples for geotechnical testing. Samples will be collected and containerized for shipment to a qualified geotechnical testing firm.

6.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

During installation of the temporary landfill gas perimeter monitoring probes, soils will be collected using plastic sampling sleeves positioned inside the direct-push drilling rods. Upon extraction from the drilling rods, the plastic sleeves will be sliced open and the soils will be logged for lithology and visually inspected for the presence or absence of solid waste. Following installation of the probes, quarterly methane monitoring is proposed to be conducted pursuant to the procedures described by the *Methane Gas Policy*, dated May 2017, published by the MDNR (**Appendix A**).

6.4 Existing Thickness and Material Evaluation of Inactive Sanitary Landfill Cover

The sampling program will include the collection of approximately ninety (90) samples at 150- ft intervals from a surveyed grid across the Inactive Sanitary Landfill. **Figure 6-1** displays the approximate sampling grid and sample locations. Each location will be sampled using a direct push drill rig pushing a tube sampler lined with clear polyethylene liners. Each sampler will be brought to the surface, the liner will be opened, and the soils will be 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.

After completing the ninety (90) initial sampling locations, thirty (30) Shelby Tube samples will be collected in accordance with ASTM D1587 at locations immediately adjacent to selected 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 testing laboratory where the tubes will be extruded and logged with representative portion of each tube tested for Atterberg Limits, grain size distribution and permeability.

6.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

No sampling is anticipated for this task.

6.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

No sampling is anticipated for this task.

7.0 SAMPLE HANDLING AND CUSTODY

7.1 Ground and Aerial Topographic Survey and Base Map Preparation

There are no sample handling and 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 form will be attached to each 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 request form will be kept by the Landfill Design Manager.

7.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

Neither visual inspections of soil samples collected in plastic sleeves nor quarterly methane measurements will result in collection of samples for laboratory analysis. Accordingly, sample handling and custody requirements are not expected to apply to landfill gas perimeter probe 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. Since these samples will not be submitted for any further off-site analysis, no additional sample handling or custody procedures are applicable.

For the portion of soil samples being collected for off-site geotechnical analysis, sample handling will involve preservation of the sample by proper sealing the container. A soil testing request form will be attached to each container including the sampling date, location, sampler's name, a general description of the material, and the requested laboratory analyses. A copy of the soil testing request form will be retained by the Landfill Design Manager.

7.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

There are no sample handling and custody issues associated with this task.

7.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

There are no sample handling and custody issues associated with this task.

8.0 ANALYTICAL METHODS

8.1 Ground and Aerial Topographic Survey and Base Map Preparation

There are no analytical methods associated with the ground and aerial topographic survey and base map preparation task.

8.2 Testing of Potential Borrow Areas

The following test methods will be employed for geotechnical testing:

- Moisture-Density relationships using the Standard Proctor Method - ASTM D698
- Grain size distribution – ASTM D421, D422 and D1140
- Atterberg Limits – ASTM 4318
- Permeability (recompacted to specified density) – ASTM 5084

8.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

Neither visual inspections of soil samples collected in plastic sleeves nor quarterly methane measurements will result in collection of samples for laboratory analysis. Accordingly, analytical methods are not expected to apply to landfill gas perimeter probe installations and measurements.

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 samples:

- Moisture Content – ASTM D2216
- Unit Weight – ASTM D2166
- Grain size distribution – ASTM D421, D422, and D1140
- Atterberg Limits – ASTM 4318
- Permeability – ASTM 5084

8.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

There are no analytical methods associated with this task.

8.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

Slope stability measurements will not result in the collection of any samples for laboratory analysis. As a result, there are no analytical methods associated with this task.

9.0 QUALITY CONTROL

9.1 Ground and Aerial Topographic Survey and Base Map Preparation

There are no sample quality control issues associated with the ground and aerial topographic survey and base map preparation task.

9.2 Testing of Potential Borrow Areas

Geotechnical testing will be conducted by a certified laboratory. Certification must be approved by the Department of Transportation from the state where the laboratory is located or similar level of authority or credentials.

9.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

Neither visual inspections of soil samples collected in plastic sleeves nor quarterly methane measurements will result in collection of samples for laboratory analysis. Accordingly, sample quality control issues are not expected to be associated with the landfill gas perimeter probe installations and measurements.

9.4 Existing Thickness and Material Evaluation of Inactive Sanitary Landfill Cover

Geotechnical testing will be conducted by a certified laboratory. Certification must be approved by the Department of Transportation from the state where the laboratory is located or similar level of authority or credentials.

9.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

There are no sample quality control issues associated with this task.

9.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

Data must be collected using calibrated equipment that meets or exceeds the industry standard. This data must also be provided as a document that is signed and sealed by a licensed surveyor in the State of Missouri.

10.0 INSTRUMENT / EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Field instruments used for landfill gas measurements and health and safety monitoring will be tested, inspected, and maintained according to manufacturer's recommendations.

10.1 Instrument / Equipment Calibration and Frequency

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.

11.0 INSPECTION / ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies and consumables for the activities described by this RD QAPP are described below.

11.1 Ground and Aerial Topographic Survey and Base Map Preparation

The inspection and acceptance of supplies and consumables are not expected to be associated with the ground and aerial topographic survey and base map preparation task.

11.2 Testing of Potential Borrow Areas

There will be no need for acceptance of supplies and consumables for this task.

11.3 Installation and Monitoring of Temporary Landfill Gas Perimeter Monitoring Probes

Required supplies and consumables for temporary landfill gas perimeter monitoring probe 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, etc. utilized by the drilling contractor to construct the probes. Wells will be drilled in accordance with Missouri Well Construction Code. Required supplies and consumables for quarterly temporary landfill gas perimeter probe monitoring 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

There will be no need for acceptance of supplies and consumables for this task.

11.5 Evaluation of Stormwater Conveyance and Leachate Pumping Well Structures

There will be no need for acceptance of supplies and consumables for this task.

11.6 Slope Stability Verification Along Western Portion of the Inactive Sanitary Landfill

There will be no need for acceptance of supplies and consumables for this task.

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. For example, monitoring well analytical results from previous sampling events will be used to determine the order of monitoring well purging and sampling (from least impacted to most impacted).

13.0 REPORTS TO MANAGEMENT

Information gathered as part of the RD phase activities will be provided to USEPA and MDNR through two primary means – Monthly Reports and the Data Evaluation Summary Report. Monthly reports will include as attachments copies of raw data provided by the analytical laboratory. The Data Evaluation Summary Report will include evaluations of the collected data as well as copies of field documentation sheets, data, validation results, etc.

14.0 DATA REVIEW, VERIFICATION, AND VALIDATION

All laboratory analytical results for soil samples will be validated in accordance with the requirements of a Level 4 validation program. Components of the Level 4 data validation program are provided in Section D.2.

15.0 VERIFICATION AND VALIDATION METHODS

Level 4 data validation will be performed in general accordance with the USEPA National Functional Guidelines for Inorganic Data Review (revised October 2004), USEPA National Functional Guidelines for Organic Data Review (revised October 1999), and the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, (Final, June 2007).

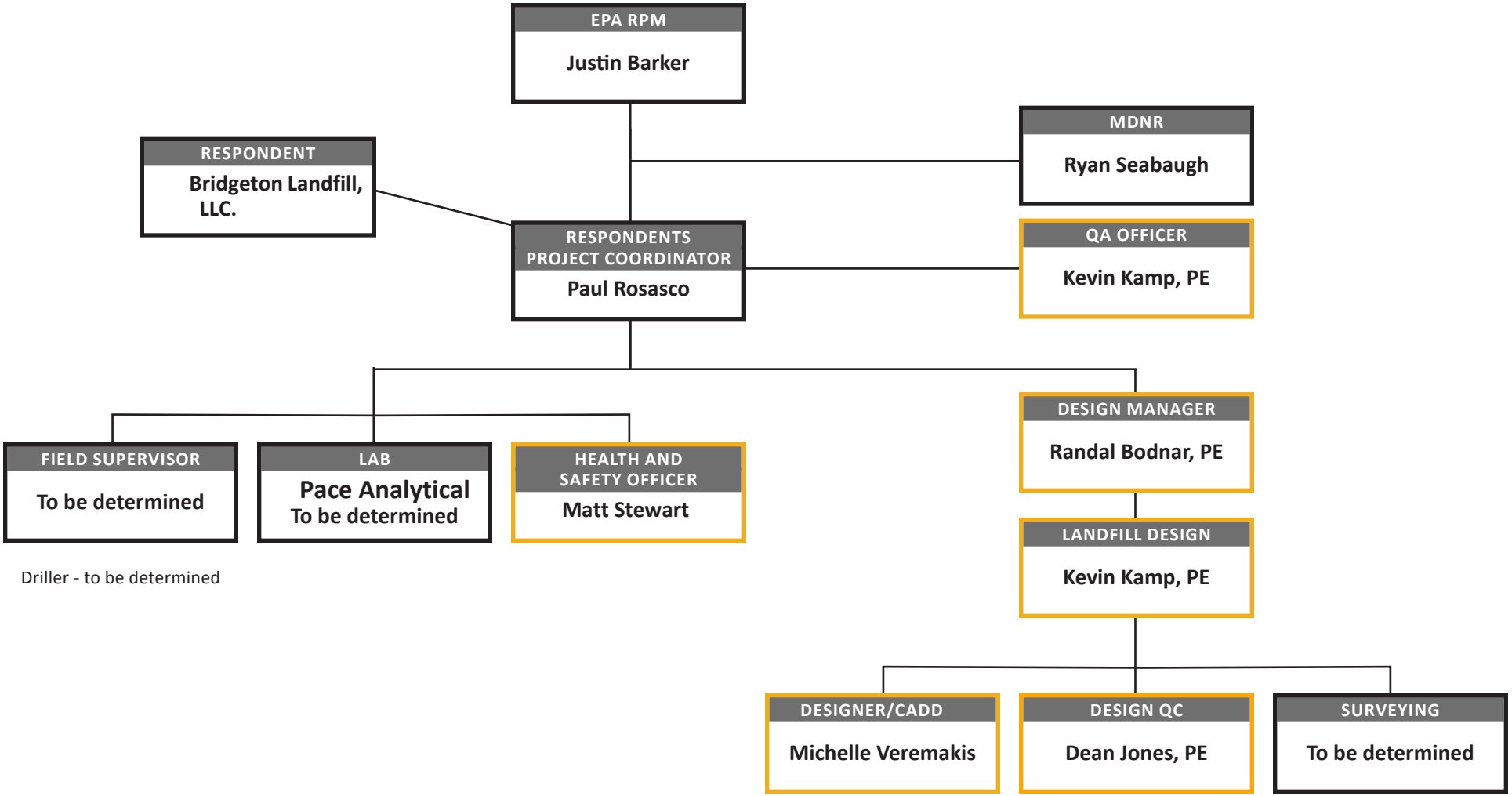
Elements of the Level 4 data validation program for organic analyses are expected to consist of:

- Holding Times;
- Initial Calibration Procedures and Results;
- Continuing Calibration Procedures and Results;
- Blank Results;
- System Monitoring Compound (Surrogate) Recoveries;
- Matrix Spike and Matrix Spike Duplicate Recoveries;
- Laboratory Control Sample Recoveries;
- Internal Standard Performance;
- Field Duplicate Sample Analysis – Relative Percent Difference (RPD);
- Laboratory Duplicate Sample Analysis – Relative Percent Difference (RPD);
- Compound Quantitation;
- Transcriptions from Raw Data to Summary Forms;
- Reporting Limits; and
- Overall Assessment of Data in the Sample Delivery Group (SDG) for Inorganic Analyses:
- ICP Interference Check Sample Results;
- MSA and Serial Dilution Check Results;

Level 4 data validation summary reports will be provided to the USEPA and the MDNR. Each validation summary report will provide a discussion of validation methods, validated analytical results, and an assessment of data accuracy, data precision, and data completeness.

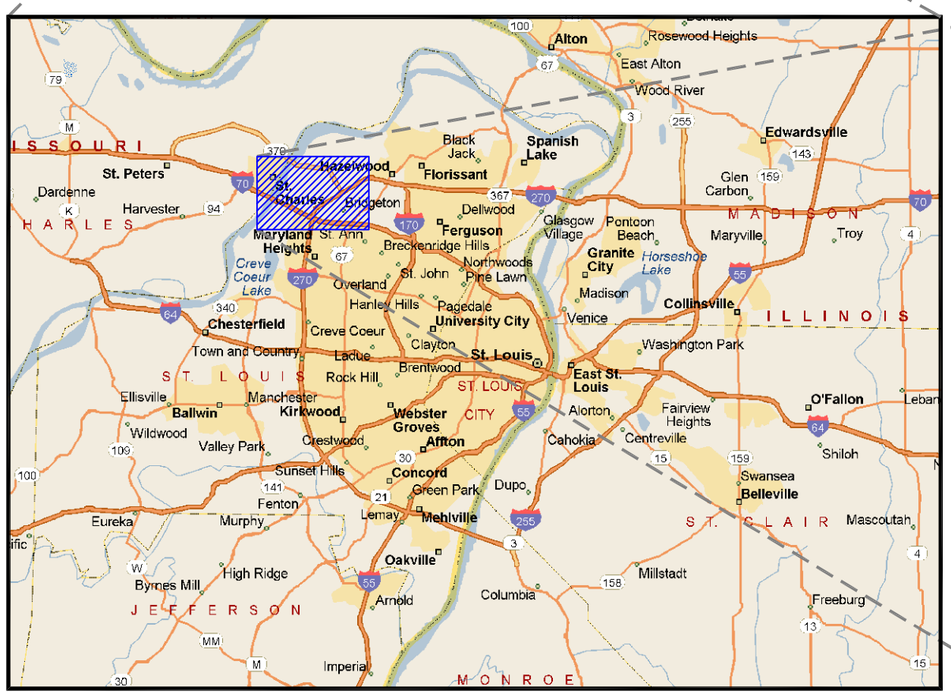
FIGURES

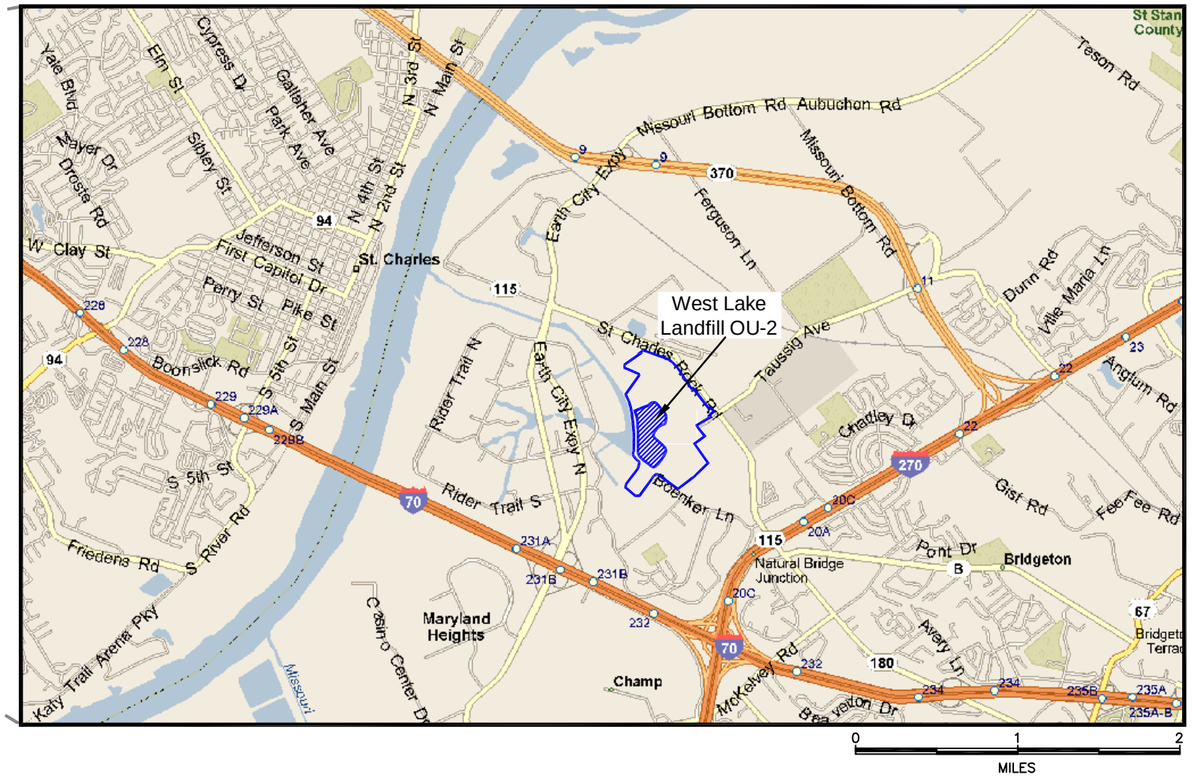
Figure A-1
Project Organization Chart



NORTH

Maps courtesy of Microsoft Streets and Trips 2005





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West Lake Landfill OU-2
Bridgeton, Missouri

Figure A-2
Site Location Map

LEGEND

- Monitoring Well
- Gas Probe
- Leachate Riser
- Leachate Sump
- Presumably Destroyed Well
- Approximate Operable Unit 2 Boundary
- Leachate Outfall
- NPDES Outfall

NPDES and Leachate Outfalls are associated with the Former Active Sanitary Landfill

NORTH

0 100 200 350 500 700

Scale in Feet
Graphic Scale: 1 inch = 350 feet

Former Active Sanitary Landfill
Permit No. 118912

Operable Unit 2
Inactive Sanitary Landfill

Operable Unit 1
Area 1

Operable Unit 1
Area 2

Closed Demolition Landfill

Former Leachate Pond

ENTRANCE STATION

CONCRETE PLANT

ASPHALT PLANT

PZ-100-SS
PZ-100-SD
PZ-100-KS
PZ-208-SS
GMP-8
NPDES Outfall 006
PZ-114-AS
PZ-115-SS
I-68
S-84
D-85
D-14
GMP-7
PZ-200-SS
PZ-102-SS
PZ-102R-SS
PZ-201A-SS
GMP-6
PZ-202-SS
GMP-5
PZ-1201-SS
PZ-104-SS
PZ-104-SD
PZ-104-KS
LCS-3C
PZ-203-SS
GMP-4
LCS-2C
PZ-101-SS
PZ-103-SS
LCS-6A
LCS-5A
LCS-1B
I-67
NPDES Outfall 001
PZ-207-AS
S-5
I-4
D-3
PZ-109-SS
PZ-108-SS
PZ-110-SS
MW-F1-S
MW-F1-D
PZ-111-SD
PZ-111-KS
PZ-206-SS
PZ-105-SS
GMP-3
GMP-13
NPDES Outfall 005
PZ-116-SS
MW-1204
GMP-12
GMP-11
LCS-4A
PZ-113-AS
PZ-113-AD
PZ-113-SS
PZ-112-AS
LR-104
PZ-305-AI
I-73
LCS-128K
GMP-2
PZ-204-SS
PZ-204A-SS
I-66
MW-F3
D-13
I-65
D-87
MW-5A
MW-4A
MW-1A
MW-3A
MW-2A
PZ-205-AS
PZ-205-SS
PZ-106-SD
PZ-106-SS
PZ-106-KS
GMP-10
GMP-1
LR-103
S-88
PZ-107-SS
Leachate Outfall 008
GMP-9
NPDES Outfall 003
LR-100
D-12
S-10
I-11
LR-102
LR-101
PZ-302-AS
PZ-302-AI
S-75
S-8
I-62
D-83
S-61
D-6
MW-102
LR-105
PZ-304-AS
PZ-304-AI
PZ-303-AS
MW-F2
D-81
S-53
MW-101
I-7
D-93
S-82
I-9
I-2
S-1
MW-103
MW-104
S-51
S-52

Date of Aerial Topography January 20, 2005, basemap provided by Sanborn.

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West Lake Landfill OU-2
Bridgeton, Missouri

Figure A-3
Existing Facility Features Map

LEGEND

- Monitoring Well
- Gas Probe
- Leachate Riser
- Leachate Sump
- Presumably Destroyed Well
- Approximate Operable Unit 2 Boundary
- Leachate Outfall
- NPDES Outfall

NPDES and Leachate Outfalls are associated with the Former Active Sanitary Landfill

NORTH

0 100 200 350 500 700

Scale in Feet
Graphic Scale: 1 inch = 350 feet

Former Active Sanitary Landfill
Permit No. 118912

Operable Unit 2
Inactive Sanitary Landfill

Operable Unit 1
Area 1

Operable Unit 1
Area 2

Closed Demolition Landfill

Former Leachate Pond

ENTRANCE STATION

CONCRETE PLANT

ASPHALT PLANT

PZ-100-SS
PZ-100-SD
PZ-100-KS
PZ-208-SS
GMP-8
NPDES Outfall 006
PZ-114-AS
PZ-115-SS
I-68
S-84
D-85
D-14
GMP-7
PZ-200-SS
PZ-102-SS
PZ-102R-SS
PZ-201A-SS
GMP-6
PZ-202-SS
GMP-5
PZ-1201-SS
PZ-104-SS
PZ-104-SD
PZ-104-KS
LCS-3C
PZ-203-SS
GMP-4
LCS-2C
PZ-101-SS
PZ-103-SS
LCS-6A
LCS-5A
LCS-1B
I-67
NPDES Outfall 001
PZ-207-AS
S-5
I-4
D-3
PZ-109-SS
PZ-108-SS
PZ-110-SS
MW-F1-S
MW-F1-D
PZ-111-SD
PZ-111-KS
PZ-206-SS
PZ-105-SS
GMP-3
GMP-13
NPDES Outfall 005
PZ-116-SS
MW-1204
GMP-12
GMP-11
LCS-4A
PZ-113-AS
PZ-113-AD
PZ-113-SS
PZ-112-AS
LR-104
PZ-305-AI
I-73
LCS-128K
GMP-2
PZ-204-SS
PZ-204A-SS
I-66
MW-F3
D-13
I-65
D-87
MW-5A
MW-4A
MW-1A
MW-3A
MW-2A
PZ-205-AS
PZ-205-SS
PZ-106-SD
PZ-106-SS
PZ-106-KS
GMP-10
GMP-1
LR-103
S-88
PZ-107-SS
Leachate Outfall 008
GMP-9
NPDES Outfall 003
LR-100
D-12
S-10
I-11
LR-102
LR-101
PZ-302-AS
PZ-302-AI
S-75
S-8
I-62
D-83
S-61
D-6
MW-102
LR-105
PZ-304-AS
PZ-304-AI
PZ-303-AS
MW-F2
D-81
S-53
MW-101
I-7
D-93
S-82
I-9
I-2
S-1
MW-103
MW-104
S-51
S-52

Date of Aerial Topography January 20, 2005, basemap provided by Sanborn.

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West Lake Landfill OU-2
Bridgeton, Missouri

Figure A-3
Existing Facility Features Map

NORTH

SCALE IN FEET

0 400 800

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www.cecinc.com

WESTLAKE LANDFILL OU-2
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

LOCATIONS OF POTENTIAL BORROW AREAS

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	A-5
DATE:	DEC. 2008	DWG SCALE:	1"=400'	PROJECT NO:	081-926		

G:\PROJECTS\2008\081-926\DWG\081926-C000.DWG (LPALMER) - DEC 9, 2008 - 12:22:52

CS-1* CS-2 CS-3* CS-4 CS-5*
CS-6* CS-7 CS-8 CS-9 CS-10* CS-11
CS-12 CS-13 CS-14* CS-15 CS-16 CS-17* CS-18
CS-19 CS-20* CS-21 CS-22 CS-23* CS-24 CS-25*
CS-26* CS-27 CS-28 CS-29* CS-30 CS-31* CS-32
CS-33 CS-34* CS-35 CS-36 CS-37* CS-38
CS-39* CS-40 CS-41 CS-42 CS-43
CS-44 CS-45* CS-46 CS-47*
CS-48* CS-49 CS-50 CS-51
CS-52 CS-53* CS-54 CS-55* CS-56 CS-57*
CS-58 CS-59 CS-60 CS-61 CS-62 CS-63 CS-64
CS-65* CS-66 CS-67* CS-68 CS-69 CS-70* CS-71
CS-72 CS-73 CS-74 CS-75 CS-76* CS-77 CS-78
CS-79* CS-80 CS-81* CS-82 CS-83 CS-84*
CS-85 CS-86 CS-87 CS-88
CS-89* CS-90

LEGEND

OU-2 BOUNDARY

COVER SAMPLING LOCATIONS CS-25

EX. LEACHATE WELL & PUMP

EX. CONC. STAND PIPE

* SHELBY TUBE SAMPLES

NORTH

SCALE IN FEET

0 200 400

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

PROPOSED SAMPLING GRID FOR THICKNESS EVALUATION OF INACTIVE LANDFILL COVER

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	A-6
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926		

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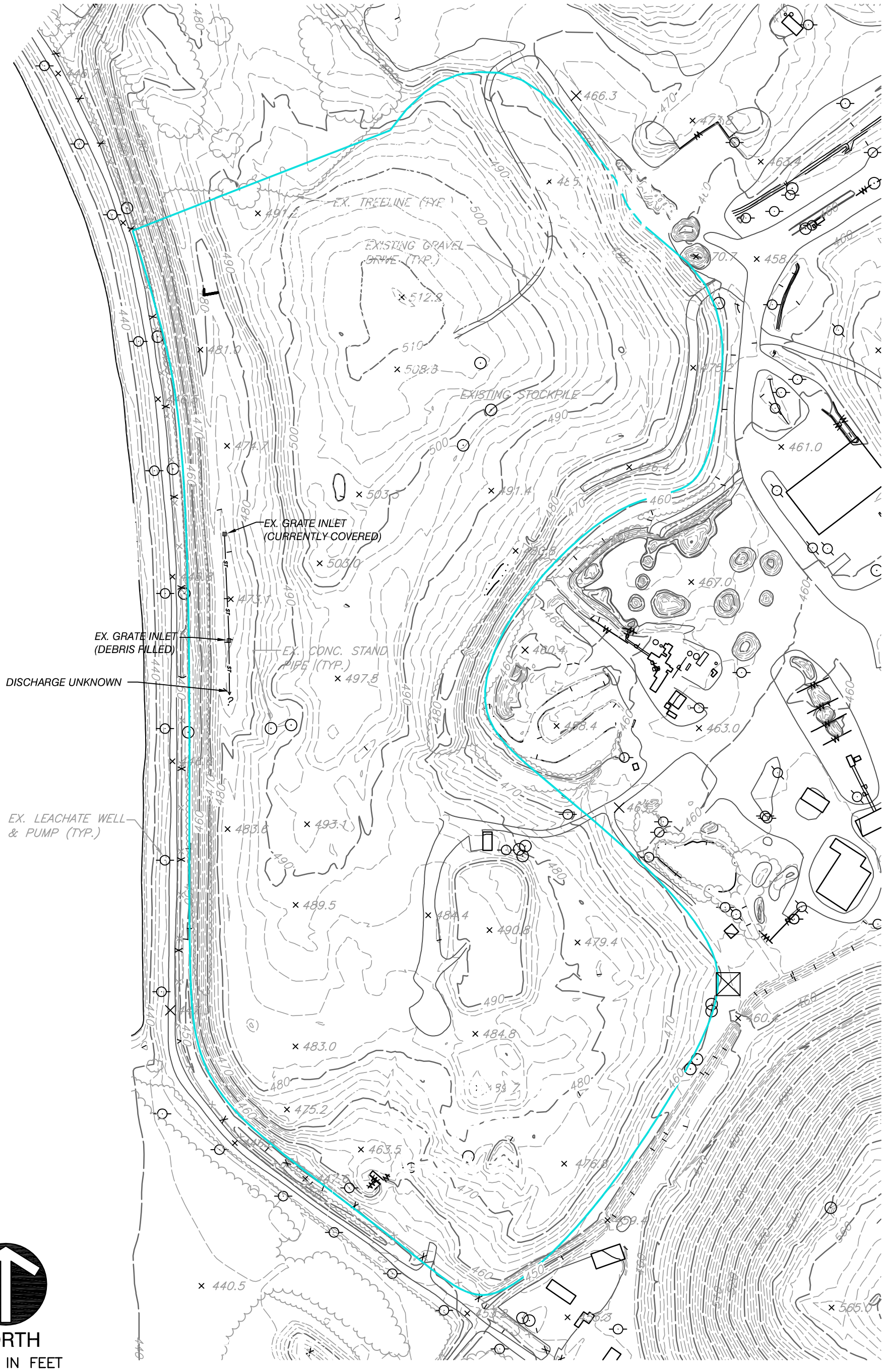

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

LOCATIONS OF EXISTING STORWATER CONVEYANCE STRUCTURES

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	A-7
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926		

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LEGEND

SLOPE MONITOR LOCATIONS

SM-1
SM-2
SM-3
SM-4
SM-5
SM-6
SM-7
SM-8
SM-9
SM-10
SM-11
SM-12
SM-13

A A
B B
C C
D D

NORTH

SCALE IN FEET

0 200 400

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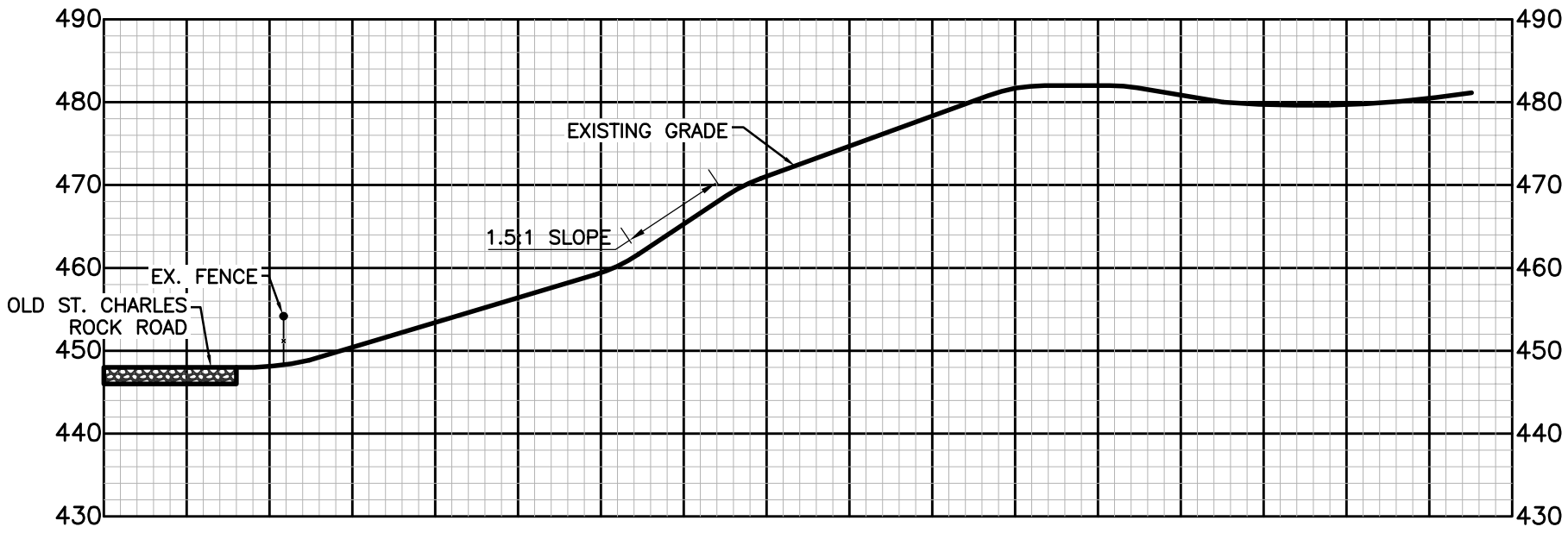
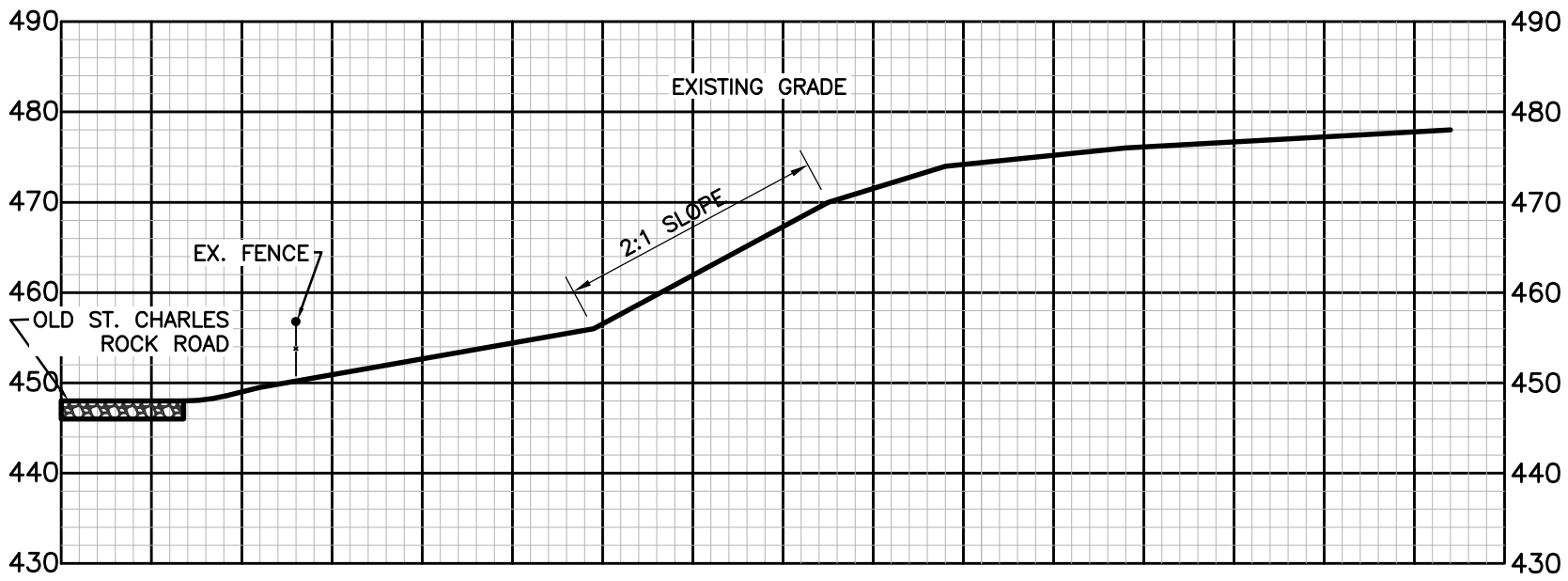
BRIDGETON, MO 63044
ST. LOUIS COUNTY

EXISTING WESTERN SLOPE OF OU-2

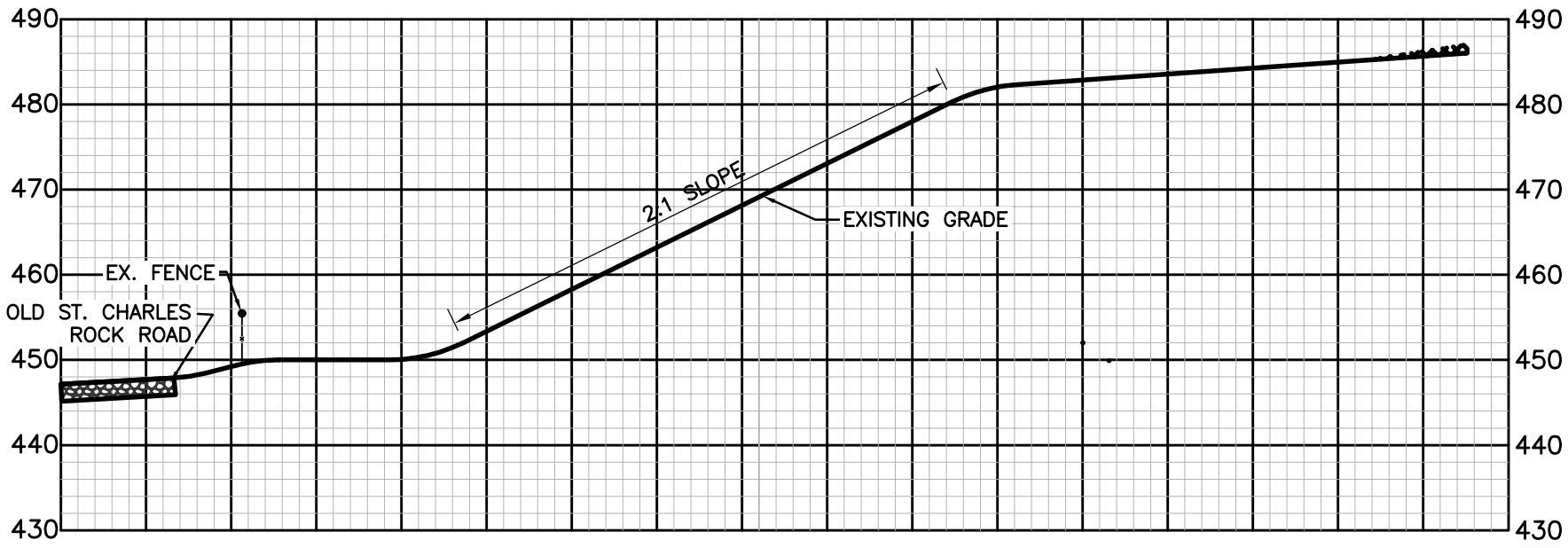
DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926	A-8a



SECTION A-A



SECTION B-B



SECTION C-C

HORIZONTAL SCALE
SCALE IN FEET
0 20 40

SECTION D-D

VERTICAL SCALE
SCALE IN FEET
0 20 40

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WESTLAKE LANDFILL OU-2
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MO 63044
ST. LOUIS COUNTY

WESTERN SLOPE SECTIONS OF OU-2

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	A-8b
DATE:	DEC. 2008	DWG SCALE:	1"=20'	PROJECT NO:	081-926		

Drilling Contractor: _____

Driller: _____

Helper: _____

Drilling Method: Direct Push

Surveyor: _____

Consulting Firm: Civil & Environmental Consultants, Inc.

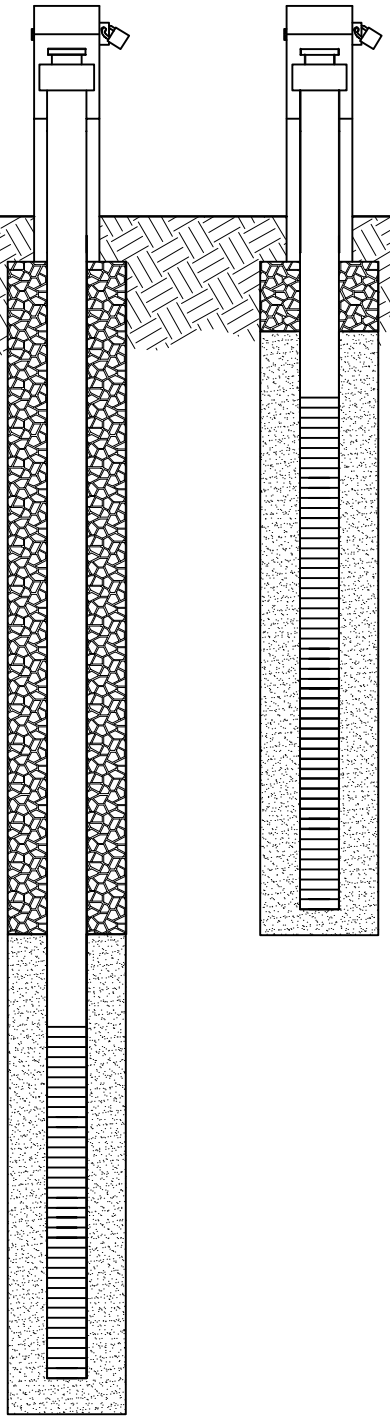
Installation Supervisor: _____

Registered Professional Geologist: _____

Date Started: _____

Date Completed: _____

Northing: _____ Easting: _____



Ground Surface

Top of Bentonite Seal: 1 ft. bgs

Riser Material: PVC

Riser Diameter: 1 inch

Secondary Casing: 4 inch
Well Protection Cover

Screen Material: Pre-pack screen (Pea Gravel)

Screen Diameter: 1 inch

Screen Slot Size: 0.010 inch

Bottom of Bentonite Seal: 23 ft. bgs

Top of Screen: 25 ft. bgs

Bottom of Screen: 35 ft. bgs

Total Depth: 35 ft. bgs

Top of Bentonite Seal: 1 ft. bgs

Bottom of Bentonite Seal: 3 ft. bgs

Top of Screen: 5 ft. bgs

Riser Material: PVC

Riser Diameter: 1 inch

Secondary Casing: 4 inch
Well Protection Cover

Screen Material: Pre-pack screen (Pea Gravel)

Screen Diameter: 1 inch

Screen Slot Size: 0.010 inch

Bottom of Screen: 20 ft. bgs

Total Depth: 20 ft. bgs

(Not to Scale)

Civil & Environmental Consultants, Inc.

West Lake Landfill OU-2
Bridgeton, Missouri

Figure B-1
Example of Temporary Gas Probe Construction

TABLE

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
Justin Barker	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) 751-3107
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.	Design Manager	11811 N Tatum Blvd, Suite 3031	Phoenix, AZ 85028	(602) 760-2324
Kevin Kamp	Civil & Environmental Consultants, Inc.	QA Officer/Landfill Designer	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
Michelle Veremakis	Civil & Environmental Consultants, Inc.	Designer/CADD	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566
Dean Jones	Civil & Environmental Consultants, Inc.	Design QC	1230 East Diehl Road, Suite 200	Naperville, IL 60563	(630) 963-6026
TBD	Civil & Environmental Consultants, Inc.	Field Supervisor	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566
TBD	Pace Analytical Services, LLC	Laboratory Project Manager	7726 Moller Road	Indianapolis, IN 46268	(317) 228-3100
TBD	Civil & Environmental Consultants, Inc.	Laboratory Quality Assurance Manager	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566
TBD	Civil & Environmental Consultants, Inc.	Surveyor	4848 Park 30 Boulevard, Suite F	Hazelwood, MO 63042	(314) 656-4566

APPENDIX A

MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Solid Waste Management Program

Methane Gas Policy

May 2017

CONTENTS

APPLICABILITY OF THE GAS POLICY

This policy applies to sanitary and demolition landfills where the Solid Waste Management Program (SWMP) has determined there is a potential threat to public health and safety due to methane gas migration from a landfill and towards neighboring properties.

The Missouri Solid Waste Management Law and implementing regulations require landfill owners/operators control decomposition gases (methane) on-site and not endanger occupants of adjacent properties. This has been a regulatory requirement from the date of the first solid waste regulations in Missouri. From their beginning, the purpose of the regulations regarding decomposition gas has been to protect public safety by requiring facilities to control the gas they generate on site. Also, since the earliest solid waste regulations were enacted, SWMP was given authority to require changes to the design or operation of any landfill when it is necessary to meet this goal (as stated in section (1) General Provisions of the current regulations 10 CSR 80-3.010 and 10 CSR 80-4.010).

METHANE GENERATION

The breakdown of solid wastes in a landfill results in the generation of methane and other decomposition gases. Landfill gas is comprised roughly of 50 percent methane and 50 percent carbon dioxide. Methane and hydrogen sulfide (a trace constituent) are the two primary constituents of concern in landfill gas. Methane concentrations between five percent and 15 percent by volume may be flammable or explosive, and higher concentrations of methane gas may pose an asphyxiation threat. Therefore, migration and accumulation of methane into buildings or other confined spaces can pose public health and safety risks. Methane may also kill vegetation (especially trees) by displacing oxygen and asphyxiating the roots.

The department has a conservative policy when addressing methane gas generation and migration. Methane migration from a landfill onto an adjacent property is a regulatory violation and is always a public safety concern because neither the landfill owner nor the state has control over current or future land uses on the adjacent property. The present situation may not appear to be a safety issue, but future development could create one. Also, it is often difficult to determine the migration pathway(s) and the volume of methane moving through the soil. Therefore, it is essential the generation and migration of methane be closely monitored and controlled on-site. Methane migration away from the landfill and toward occupied structures on adjacent properties causes an acute threat to the public. When this situation occurs, landfill owners must take immediate action to ensure that methane generated by the decomposing waste does not cause harm to the public.

This policy is intended to clarify what is expected of landfill owners and to expedite the review process for gas control system modifications.

I. GAS MONITORING

A. REGULATORY REQUIREMENTS

The subsections of the Missouri Solid Waste Management Regulations covering decomposition gas were enacted in 1988 authorizing SWMP to require owner/operators of sanitary and demolition landfills to implement a methane monitoring program and submit the monitoring results to the department. Currently, 10 CSR 80-3.010(14) (B) and 10 CSR 80-4.010(14) (B) require sanitary and demolition landfill owners/operators to design and implement gas monitoring programs capable of detecting gas migration. The programs must include a narrative and plan sheets describing the monitoring program in detail. For specific types of information required to be included in the gas monitoring plan, refer to 10 CSR 80-3.010(14) (B) and 10 CSR 80-4.010(14) (B), respectively.

B. MONITORING WELL INSTALLATION

Methane monitoring wells must be designed in accordance with the requirements of 10 CSR 23-4.060, the Construction Standards for Monitoring Wells. These requirements are discussed in *Design and Construction of Landfill Gas Monitoring Wells* (PUB 2054) at: dnr.mo.gov/pubs/pub2054.htm

One of the key aspects of well design is the sampling port. Each monitoring well must be equipped with a sampling port allowing connection of the monitoring instrument without removing the well cap.

In the past, landfill owners/operators have been allowed to use shallow or temporary holes (called bar hole punches) to test for landfill gas migration. This type of monitoring may provide a measurement of methane concentrations in the upper most surface layers of the soils at the landfill. However, the absence of methane in shallow probes does not necessarily mean there is no migration occurring. The use of bar hole punches may miss methane migrating in deeper soil layers (to the bottom elevation of waste). Additionally, due to the temporary nature of their construction, bar holes cannot be relied on for long term monitoring. Due to these inherent limitations, bar hole punches are not allowed for compliance monitoring. The monitoring data will be assured accurate only by monitoring to the lowest elevation of waste, using properly-constructed wells and employing the appropriate monitoring instruments.

The requirement to install deep monitoring wells may be waived in areas where there is a topographic cutoff or a hydrologic cutoff. An example of a topographic cutoff is a valley or ravine located between the landfill footprint and the property line, whose bottom elevation is below the bottom elevation of waste. Methane rises in soil, since it is lighter than air, except when it is under pressure. Therefore, a topographic cutoff will generally serve as an adequate barrier to gas migration. In order to demonstrate that a topographic cutoff exists, landfill owners/operators must provide proof that the elevation of the cutoff feature (ravine, valley, etc.) is below the lowest elevation of any waste. Note: all topographic interpretations of this sort are required to be made by a Missouri Registered Geologist and provided to the department for review and approval.

Methane will not migrate downward through a hydrologic cutoff such as a river or contiguous aquifer. In order to demonstrate that a hydrologic cutoff exists, landfill owners/operators must provide information that a vertically and horizontally contiguous aquifer exists between the landfill footprint and the property boundary. In most cases, the facilities should have this information on file to be able to document this allegation without further site exploration. The hydrologic information must be certified by a Missouri Registered Geologist and submitted to the department for review and approval prior to being granted a waiver for installation.

Gas monitoring wells must be located between the landfill and offsite buildings or other features that may be harmed by landfill gas or may act as conduits and allow gas from the landfill to migrate. Per 10 CSR 80-3.010(14) (B) 1.C. and CSR 80-4.010(14) (B) 1.C., well locations on the property boundary shall not be more than 500 feet apart unless the landfill owner/operator can show evidence that the potential for gas migration is low. In cases where conditions necessitate additional wells to protect public health and safety, SWMP may request installation of additional wells closer than 500 feet apart.

In the absence of gas wells at the property line, SWMP considers the wells in between the waste mass and the property boundary to be compliance wells. These wells are where the two and a half percent methane regulatory limit applies and is the location for landfill staff to monitor to ensuring methane is not migrating out away from the waste and toward adjoining properties. If at some later date new monitoring wells are placed farther out from the waste toward the property boundary, the new wells become the compliance wells and the location is where the regulatory limit would then apply. Then the former compliance wells could be used as sentry wells. The regulatory limit would not apply to these sentry wells. Instead, they would serve to give the landfill owner/operator an early warning of gas migration.

C. CONDUCTING GAS MONITORING

Implementation of facilities' gas monitoring plans is addressed in the regulations at 10 CSR 80-3.010(14)(B)1.C. and (14)(C)4 and 10 CSR 80-4.010(14)(B)1.C. and (14)(C)4. The regulations state that owners/operators of landfills are required to implement monitoring to ensure that landfills do not exceed the regulatory limits provided in 10 CSR 80-3.010(14)(C)2 and 10 CSR 80-4.010(14)(C)2. The limits are one and a quarter percent by volume methane in buildings on the landfill property and two and a half percent by volume methane in the soil at the property boundary.

Sampling of gas monitoring wells should follow the general procedures outlined in the department's publication, *Sampling of Landfill Gas Monitoring Wells* (PUB 2053) at: dnr.mo.gov/pubs/pub2053.htm. Sampling inside structures should follow the general procedures outlines in the department's publication, *Procedures for Sampling Landfill Gas Inside Buildings* (PUB2052) at: dnr.mo.gov/pubs/pub2052.htm.

1. Monitoring Instruments

The Missouri Solid Waste Management Regulations require owners/operators to use monitoring equipment warranted by the manufacturer to detect explosive gases under the conditions in which the equipment is to be used. Some gas monitoring equipment operates accurately only if methane is being measured in the presence of oxygen because the instrument measures the concentration by burning a sample while taking the reading. Instrumentation for sampling soil gas in monitoring wells shall be capable of providing an accurate methane reading in an oxygen deficient environment. All monitoring equipment shall be certified for use in explosive environments (and rated as "intrinsically safe").

Gas monitoring instruments must also be calibrated to assure the accuracy of the data. Calibration should be performed in accordance with the manufacturer's recommendations. In general, two types of calibration ensure the instruments readings are accurate:

- **Field or Office Calibration**: The instrument should be calibrated before methane samples are collected in the field, using gas cylinders of known concentrations, at temperatures similar to those the instrument will be exposed to in the field. Field calibration, at a minimum, must be conducted prior to taking methane readings from monitoring wells to prove the integrity of the data that is collected.

- **Factory Calibration**: The instrument should be maintained according to the manufacturer's instructions to assure proper operation and accurate data collection. Many manufacturers recommend at least annual factory recalibration. Factory recalibration enables the facilities to be more confident that the data accuracy has not been compromised by instrument failure or malfunction. Sensors that have deteriorated are usually replaced during factory recalibration.

2. Parameters to be Analyzed

Although the concentration of methane in any monitoring well should be the greatest importance to both the facilities and SWMP, in order to fully understand methane migration, or the potential for migration, several other parameters should be considered and studied when monitoring. These parameters include the concentrations of methane and various other gases in the well, the pressure in the monitoring well, and the weather conditions.

- **Methane Gas (CH_4)** – Methane gas is flammable and potentially explosive when confined in concentrations between five percent and 15 percent with normal atmospheric oxygen and it is also an asphyxiant at higher concentrations in enclosed spaces as it can displace oxygen. Methane is capable of migrating through soil and fractured rock in concentrations well above the lower explosive limit (5 percent by volume). When methane travels through the soil into a basement, manhole or other enclosed space, it can mix with oxygen to create an explosive mixture that needs only heat or a spark to ignite. Methane can also create a hazard by displacing oxygen in enclosed structures or spaces.

- **Carbon Dioxide (CO_2)** – Carbon dioxide is also an asphyxiant. High concentrations of carbon dioxide can create a potential hazard to nearby enclosed structures or spaces by displacing oxygen. Carbon dioxide is soluble in water and will be stripped from a gas stream as it flows through the soil, increasing the relative concentration of methane in the soil. Therefore, a gas sample from a monitoring well containing carbon dioxide concentrations equal to methane concentrations suggest that the gas has been generated through decomposition in the landfill recently. Carbon dioxide is also released naturally by the decomposition of plant and animal matter in the soil.

- **Oxygen (O_2)** – Oxygen is present in the atmosphere in concentrations near 21 percent by volume. It is also naturally present in much lower concentrations in the top few feet of soil due to gaseous interchange with the atmosphere. In general, the oxygen concentration in the soil drops off at increasing soil depths due to the decrease of this atmospheric interchange. This decrease in oxygen concentration with increasing depth is quite dramatic in heavy soils such as clays, while more porous soils at the same depth tend to have a higher oxygen concentration. Based upon this tendency, elevated oxygen levels in monitoring wells may indicate damage to a well that is allowing oxygen intrusion. Elevated oxygen levels may also indicate that too much vacuum is being applied to an active gas extraction system, causing atmospheric oxygen to be pulled towards the landfill, increasing the potential for a landfill fire.

- **Hydrogen Sulfide (H_2S)** – Like carbon dioxide and methane, hydrogen sulfide is an asphyxiant. Hydrogen sulfide is hazardous at concentrations as low as 20 parts per million (ppm). In the ambient air, hydrogen sulfide's odor may cause complaints from those nearby. Although it has a strong odor, exposure to hydrogen sulfide will rapidly fatigue the sense of smell, so odor cannot be relied upon to warn of its presence. Also, hydrogen sulfide is more soluble in water than carbon dioxide, so as landfill gases travel through saturated soils, hydrogen sulfide may be stripped from the gases, causing a loss of the odor. Therefore, odor alone should never be relied upon as an indicator of this compound and the other associated landfill gases. In confined spaces near or at the landfill, it may create toxic conditions for employees.
- **Pressure –** There are two major mechanisms for gas transport:

a. Molecular diffusion - the movement through a medium caused by a concentration gradient

b. Pressure-gradient force - the movement through a medium due to a pressure gradient

Of the two, pressure-gradient force is the more significant transport mechanism and causes more concern for public safety. Any instrument used to monitor gas concentrations in wells should be capable of sensing the pressure in the monitoring well, and the differential pressure between a well and the atmosphere.

The relative pressures in gas monitoring wells may provide important information to facilities when they are investigating a gas migration incident. Pressure readings should be taken before a well is sampled for gas concentrations so that the act of removing gas for these measurements does not relieve the pressure in the well. Hence the requirement for installing wells with a dedicated sampling port to prevent impact to the well pressure during monitoring.

When monitoring a gas well, if the readings reveal that the well contains high pressure compared to the ambient air, this indicates a significant potential for gas migration.

- **Weather Conditions** – The understanding of soil gas movement also requires an understanding of how the following conditions impact this movement and may impact a facility's methane gas readings:

    - *Barometric pressure* - Low barometric pressure events lasting for several days have been documented causing landfill gas to migrate away from a landfill. When the gas pressure in the landfill is higher than the barometric pressure in the atmosphere, flow (in this case, migration) can occur. This is because there is a greater differential between the gas pressure and the barometric pressure in the atmosphere, which increases the pressure-gradient force that pushes the landfill gas, including methane, out of the landfill. The gas will follow a pathway of least resistance away from the landfill and into the atmosphere or along a utility line or other conduit that could lead into a confined space off-site. On days of high barometric pressure, the opposite is true and the larger pressure gradient may act to confine the gas closer to the landfill.

    - *Precipitation/soil moisture conditions* - Movement of landfill gas through the soil cap and into the atmosphere is called natural venting. It is slowed or prevented as the surface soil becomes saturated or frozen. The pathways of migration to the surface through the soil pores may be blocked by water or ice, causing the gas to move horizontally rather than vertically. Gas has been documented migrating long distances from a landfill during the winter and spring when the soil is saturated or frozen. Conversely, when soil is dry and cracked during the summer months, landfill gas can vent more easily vertically through the earth's surface and horizontal migration is less likely to occur.

    - *Temperature* - Temperature of the ambient air is important because it may affect operation of monitoring instruments. When conducting gas monitoring, the sampler shall ensure that the sampling instrument is within its valid temperature operating range. Extreme high or low temperature may cause invalid results. It is also important to field calibrate instruments as close to the temperature of the gas being sampled as possible. This is due to a shift in the

ability for most sensors to detect gases when there are temperature differences, which may cause higher or lower monitoring results than may truly exist at the location.

To help interpret and understand methane gas data, the facility should observe and record information on each of these parameters when sampling monitoring wells for each monitoring event.

D. MONITORING FREQUENCY

As required by 10 CSR 80-3.010(14) (C) 4 and 10 CSR 80-4.010(14) (C) 4, owners/operators of sanitary and demolition landfills shall collect samples from gas monitoring wells at least quarterly. The data shall be submitted to the department (see Submission of Results, Subsection E below). If methane is detected in excess of regulatory limits, the monitoring frequency will be increased to a) protect public health and safety and b) provide information to assist facilities in implementing corrective actions to stop the migration. The monitoring frequency is discussed further in sections 2-4 (Response to Initial Discovery of Methane, Investigating the Extent of Methane Migration, and Remediation or Corrective Actions to Resolve Methane Migration).

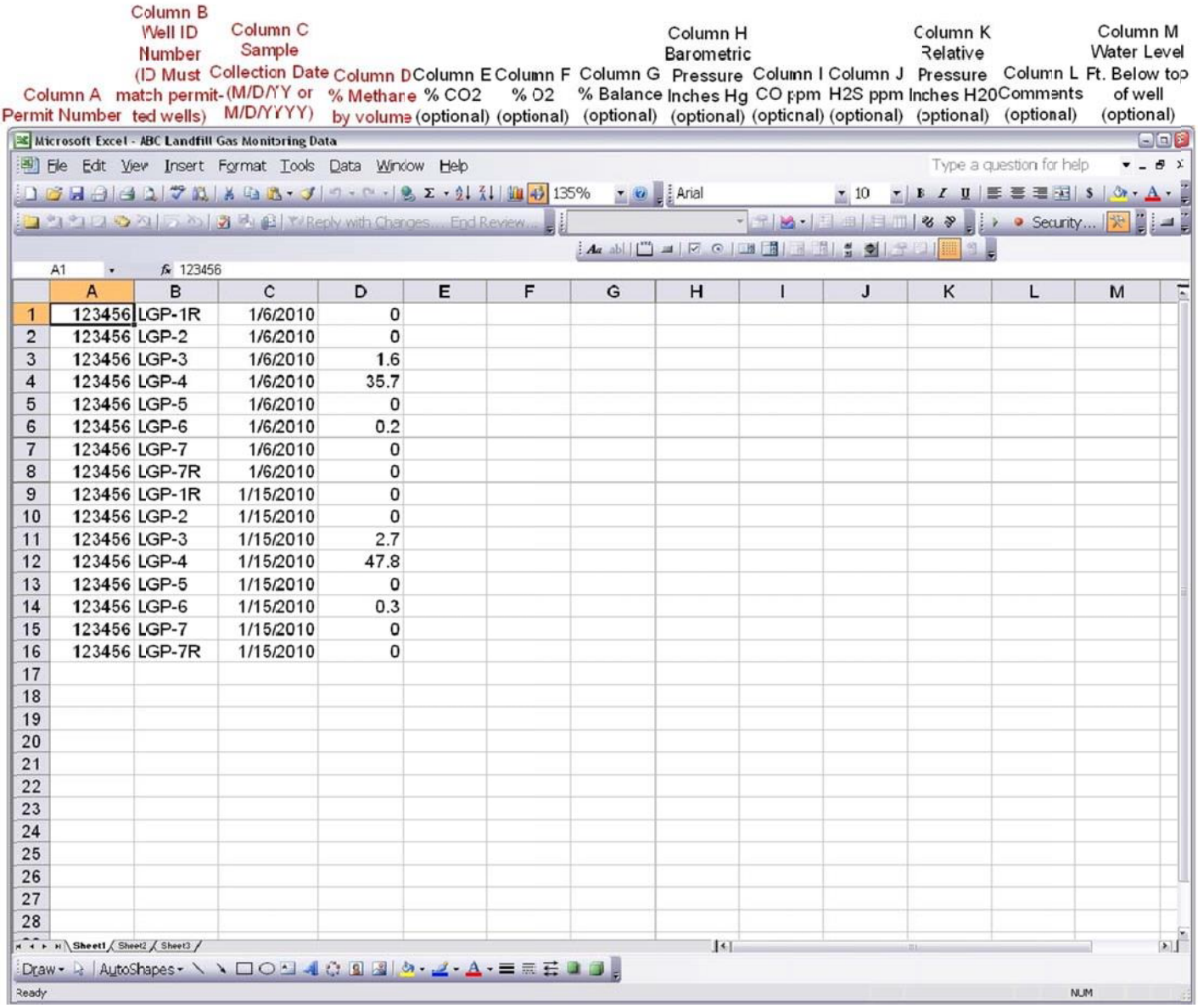
E. SUBMISSION OF MONITORING RESULTS TO THE SOLID WASTE MANAGEMENT PROGRAM

Per 10 CSR 80-3.010(14) (C) 4 and 10 CSR 80-4.010(14) (C) 4, monitoring results must be submitted electronically to SWMP. Submit monitoring data within one week of sample collection. The electronic mail address to submit the methane monitoring results is: swgasmon@dnr.mo.gov. The regulation also requires the data be submitted in a format prescribed by the department, which is an e-mail attachment in Comma Separated Value (CSV) format. The CSV file format is as follows:

Column	Description*
A.	Highest permit number for the facility (without any preceding zeros)
B.	Well ID Number (as approved by SWMP)
C.	Sample collection date (using one of the approved formats)
D.	Methane (record in percent by volume)
E.	Carbon dioxide (record in percent by volume)
F.	Oxygen (record in percent by volume)
G.	Balance gas (record in percent by volume)
H.	Barometric pressure (record inches Hg)
I.	Carbon monoxide (record in parts per million)
J.	Hydrogen sulfide (record in parts per million)
K.	Relative pressure (record in inches water)
L.	Comments
M.	Water level in well (depth in feet below surface of well)

* For a detailed description of the data submission process and the CSV format for the monitoring data, please see the guidance document for submitting landfill gas monitoring data. Only items identified in Columns A through D are required to be submitted. SWMP requests facilities submit the additional data information identified in Columns E through M, if available.

An example of a spreadsheet which meets the formatting requirements is provided below:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	123456	LGP-1R	1/6/2010	0									
2	123456	LGP-2	1/6/2010	0									
3	123456	LGP-3	1/6/2010	1.6									
4	123456	LGP-4	1/6/2010	35.7									
5	123456	LGP-5	1/6/2010	0									
6	123456	LGP-6	1/6/2010	0.2									
7	123456	LGP-7	1/6/2010	0									
8	123456	LGP-7R	1/6/2010	0									
9	123456	LGP-1R	1/15/2010	0									
10	123456	LGP-2	1/15/2010	0									
11	123456	LGP-3	1/15/2010	2.7									
12	123456	LGP-4	1/15/2010	47.8									
13	123456	LGP-5	1/15/2010	0									
14	123456	LGP-6	1/15/2010	0.3									
15	123456	LGP-7	1/15/2010	0									
16	123456	LGP-7R	1/15/2010	0									
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II. RESPONSE TO INITIAL DISCOVERY OF METHANE MIGRATION

A. REGULATORY REQUIREMENTS

For sanitary and demolition landfill owners/operators, 10 CSR 80-3.010(14) (C) 5.A and 10 CSR 80-4.010(14) (C) 5.A set out requirements and actions to be considered when methane is detected above regulatory limits in structures or in soil at the property boundary. The actions a facility must take in these two scenarios shall be in direct response to any immediate threat to public health and safety caused by methane migration. Once that threat has been removed, the action steps are the same whether the exceedance of methane is found in a structure or in a well at the property boundary.

B. NOTIFICATION PROCEDURES

1. Methane Exceeding Regulatory Limit in Buildings: Immediate Threat to Public Health and Safety

When landfill owners/operators (or their representatives) discover methane in concentrations above regulatory limits in any structure on or off-site, the first action is to evacuate the structure or area immediately. Persons exiting the structure should be directed not to create any sparks, for example, when turning a light switch off. Once all parties are out of the confined space (i.e., building) or away from the area, notify the fire department and other local emergency management personnel, then contact SWMP and the department's regional office where your facility is located. The department will follow the directions of the local emergency agencies for the protection of the public.

Because of the imminent threat to the public involved in this situation, please ensure this notification includes direct contact via telephone with a SWMP representative in Jefferson City in addition to a submission of the gas monitoring results to SWMP's Gas Monitoring e-mail account at: swgasmon@dnr.mo.gov. Do not leave a message on voice mail or advise a member of the clerical staff, but notify the project engineer, enforcement case manager, or a member of SWMP's management about this situation.

In addition to helping evacuate all structures where methane exceeds the regulatory limit and contacting the fire department, emergency management personnel, and SWMP, the landfill owner/operator is required to initiate a public notification process. The process consists of landfill representatives notifying all owners and occupants of properties within 1,000 feet of any noncompliant gas well of the potential for gas migration. The notification process is done to ensure that nearby residents, businesses and property owners are aware of the potential presence of methane gas on their properties so they may implement safety precautions. This also demonstrates that the landfill owner/operator is diligently trying to ensure public safety. Landfill representatives shall make a list of those people they notified of the migration, provide the date they were notified, and list the address and telephone number (when available) of those notified. Utility companies that have enclosed or underground infrastructure within 1,000 feet of the noncompliant well(s) must also be notified of the methane migration.

At the same time, SWMP will review the information about the migration and the surrounding properties and determine, on a case by case basis, if a press release is needed to better ensure all necessary parties are made aware of the potential for methane migration from the landfill. SWMP will discuss the need for a press release with the landfill owner/operator to try and provide the most accurate and up-to-date information possible.

2. Methane Exceeding Regulatory Limit in the Soil: Potential Threat to Public Health and Safety

When landfill owners/operators (or their representatives) discover methane in concentrations above the regulatory limit in the soil at the property boundary or in compliance wells designated as the facility's point of compliance for methane control on the site, they will also be required to notify parties of the methane migration. This requirement shall be waived only if the landfill owner/operator provides immediate documentation from a Missouri Registered Geologist or other professional that proves gas migration from the landfill is: a) not occurring or b) prevented from traveling from the landfill property boundary to nearby occupied structures or properties by a geologic or topographic cutoff.

If migration is occurring, in order to protect public health and safety, SWMP policy requires notification of the local fire department, emergency management agency or other appropriate public safety authority. As in the case of methane found in structures off of the landfill property, in order to ensure that those who live, work or conduct activities on properties near the landfill are kept safe, the landfill owner/operator is required to initiate a public notification process.

As described in Subsection B.1. above, the notification process consists of landfill representatives notifying all owners and occupants of properties within 1,000 feet of any noncompliant gas well of the potential for gas migration. The notification process is done to ensure that nearby residents, businesses and property owners are aware of the potential presence of methane gas on their properties so they may implement safety precautions. This also demonstrates that the landfill owner/operator is diligently trying to ensure public safety. Landfill representatives shall make a list of those people they notified of the migration, provide the date they were notified, and list the address and telephone number (when available) of those notified. Utility companies that have enclosed or underground infrastructure within 1,000 feet of the noncompliant well(s) should also be notified of the methane migration. During the notification process, the landfill owner/operator shall also offer to provide monitoring and other protective services that are discussed in greater detail in Subsection II.C. below.

At the same time, SWMP will review the information about the migration and the surrounding properties and determine, on a case by case basis, if a press release is needed to better ensure all necessary parties are made aware of the potential for methane migration from the landfill. SWMP will discuss the need for a press release with the landfill owner/operator to try and provide the most accurate and up-to-date information possible. If possible, SWMP will allow the landfill owner/operator to review and comment on the draft press release prior to submitting to the department's public information staff.

C. FACILITY RESPONSE TO REMOVE IMMEDIATE THREAT TO PUBLIC HEALTH AND SAFETY

1. Methane in Buildings: Immediate Threat

In most cases, the local fire department or emergency management agency has the training and authority to conduct necessary monitoring and make a determination whether a structure is safe for use. Once the determination has been made to keep people out of any structure or away from any area, the facility's responsibility will be to begin corrective actions and coordinate any actions with these entities and the department. The first step shall be to safely ventilate any structure deemed necessary and stop the immediate threat to public health and safety. Until such time that the threat is removed, the landfill owners/operators may be required to post warning signs on affected and nearby structures in case people using the affected structures or in the area did not receive notification of the migration.

The structure or confined space shall be monitored until methane concentrations have dropped below levels which threaten public health and safety. This determination shall be made by the local fire

department or emergency management agency. The landfill owner/operator shall contact the owners or occupants of those structures where methane was detected and offer to conduct a thorough methane intrusion investigation to determine the location(s) that methane is entering or is likely to enter the structure(s). Buildings/structures shall be checked for methane pathways and entrances into the structures such as cracks in foundations or floors, floor drains, utility conduits into buildings, electrical outlets, circuit breaker boxes, etc. The landfill owner/operator shall then offer to install methane detectors, as needed, to ensure safety of the building occupants.

Once the building/structure has been deemed safe for use, and prior to people returning to the structure, the landfill owner/operator shall properly seal intrusion pathways into the structure and install the detectors in any building/structure where requested by the owner/occupant of the building/structure. Detectors shall be placed in locations where methane is likely to enter the structure, such as underground utility drains or conduits into buildings, cracks in foundations or basements, or through crawl spaces. An instruction sheet describing the use of the detectors and procedures to follow if the detector sounds an alarm shall be given to the occupant(s) of the building/structure and posted next to each detector.

The facility shall make a list of those buildings/structures where detectors were installed, who owns and occupies the buildings/structures, hours of occupancy (if possible), in what room(s) the detectors were installed, on what date, and certify that instructions for the use of the detectors were provided to the occupants of these buildings/structures. This list, a copy of the methane detector instruction sheets provided to occupants of structures, and a report describing all other steps taken to protect public health and safety is required to be submitted to SWMP within seven days of initial detection of a methane exceedance. A report providing these details should satisfy the requirements for sanitary and demolition landfills given in 10 CSR 80-3.010(14) (C) 5.B and 10 CSR 80-4.010(14) (C) 5.B.

Until methane is controlled at the landfill and migration above the regulatory limit has ceased, the landfill owner/operator shall establish a temporary monitoring program in all buildings/structures where methane had been detected. Where the property owner/occupant grants permission, monitoring shall be conducted at least weekly and in accordance with *Procedures for Sampling Landfill Gas Inside Buildings* (PUB 2052) at: dnr.mo.gov/pubs/pub2052.htm. The landfill owner/operator shall submit monitoring data to SWMP within one week of sample collection.

In the event the migration is uncontrolled over an extended period of time, the landfill owner/operator shall also check methane detectors installed in the buildings/structures to ensure they are operating as designed and to change the batteries. The detectors shall continue to be checked at least semi-annually (every six months) by landfill representatives and remain in place until methane is controlled on-site.

2. Methane in Soil: Potential Threat

When owners and occupants of properties within 1,000 feet of any noncompliant well are notified of the potential for migration by landfill representatives, they should also be given the opportunity to have any nearby structure, residence, building, etc. monitored for the presence of methane. Buildings/structures should be checked for methane pathways and entrances into the structures such as cracks in foundations or floors, floor drains, utility conduits into buildings, electrical outlets, circuit breaker boxes, etc.

At the same time, the landfill owner/operator shall offer to install methane detectors in the building/structure, as needed, until such time that it is confirmed that methane is no longer migrating off of the landfill. Detectors shall be placed near locations where methane is likely to enter the structure, such as underground utility drains or conduits into buildings, cracks in foundations or basements, or through crawl spaces. An instruction sheet describing the use of the detector and

procedures to follow if the detector sounds an alarm shall be given to the occupant(s) of the building/structure and posted next to each detector.

The landfill owner/operator shall make a list of those buildings/structures where monitoring was conducted and detectors were installed; who owns and occupies the buildings/structures; hours of occupancy (if possible); in what room(s) the detectors were installed; on what date; and certify that instructions for the use of the detectors were provided to the occupants of these buildings/structures. This list, a copy of the methane detector instruction sheets provided to occupants of structures, and a report describing all other steps taken to protect public health and safety is required to be submitted to SWMP within seven days of initial detection of a methane exceedance. A report providing these details should satisfy the requirements for sanitary and demolition landfills given in 10 CSR 80-3.010(14) (C) 5.B and 10 CSR 80-4.010(14) (C) 5.B.

Until methane is controlled at the landfill and migration above the regulatory limit has ceased, the landfill owner/operator shall establish a temporary monitoring program in all buildings/structures where methane had been detected. See subsection II.C.1. above if methane has been detected in structures. The landfill owner/operator shall submit monitoring data to SWMP within one week of sample collection.

To ensure continued safety of the public and to begin the migration investigation process, the frequency of compliance well monitoring is increased from a quarterly to a weekly basis. Upon initial discovery of any of methane concentrations above two and a half percent by volume, weekly monitoring will be required for all compliance wells. Weekly monitoring will be required for any compliance well as long as it continues to exhibit methane concentrations above two and a half percent by volume. Once compliance well ceases showing readings above two and a half percent by volume for four consecutive weeks, the landfill owner/operator may submit a written request to SWMP to reduce the frequency of sampling from weekly to monthly. Once any compliance well ceases showing readings above two and a half percent by volume for three consecutive months, the facility may submit a written request to SWMP to reduce the frequency from monthly to quarterly. However, each time a compliance well has recurring methane concentration above two and a half percent by volume, the monitoring frequency will again return to a weekly basis for all compliance wells to ensure no new migration is occurring and to focus attention in the area of the migration. The landfill owner/operator shall continue weekly monitoring and submission of results to SWMP for all noncompliant monitoring wells until the concentrations fall below the regulatory limits.

In cases where a landfill has compliance well(s) with gas readings above the regulatory limit which have displayed a consistent trend in the weekly monitoring for a period of at least three months and the condition of the area around that probe has been established and the information being recorded, related to the cost of obtaining it, is neither new or useful, the facility may submit a written request to SWMP to reduce the frequency to monthly or quarterly. Any potential threat to public health and safety will be considered and the determining factor in reducing the frequency of the monitoring and as long as the approved corrective actions were ongoing and progress was being made and documented. In the event monthly/quarterly results begin to show a significant change from the current trend, SWMP may require the facility to return back to weekly monitoring.

In the event the migration is uncontrolled over an extended period of time, the landfill owner/operator shall also check methane detectors installed in the buildings/structures to ensure they are operating as designed and to change the batteries. The detectors shall continue to be checked at least semi-annually (every six months) by landfill representatives and remain in place until methane is controlled on-site.

In the event the landfill owner/operator refuses to notify property owners and occupants of structures within 1,000 feet of any noncompliant well, SWMP shall initiate notification, which may include on-

site visits, phone calls, letters and publishing a press release to ensure all potentially impacted parties are appraised of the migration of methane from the landfill. SWMP shall coordinate notification, emergency response and follow-up actions to ensure the public is protected during ongoing methane migration. As needed, enforcement action shall be initiated against the landfill owner/operator to compel compliance with the Missouri Solid Waste Management Law and Regulations (MSWML&R) with regard to notification, monitoring, emergency response and corrective actions to address methane migration.

D. METHANE GAS RESULTS ABOVE REGULATORY STANDARDS DUE TO TEMPORARY GAS SYSTEM MALFUNCTION

When landfill owners/operators (or their representatives) discover methane in concentrations above regulatory limits in any compliance wells and believe the concentration is due to a temporary gas system malfunction, the landfill owner/operator should immediately contact SWMP. Do not leave a message on voice mail or advise a member of the clerical staff, but notify the project engineer, enforcement case manager, or a member of SWMP management about this situation. The landfill owner/operator will be expected to report the sampling result, explain why they believe the result is related to equipment malfunction, what immediate actions are going to be taken to correct the issue, and identify a timeframe to correct the malfunction that must be agreed upon by SWMP staff. Once this course of action is determined, the owner/operator will be expected to update SWMP on a daily basis to ensure all actions to correct the issue are being taken to return the well in compliance within seven days. In these instances, SWMP will not require the owner/operator to undertake the procedures as identified in Section C.2. above.

If the owner/operator has repeated system malfunction problems which may cause an imminent threat to the public or if the corrective measures fail to achieve compliance within seven days, SWMP may issue a notice of violation and require the owner/operator to take all the necessary steps as outlined in this policy.

E. METHANE GAS RESULTS ABOVE REGULATORY STANDARDS DUE TO PLANNED MAINTENANCE OF GAS SYSTEM

Landfill owners/operators (or their representatives) should notify SWMP of any planned maintenance activities that may result in possible odors or non-compliance of regulated wells at the facility. Pre-notification of any such planned maintenance activities should be made to SWMP as soon as maintenance is scheduled. Information regarding the planned activities and the duration of the planned maintenance should be provided to ensure the Solid Waste Management Program may respond appropriately to any resulting inquiries or environmental concerns by the public.

In these instances, SWMP will not require the owner/operator to undertake the procedures as identified in Section C.2. above as long as the maintenance activity is short in duration (within seven days

III. INVESTIGATING THE EXTENT OF METHANE MIGRATION

A. REGULATORY REQUIREMENTS

To develop a remediation or corrective action plan to address migration, you must investigate the migration thoroughly. In order to do that, the landfill owner/operator must characterize the nature and extent of the migration. This will require monitoring the methane in the soil at a sufficient number of locations and to the appropriate depth to discover the migration pathway(s) and boundaries. The focus must be on the pathway(s) by which the methane is flowing to the monitoring wells and off-site.

Monitoring wells are simply the sentry points installed sending an alert that a problem exists at one point along the property boundary. They may not define the actual pathway by which the methane is travelling off the landfill property.

As stated earlier, 10 CSR 80-3.010(14) (B) and 10 CSR 80-4.010(14) (B) require the sanitary and demolition landfill owners/operators to prepare operating plans which include a monitoring program that is capable of detecting decomposition gas migration. Information gained in the research, design and construction of the landfill's gas monitoring plan is vital to the investigation plan and must be considered in the subsequent corrective actions taken to regain control of the gas.

Migration Investigation Plan

1. *Designing the Investigation Workplan*

   The success of the methane migration investigation and subsequent corrective actions depends largely upon acquiring accurate information on where the methane is traveling and what procedures and actions put in place will halt the migration. A quick source of information is the landfill's gas monitoring plan.

   The Missouri Solid Waste Management Regulations require the gas monitoring plan to be based upon the soil conditions, hydrogeologic and topographic conditions around the facility, and the location of facility structures, property boundaries and off-site features. The monitoring program is also required to include details about the landfill's current monitoring system; results of any prior gas assessments that have been performed, well design specifications; the design depths and bottom elevations of the wells; and boring logs of the wells. All the information acquired prior to the migration occurring will help to guide the landfill owner/operator in designing a plan to investigate and characterize the migration.

   In addition to the information in the monitoring program described above, the landfill owner/operator shall include the following information when developing the methane investigation workplan:

   - Preliminary indications of the extent of the problem. Note the location and depth of noncompliant wells. Sample for methane in nearby groundwater monitoring wells or conduct direct-push (i.e. Geoprobe®) monitoring to test for the presence of methane. Examine the groundwater monitoring results from monitoring wells in the vicinity of affected gas monitoring wells. The presence of organics in the groundwater samples may be an indication of gas migration. Look for a physical pattern of stressed vegetation, particularly dead or dying trees or patches of grass, near the noncompliant well(s). Determine the depth of trash in the landfill. This will show the maximum downward extent of the exploration. All of these steps may yield useful information to help determine the extent of the migration.

- Evaluation of current methane gas collection system. Review data of the system components or take readings to check the efficiency of the system components. Some items to consider include liquid levels in the extraction system and the efficacy of compressors and blowers. Collect methane concentrations from monitoring wells, at least weekly, when conducting efficiency checks of the collection system to know where problems within the collection system may be and focus corrective actions accordingly.

- Site geology and hydrology. Use existing information, for example, the preliminary and detailed site investigations that were conducted to obtain the landfill permit, to assess site features and characteristics that may impede or allow methane migration. Evaluate site conditions around the noncompliant well(s). Determine if there are there sand lenses or fractured bedrock in the area, a perched groundwater table or other confining geologic layers that would direct the flow of gas in an unexpected direction. Information gained from this part of the investigation may shift or guide the focus in a different direction.

- Site topography. Methane generally migrates up toward higher ground, so look for its presence in areas of higher elevation. Assess the roughness of the terrain in the area and plan for this in determining the type of equipment you will need to explore or monitor in that area.

- Location of all utilities in the area of migration. Contact all the utility companies serving the area and find out the depth of installation, the type of backfill material used, etc. Utility trenches can act as conduits and transmit landfill gas long distances. Sample all valve boxes, junction boxes, manholes, etc., in the suspect area of migration for methane.

Once the proposed investigation plan is prepared, the landfill owner/operator shall submit the plan to SWMP for review and approval.

2. Implement the Investigation Workplan

In addition to reviewing historical information and observing the site conditions, installing temporary or permanent investigation wells will provide additional information to characterize the site at the area of the migration. Tasks to implement are described below.

a. Install temporary or permanent monitoring wells.

- Temporary wells (boreholes) may be installed using direct-push technology (i.e., Geoprobe®), by drilling or by use of an auger. Wells that are 10 feet or deeper are regulated by the department's Division of Geology and Land Survey's Wellhead Protection Section. For specific information regarding these regulations, please contact the Wellhead Protection Section at 573-368-2100.

- Temporary wells (boreholes) are to be open for only 30 days. If necessary, a 30 day extension may be requested from the Division of Geology and Land Survey's Wellhead Protection Section. If the temporary boreholes are needed for longer than 60 days, they must be converted to code wells within the 60-day period.

- In order to determine the horizontal extent of the migration, temporary wells

must be installed along the property boundary (or compliance boundary) at 100 foot intervals from the noncompliant well(s), to a point at least halfway between the next monitoring well that is in compliance. Adjustments in spacing may be necessary based upon geology, hydrology, topography, physical obstructions, etc. However, when possible the spacing between investigative probes must be adjusted to be more conservative, not less conservative.

- The owner of the facility must determine the extent of the gas migration.

- All investigative wells shall extend to at least to the lowest elevation of waste in the landfill, or if another depth is proposed, it must be supported by data and information on the site geology, hydrology or topography.

- In areas of complex geology and varying soil and rock layers around the landfill, installing clusters of wells or several wells in the same approximate location that are screened at various depths, will allow you to target specific zones to determine if migration is occurring in these zones. In order to effectively monitor all unsaturated geologic zones to the lowest elevation of waste in areas where water is perched, it may be necessary to perform a hydrologic/geologic assessment of the area where gas may be migrating. This assessment will determine the appropriate zone(s) to monitor and determine how to construct your investigative monitoring wells.

b. Monitoring the investigative wells

- During the investigative period, the landfill owner/operator should monitor all investigative wells at least weekly to get detailed information to help design the corrective action plan. Monitor and record the following information:

  - Percent methane by volume (not percent lower explosive limit)
  - Percent oxygen by volume
  - Percent carbon dioxide by volume
  - Static pressure in the well
  - Water levels in wells (if applicable)
  - Atmospheric pressure and current weather

c. Submitting the monitoring results

- Submit monitoring results from investigative wells to SWMP electronically within one week of sample collection.

  Please see section I.E. above for information regarding the submission of gas monitoring data.

d. Upgrade the current methane collection system

- Once the efficiency of the collection system has been evaluated, the landfill owner/ operator shall submit a proposal for design changes or equipment upgrades to SWMP for approval. Once approval is granted, install all infrastructures as approved.

B. PREPARATION AND SUBMISSION OF THE METHANE GAS INVESTIGATION REPORT

When SWMP determines additional investigation is needed, the landfill owner/operator shall summarize the results of the migration investigation in a report and submit it to the program. The report shall describe the migration, the actions taken to investigate the migration and the findings of the investigation in detail. The investigation report shall be accompanied by the proposed methane gas corrective action/remediation plan.

The investigation report must contain, at a minimum, the following information:

- A table listing the permanent gas monitoring wells in the area(s) of the migration, the temporary wells installed for the investigation, the wells' current and historical gas readings. For each well, include historical readings for the 12-month period immediately preceding the initial exceedance of the regulatory limit, or longer if there is evidence of a trend.

- A site plan showing the following details of the affected area:

  - Site topography
  - Property boundary
  - Limits of waste
  - Elevations of landfill footprint
  - Location of all structures within 1,000 feet of the affected wells or probes
  - Location of all existing environmental controls
  - Location of all gas monitoring wells
  - Location of any wells, borings, or test pits used to evaluate the situation
  - Location of all roads
  - Location of all utilities
  - Other relevant information, i.e., areas of stressed vegetation

- Construction logs for all gas monitoring wells in the area(s) of the migration.

- An evaluation of the site geology in the area(s) of the migration, including:
  - The logs of any borings, wells, test pits, etc., used to evaluate the site geology.
  - A detailed description of the stratigraphy and any geologic or hydrologic feature that may affect the depth and pattern of methane migration. A site map showing important geologic or hydrologic features should be included, if necessary. This portion of the report must be prepared by a Missouri Registered Geologist.
  - Cross section drawings showing the depth of waste and any important geologic or hydrologic features within 1,000 feet of the area(s) of migration.

- An evaluation of the weather patterns (precipitation, barometric pressure, temperatures, etc.) corresponding to the historical methane readings in the affected wells.

The landfill owner/operator shall submit the methane gas investigation report to SMWP for review and approval. In addition, the landfill gas corrective action plan shall be submitted to the program.

IV. REMEDIATION OR CORRECTIVE ACTIONS TO RESOLVE METHANE MIGRATION

A. REGULATORY REQUIREMENTS

Per 10 CSR 80-3.010(14)(C)5.C and 10 CSR 80-4.010(14)(C)5.C, within 60 days of the initial detection of methane above the regulatory limit, the owner/operator of a sanitary or demolition landfill shall submit a remediation (corrective action) plan to SMWP for approval. The plan must be designed by a professional engineer to address the methane gas migration. Additional time to determine the extent of the methane migration pathways may be requested from SWMP. The program will evaluate the need for additional investigation time based on the content of the investigative work plan as well as any justification(s) provided. The investigative work plan must be submitted prior to the 60-day deadline.

B. CONTENT OF REMEDIATION/CORRECTIVE ACTION PLANS

The proposed remediation/corrective action plan shall be based upon information gathered through the methane gas investigation and include a detailed description of the remedy to stop the migration from occurring, including any necessary calculations, drawings and supporting documentation. The regulations require the landfill owner/operator to design a plan to address methane migration and prevent methane accumulation in onsite and offsite buildings; reduce methane concentrations in the soil at the property boundary (or in designated compliance wells) to below compliance levels; and reduce methane concentrations offsite to below compliance levels. More specific requirements for various types of gas control systems are outlined below.

1. Active Gas Control Systems

Active systems are designed to control gas migration by inducing a slight negative pressure within the pore spaces of the waste mass or the soil adjacent to the waste mass, usually through the use of a blower system to create a vacuum. Typical gas control systems include vertical slotted or screened control wells placed into boreholes drilled into the waste mass and connected through a network of piping. In shallow waste, horizontal control trenches with slotted or perforated pipe, backfilled with porous media, can be effective. In active systems, the gas is captured and piped to a flare where it is burned, or to other equipment for use as fuel.

The design documentation included for submittal of active gas control systems shall include:

- Plan sheet(s) showing proposed locations of system components, such as:

  - Extraction wells
  - Trenches
  - Piping
  - Valves
  - Blowers
  - Flares
  - Compressors
  - Condensate knockouts
  - Sumps
  - Cleanouts
  - Monitoring locations

- Cross-section drawings showing gas control well and/or trench construction details.

- A well schedule showing well depths, the bottom elevation of the landfill at that location, number of feet of slotted pipe, number of feet of solid pipe and total well depth.

- The depth of all gas control wells must be at least 75 percent of the depth of trash, but the bottom of the wells must be no closer than 10 feet from the top of the landfill liner.

- Calculations showing the radius of influence of gas control wells and/or trenches.

- Estimates of gas generation rates.

- Design criteria for sizing the blower(s).

- Design criteria for sizing all piping, including gas control wells.

- Operation and maintenance instructions for the entire gas control system.

- Proposed financial assurance for post-closure maintenance of the gas control system.

- For landfills that must comply with the New Source Performance Standards (NSPS) of the Clean Air Act, the proposed gas control system design must also be submitted to the department's Air Pollution Control Program (APCP) for approval. The landfill owner/operator shall include a copy of the cover letter sent to APCP with the submittal to SWMP.

2. Passive Gas Venting Systems

Passive vents are not an approvable first choice for mitigating a methane migration issue. Passive vents may only be used in addition to an active gas extraction system.

Passive gas systems are pipes installed in the landfill cap to assist in the venting of the methane from the landfill into the atmosphere. The vents are usually constructed of vertical slotted or perforated pipes installed in boreholes through the waste mass. These vents in the waste are intended to relieve the gas pressure to remove the driving force for gas flow. Horizontal interceptor trenches are another type of passive gas system. They are typically installed in between the waste mass and the property boundary or point of compliance to prevent the gas from migrating offsite.

Passive systems rarely are effective in controlling landfill gas migration, particularly for higher methane concentrations. SWMP does not consider passive venting of methane gas a primary measure of control. The program's experience with this type of system is that very little of the methane vents, or if some methane does flow out through the vents, not enough methane flows through them to prevent migration. Prior to proposing the use of passive venting systems as part of a methane gas corrective action plan, the landfill owner/operator shall discuss this option with SWMP's Engineering Section to ensure this option is truly a viable one to implement at the landfill experiencing migration.

In the event SWMP approves the landfill owner/operator to submit a passive vent system as part of a corrective action at the landfill, the submitted design for the system shall include the following:

- Plan sheet(s) showing proposed locations of system components, such as:

  - Vents
  - Trenches
  - Piping
  - Valves
  - Compressors
  - Condensate knockouts
  - Sumps
  - Cleanouts
  - Monitoring locations

- Estimates of gas generation rates.

- Design criteria for sizing all piping, including gas vents.

- Operation and maintenance instructions for the entire gas control system.

- Provisions for methane sampling.

- Proposed financial assurance for post-closure maintenance of gas venting system.

- For landfills that must comply with the New Source Performance Standards (NSPS) of the Clean Air Act, the proposed gas venting system design must also be submitted to the department's Air Pollution Control Program (APCP) for approval. The landfill owner/operator shall include a copy of the cover letter sent to APCP with the submittal to SWMP.

- For gas vents installed in the waste, include the following information:

  a. Cross-section drawings showing detailed vent construction.
  b. A well schedule showing well depths, the bottom elevation of the landfill at that location, number of feet of slotted pipe, number of feet of solid pipe and total well depth.

- The depth of all gas vents must be at least 75 percent of the lowest elevation of waste, where possible, but the bottom of the vents can be no closer than ten feet from the top of the landfill liner.

- For horizontal interceptor trenches, include the following information:
  a. Cross-section drawing showing the trench construction detail.
  b. Provisions for activating the system by creating a negative pressure in the collection trench, should the passive trench prove ineffective at preventing methane migration.

- Trenches shall be installed to the lowest depth of waste.

- Trenches shall be installed with a geomembrane of a minimum thickness of 30 mils on the back side of the trench (away from the landfill).

3. Other options to address and mitigate methane migration

a. External Migration Control Wells

- External wells are active gas control system wells installed outside the waste mass. If this option is proposed, the landfill owner/operator shall submit a corrective action plan to SWMP. The program will consider allowing this option under the following conditions:

- Control wells must be no closer than 50 feet from the property line.

- Control wells shall be no closer than 50 feet from any permanent gas monitoring well or temporary well.

- Proposed migration control well designs must include:

1) Plan sheet(s) showing proposed locations of system components, such as:

- Trenches
- Piping
- Valves
- Blowers
- Flares
- Compressors
- Condensate knockouts
- Sumps
- Cleanouts
- Monitoring locations

2) Cross-section drawings showing gas control well and/or trench with construction details.

3) A well schedule showing well depths, the bottom elevation of the landfill at that location, number of feet of slotted pipe, number of feet of solid pipe and total well depth the landfill.

4) Estimates of the area of influence of the gas control wells.

4. Purchase of Property

This option to resolve the methane migration involves purchasing property(ies) outside of the landfill property boundary that methane has migrated onto. In order for SWMP to consider this option, the landfill owner/operator shall completely define the extent of the methane migration onto the adjacent property(ies). This must be done in both horizontal directions along the property line on either side of the noncompliant well(s) as well as inward onto the affected adjacent property(ies). If this option is proposed, the landfill owner/operator shall submit a corrective action plan to SMWP.

Proposals to mitigate gas migration by purchasing property shall include:

a. The landfill's Methane Gas Investigation Report.

b. A request for a permit modification to relocate the landfill property boundary to include the newly-purchased property into the current landfill permit. The modification request shall include a proposed plat of survey prepared by a Registered Land Surveyor that provides the legal description of the property to be added to the permit, as well as a proposed revised Easement, Notice, and Covenant running with the land, pursuant to 10 CSR 80-2.020(2) (B) 2, 10 CSR 80-3.010(20) (C) 2., and 10 CSR 80-4.010(20) (C) 2.

c. A proposal for the location and design of permanent gas monitoring wells at the new property boundary.

C. JUDGING THE EFFECTIVENESS OF REMEDIATION/CORRECTIVE ACTIONS

Once SWMP approves the remediation/corrective action plan submitted by the landfill owner/operator, the plan shall be implemented immediately. After the corrective actions have been completed at the landfill, SWMP and the landfill owner/operator shall observe the effectiveness of the actions for six months after implementation of the plan. The department may grant additional time to allow gas concentrations to decline further if the monitoring results show a significant downward trend. In that case, the landfill owner/operator shall submit a request for extension of the observation period, including the reason for the extension request. If approved, SMWP shall send an approval letter to the landfill owner/operator that provides a new date for the end of the observation period. Thirty days after the end of the observation period, the landfill owner/operator shall submit a Corrective Action Summary Report to SMWP which summarizes the actions taken to stop the methane migration and the results documented over the observation period.

SWMP shall review the Corrective Action Summary Report submitted by the landfill owner/operator, and if the department determines the corrective actions have not been successful at stopping the gas migration, the program shall send a letter to the landfill owner/operator. This letter will require the landfill owner/operator to submit a new or revised remediation/corrective action plan within 30 days of receipt of the letter.

V. ENFORCEMENT ACTIONS

A. REGULATORY REQUIREMENTS

SWMP is charged with implementing the MWSML&R to protect the public health and safety of the citizens of Missouri and the environment. As mentioned earlier, the first Missouri Solid Waste Management Law, Rules and Regulations, enacted in December 1973, set out requirements for sanitary and demolition landfills to control decomposition gases on-site, as necessary, to avoid posing a hazard to occupants of adjacent properties. The regulations required the gases to be controlled in such a way that they did not accumulate in explosive or toxic concentrations, especially within structures. Since that time, the regulations have been expanded to require more specific information and actions from landfill owner/operators when methane migrations occur.

Because of the serious nature of methane violations, landfills will be referred to SWMP's Compliance and Enforcement Section for enforcement action when: a) methane migrates into building/structures above regulatory limits or b) methane migrates into the soil at the property boundary (or in designated compliance wells) above regulatory limits. The regulatory limits for methane at sanitary and demolition landfills are set out in 10 CSR 80-3.010(14) (C) 2 and 10 CSR 80- 4.010(14) (C) 2. Other violations that result in referral for enforcement action include failure to: monitor for methane, submit monitoring results to SWMP in a timely manner, and notify the program of exceedances of regulatory limits in compliance wells. These violations are considered high priority violations. SWMP staff will review the circumstances surrounding the violations, and determine whether or not the circumstances and violation(s) warrant(s) issuing a notice of violation to the landfill owner/operator. If a notice of violation is issued to the landfill owner/operator, the matter is automatically referred to SWMP's Compliance and Enforcement Section for enforcement action.

B. ENFORCEMENT ACTIONS

Most enforcement cases are resolved through the use of a settlement agreement from the Attorney General's Office (AGO), and it is still considered to be an out of court legal document. This agreement between SWMP and the landfill's owner/operator will resolve the landfill's violation(s) by establishing a compliance schedule in which to perform corrective actions and the payment of monetary penalties. The agreement assures SWMP and the public that a landfill owner/operator is dedicated in resolving the violation(s) and will remain vigilant, diligent and timely in implementing actions to correct the problem. Corrective actions are tied to timelines for completion, and penalties are assessed against the landfill owner/operator if the deadlines are not met. These stipulated penalties ensure completion of the corrective actions in a diligent and timely fashion. Schedules for completion of corrective actions are discussed and agreed upon between SWMP and the landfill owner/operator. The intent of settlement agreements is to document the methane gas violations at a facility and formally record the agreement of the facility's owner and/or operator to diligently take action to correct the threat and violation as soon as possible. Although agreements may request actions to be taken within two years of execution, this time period may not be sufficient for the owner and/or operator to propose, implement and observe any response to a corrective action within that time period. SWMP will coordinate the cycle of corrective action proposal submission, review, comment, approval, implementation and observation as necessary until the facility demonstrates continued and uninterrupted compliance with the MWSML&R for methane gas for a period of at least one year. In the event methane violations continue to occur at the facility two years after issuance of the notice of violation, the department may consider issuing a new notice of violation and requiring additional penalties if the facility owner/operator is not diligently designing, constructing and implementing corrective actions to address ongoing methane violations.

If a landfill owner/operator refuses to take timely measures to address methane violations, SWMP shall refer the violations to the AGO to file a lawsuit. SWMP shall work through the AGO and the court system

to acquire compliance from the landfill owner/operator through corrective actions, a schedule for completion of the actions, creation of a corrective action financial assurance instrument (FAI) to ensure landfill compliance and the payment of penalties for the ongoing violations.

Once a settlement agreement with SWMP or judgment by the court has set out corrective actions and a schedule of completion, the program's Compliance and Enforcement Section shall coordinate corrective actions with the landfill owner/operator and SWMP's Engineering Section to resolve the methane migration and bring the facility back into compliance.

Once all corrective actions have been completed, methane concentrations have decreased to below the regulatory limits, and any upfront penalties have been paid in full, SWMP shall send a letter to the landfill owner/operator advising that the case has been closed. The letter shall remind the landfill owner/operator of any suspended or stipulated penalty measures that are still in effect.

VI. CORRECTIVE ACTION FINANCIAL ASSURANCE INSTRUMENTS

A. REGULATORY REQUIREMENTS

The Missouri Solid Waste Management Law, 260.227.8 through 260.227.11 RSMo, requires a landfill owner/operator to take corrective actions to mitigate threats to the public health or environment. In order to ensure that the corrective actions actually mitigate the threat to public health caused by methane migration, Sections 260.227.9 through 260.227.11 RSMo. set out requirements for the landfill owner/operator to timely design and implement corrective actions for the landfill and for SWMP to inspect the landfill to ensure corrective actions are mitigating the threat. The Missouri Solid Waste Management Regulations also address corrective actions in 10 CSR 80-2.030(4) (C), 10 CSR 80-3.010(14) (C) 5 and 10 CSR 80-4.010(14) (C) 5.

Section 260.227 of the Missouri Solid Waste Management Law requires a landfill owner/operator to provide a corrective action plan for gas migration, and an FAI in an amount and form prescribed by the department to ensure implementation of the corrective action plan. Once the department takes formal enforcement action, a corrective action FAI may be required. This FAI must be in the form of an escrow account or an irrevocable letter of credit.

It is difficult to determine at the outset what the ultimate cost of controlling a gas migration problem will be. Based on our experience, the most effective solution has historically been to install an active gas control system. The costs are derived from *Preparing Solid Waste Disposal Area Closure and Post-Closure Plans* (PUB195) at: dnr.mo.gov/pubs/pub195.htm, and it identifies several cost worksheets to use.

VII. APPENDIX

A. SOLID WASTE MANAGEMENT PROGRAM FACT SHEETS

- Design and Construction of Landfill Gas Monitoring Wells (PUB2054), January 2007 dnr.mo.gov/pubs/pub2054.htm

- Sampling of Landfill Gas Monitoring Wells (PUB2053), June 2006 dnr.mo.gov/pubs/pub2053.htm

- Procedures for Sampling Landfill Gas Inside Buildings (PUB2052), June 2006 dnr.mo.gov/pubs/pub2052.htm

B. MISSOURI DEPARTMENT OF NATURAL RESOURCES SOLID WASTE MANAGEMENT PROGRAM GUIDANCE FOR SUBMITTING LANDFILL GAS MONITORING DATA, MAY 2017

Missouri Department of Natural Resources
Solid Waste Management Program
Guidance for Submitting Landfill Gas Monitoring Data
May 2017

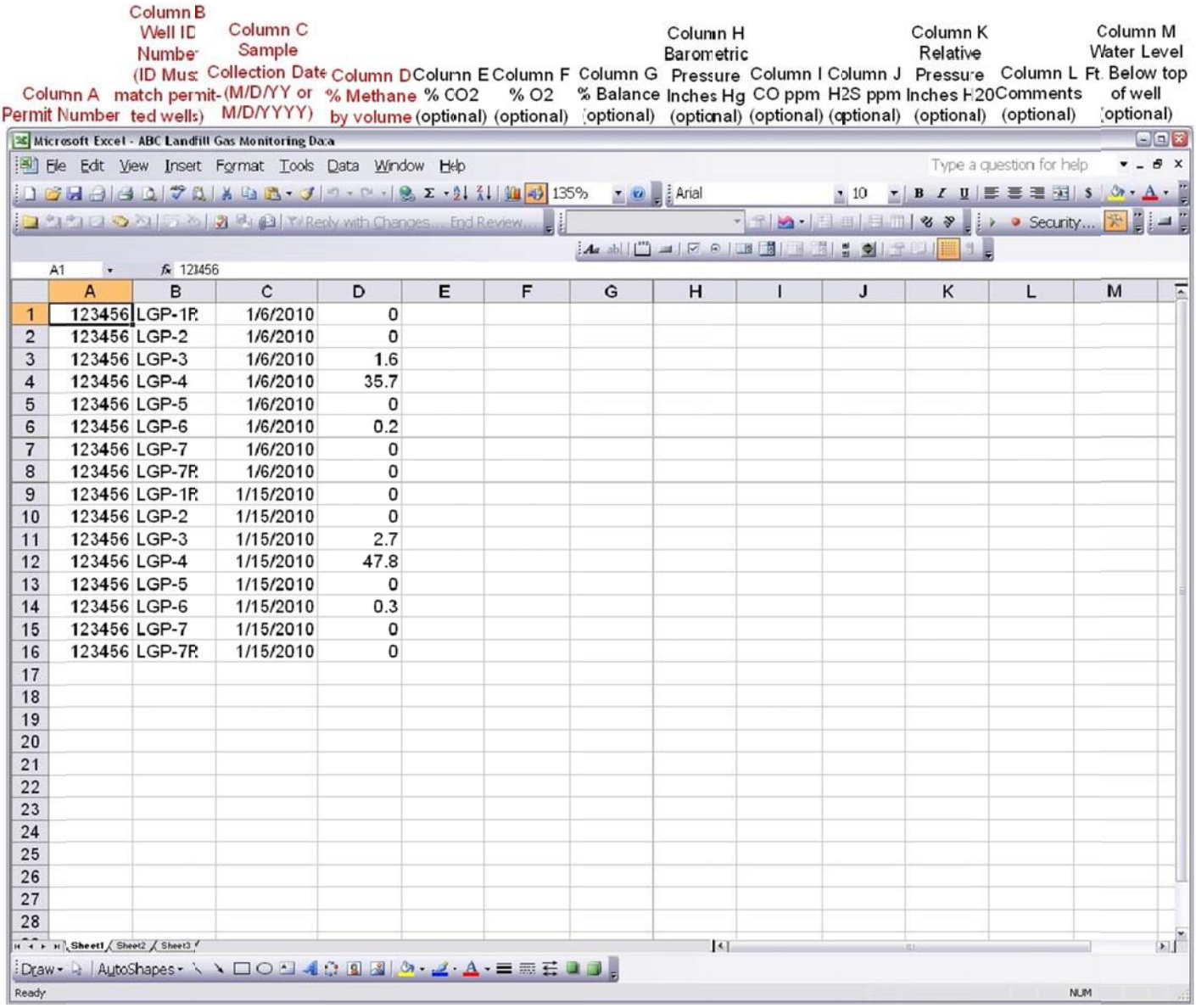
In an effort to improve efficiency and minimize the potential for data entry errors, SWMP is changing the required format in which landfill gas monitoring data is to be submitted. This change will enable SWMP to better serve the citizens of the state; yet will minimize the burdens involved with submitting this data as much as possible. The program will work with those individuals who submit gas monitoring data over the next several weeks to phase in the new format. Please follow the guidelines below and contact the Solid Waste Management Program if you have any questions as the process is implemented.

Formatting the data

Data must be formatted in a spreadsheet (see figures 1 and 2). When setting up your facility's monitoring results spreadsheet, here are some things to keep in mind:

1. The first row should only contain data and should not be a header for the information or a title.
2. Each row represents one sampling event at one well.
3. The permit number should be the highest superseding number at the facility (the most recent modification) and should be written without any preceding zeros.
4. The well IDs must exactly match the monitoring well IDs that were submitted in the facility's gas monitoring plan and approved by SWMP. Well IDs must be written exactly the same way every time the data is submitted, including proper spacing. For example, well 01-R is not the same as 1R or 01 r.
5. The database will accept the sample collection date in several formats. Please use one of the following formats when submitting your data:
   m/d/yy
   m/d/yyyy
   m/d/yy 1:56 PM
   m/d/yyyy 1:56 PM
   m/d/yy 13:56
   m/d/yyyy 13:56
6. The data in columns A through D is mandatory. All columns must not contain any extraneous information. In the event a well was not sampled, leave the field blank. Do not enter 0, NS, Not Sampled, a space, etc., or any other explanation in the cell. Only enter the value 0 if the well contained zero methane when sampled. Do not enter units, such as % or ppm after the value recorded. If you would like to explain why the well was not sampled, please include this information with the e-mail accompanying the data you submit.

Figure 1 – Example of spreadsheet



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	123456	LGP-1R	1/6/2010	0									
2	123456	LGP-2	1/6/2010	0									
3	123456	LGP-3	1/6/2010	1.6									
4	123456	LGP-4	1/6/2010	35.7									
5	123456	LGP-5	1/6/2010	0									
6	123456	LGP-6	1/6/2010	0.2									
7	123456	LGP-7	1/6/2010	0									
8	123456	LGP-7R	1/6/2010	0									
9	123456	LGP-1R	1/15/2010	0									
10	123456	LGP-2	1/15/2010	0									
11	123456	LGP-3	1/15/2010	2.7									
12	123456	LGP-4	1/15/2010	47.8									
13	123456	LGP-5	1/15/2010	0									
14	123456	LGP-6	1/15/2010	0.3									
15	123456	LGP-7	1/15/2010	0									
16	123456	LGP-7R	1/15/2010	0									
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													

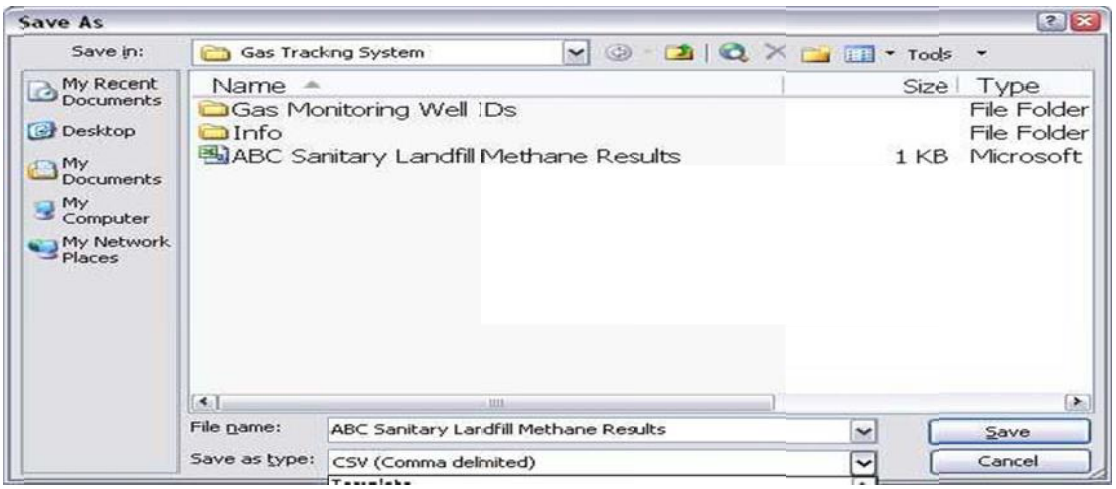
Figure 2 – Explanation of spreadsheet columns

Column	Description
A.	Highest permit number for the facility (without any preceding zeros)
B.	Well ID Number (as approved by SWMP)
C.	Sample collection date (using one of the approved formats)
D.	Methane (record in % by volume)
E.	Carbon dioxide (record in % by volume)
F.	Oxygen (record in % by volume)
G.	Balance gas (record in % by volume)
H.	Barometric pressure (record inches Hg)
I.	Carbon monoxide (record in parts per million)
J.	Hydrogen sulfide (record in parts per million)
K.	Relative pressure (record in inches water)
L.	Comments
M.	Water level in well (depth in feet below surface of well)

Saving the Comma Separated Value file type

All gas monitoring data submitted must be in the Comma Separated Value (CSV) file format. Files can be created from Microsoft Excel®, Apple Numbers®, and many other spreadsheet programs. For users who do not already have a spreadsheet program, openoffice.org contains a free, multi-platform spreadsheet program that can create CSV files. The format was chosen because it will prevent certain types of import errors that can be caused by common spreadsheet programs. The example below shows how to save a spreadsheet in CSV format using Microsoft Excel® on Windows XP®.

1. Go to File and select Save As. Choose a location to save the document.
2. Choose CSV in the Save as file type selection menu at the bottom of the window.



3. Once you click Save, you may see the message below. Select Yes. If you see this message when closing the file, select "Yes" again.

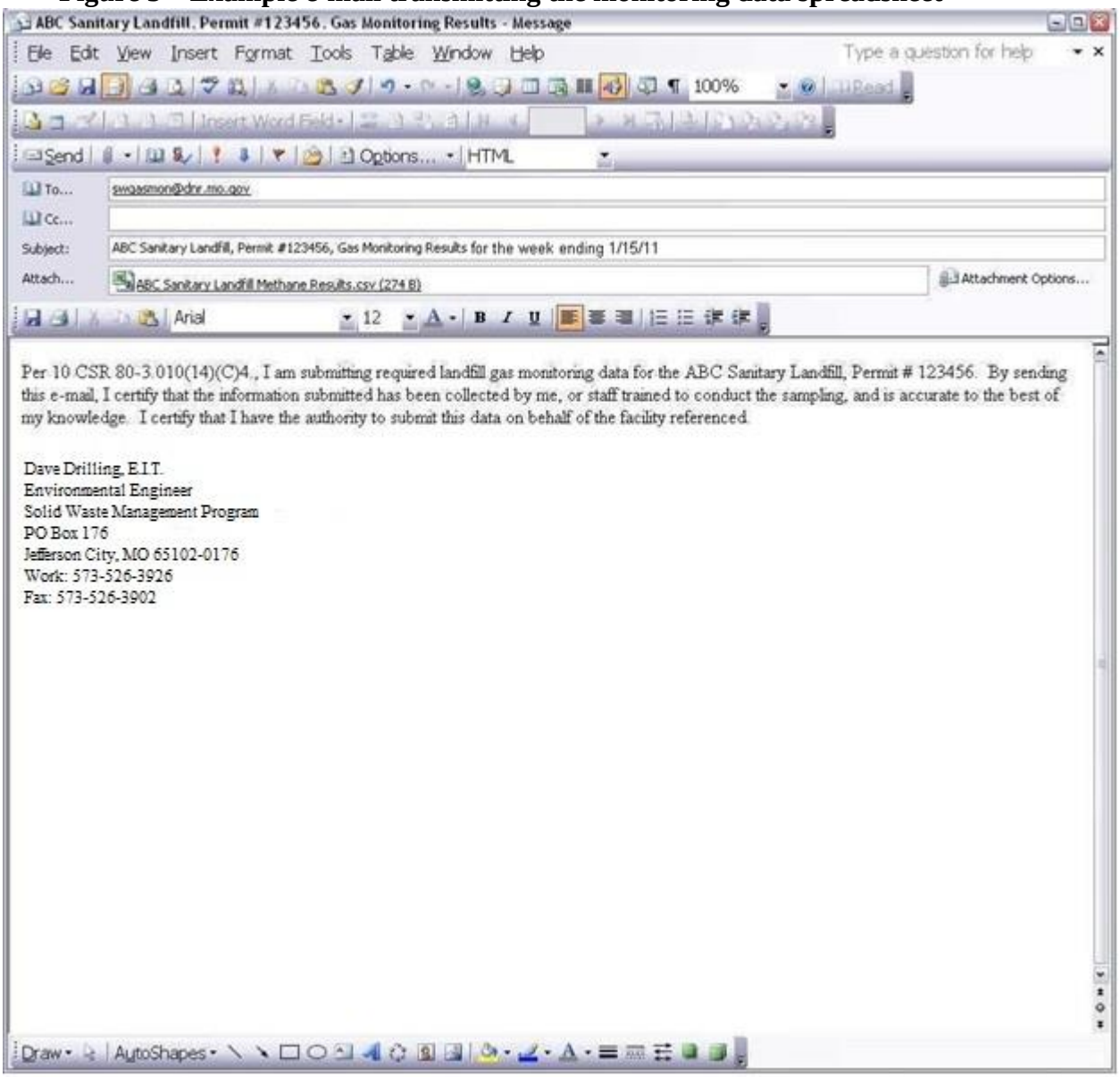
Emailing the data

After the data has been saved in the CSV format, you will need to email the data, as an attachment, to swgasmon@dnr.mo.gov. Please keep the following guidelines in mind when submitting the data to SWMP:

1. Use the following subject line in the email you submit to SWMP: (Approved Landfill Name), Permit # (Most Current and Approved Permit Number) Gas Monitoring Results for (Time Period) (i.e. 1st Qtr. 2011, Week Ending 1/7/2011, etc.). For example, ABC Sanitary Landfill, Permit #123456, Gas Monitoring Results for 3rd Qtr. 2008.
2. In addition to any comments r a description of the monitoring conducted in the attachment, include the following statement in the body of the transmittal email:
   Per 10 CSR 80-3.010(14) (C) 4 [10 CSR 80-4.010(14) (C) 4 for demolition landfills], I am submitting landfill gas monitoring data for the (Insert Landfill Name), Permit # (Insert Permit Number). By sending this email, I certify that the information submitted has been collected by me, or staff trained to conduct the sampling, and is accurate to the best of my knowledge. I certify that I have the authority to submit this data on behalf of the facility referenced.
3. The body of the email must include the name and contact information of the individual who is submitting the data. Email signature lines are acceptable if they are of the individual who is submitting the data.

4. Attach data for only one facility per email. If you need to submit data for multiple facilities, please send separate emails and attachments for each facility.
5. You may submit data for multiple monitoring dates in the same attachment. However, all data shall be submitted within seven days of sample collection to meet regulatory requirements.
6. Attach the CSV file to the transmittal e-mail.

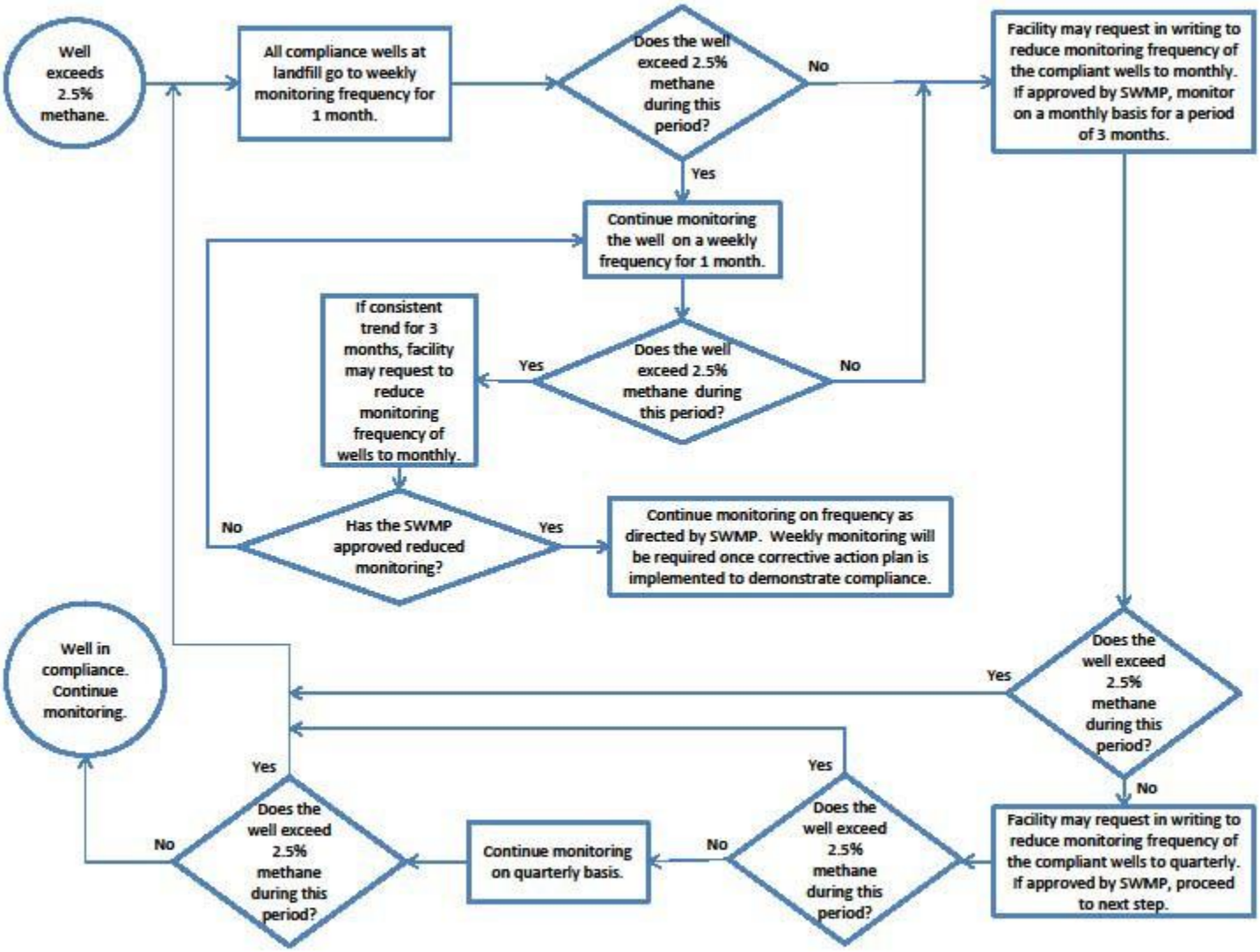
Figure 3 – Example e-mail transmitting the monitoring data spreadsheet



If you have any questions about this process, please contact:

Mr. David Drilling, Environmental Engineer
Missouri Department of Natural Resources
Solid Waste Management Program, Special Projects Unit
P.O. Box 176
Jefferson City, MO 65102-0176
573- 526-3926 (Direct)
573-751-5401 (Main)
david.drilling@dnr.mo.gov

C. GAS MONITORING FLOW CHART



APPENDIX B

QUALITY ASSURANCE MANUAL

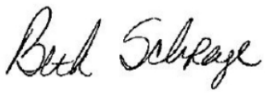
Quality Assurance/Quality Control Policies and Procedures

Pace Analytical Services, LLC – Indianapolis
7726 Moller Road
Indianapolis, IN 46268
(317)228-3100

APPROVAL

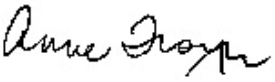
June 20, 2018
Date

Steve Sayer
General Manager
(317)228-3100



June 19, 2018
Date

Beth Schrage
Quality Manager
(317)228-3100



June 19, 2018
Date

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1.0. INTRODUCTION AND ORGANIZATIONAL STRUCTURE

"Working together to protect our environment and improve our health"
Pace Analytical Services LLC - Mission Statement

1.1. Introduction to Pace

1.1.1. Pace Analytical Services, LLC (Pace) is a privately held, full-service analytical testing firm operating a nationwide system of laboratories. Pace offers extensive services beyond standard analytical testing, including: bioassay for aquatic toxicity, air toxics, dioxins and coplanar PCB's by high resolution mass spectroscopy , radiochemical analyses, product testing, pharmaceutical testing, field services and mobile laboratory capabilities. This document defines the Quality System and Quality Assurance (QA)/Quality Control (QC) protocols.

1.1.2. Pace laboratories are capable of analyzing a full range of environmental samples from a variety of matrices, including air, surface water, wastewater, groundwater, soil, sediment, biota, and other waste products. Methods are applied from regulatory and professional sources including EPA, ASTM, USGS, NIOSH, Standard Methods, and State Agencies. Section 11 of this document is a representative listing of general analytical protocol references.

1.2. Statement of Purpose

1.2.1. To meet the business needs of our customers for high quality, cost-effective analytical measurements and services.

1.3. Quality Policy Statement and Goals of the Quality System

1.3.1. Pace management is committed to maintaining the highest possible standard of service and quality for our customers by following a documented quality system that is compliant with all current applicable state, federal, and industry standards, such as the NELAC Standard, the TNI Standard, and ISO standards and is in accordance with the stated methods and customer requirements. The overall objective of this quality system is to provide reliable data of known quality through adherence to rigorous quality assurance policies and quality control procedures as documented in this Quality Assurance Manual.

1.3.2. All personnel within the Pace network are required to be familiar with all facets of the quality system relevant to their position and implement these policies and procedures in their daily work.

1.4. Core Values

1.4.1. The following are the Pace Core Values:

- **Integrity**
- **Value Employees**
- **Know Our Customers**
- **Honor Commitments**

- **Flexible Response To Demand**
- **Pursue Opportunities**
- **Continuously Improve**

1.5. Code of Ethics and Standards of Conduct

1.5.1. **Code of Ethics**:

1.5.1.1. Each Pace employee is responsible for the propriety and consequences of his or her actions;

1.5.1.2. Each Pace employee must conduct all aspects of Company business in an ethical and strictly legal manner, and must obey the laws of the United States and of all localities, states and nations where Pace does business or seeks to do business;

1.5.1.3. Each Pace employee must reflect the highest standards of honesty, integrity and fairness on behalf of the Company with customers, suppliers, the public, and one another.

1.5.1.4. Each Pace employee must recognize and understand that our daily activities in environmental laboratories affect public health as well as the environment and that environmental laboratory analysts are a critical part of the system society depends upon to improve and guard our natural resources:

1.5.2. **Standards of Conduct:**

1.5.2.1. **Data Integrity**

1.5.2.1.1. The accuracy and integrity of the analytical results and its supporting documentation produced at Pace are the cornerstones of the company. Employees are to accurately prepare and maintain all technical records, scientific notebooks, calculations, and databases. Employees are prohibited from making false entries or misrepresentations of data for any reason.

1.5.2.1.2. Managerial staff must make every effort to ensure that personnel are free from any undue pressures that may affect the quality or integrity of their work including commercial, financial, over-scheduling, and working condition pressures.

1.5.2.1.3. The data integrity system includes in-depth, periodic monitoring of data integrity including peer data review and validation, internal raw data audits, proficiency testing studies, etc.

1.5.2.1.4. Any documentation related to data integrity issues, including any disciplinary actions involved, corrective actions taken, and notifications to customers must be retained for a minimum of five years.

1.5.2.2. **Confidentiality**

1.5.2.2.1. Pace employees must not use or disclose confidential or proprietary information except when in connection with their duties at Pace. This is effective over the course of employment and for an additional period of two years thereafter.

1.5.2.2.2. Confidential or proprietary information, belonging to either Pace and/or its customers, includes but is not limited to test results, trade secrets, research and development

matters, procedures, methods, processes and standards, company-specific techniques and equipment, marketing and customer information, inventions, materials composition, etc.

1.5.2.3. **Conflict of Interest**

1.5.2.3.1. Pace employees must avoid situations that might involve a conflict of interest or could appear questionable to others. This includes participation in activities that conflict or appear to conflict with the employees' Pace responsibilities. This would also include offering or accepting anything that might influence the recipient or cause another person to believe that the recipient may be influenced to behave or in a different manner than he would normally (such as bribes, gifts, kickbacks, or illegal payments).

1.5.2.3.2. Employees are not to engage in outside business or economic activity relating to a sale or purchase by the Company. Other problematic activities include service on the Board of Directors of a competing or supplier company, significant ownership in a competing or supplier company, employment for a competing or supplier company, or participation in any outside business during the employee's work hours.

1.5.3. Strict adherence by each Pace employee to this Code of Ethics and to the Standards of Conduct is essential to the continued vitality of Pace and to continue the pursuit of our common mission to protect our environment and improve our health.

1.5.4. Failure to comply with the Code of Ethics and Standards of Conduct will result in disciplinary action up to and including termination and referral for civil or criminal prosecution where appropriate. An employee will be notified of an infraction and given an opportunity to explain, as prescribed under current disciplinary procedures.

1.5.5. Compliance: all employees undergo annual Data Integrity/Ethics training which includes the concepts listed above. All employees also sign an annual Ethic Policy statement.

1.6. Anonymous Compliance Alertline

1.6.1. An ethical and safe workplace is important to the long-term success of Pace and the well-being of its employees. Pace has a responsibility to provide a work environment where employees feel safe and can report unethical or improper behavior in complete confidence. With this in mind, Pace has engaged Lighthouse Services, Inc. to provide all employees with access to an anonymous ethics and compliance alertline for reporting possible ethics and compliance violations. The purpose of this service is to ensure that any employee can report anonymously and without fear of retaliation.

1.6.2. Lighthouse Services provides a toll-free number along with several other reporting methods, all of which are available 24 hours a day, seven days a week for use by employees and staff.

1.6.3. Telephone: English speaking USA and Canada: (844)-970-0003.

1.6.4. Telephone: Spanish speaking North America: (800)-216-1288.

1.6.5. Website: www.lighthouse-services.com/pacelabs.

1.6.6. Email: reports@lighthouse-services.com (must include company name with report).

1.7. Laboratory Organization

1.7.1. Each laboratory within the system operates with local management, but all labs share common systems and receive support from the Corporate Office. See Attachment III for the Corporate Organizational structure.

1.7.2. A Senior General Manager (SGM) oversees all laboratories and service centers in their assigned region. Each laboratory or facility in the company is then directly managed by an SGM, a General Manager (GM), an Assistant General Manager (AGM), or an Operations Manager (OM). Quality Managers (QM) or Senior Quality Managers (SQM) at each laboratory report directly to the highest level of local laboratory management, however named, that routinely makes day-to-day decisions regarding that facility's operations. The QMs and SQMs will also receive guidance and direction from the corporate Director of Environmental Quality.

1.7.3. The SGM, GM, AGM or OM, or equivalent functionality in each facility, bears the responsibility for the laboratory operations and serves as the final, local authority in all matters. In the absence of these managers, the SQM/QM serves as the next in command, unless the manager in charge has assigned another designee. He or she assumes the responsibilities of the manager, however named, until the manager is available to resume the duties of their position. In the absence of both the manager and the SQM/QM, management responsibility of the laboratory is passed to the Technical Director, provided such a position is identified, and then to the most senior department manager until the return of the lab manager or SQM/QM. The most senior department manager in charge may include the Client Services Manager (CSM) or the Administrative Business Manager (ABM) at the discretion of the SGM/GM/AGM/OM.

1.7.4. A Technical Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full-time staff member meeting the qualifications of the technical director to temporarily perform this function. The laboratory SGM/GM/AGM/OM or SQM/QM has the authority to make this designation in the event the existing Technical Director is unable to do so. If this absence exceeds 35 consecutive calendar days, the primary accrediting authority shall be notified in writing.

1.7.5. The SQM/QM has the responsibility and authority to ensure the Quality System is implemented and followed at all times. In circumstances where a laboratory is not meeting the established level of quality or following the policies set forth in this Quality Assurance Manual, the SQM/QM has the authority to halt laboratory operations should he or she deem such an action necessary. The SQM/QM will immediately communicate the halting of operations to the SGM/GM/AGM/OM and keep them posted on the progress of corrective actions. In the event the SGM/GM/AGM/OM and the SQM/QM are not in agreement as to the need for the suspension, the Chief Operating Officer (COO) and Director of Environmental Quality will be called in to mediate the situation.

1.7.6. The technical staff of the laboratory is generally organized into the following functional groups:

- Organic Extractions
- Wet Chemistry Analysis
- Metals Analysis
- Volatiles Analysis
- Semi-volatiles Analysis

1.7.7. The organizational structure for Pace – Indianapolis is listed in Attachment II. In the event of a change in SGM/GM/AGM/OM, SQM/QM, or any Technical Director, the laboratory will notify its

accrediting authorities per their individual required timeframes, not to exceed 30 days. The QAM will remain in effect until the next scheduled revision.

1.8. Laboratory Job Descriptions

1.8.1. Senior General Manager

- Oversees all functions of all the operations within their designated region;
- Oversees the development of local GMs/AGMs/OMs within their designated region;
- Oversees and authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Oversees the preparation of budgets and staffing plans for all operations within their designated region;
- Ensures compliance with all applicable state, federal and industry standards;
- Works closely with Regional Sales Management.

1.8.2. General Manager

- Oversees all functions of their assigned operations;
- Authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Prepares budgets and staffing plans;
- Monitors the Quality Systems of the laboratory and advises the SQM/QM accordingly;
- Presents the Ethics/Data Integrity training annually to all employees in their facilities as an instructor-led training.
- Ensures compliance with all applicable state, federal and industry standards.

1.8.4. Quality Manager

- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Environmental Quality;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;
- Monitors QA/QC activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Environmental Quality office). The QM is responsible for reporting the lab's level of compliance to these standards to the Corporate Director of Environmental Quality on a quarterly basis;
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews select laboratory data and final reports;
- Reviews tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Reviews and maintains records of proficiency testing results;

- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS), and evaluates the effectiveness of training;
- Monitors corrective and preventive actions;
- Maintains calibration of support equipment such as balances and thermometers;
- Maintains the currency of the Quality Manual.

1.8.5. **Technical Director**

- Monitors the standards of performance in quality assurance and quality control data;
- Monitors the validity of analyses performed and data generated;
- May review tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Serves as the manager of the laboratory in the absence of the SGM/GM/AGM/OM and SQM/QM;
- Provides technical guidance in the review, development, and validation of new methodologies.

1.8.6. **Administrative Business Manager**

- Responsible for financial and administrative management for the entire facility;
- Provides input relative to tactical and strategic planning activities;
- Organizes financial information so that the facility is run as a fiscally responsible business;
- Works with staff to confirm that appropriate processes are put in place to track revenues and expenses;
- Provide ongoing financial information to the SGM/GM/AGM/OM and the management team so they can better manage their business;
- Utilizes historical information and trends to accurately forecast future financial positions;
- Works with management to ensure that key measurements are put in place to be utilized for trend analysis—this will include personnel and supply expenses, and key revenue and expense ratios;
- Works with SGM/GM/AGM/OM to develop accurate budget and track on an ongoing basis;
- Works with entire management team to submit complete and justified capital budget requests and to balance requests across departments;
- Works with project management team and administrative support staff to ensure timely and accurate invoicing.

1.8.7. **Client Services Manager**

- Oversees all the day to day activities of the Client Services Department which includes Project Management and, possibly, Sample Control;
- Responsible for staffing and all personnel management related issues for Client Services;

- Serves as the primary senior consultant to customers on all project related issues such as set up, initiation, execution and closure;
- Performs or is capable of performing all duties listed for that of Project Manager.

1.8.8. **Project Manager**

- Coordinates daily activities including taking orders, reporting data and analytical results;
- Serves as the primary technical and administrative liaison between customers and Pace;
- Communicates with operations staff to update and set project priorities;
- Provides results to customers in the requested format (verbal, hardcopy, electronic, etc.);
- Works with customers, laboratory staff, and other appropriate Pace staff to develop project statements of work or resolve problems of data quality;
- Responsible for solicitation of work requests, assisting with proposal preparation and project initiation with customers and maintain customer records;
- Mediation of project schedules and scope of work through communication with internal resources and management;
- Responsible for preparing routine and non-routine quotations, reports and technical papers;
- Interfaces between customers and management personnel to achieve customer satisfaction;
- Manages large-scale complex projects;
- Supervises less experienced project managers and provide guidance on management of complex projects;
- Arranges bottle orders and shipment of sample kits to customers;
- Verifies login information relative to project requirements and field sample Chains-of-Custody;
- Enters project and sample information in the Laboratory Information Management System (LIMS) for scheduling, tracking and reporting purposes.

1.8.9. **Project Coordinator**

- Enters project and sample information in the Laboratory Information Management System (LIMS) for scheduling, tracking and reporting purposes.

1.8.10. **Department Manager/Supervisor**

- Oversees the day-to-day production and quality activities of their assigned department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied;
- Assesses data quality and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Trains analysts or oversees training of analysts in laboratory operations and analytical procedures;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.11. **Quality Assurance Analyst**

- Assists the SQM/QM in the performance of quality department responsibilities as delegated by the SQM/QM;

- Reviews select laboratory data and final reports;
- Generates and reviews QC data validation packages;
- Assists in monitoring QA/QC data;
- Assists in internal audits;
- Assists in maintaining training records;
- Assists in maintaining the document control system.

1.8.12. Group Supervisor/Leader

- Trains analysts in laboratory operations and analytical procedures;
- Organizes and schedules analyses with consideration for sample holding times;
- Implements data verification procedures by assigning data verification duties to appropriate personnel;
- Evaluates instrument performance and supervises instrument calibration and preventive maintenance programs;
- Reports non-compliance situations to laboratory management including the SQM/QM.

1.8.13. Laboratory Analyst

- Performs detailed preparation and analysis of samples according to published methods and laboratory procedures;
- Processes and evaluates raw data obtained from preparation and analysis steps;
- Generates final results from raw data, performing primary review against method criteria;
- Monitors quality control data associated with analysis and preparation. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks;
- Reports data in LIMS, authorizing for release pending secondary approval;
- Conducts routine and non-routine maintenance of equipment as required;
- Performs or is capable of performing all duties associated with that of Laboratory Technician.

1.8.14. Laboratory Technician

- Prepares standards and reagents according to published methods or in house procedures;
- Performs preparation and analytical steps for basic laboratory methods;
- Works under the direction of a Laboratory Analyst on complex methodologies;
- Assists Laboratory Analysts on preparation, analytical or data reduction steps for complex methodologies;
- Monitors quality control data as required or directed. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks.

1.8.15. Field Technician

- Prepares and samples according to published methods, PACE Quality Assurance Manual and/or customer directed sampling objectives;
- Capable of the collection of representative environmental or process samples;
- Reviews project documentation for completeness, method compliance and contract fulfillment;

- Train less experienced environmental technicians and provide guidance on sampling and analysis;
- Responsible for project initiation and contact follow-up;
- Develop sampling plans and prepare test plan documents.

1.8.16. **Sample Receiving Personnel**

- Signs for incoming samples and verifies the data entered on the Chain of custody forms;
- Stages samples according to EPA requirements;
- Assists Project Managers and Coordinators in filling bottle orders and sample shipments;
- May enter project and sample information in the Laboratory Information Management System (LIMS) for scheduling, tracking and reporting purposes;
- Manages sample storage areas and sample disposal procedures.

1.8.17. **Systems Administrator or Systems Manager**

- Assists with the creation and maintenance of electronic data deliverables (EDDs);
- Coordinates the installation and use of all hardware, software and operating systems;
- Performs troubleshooting on all aforementioned systems;
- Trains new and existing users on systems and system upgrades;
- Maintains all system security passwords;
- Maintains the electronic backups of all computer systems.

1.8.18. **Safety/Chemical Hygiene Officer**

- Maintains the laboratory Chemical Hygiene Plan;
- Plans and implements safety policies and procedures;
- Maintains safety records;
- Organizes and/or performs safety training;
- Performs safety inspections and provides corrective/preventative actions;
- Assists personnel with safety issues.

1.8.19. **Hazardous Waste Coordinator**

- Evaluates waste streams and helps to select appropriate waste transportation and disposal companies;
- Maintains complete records of waste disposal including waste manifests and state reports;
- Assists in training personnel on waste-related issues such as waste handling and storage, waste container labeling, proper satellite accumulation, secondary containment, etc.;
- Conducts a weekly inspection of the waste storage areas of the laboratory.

1.9. Training and Orientation

1.9.1. Training for Pace employees is managed through web-based training systems. Employees are provided with several training activities for their particular job description and scope of duties. These training activities may include:

- Hands-on training led by supervisors;
- Job-specific training checklists and worksheets;
- Lectures and instructor-led training sessions;
- Method-specific training;
- External conferences and seminars;
- Reading Standard Operating Procedures (SOPs);
- Reading the Quality Assurance Manual and Safety Manual/Chemical Hygiene Plan;
- Core training modules (basic lab skills, etc.);
- Quality system training modules (support equipment use, corrective actions/root causes, etc.);
- Data Integrity/Ethics training;
- Specialized training by instrument manufacturers;
- On-line courses.

1.9.2. All procedures and training records are maintained and available for review during laboratory audits. Additional information can be found in the *Training Procedures* SOP or its equivalent replacement.

1.10. Laboratory Safety and Waste

1.10.1. It is the policy of Pace to make safety and waste compliance an integral part of daily operations and to ensure that all employees are provided with safe working conditions, personal protective equipment, and requisite training to do their work without injury. Each employee is responsible for his/her own safety as well as those working in the immediate area by complying with established company rules and procedures. These rules and procedures as well as a more detailed description of the employees' responsibilities are contained in the local Safety Manual/Chemical Hygiene Plan.

1.11. Security and Confidentiality

1.11.1. Security is maintained by controlled access to laboratory buildings. Exterior doors to laboratory buildings remain either locked or continuously monitored by Pace staff. Keyless door locks are accessible only to authorized personnel through the use of assigned key fobs. All visitors, including PACE staff from other facilities, must sign the Visitor's Logbook maintained by the receptionist. A staff member will accompany them during the duration of their stay on the premises unless the SGM/GM/AGM/OM, SQM/QM, or Technical Director specify otherwise. In this instance, the staff member will escort the visitor back to the reception area at the end of his/her visit where he/she signs out.

1.11.2. Additional security is provided where necessary, (e.g., specific secure areas for sample, data, and customer report storage), as requested by customers, or cases where national security is of concern. These areas are lockable within the facilities, or are securely offsite. Access is limited to specific individuals or their designees.

1.11.3. All information pertaining to a particular customer, including national security concerns will remain confidential. Data will be released to outside agencies only with written authorization from the customer or where federal or state law requires the company to do so.

1.12. Communications

1.12.1. Management within each lab bears the responsibility of ensuring that appropriate communication processes are established and that communication takes place regarding the effectiveness of the management/quality system. These communication processes may include email, regular staff meetings, senior management meetings, etc.

1.12.2. Corporate management bears the responsibility of ensuring that appropriate communication processes are established within the network of facilities and that communication takes place at a company-wide level regarding the effectiveness of the management/quality systems of all Pace facilities. These communication processes may include email, quarterly continuous improvement conference calls for all lab departments, and annual continuous improvement meetings for all department supervisors, quality managers, client services managers, and other support positions.

2.0. SAMPLE CUSTODY

2.1. Project Initiation

2.1.1. Prior to accepting new work, the laboratory reviews its performance capability. The laboratory confirms that sufficient personnel, equipment capacity, analytical method capability, etc., are available to complete the required work. Customer needs, certification requirements, and data quality objectives are defined and the appropriate sampling and analysis plan is developed to meet the project requirements by project managers or sales representatives. Members of the management staff review current instrument capacity, personnel availability and training, analytical procedures capability, and projected sample load. Management then informs the sales and client services personnel whether or not the laboratory can accept the new project via written correspondence, email, and/or daily operations meetings.

2.1.2. Additional information regarding specific procedures for reviewing new work requests can be found in the *Review of Analytical Requests* SOP or its equivalent replacement.

2.2. Sampling Materials and Support

2.2.1. Each individual Pace laboratory provides shipping containers, properly preserved sample containers, custody documents, and field quality control samples to support field-sampling events. Guidelines for sample container types, preservatives, and holding times for a variety of methods are listed in Attachment VII. Note that all analyses listed are not necessarily performed at all Pace laboratories and there may be additional laboratory analyses performed that are not included in these tables. Customers are encouraged to contact their local Pace Project Manager for questions or clarifications regarding sample handling. Pace may provide pick-up and delivery services to their customers when needed.

2.2.2. Some Pace facilities provide sampling support through a Field Services department. Field Services operates under the Pace Corporate Quality System, with applicable and necessary provisions to address the activities, methods, and goals specific to Field Services. All procedures and methods used by Field Services are documented in SOPs and Procedure Manuals.

2.3. Chain of Custody

2.3.1. A chain of custody (COC) provides the legal documentation of samples from time of collection to completion of analysis.

2.3.2. Field personnel or client representatives must complete a COC for all samples that are received by the laboratory. Samplers are required to properly complete a COC. This is critical to efficient sample receipt and to ensure the requested methods are used to analyze the correct samples. If sample shipments are not accompanied by the correct documentation, the Sample Receiving department notifies a Project Manager. The Project Manager then obtains the correct documentation/information from the customer in order for analysis of samples to proceed.

2.3.3. The COC is filled out completely and legibly with indelible ink. Errors are corrected by drawing a single line through the initial entry and initialing and dating the change. All transfers of samples are recorded on the chain of custody in the “relinquished” and “received by” sections. All information except signatures is printed.

2.3.4. Additional information can be found in the *Sample Management* SOP or its equivalent replacement.

2.4. Sample Acceptance Policy

2.4.1. In accordance with regulatory guidelines, Pace complies with the following sample acceptance policy for all samples received.

2.4.2. If the samples do not meet the sample receipt acceptance criteria outlined below, the laboratory is required to document all non-compliances, contact the customer, and either reject the samples or fully document any decisions to proceed with analyses of samples which do not meet the criteria. Any results reported from samples not meeting these criteria are appropriately communicated to the client.

2.4.3. Sample Acceptance Policy requirements:

- Sample containers must have unique client identification designations that are clearly marked with indelible ink on durable, water-resistant labels. The client identifications must match those on the chain-of-custody (COC).
- There must be clear documentation on the COC, or related documents that lists the unique sample identification, sampling site location, date and time of sample collection, and name of the sample collector.
- There must be clear documentation on the COC, or related documents that lists the requested analyses, the preservatives used, and any special remarks concerning the samples (i.e., data deliverables, samples are for evidentiary purposes, field filtration, etc.).
- Samples must be in appropriate sample containers. If the sample containers show signs of damage (i.e., broken or leaking) or if the samples show signs of contamination, the samples will not be processed without prior client approval.
- Samples must be correctly preserved upon receipt, unless the method requested allows for laboratory preservation. If the samples are received with inadequate preservation, and the samples cannot be preserved by the lab appropriately, the samples will not be processed without prior client approval.
- Samples must be received within required holding time. Any samples with hold times that are exceeded will not be processed without prior client approval.
- Samples must be received with sufficient sample volume or weight to proceed with the analytical testing. If insufficient sample volume or weight is received, analysis will not proceed without client approval.
- All samples that require thermal preservation are considered acceptable if they are received at a temperature within 2°C of the required temperature, or within the method-specified range. For samples with a required temperature of 4°C, samples with a temperature ranging from just above freezing to 6°C are acceptable. Samples that are delivered to the lab on the same day they are collected are considered acceptable if the samples are received on ice. Any samples that are not received at the required temperature will not be processed without prior client approval.
- Samples for **drinking water compliance** analyses will be rejected at the time of receipt if they are not received in a secure manner, are received in inappropriate containers, are received outside the required temperature range, are received outside the recognized holding time, are received with inadequate identification on sample containers or COC, or are

improperly preserved (with the exception of VOA samples- tested for pH at time of analysis and TOC- tested for pH in the field).

- Some specific clients may require custody seals. **For these clients**, samples or coolers that are not received with the proper custody seals will not be processed without prior client approval.

Note 1: Temperature will be read and recorded based on the precision of the measuring device. For example, temperatures obtained from a thermometer graduated to 0.1°C will be read and recorded to ± 0.1°C. Measurements obtained from a thermometer graduate to 0.5°C will be read to ± 0.5°C. Measurements read at the specified precision are not to be rounded down to meet the ≤ 6°C limit. Please reference the Support Equipment SOP for more information.

Note 2: Some microbiology methods allow sample receipt temperatures of up to 10°C. Consult the specific method for microbiology samples received above 6°C prior to initiating corrective action for out of temperature preservation conditions.

2.4.4. Upon sample receipt, the following items are also checked and recorded:

- Presence of custody seals or tapes on the shipping containers;
- Sample condition: Intact, broken/leaking, bubbles in VOA samples;
- Sample holding time;
- Sample pH and residual chlorine when required;
- Appropriate containers.

2.4.5. Additional information can be found in the *Sample Management* SOP or its equivalent replacement.

2.5. Sample Log-in

2.5.1. After sample inspection, all sample information on the COC is entered into the Laboratory Information Management System (LIMS). The lab's permanent records for samples received include the following information:

- Customer name and contact
- Customer number
- Pace Analytical project number
- Pace Analytical Project Manager
- Sample descriptions
- Due dates
- List of analyses requested
- Date and time of laboratory receipt
- Field ID code
- Date and time of collection
- Any comments resulting from inspection for sample rejection

2.5.2. If the time collected for any sample is unspecified and Pace is unable to obtain this information from the customer, the laboratory will use 08:00 as the time sampled. All hold times will be based on this sampling time and qualified accordingly if exceeded.

2.5.3. The LIMS automatically generates a unique identification number for each sample created in the system. The LIMS sample number follows the general convention of 50XXXXXX. This unique identification number is placed on the sample container as a durable label and becomes the link between the laboratory's sample management system and the customer's field identification; it will be a permanent reference number for all future interactions.

2.5.4. Sample labels are printed from the LIMS and affixed to each sample container.

2.5.5. Additional information can be found in the *Sample Management* SOP or its equivalent replacement.

2.6. Sample Storage

2.6.1. Additional information on sample storage can be found in the *Sample Management* SOP or its equivalent replacement and in the *Waste Handling and Management* SOP or its equivalent replacement.

2.6.2. **Storage Conditions**

2.6.2.1. Samples are stored away from all standards, reagents, or other potential sources of contamination. Samples are 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.

2.6.2.2. Storage blanks are stored with volatile samples and are used to measure cross-contamination acquired during storage. Laboratories must have documented procedures and criteria for evaluating storage blanks, appropriate to the types of samples being stored.

2.6.2.3. Additional information can be found in the *Monitoring Temperature Controlled Units* SOP or its equivalent replacement**.**

2.6.3. **Temperature Monitoring**

2.6.3.1. Samples are taken to the appropriate storage location immediately after sample receipt and check-in procedures are completed. All sample storage areas are located in limited access areas and are monitored to ensure sample integrity.

2.6.3.2. The temperature of each refrigerated storage area is maintained at $\leq 6^{\circ}C$ but above freezing unless state, method or program requirements differ. The temperature of each freezer storage area is maintained at $\leq -10^{o}C$ unless state, method or program requirements differ. The temperature of each storage area is checked and documented each day of use. If the temperature falls outside the acceptable limits, the following corrective actions are taken and appropriately documented:

- The temperature is rechecked after a period of time, usually two hours, to verify temperature exceedance. Corrective action is initiated and documented if necessary.
- The SQM/QM and/or laboratory management are notified if the problem persists.
- The samples are relocated to a proper environment if the temperature cannot be maintained after corrective actions are implemented.
- The affected customers are notified and/or documentation is provided on the final report, if necessary.

2.6.3.3. Additional information can be found in the *Monitoring Temperature Controlled Units* SOP or its equivalent replacement.

2.6.4. **Hazardous Materials**

2.6.4.1. Samples designated by clients upon receipt as pure product or potentially heavily contaminated samples, or samples found to be designated as such following analysis, must be labeled to indicate the hazard and stored separately from other samples.

2.6.5. **Foreign/Quarantined Soils**

2.6.5.1. Foreign soils and soils from domestic USDA quarantined areas must be adequately segregated to prevent cross-contamination and enable proper sample disposal. The USDA requires these samples and by-products to be properly identified and handled and to be treated by an approved procedure prior to disposal or as part of disposal.

2.6.5.2. Additional information regarding USDA regulations and sample handling can be found in the laboratory's *Regulated Soil Handling* SOP or its equivalent replacement.

2.7. Subcontracting Analytical Services

2.7.1. Every effort is made to perform all analyses for Pace customers within the laboratory that receives the samples. When subcontracting to a laboratory other than the receiving laboratory, whether inside or outside the Pace network, becomes necessary, a preliminary verbal communication with that laboratory is undertaken. Customers are notified in writing of the laboratory's intention to subcontract any portion of the testing to another laboratory. Work performed under specific protocols may involve special considerations. When possible, subcontracting will be to a TNI-accredited laboratory.

2.7.2. Potential subcontract laboratories must be approved by Pace based on the criteria listed in SOP S-IN-C-003 *Subcontracting Samples* or its equivalent revision or replacement. All sample reports from the subcontracted labs are appended to the applicable Pace final reports.

2.7.3. Any Pace work sent to other labs within the Pace network is handled as inter-regional work and all final reports are labeled clearly with the name of the laboratory performing the work. Any non-TNI work is clearly identified. Pace will not be responsible for analytical data if the subcontract laboratory was designated by the customer.

2.7.4. Additional information can be found in the *Subcontracting Samples* SOP or its equivalent replacement.

2.8. Sample Retention and Disposal

2.8.1. Samples, extracts, digestates, and leachates must be retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

2.8.2. The minimum sample retention time is 45 days from receipt of the samples. Samples requiring thermal preservation may be moved to ambient temperature storage when the hold time is expired, when the report has been delivered, and/or when allowed by the customer, program, or contract. 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 and their presence does not compromise the integrity of other samples.

2.8.3. After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposal of **hazardous** samples is to return the excess sample to the customer. If it is not feasible to return samples, or the customer requires Pace to dispose of excess samples, proper arrangements will be made for disposal by an approved contractor.

2.8.4. Additional information can be found in the *Waste Handling and Management* SOP and the *Sample Management* SOP or their equivalent replacements.

3.0. QUALITY CONTROL PROCEDURES

3.1. Quality Control Samples

3.1.1. The quality control samples described in this section are analyzed per batch as applicable to the method used. Acceptance criteria must be established for all quality control samples and if the acceptance criteria are not met, corrective actions must be performed and samples reanalyzed, or the final report must be appropriately qualified.

3.1.2. Quality control samples must be processed in the same manner as associated client samples.

3.1.3. Please reference the glossary of this Quality Manual for definitions of all quality control samples mentioned in this section.

3.1.4. Any deviations to the policies and procedures governing quality control samples must be approved by the QM/SQM.

3.2. Method Blank

3.2.1. A method blank is a negative control used to assess the preparation/analysis system for possible contamination and is processed through all preparation and analytical steps with its associated client samples. The method blank is processed at a minimum frequency of one per preparation batch and is comprised of a matrix similar to the associated client samples. Method blanks are not applicable for certain analyses (i.e., pH, flash point, temperature, etc.).

3.2.2. Each method blank is evaluated for contamination. Corrective actions for blank contamination may include the re-preparation and re-analysis of all samples (where possible) and quality control samples. Data qualifiers must be applied to results that are affected by contamination in a method blank.

3.2.3. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for method blanks.

3.3. Laboratory Control Sample

3.3.1. The Laboratory Control Sample (LCS) is a positive control used to assess the performance of the entire analytical system including preparation and analysis. The LCS is processed at a minimum frequency of one per preparation batch and is comprised of a matrix similar to the associated client samples.

3.3.2. The LCS contains all analytes required by a specific method or by the customer or regulatory agency, which may not include the full list of target compounds. In the absence of specified components, the laboratory will spike the LCS with the following compounds:

- For multi-peak analytes (e.g. PCBs, technical chlordane, toxaphene), a representative standard will be processed.
- For methods with long lists of analytes, a representative number of target analytes may be chosen. The following criteria is used to determine the number of LCS compounds used:
    - For methods with 1-10 target compounds, the laboratory will spike with all compounds;
    - For methods with 11-20 target compounds, the laboratory will spike with at least 10 compounds or 80%, whichever is greater;

- For methods with greater than 20 compounds, the laboratory will spike with at least 16 compounds.

3.3.3. The LCS is evaluated against the method default or laboratory-derived acceptance limits. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Any sample containing a compound that was 'out-of-control' in the associated LCS must either be re-analyzed with a successful LCS or reported with the appropriate data qualifier. When the result of the LCS exceeds the upper control limit, indicating high bias, associated samples determined to be non-detect may be reported without qualification.

3.3.4. For LCSs containing a large number of analytes, it is statistically likely that a few recoveries will be outside of control limits. This does not necessarily mean that the system is out of control, and therefore no corrective action would be necessary other than proper documentation. TNI has allowed for a minimum number of marginal exceedances, defined as recoveries that are beyond the LCS control limits (3X the standard deviation) but within than the marginal exceedance limits (4X the standard deviation). The number of allowable exceedances depends on the number of compounds in the LCS. If more analyte recoveries exceed the LCS control limits than is allowed (see below) or if any one analyte exceeds the marginal exceedance limits, then the LCS is considered non-compliant and corrective actions are necessary. The number of allowable exceedances is as follows:

- >90 analytes in the LCS- 5 analytes
- 71-90 analytes in the LCS- 4 analytes
- 51-70 analytes in the LCS- 3 analytes
- 31-50 analytes in the LCS- 2 analytes
- 11-30 analytes in the LCS- 1 analyte
- <11 analytes in the LCS- no analytes allowed out)

3.3.5. A matrix spike (MS) can be used in place of a non-compliant LCS in a batch as long as the MS passes the LCS acceptance criteria. When this happens, full documentation must be made available to the data user. If this is not allowed by a customer or regulatory body, the associated samples must be rerun with a compliant LCS when possible or reported with appropriate data qualifiers.

3.3.6. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for LCSs.

3.4. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

3.4.1. A matrix spike (MS) is a positive control used to determine the effect of the sample matrix on compound recovery for a particular method. A matrix spike/matrix spike duplicate (MS/MSD) set or matrix spike/sample duplicate set is processed at a frequency specified in a particular method or as determined by a specific customer request. The MS and MSD consist of the sample matrix that is spiked with known concentrations of target analytes.

3.4.2. The MS and MSD contain all analytes required by a specific method or by the customer or regulatory agency. In the absence of specified components, the laboratory will spike the MS/MSD with the same number of compounds as previously discussed in the LCS section.

3.4.3. A matrix spike and sample duplicate will be performed instead of a matrix spike and matrix spike duplicate when specified by the customer or method or when limited sample volume or weight prohibits the analysis of an MS/MSD set.

3.4.4. The MS and MSD are evaluated against the method or laboratory derived limits. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Batch acceptance; however, is based on method blank and LCS performance, not on MS/MSD recoveries. The spike recoveries give the data user a better understanding of the final results based on their site-specific information.

3.4.5. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for MS/MSDs.

3.5. Sample Duplicate

3.5.1. A sample duplicate is a second portion of sample that is prepared and analyzed in the laboratory along with the first portion. It is used to measure the precision associated with preparation and analysis. A sample duplicate is processed at a frequency specified by the particular method or as determined by a specific customer.

3.5.2. The sample and duplicate are evaluated against the method or laboratory limits for relative percent difference (RPD). Any duplicate that is outside of these limits is considered to be 'out of control' and must be qualified appropriately.

3.5.3. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for sample duplicates.

3.6. Surrogates

3.6.1. Surrogates are compounds that reflect the chemistry of target analytes and are added to samples for most organic analyses to measure the extraction efficiency or purge efficiency and to monitor the effect of the sample matrix on surrogate compound recovery.

3.6.2. The surrogates are evaluated against the method or laboratory derived acceptance limits. Any surrogate compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Samples with surrogate failures are typically 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 systemic error. An exception to this would be samples that have surrogate recoveries that exceed the upper control limit but have no reportable hits for target compounds. These samples would be reported and qualified to indicate the implied high bias would not affect the final results.

3.6.3. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for surrogates.

3.7. Internal Standards

3.7.1. Internal Standards are method-specific analytes that are added, as applicable, to every standard, QC sample, and client sample at a known concentration, prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes.

3.7.2. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for internal standards.

3.8. Limit of Detection (LOD)

3.8.1. Pace laboratories use a documented procedure to determine a limit of detection (LOD) for each analyte of concern in each matrix reported. Unless otherwise noted in a published method, the procedure used by Pace laboratories to determine LODs is based on the Method Detection Limit (MDL) procedure outlined in 40 CFR Part 136, Appendix B, August 28, 2017. All sample processing steps of the preparation and analytical methods are included in the LOD determination including any clean ups.

3.8.2. Additional information can be found in the *Determination of Detection and Quantitation Limits* SOP or its equivalent replacement.

3.9. Limit of Quantitation (LOQ)

3.9.1. A limit of quantitation (LOQ) for every analyte of concern must be determined. For Pace laboratories, this LOQ is referred to as the RL, or Reporting Limit. The RL may or may not be based on the lowest calibration standard concentration used in the initial calibration. Results below the lowest calibration level may not be reported without qualification since the results would not be substantiated by a calibration standard. For methods with a determined LOD, results can be reported below the LOQ but above the LOD if they are properly qualified (e.g., J flag).

3.9.2. Additional information can be found in the *Determination of Detection and Quantitation Limits* SOP or its equivalent replacement.

3.10. Estimate of Analytical Uncertainty

3.10.1. Pace can provide an estimation of uncertainty for results generated by the laboratory. The estimate quantifies the error associated with any given result at a 95% confidence interval. This estimate does not include bias that may be associated with sampling or sample matrix. The laboratory has a procedure in place for making this estimation. In the absence of a regulatory or customer-specific procedure, Pace laboratories base this estimation on the recovery data obtained from the Laboratory Control Samples (LCS). The uncertainty is a function of the standard deviation of the recoveries multiplied by the appropriate Student's t Factor at 95% confidence. Additional information pertaining to the estimation of uncertainty and the exact manner in which it is derived are contained in the *Estimation of Measurement Uncertainty* SOP or its equivalent replacement.

3.10.2. The measurement of uncertainty is provided only on request by the customer, as required by specification or regulation and when the result is used to determine conformance within a specification limit.

3.11. Proficiency Testing (PT) Studies

3.11.1. Pace laboratories participate in a defined proficiency testing (PT) program. PT samples are obtained from NIST-approved providers and analyzed and reported a minimum of two times per year for the relevant fields of testing per matrix.

3.11.2. The laboratory initiates an investigation whenever PT results are determined to be ”Not Acceptable” by the PT provider. All findings and corrective actions taken are reported to the SQM/QM or their designee. A corrective action plan is initiated and, when required, this report is sent to the appropriate state accreditation agencies for their review. Additional PTs will be analyzed and reported as needed for certification purposes.

3.11.3. Additional information can be found in the *Proficiency Testing Program* SOP or its equivalent replacement.

3.12. Rounding and Significant Figures

3.12.1. In general, Pace laboratories report data to no more than three significant figures. The rounding rules listed below are descriptive of the LIMS and not necessarily of any supporting program such as Excel.

3.12.2. **Rounding:** Pace - Indianapolis follows the odd / even guidelines for rounding numbers:

- If the figure following the one to be retained is less than five, that figure is dropped and the retained ones are not changed (with three significant figures, 2.544 is rounded to 2.54).
- If the figure following the ones to be retained is greater than five, that figure is dropped and the last retained one is rounded up (with three significant figures, 2.546 is rounded to 2.55).
- If the figure following the ones to be retained is five and if there are no figures other than zeros beyond that five, then the five is dropped and the last figure retained is unchanged if it is even and rounded up if it is odd (with three significant figures, 2.525 is rounded to 2.52 and 2.535 is rounded to 2.54).

3.12.3. **Significant Figures**

3.12.3.1. Pace - Indianapolis observes the following convention for reporting to a specified number of significant figures. Unless specified by federal, state, or local requirements or on specific request by a customer, the laboratory reports:

Values > 10 – Reported to 3 significant figures
Values ≤ 10 – Reported to 2 significant figures

3.13. Retention Time Windows

3.13.1. When chromatographic conditions are changed, retention times and analytical separations are often affected. As a result, two critical aspects of any chromatographic method are the determination and verification of retention times and analyte separation. Retention time windows must be established for the identification of target analytes. The retention times of all target analytes in all calibration verification standards must fall within appropriately determined retention time windows. If an analyte falls outside the retention time window in an ICV or CCV, new absolute retention time windows must be calculated, unless instrument maintenance fixes the problem. New retention time windows must be established when column geometry is affected by maintenance.

3.13.2. Please reference method-specific SOPs for the proper procedure for establishing retention time windows.

3.14. Analytical Method Validation and Instrument Validation

3.14.1. In some situations, Pace develops and validates methodologies that may be more applicable to a specific problem or objective. When non-standard methods are required for specific projects or analytes of interest, when the laboratory develops or modifies a method, or when the laboratory brings new instrumentation online, the laboratory validates the method and/or instrument prior to applying it to customer samples. Method validity is established by meeting criteria for precision and accuracy as established by the data quality objectives specified by the end user of the data. The laboratory records the validation procedure, the results obtained and a statement as to the usability of the method. The minimum requirements for method or instrument validation include evaluation of sensitivity, quantitation, precision, bias, and selectivity of each analyte of interest.

3.15. Regulatory and Method Compliance

3.15.1. It is Pace policy to disclose in a forthright manner any detected noncompliance affecting the usability of data produced by our laboratories. The laboratory will notify customers within 30 days of fully characterizing the nature of the nonconformance, the scope of the nonconformance and the impact it may have on data usability.

4.0. DOCUMENT MANAGEMENT AND CHANGE CONTROL

4.1. Document Management

4.1.1. Additional information can be found in the *Document Control and Management* SOP or its equivalent replacement. Information on Pace's policy for electronic signatures can also be found in this SOP.

4.1.2. Pace has an established procedure for managing documents that are part of the quality system.

4.1.3. A master list of managed documents is maintained at each facility identifying the current revision status and distribution of any controlled documents.

4.1.4. Each managed document is uniquely identified to include the date of issue, the revision identification, page numbers, the total number of pages and the issuing authorities. For complete information on document numbering, refer to the *Document Numbering* SOP or its equivalent replacement.

4.1.5. **Quality Assurance Manual (QAM):** The Quality Assurance Manual is the company-wide document that describes all aspects of the quality system for Pace. The base QAM template is distributed by the Corporate Environmental Quality Department to each of the SQMs/QMs. The local management personnel modify the necessary and permissible sections of the base template then applicable lab staff will sign the Quality Assurance Manual. Each SQM/QM is then in charge of distribution to employees, external customers or regulatory agencies and maintaining a distribution list of controlled document copies. The Quality Assurance Manual template is reviewed on an annual basis and revised accordingly by the Corporate Quality office.

4.1.6. **Standard Operating Procedures (SOPs)**

4.1.6.1. SOPs are reviewed every two years at a minimum; although, a more frequent review may be required by some state or federal agencies or customers. If no revisions are made based on this review, documentation of the review itself is made by the addition of new signatures on the cover page. If revisions are made, documentation of the revisions is made in the revisions section of each SOP and a new revision number is applied to the SOP. This provides a historical record of all revisions.

4.1.6.2. All copies of superseded SOPs are removed from general use and the original copy of each SOP is archived for audit or knowledge preservation purposes. This ensures that all Pace employees use the most current version of each SOP and provides the SQM/QM with a historical record of each SOP.

4.1.6.3. Additional information can be found in the *Preparation of SOPs* SOP or its equivalent replacement.

4.2. Document Change Control

4.2.1. Additional information can be found in the *Document Control and Management* SOP or its equivalent replacement.

4.2.2. Changes to managed documents are reviewed and approved in the same manner as the original review. Any revision to a document requires the approval of the applicable signatories. After

revisions are approved, a revision number is assigned and the previous version of the document is officially retired.

4.2.3. All copies of the previous document are replaced with copies of the revised document and the superseded copies are destroyed or archived. All affected personnel are advised that there has been a revision and any necessary training is scheduled.

5.0. EQUIPMENT AND MEASUREMENT TRACEABILITY

5.1. Standards and Traceability

5.1.1. Each Pace facility retains pertinent information for standards, reagents, and chemicals to assure traceability to a national standard. This includes documentation of purchase, receipt, preparation, and use.

5.1.2. Upon receipt, all purchased standard reference materials are recorded into a standard logbook or database and assigned a unique identification number. The entries include the facility's unique identification number, the chemical name, manufacturer name, manufacturer's identification numbers, receipt date, and expiration date. Vendor's certificates of analysis for all standards, reagents, or chemicals are retained for future reference.

5.1.3. Subsequent preparations of intermediate or working solutions are also documented in a standard logbook or database. These entries include the stock standard name and lot number, the manufacturer name, the solvents used for preparation, the solvent lot number and manufacturer, the preparation steps, preparation date, expiration dates, preparer's initials, and a unique Pace identification number. This number is used in any applicable sample preparation or analysis logs so the standard can be traced back to the standard preparation record. This process ensures traceability back to the national standard.

5.1.4. Prepared standard or reagent containers include the Pace identification number, the standard or chemical name, and expiration date. The date of preparation, concentration with units, and the preparer's initials can be determined by tracing the standard or reagent ID through the standard log database.

5.1.5. Initial calibrations must be verified with a standard obtained from a second manufacturer or a separate lot prepared independently by the same manufacturer, unless client-specific QAPP requirements state otherwise.

5.1.6. Reference standards and reference materials must be handled, stored, and maintained in a manner that prevents contamination and/or deterioration. Reference standards and reference materials must be stored per manufacturer's recommendations to avoid degradation and stored away from other materials that could contaminate them. Handle reference standards and reference materials with care to avoid evaporation, contamination, degradation or concentration of the material. If it is necessary to package and transport or ship any reference standard or reference material, consult with the manufacturer for proper packaging, labeling and shipping instructions to prevent damage, contamination or deterioration.

5.1.7. Additional information concerning the procurement of standards and reagent and their traceability can be found in the *Standard and Reagent Management and Traceability* SOP or its equivalent replacement.

5.2. General Analytical Instrument Calibration Procedures

5.2.1. Applicable instrumentation are calibrated or checked before use to ensure proper functioning and verify that laboratory, client and regulatory requirements are met. All calibrations are performed by, or under the supervision of, an experienced analyst at scheduled intervals against either certified standards traceable to recognized national standards or reference standards whose values have been statistically validated.

5.2.2. Calibration standards for each parameter are chosen to establish the linear range of the instrument and must bracket the concentrations of those parameters measured in the samples. The lowest calibration standard is the lowest concentration for which quantitative data may be reported. Data reported below this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in a narrative. The highest calibration standard is the highest concentration for which quantitative data may be reported. Data reported above this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in the narrative.

5.2.3. Instrumentation or support equipment that cannot be calibrated to specification or is otherwise defective is clearly labeled as out-of-service until it has been repaired and tested to demonstrate it meets the laboratory's specifications. All repair and maintenance activities including service calls are documented in the maintenance log. Equipment sent off-site for calibration testing is packed and transported to prevent breakage and is in accordance with the vendor's recommendations.

5.2.4. In the event that recalibration of a piece of test equipment indicates the equipment may have been malfunctioning during the course of sample analysis, an investigation is performed. The results of the investigation along with a summary of the information reviewed are documented and maintained by the quality manager. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed. This allows for sufficient investigation and review of documentation to determine the impact on the analytical results. Instrumentation found to be consistently out of calibration is either repaired and positively verified or taken out of service and replaced.

5.2.5. Raw data records are retained to document equipment performance. Sufficient raw data is retained to reconstruct the instrument calibration and explicitly connect the continuing calibration verification to the initial calibration.

5.2.6. Please reference the *Calibration Procedures* SOP or its equivalent replacement and SOPs for specific methods for more detailed calibration information.

5.3. Support Equipment Calibration and Verification Procedures

5.3.1. All support equipment is calibrated or verified at least annually using NIST traceable references over the entire range of use, as applicable. The results of calibrations or verifications must be within the specifications required or the equipment will be removed from service until brought back into control. Additional information regarding calibration and maintenance of support equipment can be found in the *Support Equipment* SOP or its equivalent replacement.

5.3.2. On each day of use, balances, ovens, refrigerators, incubators, freezers and water baths are checked in the expected range of use with NIST traceable references in order to ensure the equipment meets laboratory specifications. These checks are documented appropriately.

5.3.3. **Analytical Balances**

5.3.3.1. Each analytical balance is calibrated or verified annually by a qualified service technician. The calibration of each balance is verified each day of use with weights traceable to NIST bracketing the range of use. Working calibration weights are ASTM Class 1 or other class weights that have been calibrated against a reference weight set that is re-certified every 5 years, at a minimum, by the manufacturer or other qualified vendor, against a NIST traceable reference. If balances are calibrated by an external vendor, verification of their weights must be

available upon request. All information pertaining to balance maintenance and calibration is recorded on the balance's monitoring log and/or is maintained on file in the local Quality department.

5.3.4. **Thermometers**

5.3.4.1. Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are re-certified every 3 years, at a minimum by the manufacturer or other qualified vendor with equipment directly traceable to NIST.

5.3.4.2. Working thermometers and temperature sensors that are electronic, digital or mechanical are verified against the reference thermometer quarterly according to corporate metrology procedures. Working thermometers that are liquid-in-glass are verified against the reference thermometer annually according to corporate metrology procedures. Alternatively, working thermometers may be replaced with new thermometers in lieu of verification against the reference thermometer or may be verified by the manufacturer or other qualified vendor. Each working thermometer is individually numbered and assigned a correction factor, when applicable, based on comparison with the NIST reference source. In addition, working thermometers are visually inspected by laboratory personnel prior to use and when temperatures are documented.

5.3.4.3. Laboratory thermometer inventory and calibration data are maintained in the local Quality department.

5.3.5. **pH/Electrometers**

5.3.5.1. The meter is calibrated before use each day, at a minimum, using fresh buffer solutions.

5.3.5.2. The pH electrode is inspected daily and cleaned, filled or replaced as needed.

5.3.6. **Spectrophotometers**

5.3.6.1. During use, spectrophotometer performance is checked at established frequencies in analysis sequences against initial calibration verification (ICV) and continuing calibration verification (CCV) standards.

5.3.7. **Mechanical Volumetric Dispensing Devices**

5.3.7.1. Mechanical volumetric dispensing devices including bottle top dispensers dispensing critical volumes, pipettes, and burettes, excluding Class A volumetric glassware, are checked for accuracy on a quarterly basis.

5.4. Instrument/Equipment Maintenance

5.4.1. The objectives of the Pace Analytical maintenance program are twofold: to establish a system of instrument care that maintains instrumentation and equipment at required levels of calibration and sensitivity, and to minimize loss of productivity due to repairs.

5.4.2. Department managers are responsible for providing technical leadership to evaluate new equipment, solve equipment problems, and coordinate instrument repair and maintenance. Analysts have the primary responsibility to perform routine maintenance.

5.4.3. To minimize downtime and interruption of analytical work, preventative maintenance may routinely performed on each analytical instrument. Up-to-date instructions on the use and maintenance of equipment are available to staff in the department where the equipment is used.

5.4.4. Department managers are responsible for maintaining an adequate inventory of spare parts required to minimize equipment downtime. This inventory includes parts and supplies that are subject to frequent failure, have limited lifetimes, or cannot be obtained in a timely manner should a failure occur.

5.4.5. All major equipment and instrumentation items are uniquely identified to allow for traceability. Equipment/instrumentation is, unless otherwise stated, identified as a system and not as individual pieces. The laboratory maintains equipment records that include the following:

- The name of the equipment and its software
- The manufacturer's name, type, and serial number
- Approximate date received and date placed into service
- Current location in the laboratory
- Condition when received (new, used, etc.)
- Copy of any manufacturer's manuals or instructions
- Dates and results of calibrations and next scheduled calibration (as applicable)
- Details of past maintenance activities, both routine and non-routine
- Details of any damage, modification or major repairs

5.4.6. All instrument maintenance is documented in maintenance logbooks that are assigned to each particular instrument or system.

5.4.7. The maintenance log entry must include a summary of the problem encountered, the maintenance performed, and an indication that the instrument has been returned to an in-control status. In addition, each entry must include the initials of the analyst making the entry, the dates the maintenance actions were performed, and the date the entry was made in the maintenance logbook, if different from the date(s) of the maintenance.

5.4.8. Any equipment that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown to be defective, is taken out of service and clearly identified. The equipment shall not be used to analyze customer samples until it has been repaired and shown to perform satisfactorily. In the event of instrumentation failure, to avoid hold time issues, the lab may subcontract the necessary samples to another Pace lab or to an outside subcontract lab if possible.

5.5. General Handling, Storage, Maintenance and Transport of Equipment

5.5.1. All support, measurement, and reference equipment must be handled, stored, and maintained in a manner that prevents contamination and/or deterioration. Balances, refrigerators, freezers, incubators, ovens, and hot blocks should be kept clean and free from debris inside and outside. Reference thermometers and reference weight sets must be controlled by the Quality Department, kept in pristine condition and inspected before each use. Working thermometers, weight sets, mechanical pipettes, and bottle top dispensers should be kept clean, inspected for damage before use, and handled properly. When it is necessary to package and transport or ship any support, measurement, or reference equipment to an external vendor for repair, maintenance, calibration, or certification, consult with the external vendor for proper packing, labeling and shipping to prevent damage, contamination, or deterioration.

6.0. CONTROL OF DATA

Analytical results processing, verification, and reporting are procedures employed that result in the delivery of defensible data. These processes include, but are not limited to, calculation of raw data into final concentration values, review of results for accuracy, evaluation of quality control criteria and assembly of technical reports for delivery to the data user.

All analytical data undergo a documented multi-tier review process prior to being reported to the customer. This section describes procedures used for translating raw analytical data into accurate final sample reports as well as Pace data storage policies.

When analytical data or field data is generated, it is documented appropriately. The resulting logbooks and other laboratory records are kept in accordance with each facility's SOP for documentation storage and archival. The laboratory must ensure that there are sufficient redundant copies of electronic data so that no data is lost due to unforeseen computer issues

6.1. Primary Data Review

6.1.1. The primary analyst is responsible for initial data reduction and data review. This includes confirming compliance with required methodology, verifying calculations, evaluating quality control data, noting observations or non-conformances in logbooks or as footnotes or narratives, and uploading analytical results into the LIMS. Data review checklists, either hardcopy or electronic, are used to document the primary data review process. The primary analyst must be clearly identified in all applicable logbooks, spreadsheets, LIMS fields, and data review checklists.

6.1.2. The primary analyst compiles the initial data for secondary data review. This compilation must include sufficient documentation for secondary data review.

6.1.3. Additional information regarding data review procedures can be found in the *Data Review Process* SOP or its equivalent replacement, as well as in the *Manual Integration* SOP or its equivalent replacement.

6.2. Secondary Data Review

6.2.1. Secondary data review is the process of examining data and accepting or rejecting it based on pre-defined criteria. This review step is designed to ensure that reported data are free from calculation and transcription errors, that quality control parameters are evaluated, and that any non-conformances are properly documented.

6.2.2. The completed data from the primary analyst is sent to a designated qualified secondary data reviewer, which must be someone other than the primary analyst. The secondary data reviewer provides an independent technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. This assessment involves a quality control review for use of the proper methodology and detection limits, compliance to quality control protocol and criteria, presence and completeness of required deliverables, and accuracy of calculations, data quantitation and applicable data qualifiers. The reviewer validates the data entered into the LIMS and documents review and approval of manual integrations. Data review checklists, either hardcopy or electronic, are used to document the secondary data review process.

6.2.3. Additional information regarding data review procedures can be found in the *Data Review Process* SOP or its equivalent replacement, as well as in the *Manual Integration* SOP or its equivalent replacement.

6.3. Data Reporting

6.3.1. Data for each analytical fraction pertaining to a particular Pace project number are released in the LIMS upon validation for assembly into the final report. Anomalies encountered during technical and QC reviews are included in data qualifiers on the final report or in a separate case narrative if there is potential for data to be impacted.

6.3.2. Final reports are prepared according to the level of reporting required by the customer and can be transmitted to the customer via hardcopy or electronic deliverable. A standard Pace final report consists of the following components:

6.3.2.1. A title which designates the report as "Report of Laboratory Analysis";

6.3.2.2. Name and address of laboratory and/or subcontractor laboratories, if used;

6.3.2.3. Phone number and name of laboratory contact to whom questions can be referred;

6.3.2.4. A unique identification number for the report. The pages of the report are numbered and a total number of pages is indicated;

6.3.2.5. Name and address of customer and name of project;

6.3.2.6. Unique laboratory identification of samples analyzed as well as customer sample IDs;

6.3.2.7. Date and time of sample collection, sample receipt and sample analysis;

6.3.2.8. Identification of the test methods used;

6.3.2.9. Qualifiers to the analytical data, if applicable;

6.3.2.10. Identification of whether results are reported on a dry-weight or wet-weight basis;

6.3.2.11. Reporting limits;

6.3.2.12. Final results or measurements;

6.3.2.13. A signature and title, electronic or otherwise, of person accepting responsibility for the content of the report;

6.3.2.14. Date report was issued;

6.3.2.15. A statement clarifying that the results of the report relate only to the samples tested or to the samples as they were received by the laboratory;

6.3.2.16. A statement indicating that the report must not be reproduced except in full, without the written approval of the laboratory;

6.3.3. Any changes made to a final report shall be designated as "Revised" or equivalent wording. The laboratory must keep sufficient archived records of all laboratory reports and revisions. For higher levels of data deliverables, a copy of all supporting raw data is sent to the customer along with a final report of results. Pace will provide electronic data deliverables (EDD) as required by contracts or upon customer request.

6.3.4. Customer data that requires transmission by telephone, telex, facsimile or other electronic means undergoes appropriate steps to preserve confidentiality.

6.3.5. The following positions are the only approved signatories for Pace final reports:

- Senior General Manager
- General Manager
- Quality Manager
- Client Services Manager
- Project Manager
- Project Coordinator

6.3.6. Additional information regarding final reports and data deliverables can be found in the *Final Report and Data Deliverable Contents* SOP or its equivalent replacement.

6.4. Data Security

6.4.1. All data including electronic files, logbooks, extraction/digestion/distillation worksheets, calculations, project files and reports, and any other information used to produce the technical report are maintained secured and retrievable by the Pace facility.

6.5. Data Archiving

6.5.1. All records compiled by Pace are archived in a suitable, limited-access environment to prevent loss, damage, or deterioration by fire, flood, vermin, theft, and/or environmental deterioration. Records are retained for a minimum of five years unless superseded by federal, state, contractual, and/or accreditation requirements. TNI-related records will be made readily available to accrediting authorities. Access to archived data is controlled by the Quality Department.

6.5.2. Records that are computer-generated have either a hard copy or electronic backup copy. Hardware and software necessary for the retrieval of electronic data is maintained with the applicable records. Archived electronic records are stored protected against electronic and/or magnetic sources.

6.5.3. In the event of a change in ownership, accountability or liability, reports of analyses performed pertaining to accreditation will be maintained per the purchase agreement. In the event of bankruptcy, laboratory reports and/or records will be transferred to the customer and/or the appropriate regulatory entity upon request.

6.6. Data Disposal

6.6.1. Data that has been archived for the facility's required storage time may be disposed of in a secure manner by shredding, returning to customer, or utilizing some other means that does not jeopardize data confidentiality. Records of data disposal will be archived for a minimum of five years unless superseded by federal, contractual, and/or accreditation requirements. Data disposal includes any preliminary or final reports, raw analytical data, logs or logbooks, and electronic files.

7.0. QUALITY SYSTEM AUDITS AND REVIEWS

7.1. Internal Audits

7.1.1. Responsibilities

7.1.1.1. The SQM/QM is responsible for managing, assigning and/or conducting internal audits in accordance with a predetermined schedule and procedure. Since internal audits represent an independent assessment of laboratory functions, the auditor must be independent from laboratory operations to ensure objectivity. 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 SQM/QM evaluates audit observations and verifies the completion of corrective actions. In addition, a periodic corporate audit will be conducted. The corporate audits will focus on the effectiveness of the Quality System as outlined in this manual but may also include other quality programs applicable to an individual laboratory.

7.1.1.2. Additional information can be found in the *Internal and External Audits* SOP or its equivalent replacement.

7.1.2. Scope and Frequency of Internal Audits

7.1.2.1. The complete internal audit process consists of the following four sections, at a minimum:

- Raw Data Review audits- conducted according to a schedule per local SQM/QM. A certain number of these data review audits may be conducted per quarter to accomplish this yearly schedule;
- Quality System audits- considered the traditional internal audit function and includes analyst interviews to help determine whether practice matches method requirements and SOP language;
- Final Report reviews;
- Corrective Action Effectiveness Follow-up

7.1.2.2. Internal systems audits are conducted annually at a minimum. The scope of these audits includes evaluation of specific analytical departments or a specific quality related system as applied throughout the laboratory.

7.1.2.3. Where the identification of non-conformities or departures cast doubt on the laboratory's compliance with its own policies and procedures, the lab must ensure that the appropriate areas of activity are audited as soon as possible.

7.1.2.4. Certain projects may require an internal audit to ensure laboratory conformance to site work plans, sampling and analysis plans, QAPPs, etc.

7.1.2.5. The laboratory, as part of their overall internal audit program, ensures that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery and reporting of potential data integrity issues are handled in a confidential manner. All investigations that result in findings of inappropriate activity are fully documented, including the source of the problem, the samples and customers affected the impact on the data, the corrective actions taken by the laboratory, and identification of final reports that were re-issued. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed.

7.1.3. **Internal Audit Reports and Corrective Action Plans**

7.1.3.1. A full description of the audit, including the identification of the operation audited, the date(s) on which the audit was conducted, the specific systems examined, and the observations noted are summarized in an internal audit report. The Quality Department auditor writes and issues the internal audit report identifying which audit observations are deficiencies that require corrective action.

7.1.3.2. When audit findings cast doubt on the effectiveness of the operations or on the correctness of validity of the laboratory's environmental test results, the laboratory will take timely corrective action and notify the customer in writing within three business days, if investigations show that the laboratory results may have been affected.

7.1.3.3. Additional information can be found in the *Internal and External Audits* SOP or its equivalent replacement.

7.2. External Audits

7.2.1. Pace laboratories are audited routinely by regulatory agencies to maintain laboratory certifications and by customers to maintain appropriate specific protocols.

7.2.2. External audit teams review the laboratory to assess the effectiveness of quality systems. The SQM/QM host the external audit team and assist in facilitation of the audit process. After the audit, the external auditors will prepare a formalized audit report listing deficiencies observed and follow-up requirements for the laboratory. The laboratory staff and supervisors develop corrective action plans to address any deficiencies with the guidance of the SQM/QM, who provides a written response to the external audit team. The SQM/QM follows-up with the laboratory staff to ensure corrective actions are implemented and that the corrective action was effective.

7.3. Annual Managerial Review

7.3.1. A managerial review of Management and Quality Systems is performed on an annual basis at a minimum. This allows for assessing program effectiveness and introducing changes and/or improvements. Additional information can be found in the *Review of Laboratory Management Systems* SOP or its equivalent replacement.

7.3.2. The managerial review must include the following topics of discussion:

- Suitability of policies and procedures
- Reports from managerial personnel
- Internal audit results
- Corrective and preventive actions
- External assessment results
- Proficiency testing studies
- Sample capacity and scope of work changes
- Customer feedback, including complaints
- Recommendations for improvement,
- Other relevant factors, such as quality control activities, resources, staffing, and safety/waste activities.

7.3.3. This managerial review must be documented for future reference by the SQM/QM and copies of the report are distributed to laboratory staff. Results must feed into the laboratory planning system and must include goals, objectives, and action plans for the coming year. The laboratory shall ensure that any actions identified during the review are carried out within an appropriate and agreed upon timeframe.

8.0. CORRECTIVE ACTION

Additional information can be found in the *Corrective and Preventive Actions* SOP or its equivalent replacement.

During the process of sample handling, preparation, and analysis, during review of quality control records, or during reviews of non-technical portions of the lab, certain occurrences may warrant corrective actions. These occurrences may take the form of analyst errors, deficiencies in quality control, method deviations, or other unusual circumstances. The Quality System of Pace provides systematic procedures for the documentation, monitoring, completion of corrective actions, and follow-up verification of the effectiveness of these corrective actions. This can be done using Pace's LabTrack system or other system that lists at a minimum, the deficiency by issue number, the deficiency source, responsible party, root cause, resolution, due date, and date resolved.

8.1. Corrective and Preventive Action Documentation

8.1.1. The following items are examples of sources of laboratory deviations or non-conformances that may warrant some form of documented corrective action:

- Internal Laboratory Non-Conformance Trends
- Proficiency Testing Sample Results
- Internal and External Audits
- Data or Records Review
- Client Complaints
- Client Inquiries
- Holding Time violations

8.1.2. Documentation of corrective actions may be in the form of a comment or footnote on the final report that explains the deficiency or it may be a more formal documentation. This depends on the extent of the deficiency, the impact on the data, and the method or customer requirements for documentation.

8.1.3. The person who discovers the deficiency or non-conformance initiates the corrective action documentation within LabTrack. The documentation must include the affected projects and sample numbers, the name of the applicable Project Manager, the customer name, and any other pertinent information. The person initiating the corrective action documentation must also list the known causes of the deficiency or non-conformance as well as any corrective/preventative actions that they have taken. Preventive actions must be taken in order to prevent or minimize the occurrence of the situation.

8.1.4. **Root Cause Analysis**: Laboratory personnel and management staff will start a root cause analysis by going through an investigative process. During this process, the following general steps must be taken into account: defining the non-conformance, assigning responsibilities, determining if the condition is significant, and investigating the root cause of the nonconformance. General non-conformance investigative techniques follow the path of the sample through the process looking at each individual step in detail. The root cause must be documented within LabTrack.

8.1.5. Based on the determined root cause(s), the lab implements applicable corrective actions and verifies their effectiveness. In the event that analytical testing or results do not conform to documented

laboratory policies or procedures Project Management will notify the customer of the situation and will advise of any affect to data quality, if applicable.

8.2. Corrective Action Completion

8.2.1. Internal Laboratory Non-Conformance Trends

8.2.1.1. There are several types of non-conformance trends that may occur in the laboratory that would require the initiation of a corrective action report. Laboratories may choose to initiate a corrective action for all instances of one or more of these categories; however, the intent is that each of these would be handled according to its severity; one time instances could be handled with a footnote or qualifier whereas a systemic problem with any of these categories may require an official corrective action process. These categories, as defined in the Corrective Action SOP are as follows:

- Login error
- Preparation Error
- Contamination
- Calibration Failure
- LCS Failure
- Calculation error
- Laboratory accident
- Instrument Failure
- Final Reporting/Data Entry error

8.2.2. PE/PT Sample Results

8.2.2.1. Any PT result assessed as "not acceptable" requires an investigation and applicable corrective actions. The operational staff is made aware of the PT failures and they are responsible for reviewing the applicable raw data and calibrations and list possible causes for error. The SQM/QM reviews their findings and initiates a replacement PT sample if required. Replacement PT results must be monitored by the SQM/QM and reported to the applicable regulatory authorities.

8.2.2.2. Additional information, such as requirements regarding time frames for reporting failures to states, makeup PTs, and notifications of investigations, can be found in the *Proficiency Testing Program* SOP or its equivalent replacement.

8.2.3. Internal and External Audits

8.2.3.1. The SQM/QM or designee is responsible for documenting all audit findings and their corrective actions. This documentation must include the initial finding, the persons responsible for the corrective action, the due date for responding to the auditing body, the root cause of the finding, and the corrective actions needed for resolution. The SQM/QM or designee is also responsible for providing any back-up documentation used to demonstrate that a corrective action has been completed.

8.2.4. **Data Review**

8.2.4.1. In the course of performing primary and secondary review of data or in the case of raw data review, errors may be found which require corrective actions. Any finding that affects the quality of the data requires some form of corrective action, which may include revising and re-issuing of final reports.

8.2.5. **Client Complaints**

8.2.5.1. Project Managers are responsible for issuing corrective action requests, when warranted, for customer complaints. As with other corrective actions, the appropriate analyst or supervisor begin an investigation to determine possible causes and corrective actions. After potential corrective actions have been determined, the Project Manager reviews the corrective action to ensure all customer needs or concerns are being adequately addressed.

8.2.6. **Client Inquiries**

8.2.6.1. When an error on the customer's final report is discovered, the Project Manager is responsible for initiating a formal corrective action form that describes the failure (e.g., incorrect analysis reported, reporting units are incorrect, or reporting limits do not meet objectives). The Project Manager is also responsible for revising the final report if necessary and submitting it to the customer.

8.2.7. **Holding Time Violations**

8.2.7.1. In the event that a holding time has been exceeded due to laboratory error, the analyst or supervisor must complete formal corrective action. The Project Manager and the SQM/QM must be made aware of all holding time violations due to laboratory error.

8.2.7.2. The Project Manager must contact the customer in order that appropriate decisions are made regarding the out-of-hold sample and the ultimate resolution is then documented and included in the customer project file.

9.0. GLOSSARY

The source of some of the definitions is indicated previous to the actual definition (e.g., TNI, DoD).

Terms and Definitions	
3P Program	The Pace continuous improvement program that focuses on Process, Productivity, and Performance. Best Practices are identified that can be used by all Pace labs.
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.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program.
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	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	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.
Analytical Method	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.
Annual (or Annually)	Defined by Pace 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).
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. 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 - 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).

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	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.
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	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	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	Action taken to eliminate a detected non-conformity.
Corrective Action	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 – α) that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	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	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.
Detection Limit (DL)	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)	Deuterated compounds used as surrogates for GC/MS 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).
Digestion	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	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	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	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	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 space 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.

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).
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.
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.
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)	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.
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 - 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)	The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
LabTrack	Database used by Pace to store and track corrective actions and other laboratory issues.
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.
Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level.
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.
Linear Dynamic Range	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.
May	EPA – The word "may" is used to provide guidance on aspects of the method that are useful but not essential.
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).
Measurement Uncertainty	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.
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 Pace 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.
Must	EPA – The word "must" is used to indicate aspects of the method that are considered essential to its performance, based on sound analytical practices.
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.

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.
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	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.
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 - 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.
Quantitation Range	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	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	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 lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions. 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.
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".
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.
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	EPA – The word "shall" is used to indicate aspects of the method that are considered essential to its performance, based on sound analytical practices.
Should	EPA – The word "should" is used to provide guidance on aspects of the method that are useful but not essential.
Signal-to-Noise Ratio (S/N)	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.
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	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	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	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	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	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	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).

10.0. REFERENCES

10.1. "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, most current version.

10.2. "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.

10.3. "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.

10.4. U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis.

10.5. U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis.

10.6. "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.

10.7. "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.

10.8. "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.

10.9. "NIOSH Manual of Analytical Methods", U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, most current version.

10.10. "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).

10.11. Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.

10.12. Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.

10.13. Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.

10.14. Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.

10.15. Requirements for Quality Control of Analytical Data for the Environmental Restoration Program, Martin Marietta, ES/ER/TM-16, December, 1992.

10.16. Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, most current version.

10.17. National Environmental Laboratory Accreditation Conference (NELAC) Standard- most current version.

10.18. ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories- most current version.

10.19. Department of Defense Quality Systems Manual (QSM), most current version.

10.20. TNI (The NELAC Institute) Standard- 2003 and 2009.

10.21. UCMR Laboratory Approval Requirements and Information Document, most current version.

10.22. US EPA Drinking Water Manual, most current version.

11.0. REVISIONS

The Pace Corporate Environmental Quality Office files an electronic version of a Microsoft Word document with tracked changes detailing all revisions made to previous versions of the Quality Assurance Manual. This document is available upon request. All current revisions are summarized in the table below.

Document Number	Reason for Change	Date
Quality Assurance Manual 19.0	General: made administrative edits that do not affect the policies or procedures within the document (including revising company name to Pace Analytical Services, LLC). Cover page: removed corporate approval signature lines and revised document control format. Table of Contents: added Attachment VII – Pace COC Old Section 3: moved to other sections of the QAM as applicable and deleted entire section (All section references below reflect the new section numbers). Section 1.1.2: replaced with section 3.1.1. Sections 1.3, 1.4, 1.11: removed extraneous language. Sections 1.5: added language from old section 1.6. Section 1.6: revised anonymous reporting information. Section 1.8: removed job descriptions for non-applicable personnel. Section 1.8.4: added tasks to QM job description. Section 1.8.8: added tasks to PM job description. Section 1.11.1: added keyless entry using key fobs detail. Section 2: rearranged existing sections. Section 2.4: reworded to match existing Sample Acceptance policy document. Section 2.6.3.2: added some detail regarding temperature monitoring corrective action. Section 2.6.5.1: added by-products of USDA soils. Section 3.2.2: added basic evaluation criteria. Section 3.4.3: added MS and Dup as optional alternative to MS/MSD. Section 3.5.2: added basic evaluation criteria. Section 3.9.1: added that RL may be based on calibration standard. Section 3.14: added new instrumentation as requiring validation. Section 4: in general, for each QC type, removed language regarding frequency and corrective actions and referenced lab-specific SOPs. Section 5: in general, removed extraneous language and Management of Change section. Section 5.1, 5.2: reorganized into Primary and Secondary Review sections and removed extraneous language. Section 5.3.2: specified types of support equipment to be monitored daily. Section 5.3.3.1: specified “working” weights. Section 5.3.4.2: added temperature sensors and added alternatives to annual in-house verification. Section 5.3.5: added pH electrode inspection/maintenance. Section 6: removed extraneous language including Quarterly Report section. Section 8.2.3.1: added “or designee”. Section 9 (glossary): revised and added definitions based on 2016 TNI Standard. Added “may, must, shall and should” based on SW-846 definition. Section 10: Added EPA DW Manual and revised references as applicable. Attachment III: updated corporate organizational chart. Old Attachment IV: removed floor plan attachment. Old Attachment VII: removed COC (available in SOPs). Indy added back in.	22Mar2017

Document Number	Reason for Change	Date
Quality Assurance Manual 19.1	Throughout the document, references to SOP numbers were removed leaving only SOP titles. Section 1.8.9: added for Project Coordinator position. Section 2.4.3: changed "drinking water" to "drinking water compliance" for clarity. Section 2.6.4.1: clarified hazardous sample labeling. Section 3.8.1: updated the 40 CFR Part 136 reference. Section 3.12.1: removed language that limits the use of 3 sig figs. Section 5.1.6: added section to generally cover handling, storage, and transport of reference standards and reference materials. Section 5.2: removed details and added reference to Calibration Procedures SOP. Section 5.3.4: updated to reflect quarterly digital/mechanical thermometer calibration. Section 5.5: added section to generally cover handling, storage, maintenance and transport of measurement equipment. Section 6.3.1: clarified data review anomalies will be qualified or narrated. Section 6.3.2.1: updated to include the actual name of the final report. Section 8.2.2.1: added "calculation error" as a possible type of non-conformance. Glossary: updated definition of Deuterated Monitoring Compounds, removed DoD references, and updated the definition of Reporting Limit (RL). Attachment II: updated Attachment III: updated Attachment VI: updated Attachment V: updated Attachment VI: updated	14Jun2018

ATTACHMENT I- QUALITY CONTROL CALCULATIONS

PERCENT RECOVERY (%REC)

$$\%REC = \frac{(MSConc - SampleConc)}{TrueValue} * 100$$

NOTE: The SampleConc is zero (0) for the LCS and Surrogate Calculations

PERCENT DIFFERENCE (%D)

$$\%D = \frac{MeasuredValue - TrueValue}{TrueValue} * 100$$

where:
TrueValue = Amount spiked (can also be the $\overline{CF}$ or $\overline{RF}$ of the ICAL Standards)
Measured Value = Amount measured (can also be the CF or RF of the CCV)

PERCENT DRIFT

$$\%Drift = \frac{CalculatedConcentration - TheoreticalConcentration}{TheoreticalConcentrtion} * 100$$

RELATIVE PERCENT DIFFERENCE (RPD)

$$RPD = \frac{|(R1 - R2)|}{(R1 + R2)/2} * 100$$

where:
R1 = Result Sample 1
R2 = Result Sample 2

CORRELATION COEFFICIENT (R)

$$CorrCoeff = \frac{\sum_{i=1}^{N} W_i * (X_i - \overline{X}) * (Y_i - \overline{Y})}{\sqrt{\left(\sum_{i=1}^{N} W_i * (X_i - \overline{X})^2\right) * \left(\sum_{i=1}^{N} W_i * (Y_i - \overline{Y})^2\right)}}$$

With:		
	N	Number of standard samples involved in the calibration
	i	Index for standard samples
	Wi	Weight factor of the standard sample no. i
	Xi	X-value of the standard sample no. i
	X(bar)	Average value of all x-values
	Yi	Y-value of the standard sample no. i
	Y(bar)	Average value of all y-values

ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

STANDARD DEVIATION (S)

$$S = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{(n-1)}}$$

where:
n = number of data points
X_i = individual data point
$\overline{X}$ = average of all data points

AVERAGE ($\overline{X}$)

$$\overline{X} = \frac{\sum_{n=1}^{i} X_i}{n}$$

where:
n = number of data points
X_i = individual data point

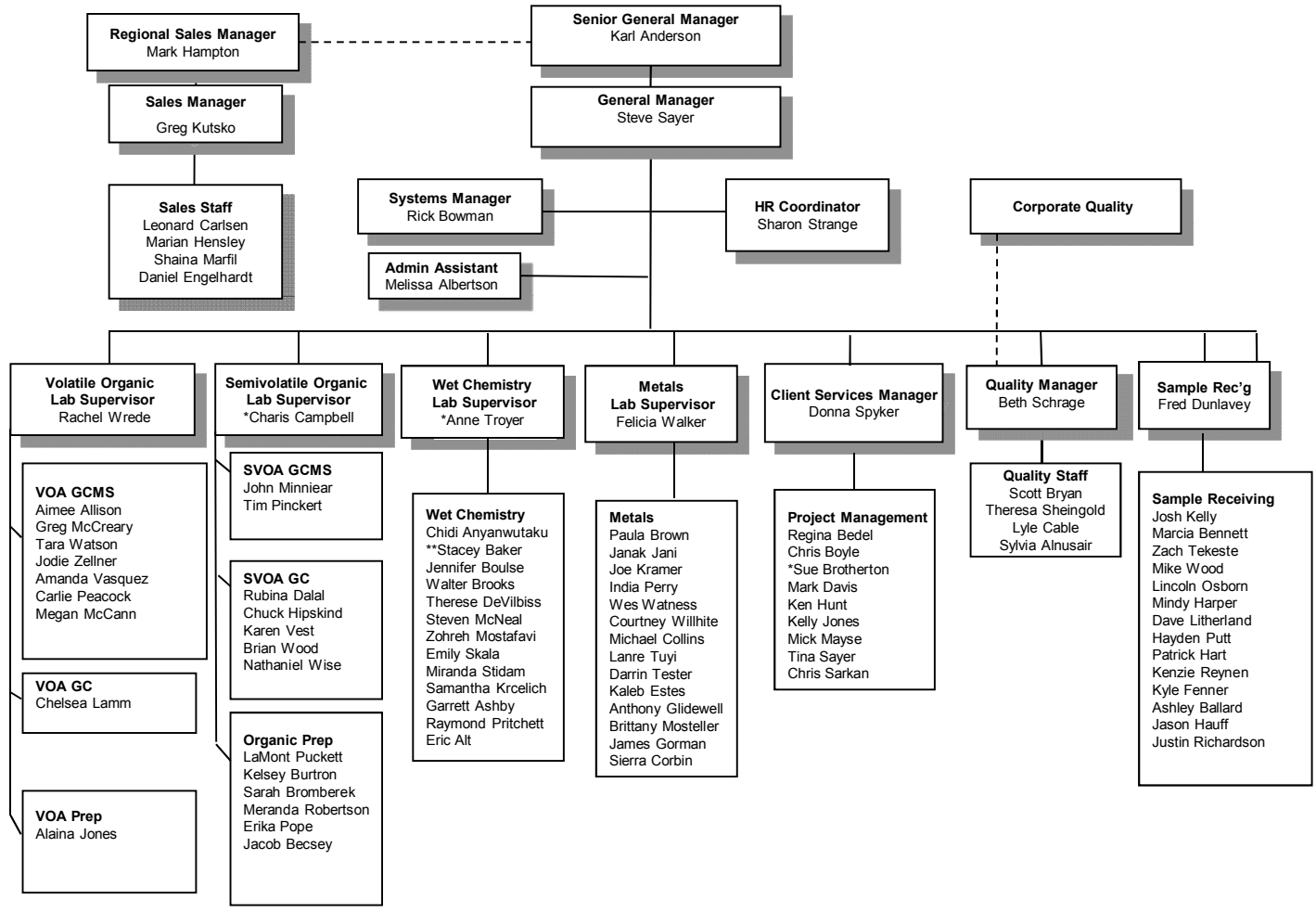
RELATIVE STANDARD DEVIATION (RSD)

$$RSD = \frac{S}{\overline{X}} * 100$$

where:
S = Standard Deviation of the data points
$\overline{X}$ = average of all data points

ATTACHMENT II- LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)

PACE ANALYTICAL SERVICES - INDIANAPOLIS

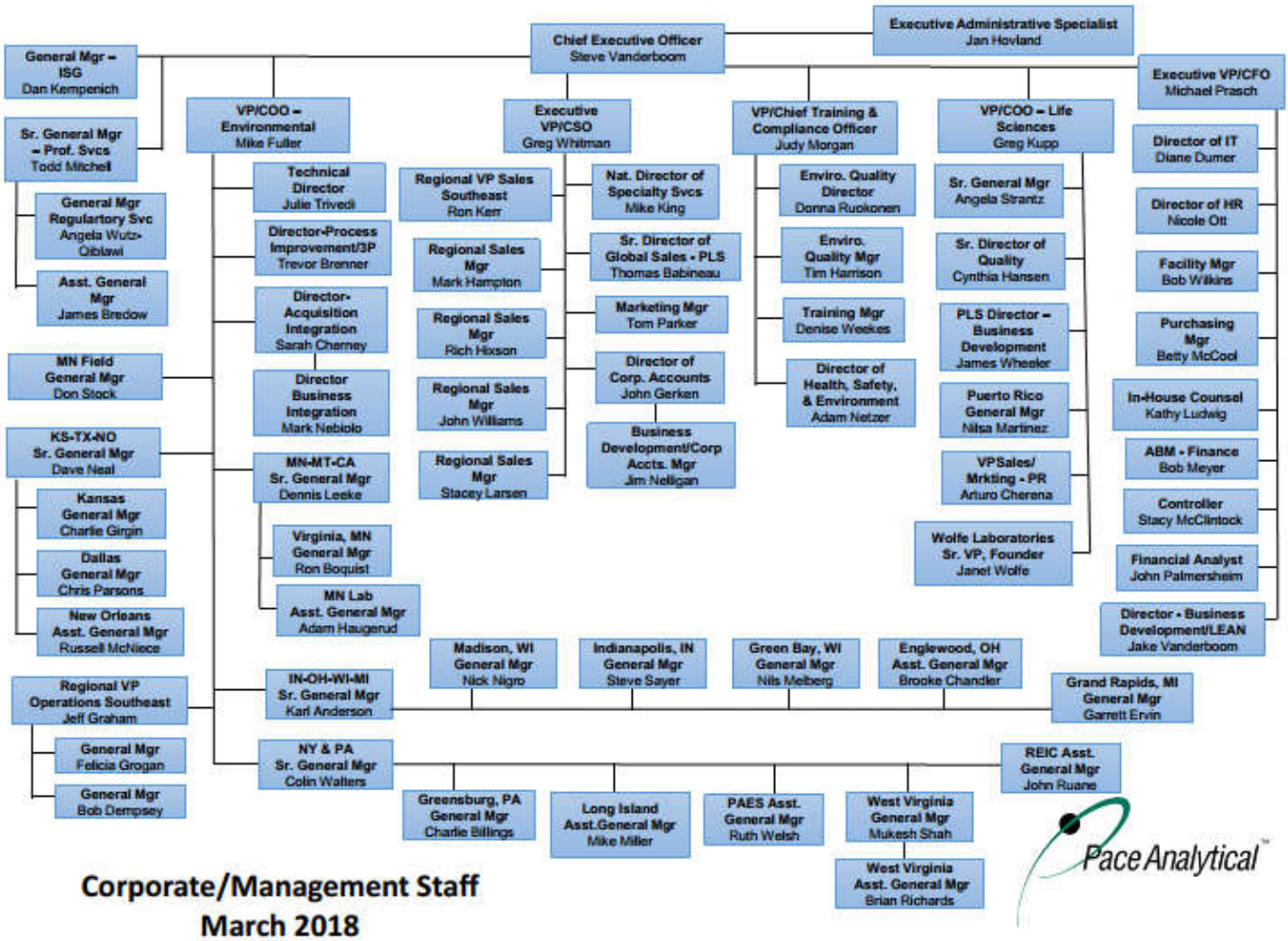


*TNI TECHNICAL DIRECTOR

**DEPT LEAD

Last Revised 5/11/18

ATTACHMENT III- CORPORATE ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



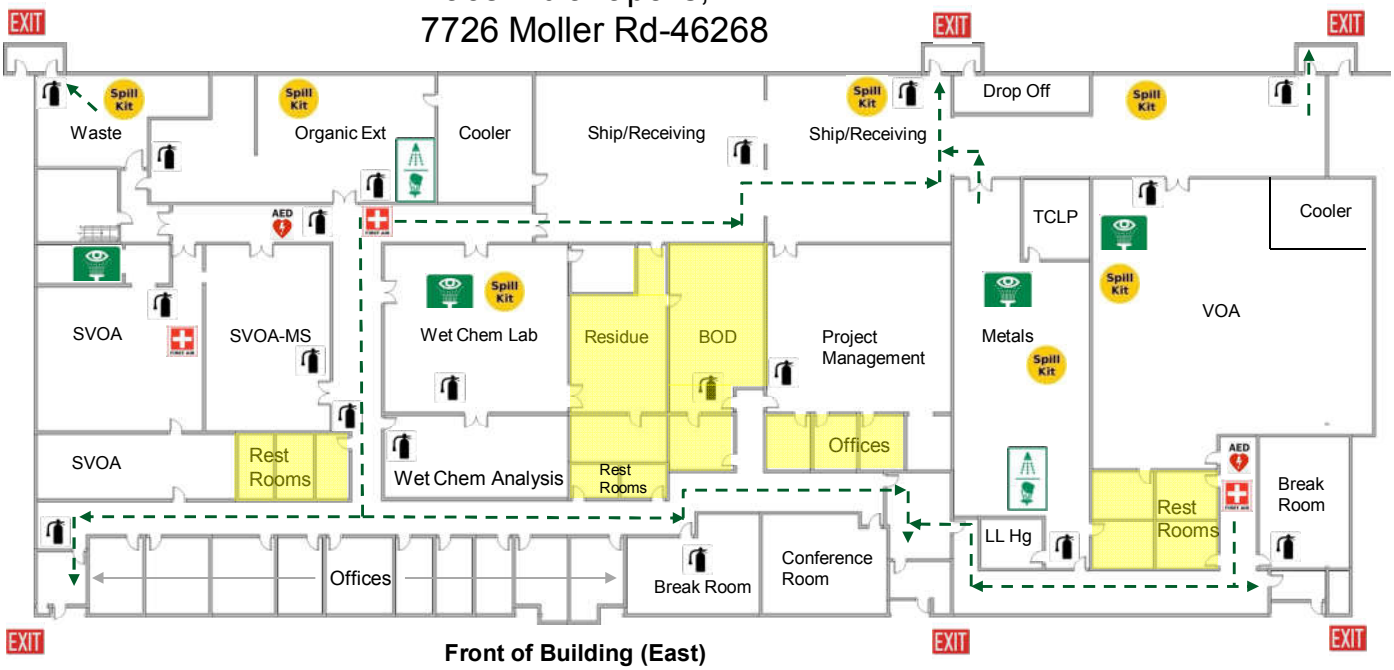
ATTACHMENT IV- EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

Pace 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	OI	8260/624/524.2 VOC	2007
GC/MS	Agilent	7890	MS 5975C	Archon	8260	2008
GC/MS	Agilent	6890	MS 5975	OI	8260/624/524.2 VOC	2007
GC/MS	Agilent	6890	5975	Centurion	8260/624 VOC	2008
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	8100	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	CETAC	M-8000	n/a	ASX520	Low-Level Mercury	2015
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	Spec 20	Labtronics	n/a	n/a	Sulfide	2002
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
TOC Analyzer	Teledyne	Phoenix 8000	n/a	n/a	TOC, DOC	2005
Discrete Analyzer	Smart Chem	200	n/a	n/a	Cyanide, Phosphorus	2006
Ion Chromatogram	Dionex	IC3000	n/a	AS-1	Cl-, F-, SO4-, Br-, NO3/NO2	2008
Ion Chromatogram	Dionex	ICS2100	n/a	AS-AP	Cl-, F-, SO4-, Br-, NO3/NO2	2013

ATTACHMENT V- LABORATORY FLOOR PLAN (CURRENT AS OF ISSUE DATE)

Pace Indianapolis, IN
7726 Moller Rd-46268



Employee Entrance

Front of Building (East)

= Your Location

Main Entrance

Employee Entrance

= Automated External defibrillator

= First Aid Station

= Spill Kits

= Shower/Eyewash Combo

= Eyewash/Drench Hose Available

= ABC Extinguisher Location

= Severe Weather Shelters

Fire Evacuation Meeting Place
(Front Parking lot. Greenway by road between main entrance and south entrance)

Effective:
3/26/18

ATTACHMENT VI- LABORATORY CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

Pace Analytical Services, LLC
Indianapolis Laboratory Certifications

Accrediting Authority	Program Category	Accrediting Agency	Accreditation #	Expiration Date
Illinois (Secondary TNI)	Hazardous Waste	IL-EPA	200074	10/12/2018
Illinois (Secondary TNI)	Non-Potable Water	IL-EPA	200074	10/12/2018
Indiana	Drinking Water	ISDH	C-49-06	12/31/2021
Kansas (Primary TNI)	Hazardous Waste	KDHE	E-10177	06/30/2018
Kansas (Primary TNI)	Non-Potable Water	KDHE	E-10177	06/30/2018
Kentucky	UST	KDEP	80226	06/30/2018
Kentucky	Wastewater	KDEP	KY98019	12/31/2018
Ohio VAP	Hazardous Waste	OH-EPA	CL0065	01/10/2020
Ohio VAP	Non-Potable Water	OH-EPA	CL0065	01/10/2020
Oklahoma	Non-Potable Water	OK DEQ	9204	08/31/2018
Oklahoma	Solids	OK DEQ	9204	08/31/2018
Texas (Secondary TNI)	Non-Potable Water	TX CEQ	T104704355	01/31/2019
Texas (Secondary TNI)	Solid Chemical Mat.	TX CEQ	T104704355	01/31/2019
USDA	Compliance Agreement	USDA	IN-16-SL-FR-002	05/04/2019
USDA	Foreign Soil Permit	USDA	P330-16-00257	08/19/2019
West Virginia	Hazardous Waste	WV-DEP	330	10/31/2018
West Virginia	Non-Potable Water	WV-DEP	330	10/31/2018
Wisconsin	Non-Potable Water	WI DNR	999788130	08/31/2018
Wisconsin	Waste, Soil, Tissue	WI DNR	999788130	08/31/2018

ATTACHMENT VII- PACE CHAIN-OF-CUSTODY (CURRENT AS OF ISSUE DATE)

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Section A **Required** Client Information:	**Section B** **Required** Project Information:	**Section C** Invoice Information:	Page: of
Company:	Report To:	Attention:	
Address:	Copy To:	Company Name:	REGULATORY AGENCY
		Address:	☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
Email To:	Purchase Order No.:	Pace Quote Reference:	☐ UST ☐ RCRA ☐ OTHER
Phone: Fax:	Project Name:	Pace Project Manager:	Site Location
Requested Due Date/TAT:	Project Number:	Pace Profile #:	STATE:

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Matrix Codes	MATRIX / CODE
Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED: COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Y/N ➡ Analysis Test ➡	Requested Analysis Filtered (Y/N)												Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1																																
2																																
3																																
4																																
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12																																

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: **DATE Signed (MM/DD/YY):**

ATTACHMENT VIII- METHOD HOLD TIME, CONTAINER AND PRESERVATION GUIDE (CURRENT AS OF ISSUE DATE)

THE HOLDING TIME INDICATED IN THE CHART BELOW IS THE MAXIMUM ALLOWABLE TIME FROM COLLECTION TO EXTRACTION AND/OR ANALYSIS PER THE ANALYTICAL METHOD. FOR METHODS THAT REQUIRE PROCESSING PRIOR TO ANALYSIS, THE HOLDING TIME IS DESIGNATED AS 'PREPARATION HOLDING TIME/ANALYSIS HOLDING TIME'.

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Acid Base Accounting	Sobek	Solid	Plastic/Glass	None	N/A
Acidity	SM2310B	Water	Plastic/Glass	$\leq 6^oC$	14 Days
Acid Volatile Sulfide	Draft EPA 1629	Solid	8oz Glass	$\leq 6^oC$	14 Days
Actinides	HASL-300	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Actinides	HASL-300	Solid	Plastic/Glass	None	180 Days
Alkalinity	SM2320B/310.2	Water	Plastic/Glass (NY requires separate bottle filled to the exclusion of air)	$\leq 6^oC$	14 Days
Alkylated PAHs		Water	1L Amber Glass	$\leq 6^oC$; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved
Alkylated PAHs		Solid	8oz Glass	$\leq 10^oC$	1 Year/40 Days
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0/300.1/SM4110B	Water	Plastic/Glass	$\leq 6^oC$; EDA if bromate or chlorite run	All analytes 28 days except: NO_2, NO_3, o-Phos (48 Hours); chlorite (immediately for 300.0; 14 Days for 300.1). NO_2/NO_3 combo 28 days.
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0	Solid	Plastic/Glass	$\leq 6^oC$	All analytes 28 days except: NO_2, NO_3, o-Phos (48 hours); chlorite (immediately). NO_2/NO_3 combo 28 days.

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4	9056	Water/ Solid	Plastic/Glass	$\leq 6^oC$	48 hours
Aromatic and Halogenated Volatiles (see note 1)	8021	Solid	5035 vial kit	See note 1	14 days
Aromatic and Halogenated Volatiles	602/8021	Water	40mL vials	pH<2 HCl; $\leq 6^oC$; $Na_2S_2O_3$ if Cl present	14 Days (7 Days for aromatics if unpreserved)
Asbestos	EPA 600/R-93/116	Solid	Plastic/Glass; bulk- 2" square; popcorn ceiling- 2tbsp; soil- 4oz	None (handling must be done in HEPA filtered fume hood; drying may be required)	N/A
Bacteria, Total Plate Count	SM9221D	Water	Plastic/WK	$\leq 6^oC$; $Na_2S_2O_3$	24 Hours
Base/Neutrals and Acids	8270	Solid	8oz Glass	$\leq 6^oC$	14/40 Days
Base/Neutrals and Acids	625/8270	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.2	Water	1L Amber Glass	pH<2 HCl; $\leq 6^oC$; Na sulfite if Cl present	14/30 Days
Biomarkers		Water	$\leq 6^oC$; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	$\leq 6^oC$; pH<2 1:1 HCl (optional)
Biomarkers		Solid	$\leq 10^oC$	1 Year/40 Days	$\leq 10^oC$
BOD/cBOD	SM5210B	Water	Plastic/Glass	$\leq 6^oC$	48 hours
Boiling Range Distribution of Petroleum Fractions	ASTM D2887-98	Product	10mL glass vials	$\leq 6^oC$	N/A
BTEX/Total Hydrocarbons	TO-3	Air	Summa Canister	None	28 Days
BTEX/Total Hydrocarbons	TO-3	Air	Tedlar Bag or equivalent	None	72 Hours
Carbamates	531.1	Water	Glass	$Na_2S_2O_3$, Monochloroacetic acid pH <3; $\leq 6^oC$	28 Days
Carbamates	8318	Water	Glass	Monochloroacetic acid pH 4-5; $\leq 6^oC$	7/40 Days
Carbamates	8318	Solid	Glass	$\leq 6^oC$	7/40 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Carbon Specific Isoptope Analysis (CSIA)	AM24	Water	40mL clear VOA vial with TLS	≤ 6°C, trisodium phosphate or HCl	N/A
Cation/Anion Balance	SM1030E	Water	Plastic/Glass	None	None
Cation Exchange	9081	Solid	8oz Glass	None	unknown
Cations (Ferrous Iron, Ferric Iron, Divalent Manganese)	7199 modified	Water	40mL clear VOA vials with mylar septum	≤ 6°C; HCl	48 Hours
Chloride	SM4500Cl-C,E	Water	Plastic/Glass	None	28 Days
Chlorinated Hydrocarbons in Vapor	AM4.02	Vapor	20cc vapor vial with flat septum	None	N/A
Chlorine, Residual	SM4500Cl-D,E,G/330.5/Hach 8167	Water	Plastic/Glass	None	15 minutes
Chlorophyll	SM10200H	Water	Opaque bottle or aluminum foil	≤ 6°C	48 Hours to filtration
COD	SM5220C, D/410.4/Hach 8000	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Coliform, Fecal	SM9222D	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Coliform, Fecal	SM9222D	Solid	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	24 Hours
Coliform, Fecal	SM9221E	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Coliform, Fecal	SM9221E	Solid	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	24 Hours
Coliform, Total	SM9222B	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Coliform, Total	SM9221B	Solid	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Coliform, Total, Fecal and E. coli	Colilert/ Quanti-tray	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Coliform, Total and E. coli	SM9223B	Drinking Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	30 Hours
Color	SM2120B,E	Water	Covered Plastic/Acid Washed Amber Glass	≤ 6°C	48 Hours
Condensable Particulate Emissions	EPA 202	Air	Solutions	None	180 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Cyanide, Reactive	SW846 chap.7	Water	Plastic/Glass	None	28 Days
Cyanide, Reactive	SW846 chap.7	Solid	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	SM4500CN-A,B,C,D,E,G,I,N/9010/ 9012/335.4	Water	Plastic/Glass	pH≥12 NaOH; ≤ 6°C; ascorbic acid if Cl present	14 Days (24 Hours if sulfide present- applies to SM4500CN only)
Diesel Range Organics- Alaska DRO	AK102	Solid	8oz Glass	≤ 6°C	14/40 Days
Diesel Range Organics- Alaska DRO	AK102	Water	1L Glass	pH<2 HCl; ≤ 6°C	14/40 Days
Diesel Range Organics- TPH DRO	8015	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Diesel Range Organics- TPH DRO	8015	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Diesel Range Organics- TPH DRO	8015	Tissue	1L Amber Glass	≤ - 10°C	1 Year if frozen/40 Days
Diesel Range Organics- TPH DRO	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	≤ 6°C but above freezing	28 Days
Diesel Range Organics- NwTPH-Dx	Nw-TPH-Dx	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Diesel Range Organics- NwTPH-Dx	Nw-TPH-Dx	Water	1L Amber Glass	pH <2 HCl; ≤ 6°C	14/40 Days; 7 Days from collection to extraction if unpreserved
Diesel Range Organics- Wisconsin DRO	WI MOD DRO	Solid	Tared 4oz Glass Jar	≤ 6°C	10/47 Days
Diesel Range Organics- Wisconsin DRO	WI MOD DRO	Water	1L Amber Glass	≤ 6°C; pH <2 HCl	14/40 Days
Dioxins and Furans	1613B	Solid	8oz Glass	≤ 6°C	1 year
Dioxins and Furans	1613B	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	1 year

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Dioxins and Furans	1613B	Fish/ Tissue	Aluminum foil	≤ 6°C	1 year
Dioxins and Furans	8290	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	30/45 Days
Dioxins and Furans	8290	Solid	8oz Glass	≤ 6°C	30/45 Days
Dioxins and Furans	8290	Fish/ Tissue	Not specified	< -10°C	30/45 Days
Dioxins and Furans	TO-9	Air	PUF	None	7/40 Days
Diquat/Paraquat	549.2	Water	Amber Plastic	≤ 6°C; $Na_2S_2O_3$	7/21 Days
EDB/DBCP (8011) EDB/DBCP/1,2,3-TCP (504.1)	504.1/8011	Water	40mL vials	≤ 6°C; $Na_2S_2O_3$ if Cl present	14 Days
Endothall	548.1	Water	Amber Glass	≤ 6°C; $Na_2S_2O_3$	7/14 Days
Enterococci	EPA 1600	Water	100mL Plastic	≤ 10°C	8 Hours
Enterococci	Enterolert	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Explosives	8330/8332	Water	1L Amber Glass	≤ 6°C	7/40 Days
Explosives	8330/8332	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	NJ EPH	Water	1L Amber Glass	pH < 2 HCl; ≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	NJ EPH	Solid	4oz Glass Jar	≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Water	1L Amber Glass	pH<2 HCl; ≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Solid	4oz Glass Jar	≤ 6°C	7/40 Days
Fecal Streptococci	SM9230B	Water	100mL Plastic	≤ 10°C; $Na_2S_2O_3$	8 Hours
Ferrous Iron	SN3500Fe-D; Hach 8146	Water	Glass	None	Immediate

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Flashpoint/ Ignitability	1010	Liquid	Plastic/Glass	None	28 Days
Florida PRO	FL PRO DEP (11/1/95)	Liquid	Glass, PTFE lined cap	$\leq 6^oC$; pH <2 H_2SO_4 or HCl	7/40 Days
Fluoride	SM4500Fl-C,D	Water	Plastic	None	28 Days
Gamma Emitting Radionuclides	901.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Gasoline Range Organics	8015	Water	40mL vials	pH<2 HCl	14 Days
Gasoline Range Organics	8015	Solid	5035 vial kit	See note 1	14 days
Gasoline Range Organics (C3-C10)	8260B modified	Water	40mL vials	$\leq 6^oC$; HCl	14 Days
Gasoline Range Organics (C3-C10)	8260B modified	Solid	4oz Glass Jar	$\leq 6^oC$	14 Days
Gasoline Range Organics- Alaska GRO	AK101	Solid	5035 vial kit	See 5035 note*	28 Days if GRO only (14 Days with BTEX)
Gasoline Range Organics- Alaska GRO	AK101	Water	40mL vials	pH<2 HCl; $\leq 6^oC$	14 Days
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Water	40mL vials	pH<2 HCl; $\leq 6^oC$	7 Days unpreserved; 14 Days preserved
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Solid	40mL vials	$\leq 6^oC$; packed jars with no headspace	14 Days
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Water	40mL vials	pH<2 HCl; $\leq 6^oC$	14 Days
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Solid	40mL MeOH vials	$\leq 6^oC$ in MeOH	21 Days
Glyphosate	547	Water	Glass	$\leq 6^oC$; $Na_2S_2O_3$	14 Days (18 Months frozen)
Grain Size	ASTM D422	Solid	Not specified	Ambient	N/A
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6	Water	Plastic/Glass	pH<2 HNO_3	48 Hrs
Gross Alpha and Gross Beta	9310/900.0	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Gross Alpha and Gross Beta	9310	Solid	Glass	None	180 Days
Haloacetic Acids	552.1/552.2	Water	40mL Amber vials	NH_4Cl; $\leq 6^oC$	14/7 Days if extracts stored $\leq 6^oC$ or 14/14 Days if extracts stored at $\leq -10^oC$

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Hardness, Total ($CaCO_3$)	SM2340B,C/130.1	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Heterotrophic Plate Count (SPC/HPC)	SM9215B	Water	100mL Plastic	$\leq 10^oC$; $Na_2S_2O_3$	8 Hours
Heterotrophic Plate Count (SPC/HPC)	SimPlate	Water	100mL Plastic	$\leq 10^oC$; $Na_2S_2O_3$	8 Hours
Herbicides, Chlorinated	8151	Solid	8oz Glass Jar	$\leq 6^oC$	14/40 Days
Herbicides, Chlorinated	8151	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	7/40 Days
Herbicides, Chlorinated	515.1/515.3	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	14/28 Days
Hexavalent Chromium	7196/218.6/ SM3500Cr-B, C	Water	Plastic/Glass	$\leq 6^oC$	24 Hours (see note 4)
Hexavalent Chromium	218.6/SM3500Cr-B, C	Water	Plastic/Glass	Ammonium Buffer pH 9.3-9.7	28 Days (see note 4)
Hexavalent Chromium	218.6/218.7	Drinking Water	Plastic/Glass	Ammonium Buffer pH >8	14 Days (see note 4)
Hexavalent Chromium	7196 (with 3060A)	Solid	Glass	$\leq 6^oC$	30 Days from collection to extraction and 7 days from extraction to analysis
Hydrocarbons in Vapor	AM4.02	Vapor	20cc vapor vial with flat septum	None	N/A
Hydrogen by Bubble Strip	SM9/AM20GAx	Water	20cc vapor vial with stopper septum	None	14 Days
Hydrogen Halide and Halogen Emissions	EPA 26	Air	Solutions	None	6 Months
Ignitability of Solids	1030	Non-liquid Waste	Plastic/Glass	None	28 Days
Lead Emissions	EPA 12	Air	Filter/Solutions	None	6 Months
Light Hydrocarbons by Bubble Strip	SM9/AM20GAx	Water	20cc vapor vial with stopper septum	None	14 Days
Light Hydrocarbons in Vapor	AM20GAx	Vapor	20cc vapor vial with flat septum	None	14 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Lipids	Pace Lipids	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen
Mercury, Low-Level	1631E	Solid	Glass	None	28 Days
Mercury, Low-Level	1631E	Water	Fluoropolymer bottles (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 Hours for preservation or analysis; 28 Days to preservation if sample oxidized in bottle; 90 Days for analysis if preserved
Mercury, Low-Level	1631E	Tissue	Plastic/Glass	≤ - 10°C	28 Days if frozen
Mercury	7471	Solid	8oz Glass Jar	≤ 6°C	28 Days
Mercury	7470/245.1/245.2	Water	Plastic/Glass	pH<2 HNO_3	28 Days
Mercury	7471/245.6	Tissue	Plastic/Glass	≤ - 10°C	28 Days if frozen
Metals (GFAA)	7000/200.9	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Metals (ICP)	NIOSH 7300A/7303	Air	Filters	None	180 Days
Metals (ICP/ICPMS)	6010/6020	Solid	8oz Glass Jar	None	180 Days
Metals (ICP/ICPMS)	6010/6020/200.7/200.8	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Metals (ICP/ICPMS)	6020	Tissue	Plastic/Glass	≤ -10°C	180 Days if frozen
Methane, Ethane, Ethene	8015 modified	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	RSK-175; PM01/AM20GAx	Water	20mL vials	HCl; or trisodium phosphate or benzalkonium chloride and ≤ 6°C	14 Days; 7 Days unpreserved
Methane, Ethane, Ethene	EPA 3C	Air	Summa Canister	None	28 Days
Methane, Ethane, Ethene	EPA 3C	Air	Tedlar Bag or equivalent	None	5 Days
Methanol, Ethanol	8015 modified	Water	40mL vials	≤ 6°C	14 Days
Methanol, Ethanol	8015 modified	Solid	2oz Glass	≤ 6°C	14 Days
Methyl Mercury	1630	Water	Teflon/ fluoropolymer	Fresh water- 4mL/L HCl; Saline water- 2mL/L H_2SO_4 (must be preserved within 48 hours of collection)	6 months

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Methyl Mercury	1630	Tissue	2-4oz glass jar	≤ 0°C	28 Days; ethylated distillate 48 hours
Nitrogen, Ammonia	SM4500NH3/350.1	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Nitrogen, Total Kjeldahl (TKN)	351.2	Solid	Plastic/Glass	≤ 6°C	28 Days
Nitrogen, Total Kjeldahl (TKN)	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Nitrogen, Nitrate	SM4500-NO3/352.1	Water	Plastic/Glass	≤ 6°C	24 Hours preferred
Nitrogen, Nitrate & Nitrite combination	353.2	Solid	Plastic/Glass	≤ 6°C	28 Days
Nitrogen, Nitrate & Nitrite combination	SM4500-NO3/353.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Nitrogen, Nitrite or Nitrate separately	SM4500-NO2/353.2	Water	Plastic/Glass	≤ 6°C	48 Hours
Nitrogen, Organic	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Non-Methane Organics	EPA 25C	Air	Summa Canister	None	28 Days
Non-Methane Organics	EPA 25C	Air	Tedlar Bag or equivalent	None	72 Hours
Odor	SM2150B	Water	Glass	≤ 6°C	24 Hours
Oil and Grease/HEM	1664A/SM5520B/9070	Water	Glass	pH<2 H_2SO_4 or HCl; ≤ 6°C	28 Days
Oil and Grease/HEM	9071	Solid	Glass	≤ 6°C	28 Days
Oil Range Organics	8015	Solid	Glass	≤ 6°C	14/40 Days
Oil Range Organics	8015	Water	Glass	≤ 6°C	7/40 Days
Organic Matter	ASA 29-3.5.2	Solid	Plastic/Glass	None; samples air-dried and processed prior to analysis	N/A
Oxygen, Dissolved (Probe)	SM4500-O	Water	Glass	None	15 minutes
Oxygenates on Product (GCMS SIM)	1625 modified	Product	10mL glass vial	≤ 6°C	14 Days (7 Days from extraction)
PBDEs	1614	Water	1L Amber Glass	≤ 6°C	1 Year/1 Year
PBDEs	1614	Solid	Wide Mouth Jar	≤ 6°C	1 Year/1 Year
PBDEs	1614	Tissue	Aluminum Foil	≤ -10°C	1 Year/1 Year

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
PCBs and Pesticides, Organochlorine (OC)	TO-4/TO-10	Air	PUF	None	7/40 Days
PCBs and Pesticides, Organochlorine (OC)	608	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	Pest: 7/40 Days; PCB: 1 Year/1 Year
PCBs, Pesticides (OC), Herbicides	508.1	Water	Glass	Na2SO3; pH<2 HCl; $\leq 6^oC$	14/30 Days
PCBs, total as Decachlorobiphenyl	508A	Water	1L Glass, TFE lined cap	$\leq 6^oC$	14/30 Days
Perchlorate	331	Water	Plastic/Glass	$\geq$0-6^oC, field filtered with headspace	28 Days
Permanent Gases (O2, N2, CO2)	RSK-175; PM01/AM20GAx	Water	40mL vials	benzalkonium chloride and $\leq 6^oC$	14 Days
Permanent Gases by Bubble Strip	SM9/AM20GAx	Water	20cc vapor vial with stopper septum	None	14 Days
Permanent Gases in Vapor	AM20GAx	Vapor	20cc vapor vial with flat septum	None	14 Days
Pesticides, Organochlorine (OC)	8081	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organochlorine (OC)	8081	Solid	8oz Glass Jar	$\leq 6^oC$	14/40 Days
Pesticides, Organochlorine (OC)	8081	Tissue	8oz Glass Jar	$\leq -10^oC$	1 Year if frozen/40 Days
Pesticides, Organophosphorous (OP)	8141	Solid	8oz Glass Jar	$\leq 6^oC$	14/40 Days
Pesticides, Organophosphorous (OP)	8141	Water	1L Amber Glass	pH 5-8 with NaOH or H_2SO_4; $\leq 6^oC$; $Na_2S_2O_3$ if Cl present	7/40 Days
PCBs (Aroclors)	8082	Water	1L Amber Glass	$\leq 6^oC$; $Na_2S_2O_3$ if Cl present	1 Year/1 Year
PCBs (Aroclors)	8082	Solid	8oz Glass Jar	$\leq 6^oC$	1 Year/1 Year
PCBs (Aroclors)	8082	Tissue	Plastic/Glass	$\leq -10^oC$	1 Year if frozen/1 Year

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
PCB Congeners	1668A	Water	1L Amber Glass	≤ 6°C but above freezing	1 Year/1 Year
PCB Congeners	1668A	Solid	4-8oz Glass Jar	≤ 6°C but above freezing	1 Year/1 Year
PCB Congeners	1668A	Tissue	4-8oz Glass Jar	≤ -10°C	1 Year/1 Year
Paint Filter Liquid Test	9095	Water	Plastic/Glass	None	N/A
Particle Size	ASA 15-5 modified	Solid	Plastic/Glass (100g sample)	None	N/A
Particulates	PM-10	Air	Filters	None	180 Days
Permanent Gases	EPA 3C	Air	Summa Canister	None	28 Days
Permanent Gases	EPA 3C	Air	Tedlar Bag or equivalent	None	5 Days
pH	SM4500H+B/9040	Water	Plastic/Glass	None	15 minutes
pH	9045	Solid	Plastic/Glass	None	7 Days
Phenol, Total	420.1/420.4/9065/9066	Water	Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Phosphorus, Orthophosphate	SM4500P/365.1/365.3	Water	Plastic	≤ 6°C	Filter within 15 minutes, Analyze within 48 Hours
Phosphorus, Total	SM4500P/ 365.1/365.3/365.4	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days
Phosphorus, Total	365.4	Solid	Plastic/Glass	≤ 6°C	28 Days
Polynuclear Aromatic Hydrocarbons (PAH)	TO-13	Air	PUF	None	7/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	≤ 6°C but above freezing	28 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen/40 Days
Purgeable Organic Halides (POX)	9021	Water	Glass; no headspace	≤ 6°C	14 Days
Radioactive Strontium	905.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-226	903.0/903.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 3)	9320/904.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 3)	9320	Solid	Plastic/Glass		
Residual Range Organics- Alaska RRO	AK103	Solid	8oz Glass	≤ 6°C	14/40 Days
Saturated Hydrocarbons		Water	≤ 6°C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	≤ 6°C; pH<2 1:1 HCl (optional)
Saturated Hydrocarbons		Solid	≤ 10°C	1 Year/40 Days	≤ 10°C
Silica, Dissolved	SM4500Si-D	Water	Plastic	≤ 6°C	28 Days
Solids, Settleable	SM2540F	Water	Glass	≤ 6°C	48 Hours
Solids, Total	SM2540B	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total	SM2540G	Solid	Plastic/Glass	≤ 6°C	7 Days
Solids, Total (FOC, OM, Ash)	ASTM D2974	Solid	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Dissolved	SM2540C	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Suspended	SM2540D/USGS I-3765-85	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Volatile	160.4/SM2540E	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Volatile	160.4	Solid	Plastic/Glass	≤ 6°C	7 Days
Specific Conductance	SM2510B/9050/120.1	Water	Plastic/Glass	≤ 6°C	28 Days
Stationary Source Dioxins and Furans	EPA 23	Air	XAD Trap	None	30/45 Days
Stationary Source Mercury	EPA 101	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source Metals	EPA 29	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source PM10	EPA 201A	Air	Filters	None	180 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Stationary Source Particulates	EPA 5	Air	Filter/Solutions	None	180 Days
Sulfate	SM4500SO4/9036/9038/375.2/ASTM D516	Water	Plastic/Glass	$\leq 6^oC$	28 Days
Sulfide, Reactive	SW-846 Chap.7	Water	Plastic/Glass	None	28 Days
Sulfide, Reactive	SW-846 Chap.7	Solid	Plastic/Glass	None	28 Days
Sulfide, Total	SM4500S/9030	Water	Plastic/Glass	pH>9 NaOH; ZnOAc; $\leq 6^oC$	7 Days
Sulfite	SM4500SO3	Water	Plastic/Glass	None	15 minutes
Surfactants (MBAS)	SM5540C	Water	Plastic/Glass	$\leq 6^oC$	48 Hours
Total Alpha Radium (see note 3)	9315/903.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Total Alpha Radium (see note 3)	9315	Solid	Plastic/Glass	None	180 days
Total Inorganic Carbon (TIC)	PM01/AM20GAx	Water	40mL VOA vial with mylar septum	$\leq 6^oC$	14 Days
Total Organic Carbon (TOC)	SM5310B,C,D/9060	Water	Glass	pH<2 H_2SO_4 or HCl; $\leq 6^oC$	28 Days
Total Organic Carbon (TOC)	9060/Walkley Black/Lloyd Kahn	Solid	Glass	$\leq 6^oC$	14 Days
Total Organic Halogen (TOX)	SM5320/9020	Water	Glass; no headspace	$\leq 6^oC$	14 Days
Total Petroleum Hydrocarbons (aliphatic and aromatic)	TPHCWG	Water	40mL vials	pH<2 HCl, no headspace, $\leq 6^oC$	7 Days
Total Petroleum Hydrocarbons (aliphatic and aromatic)	TPHCWG	Solid	Glass	$\leq 6^oC$	14 days
Tritium	906.0	Water	Glass	None	180 days
Turbidity	SM2130B/180.1	Water	Plastic/Glass	$\leq 6^oC$	48 Hours
Total Uranium	908.0/ASTM D5174-97	Water	Plastic/Glass	pH<2 HNO_3	180 days
UCMR Metals	200.8	Water	Plastic or glass	pH<2 HNO_3	28 Days
UCMR Hexavalent Chromium	218.7	Water	HDPE or propylene	Na_2CO_3/$NaHCO_3$/ $(NH_4)_2SO_4$; pH>8	14 Days
UCMR Chlorate	300.1	Water	Plastic or glass	EDA	28 Days
UCMR Perfluorinated Compounds	537	Water	Polypropylene	Trizma	14 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
UCMR 1, 4 Dioxane	522	Water	Glass	Na_2SO_3, $NaHSO_4$; pH<4	28 Days
UV254	SM5910B	Water	Glass	≤ 6°C	48 Hours
Vermiculite	EPA 600/R-93/116	Solid	Plastic/Glass	None (handling must be done in HEPA filtered fume hood; drying may be required)	N/A
Volatile Fatty Acids	AM21G	Water	40mL clear VOA vials	≤ 6°C	21 Days
Volatile Fatty Acids (low level)	AM23G	Water	40mL clear VOA vials	≤ 6°C with benzalkonium chloride	14 Days
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Water	40mL vials	pH<2 HCl; ≤ 6°C	14 Days preserved
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Solid	4-8oz Glass Jar	≤ 6°C; packed jars with no headspace	7/28 Days
Volatiles	TO-14	Air	Summa Canister	None	28 Days
Volatiles	TO-14	Air	Tedlar Bag or equivalent	None	72 Hours
Volatiles	TO-15	Air	Summa Canister or Tedlar Bag	None	28 Days
Volatiles	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	≤ 6°C but above freezing	28 Days
Volatiles	TO-18/8260	Air	Tedlar Bag or equivalent	None	72 Hours
Volatiles	8260	Solid	5035 vial kit	See note 1 (analyze for acrolein and acrylonitrile per local requirements)	14 days
Volatiles	8260	Water	40mL vials	pH<2 HCl; ≤ 6°C; $Na_2S_2O_3$ if Cl present (preserve and analyze for acrolein and acrylonitrile per local requirements)	14 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Volatiles	8260	Conc. Waste	5035 vial kit or 40mL vials	≤ 6°C	14 Days
Volatiles	624	Water	40mL vials	pH<2 HCl; ≤ 6°C; $Na_2S_2O_3$ if Cl present (or unpreserved if run within 7 days of collection) (preserve and analyze for acrolein and acrylonitrile per local requirements)	14 Days (7 Days for aromatics if unpreserved)
Volatiles (see note 2)	524.2	Water	40mL vials (in duplicate)	pH<2 HCl; ≤ 6°C; Ascorbic acid or $Na_2S_2O_3$ if Cl present[2]	14 Days
Whole Oil	ASTM D3328 (prep); ASTM D5739	Product	10mL glass vials	≤ 6°C	N/A

[1] **5035/5035A Note**: 5035 vial kit typically contains 2 vials water, preserved by freezing **or**, 2 vials aqueous sodium bisulfate preserved at 4°C, **and** one vial methanol preserved at ≤6°C **and** one container of unpreserved sample stored at ≤6°C.

[2] Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected, unless gases or Table 7 compounds are NOT compounds of interest and then sodium thiosulfate is the preservative recommended.

[3] Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the lab within 5 days of collection, preserved in the lab, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.

[4] The holding time for hexavalent chromium may be extended by the addition of the ammonium buffer listed in EPA 218.6 per the 2012 EPA Method Update Rule. Although Method 218.6 stipulates a different pH range (9.0 to 9.5) for buffering, this method requirement was modified in the Method Update Rule to a pH range of 9.3 to 9.7.For non-potable waters, adjust the pH of the sample to 9.3 to 9.7 during collection with the method required ammonium sulfate buffer to extend the holding time to 28 days. For potable waters, addition of the buffer during collection will extend the holding time for 14 days per EPA 218.7 and the EPA UCMR program.

APPENDIX D

REMEDIAL DESIGN SAMPLING AND ANALYSIS PLAN

REMEDIAL DESIGN
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
(RD SAP)

WEST LAKE LANDFILL 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

JUNE 11, 2019

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FIGURES

1.0 INTRODUCTION

This Remedial Design Environmental Sampling and Analysis Plan (RD SAP) has been prepared by Civil & Environmental Consultants, Inc. (CEC) to provide guidance for field sample collection activities and field measurements to be performed in accordance with the Remedial Design Environmental Quality Assurance Project Plan (RD QAPP). The RD QAPP is being submitted as a companion document to this RD SAP.

Environmental conditions at the West Lake Landfill OU-2 facility (**Figure 1-1**) have been previously defined by past studies. Existing facility features, including monitoring wells, the Inactive Sanitary Landfill boundary, etc., are provided in **Figure 1-2**. Activities described in this RD SAP are intended to enhance the decision-making process for the Remedial Design by providing an updated assessment of environmental conditions in the vicinity of the West Lake Landfill OU-2 facility.

2.0 SAMPLING OBJECTIVES

The primary objectives of the West Lake Landfill OU-2 facility RD QAPP and RD SAP are to provide updated evaluations of subsurface vapor conditions in the vicinity of the OU-2 facility and evaluate current cover thickness on the Inactive Sanitary Landfill. Other Remedial Design tasks are discussed in the QAPP, but these tasks are not anticipated to require field sampling.

Groundwater sampling issues and monitoring for OU-2 will be deferred to the OU-3 RI/FS Process and will not be addressed as part of this RD SAP.

Field sampling activities to be performed in accordance with this RD SAP consists of:

- Monitoring of temporary landfill gas perimeter monitoring probes after installation;
- Performance of a ground and aerial topographic survey;
- Collection of cover thickness samples from the Inactive Sanitary Landfill (OU-2);
- Evaluation of the existing slope along the western side of OU-2; and
- Geotechnical evaluation and estimated volumes for potential borrow areas near OU-2.

Each of the above-referenced tasks is described in the following sections.

3.0 TEMPORARY LANDFILL GAS MONITORING PROBE MEASUREMENTS

To assess the status of subsurface decomposition gases in the vicinity of the West Lake Landfill OU-2 facility, temporary landfill gas perimeter monitoring probes are proposed to be installed. As described by the RD QAPP, two (2) temporary landfill gas monitoring probe screened intervals are proposed to be installed at each approximate location (**Figure 3-1**) to allow monitoring of discrete zones.

Subsequent to completion of temporary perimeter landfill gas monitoring probe installation activities, quarterly measurements for methane will be performed pursuant to the procedures described by the *Methane Gas Policy*, dated May 2017, published by the Missouri Department of Natural Resources (MDNR).

4.0 GROUND AND AERIAL TOPOGRAPHIC SURVEY

Field activities associated with the topographic survey will include, but not necessarily be limited to, surveying ground surface elevations and, if possible, establishing the routing and discharge of the existing surface water controls. This task does not include the sampling of any materials or laboratory analysis.

5.0 THICKNESS EVALUATION OF INACTIVE SANITARY LANDFILL COVER

Sampling of existing cover materials from the Inactive Sanitary Landfill will be conducted to evaluate cover thickness and assess selected geotechnical soil properties. The assessments will provide an estimate the volume of materials needed for construction of the final cover and the suitability of using the existing material as landfill cover.

Sampling of the landfill cover materials will indicate and confirm where excess cover materials are available within portions of OU-2 and where additional material needs to be added. The average thickness of the topsoil to be removed and reinstalled after construction will be established.

5.1 LANDFILL COVER THICKNESS EVALUATION

The sampling program will include the collection of approximately ninety (90) samples at 150- ft intervals from a surveyed grid across the Inactive Sanitary Landfill. **Figure 6-1** displays the approximate sampling grid and sample locations. This sampling task will be coordinated with the aerial flyover and topographic survey.

Each sampling location will initially be surveyed for northing, easting, and ground surface elevation. The thickness of the cover will be determined by full depth sampling of the cover material. Each location will be sampled using a direct push drill rig pushing a tube sampler lined with clear polyethylene liners. Each sampler will be brought to the surface, the liner will be opened, and the soils will be 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.

5.2 EXISTING MATERIAL EVALUATION

After completing the ninety (90) initial sampling locations, thirty (30) Shelby Tube samples will be collected in accordance with ASTM D1587 at locations immediately adjacent to selected 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 testing laboratory where the tubes will be extruded and logged with representative portion of each tube tested for Atterberg Limits, grain size distribution and permeability.

6.0 ANALYSIS OF EXISTING WESTERN SLOPE

The existing slope along the western perimeter of OU-2 was established in the mid-1990's. **Figure 7-1** displays the location, contour details, and a cross-section of the western slope. Based on observations during a site visit conducted by the Landfill Design team on November 11, 2008, the existing slope appeared to be stable.

One of the RD tasks is to further document the history and stability of the existing western slope. To meet this objective, a series of thirteen (13) survey pins will be installed in the western slope. The pin locations are displayed in **Figure 7-1**. The purpose of the pins is to show slope movement over a specified period of time. These pins will be surveyed monthly during the RD phase to document slope stability. This task is not anticipated to include any soil sampling or laboratory analysis.

If additional documentation of slope stability is warranted, an on-site biological assessment of existing vegetation along the western slope may be implemented. Derived conclusions would be documented to further determine the stability control provided by existing vegetation. This task is not anticipated to include any soil sampling or laboratory analysis.

If additional documentation of slope stability is warranted, a geotechnical sampling investigation may be implemented. Such an evaluation would require a significant number of soil borings to identify any potential failure planes or unstable portions of the western slope.

7.0 GEOTECHNICAL TESTING OF POTENTIAL BORROW AREAS

Soils used for final cover must meet soil classification and permeability specifications. As part of the RD phase of this project, 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 excavated in each of the proposed borrow areas. The testing program will include natural moisture content, Atterberg Limits, Standard proctor dry density determination, and recompacted permeability. The resultant data are needed for approval of the borrow soils before construction and will be identified in the Remedial Action construction specifications that are developed following completion of the RD phase of this project.

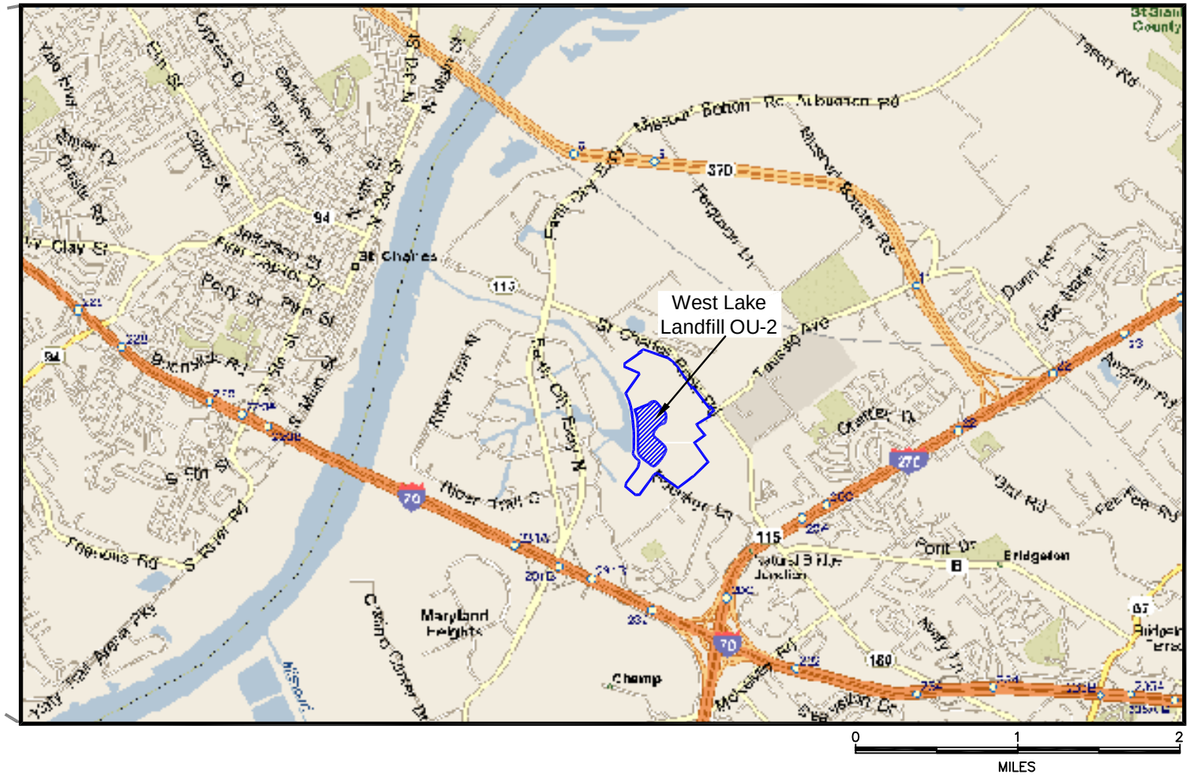
The Landfill Design Manager will retain final authority for determining the appropriate number of samples, sampling method, and geotechnical testing parameters. In addition, a ground survey of the stockpiled material will be performed to determine the volume of material that can potentially be used as final cover.

Potential sources of cover material for the OU-2 remedy previously included three (3) on-site locations. The potential locations are displayed in **Figure 8-1**. However, these sources are no longer available and new cover material sources will need to be identified.

FIGURES

NORTH

Maps courtesy of Microsoft Streets and Trips 2005



Civil & Environmental Consultants, Inc.

West Lake Landfill OU-2
Bridgeton, Missouri

Figure 1-1
Site Location Map

LEGEND

- Monitoring Well
- Gas Probe
- Leachate Riser
- Leachate Sump
- Presumably Destroyed Well
- Approximate Operable Unit 2 Boundary
- Leachate Outfall
- NPDES Outfall

NPDES and Leachate Outfalls are associated with the Former Active Sanitary Landfill

NORTH

0 100 200 350 500 700

Scale in Feet
Graphic Scale: 1 inch = 350 feet

Former Active Sanitary Landfill
Permit No. 118912

Operable Unit 1
Area 1

Operable Unit 1
Area 2

Operable Unit 2
Inactive Sanitary Landfill

Closed Demolition Landfill

Former Leachate Pond

ENTRANCE STATION

CONCRETE PLANT

ASPI PLANT

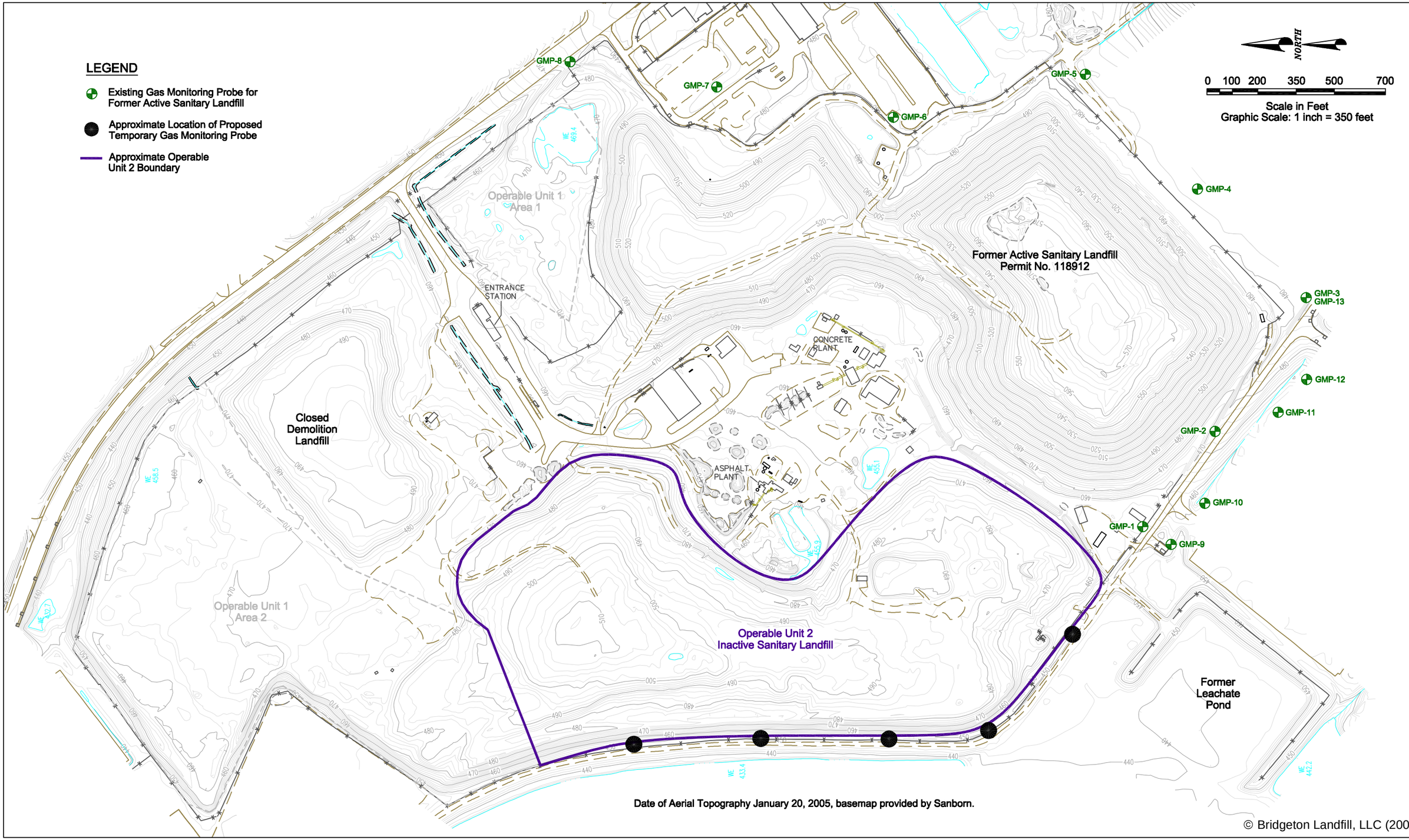
PZ-100-SS, PZ-100-SD, PZ-100-KS
PZ-208-SS
GMP-8
NPDES Outfall 006
GMP-7
PZ-200-SS
PZ-102-SS, PZ-102R-SS
PZ-201A-SS
GMP-6
PZ-202-SS
GMP-5
PZ-1201-SS
PZ-104-SS, PZ-104-SD, PZ-104-KS
PZ-114-AS, PZ-115-SS
I-68
PZ-101-SS
PZ-103-SS
LCS-3C
PZ-203-SS
GMP-4
LCS-6A
LCS-5A
D-14
S-84
D-85
LCS-1B
LCS-2C
I-67
NPDES Outfall 001
PZ-207-AS
PZ-109-SS
PZ-105-SS
GMP-3, GMP-13
NPDES Outfall 005
S-5
I-4
D-3
PZ-110-SS
PZ-108-SS
MW-F1-S
PZ-111-SD, PZ-111-KS
MW-F1-D
PZ-206-SS
PZ-116-SS
MW-1204
GMP-12
I-66
MW-F3
PZ-113-AS, PZ-113-AD, PZ-113-SS
PZ-112-AS
LCS-4A
GMP-11
LR-104
PZ-305-AI
GMP-2
PZ-204-SS, PZ-204A-SS
D-13
I-73
LCS-128K
MW-5A
MW-4A
MW-1A
MW-3A
MW-2A
PZ-205-AS, PZ-205-SS
PZ-106-SD, PZ-106-SS, PZ-106-KS
GMP-10
D-87
I-65
PZ-107-SS
GMP-1
LR-103
S-88
Leachate Outfall 008
GMP-9
NPDES Outfall 003
D-12
S-10
I-11
LR-100
LR-102
LR-101
S-75
PZ-302-AS, PZ-302-AI
S-8
I-62
D-83
S-61
D-6
MW-102
LR-105
S-53
MW-101
I-7
PZ-304-AS, PZ-304-AI
PZ-303-AS
MW-F2
D-81
MW-103
MW-104
S-51
D-93
S-82
I-9
I-2
S-1
S-52

Date of Aerial Topography January 20, 2005, basemap provided by Sanborn.

Civil & Environmental Consultants, Inc.

West Lake Landfill OU-2
Bridgeton, Missouri

Figure 1-2
Existing Facility Features Map



Date of Aerial Topography January 20, 2005, basemap provided by Sanborn.

Civil & Environmental Consultants, Inc.

West Lake Landfill OU-2
Bridgeton, Missouri

Figure 3-1
Approximate Locations of Proposed Temporary Landfill Gas Perimeter Monitoring Probes

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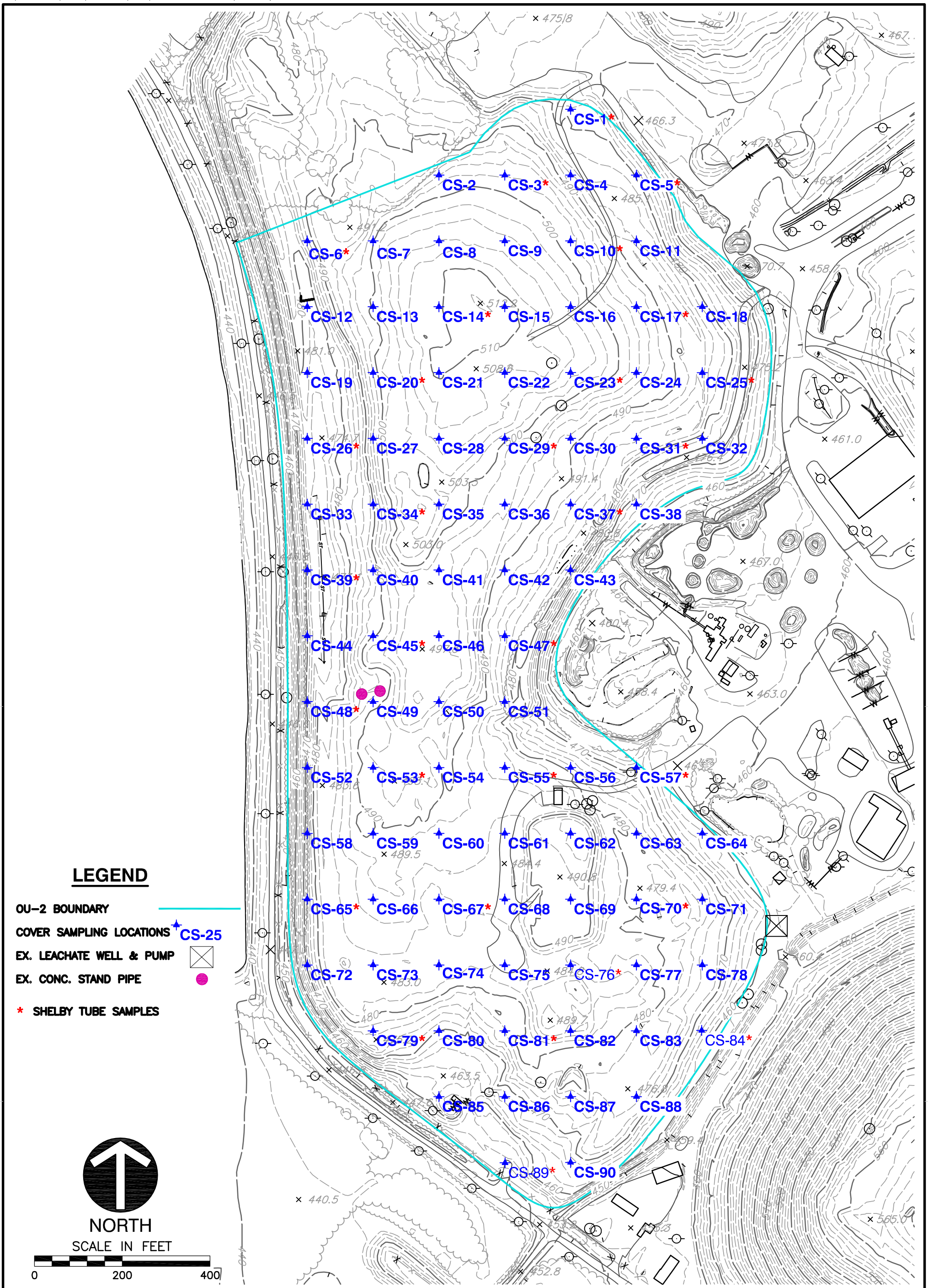

LEGEND

- OU-2 BOUNDARY
- COVER SAMPLING LOCATIONS CS-25
- EX. LEACHATE WELL & PUMP
- EX. CONC. STAND PIPE
- * SHELBY TUBE SAMPLES

NORTH

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

PROPOSED SAMPLING GRID FOR THICKNESS EVALUATION OF INACTIVE LANDFILL COVER

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	6-1
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926		

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LEGEND

SLOPE MONITOR LOCATIONS

SM-1
SM-2
SM-3
SM-4
SM-5
SM-6
SM-7
SM-8
SM-9
SM-10
SM-11
SM-12
SM-13

A A
B B
C C
D D

NORTH

SCALE IN FEET

0 200 400

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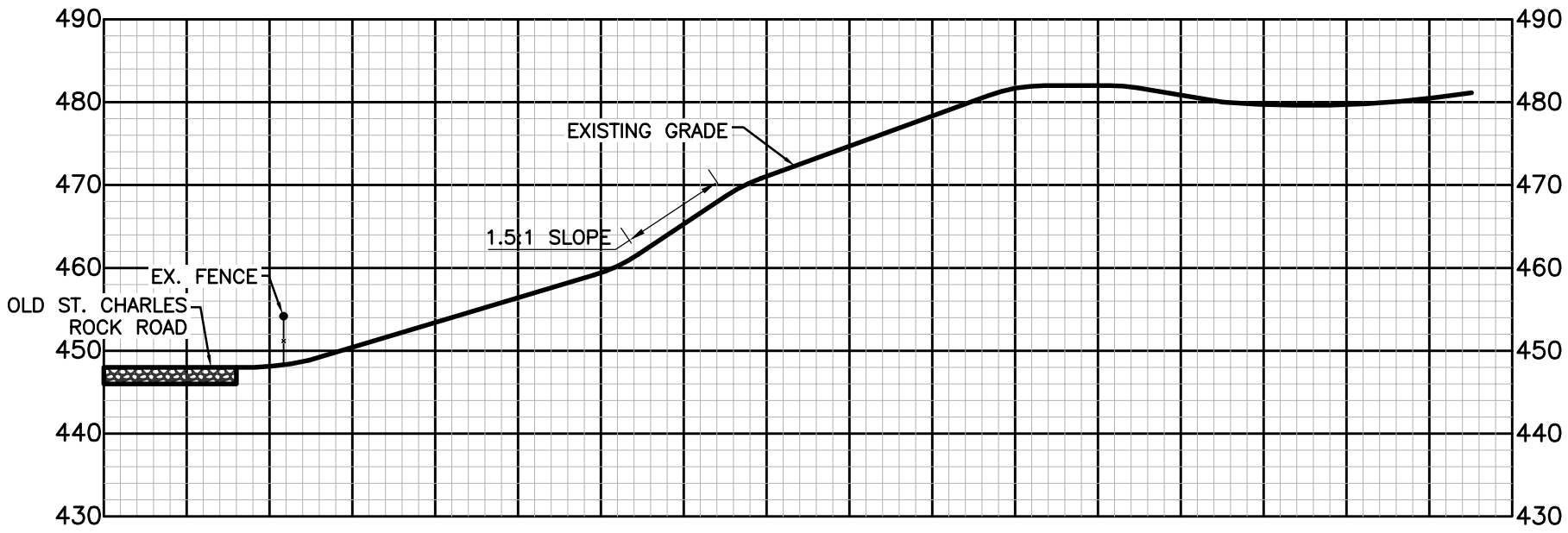
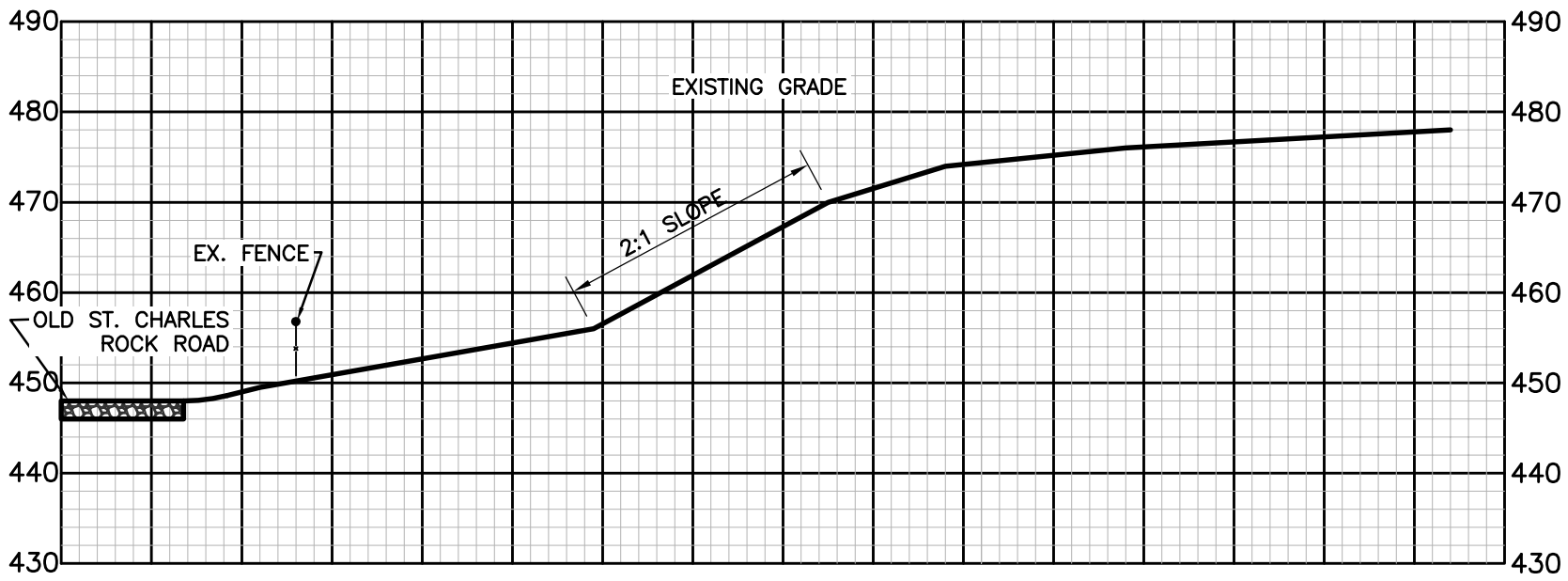
EXISTING WESTERN SLOPE OF OU-2

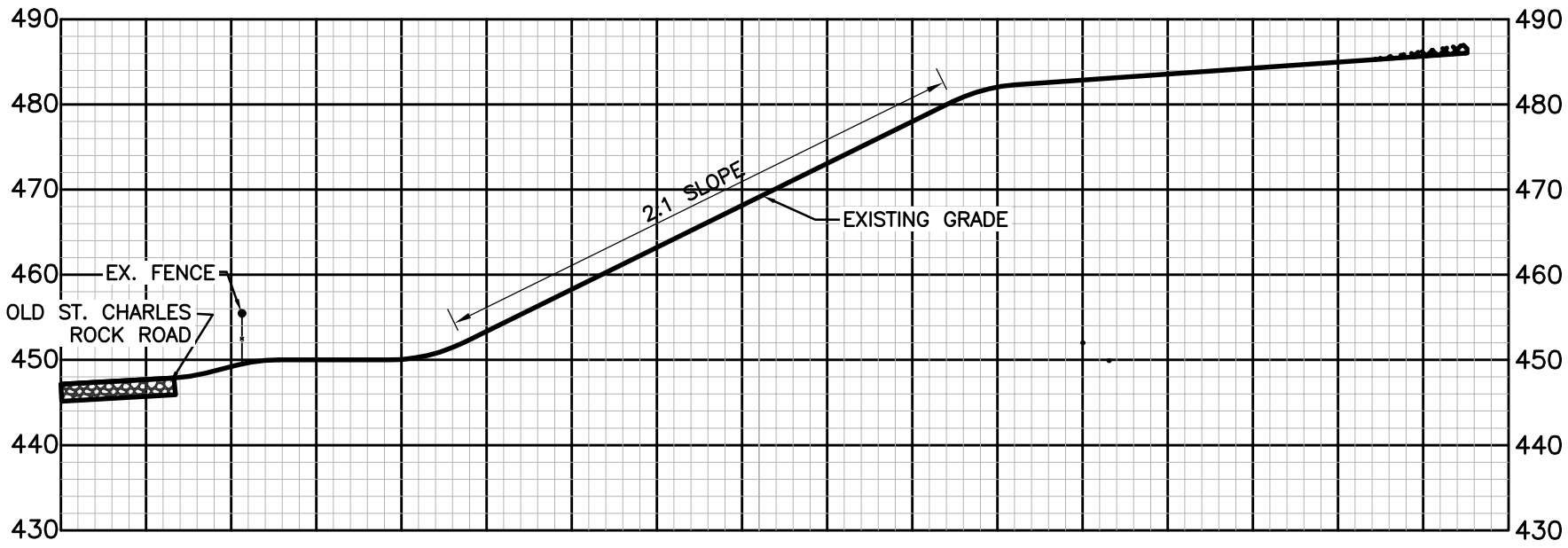
DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:
DATE:	DEC. 2008	DWG SCALE:	1"=200'	PROJECT NO:	081-926	7-1a



SECTION A-A



SECTION B-B



SECTION C-C

HORIZONTAL SCALE
SCALE IN FEET
0 20 40

SECTION D-D

VERTICAL SCALE
SCALE IN FEET
0 20 40

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

WESTERN SLOPE SECTIONS OF OU-2

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:
DATE:	DEC. 2008	DWG SCALE:	1"=20'	PROJECT NO:	081-926	7-1b

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NORTH

SCALE IN FEET

0 400 800

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BRIDGETON, MO 63044
ST. LOUIS COUNTY

LOCATIONS OF POTENTIAL BORROW AREAS

DRAWN BY:	LEP	CHECKED BY:	KTK	APPROVED BY:	*DFM	FIGURE NO.:	8-1
DATE:	DEC. 2008	DWG SCALE:	1"=400'	PROJECT NO:	081-926		

APPENDIX E

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

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PHOENIX, ARIZONA

CEC Project 191-750

JUNE 11, 2019

Civil & Environmental Consultants, Inc.

Phoenix | 11811 N. Tatum Boulevard, Suite 3057 | Phoenix, AZ 85028 | p: 602-760-2324 f: 602-760-2330 | www.cecinc.com

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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**
Matt Stewart, P.G.	Bridgeton Landfill, LLC	Site Health and Safety Officer	(314) 477-6140
Randal Bodnar, P.E.	Civil & Environmental Consultants, Inc.	Project Manager	(602) 760-2324
Kevin Kamp, P.E.	Civil & Environmental Consultants, Inc.	Project Health and Safety Coordinator	(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.

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; 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 probes.
- 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.

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 >25 ppm in breathing zone (other than a peak) OR >50 ppm	Temporarily cease operations
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. Turn 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 illustrates the rout 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.

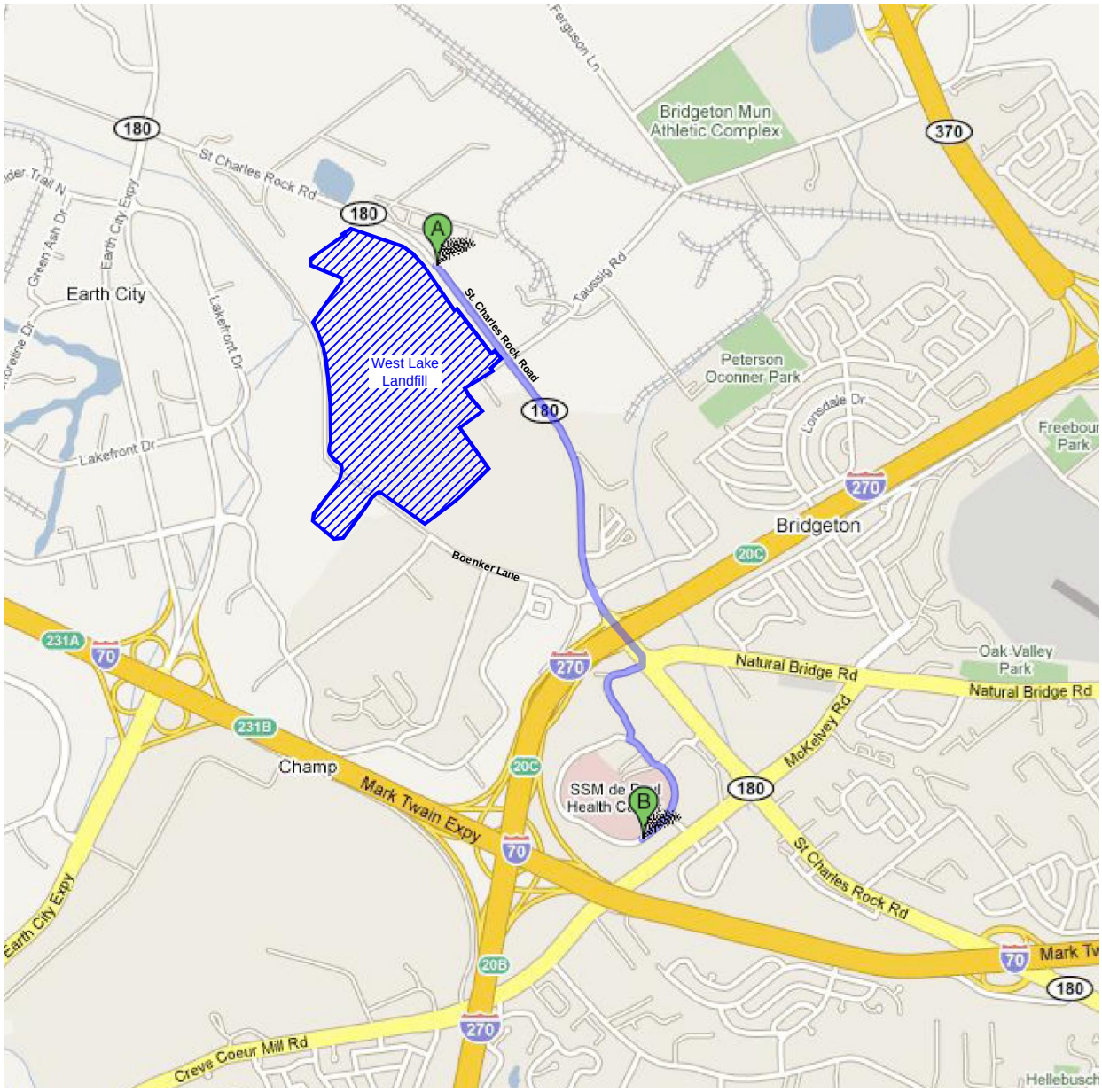
12. The protective casing and any other casing pipe used shall be steam cleaned.

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.

FIGURE

Google Maps

Directions to 12303 De Paul Dr, Bridgeton, MO 63044
2.1 mi – about **7 mins**



A **13570 St Charles Rock Rd**
Bridgeton, MO 63044

180	1. Head **southeast** on **MO-180/St Charles Rock Rd** toward **Taussig Ave** About 5 mins	go 1.3 mi total 1.3 mi
↱	2. Turn **right** at **Mareschal Ln**	go 0.1 mi total 1.5 mi
↖	3. Slight **left** at **De Paul Dr**	go 0.2 mi total 1.7 mi
↰	4. Turn **left** to stay on **De Paul Dr** Destination will be on the right About 2 mins	go 0.4 mi total 2.1 mi

B **12303 De Paul Dr**
Bridgeton, MO 63044

NORTH

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Civil & Environmental Consultants, Inc.

West Lake Landfill OU-1
Bridgeton, Missouri

Figure 1
Directions to Hospital from West Lake Landfill

APPENDIX F

SHELBY TUBE SAMPLE RESULTS

Results of Laboratory Testing

Project: OU-2 Landfill Cap Evaluation
Client: Republic Services
WEI Job No.: 081-926

Prepared by: CAC
Checked by: MDJ
Date: May 20, 2009

Sample ID	Depth	Soil Classification	Moisture Content	Atterberg			Particle Size				Average Permeability		Dry Density	Void Ratio	Notes:
		D2488	D2216	D4318			D422				D5084				
	(ft)	(USCS)	MC (%)	LL (%)	PL (%)	PI (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	k_t (cm/s)	$k_{20°C}$ (cm/s)	γ_d (pcf)	e_o (dim)	
CS-04	0.0 - 2.0	Lean Clay (CL)	24	36	20	16	0.0	0.5	78.2	21.3	2.59E-08	2.47E-08	101.6	0.659	
CS-06	0.0 - 2.0	Lean Clay (CL)	17	34	20	14	0.0	0.8	76.3	22.9	8.26E-08	7.87E-08	112.7	0.524	
CS-24	0.0 - 2.0	*Sand-Silty Sand (SP-SM)*	27												No Testing / Granular
CS-33	2.0 - 4.0	Lean Clay (CL)	20	34	22	12	0.0	6.3	75.5	18.2	1.15E-06	1.10E-06	105.6	0.626	
CS-36	0.0 - 2.0	Silt (ML)	25	38	25	13	0.4	14.6	68.2	16.8	1.11xE-6	1.04E-06	96.3	0.745	
CS-53	0.0 - 2.0	Lean Clay (CL)	27	47	20	27	0.0	5.5	58.0	36.6	1.57E-07	1.47E-07	100.7	0.675	
CS-54	0.0 - 2.0	Silt (ML)	21	25	23	2	0.1	5.4	79.6	14.9	3.66E-07	3.41E-07	104.2	0.621	
CS-57	0.0 - 2.0	Silty Clay with Sand (CL-ML)	21	26	20	6	1.2	20.3	64.8	13.6	4.74E-07	4.41E-07	103.8	0.596	
CS-65	2.0 - 4.0	Silt with Sand (ML)	17	28	23	5	0.2	23.1	62.1	14.6	1.46E-07	1.38E-07	104.4	0.615	
CS-70	0.0 - 2.0	*Lean Clay (CL)*	--	33	21	12	1.1	7.5	68.0	23.4					No Testing / Granular
CS-80	0.0 - 2.0	Lean Clay (CL)	18	38	23	15	0.6	5.1	69.1	25.2	1.83E-06	1.70E-06	144.6	0.505	
CS-87	0.0 - 2.0	Lean Clay with Gravel	21	34	20	14	13.7	12.6	53.5	20.3	1.76E-07	1.61E-07	108.1	0.59	

Notes: *LL= Liquid Limit*
PL= Plastic Limit
PI= Plastic Index
$\gamma_{d\,max}$=dry unit weight