FEASIBILITY STUDY

FOR INTERSTATE POWER COMPANY'S FORMER MANUFACTURED GAS PLANT MASON CITY, IOWA

SEPTEMBER 23, 1994
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ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BRA	Baseline Risk Assessment
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
CRDL	contract required detection limit
CWA	Clean Water Act
EE/CA	engineering evaluation/cost analysis
EPA	Environmental Protection Agency
FMGP	Former Manufactured Gas Plant
FS	feasibility study
GTI	Groundwater Technology, Inc.
HAL	health advisory level
HEA	health effects assessments
IDNR	Iowa Department of Natural Resources
IPW	Interstate Power Company
JMM	James M. Montgomery Consulting Engineers (now Montgomery Watson)
KCPL	Kansas City Power & Light Company
Kd	Soil-waste partitioning coefficient
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
μg/L	micrograms per liter
mg/kg	milligrams per kilogram
MW	Montgomery Watson (formerly James M. Montgomery [JMM] Consulting Engineers
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Emission System
NPL	National Priorities List
NRL	negligible risk level
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
POTW	publicly owned treatment works
PRG	proposed remediation goal
PHRBRG	preliminary health risk-based remediation goal
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RIA	Remedial Investigation Addendum
RME	reasonable maximum exposure
ROD	record of decision
RQD	rock quality designations
SARA	Superfund Amendments and Reauthorization Act
SB	soil borehole
SDWA	Safe Drinking Water Act
SQL	sample quantitation limit
TBC	to be considered
TCA	tetrachloroethane
TCLP	toxicity characteristic leaching procedure
TSCA	Toxic Substances Control Act
USC	United States Code
VOC	volatile organic compound

EXECUTIVE SUMMARY

On October 1, 1991, Interstate Power Company (IPW) and the US EPA Region VII entered into a consent agreement (Administrative Order on Consent, US Docket No. 85-F-0032) to conduct a Remedial Investigation and Feasibility Study (RI/FS) at the former manufactured gas plant (FMGP) site in Mason City, Iowa. The approximately 1.47-acre site is owned by IPW and the City of Mason City. On December 29, 1993, Kansas City Power & Light (KCPL) entered into an agreement with IPW allowing KCPL to prepare the feasibility study for the project. This report presents the feasibility study for the Mason City FMGP site with revisions reflecting the US EPA Region VII's October 24 letter.

The site occupies a small property located along the south bank of Willow Creek near downtown Mason City. A coal gasification plant occupied the site between 1897 and 1951. In 1952, the plant was decommissioned and the buildings demolished. In 1984, the remnants of the FMGP were discovered during the construction of a sanitary sewer across the northern portion of the property owned by Mason City. This discovery resulted in the beginning of the investigations which have been conducted over the intervening 10-year period.

The RI results to date show that the soils and groundwater at the site contain elevated concentrations of compounds that are typically associated with manufactured gas plant operations. Compounds detected include polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and metals. In soils, the highest concentrations of these compounds were detected in soil samples collected from the northwest corner of the site and from the waste pile on-site. The waste pile contains materials that were excavated in 1984 during the installation of the sewer line. In groundwater, the highest concentrations of these compounds were detected in the northwest and middle portions of the site in the shallow unconsolidated fill and upper fractured bedrock. Low levels of three PAH compounds were detected in the groundwater in the deep aquifer. Additional sampling is being conducted to determine whether these values are valid or possibly to due cross-contamination during drilling or sampling.

The interim baseline risk assessment (interim BRA) and the addendum to the interim BRA prepared for the site by EPA identified on-site exposure to soils and off-site exposure to groundwater migrating off-site as posing potential unacceptable risks to area residents who may come into contact with these media. Data from the interim BRA and the addendum to the interim BRA were used to calculate Preliminary Health Risk-Based Remediation Goals (PHRBRGs). These PHRBRGs were then used to establish remedial response objectives and proposed remediation goals (PRGs). This feasibility study evaluated a series of remedial options that would meet the remedial response objectives and address the potential risks identified in the risk assessment.

The feasibility study was conducted in accordance with the EPA's 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. First, remedial technologies applicable to the contaminated soils and groundwater were identified. The most applicable technologies were then combined into remedial alternatives to address soils and groundwater separately. The remedial alternatives were then screened. Those remedial alternatives which meet the criteria of effectiveness, implementability and cost (in terms of order of magnitude) were then evaluated in detail against nine evaluation criteria to provide decision makers with the requisite information to select a remedy for the site.

Remedial alternatives for soil include no action, institutional controls, containment, excavation and treatment/disposal. No action is the baseline against which the other alternatives are compared. Containment includes capping, does not remove the contamination. Treatment alternatives include thermal treatment, biological treatment, and stabilization. The treatment alternatives meet the remedial response objectives; however, they do so at a higher cost and with a greater degree of operational concern and potential exposure to the nearby residents than capping. The treatment alternatives contain the components of excavation and disposal.

Remedial alternatives for groundwater include no action, institutional controls, and several alternatives to either contain or remove and treat the on-site groundwater. Institutional controls would not eliminate the contamination.

1.0 INTRODUCTION

This FS evaluates remedial alternatives as applicable to conditions at the former manufactured gas plant (FMGP) site, which is located on property owned by the Interstate Power Company (IPW) and the City of Mason City, in Mason City, Iowa. KCPL entered into an agreement with IPW on December 29, 1993, to prepare an FS report in accordance with the Administrative Order on Consent (Consent Order) between IPW and the United States Environmental Protection Agency (EPA) dated October 1, 1991. The consent order required IPW to conduct a Remedial Investigation and Feasibility Study (RI/FS) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended; the National Contingency Plan (NCP); and EPA Guidance documents, including the "Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA," dated October, 1988.

Following initial discovery of the FMGP site in 1984 by a contractor installing a sanitary sewer line across a portion of the site, extensive studies have been performed to determine the extent and impact of compounds affecting the site. Primary chemical compounds at FMGP sites are due to residual coal tar left in the soils and in underground remnants of the gas manufacturing process. Derivatives of coal tar which are typically the compounds of concern are polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), lead, and cyanide. At the Mason City FMGP, coal tars and their derivatives have been discovered in the soils and the shallow groundwater. It has not been conclusively determined at the time of preparation of this FS report as to whether these compounds have impacted the deeper groundwater aquifer (also known as the "first transmissive zone"). Although the data suggests the deeper aquifer is uncontaminated; verification sampling results will not be available until after completion of the FS.

This submittal completes the primary objectives for this site as contained in the October 1, 1991, consent order.

1.1 Purpose and Organization of Report

The purpose of this report is to present to the EPA technology alternatives evaluated as part of the FS for the site. This FS is being conducted under the Administrative Order on Consent for Remedial Investigation/Feasibility Study (Consent Order), US Docket No. 85-F-0032, dated October 1, 1991, between IPW and EPA. IPW and the City of Mason City own property where in 1984 remnants of a coal gasification plant were discovered. It was subsequently discovered, through sampling and laboratory analysis, compounds that were associated with the coal tar byproduct of the FMGP.

This discovery prompted a succession of site investigations commencing in 1984. On January 18, 1994, the EPA proposed to list the Mason City Coal Gasification Plant on the National Priorities List (59 *Federal Register*, 2568). The National Priorities List (NPL) is a list of uncontrolled hazardous waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1984 (SARA). As outlined in the consent order, the RI/FS had the following purpose and objectives:

1. Define the extent and nature of groundwater impact at and/or from the site;

2. Implementation of a groundwater recovery program to contain the migration of impacted groundwater from the site until a soil and groundwater remediation alternative is chosen by the EPA;

3. Define the extent and nature of surface and subsurface soil impact;

4. Characterize the upper bedrock;

5. Characterize and monitor the waste pile;

6. Define the extent and nature of surface water and sediment contamination in Willow Creek;

7. Determine the volume and toxicity of contaminated source material including any contaminated source migration area.

This FS has been prepared in accordance with the FS Scope of Work contained in the Consent Order, the NCP, and the EPA document, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," Interim Final, EPA/540/6-89/004, October 1988 and the EPA letter of October 24, 1994. Accordingly, the FS is organized as follows:

- Section 1.0 includes the purpose and organization of the report, the site background, physical characterizations from the RI, the nature and extent of contamination, contaminant fate and transport, and a summary of the interim BRA.

- Section 2.0 identifies and screens technologies, describes the remedial action objectives, the federal and State of Iowa potentially applicable or relevant and appropriate requirements (ARARs), risk-based cleanup objectives based on the interim BRA, and general response actions. This section also presents the technology screening for soil and groundwater including the major approaches for containment, treatment and disposal.

- Section 3.0 presents the development and screening of remedial action alternatives based on implementability, effectiveness, and cost.

- Section 4.0 contains a detailed analysis of alternatives based on protection of human health and the environment, compliance with ARARs, Long-term effectiveness and permanence, reduction of toxicity, mobility or volume; short-term effectiveness; implementability; cost; regulatory acceptance, and; community acceptance. This section includes both an individual and comparative analysis of selected alternatives.

- Section 5.0 contains references used in preparing this report.

1.2 Background Information

The information contained in this section has been obtained from several reports prepared by Montgomery Watson and Jacobs Engineering (see Reference section).

1.2.1 Site Location

The Mason City FMGP site occupies a small piece of property located along the south bank of Willow Creek near downtown Mason City, Iowa (see figure 1-1). The site measures approximately 64,000 square feet (about 320 feet by 200 feet) and is bordered on the west by South Delaware Avenue, on the south by 5th Street SE, and on the east by South Pennsylvania Avenue (see figure 1-2). The site is vacant except for approximately 16,800 square feet (about 120 feet by 140 feet) which is occupied by an electrical substation and small storage building owned and operated by IPW.

1.2.2 Site Description

The approximately 1.47-acre site (including the electrical substation) is essentially flat and covered with gravel. Two major exceptions are the electrical substation, occupying the southwest corner of the site, and the tarp-covered coal tar waste pile located on the southeast portion of the site. Surface drainage is generally northeast and the site is surrounded by a fence and locked gate.

Willow Creek is lined with concrete flood walls as it flows west to east along the northern edge of the site. A movable low-head dam crosses Willow Creek just beyond the northeast corner of the site. This dam, originally installed to provide cooling water for a former electrical power plant located just west of the subject site (across South Delaware Avenue), can be mechanically raised and lowered which affects the water elevation of Willow Creek. To the north of Willow Creek is a small, landscaped area with a walking trail paralleling Willow Creek. The topography rises quickly (about 18 feet) over limestone rock outcrops to the approximate elevation of downtown Mason City.

1.2.3 Site History

According to information obtained by Montgomery Watson (RIA, April 1994) the manufactured gas plant was constructed on the site between 1897 and 1901 in the northwest portion of the site. The facility was enlarged in 1909 and 1915 including a large capacity gas holder near the east side of the site. The gas plant was decommissioned in 1951 and demolished in 1952.

According to IPW, the large gas holder on the east side of the site is no longer present. Subsurface components of the former facility located in the north and northwest portion of the site were rediscovered in 1984 during construction of a sanitary sewer line by a contractor hired by the City of Mason City (the northern 20 foot portion of the site parallel to Willow Creek was purchased by the City from IPW for installation of the sewer line). During construction, the contractor used explosives to blast through the bedrock. Construction was halted in the area following citizen complaints due to the contractor pumping coal tar into Willow Creek resulting in a sheen on the water surface. This resulted in an initial investigation by the Iowa Department of Natural Resources (IDNR). The contractor was allowed to continue installation of the sewer although he was requested to refrain from continued blasting of the bedrock. The contractor collected and contained the liquid coal tar in order to continue his work. The coal tar was reportedly disposed of by three different methods. These included: dumping into Willow Creek, placing it into a settling basin dug on-site, and mixing with sand and placing in a pile on the southeast portion of the property. The "waste pile" was later covered with an impermeable cap.

Significant milestones and previous reporting dates for the site over the last 10 years are as follows.

June 1986	Initial EPA-IPW consent order signed. EPA and IPW.
August 1986	"Preliminary Assessment, Plan of Study, Mason City Coal Gasification Plant."
August 1986-May 1987	Preliminary Assessment performed. Hickock & Assoc.
May 1987	"Field Investigation and Preliminary Assessment" Report. Hickock & Assoc.
October 1987	"Plan of Investigation" (Phase II) Work Plan. Hickock & Assoc.
October 1987-April 1988	Phase II site investigation. Hickock & Assoc.
March 1988	"Phase II Investigation" Report. Hickock & Assoc.
June 1988	"Supplemental Investigation Work Plan (Phase III)." Hickock & Assoc.

June 1988	Risk Evaluation Report. Hickock & Assoc.
December 1988	Waste pile test trenching and general site cleanup.
February 1989	"Well Inventory of Mason City, Iowa" Report. Hickock & Associates.
June 1988–March 1989	Phase III Investigation. Hickock & Assoc.
February 1989	"Phase III Supplemental Field Investigation, Mason City, Iowa" Report. Hickock & Assoc.
August 1990	"Feasibility Study for Mason City FMGP, Mason City, Iowa" Report. JMM Consulting Engineers.
October 1991	Second EPA–IPW Consent Order signed. EPA and IPW.
December 1991	"RI/FS Work Plans" (RI/FS Work Plan, Field Sampling Plan, QA Project Plan, and Health and Safety Plan. Montgomery Watson.
December 1991–September 1992	Remedial Investigation. Montgomery Watson.
January 1993	"Remedial Investigation Report." Montgomery Watson.
August 1993	Revisions to RI Report. Montgomery Watson.
September 1993	"Interim Baseline Risk Assessment." Jacobs Engineering.
January 1994	Mason City Coal Gasification Site proposed for NPL in *Federal Register*.
April 1994	"RI Addendum Report" (also known as "RIA"). Montgomery Watson.
June 21, 1994	"Addendum to Interim Baseline Risk Assessment." Jacobs Engineering.
August 5, 1994	Draft Feasibility Study Report Groundwater Technology.
August 19, 1994	Revisions to RI Addendum Report. Montgomery Watson.
September 23, 1994	Revised FS Report Groundwater Technology.

A summary of investigation findings and site history (conducted prior to the second consent order) is contained in Section 1.5.2 of the January 1993 Remedial Investigation Report. An overview of the most recent site investigation findings (through the August 1994 revisions to the RIA) will be provided in the following sections of this FS.

The following figures from the Remedial Investigation (Montgomery Watson, April 1994) have been included to illustrate key site conditions:

1-3. Potential Source Areas (Former Site Plan)
1-4. Total PAHs in Soil
1-5. Total Carcinogenic PAHs in Soil
1-6. Total PAHs in Groundwater (Shallow Aquifer)
1-7. Total Carcinogenic PAHs in Groundwater (Shallow Aquifer)
1-8. Total PAHs in Groundwater (Intermediate Zone)
1-9. Total PAHs in Groundwater (First Transmissive Zone)
1-10. Shallow Aquifer Potentiometric Surface (12-13-93)
1-11. Shallow Aquifer Potentiometric Surface (2-28-94)
1-12. First Transmissive Zone Potentiometric Surface (12-13-93)
1-13. First Transmissive Zone Potentiometric Surface (2-28-94)
1-14. Total PAH Concentration Contours (Shallow Aquifer)
1-15. Benzene Concentration Contours (Shallow Aquifer)
1-16. Conceptual Model of Contaminant Transport

1.2.4 Site Soils

In general, the soils of the FMGP site and former electric power plant site located to the west of South Delaware Avenue consist of a nonhomogeneous variety of fill material including bricks and brick fragments, concrete, gravel, wood, sand, and silt. Naturally occurring soils were occasionally encountered as apparently isolated pockets immediately above the bedrock surface.

The extent of soil and fill present at the off-site RIA drilling locations was limited. To the west of the site, bedrock remains at the same elevation along Willow Creek but rises to only 2 feet below the ground surface at MW-26 and MW-35. At most of the other RIA drilling locations (off-site) the bedrock surface was within only a few feet of the ground surface, limiting the amount of soil available for sample collection. At locations MW-29 through MW-31, the ground surface actually is the top of the bedrock. No soil cover exists at these locations.

The only off-site locations with an appreciable thickness of soil and fill were MW-27 and MW-28. Both of these locations had significant amounts of fill material. All investigations have consistently identified on-site soil and fill thickness ranging from 9 to 14 feet thick.

1.2.5 Geology

The uppermost bedrock unit on the FMGP site has been identified as the Cedar Valley Formation. This bedrock unit underlies the unconsolidated sediments and fill at the site. The bedrock unit is divided into an upper bedrock unit and the first transmissive zone. The Cedar Valley Formation contains shale stringers within the bedrock unit.

Geophysical evaluations were performed by Montgomery Watson to determine the "first transmissive zone" in the wells that were not cored. Based on the responses noted in the logs, visual observations of porosity, and the production of water during the drilling process, the first transmissive zone was noted for each of the five deep wells and later verified by packer testing. These tests revealed only minor changes in the lithology of the bedrock below the shale zone on and immediately around the site. No fracture zones or voids were encountered in any of the deep holes.

Rock quality designations (RQD) were calculated for holes cored as part of the RIA. In each of the holes, RQD increased with depth and reached 100% in sections of each of the cores. This indicated that the fracture frequency of the rock decreases with depth. Below the uppermost fracture zone of bedrock, the RQDs were typically greater than 75%.

One naturally occurring near-vertical fracture was observed in the core from MW-31 at approximately 73 to 75 feet below grade. The top of this fracture terminated in the core at a horizontal bedding plane fracture. All other naturally occurring fractures were oriented along bedding planes of the rock (approximately perpendicular to the core section). Montgomery Watson concluded that while these observations do not eliminate the possibility of more significant vertical fractures, the integrity of the core samples indicates the rock is predominantly competent, rather than highly fractured or fragmented.

Geotechnical evaluations were performed on bedrock cores collected from the first transmissive zone to determine bulk density of the rock, percent clay by weight, and vertical hydraulic conductivity. Montgomery Watson concluded that the vertical hydraulic conductivity obtained for each of the core sections analyzed indicated that the rock in and immediately below the shale zone will effectively prevent downward migration of the compounds or the impacted groundwater at the site through the rock structure. Therefore, the only potential for vertical migration would be restricted to potential vertical fractures that have not been specifically identified.

1.2.6 Hydrogeology

Montgomery Watson has identified two primary aquifers related to the subject site. Groundwater flow in the shallow aquifer is generally to the northeast. Groundwater flow in the first transmissive zone (or deeper aquifer below the shale zone) has consistently been to the southwest.

Groundwater flow in the shallow aquifer in the vicinity of the site is partially controlled by water levels in Willow Creek. These levels are also controlled by the variable height, low head dam located just northeast of the site. When the dam is in the down position, shallow groundwater flows onto the site from the southwest. When the dam is in the raised position or when the elevation of Willow Creek increases as the result of a high precipitation event, water from Willow Creek enters the groundwater system upstream of the retaining walls and flows around the retaining walls and dam. This results in a reversal or significant change in the direction of groundwater flow west of Delaware Avenue and in the northwestern portion of the site.

The northernmost (off-site) monitoring wells identified a strong southerly component of shallow groundwater flow that, when combined with the northeasterly flow previously discussed, results in a groundwater trough in the area of MW-15 and the MW-16, 17, 18 cluster. According to Montgomery Watson the two components of flow then join to bring about an easterly flow toward MW-19. Immediately beyond MW-19, shallow groundwater appears to continue on an easterly course. However, it is suspected that groundwater flow will resume a more northeasterly flow direction beyond this point because of influences from nearby rock outcrops and nearby Willow Creek. Montgomery Watson concludes that the southerly component of flow on the north side of Willow Creek indicates that all the wells north of the creek may, to some degree, be affected by groundwater flow from the downtown Mason City area.

Montgomery Watson describes three aquifers at the site. A shallow aquifer, an intermediate aquifer and the first transmissive zone (deep aquifer). The shallow aquifer is considered to be the unconsolidated fill material and the upper portion of the fractured bedrock that is weathered (approximately 1 foot). The intermediate aquifer is the fractured bedrock above a shale zone. The first transmissive zone is the bedrock below a shale zone. The interim BRA identified as the deep aquifer the portion of the fractured bedrock that Montgomery Watson called the intermediate aquifer. The addendum to the interim BRA modified the description of the shallow aquifer to include the portions of the aquifer identified by Montgomery Watson as the shallow and intermediate aquifer. The deep aquifer in the addendum to the interim BRA is the same as the first transmissive zone described by Montgomery Watson.

Conductivity in the unconsolidated, saturated, fill material ranged from 2.9x10 [illegible] centimeters per second (cm/sec) at MW-2 to 2×10^{-2} cm/sec at MW-3 with the majority of the reported hydraulic conductivities in the 10 [illegible] to 10 [illegible] cm/sec range.

The hydraulic conductivity of the shallow fractured bedrock ranges from 8.6×10^{-3} cm/sec at MW-7 (aquifer pumping test) to 4.7×10^{-4} cm/sec at MW-7 (slug test). MW-8 and MW-10 are deeper in the fractured bedrock and have hydraulic conductivities of 1.3×10^{-4} cm/sec and 4.8×10^{-5} cm/sec respectively.

The transmissivity of the shallow aquifer was determined by the analysis of aquifer pumping test data. The pumped well was MW-23. The average transmissivity was calculated to be 0.20 cm^2/sec. The average storativity from the pumping test was 0.02 (dimensionless).

Core samples were collected from the interval between the first transmissive zone and the shallow aquifer. This interval was described by Montgomery Watson as the shale zone. The bedrock in the shale zone has less fractures and more shale content than the overlying shallow aquifer and less primary and secondary porosity than the first transmissive zone. The cores were tested for vertical hydraulic conductivity. Test results indicated the bedrock in the shale zone will effectively prevent downward migration due to very low vertical hydraulic conductivity.

The first transmissive zone lies beneath the shallow aquifer and is separated from the shallow aquifer by the shale zone. Slug tests performed on wells screened in the first transmissive zone yielded hydraulic conductivities that ranged from 3.1×10^{-3} cm/sec at MW-25 to 2.3×10^{-5} cm/sec at MW-34.

1.3 Nature and Extent of Contamination

1.3.1 Soils

The RI report identified total PAH concentrations in soils on the subject site ranged from below detection to 1,906 mg/kg. Carcinogenic PAHs in soils on the subject site ranged from below detection to 1,246 mg/kg. Concentrations in the waste pile for total PAHs ranged from below detection to 25,860 mg/kg. Carcinogenic PAHs in the waste pile ranged from below detection to 67 mg/kg.

At some of the off-site locations, Montgomery Watson identified PAHs that exist in significant concentrations at locations that are topographically higher than the FMGP site. PAHs were also detected in the 10- to 16-foot-depth interval at MW-15 located just north of Willow Creek. The contamination detected at MW-15 is most likely from on-site sources since MW-15 is located in a downgradient flow path from the site.

PAHs were also detected at MW-20 at a depth of 24 to 26 feet below ground surface. This location does not appear to be downgradient of any known contaminant sources, may be hydraulically connected to Willow Creek, and may be influenced by storm sewer discharges. IDNR records contain several reports of documented releases of petroleum products through the storm sewer.

According to Montgomery Watson, the principal VOC of concern at the site is benzene. The maximum concentration of benzene detected was 6 μg/kg at soil bore location SB/FF. Vinyl chloride was detected in a single soil sample collected from the waste pile in October of 1988. It was also apparently detected during a single groundwater sampling event in groundwater samples collected from MW-6 and MW-10 during November of 1988. Vinyl chloride has not been detected in any samples analyzed since that time. Montgomery Watson concludes, therefore, that the presence of vinyl chloride is not supported by the repeated sampling events of both groundwater and the waste pile.

The results of the RIA were not complete before the preparation of this FS. The current results of the RIA are inconclusive regarding the extent of off-site migration of contaminants. A sampling location upgradient from the site (MW-28) has higher soil concentrations than some sampling locations on-site and is topographically at a higher elevation than any monitoring well on-site. In order for the contaminants detected in soils north of the site to be attributable to on-site contamination, the contaminants would have to dissolve in groundwater, move with the groundwater, and then sorb to the soils at the off-site location. This scenario is unlikely because PAHs as a class of compounds are not very soluble, have an affinity for sorption to soils, and, therefore, are not very mobile. This scenario also assumes that the groundwater would flow under Willow Creek. The latest water table maps and other RI data indicate that Willow Creek is hydraulically connected to the shallow groundwater system, and that it is a discharge area for the shallow groundwater.

1.3.2 Bedrock

The extent of bedrock contamination is based primarily upon visual observation. According to Montgomery Watson, of all of the rock coring and air rotary drilling locations, visible impact was observed only at MW-25. Sporadic staining of the rock surface and small pockets of free-phase coal tar material in open pores were noted in decreasing amounts to a total depth of approximately 29 feet below ground surface at this location. The visible impact did not extend below the top of the shale zone. Montgomery Watson concluded that visible bedrock contamination appears limited to the Mason City FMGP site and is confined to the upper, more highly fractured portions of the bedrock and does not penetrate the shale zone.

1.3.3 Groundwater

All monitoring wells were sampled in December 1993, for the RIA. During the sampling events, the dam on Willow Creek was in the down position. All of the monitoring wells sampled during the RIA located in the shallow aquifer (above the shale zone) contained PAH compounds with the exception of MW-20. The concentrations of total PAHs ranged from 0.27 µg/L at MW-6 to approximately 9,260 µg/L at MW-2. Notable increases were observed in PAH concentrations in several wells when compared to the dam-down sampling events of the RI. In the northwest corner, MW-2 showed an increase of 56 µg/L to 9,260 µg/L, and MW-14 increased from 8 µg/L to approximately 158 µg/L. The wells surrounding MW-2 and MW-14 did not, however, show dramatic changes in PAH concentrations. Montgomery Watson suggested these changes may be due to: 1) higher rates of infiltration during the unusually wet spring and summer of 1993 or, 2) movement of previously stable contamination due to high water levels in Willow Creek, which influenced the groundwater regime.

Other locations with notable increases in total PAH concentrations are on the southeastern portion of the site at MW-5 and MW-24. PAH concentrations increased from approximately 2.1 µg/L to 46.9 µg/L at MW-5. At MW-24, PAHs were not detected during the RI in the dam-down sampling event but were detected at approximately 32.4 µg/L during the RIA. Montgomery Watson speculated that these increases may have been due to the flooding or from off-site sources to the south of the site. Montgomery Watson also discounted the likelihood of infiltration of contaminants from the waste pile due to its impermeable cover.

North of Willow Creek, the concentrations of total PAHs at MW-17 increased from 67 µg/L to approximately 1,529 µg/L. The major PAH constituent detected was naphthalene at 1,190 µg/L. The concentration of total PAHs at MW-15 remained virtually unchanged. Montgomery Watson speculated that because naphthalene is one of the more mobile PAH compounds, that its appearance at MW-17 may represent (although this is speculative) the leading edge of a plume of dissolved PAHs. Low level PAHs were detected in MW-19 for the first time. According to Montgomery Watson, these low levels may have gone undetected previously due to higher analytical method detection limits experienced during the RI.

West of the site, monitoring wells MW-26 and MW-27 revealed low-level PAH concentrations at 6.03 µg/L and 1.34 µg/L, respectively. Water level data indicates that during dam-down conditions groundwater flow at both wells is toward Willow Creek and not downgradient of the Mason City FMGP site. Montgomery Watson suggests that the extent of shallow site-derived groundwater contamination to the west of the Mason City FMGP site likely does not extend beyond these wells and in consideration of groundwater flow direction, is likely much closer to the site.

Benzene was detected both on- and off-site during the RIA sampling event, with the highest concentrations detected at MW-2 and MW-17 with 2,000 µg/L and 12,000 µg/L, respectively. These wells traditionally had the highest concentrations of benzene. The benzene concentration at MW-17 nearly doubled from the RI dam-down sampling event. Montgomery Watson speculates that the benzene may also be within the leading edge of a plume of contamination with the naphthalene.

Low-level concentrations of benzene were detected in several of the new wells installed for the RIA. Elevated concentrations of lead were detected at MW-13 and MW-14 during the RIA. These higher concentrations were attributed to the change in analytical method from dissolved to total lead. Lead concentrations have been detected at several wells both on and off-site. Concentrations of lead in MW-13 and MW-14 were 1,060 μg/L and 2,590 μg/L respectively. Although Montgomery Watson is unclear as to the source of the lead in the groundwater, they conclude that the extent of lead is adequately defined by the existing suite of wells.

Groundwater samples collected from the "intermediate zone" indicated the presence of PAH compounds in MW-8, MW-10, and MW-22. No PAHs were detected in MW-18 during the RIA sampling. Montgomery Watson attributes PAH concentrations in MW-8 as a result of downward migration of dissolved contaminants. This may also be the case at MW-22; however MW-22 is upgradient of the site and the PAHs may be due to off-site sources or may represent background concentrations at this location. Montgomery Watson speculates that the increased benzene concentration in MW-8 may be due to leakage around the well casing.

Analysis of groundwater samples collected from the "first transmissive zone" (below the shale zone) detected low-level concentrations of PAH compounds in MW-25 and MW-34. No PAHs were detected in the samples collected from MW-31, MW-33, and MW-35. The concentrations of specific PAHs detected in MW-25 and MW-34 are only slightly greater than the detection limits and, Montgomery Watson speculates, are likely background concentrations or the result of outside influences such as well installation and construction procedures. Additional sampling will be performed to verify this assumption.

No VOCs, acid-extractable organics, or cyanide were detected in any of the samples collected from the first transmissive zone.

Flow reversal in the shallow aquifer resulting from high precipitation events or the dam-down scenario is discussed in Section 1.2.6. This can effect the transport of contaminants from the FMGP site.

Furthermore, it is highly likely that the northern tier wells (i.e., MW-15, 16, 17, 18, 28, 29, 30, 31, and 32) are affected by off-site sources during the dam-down or normal stream flow events. Additionally, contaminants may have migrated off-site during normal flow conditions or the dam-down scenario as indicated by site-related contamination detected in off-site monitoring wells. Furthermore, prior to the installation of the retaining wall lining both sides of Willow Creek, on-site contaminants may have migrated to locations where the northern tier wells are installed. Contaminants are also expected to migrate to northern locations under certain flow conditions regardless of the retaining walls since the walls do not incise or provide a hydraulic cut-off for the entire hydraulically connected saturated zone.

1.4 Fate and Transport of Contaminants

Based on the additional information obtained during the RIA regarding the first transmissive zone, groundwater flow directions north of Willow Creek, contaminant distribution, and evidence of minor off-site sources of contamination, Montgomery Watson has revised the conceptual model (figure 1-16). The model was revised to reflect the compounds of concern negotiated for the RIA analytical work for the existing monitoring wells and includes the first transmissive zone. The core of the model is unchanged in that the potential sources, contaminated media, and the pathways of contaminant migration are identified. Based on the available data, possible contaminant migration routes are identified by Montgomery Watson as probable or potential.

Due to the elevated concentration of PAHs detected at MW-28 (north of Willow Creek and topographically higher than the site), Montgomery Watson added a category identified as "Off-Site Sources" to the original model.

1.5 Interim Baseline Risk Assessment

Jacobs Engineering was contracted by EPA to perform the interim baseline risk assessment for the Mason City FMGP site. The interim Baseline Risk Assessment (BRA) was based on data collected during the Remedial Investigation (Montgomery Watson, January 1993). An addendum to the interim BRA was prepared by Jacobs Engineering following submittal of the RIA report in April 1994. As of the date of completion of the FS, the interim BRA has not been amended to include data from the August 19, 1994, changes to the RIA. The objectives of the interim baseline risk assessment were to assess the magnitude and probability of actual or potential harm to the public health and the environment by releases of hazardous substances from the Mason City FMGP site.

The interim BRA concluded that the risks associated with the potential exposure to groundwater and soil fell within or were greater than the 10^{-6} to 10^{-4} risk range. However the results were recognized as having an unacceptable degree of uncertainty for the following two major reasons: (1) sample quantitation limits (SQLs) used during the RI were too high and, thus, risks may have been underestimated, and (2) the horizontal and vertical extent of groundwater impact had not been adequately defined and, therefore, risks may not have been adequately addressed.

The objective of the addendum to the interim BRA was to assess the impact of the newly obtained data on the original conclusions. According to the interim BRA, uncertainty existed in the original interim BRA because of the identification of some contaminants of potential concern (COPCs) due to the high SQLs. Therefore, although a risk could not be quantified for these compounds, it was not possible to eliminate them as COPCs because they could be present at the SQL that was above the risk-based preliminary remediation goal (PRG). In the original interim BRA, PRGs were calculated using a health protective default exposure scenario for residential land use.

In the data obtained from the RIA, in all cases the SQL range was below the contract-required detection limit (CRDL). For some compounds the SQL was below the risk-based PRG. In other instances, although the SQLs were decreased to the appropriate CRDL, the SQL was still above risk-based PRGs. This was primarily the case for compounds with carcinogenic effects, for example chloromethane, tetrachloroethane (TCA), and vinyl chloride. PRGs were calculated, however, using residential land use in order to not underestimate risk. The interim BRA states that these PRGs do not take into account technical or economic feasibility. The dramatic reduction in the SQLs for the nondetectable analytes in the new groundwater data (Montgomery Watson, RIA, April 1994) increases the confidence that these compounds were not detected at the site. The new RIA data did not eliminate any previously identified soil COPCs.

New information in the RIA indicates that the Cedar Valley formation is the uppermost bedrock at the site. This formation is a local groundwater resource. Drinking water wells in the Mason City area are currently screened in this formation, including some municipal water supply wells. According to the addendum to the interim BRA, new on- and off-site rock core data indicate that there is approximately 15 feet of fractured, weathered bedrock underlying the fill material at the site. Slug tests indicated sufficient horizontal hydraulic conductivity for wells screened in the shallow fractured, weathered aquifer to supply water for domestic purposes. The vertical conductivity was not measured; however, vertical fractures present in rock cores may allow compounds to be distributed where fractures are present. The addendum to the interim BRA further states that rock cores indicate competent bedrock with intermittent stringers of shale are present underlying the shallow fractured, weathered bedrock zone. Slug test data indicate that the "competent bedrock zone" between the "fractured, weathered zone" and the "first transmissive zone" ... "may be adequate to prevent the vertical migration of contamination into the first transmissive zone." However, the slug test data accuracy may be questionable if the analysis assumes homogeneous isotropic unconsolidated aquifer conditions for a fractured bedrock system. Localized fracturing may allow compounds from the shallow upper zone to migrate into the first transmissive zone. The interim

BRA goes on to say "the first transmissive zone of the Cedar Valley formation represents a potential supply of groundwater for residential and/or industrial use in the area."

However, the addendum to the interim BRA later states that the "first transmissive zone in the upper bedrock aquifer"... has a groundwater gradient to the southwest, has a flow inconsistent with the flow in the shallow fractured, weathered zone, and indicates only limited communication between the fractured, weathered zone and the first transmissive zone.

Due to minor concentrations of compounds detected in MW-25, MW-33, and MW-34, the potential for communication is minimal but may exist, according to the addendum to the interim BRA. The addendum to the interim BRA states that the residential exposure scenario is justified in assessing risk because of potential communication between the aquifers, the influence of Willow Creek on the flow direction of the shallow aquifer, and the stated fact (in the interim BRA) that the shallow, fractured bedrock may be a source for Willow Creek.

There was no correlation between PAH and BTEX levels in any of the monitoring wells in the RI data reviewed for the interim BRA. In the RIA data both MW-2 and MW-17 had high PAH and benzene concentrations, suggesting, according to the EPA, that the organic solvent (benzene) may increase the mobility of PAHs in groundwater. This was not the case for MW-23 — one of the highest PAH wells.

RIA data supports the original suggestion that PAHs have migrated into the shallow weathered/fractured aquifer. RIA data from the monitoring wells screened in the first transmissive zone of the Cedar Valley Aquifer (MW-25, 31, 33, 34, and 35) suggest that there is little downward migration in this zone. PAH compounds identified in the first transmissive zone are as follows:

MW-25	acenaphthene	1.38 μg/L
MW-34	benzo(a)anthracene	0.025 μg/L
MW-34	pyrene	0.39 μg/L

EPA speculates that the presence of the compounds, at levels below the conservative risk-based PRGs, may be due to drilling or cross-contamination during sampling.

Regarding PAH compounds detected in Willow Creek, the interim BRA suggested and the RIA data supports, that discharge from the shallow aquifer to Willow Creek is occurring. However, the EPA acknowledges (in the interim BRA) that a letter exists as proof that coal tar was dumped into Willow Creek during construction of the sanitary sewer.

The new RIA data resulted in the elimination of many of the unusually high SQLs. However, in some cases, the highest detected concentrations in the RIA groundwater data were higher than the highest detected level in the original data set (Montgomery Watson, RI, January 1993). In general, for most of the COPCs, the highest level detected in the RIA was greater than those detected in the RI. Some were lower, but detection levels for benzene and benzo(a)pyrene were about double in the RIA. EPA anticipates that inclusion of these data would result in higher estimates of exposure.

In the interim BRA, exposure point concentrations were estimated by grouping data according to the placement of all well data in either the shallow or deep aquifer. RIA data suggests that all RI groundwater data was from the shallow aquifer and, therefore, all of these data points should be grouped together. In the interim BRA, only three wells were evaluated as being representative of the deep aquifer and in these wells only chrysene was detected.

RIA data had only minimal effect on the calculation of exposure point concentration in soil.

To estimate the blood lead levels in children exposed to lead in the shallow aquifer, exposure was calculated using a pharmacokinetics model under a residential use scenario. In the RIA, total lead was analyzed (as opposed to dissolved lead in the RI) resulting in an increase in the highest lead concentration from 51 mg/L to 2,590 mg/L. Fourteen samples in the RIA were higher than the EPA action level for lead in drinking water.

Since publishing of the interim BRA, the slope factors used in estimating carcinogenic risk have decreased by an order of magnitude for two carcinogenic PAH compounds (chrysene and benzo(k)fluoranthene). This affects the toxicity assessment by decreasing the total carcinogenic risk for ingestion in both soils and water.

The addendum to the interim BRA conclusions on risk characterizations at the Mason City FMGP are as follows:

- "The resulting increase in the hazard associated with potential exposure to groundwater from the shallow aquifer does not alter the conclusions of the original interim BRA."
- "No unacceptable noncarcinogenic hazards are associated with this environmental media."
- "The conclusion of the original...BRA, that an unacceptable risk is associated with potential exposure to groundwater, is unchanged."
- "...The hazard quotients calculated for exposure to soil in the original interim BRA were well below zero."

- "...The changes in the carcinogenic slope factors for benzo(k)fluoranthene and chrysene do not alter the conclusion of the original interim BRA (Jacobs Engineering, September 1993), that unacceptable risk is associated with the potential exposure to groundwater in the shallow aquifer."

- [With the] "...new interpretation of hydrogeology...therefore, the potential risks associated with exposure to groundwater have not been underestimated."

- "The greatest change...[was] associated with lead in the groundwater. ...The conclusion of the original interim BRA should be amended to indicate that a significant hazard is likely to be associated with the potential future exposure of children to lead in groundwater from the shallow aquifer."

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

This section identifies and screens potential remediation technologies to evaluate the appropriate technologies that can be assembled into media-specific remedial action alternatives in Section 3.0. Relevant technologies and process options were identified and screened through a four-step approach, as follows:

- Development of remedial action objectives that will address the contaminants and media of concern, the identified exposure pathways, and the initial remediation goals
- Selection of general response actions for each medium of concern
- Identification and screening of the applicable technologies for each medium
- Evaluation of the most appropriate process option(s) with a technology for use in assembling the remedial alternatives by media

Remedial action objectives were developed to address the contamination identified during the RI and risks identified in the interim BRA for each medium. Potentially applicable or relevant and appropriate requirements (ARARs) were reviewed with regard to specific chemicals, the site location, and probable remedial action(s). Using the calculated risks from the interim BRA, risk-based concentration cleanup levels were calculated. Remediation goals were developed which incorporated all of the criteria listed above.

General response actions were developed for the environmental media of concern at the site, which includes surface and subsurface soils, the waste pile, and groundwater. Applicable remedial technologies were developed and screened for each general response action. The remedial technologies that were retained were used to develop remedial alternatives by media for Section 3.0.

2.2 Remedial Action Objectives

Remedial action objectives address contaminants of concern for each medium, potential exposure pathways, and remediation goals. The remedial action objectives for the site are based on the following:

- Evaluation of the conceptual site models as presented in the RI Addendum (RIA) Report and the interim BRA
- Identification of chemical-specific, location-specific, and action-specific ARARs
- Calculation of risk-based concentrations
- Development of remediation goals

2.2.1 Conceptual Site Model

A conceptual site model (figure 1-16) was developed by Montgomery Watson based on the information provided in the RIA Report. The assumptions for the conceptual site model and its use are presented in the RI Report. Jacobs Engineering also developed a conceptual site model for the site in the interim BRA (figure 2-1). Components common to both conceptual site models are:

- Potential sources
- Types of contaminants and media
- Known and potential routes of migration

The conceptual site model in the interim BRA also identifies potential human and environmental receptors. These components will be discussed briefly in the following sections.

2.2.1.1 Known or suspected sources of contamination. The known or suspected sources of contamination are the structures associated with the FMGP that existed at the site. These structures are shown in figure 1-3. Specifically, these structures are located in the northwest corner of the site and the middle portion of the site. A potential secondary source of contamination is the waste pile created during the installation of a sanitary sewer line across the northern border of the site. The RIA (August 1994) has also identified potential minor off-site sources to the north and west of the site.

2.2.1.2 Types of contaminants and affected media. The types of contaminants identified at the site include VOCs, PAHs, and metals. The affected media, as identified in the RI, include soil, groundwater, sediment, and surface water. The contaminants detected in each medium are presented in table 2-1. A summary of the results of the investigation with regard to the types and distribution of compounds in described in Section 1 of this FS. The interim BRA identified chemicals of potential concern (COPC) for each medium. These chemicals are presented in table 2-2.

2.2.1.3 ***Known or potential routes of migration.*** The known or potential routes of migration are illustrated in figure 1-16. The routes of migration are categorized into probable and potential pathways. The recent revision of the RIA Report (Montgomery Watson, August 1994) included a discussion concerning the potential for PAHs to migrate from the on-site soils to the groundwater and then be transported to off-site soils through the mechanism of water table fluctuation. Montgomery Watson concluded that because the relative concentrations of PAHs in the groundwater are lower compared to off-site soils, this mechanism should not be considered a route of migration.

Data presented in the RIA Report (August 1994) show that a groundwater trough exists in the shallow aquifer with the groundwater north of Willow Creek flowing south to southeast and groundwater south of Willow Creek flowing northeast and possibly discharging to Willow Creek. Only one of the downgradient (north and east of the site) monitoring wells (MW-19) has detected concentration levels of any of the chemicals of concern. Benzo(a)pyrene was detected at 0.02 micrograms per liter ($\mu g/L$) which is 10 times lower than the SDWA MCL of 0.2 $\mu g/L$ and chrysene was detected at 0.034 $\mu g/L$ which is a factor of 350 lower than the PRG calculated in the addendum to the interim BRA. It is also well documented that PAHs are associated with a variety of materials such as diesel fuel, fuel oils, and waste oils.

2.2.1.4 ***Known or potential human and environmental receptors.*** The known or potential receptors as identified in the interim BRA are presented below. These receptors are based on current and potential future land use conditions.

Receptors	**Current Land Use**	**Potential Future Land Use**
Human Receptors		
On-site resident (child/adult)	None	None
Off-site resident (child/adult)	None	Potential
On-site construction worker	Potential	Potential
On-site trespasser (child/adult)	Potential	Potential
Off-site recreational user (child/adult)	Potential	Potential

An ecological risk assessment was also performed. It was concluded in the ecological risk assessment that the low concentration of the single PAH detected (benzo(a)anthracene) in surface water posed no harm to ecological receptors.

2.2.2 *Chemical-Specific, Location-Specific, and Action-Specific ARARs*

As part of this feasibility study, applicable or relevant and appropriate requirements (ARARs) were identified. The National Contingency Plan (NCP) requires compliance with federal and state environmental laws that are legally applicable or are relevant and appropriate. Requirements are evaluated to determine if they are ARARs; proposed remedial actions are then examined to ascertain whether or not they can comply with all the identified ARARs for the site.

Applicable requirements are cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (EPA 1988).

Relevant and appropriate requirements are cleanup standards, standards of control, or other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that, while not legally applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site such that their use is well-suited to the particular site (EPA 1988).

When the analysis shows that a requirement is both relevant and appropriate, it must be complied with to the same degree as if it were applicable (EPA 1988). The NCP specifies eight factors to be used in evaluating whether a requirement is relevant and appropriate. The factors are used to determine if the requirement is addressing a problem or situation that is sufficiently similar to the proposed remedial action (relevant) and also whether the requirement is applicable to the site (appropriate). This evaluation ensures that a requirement that is determined to be relevant is also determined to be appropriate and, therefore, is qualified as an ARAR.

The ARAR provision in CERCLA addresses only on-site actions. Section 121(e) exempts on-site actions from having to obtain federal, state and local permits.

An additional factor to consider in evaluating requirements for compliance is whether the requirement is administrative or substantive. Substantive requirements are those requirements that pertain directly to actions or conditions in the environment; administrative requirements are those mechanisms that facilitate the implementation of the substantive requirements or a statute or regulation. CERCLA response actions must comply with substantive requirements of other environmental laws, but not administrative requirements. Substantive requirements include cleanup standards or levels of control. Administrative requirements include procedures such as fees, permitting, inspection and reporting. Off-site actions must comply not only with requirements that are legally applicable, but must comply as well with both the substantive and administrative parts of those requirements.

Proposed standards and nonpromulgated criteria, advisories, and/or guidance documents issued by either state or federal agencies are **not** considered ARARs. These nonpromulgated criteria, advisories, and/or guidance documents may be classified as "to be considered" (TBC) when no specific ARARs exist for a chemical or when ARARs are not sufficiently protective of human health and environment. TBCs are not enforceable; therefore, identification of and compliance with TBCs are not mandatory. These TBCs may be used to interpret ARARs or determine cleanup levels that are protective of human health and environment.

ARARs can be placed into three categories: chemical-specific, location-specific, and action-specific. The definition of each type is given below.

- **Chemical-specific requirements** are usually health- or risk-based numerical values or methodologies that represent an acceptable amount or concentration in the medium of concern (groundwater, surface water, soil, or air) in the absence of consideration of site-specific exposure conditions. If a chemical has more than one standard, the more stringent standard is used as the appropriate ARAR.

- **Location-specific requirements** are limitations on allowable concentrations of hazardous substances or on activities solely because they may impact special locations including fragile ecosystems, floodplains, wetlands, or historic designations.

- **Action-specific requirements** are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. The requirements are triggered not by the specific chemicals present at a site but rather by the particular remedial activities that are selected.

The following sections detail the potential chemical-specific, action-specific, and location-specific ARARs and TBCs. The potential ARARs and TBCs are grouped in terms of origin (federal or state).

Tables 2-3 through 2-8 summarize potential ARARs by classification. Table 2-3 summarizes federal and state potential chemical-specific ARARs and TBCs for drinking water use. Table 2-4 summarizes federal and state potential chemical-specific ARARs and TBCs for surface water. Table 2-4a summarizes federal potential chemical-specific ARARs and TBCs for air quality. Table 2-5 summarizes chemical-specific State ARARs. Table 2-6 summarizes potential federal action-specific ARARs. Table 2-7 summarizes potential federal location-specific ARARs. (Potential state location-specific ARARs and TBCs are not presented in a table.) Table 2-8 summarizes potential state of Iowa action-specific ARARs.

2.2.2.1 Potential federal ARARs.

2.2.2.1.1 Potential chemical-specific federal requirements. Potentially applicable requirements include: [NOTE: for distinctions as to applicability or relevance and appropriateness, see referenced tables.]

Safe Drinking Water Act (42 USC 300C[E]): The Safe Drinking Water Act authorizes promulgation of maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs). MCLs are enforceable standards for contaminants in public drinking water supply systems. They not only consider health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. MCLs are ARARs for this action, but are not available for each chemical present on-site.

Three chemicals identified as chemicals of potential concern have been detected in the groundwater at levels above established MCLs. These three chemicals are benzene, benzo(a)pyrene, and lead. All other chemicals detected in the groundwater were either below established MCLs or no final MCL has been established. The remainder of the chemicals of concern will have cleanup levels based on health-risk-based concentration levels.

Groundwater: CERCLA states that MCLs are cleanup standards for groundwater when it is determined to be a current or potential source of drinking water and if the MCLs are relevant and appropriate. The BRA has concluded that the shallow aquifer is a potential source of drinking water. Nonzero MCLGs are potential ARARs for groundwater determined to be a current or potential source of drinking water (where MCLs are not available). CERCLA identifies nonzero MCLGs as potentially relevant and appropriate even though they are not otherwise enforceable standards.

Surface Water: The state of Iowa's water use designation for Willow Creek is for wildlife, aquatic life and secondary body contact users (limited resource warm water: supports only populations of species not generally harvested for human consumption). Because Willow Creek is not a current or potential source of drinking water, federal and state MCLs and federal nonzero MCLGs are not potentially relevant and appropriate for this surface water body.

Clean Water Act (as amended) of 1987: The objective of this act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The act governs permitting and regulation of point-source discharge through the National Pollutant Discharge Elimination System (NPDES), effluent limitation guidelines for existing sources, standards of performance for new sources, discharge of dredge or fill materials, and oil and hazardous spills to US waters. Depending on the selected disposal method for accumulated surface water during source removal (activities or groundwater from a groundwater pumping scenario a new point source discharge to Willow Creek would make these criteria applicable or relevant and appropriate.

Surface Water: Options considered for discharge of accumulated surface and groundwater include treatment followed by discharge to the POTw or to Willow Creek. Discharges to Willow Creek as it passes adjacent to the Mason City FMGP site would be considered on-site. As such the discharge would need to comply with the substantive parts of the CWA. Off-site discharges would need to comply with substantive and administrative legally applicable requirements. Technology-based requirements through effluent limitations guidelines may be developed case-by-case by EPA for pollutants that are regulated under the CWA. These effluent limitations would then be applied to the point source discharge to surface water. No effluent limitations currently exist for CERCLA sites.

Federal water quality criteria (FWQC) are nonenforceable guidelines used by states to set water quality standards for surface water. They are relevant and appropriate if no state standards exist. However, since the FWQC incorporate the most current scientific data on contaminant levels to prevent contamination that will be injurious to human health or aquatic life, they will be treated as TBCs.

Discharge to a POTW, should it be selected, is considered an off-site activity and would be subject to both the substantive and administrative legally applicable requirements of the national pretreatment program (40 CFR Part 403).

Groundwater. FWQC may be relevant and appropriate standards for groundwater only if the groundwater is a current or potential source of drinking water and other cleanup standards for drinking water (e.g. MCLs and nonzero MCLGs) are not available.

2.2.2.1.2 *Potential location-specific federal requirements.* The only location-specific potential ARAR to be considered is the fact that the site is currently within the 100-year floodplain (Executive Order 11988, Protection of Floodplains, and 40 CFR 6.302). However, the Federal Emergency Management Agency has recently revised the boundaries of the 100-year floodplain and the proposed changes are currently undergoing public review and comment. If the new boundaries are adopted the site will be outside of the 100-year-floodplain boundaries; until such a change occurs, floodplain management requirements are ARARs (see table 2-5).

2.2.2.1.3 *Potential action-specific federal requirements.* Potential ARARs include (see table 2-6): *Resource Conservation and Recovery Act (RCRA) of 1976 (Amended 1984).* Governs the generation, transportation, storage, and disposal of hazardous wastes. RCRA 40 CFR Part 264 standards are used for remedial actions including on-site capping and landfilling, and groundwater monitoring. RCRA 40 CFR Part 262 standards identify those solid wastes that are subject to regulation, establish standards for generators of hazardous waste, and establish minimum national standards that define the acceptable management of hazardous waste. These are considered potential ARARs for this site.

Amendment to the National Oil and Hazardous Substances Pollution Contingency Plan; Procedures for Planning and Implementing Off-Site Response Actions (40 CFR Part 300): Also known as the "CERCLA Off-Site Rule," this rule requires that in the case of any CERCLA response action involving the off-site transfer of any hazardous substance, pollutant, or contaminant (CERCLA waste), that CERCLA waste may only be placed in a facility that is in compliance with RCRA (or other applicable federal law) and applicable state requirements. The proposed remedial alternatives include the off-site transport of hazardous waste. Off-site remedial actions must comply with both substantive and administrative requirements that are legally applicable (table 2-6). The CERCLA "off-site rule" is legally applicable

Clean Air Act (CAA) of 1971: The National Ambient Air Quality Standards (NAAQS) set treatment standards for emissions to air from incinerators and fugitive air emissions. Excavation activities may result in emissions for lead and particulate matter that may be applicable under the NAAQS (table 2-4a).

Clean Water Act: Includes standards for water quality based on toxicity to aquatic organisms and human health (Ambient Water Quality Guidelines) which are relevant and appropriate for this action; the National Pretreatment Standards control discharges to a POTW which may be applicable if this alternative is chosen; and the Toxic Pollutant Pretreatment Standards which set effluent criteria for specific toxic pollutants (aldrin/ dieldrin, DDT, endrin, toxaphene, benzidine, PCBs) which have not been identified at the Mason City FMGP site and, therefore, are not applicable or relevant and appropriate.

Hazardous Materials Transportation Act (HMTA): Regulates the transportation of hazardous materials. These requirements are applicable to all alternatives that involve transport of contaminated materials from the site

*2.2.2.2 **Potential federal TBCs.***

Ambient Water Quality Criteria: These criteria were developed for 64 pollutants in 1980 (40 CFR Part 231) pursuant to Section 304(a)(1) of the Clean Water Act. In 1983, EPA revised nine criteria previously published in "Red Book" (Quality Criteria for Water, 1976), and in 1980 criteria documents. In 1986, further revisions were incorporated into "Gold Book", which is the most recent compilation to date. According to Proposed Revisions for the NCP (1992), if certain criteria are met, Ambient

Water Quality Criteria can be site-specific potential ARARs. These are relevant and appropriate for surface water discharges not addressed by the NPDES program. They are listed in table 2-4.

US EPA Health Advisories (1981): Health Advisories are nonenforceable guidelines, developed by the EPA Office of Drinking Water, for chemicals that may be intermittently encountered in public water supply systems. Health Advisories are available for short-term, longer-term, and lifetime exposures for a 10 kilogram (kg) child and a 70 kg adult. These are TBCs for this action for groundwater, which are listed in table 2-3 for chemicals of concern identified at the Mason City FMGP site.

US EPA Health Effects Assessments (HEAs): HEAs present chemical-specific carcinogenic potency factors and reference doses for use in public health assessments. Also to be considered are chemical-specific carcinogenic potency factors and reference doses. These data are TBCs for the risk assessment for soil, groundwater, and surface water.

Safe Drinking Water Act: EPA has proposed Maximum Contaminant Level Goals (MCLGs) in drinking water. MCLGs are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal. They are TBCs for both groundwater and surface water at this site. They are listed in table 2-3 for chemicals of concern identified at the Mason City FMGP site.

Groundwater Protection Strategy: EPA's policy is to protect groundwater for its highest present or potential beneficial use. The policy will be incorporated into future regulatory amendments. The strategy designates three categories of groundwater: Class 1 — Special Ground Waters, Class 2 — Current and Potential Sources of Drinking Water and of Limited Beneficial Use, and Class 3 — Ground Water Not a Potential Source of Drinking Water and of Limited Beneficial Use. The groundwater classifications provide a TBC narrative cleanup standard, numerical chemical-specific ARARs for Class I and II aquifers are found in the MCLs and nonzero MCLGs. These are potential TBCs for groundwater at this site.

2.2.2.3 Potential State ARARs

The State of Iowa's water use designation for Willow Creek is for wildlife, aquatic life, and secondary body contact uses (limited resource warm water: supports only populations of species not generally harvested for human consumption). Because Willow Creek is not a current or potential source of drinking water, federal and state MCLs and federal nonzero MCLGs are not potentially relevant and appropriate for this surface water body.

2.2.2.3.1 *Potential chemical-specific State requirements.*

Iowa Water Quality Standards: The State of Iowa has established these water quality standards to protect public health and to preserve the quality of the state's surface waters. The standards establish limits on the amounts of certain pollutants which may be discharged to the state's surface waters. These standards would apply to any waters discharged from the site to Willow Creek.

Iowa Department of Natural Resources — Chapter 133: Rules for Determining Cleanup Actions: These Iowa regulations establish action levels (remediation levels) for contaminated groundwater and soils. For each contaminant, a remediation must first try to meet the EPA lifetime health advisory level (HAL). If there is no HAL established, the remediation must meet the EPA negligible risk level (NRL) for carcinogens. The NRL is the level of the contaminant that will not result in more than one excess cancer death in one million people (the 10^{-6} risk level). If there is no HAL or NRL, the remediation must meet the Safe Drinking Water Act MCL. If there is no HAL, NRL or MCL, the Iowa Department of Natural Resources (IDNR) may set an action level, on a case-by-case basis. Published HALs for the contaminants of concern at the Mason City FMGP site are identified on tables 2-3 through 2-5. No published NRLs have been identified for the contaminants of concern. Site-specific, risk-based remedial action levels for target risk levels of $1x10^{-4}$, $1x10^{-5}$, and $1x10^{-6}$ based on the risk assessment exposure scenarios are presented in Section 2.2.3.

The State of Iowa's MCLs for drinking water are not potential ARARs for Willow Creek because Willow Creek is not designated for drinking water use.

2.2.2.3.2 *Potential location-specific State requirements.*

Location-specific ARARs are used to protect sensitive locations, such as wetlands, historical places, flood plains, or sensitive habits. These ARARs may restrict the concentration of a hazardous substance that may be disposed of in the location or may restrict or regulate the types of remedial activities that can be performed in the location.

Table 2-7 lists the potential location-specific ARARs for the Mason City FMGP site. The table includes the citation for the ARAR, a description, whether the ARAR is applicable or relevant and appropriate, and an explanatory comment. No location-specific ARARs were identified for the Mason City FMGP site.

2.2.2.3.3 *Potential action-specific State requirements.*

Action-specific requirements are not established for a specific contaminant, but rather by the activities that are selected to accomplish a remedy. They may establish performance levels, actions, or technologies as well as specific levels for discharged or residual contaminants.

Table 2-8 lists the potential action-specific ARARs for the Mason City FMGP site. The action-specific ARARs for each alternative will vary, depending on the technologies employed to meet the remedial action objectives. Some action-specific ARARs that generally apply to remedial alternatives are discussed below. The specific ARARs for each alternative will be identified in Section 4.0 during the detailed evaluation of each alternative.

2.2.3 Remedial Action Objectives

2.2.3.1 Evaluation of single-exposure health risks. The interim BRA calculated both noncarcinogenic and carcinogenic health risks for five different scenarios. The exposure scenarios included the following

- Future off-site resident exposure to groundwater (both adult and child)
- Current and future on-site commercial/industrial worker exposure to surface soil
- Future on-site commercial/industrial worker exposure to subsurface soil
- Current and future on-site trespasser exposure to surface soil and the waste pile (adult and child)
- Current and future off-site recreational user exposure to sediment or surface water and fish (adult and child)

The detailed explanations of the exposure scenarios and the associated calculations of the health risks are found in the interim BRA. Results of calculations showed that:

- The hazard quotient was less than 1 and the cancer risk was less than 1×10^{-6} for current and future off-site recreational user exposure to sediment or surface water and fish (adult and child)
- None of the scenarios listed above would result in a noncarcinogenic risk with a hazard quotient greater than 1

Therefore, the only elevated risks are due to exposure to carcinogenic compounds within, or exceeding the $1x10^{-6}$ to $1x10^{-4}$ carcinogenic risk. The exposure scenarios that resulted in a elevated risk are:

- Future off-site resident exposure to groundwater (both adult and child)
- Current and future on-site commercial/industrial worker exposure to surface soil
- Future on-site commercial/industrial worker exposure to subsurface soil
- Current and future on-site trespasser exposure to surface soil and the waste pile (adult and child)

For the first exposure scenario listed above (potential future off-site exposure to groundwater), the significant carcinogenic risk is for the shallow aquifer. The shallow aquifer was defined as the unconsolidated sediments and fractured bedrock above the first transmissive zone. Risk calculations for the potential future off-site residential exposure scenario used current on-site concentration values. Another risk calculation was also performed using the on-site monitoring well with the highest detected concentrations. On-site concentration values were used for the off-site residential exposure scenario because no modeling has been conducted to predict off-site future concentrations, if any.

The addendum to the interim BRA also indicated that a significant hazard for children is associated with the potential future exposure to lead in shallow groundwater. No quantitative risk calculation was performed because the lead values reported in the RIA did not allow calculation of blood lead levels using EPA's biokinetic uptake model. The addendum to the interim BRA referenced the EPA action level of 15 μg/L for lead as a criterion for the risk.

2.2.3.2 Evaluation of multiple-media exposure health risks. After evaluation of health risks for individual scenarios, the interim BRA developed four multiple-media exposure scenarios to develop reasonable maximum exposure (RME) health risks. The four RME health risk exposure scenarios were:

- Current trespasser/recreational user (child)
- Current on-site worker/recreational user (adult)
- Future trespasser/off-site resident recreational user (child)
- Future on-site construction worker/off-site resident/recreational user (adult)

The calculated RME health risks for the multiple-media exposure scenarios were used to develop preliminary health risk-based remediation goals for soils and groundwater. Following the guidance in the April 1993 EPA memorandum regarding Superfund Risk Decisions, the RME health risks were evaluated to determine which exposure scenarios had a calculated cumulative health risk above

1×10^{-6} is a single exposure. Three of the four exposure scenarios had a cumulative health risk above 1×10^{-4}. The three exposure scenarios above 1×10^{-4} were:

- Current trespasser/recreational user (child)
- Future trespasser/off-site resident recreational user (child)
- Future on-site construction worker/off-site resident/recreational user (adult)

The first exposure scenario involves exposure only to soil or sediment and not to groundwater; therefore, a groundwater preliminary health risk-based goals were not calculated for this scenario. For each of these scenarios, the health risk was evaluated on a compound-specific basis. Preliminary health risk-based remediation goals (PHRBRGs) were calculated for those compounds with a calculated health risk above 1×10^{-6}. The PHRBRGs for soil types by exposure scenario are presented in table 2-10. Some PHRBRG values are identical for different soil types because the interim BRA had the same potential dose factor value for different media. The PHRBRGs for groundwater by exposure scenario are presented in table 2-11.

2.2.3.3 ***Establishment of remedial action objectives.*** The results of the addendum to the BRA were used to establish remedial action objectives for each medium at the site. A remediation goal for the contaminated soils at the site is to prevent the continued leaching of contaminants from the source soils to the groundwater system. These remedial action objectives are presented in table 2-9. The overall remedial action objective for soil is to prevent exposure to on-site workers and/or trespassers to specific compound concentrations above the 1×10^{-6} carcinogenic risk. Numerous records of decisions (RODs) written by the EPA have used the range of 1×10^{-6} to 1×10^{-4} carcinogenic risk for PAHs when setting cleanup levels (appendix A).

A remediation goal for the site-related contamination in groundwater is to limit or prevent the ongoing migration of contaminated groundwater off-site. The overall remedial action objective for groundwater is to prevent exposure to off-site residents to specific compound concentrations above the 1×10^{-6} carcinogenic risk or above established SDWA MCLs. Numerous RODs have used the 1×10^{-6} carcinogenic risk or established SDWA MCLs for specific compounds in groundwater.

2.2.4 Proposed Remediation Goals

Proposed remediation goals were developed by reviewing the applicable chemical-specific, location-specific, and action-specific ARARs. For compounds where no applicable chemical-specific ARARs were available, risk-based concentration levels were used to develop proposed remediation goals (PRGs). For media with more than one PHRBRG the lowest value was chosen for the PRG. table 2-12 presents the PRGs for soil corresponding to a compound- and exposure-specific carcinogenic risk of 1×10^{-6}. The risk-based concentration level developed for vinyl chloride is less than the method reporting (quantitation) limit so the PRG for vinyl chloride was set at the method reporting limit. PRGs were developed for benzene, arsenic, vinyl chloride, and the carcinogenic PAHs. Review of the soils data presented in the RIA Report showed that arsenic concentrations detected in all soil samples except soil samples from the site are less than the PHRBRG except for sample SB-AA. SB-AA is included in the soil volume calculations because of PAH levels. Details of calculation of the risk-based concentration levels are presented in appendix B. The proposed soil remediation goal is the concentration level corresponding to a $1x10^{-6}$ carcinogenic risk.

The results of the calculation of risk-based groundwater concentration levels showed that groundwater concentrations corresponding to a $1x10^{-6}$ cancer risk were less than method quantitation limits as listed in EPA Method 8310 for benzo(a)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene. EPA Method 8310 is a high-performance liquid chromatography (HPLC) method which is used to achieve low-level quantitation limits for PAHs. Therefore, the risk-based concentrations are analytically not achievable.

Since the risk-based concentration levels are not achievable for every compound, the proposed groundwater remediation goal is the SDWA MCL or the proposed SDWA MCL for benzo(a)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene. The proposed MCLs are approximately 10 times higher than the analytical detection limits or equivalent to the practical quantitation limits as determined by EPA Method 8310. Since Method 8310 is susceptible to matrix interferences, when dealing with compounds that are of a petroleum hydrocarbon nature, such as coal tars, gasoline, fuel oils, etc., the proposed MCLs provide low remediation goals while greatly reducing the possibility of false positives during analysis. The proposed MCLs represent a range of health-risk levels from $1x10^{-5}$ to $8x10^{-5}$ cancer risk. The proposed remediation goals for groundwater are presented in table 2-13.

Benzene and seven carcinogenic PAHs have been detected at levels in the soil that exceed the proposed soil remediation goals. Vinyl chloride was detected in the waste pile at a level that exceeded the proposed remediation goal. However, the risk calculations were based on a single detection of vinyl chloride for a trench sample collected in October 1988, during the Phase III investigation (Hickock, 1989). Analysis of two additional samples collected from the waste pile in 1992 showed no vinyl chloride above the detection limit. Benzene and seven carcinogenic PAHs have been detected at levels in the groundwater that exceed the proposed remediation goals.

The proposed remedial action objectives listed in table 2-9 were used to develop general response actions. These general response actions were then used to develop a list of applicable remedial technologies. The remedial technologies were screened based on their ability to achieve remedial action objectives and proposed remediation goals.

2.3 General Response Actions

General response actions which could meet the remedial action objectives were developed. General response actions are developed for each media, and may include containment, excavation, treatment, disposal, pumping, or other activities. The general response actions for this site are summarized in table 2-9.

Four general response actions were developed for both soils and groundwater. These general response actions are: no action; institutional control; containment; and treatment/disposal. The "no action" alternative serves as a baseline comparison to consider the situation where no action is taken to deal with the contamination that has been identified. Institutional control involves a situation where access to the contamination media is restricted through such measures as fencing or deed restrictions. Treatment/disposal employs actions designed to treat the contaminated media and then dispose of the treated media. Containment employs actions designed to keep the contaminated media in the current area or volume. Soil general response actions also address the excavation of the contaminated media. Groundwater general response actions address monitoring and response actions to prevent human exposure.

An estimate of the soil volume has been calculated to be used for the screening of the soil technologies. These estimates will also be used in the screening and detailed analysis of alternatives. The soil volumes, based on $1x10^{-6}$ carcinogenic risk, were 3,860 cubic yards (5,790 tons) of contaminated soil including the waste pile; 1,700 cubic yards (2,550 tons) of clean overburden (to be segregated and stockpiled on-site); and 1,100 cubic yards (1,650 tons) of debris (concrete, brick, rock, etc.) requiring processing, mechanical cleaning, and on-site disposed. This soil volume is associated with surface and subsurface soils located within the boundaries of the Mason City FMGP site and does not include any off-site soils with concentration levels above the proposed remediation goals. Numerous potential off-site source areas exist with the immediate vicinity of the site, including a former coal-fired power plant site immediately to the west of the Mason City FMGP site. Soil volume calculations are found in appendix C. Volume estimates may change due to the limited characterization of soil contamination underlying the waste pile.

The area of groundwater remedial actions is the groundwater below the site itself. The withdrawal of groundwater is part of several remedial technologies and will probably be incorporated in several remedial alternatives for the remedial action screening process. Therefore, groundwater removal rates have been calculated for two scenarios:

- Withdrawal of shallow groundwater at the site using one or more wells
- Withdrawal of shallow groundwater from the unconsolidated fill only using an extraction trench

The maximum groundwater removal rate for withdrawal of the shallow groundwater is estimated to be 6 gallons per minute (gpm) per well, and the maximum removal rate for withdrawal of shallow groundwater from the unconsolidated fill using an extraction trench is estimated to be 10 gpm. The groundwater removal rate was also estimated for the scenario where vertical barriers are installed and the fractured bedrock is grouted. Groundwater removal would only be to reduce the head with the contained unconsolidated fill. The estimated removal rate for this scenario is 2 gpm. The groundwater removal rate calculations are found in appendix D.

2.4 Identification and Screening of Technology Types and Process Options

Based on the general response actions and remediation goals described earlier in this section, remedial technologies have been identified and evaluated to determine those technologies which are applicable to the site. This section identifies and screens applicable remedial technologies for both soil and groundwater. Technologies that pass the screening identified in this section are combined into remedial alternatives in Section 3.

The screening of representative technologies performed in this section is based on the criteria of implementability and technical effectiveness. The "no action" technology has been retained throughout the feasibility study to serve as the baseline against which the other remedial technologies are evaluated.

2.4.1 Remedial Technologies for Soil

Table 2-14 provides a summary of the technologies that have been considered for the soils. The table describes the general response actions, identifies the technologies that can meet the general response actions, describes each technology, and highlights the results of the technology screening. Technologies that have been retained for inclusion into remedial alternatives are shown as unshaded boxes in table 2-14, while technologies that have been eliminated from further consideration are shown in shaded boxes.

2.4.1.1 No action. The no action technology has been retained for consideration, and serves as the baseline against which all other remedial technologies are evaluated. In the case of the Mason City FMGP site, this technology would consist of taking no further action, including not maintaining the fencing around the site which now restricts access to area residents. The technology is not realistic, in that some form of access restriction to the property would likely be maintained indefinitely in the future due to the presence of the active substation on a portion of the site. However, as required by the NCP, the technology is retained for consideration as a baseline against which other technologies can be evaluated.

2.4.1.2 Institutional control. A separate response considered consists of restricting access to the site through the implementation of institutional controls. The two technologies identified in table 2-14 under this scenario include access restrictions and deed restrictions. Both technologies are feasible and have been retained for future consideration.

Access restrictions are feasible at the site due to the presence of the existing fencing, which restricts access of nearby residents to the soils deemed to have an unacceptable health risk. It is likely that IPW will maintain the fencing surrounding the site due to the presence of the active substation. It would be feasible for IPW to continue this access restriction in the future if substation operations are suspended

Deed restrictions would take the form of restricting the area from future development as a residential property, restricting excavation on the site, and establishing a restriction on the installation of groundwater wells. Since the bulk of the property is owned by IPW, establishing such restrictions for the bulk of the property would be implementable and feasible. A portion of the property, however, is owned by the City of Mason City.

Considering the information available at this time, both access restrictions and deed restrictions are maintained as technologies that could be implemented. It is anticipated that both IPW and the City of Mason City will be willing to implement these institutional controls

2.4.1.3 Containment. Under the general response action of containment, a number of technologies are potentially applicable for the soils, as shown in table 2-14. All technologies involve placing some type of cap over the contaminated soils to preclude future human contact with the soils. Of the technologies considered, the improved multimedia cap has passed the screening and is being further considered, while the other technologies have been eliminated from future consideration.

Placing a simple clay cap over the site has been eliminated because it would not be technically effective. This technology is easily implementable; however, placing a cap of only clay over the site would likely lead to problems related to erosion, cracking, and leakage. Some type of vegetative cover would be preferable to ensure the long-term stability of the cap.

Installing caps of either asphalt or concrete have also been eliminated from consideration. Both require long-term maintenance to ensure integrity. Inspections would be required to ensure that cracks do not develop in the future. If cracks do occur, additional actions for sealing and maintenance would be required. Asphalt could also be a potential source of PAHs, which are the compounds that are driving the need for the remedial action.

The containment technology retained for further consideration would be to place a multimedia cap over the site. The multimedia cap would consist of an initial compacted 1-foot native soil leveling layer, overlain by a 1- to 2-foot layer of clay or equivalent, overlain by a synthetic membrane, overlain by a 1-foot granular drainage layer of sand or gravel with filter fabric on top and covered by a 2- to 3-foot compacted native soil layer with 6 inches to 1 foot of top soil sustain vegetation. The vegetation would aid in preventing erosion, and would minimize the future maintenance of the cap. Native soil is assumed to be clean local fill soil brought to the property from an off-site location.

One final consideration in the capping technology would be the presence of the approximately 660-cubic-yard waste pile presently on-site. Under the capping alternatives, it would be feasible to spread the waste pile on the surface on-site, then emplace the cap over the soil surface. This would be consistent with the remediation goal of eliminating contact to the soils, and would also assist in the technical implementability of capping the site.

2.4.1.4 Excavation. In association with other remediation technologies, the general response action of excavation has been considered for the FS. Excavation would entail removing areas of soil containing contaminants of concern above the remedial action objectives outlined in this section. This is not a stand-alone remediation technology, but rather a technology that could be implemented in conjunction with other treatment technologies under which soils are treated with an *ex situ* treatment process

For the purposes of this study, the excavation technology is considered applicable for the unconsolidated soils at the site, and also the very upper portion of the weathered bedrock underlying the unconsolidated materials. Field experience at the site indicates that the top 1 foot of the bedrock is weathered and friable. This material could possibly be removed by means of mechanical excavation using a backhoe or similar excavation device, although the implementability of this approach is questionable and may not prove to be effective.

Excavation is not considered applicable for the more competent bedrock. For the purposes of this FS, this is considered to be the bedrock below the upper 1 foot of weathered material. This is based on observations made during the installation of the sanitary sewer on site. The construction contractor had to blast the bedrock to install the line, which indicates that this material is too hard to allow for excavation by common mechanical technologies.

The site investigation indicates that the lower portion of the unconsolidated materials and the upper bedrock is probably saturated with water. For this reason, some type of dewatering would be necessary in order to facilitate the excavation. For the purposes of this FS, it is presumed that standard construction dewatering practices could be followed, consisting of either pumping utilizing well points or the installation of sheet-piling cutoff walls during construction. This would require that the pumped water be treated prior to discharge. The ramifications of dewatering during excavation are discussed in Sections 3 and 4, Development of Remedial Alternatives and Detailed Evaluation of Remedial Alternatives, respectively.

2.4.1.5 Treatment. The next general response action to consider is treatment of the soils containing compounds above the levels of concern established in the remediation goals. For the purposes of this FS, treatment technologies have been divided into those that can be implemented *in situ*, requiring limited excavation of soils, and those technologies that would be implemented *ex situ* after first excavating contaminated soils. Under the heading of *ex situ* technologies, these can be divided into those technologies that could be implemented on-site, and those that could be implemented off-site. Each of these types of technologies are considered in the following sections.

2.4.1.5.1 *In situ soil treatment.* A number of technologies could be implemented *in situ*, without requiring substantial excavation of contaminated soils, as shown in table 2-14. In general, most of these technologies would be ineffective or not easily implementable at the site; therefore, most have been eliminated from further consideration.

Both types of *in situ* biological treatment, aerobic and anaerobic, have been eliminated from consideration. Traditionally, biological treatment of coal tar constituents is difficult and requires intimate contact of the soils, oxygen, and nutrients to be successful. This is much more technically feasible if the soils are first excavated and passed through a soil conditioning and mixing process to promote the intimate contact of the soils and nutrients. For these reasons, *ex situ* biological processes are retained for further evaluation but *in situ* processes are eliminated from further consideration.

Chemical *in situ* processes such as soil flushing and oxidation have also been eliminated from further consideration. These technologies also require the intimate contact of the soils with the treatment agent (surfactants or oxidants), which is difficult to ensure *in situ*. Also, soil flushing has only limited effectiveness with PAH compounds, which have a high soil–water partitioning coefficient (Kd) and, therefore, have a much greater affinity for soils than water. The addition of oxidants into this system is further complicated by the significant inorganic content of the groundwater, which would promote fouling and which would preferentially react with any oxidant added to the subsurface.

In situ thermal processes such as vitrification or steam injection have been eliminated from consideration. Site geologic conditions and/or nature and extent of contaminants present make the processes technically infeasible. *In situ* vitrification is also unproven at the field level.

In situ stabilization processes are considered technically effective and implementable and are, therefore, retained for further evaluation. These processes take the form of advancing large-diameter boreholes into the subsurface. As the boreholes are advanced, stabilizing agents such as cement, fly-ash, or other chemicals are added and mixed in with the soils. Processes that can advance boreholes as large as 18 feet in diameter are now commercially available. The use of this technology would require a pilot test to determine the correct mixture of cement, fly ash, and/or stabilizing agent, considering the soil matrix and the contaminant level within the soils. However, based on the general knowledge available in the industry, and the fact that the majority of the soil contamination is shallow, this technology is retained for further evaluation in the FS.

2.4.1.5.2 *<u>Ex situ</u> soil treatment.* A number of *ex situ* remediation technologies are also potentially applicable to the soils at the Mason City FMGP site. These technologies would all require that excavation be performed to remove the soils for treatment. These technologies can also be implemented on-site, meaning on the property itself, or off-site, which applies to treatment at facilities and/or properties not specifically associated with the Mason City FMGP site. Table 2-14 shows the technologies that are considered under this category.

Ex situ biological treatment is considered a feasible technology. Laboratory feasibility testing was performed on soils from the Mason City FMGP site, the report of which is contained in appendix F. The feasibility tests showed *ex situ* biological treatment is a viable option although site-specific applicability is still inconclusive. For this reason, *ex situ* treatment has been retained for further consideration.

There are three options to consider in the implementation of *ex situ* biological treatment. The first is to process the materials and construct a biological treatment cell on-site, within the confines of the Mason City FMGP site. The second is to process the materials and create an aqueous slurry by combining the contaminated soils with water prior to being fed to an aerated bioreactor. The third would be to process the materials and construct a biological treatment cell off-site, at a property owned by IPW approximately 10 miles away from the Mason City FMGP site. Both of the dry treatment cell options are feasible and are included in the remedial alternatives presented in Section 3. The liquid/solid bioslurry process has been eliminated based on the anticipated quantity of soils to be processed and the un-proven status of this technology at full-scale field level.

Other *ex situ* soil treatment technologies would consist of chemical treatment, using surfactants or oxidizing agents. These technologies have been retained for further evaluation, but not as stand-alone treatment technologies. Rather, they can be implemented as pre-treatment steps to assist with the biological degradation process, which has been shown to be effective at reducing the PAH levels in soils, as shown during the treatability tests (appendix F).

Ex situ stabilization processes are also considered feasible and are retained for further evaluation in the FS. These processes consist of excavating the contaminated soils and mixing them with cement, fly ash, and/or stabilizing agents to reduce the mobility of contaminants within the soil matrix. Implementation of this technology would require site-specific bench tests during design, but considering the knowledge developed within the industry regarding the cleanup of coal tar related sites, this technology is retained for further evaluation.

A series of thermal treatment technologies are also applicable for the contaminated soils on-site, as shown in table 2-14. These include treatment of the soils in a cement plant; treatment of the soils in an asphalt plant; treatment of the soils in a power plant; treatment of the soils in a fixed, off-site thermal treatment unit; and treatment of the soils in a mobile thermal treatment unit, which would be constructed on the Mason City FMGP site or on IPW property located approximately 10 miles north of Mason City. All of these technologies are both technically feasible and implementable; therefore, all of these technologies are taken under further consideration in Section 3.

The treatment of soils in the above-mentioned off-site facilities would require that the soils be classified as nonhazardous. This would require that the soils pass a Toxicity Characteristic Leaching Procedure (TCLP) test. If the soils did not pass a TCLP test and were, therefore, classified as hazardous, the only off-site treatment technology that would be applicable would be to treat the materials in a permitted hazardous waste incinerator. For the purposes of this FS, it is assumed that the soils can be appropriately handled or processed such that they would be classified as nonhazardous for any of the off-site treatment options.

2.4.1.6 ***Disposal.*** As shown in table 2-14, two disposal options are available for the soils at the Mason City FMGP site: on-site disposal in a constructed landfill, and disposal in an acceptable off-site landfill. For the purposes of this FS, it is considered that there are potentially two types of on-site landfill options that are available: constructing an on-site landfill that will contain treated soils, and constructing an on-site landfill that will contain untreated soils.

By KCPL and IPW management's policy directive, off-site landfill disposal with or without prior treatment has been eliminated from consideration. Off-site landfill disposal poses unacceptable long-term risks to KCPL and IPW management related to the liability associated with landfill facilities. Therefore, off-site landfill disposal has been eliminated from further consideration in this FS.

Constructing an on-site landfill is technically feasible and implementable. Since the landfill will contain a cap and cover, this technology will meet the remedial response objectives of eliminating contact to potentially contaminated soils on-site. Therefore, this technology has been retained for further evaluation in the FS.

2.4.2 Remedial Technologies for Groundwater

Table 2-15 summarizes the results of the remedial technology screening for addressing groundwater in accordance with the remediation goals established in this section. Technologies that pass the screening and are retained for further consideration are shown in unshaded boxes in table 2-15, while technologies that are eliminated from further consideration are shown in shaded boxes. The following sections provide a discussion of the technology screening.

2.4.2.1 ***No action.*** As with soils, the "no action" technology is retained for future consideration, and is the baseline against which all other remedial groundwater technologies are evaluated. This technology would consist of taking no further remedial actions for groundwater, including no institutional controls. This technology could be taken in conjunction with groundwater monitoring (Section 2.4.2.3) to evaluate long-term groundwater characteristics.

2.4.2.2 ***Institutional control.*** Institutional controls would consist of placing deed restrictions on the property, precluding the development of groundwater wells on the property itself. This would require consultation and negotiation with the IDNR, EPA, and the City of Mason City, which owns the northern portion of the property adjacent to Willow Creek and the dam. Assuming a hydraulic connections between the creek and the shallow aquifer, maintaining the Willow Creek dam in the down position would help limit fluctuations in the shallow groundwater. It would also help maintain a predictable flow pattern toward Willow Creek which would assist with future evaluations of contaminant transport and migration. Because of the technical feasibility and effectiveness at meeting the remedial action objectives for groundwater, institutional controls are retained for further evaluation in the FS. As with the "no action" technology, institutional controls would not preclude the implementation of a groundwater monitoring program.

2.4.2.3 ***Monitoring.*** Groundwater monitoring is retained as a feasible remedial technology for the FS. Monitoring could be implemented in conjunction with any of the selected remedial actions, including the no action and/or institutional control actions discussed above. The breadth and scope of any monitoring program would depend on the soil and groundwater remediation program selected. Groundwater monitoring could also be performed to evaluate the effectiveness of a soil remediation program to determine its effect on the groundwater quality.

The two types of monitoring programs shown in table 2-15 consist of monitoring only existing wells on-site, and potentially constructing additional monitoring wells to verify conditions at other locations on-site. Both types of technologies are easily implementable and technically feasible; therefore, monitoring is included in the remedial actions evaluated in Section 3.

2.4.2.4 ***Containment.*** Various technologies are available to meet the general response action of containment, or the prevention of migration of contaminated groundwater off-site. For the purposes of the FS, it must be considered that two separate shallow groundwater zones are present underneath the site: the saturated portion of the unconsolidated fill above the bedrock and the fractured bedrock above the first transmissive zone (appendix D). Remedial technologies for these two different systems must take into account the inherent differences in the physical matrices of these zones.

The containment technologies are designed to limit the horizontal migration of groundwater. This implies that they consist of some type of vertical barrier to groundwater flow, which can be instituted by a variety of means. Common to all of these technologies, however, is the need to control the vertical inflow of water (rainfall) into the area to be isolated. Therefore, as shown in table 2-15, soil capping alternatives are also considered groundwater alternatives. Soil capping would place a horizontal barrier to prevent the vertical recharge of rainfall into the groundwater system being isolated under the containment response action.

For shallow groundwater zone developed in the unconsolidated fill and the very top of the fractured bedrock, there are a number of common technologies that could be employed to construct a suitable vertical barrier to subsurface flow. A slurry wall could be excavated down to competent bedrock and filled with a suitable bentonite grout. A grout curtain could be installed by pressure-grouting the shallow zone using a series of regularly spaced boreholes. Sheet-piling could also be used to isolate the area. In addition, the vibrating beam technology could be used, whereby beams are driven into the ground and grout is emplaced as the beams are removed from the subsurface.

All of these technologies are implementable within the geologic and depth constraints of the unconsolidated soils and the top of the bedrock, and if properly engineered would isolate shallow horizontal groundwater flow. Selection of the best method to use would be based on detailed engineering concerns, which are best addressed during final design. Therefore, for the purposes of this FS, these different technologies will be grouped together into a single process option. Groundwater remedial alternatives that include vertical barriers in the unconsolidated deposits will not differentiate between these essentially equivalent process options. This will simplify the FS, and will also allow maximum flexibility for future design if this type of remedial alternative is part of the selected remedy.

For groundwater present within the fractured bedrock zone of the shallow aquifer, there are fewer technically feasible containment technologies. Slurry walls would not be technically feasible since excavation can only proceed into approximately the top 1 foot of bedrock before refusal is met. This will not be a sufficient depth to encapsulate the contaminated groundwater within the more competent bedrock, estimated to be the top 15 feet of bedrock. Similarly, sheet-piling cannot be driven to this depth within the more competent bedrock, and the vibrating beam technology would experience similar limitations. The only technically feasible and implementable technology would be the use of pressure grouting. Under this technology, closely spaced holes could be drilled and the fractures within the competent bedrock would be sealed by injecting cement–bentonite grout into the formation. This is the only containment technology that is feasible and implementable for fractured bedrock; therefore, this is the only technology retained for further evaluation.

2.4.2.5 Groundwater collection. Groundwater collection could be performed at the site in either unconsolidated fill or the fractured bedrock zones. In the unconsolidated fill, collection could be performed using wells or interceptor trenches. Because of the limited saturated thickness (1–4 feet) of the unconsolidated deposits, extracting groundwater from an interceptor trench is more feasible than groundwater extraction using multiple pumping wells. Therefore, interceptor trenches have been retained for further consideration although pumping wells have been excluded for the unconsolidated zone.

For fractured bedrock, interceptor trenches would not be feasible since excavation cannot be performed within this material. Therefore, extraction through wells is the only groundwater collection technology retained for further consideration for this zone.

2.4.2.6 <u>In situ</u> groundwater treatment. A number of *in situ* groundwater treatment technologies are available for consideration. However, as with the *in situ* soil technologies, these are generally not applicable to the site given the site-specific physical and chemical characteristics. These technologies have generally been eliminated from further consideration in the FS.

In situ biological treatment would attempt to enhance the natural biodegradation of PAHs in the groundwater through the addition of nutrients and a liquid-based oxidant such as hydrogen peroxide. This technology has shown acceptable results at some remediation sites. This technology has been eliminated from further consideration at this site, however, due to the high concentration of inorganics (calcium and magnesium) in the groundwater. This mineralized water results from the local calcareous geology. Peroxide would preferentially react with the inorganic compounds, which would lead to inorganic precipitation and fouling. The peroxide would not spread within the aquifer, which would limit the effective zone of remediation from this technology.

Aquifer sparging with air is another *in situ* remediation technology that is being implemented widely at groundwater remediation sites. This technology consists of injecting air below the water table. The injected air "strips" volatiles present in the groundwater and on saturated soil grains below the water table, and transfers the volatiles to the vapor phase. These vapors then emanate from the groundwater surface and are collected using a technology such as soil vapor extraction. This technology has achieved very effective remediation results at sites with volatile contamination in groundwater.

At this site, there is some volatile contamination in groundwater (benzene), but there are also unacceptable concentrations of PAHs and possibly lead. Aquifer sparging with air would have a limited effect on either PAHs or lead and, therefore, this technology is eliminated from further consideration.

A variation of aquifer sparging with air is to inject air containing a dilute stream of ozone. Ozone is a strong oxidant which can promote the breakdown of a number of organic constituents, including in some instances PAHs. However, at this site, aquifer sparging with ozone has been eliminated from further consideration. The oxidizing capability of the injected ozone would be preferentially used to oxidize the dissolved inorganics present in the groundwater and, as such, would not be available to have a significant effect on the dissolved organics of concern. The "hard" water resulting from the calcareous geology would render this technology ineffective at this site.

The preceding inorganic fouling concerns are based on best engineering judgement and data obtained from the RIA. Should these technologies warrant further consideration a treatability study would be required to fully quantify the predicted results.

2.4.2.7 ***Ex situ groundwater treatment.*** Technologies associated with *ex situ* groundwater treatment would be applicable, in conjunction with the groundwater collection (extraction) technologies discussed in Section 2.4.2.5. As envisioned in this FS, *ex situ* treatment would consist of those steps necessary to treat the extracted groundwater to acceptable levels for their discharge to an acceptable location.

A number of different physical treatment processes would potentially be applicable to the groundwater that may be withdrawn from the site. These include gravity separation to remove potentially separate-phased liquids should they be present in the groundwater; precipitation to eliminate and/or manage the inorganics known to exist in the groundwater; air stripping to remove volatiles; filtration to remove solids (in particular lead, which was detected during the latest groundwater sampling); organophilic clay and carbon adsorption to remove organics and certain inorganics.

If combined, these technologies would be technically effective in treating the groundwater stream expected to be associated with the groundwater extraction technologies. However, none of these technologies would be able to serve as a "stand-alone" treatment process to effectively reduce groundwater concentrations to appropriate levels for discharge. Therefore, for the purposes of this FS, these physical treatment processes are combined into one groundwater treatment process train, which would be applied sequentially to treat withdrawn groundwater.

Other treatment technologies, for example chemical treatment using oxidants or ion exchange, would pose technical complications and/or difficulties that would make their implementability more difficult than the identified physical treatment train. For example, using oxidants in an *ex situ* treatment train would encounter the same difficulties as if oxidants were used *in situ*. This would lead to significant fouling and the depletion of the oxidant on the inorganics present in the groundwater. Ion exchange would involve difficulties with the inorganics, resulting in a build-up of deposits in the resins. The physical treatment train is much simpler to operate, the components are more readily available from a number of vendors within the industry, and with proper engineering can be designed to achieve the requisite cleanup to allow the safe discharge of the groundwater to the appropriate receiving location. Therefore, chemical treatment processes are eliminated from further consideration in the FS.

The inorganic fouling concerns are based on best engineering judgement and site data obtained from the RIA. Should these technologies warrant further consideration a bench or pilot-scale treatability study would be required to fully quantify the predicted results.

2.4.2.8 Groundwater discharge. Three potential technologies are identified for groundwater discharge: disposal into surface water (Willow Creek), disposal into the POTW, and reinjection on the site. Of these, disposal into surface water and disposal into the POTW are both technically feasible and implementable and are retained for further evaluation. There are significant differences that may be realized between these two discharge options; therefore, they are evaluated in separate remedial alternatives in Section 3. Re-injection of treated groundwater has been eliminated from further consideration. The unsaturated zone is relatively thin, which would make re-injection difficult, and also there would be a significant potential for inorganic fouling and plugging of any type of reinjection gallery. Re-injection would require a significant degree of maintenance and frequent treatment to eliminate fouling and is, therefore, eliminated from further consideration.

2.5 Summary

A number of remediation technologies have been evaluated based on their technical effectiveness and implementability to address contaminated soils and groundwater at the Mason City FMGP site. Ineffective technologies, or those which would be difficult to implement given the site-specific conditions, have been eliminated from consideration. Those technologies that are retained are those that can achieve the general response actions identified, either by themselves or in conjunction with other technologies. The technologies that have been retained provide a wide range of options that can be combined into remedial alternatives to adequately address the remedial response objectives for soils and groundwater at the Mason City FMGP site.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

In this section, the technologies that passed the screening in Section 2 are combined into remedial alternatives to address the remediation goals also outlined in Section 2. Separate alternatives are developed for soils and groundwater. The alternatives are then screened against three criteria: effectiveness, implementability, and cost. This initial screening is designed to eliminate from consideration those alternatives that are technically infeasible or less effective than other alternatives, while at the same time preserving a range of remedial options that will be evaluated in more detail in Section 4. The evaluation of these alternatives assumes the Mason City FMGP soils are, or can be, rendered nonhazardous prior to transport from the site.

The criteria under which the alternatives are evaluated in this initial screening are as follows:

- Effectiveness — This criteria entails an evaluation of a remedial alternative relative to its established performance characteristics. A preference is shown toward those alternatives that contain technologies that have an established positive performance record, or those alternatives that site-specific testing data indicate will be effective in this application.

- Implementability — This criteria entails an evaluation of the degree of difficulty of implementing a remedial alternative given site-specific constraints, such as space limitations or geologic conditions that may favor one alternative over another.

- Cost — At this stage in the evaluation process, costs are evaluated on an order-of-magnitude basis. Alternatives may be eliminated on the basis of costs only if the costs are an order of magnitude different from the costs associated with an equivalent alternative that can achieve the same degree of effectiveness and implementability.

  The costs provided in this section are approximate costs only, and are based on broad assumptions and in some cases unit costs provided by vendors. More detailed costs are provided in Section 4 for alternatives that pass the screening in this section and are retained for detailed evaluation in the FS.

Alternatives that pass the initial screening will be evaluated against the nine criteria specified in the *Guidance for Conducting RI/FS Under CERCLA* (EPA 1988). This detailed evaluation is presented in Section 4. The intent of this initial screening is to preserve a range of remedial options that achieve the general response actions of no action, containment, and treatment, while at the same time reducing the number of alternatives that undergo the more rigorous detailed evaluation in Section 4.

3.1 Remedial Alternatives for Soil

Based on the technology screening presented in Section 2, the following alternatives have been developed for soils:

1. No Action
2. Institutional Control
3. Capping
4. Excavation/Thermal Treatment (Cement Plant)
5. Excavation/Thermal Treatment (Asphalt Plant)
6. Excavation/Thermal Treatment (Power Plant)
7. Excavation/Thermal Treatment (Fixed Treatment Plant)
8. Excavation/Thermal Treatment (Transportable Treatment Plant)
9. Excavation/Biological Treatment (On-Site)
10. Excavation/Biological Treatment (Off-Site)
11. *In Situ* Fixation
12. Excavation/*Ex Situ* Fixation/On-Site Disposal

Each of these alternatives is evaluated against the three criteria in the following sections.

3.1.1 No Action

This is the baseline against which all remedial alternatives are evaluated, and will be retained throughout the FS. The "no action" alternative would consist of not maintaining the existing fence around the property, and maintaining no future control over the access of residents to the soils on-site.

Effectiveness — This alternative would be ineffective at meeting the remedial response objective of eliminating potential contact of residents to contaminated soils, as no access restrictions to the soils would be undertaken.

Implementability — This action is easily implementable. It is likely that under this scenario IPW would choose to maintain a fence around the substation to protect the area residents from the operation of this facility.

Cost — There would be no or minimal costs associated with this activity.

Evaluation — This alternative is retained for further evaluation and is the baseline against which the remaining alternatives are evaluated.

3.1.2 Institutional Controls

Institutional controls would take the form of maintenance of the present fence at the property boundary to restrict access to the contaminated soils, and also placing deed restrictions on future use of the property. The bulk of the Mason City FMGP site is owned by IPW; however, the northern portion of the site adjacent to Willow Creek is owned by the City of Mason City.

Effectiveness — This alternative would meet the remedial response objective of preventing contact with the contaminated soils on-site through the maintenance of the fence which presently exists around the property. In addition, warning signs could be posted to warn trespassers, which would further enhance the effectiveness of this alternative. However, this alternative does not reduce the toxicity, mobility, or the volume of contaminants known to exist at the site.

Implementability — The alternative would be relatively easy to implement. IPW would be willing to maintain the fence and property restrictions for their portion of the site.

Cost — There would be minimal cost associated with this activity, consisting of administrative costs associated with filing deed and access restrictions. Also, minimal cost would be required for the long-term upkeep of the fence.

Evaluation — This alternative meets the remedial response objectives and is implementable. This alternative is, therefore, retained for further consideration.

3.1.3 Capping

This alternative would consist of constructing a cap over the soils at the site. It is envisioned that a multimedia cap would be used, consisting of an initial compacted 1-foot native soil leveling layer, overlain by a 1- to 2-foot layer of clay or equivalent, overlain by a synthetic membrane, overlain by a 1-foot granular drainage layer of sand or gravel with a geotextile fabric on top, which would be overlain by a 2- to 3-foot compacted native soil layer with a sufficient thickness of topsoil to support vegetation. The vegetation will help to minimize erosion and stabilize the cap. Some long-term maintenance would be required in the event that cracks or weathering occurred; however, the multilayered approach and the presence of the surface layer would effectively minimize this type of maintenance.

There is an approximately 660-cu-yd pile of soil and debris on-site, which resulted from the previous construction activities associated with the installation of the sewer line. Under the capping alternative, this material would be spread over the existing soil surface so as to smooth and properly grade the surface prior to installing the cap. In addition, a limited amount of additional earthwork grading may be required to eliminate low and/or high spots to promote drainage and cap stability.

As envisioned, the cap would cover the entire site except for the substation. The substation is now approximately 8 feet above the ground surface of the remainder of the site; therefore, there is adequate vertical room to install the cap below the level of the substation grade.

- Effectiveness — The cap would be effective at meeting the remedial response objective of eliminating the contact of area residents to contaminated soils. However, there would be no reduction in the volume or toxicity of contamination and the mobility would not be appreciably reduced. Under this alternative, it would not be necessary to restrict site access if an alternate site usage is deemed applicable in the future. However, deed restrictions on future excavation would be required since contaminated soils would not be removed or treated

- Implementability — A cap would be easily implementable. The cap can be built using standard construction techniques. Qualified construction contractors and materials are readily available. Risks to exposed soils are minimal, with the greatest risk being incurred during spreading of the soil pile. Long-term maintenance needs are minimized by the establishment of the vegetative cover.

- Cost — The cost of constructing a multimedia cap is estimated to range from $6.00 per square foot to $12.00 per square foot. Cost is sensitive to the size and location of the site. Considering the area of the site at approximately 50,000 square feet, the total estimated capital cost of this alternative is approximately $500,000 based on a $10.00 per square foot unit cost.

- Evaluation — This alternative would be effective and implementable, and would meet the remedial response objectives established for soils at a reasonable price. This alternative will be retained for further evaluation.

3.1.4 Excavation/Thermal Treatment (Cement Plant)

This alternative entails the excavation of contaminated soils present above the action levels discussed in Section 2, and the treatment of these soils in a cement plant. Under this technology, the excavated soil is transported to the cement plant and incorporated with other feed stock materials within a high-temperature furnace or kiln for the manufacturer of portland cement. Contaminants within the soils are effectively incinerated at the facility in the course of these normal operations. A number of such plants are commercially available throughout the United States to treat soils in this fashion

A cement plant operated by the LaFarge Corporation in Davenport, Iowa, was identified that could treat the Mason City FMGP soils. The verbally quoted treatment cost is $35.00 per ton.

As discussed in the technology screening discussion (Section 2), excavation by common mechanical means is considered applicable for the unconsolidated soils and possibly for the upper 1 foot of bedrock. Below this, the bedrock becomes more competent. During the construction of the sewer line at the site the bedrock had to be blasted to facilitate construction. It is undesirable to blast the bedrock to facilitate excavation; therefore, under alternatives requiring excavation it is assumed that only the friable, weathered bedrock immediately underneath the unconsolidated soil would be removed during excavation.

Excavation would require some type of dewatering to facilitate construction activities, since the lower portion of the unconsolidated deposits and the upper bedrock are probably saturated with water. This would entail standard construction dewatering practices, such as pumping from sumps during the operation or potentially driving sheet piling around the limits of the excavation combined with a wellpoint dewatering system. The groundwater that is removed would likely require treatment prior to discharge. Discharge would likely be to the sanitary sewer which traverses the facility, after obtaining permission from the POTW and establishing treatment requirements (if any).

- Effectiveness — Excavation is an effective technology for removing contaminated soils. Verification sampling would be required to verify when "clean" conditions are met.

  Thermal treatment at a cement kiln is an effective thermal treatment technology, which has been used at a number of remediation sites. The thermal treatment is done at sufficiently high temperatures to destroy even recalcitrant PAH compounds.

- Implementability — Excavation is easily implementable at the site and the LaFarge facility is permitted for FMGP soils and is a reasonable distance from Mason City. Standard construction practices related to dewatering and safety (sidewall shoring) would need to be followed. Coordination would be required with the POTW regarding the level of pre-treatment of pumped groundwater, and the quantity of groundwater which could be discharged to the POTW. These logistical concerns would have to be considered during remediation, but would not preclude the use of excavation to remove the soils.

- Cost — General industry costs for treatment of soil at a cement plant ranges from $30 to $50 per ton. The quoted price at the LaFarge facility in Davenport, Iowa, is $35 per ton. Adding typical associated unit costs per ton for excavation, soil processing, transportation, and backfilling, total estimated cost per ton for this alternative range from $200 to $250 per ton.

Assuming approximately 7,500 tons require treatment, and $225 per ton, the total cost of this alternative is approximately $1,690,000.

- Evaluation — This alternative would be effective and implementable and would meet the remedial response objectives for soils and is, therefore, retained for further consideration in Section 4.

3.1.5 Excavation/Thermal Treatment (Asphalt Plant)

This remedial alternative is identical to the alternative discussed above, except that the contaminated soils would be treated in an asphalt plant. Under this type of treatment technology, the soils are heated and used as aggregate within the asphalt mix. The heating process helps promote volatilization and thermal desorption of many of the organic contaminants, while the incorporation of the material in the asphalt provides a beneficial end use for disposal, rather than some other types of disposal (such as landfills).

- Effectiveness — This is a remedial alternative for soils, which is gaining more acceptance within the environmental industry. The thermal treatment is not conducted at a sufficiently high temperature to destroy all organic compounds; however, a significant percentage of these compounds can be driven off of the soils. In addition, there is a beneficial end usage for the material rather than disposal.

- Implementability — The unconsolidated soils at the Mason City site are generally fine-grained, with a predominant percentage of grain size in the silt size fraction (10 to wt.% passing a 200 mesh screen). Asphalt plants typically require a coarser-grained material for inclusion in the final product, for example coarse sand to fine gravel and limit the allowable weighted percentage of material less than a 200 mesh screen size to between 2 and 3 wt.%. The coarser material promotes strength and stability, while the finer-grained material can deleteriously impact these qualities. As a result, the Mason City FMGP soil will require extensive blending with large quantities of sand in order to meet specifications resulting in excessive handling and treatment costs.

- Cost — General industry costs for treatment of soil at asphalt plants are approximately $35 to $50 per ton. Assuming cost in this range, and additional costs for excavation, shoring, dewatering, sand additive, soil conditioning, backfilling, regrading, and transportation, the cost per ton for implementing this alternative is estimated at $150 to $200 per ton. Assuming 7,500 tons of soil and over 23,000 tons of sand additive requires treatment, the total cost of this alternative is approximately $4,900,000.

reinjection gallery. Re-injection would require a significant degree of maintenance and frequent treatment to eliminate fouling and is, therefore, eliminated from further consideration

2.5 Summary

A number of remediation technologies have been evaluated based on their technical effectiveness and implementability to address contaminated soils and groundwater at the Mason City FMGP site. Ineffective technologies, or those which would be difficult to implement given the site-specific conditions, have been eliminated from consideration. Those technologies that are retained are those that can achieve the general response actions identified, either by themselves or in conjunction with other technologies. The technologies that have been retained provide a wide range of options that can be combined into remedial alternatives to adequately address the remedial response objectives for soils and groundwater at the Mason City FMGP site

- Evaluation — Despite the initial attractiveness of this alternative in terms of disposal price, it has been eliminated from further consideration. The grain size of the soils would preclude their use in an asphalt mix without extensive conditioning. The extensive conditioning process would require increased excavation time and a higher potential for exposure to fugitive dust emissions both to workers and nearby residents.

3.1.6 Excavation/Thermal Treatment (Power Plant)

Treatment of contaminated soils in a power plant is an established technology, particularly as it relates to coal tar contaminated soils. Through the process known as "co-burning", small quantities of contaminated soils are introduced into the boiler feed in the power plant, where they are incinerated at the high temperatures inside of the furnace. This technology is particularly attractive to utilities, which due to past operations have responsibility over coal tar contaminated soils and which also have access to the power plants in which to treat the soils. To date, this technology is most commonly employed only at power plants using cyclone-type boilers for power generation.

- Effectiveness — This is an effective technology for thermally treating soils contaminated with coal tars, and is actively being performed now at some locations.

- Implementability — A survey of regional power plants conducted as part of this FS identified only one permitted power plant with the legitimate ability to co-burn the Mason City FMGP soils. This plant is the Illinois Power Company facility located in Baldwin, Illinois. All other known permitted FMGP soil burning power plants in the region have no additional capacity for 2 to 4 years. This is because of the volume of FMGP soil being co-burned and the fact that the soils must be blended with coal and fed into the boilers at a low, controlled rate to prevent adversely affecting operational efficiency.

  IPW does not operate any cyclone boiler power plants. KCPL operates a single cyclone boiler-type power plant in LaCygne, Kansas; however, the plant has never co-burned blended FMGP soil and would require operational and permit modifications that may take a considerable time to implement.

- Cost — Costs for commercial "co-burning" upon delivery of the soils to the Illinois Power facility are anticipated at $75 per ton although the facility has not begun accepting non–Illinois Power FMGP soils. Considering the previous unit costs for excavation, shoring, dewatering, soil conditioning, backfilling, regrading, and transportation, this brings the total cost of this alternative to approximately $330 per ton, or $2,500,000.

KCPL has investigated the possibility of co-burning the Mason City FMGP coal tar waste in their only cyclone boiler plant located in LaCygne, Kansas, (about 375 miles from Mason City, Iowa). The KCPL power production group indicated that it should cost about the same for permitting and equipment changes as other utility power plants that have successfully completed the permitting process (estimated at around $600,000). Facility modifications would have to be designed and an analysis would have to be performed to assess impacts to existing pollution control equipment (estimated at about $100,000). In addition, a test burn would be required to accurately assess power plant operation and compatibility with the Mason City FMGP soil. If the tests were successful, construction of screening, crushing, and blending facilities would be required (estimated at up to $500,000). This process could require 2 to 4 years to complete with the engineering, permitting, and equipment fully expensed against the Mason City FMGP site. Due to time and cost considerations, this co-burning option is not considered feasible.

- Evaluation — This alternative, using the Illinois Power Company facility in Baldwin, Illinois, is retained for further evaluation.

3.1.7 Excavation/Thermal Treatment (Fixed Treatment Plant)

This alternative is similar to the previously discussed alternatives, except that treatment is performed in a thermal aggregate-type rotary dryer treatment unit equipped with off-gas incineration. The unit considered for this alternative is located in Marion, Iowa, and is currently being used by IPW to treat soils from other former manufactured gas plant sites. This particular unit exposes soils to temperatures in the range of 900°F; therefore, it would be considered a thermal desorption unit rather than incineration. Off-gases are exposed to temperatures in the range of 1,800°F. Following treatment, the soils are tested and then transported back to the site and used to backfill the excavation.

- Effectiveness — While not as effective as incineration at destroying all organic compounds within the soils, thermal desorption has been shown to be applicable at treating soils from manufactured gas plant sites to acceptable levels. IPW is currently using the thermal desorption unit located in Marion, Iowa, to treat soils from other manufactured gas plant sites. Because this technology does not destroy all coal tars, its effectiveness is dependent on the subject site's soil PAH concentration and the required cleanup objectives.

- Implementability — Thermal treatment in the identified desorption unit could be implemented provided a full operating permit is secured by the operator. The unit currently has a test-burn air permit that has been secured by the vendor. IPW has an existing contract with this vendor and it would be feasible to expand that contract to include the soils from the Mason

City site as well if the test burn is successful and acceptable soil clean-up objectives are defined.

- Cost — The cost for treatment of the soils in this thermal unit is approximately $85 per ton. Using the previous unit costs for excavation, shoring, dewatering, soil conditioning, transportation (contaminated soils to the facility and back to the site), backfilling, and regrading, the capital cost of this alternative would be approximately $2,100,000 considering the 7,500 tons of soil designated for treatment.

- Evaluation — This alternative would be easy to implement and is technically effective; therefore, this alternative is retained for detailed evaluation in Section 4.0.

3.1.8 Excavation/Thermal Treatment (Transportable Treatment Plant)

Under this alternative, the thermal desorption process would be conducted using a mobile treatment plant. A number of vendors now market mobile treatment units that can be transported to a site to conduct the thermal treatment process on-site. These types of units are typically classified as desorption units (operate at approximately 900 °F) and include off-gas treatment/incineration at temperatures up to 1,800 °F.

The advantage to using these types of units is that transportation costs (and risks) are lowered because the soils can be treated on or near the site. However, these units have the disadvantage compared with fixed units in that they must be permitted for each use at each location. Also, they are typically smaller units with a lower flow-through capacity, which can lengthen the time of remediation over that which can be achieved using a fixed, larger capacity off-site unit.

- Effectiveness — Thermal desorption units with off-gas treatment have been shown to be effective at treating organics within soil matrices.

- Implementability — It would be difficult to implement this alternative at the Mason City site. The site itself is small, which would place space limitations on the processes that would be conducted. The site is also located within a residential area, and it may be inadvisable from a public perception standpoint to conduct a thermal soil treatment process so close to residents within Mason City. However, IPW owns farmland surrounding a substation located about 10 miles north of Mason City. This site would be a much more acceptable location for a transportable thermal treatment plant. The unit would require permitting, which would pose an extra difficulty over using an existing permitted off-site unit.

- Cost — Based on information supplied by vendors, the typical cost to mobilize, transport, set-up, and operate a mobile thermal treatment unit is $40 to $50 per ton. Assuming the same unit costs for excavation through backfilling and regrading, and assuming a 3 month construction/treatment period, the total capital cost of this alternative would be approximately $1,600,000.

- Evaluation — Based on these criteria and the IPW site 10 miles north of Mason City, this alternative is retained for detailed evaluation in Section 4.

3.1.9 Excavation and Biological Treatment (On-Site)

As discussed in Section 2, soils from the Mason City FMGP site have been tested for their amenability to treatment using biological processes. The test results indicate that the contaminants are biodegradable although the technical screening test is not yet complete. The components of this remedial alternative would consist of first excavating the soils from the targeted areas on-site. The soils would be processed through a mechanical shredder/conditioning unit, and nutrients added.

Excavated areas would be double lined with a geomembrane system equipped with interstitial monitoring and upper drainage collection layer. The conditioned mixture of soils and nutrient additives would then be placed on top of the upper geomembrane drainage layer. A series of pipes would be installed throughout the backfilled soil. Some piping would be slotted to allow for the ventilation of air from the biological treatment cell, while other piping would be installed to allow for the addition of nutrients and/or additional water in the future. After the completion of the construction of the treatment cell, the area would be covered with a multimedia-type cap.

The treatment cell would be operated by connecting the slotted pipes to a regenerative-type extraction blower. The blower would withdraw air from within the treatment cell, thus promoting oxygenation of the soils within the treatment cell. The treatment cell would continue operation until samples of the blower gas effluent indicated a 90% reduction of the VOC levels, and a 90% reduction in the CO_2 content of the gas stream. The CO_2 content is an indicator that the biological activity within the cell has been reduced, which indicates that available organic constituents have been metabolized by the biological activity. At that point, and for the purpose of this FS, a representative number of soil samples will be collected and analyzed for individual PAH compounds. The actual number of samples will be determined when Final Performance Standards are developed during remedial design. It is anticipated that biological treatment will be judged complete when concentrations of individual COCs are below a 95% upper confidence level of the risk-based concentration. EPA will set the final level of biological treatment based risk-based criteria and compliance with ARARs.

Following the operation of the treatment cell, any piping emanating from the pile would be cut off, and pipes within the cell would be filled with grout. This would constitute the end of the operation of the remedial alternative. Permitting is required for the off-site discharge of water.

- Effectiveness—The treatability study data indicates that biological treatment with the proper degree of mixing between the contaminated soil, nutrients, and oxygen, can reduce the concentration of PAHs in the soil. The soil processing steps, and the operation of the cell by continually overturning the air mass and promoting oxygenation of the cell, should be able to replicate the laboratory tests and successfully treat the contaminated soils at the site.

- Implementability—This alternative is implementable, although there will be logistical concerns due to the space limitations at the site. Careful coordination will be required between areas being excavated, the location of the soil conditioning/processing unit, and the areas being backfilled with the treated soils. Water that would be associated with the excavation would have to be managed as previously discussed under the other excavation alternatives. Permitting would be required for the off-site discharge of water generated during construction, and for the air discharge coming off of the biological treatment cell. These difficulties would have to be taken into account during the operation, but would not preclude the use of this alternative.

- Cost—The estimated unit capital cost for biological treatment, including excavation, the soil mixing/shredding preparation process and the addition of nutrients, is approximately $150 to $175 per ton. The estimated capital cost of this alternative, including the installation of the liner and cap, the soil vapor extraction and nutrient addition equipment, instrumentation and piping, is approximately $2,700,000 based on 7,500 tons and a unit capital cost of $170 per ton.

- Evaluation—This remedial alternative should be effective at meeting the remediation goals, and is implementable, although this would require a greater degree of logistical planning for construction than presented by some of the other alternatives considered. The alternative is retained for further evaluation in Section 4.

3.1.10 Excavation/Biological Treatment (Off-Site)

This alternative is identical to the alternative just discussed, with the exception that the operation would be conducted at an IPW property located approximately 10 miles north of the Mason City site. This alternative is being considered to weigh the relative advantages and disadvantages posed by the site logistical concerns during construction.

At the IPW property being considered, there would be more available area on this property to set up the soil conditioning/processing equipment. The operation would be able to proceed more rapidly because the treatment cell could be constructed in another corner of the property away from the soil processing unit.

The envisioned treatment cell would be identical to the one discussed for the on-site option, consisting of a liner and a cap. Internal plumbing would be installed while constructing the cell to allow for nutrient addition, and to allow for the withdrawal of air to promote oxygenation.

Closure of the off-site cell would require different concerns than the on-site cell. The off-site cell would have to be dismantled after the operation, with the treated soil spread on the surface of the property. The on-site cell could essentially be closed in-place, which would be an easier alternative to implement.

- Effectiveness — This alternative would be at least as effective as the on-site option, and possibly more effective. There would be fewer space limitations on the size of the cell; therefore, the dimensions could be altered during design to develop the optimal configuration (height vs. width) to promote airflow and oxygenation of the soils. This could possibly improve the performance of the biological treatment technology.

- Implementability — There would be advantages and disadvantages from an implementability standpoint with this alternative versus the on-site alternative. The additional space on the off-site property would lead to less logistical concerns during construction. However, this would have to be balanced against transporting the untreated soils from the Mason City site to the other property. Also, there would be a possibility of contaminating the virgin soils at the off-site location with contaminated soils from the Mason City site in the event of accidents or spillage.

- Cost — The cost of this alternative would be the same as the on-site alternative, with the addition of transportation costs, the cost to backfill the excavation on the Mason City property, and the cost to dismantle the pile at the off-site location. These factors would add an incremental unit cost of approximately $20 to $25 per ton, based on the 7,500 tons hauled to the disposal site. The estimated capital cost of this alternative is approximately $1,500,000.

- Evaluation — In an overall sense the disadvantages of this alternative outweigh the advantages and this alternative has been eliminated from further consideration. An identical degree of treatment is achieved using the on-site option, while incurring less risk due to transportation and potential spillage or accidents at the off-site location. These potential risks outweigh the potential operational advantages and eliminates this alternative from further consideration.

3.1.11 In Situ Fixation

This alternative would consist of fixating/stabilizing the soils at the site in place, without prior excavation. Commercial processes are now available whereby large-diameter boreholes (up to 18-foot-diameter) can be advanced into the subsurface. Cement, fly ash, and/or chemical fixating agents are added to the soils as the boreholes are advanced. These agents solidify and stabilize the soils in-place. The boreholes are advanced on a grid pattern whereby all of the soils in an area of concern are solidified, making them less susceptible to leaching and reducing the risks associated with contact of the soils.

Bench scale tests are required to determine the proper mixture of cement, fly ash, and/or stabilizing agent to add to the soil. After the proper mixture is determined, the necessary raw materials are transported to the site along with the drilling rig, and the operation can commence.

- Effectiveness — Pending the results of laboratory bench scale testing, this process can be effective at reducing the leaching potential of contaminants in soils, and making them less available for exposure to human contact. If the bench scale testing is successful, this process would be effective at meeting the remediation goals for the shallow soils.

- Implementability — By definition, the soils under consideration are the unconsolidated deposits soils and the very upper portion of the weathered bedrock. The unconsolidated deposits are approximately 7 feet thick, while the upper weathered bedrock is approximately 1 foot thick. Commercially available drilling rigs can reportedly advance boreholes up to 60 feet in depth in unconsolidated deposits, which is far greater than required at this site. On this basis, the alternative should be physically implementable at the site. However, these units cannot be operated efficiently or effectively at sites with large amounts of rock, debris, and foundations in the subsurface as exists at the Mason City FMGP site.

  The implementation of this alternative would not require dewatering, as would be required with the excavation alternatives. In the unsaturated soils, water would have to be added to the boreholes to promote solidification. In the saturated soils, the water in the formation would promote the stabilization process. From this standpoint, this alternative would require less effort than the excavation alternatives.

  By other criteria, however, the implementation of this alternative would be more complex than the excavation alternatives. This alternative would require logistical coordination regarding the mixing of additives, the location of staging areas versus drilling locations, and other complexities which would not be associated with standard excavation practices.

- Cost — Information provided by vendors suggests a cost in the range of $50 to $75 per cubic yard of soil treated by this method. Cost variability is primarily dependent on subsurface obstructions encountered and to a lesser extent, on the required ratio of additive to soil. Applying the upper end of these unit rates, based on the anticipated extent of subsurface rubble at the site, to the volume of soil to be addressed would lead to an overall estimated capital cost in the range of $3,500,000 for the site.

- Evaluation — This alternative is eliminated from further consideration based on excessive impacts from encountering subsurface obstructions.

3.1.12 Excavation/Ex Situ Fixation/On-Site Disposal

This alternative contains a similar treatment alternative to the in-situ fixation alternative. The difference would be that under this alternative the materials to be treated would first be excavated. The excavated materials would be passed through an aboveground treatment process whereby the soils would be conditioned and then additives would be mixed in followed by placement of the treated mixture within the excavations on-site. Since the materials would solidify in a short time, there would be no reason to install a liner in the excavation under this alternative, but the installation of cover material and vegetation would be required.

- Effectiveness — This alternative would likely have a slightly greater degree of effectiveness than the *in situ* alternative. This would be due to being able to closely control the mixing/additive addition process using an above ground treatment train as opposed to performing the mixing *in situ*.

- Implementability — The *ex situ* alternative would have some differences in implementability concerns compared with the *in situ* alternative. There should be more widely available contractors and vendors to assist in the *ex situ* alternative, since excavation is a standard construction technique. On the other hand, there will still be a need to use a more specialized group of vendors who have demonstrated the ability to successfully implement the aboveground treatment process. Dewatering during excavation would also be a difficulty with this alternative as opposed to the *in situ* alternative although it would not be unlike other alternatives requiring excavation.

- Cost — Prior experience suggests a unit cost of approximately $150 to $175 per ton to excavate and treat the material in an aboveground flow-through process followed by backfilling (using the treated material), and regrading. The estimated capital cost to treat the contaminated soils at the site with this process is approximately $1,300,000, based on 7,500 tons and $170 per ton.

- Evaluation — This alternative is retained for further consideration in Section 4.

3.1.13 Summary of Soil Alternatives

A range of soil alternatives has been assembled within the general response actions of no action, containment, and treatment. These alternatives have been screened against the criteria of effectiveness, implementability, and cost. The most promising of these alternatives that have passed this screening are taken into detailed evaluation in Section 4.0. The soil treatment alternatives that will be further evaluated include:

- Alternative 1 — No Action
- Alternative 2 — Institutional Controls
- Alternative 3 — Capping
- Alternative 4 — Excavation with Thermal Treatment (Fixed Treatment Plant)
- Alternative 5 — Excavation with Thermal Treatment (Transportable Treatment Plant)
- Alternative 6 — Excavation with Thermal Treatment (Power Plant)
- Alternative 7 — Excavation with Thermal Treatment (Cement Plant)
- Alternative 8 — Excavation with Biological Treatment (On-Site)
- Alternative 9 — Excavation with *Ex Situ* Fixation

3.2 Remedial Alternatives for Groundwater

Based on the technology screening in Section 2.4, the following remedial alternatives are considered for groundwater.

1. No Action
2. Institutional Controls
3. Fractured Bedrock Grouting/Unconsolidated Fill Vertical Barrier/Groundwater Pumping
4. Groundwater Pumping/Treatment/Discharge to Sanitary Sewer
5. Groundwater Pumping/Treatment/Surface Water Discharge
6. Fractured Bedrock Grouting/Shallow Groundwater Pumping

These alternatives cover the range of remedial response objectives consisting of no action, containment, and treatment. All alternatives, except no action, would include groundwater monitoring. The type and degree of groundwater monitoring would depend on the alternative selected. The preliminary screening of these alternatives is presented in the following sections.

3.2.1 No Action

This is the baseline against which all of the groundwater remedial actions are evaluated. The no action alternative would consist of taking no further steps to mitigate groundwater contamination, including taking no institutional steps to control access to groundwater development on-site in the future.

- Effectiveness — There is no human exposure to groundwater on-site at the present time, as there are no users of the shallow groundwater. However, the no action scenario would not meet the remedial action objective of prohibiting potential future exposure to shallow groundwater, since no access restrictions would be established under this scenario.

- Implementability — The no action alternative is easily implementable, as no activities would be required by IPW.

- Cost — There would be minimal costs associated with this activity.

- Evaluation — This action would not meet the remedial response objective of protecting future residents from exposure to the shallow groundwater, but is retained for further evaluation in accordance with the NCP to serve as the baseline against which remedial alternatives are evaluated

3.2.2 Institutional Controls

This alternative would consist of placing deed restrictions to restrict the development of future water supplies from the shallow aquifer in the area and maintaining the dam permanently in the down position. Although groundwater contamination has been detected primarily on-site with a limited amount of contamination detected off-site, this alternative would include expanding the well restriction area to areas outside of the property boundary. This would add an extra measure of health protection to this alternative. Institutional controls will not reduce the mobility, toxicity, or volume of contaminants located on- and off-site.

The dam is owned by the city of Mason City. There are indications in discussions with city officials that the city has Willow Creek beautification plans that include maintaining the dam in the up position for at least part of the year. [NOTE: At this time the city's plans are in the initial thought process. This remediation action should take place before the city completes its planning process so the city should be able to design their plans to account for any impact from a remediation action.] However, the dam may require expensive repairs and maintenance (according to IPW) in order to be operated and other requirements due to State of Iowa location-specific ARAR governing upkeep and maintenance of dams. Previous investigation reports, the baseline risk assessment, and this FS will provide the property owners with the required information from which to make decisions regarding the future land use and/or land use restrictions for their property.

- Effectiveness — This alternative would be effective at protecting future off-site residents from exposure to groundwater from within the area of the established well restriction. The effectiveness of this alternative would be enhanced by coupling it with a long-term groundwater monitoring program, which could serve to document that any contaminants do not migrate past the limits of the well restriction zone in the future. Assuming a hydraulic connection between Willow Creek and the shallow aquifer, a permanent dam-down scenario may help control fluctuations in the shallow groundwater. It may also assist monitoring by removing a complicating factor (changing water table elevations and flow direction changes)

- Implementability — The establishment of deed restrictions would be easily accomplished for the property owned by IPW. Coordination with the City of Mason City and other nearby property owners would be required to ensure their cooperation with the deed restrictions and the dam-down scenario. While it is not known at this time what the position of the property owners would be, it is known that no shallow residential wells are developed in the vicinity of the site. Therefore, the establishment of a well restriction zone should not pose an undue burden on nearby property owners. This may assist in obtaining cooperation for the implementation of this alternative. After the City is made aware of potential repair and maintenance costs for the dam and the environmental implications, it is expected that the City's cooperation can be obtained.

- Cost — Capital costs for this alternative would be relatively minor, and would consist of legal and administrative costs to negotiate with nearby property owners, filing the deed restrictions, and minor mechanical alterations (e.g., removing the pistons) to the dam.

  In this and other groundwater alternatives, a long-term groundwater monitoring program would be required. For the purposes of cost estimating at this juncture in the FS, and unless otherwise noted, it is assumed that a 30-year groundwater monitoring program would be implemented. The program would consist of semi-annual sampling of five wells in the area for a 30-year time period.

The 30-year time period has been selected for use in this FS for two reasons. First, this is the longest period of time for which it is typically considered valid to perform a present worth analysis on an assumed annual cost item. Second, the PAH compounds detected in the groundwater can be persistent at low levels in the environment for extended periods of time, and using a 30-year time frame will conservatively estimate the annual cost for the purposes of this FS. The estimated total present worth of the 30-year monitoring program is $452,000.

- Evaluation — This alternative would meet the remedial action objective of preventing off-site residential exposure to groundwater. The effectiveness of the alternative would be enhanced by monitoring to ensure that groundwater contamination did not migrate past the boundaries of the well restriction zone. Periodic follow-up to ensure compliance with the well restriction would also be advisable, although the shallow aquifer is not presently used in the general area.

3.2.3 Fractured Bedrock Grouting/Unconsolidated Vertical Barrier/Groundwater Pumping

Under this alternative, contaminated groundwater from within the unconsolidated fill and shallow weathered, fractured bedrock zones, and groundwater from within the upper 15 feet of weathered, fractured bedrock, would be contained by implementing feasible vertical groundwater flow barriers. This alternative addresses the general response action of containment as outlined in the NCP.

In the unconsolidated fill and the upper 1 foot of weathered, fractured bedrock, containment would be achieved by instituting some type of vertical barrier to groundwater flow. As indicated in the technology screening (Section 2.4), any number of different technologies would be effective to eliminate horizontal groundwater flow from within these zones (sheet piling, vibrating beam, slurry wall). The appropriate technology to implement would be selected during engineering design.

In the upper 15 feet of competent fractured bedrock, containment would be realized by instituting a pressure grouting program. Closely spaced boreholes would be advanced within the area of concern, and grout would be injected into the boreholes. Injection would be performed until fractures within the bedrock were sealed. This is a commonly employed practice in the construction industry, for example, to seal bedrock formations during dam installations. Using these common practices, the upper bedrock surface in the area of concern would be sealed and isolated from future groundwater movement.

The placement of vertical barriers within the unconsolidated deposits, and the sealing of the upper 15 feet of bedrock, would require the implementation of some type of remedial technology to either prohibit the vertical migration of rainfall into the isolated area, or to pump out the rainfall that would fall on the area. Prohibiting rainfall infiltration could be accomplished by combining the capping technology discussed in Section 3.1.3 with the vertical barriers and bedrock grouting. Alternatively, groundwater pumping from the shallow zone could be performed to periodically drain the isolated unconsolidated deposits if no cap was employed.

For the purposes of the FS, and to develop a series of remedial alternatives for groundwater that do not require coupling with soil remedial alternatives, this particular groundwater containment alternative includes provision for groundwater pumping. A groundwater withdrawal sump would be placed inside of the isolated area. If pressure were to build up inside of the sealed area, the pump would be activated and the isolated area drained to prevent the breaching of the vertical barrier. The sump would be constructed so as to operate whenever required, based on the water level which may develop inside of the slurry wall in the future.

During final remedy selection, if this groundwater containment alternative is selected and soil capping is also selected, the interrelationship between these alternatives would have to be taken into account. This is to ensure the long-term stability of the overall site containment system, and to minimize the potential for pressure build-up and potential breaching of the slurry walls in the shallow groundwater zone.

As with the other groundwater remedial alternatives, a groundwater monitoring program would be implemented to ensure that the containment systems were performing in the future. The envisioned system would consist of monitoring wells outside of the containment zone to detect breakthrough.

- <u>Effectiveness</u> — The construction of a vertical groundwater barrier in the shallow unconsolidated deposits would be an effective alternative to prevent the migration of shallow groundwater at the site. Similarly, bedrock grouting would effectively seal fractures present within the upper 15 feet of bedrock, which are known to be stained and which could potentially leach contaminants over time. By sealing the fractures with grout, the contact with groundwater would be eliminated, effectively meeting the remediation goals.

- <u>Implementability</u> — Both types of technologies are easily implemented at the site. The vertical groundwater barrier would only require installation to a shallow depth, approximately 8 feet below grade. This is well within the depth range of successfully installing vertical groundwater barriers. Bedrock pressure grouting is an established practice within the construction industry, and a number of vendors should be available to successfully implement this alternative.

- <u>Cost</u> — The cost to install a vertical groundwater barrier is typically ranges between $15 and $30 per square foot. To completely encapsulate the Mason City FMGP site, this would require the installation of approximately 14,000 square feet of barrier, bringing the total cost of this portion of the alternative to $275,000.

Pressure grouting estimates were obtained from geotechnical contractors. Within the depth range required (approximately 8 to 29 feet below grade), the costs for pressure grouting a fractured formation range between $50 and $75 per cubic yard of material. Considering the area contemplated for pressure grouting of approximately 30,000 square yards, the total cost of this portion of the alternative would be approximately $2,200,000.

There is a potential to pump small amounts of groundwater for the life of this alternative, in particular if a cap were not installed in conjunction with the vertical barriers. Using a conservative long-term pumping rate of 2 gallons per minute and a conservative groundwater treatment process train, the cost to pump and treat groundwater in association with this alternative would be approximately $160,100. Using the time frame for costing of 30 years, the estimated total present worth cost of groundwater pumping and treatment under this scenario, including the 30-year groundwater monitoring program, would be approximately $6,000,000.

Groundwater monitoring would be conducted under this scenario. Using the same assumptions as discussed under the institutional controls scenario.

- Evaluation—This alternative provides both the containment and treatment general response actions. Although relatively expensive, it is within the upper range of other alternatives considered. It would effectively isolate the contaminated soils from the shallow groundwater and contain and isolate the deeper contaminants in the fractured bedrock. Therefore, this alternative is retained for further evaluation.

3.2.4 Groundwater Pumping/Treatment/Discharge to Sanitary Sewer

This alternative consists of extracting groundwater from the unconsolidated fill/weathered bedrock zone and the top 15 feet of fractured bedrock zone beneath the unconsolidated fill/weathered bedrock. The groundwater would be treated by passing it through a groundwater treatment plant constructed on-site. The treated groundwater would then be discharged to the on-site sanitary sewer. This alternative is being considered within the general remedial response objective of treatment.

The groundwater withdrawal system would consist of pumping wells drilled to approximately the upper 15 feet in the fractured bedrock. Groundwater would be withdrawn from the fractured bedrock wells at a rate appropriate to develop a drawdown cone and eliminate the potential of groundwater migration off-site. The information presented in the RI and RIA reports prepared by Montgomery Watson suggests that there is adequate vertical hydrologic conductivity between the groundwater in the fractured bedrock and the groundwater in the overlying unconsolidated deposits. During a pumping test, withdrawal of groundwater from the shallow bedrock produced a measurable drawdown within the groundwater within the unconsolidated deposits. Therefore, pumping from the fractured bedrock should effectively control the groundwater in the unconsolidated fill zone as well as the groundwater in the fractured bedrock.

Lead and PAHs, however, are persistent compounds in the environment. Groundwater pumping systems typically remove very little of the total contaminant mass even over long periods. The possibility exists, that even after an extended period of pumping (30 years) that the concentrations of lead and PAHs would still not be reduced below the risk-based levels in the on-site groundwater.

The locations of the groundwater wells are shown on figures presented in appendix D. Supporting groundwater flow calculations, and predicted water level maps resulting from the implementation of this alternative are also detailed in appendix D.

The pumped groundwater would be passed through a water treatment system constructed on-site. As discussed in the technology screening (Section 2.4), a multistage treatment process is being considered for this FS. Groundwater would be pumped into a separation tank, where separate-phase liquids (if present) would be removed from the water stream. The aqueous stream would then be passed through an inorganics treatment process to filter out suspended particulates, remove metals and condition the mineralized water that is expected, based on the RI results. The conditioned water would then be passed through an air stripper, where volatiles would be removed, followed by a secondary particulat. removal stage and organophilic clay and carbon adsorption polishing before discharge. The organophilic clay and carbon polishing would remove less-volatile organics, and possibly inorganics, from the water stream before discharge.

The addendum to the BRA identifies lead as a potential compound of concern in the groundwater. A review of the data indicates that dissolved lead concentrations in the groundwater are generally low, but that when total lead analyses were performed, the lead concentrations in groundwater increased. This indicates that the lead detected in the water samples is probably associated with suspended solids in the groundwater, which were analyzed in the total (unfiltered) groundwater samples. This lead would be easily removed from the groundwater stream through the filtration step.

Following treatment, the groundwater would be discharged to the sanitary sewer. This will require negotiations with the local POTW to establish the quantity and quality of discharge it will accept. It is possible that the degree of treatment envisioned in this alternative will not be required by the

POTW for waters that it will accept. However, for the purposes of conservative planning, it is assumed that the treatment will be conducted using the entire treatment train described.

For the purposes of this FS, it is assumed that this alternative would be implemented for a 30-year time period. Remediation systems consisting of groundwater pumping alone remove very little contaminant mass over time as compared to more aggressive source removal remediation systems, and this will establish a conservative estimate of the time frame of the operation of a groundwater pumping system. It is also assumed that a groundwater monitoring program would be conducted to evaluate the effectiveness of the groundwater extraction system.

- Effectiveness — Groundwater pumping is a well established technology, and the pumping system could easily be designed to prevent the migration of any groundwater off of the Mason City FMGP site. The groundwater treatment train envisioned uses common water treatment components that have an established record of reliability. Therefore, this should be an effective alternative to meet the remedial response objectives established for groundwater.

- Implementability — The groundwater pumping and treatment systems envisioned consist of technologies and processes that are widely used in remediation. Multiple vendors are available from which to procure equipment and/or services necessary to construct and operate the systems. Long-term operation and maintenance of the systems is envisioned; this must be taken into account during design and the selection of equipment for the system.

  Coordination would be required with the local POTW to accept the treated discharge water from the site. Typically, the POTW does not require that groundwater be treated to nondetectable levels of organics; therefore, these negotiations would be used to establish the degree of treatment required, and the quantity of discharge that the POTW would accept. In some instances the POTW would prefer to accept discharges that contain some organic content, to avoid putting only an additional hydraulic loading on the sanitary treatment cells in the POTW.

- Cost — The capital cost to construct the shallow groundwater and treatment system is expected to be approximately $490,000.

  Long-term operations and maintenance costs would be associated with periodic operations inspections (assumed monthly for this FS), routine maintenance of equipment, and equipment replacement. Typical POTW discharge fees are assumed at $1.00 per

1,000 gallons. Over a 1-year time span, this would equate to approximately $18,900 per year or a 30-year present worth cost of $290,500. Using the same groundwater monitoring program present worth cost included in the other alternatives, the total operations, maintenance, monitoring, and discharge fee present worth cost of this alternative is approximately $3,220,000.

The total present worth capital and 30-year operations, maintenance, and monitoring cost for this alternative is approximately $3,710,000.

- Evaluation — This alternative achieves the remediation goals outlined in Section 2.0, and is feasible to implement. This alternative is, therefore, retained for further consideration.

3.2.5 Groundwater Pumping/Treatment/Discharge to Surface Water

This alternative is the same as the pumping and treatment alternative discussed above, except that the treated water would be discharged to Willow Creek as opposed to the sanitary sewer. Off-site discharge to surface water requires obtaining an NPDES permit. All elements of this alternative are identical to the alternative just presented, with the exception of the discharge location.

- Effectiveness — This alternative would offer the same degree of effectiveness as the alternative calling for discharge to the sanitary sewer. There would be no differences in the degree of protection and cleanup associated with this alternative.

- Implementability — There would be differences relating to the implementability of discharging to surface water as opposed to the sanitary sewer. Discharging to surface water requires obtaining an NPDES permit, under which more stringent treatment levels are typically required than with discharge to a sanitary sewer. This could potentially require additional operations and maintenance costs associated with the upkeep of the system. Also, there may be public perception concerns associated with discharging to Willow Creek, regardless of the degree of treatment achieved in the treatment plant. Historically, there were discharges into Willow Creek from activities on this site.

- Cost — The cost of this alternative is expected to be virtually identical to the alternative calling for discharge to the sanitary sewer. Under this alternative, additional costs would probably be incurred with extra maintenance to ensure the proper operation of the treatment system. However, under this alternative no costs would be incurred for discharge fees into the POTW. Considering the level of cost detail performed at this portion of an FS, the costs of these two alternatives would be considered identical.

- Evaluation — Discharging to Willow Creek would entail more operational difficulties associated with the treatment plant maintaining a pristine discharge, and may potentially pose public perception difficulties as well. The alternative offers no greater degree of environmental protection over the previously considered alternative; therefore, this alternative is eliminated from further consideration.

3.2.6 Fractured Bedrock Grouting/Shallow Groundwater Pumping

The last groundwater alternative considered would be a combination of the containment and treatment alternatives discussed previously in this section. The containment portion of the alternative would consist of fractured bedrock grouting, as discussed in Section 3.2.3. The treatment portion of the alternative would consist of groundwater pumping from the shallow unconsolidated fill zone only. This alternative is considered to evaluate the full range of potential response actions in groundwater.

Pumping in the shallow unconsolidated fill zone would be accomplished through the installation of a trench. Because there is very little saturated thickness in the shallow unconsolidated fill zone (1–3 feet), pumping from individual wells would likely be ineffective. There would be a limited potential to develop a cone of depression from individual wells installed in such a formation.

Groundwater withdrawal from a trench would likely be much more effective in such a scenario. The trench would be excavated to the top of the competent fractured bedrock. A french drain would be installed at the base of the trench, and would be appropriately sloped to approximately three sumps located along the length of the trench. The trench would be located along the northwest and western portions of the property, adjacent to Willow Creek and South Pennsylvania Avenue. The trench location is shown in Appendix D.

It is estimated that the groundwater flow rate from the trench would be low, approximately 8 gpm total. This is based on the available data regarding the natural groundwater flow conditions at the site under present circumstances. If this alternative were to be employed in conjunction with the capping alternative for soils, the flow rate would likely decrease due to eliminating rainfall recharge to the property.

Under this scenario, it would be necessary to treat and discharge groundwater withdrawn from the shallow zone. Technologies for groundwater treatment and discharge are discussed in Section 3.2.4 and 3.2.5. During final remedy selection, if this alternative is chosen for groundwater, the criteria for groundwater treatment and discharge presented in 3.2.4 and 3.2.5 should be taken into account for final system design.

- Effectiveness — This alternative would be effective at achieving the remediation goals of eliminating contact of nearby residents to potentially contaminated groundwater. The upper fractured bedrock would be sealed, which minimizes the potential for this zone to pose a long-term groundwater problem. The maintenance of a shallow pumping system in the shallow zone at the property boundary would provide a barrier to future groundwater migration off-site from this zone, which would also achieve the remedial action objective.

- Implementability — This alternative would be feasible to implement at the site. The bedrock grouting portion of the alternative would be performed by contractors experienced in this type of work related to civil construction projects. The installation and maintenance of a shallow groundwater pumping trench is a common practice in the environmental field, and uses commonly accepted industry practices. The groundwater treatment and discharge portions of this alternative use widely available equipment and technologies that are commonly employed in the industry.

- Cost — The bedrock grouting portion of the alternative is expected to cost approximately $2,200,000, as discussed in Section 3.2.3. The installation of the shallow groundwater pumping trench is expected to cost approximately $30 per linear foot. The trench length is approximately 500 feet; therefore, the expected installation cost of this portion of the alternative, without miscellaneous contingency or engineering costs added, is $15,000.

  Using the O&M cost estimates presented in the previous alternatives and applying a scaling factor to consider the lower flow rate of the pumping portion of this alternative, the total present worth 30-year O&M cost estimate for this alternative, including groundwater monitoring, is approximately $2,350,000. The estimated overall capital and present worth 30-year O&M and groundwater monitoring cost of this alternative is approximately $5,980,000.

- Evaluation — This alternative combines both the containment and treatment general response actions. The alternative would be effective and implementable, and the estimated costs are within a similar range to the costs of the other alternatives considered. Therefore, this alternative is retained for further evaluation.

3.2.7 Summary of Groundwater Alternatives

A series of alternatives to address contaminated groundwater were assembled and screened against the criteria of effectiveness, implementability, and cost. Alternatives within the general response actions of no action, containment, and treatment were considered. The most promising of the alternatives that have passed this screening and which are taken into detailed evaluation in Section 4 are listed below:

- Alternative 1 — No Action
- Alternative 2 — Institutional Controls
- Alternative 3 — Fractured Bedrock Grouting/Unconsolidated Fill Vertical Barrier/Groundwater Pumping
- Alternative 4 — Groundwater Pumping/Treatment/Discharge to Sanitary Sewer
- Alternative 5 — Fractured Bedrock Grouting/Shallow Groundwater Pumping

4.0 DETAILED EVALUATION OF ALTERNATIVES

In this section, a detailed evaluation of the alternatives that passed the screening in section 3 is performed. Each alternative retained for both soils and groundwater is evaluated separately against the nine criteria evaluation required by CERCLA. Following this evaluation, the alternatives are comparatively ranked within each criterion. The criteria are found in 40 CFR part 300.450 (e)(7) and are described below.

- **Overall Protection of Human Health and the Environment**

  This criterion draws on assessments under the other criteria listed below, and evaluates in an overall sense the degree to which the alternative adequately protects human health and environment consistent with the established remedial response objectives.

- **Compliance with ARARs**

  This criterion assesses whether a given alternative complies with applicable federal, state, or local laws and/or requirements, and addresses the factors that must be taken into account to ensure compliance with applicable ARARs.

- **Long-Term Effectiveness and Permanence**

  This criterion assesses the degree to which a given alternative will provide a long-term solution to the contaminants at the site, and assesses the degree to which permanence can be assumed. Factors which could pose problems in the long-term through the implementation of an alternative are addressed under this criteria.

- **Reduction of Toxicity, Mobility, and Volume**

  This criterion assesses the degree to which a given alternative reduces the toxicity, mobility, or volume of contamination at a site. For example, containment alternatives would reduce contaminant mobility, but not their toxicity or volume. The degree to which an alternative affords reductions in these three categories can be influential in the selection of a preferred remedy.

- **Short-Term Effectiveness**

  This criterion assesses the difficulties which could be posed through the implementation of an alternative. Factors such as potential risks to workers and residents, and potential risks to environmental receptors, are addressed. In addition, the time required to implement an alternative is addressed under this criteria.

- **Implementability**

  This criterion assesses the relative degree of difficulty associated with implementing an alternative. The assessments made under this criteria include technical feasibility, administrative feasibility, and the availability of goods and services required to implement the alternative.

- **Cost**

  The cost of implementing each alternative is estimated. Costs considered include capital construction costs (including direct an indirect expenses), and annual operation and maintenance (O&M) costs. To provide an equivalent basis for cost evaluation, the net present value of the long-term O&M costs are calculated for the presumed life-time of the project. As specified in the *Guidance for Conducting RI/FS Under CERCLA* (EPA 1988), cost estimates should fall within the range of +50% to -30% of the estimated final cost of implementing an alternative.

  For an FS report, detailed cost estimates and quantity take-off estimates are typically not available. Therefore, it is acceptable to use realistic assumptions of cost items, standard unit costs from construction estimating guidelines, vendor quotations, or if necessary best engineering judgment to derive cost estimates for the given alternatives. Where possible, preference is shown for using equivalent assumptions between alternatives for similar cost items, which allows for a comparison of the cost of one alternative versus another. Cost justifications are presented in appendix E.

- **State Acceptance**

  This criterion assesses the State's comments or positions relative to a given alternative. Typically, this criterion is not addressed in an FS. After the State reviews the FS and supporting RI or BRA documents, key State comments or concerns are addressed by the EPA.

- **Community Acceptance**

  This criterion assesses the community's concerns or support for the implementation of a given alternative. Typically, this criterion is not addressed in the FS. After the FS and other supporting documentation are provided to the public for review, the community concerns and/or support for an alternative are addressed by the EPA after release of the proposed remedies.

Detailed evaluation of the soil and groundwater alternatives is performed in the following sections. Alternatives for soil and groundwater are evaluated separately. This will allow for an independent evaluation of proposed remedial options for these two media. It should be recognized, however, that certain soil and groundwater alternatives could be easily combined to select an overall remedy for the site, while other combinations would require some adjustments of the envisioned alternatives due to site physical characteristics or the nature of the remedial alternatives selected.

4.1 Remedial Alternatives for Soil

4.1.1 Alternative 1: No Action

The "no action" alternative is included to provide a baseline by which to compare other alternatives as required by the NCP. This remedial alternative would require no actions to be implemented at the site. Under this alternative, the waste pile would be uncovered and no further monitoring would occur at the site. The fence around the property would be replaced by a fence around only the substation facility. The long-term health risks to surface soils, subsurface soils, and the waste pile would essentially be the same as the risks calculated in the risk assessment.

- Overall Protection of Human Health and the Environment

  The no action alternative provides no control of exposure to contaminated surface soils, subsurface soils, and the waste pile at the site. This alternative will not provide a reduction in risk to human health by exposure to the contaminated media. This alternative would not contain or reduce the soils contamination at the site.

- Compliance with ARARs

  This alternative would not meet the proposed remediation goals developed in this FS. Although the proposed remediation goals are not directly listed as chemical-specific ARARs, the proposed remediation goals are based on the calculated health-risk data.

- Long-Term Effectiveness and Permanence

  This alternative does not provide for controls to prevent exposure or for long-term management of the site. This alternative would result in a gradual reduction of benzene and PAHs in soils as natural degradation processes continue to occur.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would not significantly reduce the toxicity or the mobility of benzene, or PAHs in the soils. The volume of benzene and PAHs in soils would be reduced as natural degradation processes continue to occur.

- Short-Term Effectiveness

  No technologies are included as part of this alternative. Therefore, this alternative would have no short-term effectiveness criteria. There would be no exposure or safety concerns to workers, the environment, and the community during implementation of this alternative.

- Implementability

  Implementability is not an issue in the no action alternative as no technologies would be applied to the site.

- Cost

  No capital or O&M costs are associated with this alternative.

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.2 Alternative 2: Institutional Controls

This alternative would involve the following actions: maintenance of the present fence at the property boundary to restrict access to the contaminated soils, maintenance of the protective cover over the waste pile, placing deed restrictions on future uses of the property, and potentially placing warning signs on the fence. The deed restriction would also require that, in the event of needed utility repairs, any workers at the site must have proper OSHA training, that the work be conducted under the supervision of properly trained personnel, and that a Health and Safety Plan be developed for any work conducted at the site. The bulk of the site is owned by IPW; however, the northern portion of the site adjacent to Willow Creek is owned by the City of Mason City.

- Overall Protection of Human Health and the Environment

  This alternative provides control of exposure to contaminated surface soils, subsurface soils, and the waste pile at the site by preventing access to the site. This alternative will also provide a reduction in risk to human health by preventing exposure to the contaminated media. This alternative would not contain or reduce the soils contamination at the site other than through natural degradation processes.

- Compliance with ARARs

  This alternative would not meet the proposed remediation goals developed in this FS. Although the proposed remediation goals are not directly listed as chemical-specific ARARs, the proposed remediation goals are based on the calculated health risk data.

- Long-Term Effectiveness and Permanence

  This alternative does provide for controls to prevent human exposure and for long-term management of the site. This alternative would result in a gradual reduction of benzene and PAHs in soils as natural degradation processes continue to occur.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would not reduce the toxicity or the mobility of benzene, or PAHs in the soils. The volume of benzene and PAHs in soils would be reduced as natural degradation processes continue to occur.

- Short-Term Effectiveness

  No technologies are included as part of this alternative. The fence and the cover over the waste pile are already in place. If the decision was made to place signs on the fence, this activity could be performed without entering the site. Therefore, this alternative would have no short-term effectiveness criteria for construction. There would be no exposure or safety concerns to the environment and the community during implementation of this alternative. Workers conducting maintenance on the site would need proper training, and there is the potential for short-term exposure while conducting maintenance on the waste pile cover.

- Implementability

  This alternative would be easily implementable. Fencing already exists at the site and would be maintained. Likewise, the waste pile is already covered and would simply be maintained. IPW has stated that they would maintain the site and have agreed to property restrictions for the site. Property and access restrictions will need to be put in place. Negotiations would be required with the City of Mason City to maintain the deed and access restrictions for their portion of the property. At this time, the position of the City on this issue is unknown, but it is expected that the previous reports, the baseline risk assessment, and this FS will provide the City officials with the requisite information to be able to make a final determination on the disposition of their portion of the property.

- Cost

  No capital costs are associated with this alternative with the possible exceptions of signs, and replacement of the waste pile cover, if needed. O&M costs would be minimal and consist of regularly scheduled visits to the site for checking the fence and waste pile cover. There would also be administrative/legal costs associated with filing the deed and access restrictions.

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.3 Alternative 3: Capping

This alternative would consist of constructing a cap over the soils at the site. It is envisioned that a multimedia cap would be used, consisting of a drainage layer, overlain by a 2-foot layer of clay, overlain by a synthetic membrane, which would be overlain by a sufficient thickness of topsoil to support vegetation. The vegetation will help to minimize erosion and stabilize the cap. Some long-term maintenance would be required in the event that cracks or weathering occurred; however, the multilayered approach and the presence of the surface layer would effectively minimize this type of maintenance.

There is an approximately 660-cubic-yard pile of soil and debris on-site which resulted from the previous construction activities associated with the installation of the sewer line on-site. Under the capping alternative, this material would be spread over the existing soil surface so as to smooth the surface prior to installing the cap. During design and construction a limited amount of earthwork may be required to eliminate low and/or high spots to promote cap stability.

As envisioned, the cap would cover the entire site except for the substation. The substation is now approximately 8 feet above the ground surface of the remainder of the site; therefore, there is adequate vertical room to install the cap below the level of the substation grade. State solid waste requirements must also be met.

- Overall Protection of Human Health and the Environment

  This alternative would be protective of human health and the environment. Risks to workers and nearby residents would be minimal during construction, mostly taking the form of potential generation of dust during early construction activities. These risks could be easily managed by taking appropriate dust suppression measures during construction. In the long-term, with proper inspection and maintenance, the cap integrity can be assured. If problems were to occur with the integrity of the cap, repairs could be facilitated easily since the cap is present at the soil surface.

- Compliance with ARARs

  Capping will not meet chemical specific ARARs. Other ARARs that are potentially applicable that will be achieved during construction of the cap would be compliance with State ARARs for air emissions during spreading of the soil pile prior to installation of the cap.

- Long-Term Effectiveness and Permanence

  This alternative would pose an effective long-term solution to exposure of area residents to the soils on-site. The degree of permanence would depend on the long-term stability of the cap, and the maintenance of the cap over time. Using an upper vegetative cover allows for a degree of "self-healing" to the top of the cap over use of cement or asphalt. If the cap is properly inspected and maintained, and in particular if cracks are sealed and the cap maintained quickly if a problem is detected, this alternative would pose an effective long-term solution to the exposure to the soils at the site; however, it would not significantly reduce contaminant migration to groundwater.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would not reduce the toxicity or volume of contamination present in the soils at the site. However, this alternative would reduce contaminant mobility, and would eliminate exposure to the surface and subsurface soils underneath the cap.

- Short-Term Effectiveness

  The threat to construction workers and nearby residents during the implementation of this alternative would be from fugitive dust and VOCs generated during initial site grading. The first construction activity undertaken would be to remove the waste pile presently on site and spread the pile on the surface. These potential risks would be minimized by using standard construction dust suppression techniques and monitoring for VOCs with upgrades in personal protective equipment based on exposure criteria.

  Following the initial grading of the surface, the cap would be emplaced. This portion of the operation would essentially consist of "clean" construction, grading the site and adding clean materials to the cap on a sequential basis. As such, this activity would pose minimal threat to nearby residents or workers.

  The construction period for the cap is expected to require 2 to 3 months, and could be constructed within one construction season.

- Implementability

  Emplacement of a cap would be easily implementable. The cap can be built using standard construction techniques. Qualified construction contractors and materials are readily available. Long-term maintenance needs are minimized by the establishment of the vegetative cover.

- Cost

  The 30-year present worth cost of this alternative is estimated to be $522,900, with a capital cost of $307,700 and an annual O&M cost of $14,000 (see table 4-1). The basis of the estimated cost for constructing the cap is presented in Appendix E.

- State Acceptance

  This is a common proven technology implemented at many sites and has been issued in other RODs and/or engineering evaluation/cost analysis (EE/CA) as final remedies. Final state acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.4 Alternative 4: Excavation/Thermal Treatment (Fixed Treatment Plant)

This alternative entails the excavation of contaminated soils present above the action levels discussed in section 2, and the treatment of these soils in a fixed, off-site thermal treatment unit. The plant that is envisioned is the Advanced Environmental Services, Inc. (AESI) facility located in Marion, Iowa. Presently, the facility has obtained a test burn permit to thermally treat soils from another FMGP site.

Under this alternative, soils from the Mason City FMGP site would be excavated and transported off-site for treatment. At the facility, the soils are stored in segregated piles depending on the generating site. Batches are run using the soils from a given site. After the soils have been thermally treated, the soils are tested and are transported back to the site and used to backfill the excavation. This will require keeping the excavation open during the treatment process.

As discussed during technology screening (section 2.4), excavation by common mechanical means is considered applicable for the unconsolidated soils and the upper 1 foot of bedrock. Below this, the bedrock becomes more competent and would be difficult to implement. Therefore, this alternative applies only to unconsolidated fill and the top 1 foot of weathered bedrock which could be removed by common mechanical excavation techniques.

Excavation would likely require some type of dewatering to facilitate the construction activities, since the lower portion of the unconsolidated fill above the upper bedrock are saturated with water. This would entail standard construction dewatering practices, such as pumping from sumps during the operation or potentially driving sheet piling around the limits of the excavation. The groundwater that is removed would likely require treatment prior to discharge. Discharge would likely be to the sanitary sewer that traverses the facility, after obtaining permission from the POTW and establishing treatment requirements (if any). Groundwater treatment technologies are discussed in Section 2.4.2.7.

In addition, it may be necessary to manage water that may enter into the open excavation while the soils are undergoing off-site treatment. It is expected that any such water would be removed by standard dewatering techniques and also treated and discharged to the POTW. During final design, the necessary construction logistics could be arranged to minimize the amount of time that the excavations are left open.

One final concern with this alternative is the waste classification of the soils to be transported off-site for thermal treatment. As discussed in section 3, it is assumed for the purposes of this FS that the soils would be classified as nonhazardous (special wastes) and as such could be transported to and treated at the facility identified. This classification would depend on the soils passing a TCLP test. Such testing data are not available at this time. Therefore, prior to implementing this alternative it would be necessary to conduct TCLP testing to ensure that the soils would be classified as nonhazardous prior to shipment to or treatment by the subject facility, or render the soils nonhazardous in accordance with the Edison Electric Institute's (EEI) remediation strategy prior to shipment.

The EEI strategy (MGP Site Remediation Strategy, EEI, February, 1993) describes an approach to perform on-site treatment of MGP soils that are characteristic hazardous waste due to benzene. The strategy is in compliance with RCRA regulations for less than 90-day accumulation of hazardous materials. This strategy was endorsed by the EPA Office of Solid Waste in an April 26, 1993 memorandum.

- Overall Protection of Human Health and the Environment

  This alternative would meet the established remedial response objectives and be protective of human health and the environment. The excavation process would result in fugitive dust and, potentially, VOC emissions, which would have to be managed during excavation. Air discharges would result from the thermal treatment process, but the thermal treatment unit is permitted and would be expected to comply with its applicable discharge requirements. The technology employed in this alternative, thermal treatment, effectively destroys organic contaminants, rendering the resultant treated soils benign from an environmental risk or human exposure standpoint.

- Compliance with ARARs

  Regulations relating to the proper shipment and treatment of wastes are applicable to this alternative. Assuming the soils pass the TCLP test, they would be classified as nonhazardous and, as such, could be shipped and treated at the identified facility. If, however, the soils do not pass the TCLP test, they would be considered hazardous and RCRA regulations would be applicable.

  The management of fluids generated during construction would require coordination with the local POTW regarding the quantity of water that could be discharged and the treatment level (if any) that would be required prior to discharge to the POTW.

- Long-Term Effectiveness and Permanence

  Thermal treatment effectively destroys organic compounds which are bound to soils, therefore this alternative would represent a permanent solution to the organic contamination observed in soils assuming satisfactory cleanup standards can be achieved with these units. Since most of the organic constituents would be destroyed, there would be a minimal potential for organic exposure or leaching from the treated soils brought back to the site and backfilled in the excavation.

- Reduction of Toxicity, Mobility, and Volume

  Thermal treatment would effectively destroy most of the organic contamination on soils, which would eliminate the contamination. This represents a reduction in the volume of the contaminants in the soils, and reduces the toxicity of the soils themselves. Since most of the organic contamination is effectively destroyed, there would be no concern over future mobility. It would be necessary to conduct a test burn on the Mason City FMGP site soils and compare to the risk-based concentration levels established for this site.

- Short-Term Effectiveness

Risks to workers and nearby residents would take the form of potential dust and VOC generation during excavation on-site and would require suppression, monitoring and proper personal protective equipment. In addition, this alternative requires the off-site transportation of untreated soils to the thermal treatment unit. Transportation of such materials include some inherent risks associated with accidental spillage or overturning.

Depending on the capacity of the thermal treatment unit, the operation could be conducted fairly rapidly.

- Implementability

Thermal treatment in the identified desorption unit would be relatively easily implemented. Assuming the operator can obtain the necessary state air permit, no air permitting is required on the part of IPW. In addition, IPW has an existing contract with this vendor and it would be feasible to expand that contract to include the soils from the Mason City FMGP site as well.

The excavation techniques which would be employed to obtain the soils use standard construction practices, and a number of vendors would be available to provide the necessary subcontracting services. Dewatering would be required during the operation; however, this is a standard construction practice and as such is easily implementable.

- Cost

The basis of the estimated costs for this alternative are presented in appendix E. The capital cost of this alternative, assuming soils are nonhazardous upon excavation, is estimated to be $2,560,800 (see table 4-2A). The capital cost of this alternative, assuming soils are rendered nonhazardous in accordance with the blending strategy following excavation, is estimated to be $3,319,200 (see table 4-2B)

In order to prevent rainwater from contacting either contaminated soil or exposed bedrock during excavation activities, and to control the release of possible odors, a portable clear span type building will be constructed over the excavation areas. A 140-foot-long by 100-foot-wide building has been assumed based on the largest projected excavation. Clear span buildings are built with light weight aluminum trusses covered with a weather resistant fabric. Ventilation fans will maintain a negative pressure within the building and exhaust air through activated carbon canisters to control odors.

There would be no long-term monitoring or maintenance costs associated with this alternative. Since the soils will have been effectively treated off-site and the primary organic contamination reduced to risk-based levels, there would be no need to monitor the site in the future

- State Acceptance

State acceptance of this alternative will be addressed after receipt of State comments to the FS.

- Community Acceptance

Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.5 Alternative 5: Excavation/Thermal Treatment (Transportable Treatment Plant)

This alternative is the same as Alternative 4, except that thermal treatment would be accomplished using a transportable treatment plant. A number of vendors now market mobile treatment units that can be transported to a site to conduct the thermal treatment process on-site. These units are typically classified as desorption units (operate at 900 °F) and include off-gas treatment and/or incineration at temperatures up to 1,800 °F.

As envisioned for the purposes of this FS, the transportable treatment plant would be set up at an IPW substation located approximately 10 miles north of the Mason City FMGP site. The substation is a rural location with no nearby residents, as opposed to the FMGP site, which is situated in a residential area in Mason City. In addition, there are space limitations at the Mason City FMGP site, while the substation site is much larger and would have fewer space limitations.

- Overall Protection of Human Health and the Environment

  This alternative would entail the same degree of overall protection of human health and the environment as Alternative 4. The excavation process would result in fugitive dust and, potentially, VOC emissions, which would have to be managed during excavation. The thermal treatment process would effectively destroy the contamination. Since desorption is used as opposed to incineration, no off-site disposal of the treated soils is required; the soils can be transported back to the site and backfilled in the excavation. Since off-site transportation would be required, it would be necessary to ensure that the soils first pass a TCLP test or be rendered nonhazardous prior to shipment.

- Compliance with ARARs

  The same ARARs as required under Alternative 4 would be applicable to this alternative. In addition, it would be necessary to obtain an air permit to install and operate the transportable treatment unit at the substation site. The permitting would have to be performed by IPW and the vendor. Under Alternative 4, which uses a pre-permitted, fixed, off-site unit, no additional air permitting would be required on the part of IPW.

- Long-Term Effectiveness and Permanence

  This alternative would have the same long-term effectiveness and permanence characteristics as posed by Alternative 4. Thermal treatment effectively destroys the contamination, therefore, this alternative should pose a permanent solution to the contamination found on the soils.

- Reduction of Toxicity, Mobility, and Volume

  Thermal treatment by desorption reduces the volume of contamination. By eliminating the contamination, the toxicity of the soils is lessened. Since contamination is effectively destroyed, there is no concern over future mobility.

- Short-Term Effectiveness

  This alternative would have similar short-term effectiveness concerns as Alternative 4 regarding performing the excavation, loading, and shipping of the soils to be treated. This alternative will have additional short-term concerns relating to obtaining the permit, and setting up and operating the thermal treatment plant at the substation. In the case of Alternative 4, the soils are being treated in a fixed unit that is specifically designed and staffed with operators for conducting soil treatment. Such considerations as materials handling, operating conditions, and flow-through rates are established by experienced operators at the facility. Under this alternative, these concerns about the treatment process logistics will have to be addressed during the one-time application of this technology to the Mason City FMGP site soils. This increases the short-term difficulties associated with implementing this alternative.

- Implementability

This alternative has the same implementability concerns as Alternative 4, with the additional concerns over setting up and successfully operating the unit for the one-time application necessary for the Mason City FMGP soils. This lessens the ease of implementing this alternative relative to Alternative 4. In addition, there are not expected to be a large number of vendors available to provide the mobile treatment units, but there should be enough to secure a competitive bid to perform the work.

- Cost

The estimated capital cost for this alternative, assuming soils are nonhazardous upon excavation, is $2,073,300 (see table 4-3A). The capital cost of this alternative, assuming soils are rendered nonhazardous in accordance with the blending strategy following excavation, is estimated to be $2,443,800 (see table 4-3B). The basis of the estimated costs for this alternative are presented in appendix E. Both costs include construction of a clear span building to control odors and rainfall. There would be no long-term monitoring or maintenance costs associated with this alterative for the same reason presented in Alternative 4.

- State Acceptance

State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.6 Alternative 6: Excavation/Thermal Treatment (Power Plant)

This alternative includes the excavation of the soils on-site, and the treatment of the soils in a power plant. Through the process known as "co-burning," the soils can be mixed with coal and/or a stabilizing agent and shipped to a power plant. The power plant slowly bleeds in the soil–coal mixture with its fuel supply for the boilers. The soils are then burned through the normal combustion process in the power plant.

This process is being actively pursued by some utilities as a method to treat soils from FMGP sites. Due to the high temperatures achieved in the power plants, this thermal treatment process falls under the category of combustion as opposed to desorption. Treated soils are disposed with the ash that normally accumulates within the power plant furnaces.

One substantive difference between this alternative and the two alternatives previously discussed (Alternatives 3 and 4) is the need to mix the soils with coal and/or other additives to facilitate the co-burning operation. As envisioned, this mixing would be performed at the Mason City FMGP site and the combined soil–coal mixture would be loaded and shipped to the power plant. With the other alternatives, the soil itself can be shipped and treated without mixing, assuming that the soils are classified as nonhazardous, based on the results of a TCLP test.

IPW and KCPL do not possess the requisite fuel-handling system in any of its power plants to undertake the co-burning process without first performing extensive facility modifications. To investigate this alternative for the purposes of this FS, a number of utilities in the Midwest were contacted to determine plant configuration (if modifications had already been made to facilitate co-burning) and capacity (co-burning mixtures must be bled into the fuel feed slowly). Illinois Power has a facility in Baldwin, Illinois, which based on its present operating configuration, has the requisite fuel-handling system and the capacity to handle the soils from the Mason City FMGP site. In addition, the Illinois Power facility has recently received (or is expected to receive) a permit to co-burn FMGP-impacted soils. It should be noted that this capacity is based on present-day conditions, and it cannot be guaranteed that the capacity will be available at the time the remediation program is undertaken for the Mason City FMGP site.

- Overall Protection of Human Health and the Environment

  Since the contaminants are completely destroyed under this alternative, it represents a permanent solution to the risks posed by the soils. The excavation process would result in fugitive dust and, potentially, VOC emissions, which would have to be managed during excavation. Off-site transportation of the material is required to take it to the power plant (estimated distance 500 miles) and this poses a degree of risk to this alternative over the previous two alternatives (Alternatives 3 and 4), which had shorter transportation distances.

Emissions from the power plant are permitted, and it would be necessary to ensure that the permit conditions are complied with during the co-burning operation. In addition, since mixing is performed, this adds a degree of difficulty and potential risk to the operation that is not realized with the other thermal treatment alternatives previously discussed.

- Compliance with ARARs

This alternative invokes the same ARARs as outlined for Alternative 4, excavation and off-site thermal treatment in a fixed treatment plant. In addition, this includes OSHA requirements (although they are not ARARs) to be addressed during construction, shipping of contaminated soil requirements, and air requirements at the treatment facility. Also, since dewatering would be performed, ARARs relating to the discharge of the water generated during construction would have to be invoked. Prior to instituting this alternative, it would be necessary to verify that the vendor is in compliance with all operating permits as required by the "CERCLA Off-Site Rule," including air permits.

- Long-Term Effectiveness and Permanence

Since thermal incineration is employed by this alternative, this would represent a permanent solution to the contamination present in the soils. The ash from the co-burning process would be included with and disposed of in the normal fashion for the power plant fuel.

- Reduction of Toxicity, Mobility, and Volume

Thermal incineration completely destroys organic contamination, thereby reducing the volume of contamination and the toxicity of the soils that contained the contamination. Since complete destruction is achieved, future mobility is not an issue.

- Short-Term Effectiveness

Short-term effectiveness concerns with this alternative would include performing the excavation as with the other alternatives. In addition, this alternative would require that a staging and mixing area be established on the site to blend the soils and coal for shipment. This adds a degree of difficulty during the operation that is not present with Alternatives 3 and 4. Lastly, the shipping distance to the Illinois Power facility (500 miles) is much greater than the shipping distance associated with Alternatives 3 and 4, posing a greater degree of hazard of spillage during transport.

One aspect of this alternative that would pose fewer short-term concerns would be that the excavation can be backfilled as the operation progresses, rather than waiting for the treated soils be transported back to the site for backfilling after treatment. While this does add costs to the operation for backfill, this allows the excavated areas to be regraded concurrently with the operation. This leaves the excavation open for a shorter period of time than would be realized with the other alternatives.

- Implementability

This alternative is being actively pursued to treat the soils from other FMGP sites in Iowa; therefore, it is known to be technically effective. Test burns would be required to ensure that the appropriate mixture of soil, coal, and additives is developed to ensure that the burning process is effective. This alternative is highly dependent on the capacity of the power plant to accept the soil–coal blend, which adds additional implementability concerns. Due to the specialized nature of the operation at the power plant, a very select number of vendors would be available to implement the operation.

- Cost

The estimated capital cost to implement the alternative, assuming soils are nonhazardous upon excavation, is $2,912,800 (see table 4-4A). The estimated capital cost to implement this alternative, assuming soils are rendered nonhazardous in accordance with the blending strategy following excavation, is $4,063,800 (see table 4-4B). Both costs include construction of a clear span building to control odors and rainfall. The basis of the estimated costs for this alternative are presented in appendix E.

There would be no long-term monitoring or maintenance costs associated with this alternative for the same reason presented in Alternative 4.

- State Acceptance

State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.7 Alternative 7: Excavation/Thermal Treatment (Cement Plant)

This alternative also entails the excavation and thermal treatment of the contaminated soils. In this case, the soils are treated in a cement plant. Treatment is accomplished by incineration, or completely burning the soils in the rotary kilns that are used to heat the limestone as part of the cement manufacturing process. The treated soils are disposed along with the normal ash from the kiln furnace, and backfill is brought back to the site to fill the excavation.

For the purposes of this FS, the LaFarge cement plant located in Davenport, Iowa, was contacted regarding pricing and availability of capacity to treat the soils. They indicated that at this time there is sufficient capacity to treat the soils generated during the remediation program at the site. It should be noted, however, that the available capacity of this plant cannot be guaranteed in the future. If this alternative is selected, appropriate arrangements with a qualified vendor would have to be made at the time of implementation.

- Overall Protection of Human Health and the Environment

  This alternative poses a similar degree of overall protection of human health and the environment as excavation and treatment in a power plant. The excavation process would result in fugitive dust and, potentially, VOC emissions, which would have to be managed during excavation. No on-site mixing would be required (assuming that the material is classified as nonhazardous), which would make this alternative easier to implement than the power plant option. Emissions would be controlled at the cement plant through the normal operating permit. The other aspects of this alternative are identical to thermal treatment in the power plant.

- Compliance with ARARs

  The same ARARs would be invoked with this alternative as with incineration in a power plant. Emissions regulation would be at the cement kiln.

- Long-Term Effectiveness and Permanence

  This alternative would pose the same degree of long-term effectiveness and permanence. Thermal treatment through incineration completely destroys the organic contamination, making this a permanent remedy.

- Reduction of Toxicity, Mobility, and Volume

  Thermal incineration completely destroys the organic contamination, reducing the volume of contamination and the toxicity of the soils. Since contamination is destroyed, concerns over future mobility are not an issue.

- Short-Term Effectiveness

  This alternative would have fewer short-term concerns than thermal destruction in a power plant, since mixing would not be required on-site (assuming that the material is classified as nonhazardous). Other concerns over on-site construction activities (excavation, dewatering) would be the same as with the previous thermal desorption alternatives.

- Implementability

  This alternative is technically implementable, and is being used to treat soils contaminated with organic compounds from other sites. This is a rather specialized field (cement kilns that have been modified to burn soils); therefore, a select group of vendors would be available to provide the necessary services.

- Cost

  The total estimated capital cost of this alternative, assuming soils are nonhazardous upon excavation, is $2,171,100 (see table 4-5A). The estimated cost to implement this alternative, assuming soils are rendered nonhazardous in accordance with the blending strategy following excavation is $2,767,700 (see table 4-5B). Both costs include construction of a clear span building to control odors and rainfall. The basis of the estimated costs for this alternative are presented in appendix E.

  There would be no long-term monitoring or maintenance costs associated with this alternative for the same reason presented in Alternative 4.

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.1.8 Alternative 8: Excavation/Biological Treatment (On-Site)

As discussed in section 3, soils from the Mason City FMGP site have been tested for their amenability to treatment using biological processes. The test results through the 62-day period indicate that the soils may be amenable to bioremediation or biostabilization. Biostabilization is the concept of removing organic contaminants available to microbial consumption, leaving more stable organic compounds that would be much less available to the environment.

The components of this remedial alternative would consist of first excavating the soils from the targeted areas on-site. The soils would be processed through a mechanical shredder/conditioning unit, and nutrients and oxygen would be added. Pre-treatment of the conditioned soils using ozone or other technologies could enhance the long-term effectiveness of this technology.

The areas that were excavated would be lined with a geomembrane. The conditioned mixture of soils and additives would then be placed back on top of the geomembrane. During emplacement, a series of pipes would be installed throughout the backfilled soil. Some piping would be slotted to allow for the ventilation of air from the biological treatment cell, while other piping would be installed to allow for the addition of nutrients and/or water in the future. After the completion of the construction of the treatment cell, the area would be capped.

The treatment cell would be operated by connecting the slotted pipes to a regenerative blower. This blower would withdraw air from within the treatment cell, thus promoting turnover and oxygenation of the soils within the treatment cell. The treatment cell would continue operation until samples of the blower gas effluent indicated a 90% reduction of the VOC levels, and a 90% reduction in the CO_2 content of gas stream. The CO_2 content is an indicator that the biological activity within the cell has been reduced, which indicates that available organic constituents have been metabolized by the biological activity. At that point, and for the purpose of this FS, a representative number of soil samples will be collected and analyzed for individual PAH compounds by EPA Method 8310 (HPLC). The actual number of samples will be determined as Final Performance standards during remedial design. Biological treatment will be judged complete when concentrations of individual COCs meet the 95% upper confidence level test. EPA will make the final determination based on risk-based considerations and compliance with ARARs.

Following the operation of the treatment cell, any piping emanating from the pile would be cut off, and pipes within the cell would be filled with grout. This would constitute the end of the operation of the remedial alternative.

- Overall Protection of Human Health and the Environment

  This alternative would meet the remediation goals for soils by reducing the concentration of organics in the soils. Fugitive dust and, potentially, VOC emissions would be produced during the excavation process which would have to be managed. There will be an air discharge from the operation, which will likely contain some VOC vapors which would be withdrawn from the more volatile fraction of contamination on the soils. It would be necessary to obtain an air permit for this operation. The permit will identify and establish the levels of VOCs in the discharge which are deemed protective of human health and the environment during the operation of the pile.

- Compliance with ARARs

  Although OSHA regulations are not an ARAR, the regulations would be followed during the construction activities, particularly those regarding sidewall shoring during excavation and OSHA regulations found under 40 CFR 1910.120 regarding work at hazardous waste sites.

  Two types of discharges would result from this operation: (1) waters potentially generated during the excavation; and (2) air discharge from the blower connected to the biological treatment cell. If wastewater is discharged on-site, then the substantive NPDES regulations are applicable. If wastewater is discharged off-site, then the discharge must be to a permitted facility. The water discharge would require the approval of the POTW. Air discharge permits are unnecessary for on-site discharges, but the applicable federal or state emissions standards must be met.

- Long-Term Effectiveness and Permanence

  The biological treatment process destroys organic contamination through the metabolism of the organics by naturally occurring bacteria. As such, this is a destruction technology which, if effective, will destroy the organic contaminants and render the resultant soils benign from an environmental standpoint. This would represent a permanent treatment technology.

  The envisioned treatment cell would be constructed within the excavation and covered with a cap. Following the completed biological operation, the soils would not be removed. Therefore, there would be some degree of continuing long-term monitoring associated with ensuring that excessive erosion of the cap over time did not occur. Institutional controls in forms of deed restrictions may be necessary to avoid future excavation on site.

- Reduction of Toxicity, Mobility, and Volume

  The biological processes identified will destroy or render unavailable the organic contamination on the soils, which effectively decreases the volume of contamination and which would also reduce the toxicity of the treated soils. Since the contamination is destroyed or unavailable, future contaminant mobility would also be reduced.

- Short-Term Effectiveness

  Risks to on-site workers and nearby residents would take the form of risks associated with fugitive dust and VOC generation during construction. Since the application would entail excavation, aboveground processing and mixing of the soils, there would be a more significant potential for dust and VOC generation with this alternative than with the other alternatives considered. Therefore, dust control and monitoring for VOC levels would be important during the operation.

  There would be substantial construction logistical concerns during the implementation of this alternative. There is limited space available on the site; therefore, the location of the excavation relative to stockpile areas relative to the processing equipment would be critical factors to address during design and implementation.

- Implementability

This alternative is implementable, although there will be logistical concerns due to the space limitations at the site. Careful coordination will be required between areas being excavated, the location of the soil conditioning/processing unit, and the areas being backfilled with the treated soils. Also, water which would be associated with the excavation would have to be managed as previously discussed under the other excavation alternatives.

The bulk of the activities would require services that are readily and widely available in the construction industry. Soil processing is a widely available technology, and equipment could be procured from a number of vendors. The mixing activity itself, whereby soils are mixed with the appropriate nutrients and properly conditioned, would require oversight by more specialized personnel familiar with this type of remediation operation. Biological treatment cells are used fairly widely in the environmental industry, but available vendors are not as widespread as standard construction contractors.

- Cost

The 10-year present worth cost of this alternative, including capital costs of $1,740,800 and an annual O&M cost of $125,200, is estimated to be $2,708,100 (see table 4-6). The 10-year operational period has been conservatively used as the anticipated treatment period. Both costs include construction of a clear span building to control odors and rainfall. The basis of the estimated costs are presented in appendix E.

- State Acceptance

State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

Community acceptance of this alternative will be addressed during the public comment period after release of EPA's proposed remedies.

4.1.9 Alternative 9: Excavation with Ex Situ Fixation/On-Site Disposal

This alternative consists of excavating contaminated soils, and passing the soils through an aboveground conditioning/processing step in a treatment plant constructed on-site. The treated soils would be backfilled in the excavation. Soil would be placed over the fixated soils, and vegetation would be established.

Prior to implementing this alternative, it would be necessary to conduct bench scale testing to determine the proper mixture of cement, fly ash, and/or possibly chemical fixating agents to mix in with the soil to achieve a resultant product which would have minimal leaching potential. Such a test has not been performed at this time. However, for the purposes of this FS, it is assumed that the soils would be mixed with approximately 25% (by weight) of cement, processed, and replaced in the excavation.

Since the materials would be solidified, there would be no reason to install a liner at the base of the excavation where the soils would be replaced. Similarly, there would be no reason to install a cap (membrane) over the top of the excavation. However, a cover of topsoil and vegetation would be established for aesthetic reasons, and also to add a measure of protection against potential future erosion at the site.

During the excavation and soil conditioning/processing operation, large fragments of boulders, bricks, and/or other uncovered construction rubble would be screened out and set aside in a separate temporary storage area. Since these types of materials would interfere with the successful mixing of the soil and conditioning agents, they would require further processing prior to being added back into the mixing process. Additional rubble processing would include crushing and metals segregation. All separated metals would be disposed of on-site after a thorough mechanical cleaning and proper waste characterization analyses.

- Overall Protection of Human Health and the Environment

  This alternative would meet the remediation goals by fixating the contaminants to the soil, making them unleachable and immobile. This would effectively eliminate the risks to the public from future exposure to the soils. The above ground mixing and conditioning process would be a source of potential fugitive dust and VOC emissions during construction, which would have to be managed during construction. Commercially available processes are available whereby the resultant solidified soil mixtures are subjected to simulated extended-time leaching scenarios, and the soils would have to pass these demonstrations before the alternative could be implemented.

- Compliance with ARARs

  OSHA regulations (although not ARARs) regarding construction activities for excavations and construction activities at hazardous waste sites would be applicable. In addition, local regulations regarding fugitive dust and VOC emissions would also be applicable during soil excavation and mixing. Coordination would be required with the POTW regarding the treatment and discharge (based on POTW permitted discharge limits) of groundwater which could be generated during the excavation. The treated backfill soils must meet RCRA requirements for landfills. RCRA requirements are relevant and appropriate for the disposal cell.

- Long-Term Effectiveness and Permanence

  Processes are available whereby fixated products can be subjected to simulated leaching tests for extended time frames for testing of permanence of these types of remedial technologies. If this alternative is selected, it would be necessary to conduct these tests, and the fixated product would have to pass these tests.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would reduce the mobility of the contaminants, and would reduce the toxicity of the soils by rendering the contaminants immobile and unavailable for human contact. This alternative would increase the overall volume of contaminated material, however, due to the addition of the cement and/or other stabilizing agents.

- Short-Term Effectiveness

  This alternative would have similar short-term effectiveness to the other excavation and on-site aboveground treatment alternatives. Potential exposures to workers and nearby residents could be realized during the excavation/soil processing steps. These exposures would have to be managed during construction.

- Implementability

  Soil excavation and processing activities are widely practiced in the construction field and there should be a number of available vendors to assist in these activities. The establishment of the correct mixture of cement and additives is a more specialized field, and these services would be available from a more select group of vendors.

  There is limited space available at the site; therefore, construction logistics would be a concern. Careful staging and management of the process would be required to ensure adequate space was available for excavation, processing, the stockpile area, and backfilling.

- Cost

  The basis of the estimated capital and O&M cost for this alternative is presented in appendix E. The 10-year present worth cost of this alternative including capital costs of $1,771,700 and an annual O&M cost of $14,000, is estimated to be $1,879,900 (see table 4-7). Both costs include construction of a clear span building to control odors and rainfall. The 10-year operational period has been conservatively used as the anticipated treatment and/or monitoring period.

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.2 Detailed Analysis of Groundwater Remedial Alternatives

4.2.1 Alternative 1: No Action

The "no action" alternative is included to provide a baseline by which to compare other alternatives as required by the NCP. This remedial alternative would require no actions to be implemented at the site. Under this alternative no further monitoring of the groundwater would occur at the site. The long-term health risks to groundwater would be essentially the same as the risks calculated in the risk assessment.

- Overall Protection of Human Health and the Environment

  The no action alternative provides no control of exposure to contaminated groundwater at the site. This alternative will not provide a reduction in risk to human health by exposure to the contaminated media. This alternative would not contain or reduce the groundwater contamination at the site.

- Compliance with ARARs

  This alternative would not meet the chemical-specific ARARs or the proposed remediation goals developed in this FS. Although the proposed remediation goals are not directly listed as chemical-specific ARARs, the proposed remediation goals are based on the calculated health risk data.

- Long-Term Effectiveness and Permanence

  This alternative does not provide for controls to prevent exposure or long-term management of the site. This alternative would result in a gradual reduction of benzene and PAHs in soils as natural degradation and leaching processes continue to occur. Contamination in soils would continue to contribute to the groundwater contamination in the long-term.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would not reduce the toxicity or the mobility of benzene, lead, or PAHs in the groundwater. The volume of benzene and PAHs in groundwater would be reduced through attenuation, dispersion, and natural degradation processes.

- Short-Term Effectiveness

  No technologies are included as part of this alternative. Therefore, this alternative would have no short-term effectiveness criteria. There would be no exposure or safety concerns to workers, the environment, and the community during implementation of this alternative.

- Implementability

  Implementability is not an issue in the no action alternative as no technologies would be applied to the site.

- Cost

  No capital or O&M costs are associated with this alternative.

- State Acceptance

  State acceptance of this alternative would be addressed after receipt of State comments to the FS.

- Community Acceptance

  Community acceptance of this alternative would be evaluated during the public comment period after the issuance of the EPA's proposed remedies.

4.2.2 Alternative 2: Institutional Controls

This alternative would involve placing deed restrictions to restrict the development of future water supplies from the shallow aquifer in the area and/or maintaining the Willow Creek dam in the down position. Although the off-site groundwater contamination downgradient of the site is limited and evidence exists that groundwater contamination may be due to sources other than the Mason City FMGP site, this alternative would include expanding the well restriction area to beyond the site boundaries. This would add an extra measure of health protection to this alternative. The dam is owned by the City of Mason City. There are indications in discussions with city officials that the city has Willow Creek beautification plans that include maintaining the dam in the up position for at least part of the year. However, the dam may require expensive repairs and maintenance (according to IPW) in order to be operated.

This alternative would also include a long-term groundwater monitoring program to evaluate changes in the groundwater quality off-site. This program would consist of sampling and analysis of groundwater from five off-site monitoring wells. The monitoring wells would be sampled on a quarterly basis and the samples would be analyzed for a selected set of representative compounds. The groundwater monitoring program would be conducted for a 30-year time frame.

- Overall Protection of Human Health and the Environment

  Deed restrictions on future shallow aquifer use provide control of exposure to contaminated groundwater at and near the site by preventing groundwater withdrawal and will also provide a reduction in risk to human health by preventing exposure to the contaminated groundwater. A permanent dam-down scenario may help control future contaminant mobility and groundwater contamination by reducing groundwater contact with impacted soils. This alternative would not contain or reduce the groundwater contamination at the site.

- Compliance with ARARs

  This alternative would not meet the chemical-specific ARARs for benzene, lead, and benzo(a)pyrene or the proposed remediation goals developed in this FS. Although the proposed remediation goals are not directly listed as chemical-specific ARARs, the proposed remediation goals are based on the calculated health risk data.

- Long-Term Effectiveness and Permanence

This alternative does provide for controls to prevent human exposure and for long-term off-site monitoring of the groundwater. This alternative would result in a gradual reduction of benzene and PAHs in groundwater as result of attenuation, dispersion and natural degradation processes. The off-site monitoring would be effective at evaluating off-site groundwater conditions with regard to any changes in water quality. Also, the groundwater monitoring program would be designed in conjunction with the state agency to ensure effectiveness. The monitoring program could also include a well survey on a routine basis to ensure compliance with the deed restrictions.

- Reduction of Toxicity, Mobility, and Volume

This alternative would not reduce the toxicity or the mobility of benzene, lead, or PAHs in the groundwater. The volume of benzene and PAHs in the groundwater would be reduced as natural degradation processes continue to occur.

- Short-Term Effectiveness

No technologies are included as part of this alternative. Therefore, this alternative would have no short-term effectiveness criteria for construction. There would be no exposure or safety concerns to the workers, the environment and the community during implementation of this alternative.

- Implementability

This alternative would be easily implementable. The establishment of deed restrictions would be easily accomplished for the property owned by IPW. The establishment of a well restriction zone should not pose an undue burden on nearby property owners. This may assist in obtaining cooperation for the implementation of this alternative.

- Cost

No capital costs are associated with this alternative. The annual O&M costs associated with groundwater monitoring would be minimal and would consist of regularly scheduled visits to sample the selected monitoring wells, laboratory analytical costs, data compilation, evaluation and reporting costs, and periodic visits to perform a well survey. There would also be administrative and legal costs associated with the negotiations with the City of Mason City and with other property owners and with filing the deed and access restrictions.

The 30-year present worth cost of the groundwater monitoring program is estimated to be $451,900 (see table 4-8). The basis of the estimated costs for the monitoring program is presented in appendix E.

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative would be evaluated during the public comment period after the issuance of the EPA's proposed remedies.

4.2.3 Alternative 3: Fractured Bedrock Grouting/Unconsolidated Fill Vertical Barrier/Groundwater Pumping

Under this alternative, contaminated groundwater from within the unconsolidated fill and the upper 15 feet of shallow fractured bedrock would be contained by implementing vertical barriers to the groundwater flow. This alternative addresses the general response action of containment as outlined in the NCP.

In the unconsolidated fill and the upper 1 foot of weathered, fractured bedrock, containment would be achieved by instituting some type of vertical barrier around the boundaries of the site. The vertical barriers would prevent groundwater flow in the unconsolidated fill and the upper 1 foot of the weathered, fractured bedrock. A number of different technologies (sheet-piling, vibrating beam, slurry wall as described in section 2.4) would be effective in preventing horizontal groundwater flow on-site within the unconsolidated fill and the upper 1 foot of the weathered, fractured bedrock. The appropriate technology to implement would be selected during design.

Below the interval enclosed by the vertical barriers, containment would be achieved by instituting a pressure grouting program in the bedrock. Closely spaced boreholes would be advanced into the bedrock beneath the site, and grout would be injected into the boreholes. Injection would be performed until fractures within the bedrock were sealed. This is a commonly employed practice within the civil construction field and is used, for example, to seal bedrock formations in conjunction with the construction of a dam. Using these common practices, the upper bedrock surface beneath the site would be sealed and isolated from future groundwater movement.

The placement of vertical barriers within the unconsolidated deposits, and the sealing of the upper 15 feet of bedrock, would require the implementation of some type of remedial technology to either prohibit the vertical migration of rainfall into the isolated area, or to pump out the rainfall that would fall on the area. The prevention of rainfall infiltration would be accomplished by groundwater pumping from the shallow zone to periodically drain the isolated unconsolidated fill. A groundwater withdrawal sump would be placed inside of the isolated area. If pressure were to build up inside of the sealed area, the pump would be activated and the isolated area drained to prevent the breaching of the vertical barrier. The sump would be constructed so as to operate whenever required, based on the water level that may develop inside of the slurry wall in the future. Treatment of the extracted groundwater would be minimal, consisting of carbon polishing. Groundwater disposal would be to the sanitary sewer

During final remedy selection, if this groundwater containment alternative is selected and soil capping is also selected, the interrelationship between these alternatives would have to be taken into account during design. This is to ensure the long-term stability of the overall site containment system, and to minimize the potential for pressure build-up and breaching of the slurry walls in the shallow groundwater zone

As with the other groundwater remedial alternatives, a groundwater monitoring program would be implemented to ensure that the containment systems were performing in the future. The envisioned system would consist of monitoring wells outside of the containment zone to detect breakthrough. The groundwater monitoring program is projected to last for 30 years.

- Overall Protection of Human Health and the Environment

  This alternative provides control of exposure to contaminated groundwater by preventing migration of groundwater from the site. This alternative will also provide a reduction in risk to human health by preventing exposure to the contaminated groundwater. This alternative would also contain groundwater contamination at the site. Minimal risks to workers and nearby residents would be realized during construction, mostly taking the form of potential generation of dust and possibly VOCs during the early construction activities. These risks could be easily managed by taking the appropriate dust suppression measurements and monitoring for VOCs during construction.

- Compliance with ARARs

This alternative would not meet the chemical-specific ARARs for benzene, lead, and benzo(a)pyrene or the proposed remediation goals developed in this FS. The ARARs and/or goals could be met in the future by containment of the groundwater on-site and continued removal of the groundwater from the unconsolidated fill. Essentially, the soil would be continually flushed by infiltration of rainfall followed by removal by pumping.

Although not ARARs, OSHA regulations related to excavations would apply during construction, specifically OSHA requirements relating to excavation sidewall shoring, marking and fencing. Also, during excavation and backfilling workers would be required to follow OSHA guidelines outlined in 40 CFR 1910.120 for field activities at hazardous waste sites.

On-site discharges of treated groundwater must meet substantive NPDES requirements. Off-site disposal of soils must comply with the "off-site" rule. If the excavated soils are not RCRA characteristic wastes, then RCRA requirements would be relevant and appropriate and the waste must be managed accordingly.

A chemical-specific and action-specific ARAR would be the management of fluids generated during construction and implementation of this remedial alternative. This would require coordination with the local POTW regarding the quantity of water that could be discharged and the treatment level (if any) that would be required prior to discharge to the POTW (groundwater discharges to the sanitary sewer must meet all applicable federal, state, and local discharge requirements). The treatment process for this alternative would result in treated water that would very likely meet the chemical-specific discharge requirements of the POTW.

An action-specific ARAR would be the management and disposal of any soils generated during construction as required under the RCRA regulations regarding classification of solid wastes. If soil remediation is selected, these soils could be disposed of as part of that operation. If no soil alternative is chosen, potential chemical-specific ARARs and action-specific ARARs would be the requirements of the local sanitary landfill for disposal of nonhazardous solid waste. Excavated soils that are not RCRA characteristic must be managed as relevant and appropriate with regard to RCRA. Off-site facility requirements are not ARARs. Off-site disposal must comply with the CERCLA off-site rule.

- Long-Term Effectiveness and Permanence

  The construction of a vertical groundwater barrier in the shallow unconsolidated deposits would be an effective alternative to prevent the migration of shallow groundwater at the site. Similarly, bedrock grouting would effectively seal fractures present within the upper 15 feet of bedrock, which are known to be stained and which could potentially leach contaminants over time. By sealing the fractures with grout, the contact with groundwater would be eliminated, effectively meeting the remediation goals.

  This alternative provides for controls to prevent human exposure and to prevent migration of groundwater off-site. This alternative provides treatment of the water extracted from the unconsolidated fill and containment of the fractured bedrock. The off-site monitoring would be effective at evaluating off-site groundwater conditions with regard to any changes in water quality. Also, the groundwater monitoring program would be designed in conjunction with the appropriate state agency to ensure communication of the conditions.

- Reduction of Toxicity, Mobility, and Volume

  This alternative would not reduce the toxicity of the benzene, lead, or PAHs in the groundwater. This alternative does reduce the mobility of the benzene, lead, and PAHs by containing the on-site groundwater. The volume of benzene, lead and PAHs in the unconsolidated fill zone groundwater would be reduced through extraction of groundwater and treatment prior to discharge. The treatment of the extracted groundwater would reduce the toxicity of the groundwater prior to discharge.

- Short-Term Effectiveness

  During construction of this alternative there is the potential for exposure to on-site construction workers, the environment and the community. The potential exposure would be from the fugitive dust emissions and possibly VOC emissions during the installation of the vertical barriers and during the drilling of the boreholes for the pressure grouting. There are also safety concerns for the on-site workers during the construction. After construction of the alternative, while the alternative is being implemented (operation of the groundwater pumping system), there would be minimal exposure or safety concerns for workers, the environment or the community.

- Implementability

  Both types of technologies are easily implemented at the site. The vertical groundwater barrier would only require installation to a shallow depth, approximately 8 feet below grade. This depth range is well within the range of previous successfully installed vertical groundwater barriers. Bedrock pressure grouting is an established practice within the construction industry, and a number of vendors should be available to successfully implement this alternative.

- Cost

  The basis of the estimated costs of constructing and implementing this alternative is shown in appendix E. The 30-year present worth cost of this alternative, including capital costs of $3,985,000 and an annual O&M and groundwater monitoring program cost of $133,700, is estimated to be $6,040,000 (see table 4-9).

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies

4.2.4 Alternative 4: Groundwater Pumping/Treatment/Discharge to Sanitary Sewer

This alternative consists of extracting groundwater from the unconsolidated fill/weathered bedrock zone and the top 15 feet of fractured bedrock zone beneath the unconsolidated fill/weathered bedrock. The groundwater would be treated by passing it through a groundwater treatment plant constructed on-site. The treated groundwater would then be discharged to the on-site sanitary sewer. This alternative is being considered within the general remedial response objective of treatment.

The groundwater withdrawal system would consist of pumping wells drilled to approximately the upper 15 feet in the fractured bedrock. Groundwater would be withdrawn from the fractured bedrock wells at a rate appropriate to develop a drawdown cone and eliminate the potential of groundwater migration off-site. The information presented in the RI and RIA reports prepared by

Montgomery Watson suggests that there is adequate hydrologic communication between the groundwater in the fractured bedrock and the groundwater in the overlying unconsolidated deposits. During a pumping test, withdrawal of groundwater from the shallow bedrock produced a measurable drawdown within the groundwater within the unconsolidated deposits. Therefore, pumping from the fractured bedrock should effectively control the groundwater in the unconsolidated fill zone as well as the groundwater in the fractured bedrock.

Lead and PAHs, however, are persistent compounds in the environment. Groundwater pumping systems typically remove very little of the total contaminant mass, even over long periods. The possibility exists that, even after an extended period of pumping (30 years), the concentrations of lead and PAHs would still not be reduced below the risk-based levels in the on-site groundwater.

The locations of the groundwater wells are shown on figures presented in appendix D. Supporting groundwater flow calculations, and predicted water level maps resulting from the implementation of this alternative are also detailed in appendix D.

The pumped groundwater would be passed through a water treatment system constructed on-site. As discussed in the technology screening (section 2.4), a multistage treatment process is being considered for this FS. Groundwater would be pumped into a separation tank, where separate-phase liquids (if present) would be removed from the water stream. The aqueous stream would then be passed through an inorganics treatment process to filter out suspended particulates, remove metals and condition the mineralized water that is expected, based on the RI results. The conditioned water would then be passed through an air stripper, where volatiles would be removed, followed by a secondary particulate removal stage and organophilic clay and carbon adsorption polishing step before discharge. The organophilic clay and carbon adsorption polishing would remove less-volatile organics, and possibly inorganics, from the water stream before discharge.

The addendum to the BRA identifies lead as a potential compound of concern in the groundwater. A review of the data indicates that dissolved lead concentrations in the groundwater are generally low, but that when total lead analyses were performed, the lead concentrations in groundwater increased. This indicates that the lead detected in the water samples is probably associated with suspended solids in the groundwater, which were analyzed in the total (unfiltered) groundwater samples. This lead would be easily removed from the groundwater stream through the filtration step.

Following treatment, the groundwater would be discharged to the sanitary sewer. This will require negotiations with the local POTW to establish the quantity and quality of discharge it will accept. It is possible that the degree of treatment envisioned in this alternative will not be required by the

POTW for waters that it will accept. However, for the purposes of conservative planning, it is assumed that the treatment will be conducted using the entire treatment train described.

For the purposes of this FS, it is assumed that this alternative would be implemented for a 30-year time period. Remediation systems consisting of groundwater pumping alone remove very little contaminant mass over time as compared to more aggressive source removal remediation systems, and this will establish a conservative estimate of the time frame of the operation of a groundwater pumping system. It is also assumed that a groundwater monitoring program would be conducted to evaluate the effectiveness of the groundwater extraction system.

- Overall Protection of Human Health and the Environment

  This alternative provides control of exposure to contaminated groundwater by preventing migration of groundwater from the site. This alternative will also provide a reduction in risk to human health by preventing exposure to the contaminated groundwater. This alternative would also treat the groundwater contamination at the site. Minimal risks to workers would be realized during construction, mostly taking the form of potential generation of dust and possibly VOCs during the drilling activities. These risks could be easily managed by taking the appropriate dust suppression measurements and monitoring for VOCs during construction. Since the drilling process itself results in small quantities of dust particulates, there is minimal risk to the nearby residents during installation of the groundwater pumping system.

- Compliance with ARARs

  This alternative may meet the chemical-specific ARARs for benzene, lead, and benzo(a)pyrene and the proposed remediation goals developed in this FS. However, lead and PAHs are persistent compounds in the environment and groundwater pumping systems typically remove very little of the total contaminant mass over long periods of time. It is possible that, after an extended period of pumping, the concentrations of these compounds would still not be reduced below action levels in the groundwater on-site.

  Although not ARARs, OSHA regulations related to excavations would apply, specifically OSHA requirements relating to excavation sidewall shoring, marking and fencing. Also, during excavation and backfilling workers would be required to follow OSHA guidelines outlined in 40 CFR 1910.120 for field activities at hazardous waste sites. Any off-site disposal of soils must comply with the "off-site rule." If the excavated soils are not RCRA characteristic wastes, then RCRA requirements are relevant and appropriate and the waste must be managed accordingly.

A chemical-specific and action-specific ARAR would be the management of fluids generated during construction and during implementation of this remedial alternative. This would require coordination with the local POTW regarding the quantity of water that could be discharged and the treatment level (if any) that would be required prior to discharge to the POTW. NPDES limits are chemical-specific ARARs that must be met for on-site discharges. The treatment process for this alternative would result in treated water that would very likely meet the chemical-specific discharge requirements of the POTW.

Action-specific ARARs would be the management and disposal of any soils generated during construction as required under the RCRA regulations regarding classification of solid wastes. Potential chemical-specific ARARs and action-specific ARARs would be the requirements of the local sanitary landfill for disposal of nonhazardous solid waste. Alternatively, these materials could be handled in conjunction with the soils alternative chosen, including capping.

- Long-Term Effectiveness and Permanence

Groundwater pumping is a well established technology, and the pumping system could easily be designed to prevent the migration of any groundwater off of the Mason City FMGP site. The groundwater treatment train envisioned uses common water treatment components that have an established record of reliability in the industry. Therefore, this should be an effective alternative to meet the remedial response objectives established for groundwater.

This alternative provides for controls to prevent human exposure and to prevent migration of groundwater off-site. This alternative provides treatment of the water extracted from the unconsolidated fill and fractured bedrock. The monitoring would be effective at evaluating groundwater conditions with regard to any changes in water quality.

- Reduction of Toxicity, Mobility, and Volume

This alternative would not reduce the toxicity of the benzene, lead, or PAHs in the groundwater. This alternative does reduce both the mobility and volume of the benzene, lead, and PAHs by containing and treating the on-site groundwater. The treatment of the extracted groundwater would reduce the toxicity of the groundwater prior to discharge.

- Short-Term Effectiveness

During construction for implementing this alternative, there is the potential for exposure to on-site construction workers. The potential exposure would be from the fugitive dust emissions and possibly VOC emissions during the installation of the extraction wells. There are also safety concerns for the on-site workers during the construction. There is very little potential for exposure to the environment and the community because the only construction consists of drilling activities. After construction of the alternative, while the alternative is being implemented (operation of the groundwater pumping system) there would be minimal exposure or safety concerns for workers, the environment or the community.

- Implementability

This alternative is easily implementable. The groundwater pumping and treatment systems envisioned consist of technologies and processes that are widely used in the remediation industry. Various vendors are available from which to procure equipment and/or services necessary to construct and operate the systems. Long-term operation and maintenance of the systems is envisioned, which must be taken into account during design and the selection of equipment for the system.

- Cost

The basis of the estimated costs of constructing and implementing this alternative is shown is appendix E. The 30-year present worth cost of this alternative including capital cost of $492,400 and an annual O&M and groundwater monitoring program cost of $209,300, is estimated to be $3,709,300 (see table 4-10).

- State Acceptance

State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.2.5 *Alternative 5: Fractured Bedrock Grouting/Shallow Groundwater Pumping*

The last groundwater alternative for detailed analysis would be a combination of the containment and treatment alternatives discussed previously in this section. The containment portion of the alternative would consist of fractured bedrock grouting. This technique is discussed in detail in section 4.2.3. The same interval (upper 15 feet) of the fractured bedrock would be grouted. The treatment portion of the alternative would consist of groundwater extraction from only the unconsolidated fill zone. This alternative is considered to evaluate the full range of potential response actions in groundwater.

Groundwater extraction in the unconsolidated fill zone would be accomplished through the installation of a trench. The use of individual extraction wells would likely be ineffective because there is very little saturated thickness in the unconsolidated fill zone (1–3 feet). There would be a limited potential to develop a cone of depression from individual wells installed in such material.

Groundwater withdrawal from a trench would probably be much more effective. The trench would be excavated to the top of the competent fractured bedrock. A french drain would be installed at the base of the trench, and would be appropriately sloped to approximately three sumps located along the length of the trench. The trench would be located along the northwest and western portions of the property, adjacent to Willow Creek and South Pennsylvania Avenue. The trench location is shown in appendix D.

It is estimated that the groundwater flow rate from the trench would be low, approximately 2 gpm. This is based on the available data regarding the natural groundwater flow conditions at the site under present circumstances. If this alternative were to be employed in conjunction with the capping alternative for soils, the flow rate would probably decrease due to the elimination of rainfall recharge to the property.

This alternative would treat groundwater withdrawn from the unconsolidated fill using the same treatment technology described in section 4.2.4. Discharge would be to the sanitary sewer. If this alternative is chosen for groundwater the criteria for groundwater treatment and discharge presented in 4.2.4 should be taken into account for final system design. This alternative will meet MCL treatment standards, assuming a 30-year cleanup time frame. However, the potential exists that a time frame greater than 30 years may be required. The cost estimate is based on a 30-year time frame.

- Overall Protection of Human Health and the Environment

  This alternative provides control of exposure to contaminated groundwater by preventing migration of groundwater from the site. This alternative will also provide a reduction in risk to human health by preventing exposure to the contaminated groundwater. This alternative would also treat the groundwater contamination at the site. Minimal risks to workers and nearby residents would be realized during construction, mostly taking the form of potential generation of dust and possibly VOCs during the early construction activities. These risks could be easily managed by taking the appropriate dust suppression measurements and monitoring for VOCs during construction.

- Compliance with ARARs

This alternative may meet the chemical-specific ARARs for benzene, lead, and benzo(a)pyrene and the proposed remediation goals developed in this FS. However, some of these compounds may persist in the environment for many years, potentially even longer than the 30-year time-frame used in this FS.

Although not ARARs, OSHA regulations related to excavations would apply, specifically OSHA requirements relating to excavation sidewall shoring, marking and fencing. Also, during excavation and backfilling workers would be required to follow OSHA guidelines outlined in 40 CFR 1910.120 for field activities at hazardous waste sites.

A chemical-specific and action-specific ARAR would be the management of fluids generated during construction and during implementation of this remedial alternative. This would require coordination with the local POTW regarding the quantity of water that could be discharged and the treatment level (if any) that would be required prior to discharge to the POTW. NPDES limits are chemical-specific ARARs that must be met for on-site discharges.

Action-specific ARARs would be the management and disposal of any soils generated during construction as required under the RCRA regulations regarding classification of solid wastes. Alternatively, the soils could be managed with the soils generated during a soil remedial action program. If no soil remedial action is selected, potential chemical-specific ARARs and action-specific ARARs would be the requirements of the local sanitary landfill for disposal of nonhazardous solid waste. Any off-site disposal of soils must comply with the "off-site rule." If the excavated soils are not RCRA characteristic wastes, then RCRA requirements are relevant and appropriate and the waste must be managed accordingly.

- Long-Term Effectiveness and Permanence

This alternative would be effective at achieving the remediation goals of eliminating contact of nearby residents to potentially contaminated groundwater. Bedrock grouting would effectively seal fractures present within the upper 15 feet of bedrock, which are known to be stained and which could potentially leach contaminants over time. By sealing the fractures with grout, the contact with groundwater would be eliminated, effectively meeting the remediation goals.

The maintenance of a extraction system in the unconsolidated fill at the property boundary will provide a barrier to potential future groundwater migration off-site. Therefore, this alternative could meet the remedial response objectives established for groundwater.

This alternative provides for controls to prevent human exposure and to prevent migration of groundwater off-site. This alternative provides treatment of the fractured bedrock and the water extracted from the unconsolidated fill. The monitoring would be effective at evaluating groundwater conditions with regard to any changes in water quality. Also, the groundwater monitoring program would be designed in conjunction with the state agency to ensure effectiveness.

- Reduction of Toxicity, Mobility, and Volume

This alternative would not reduce the toxicity of the benzene, lead, or PAHs in the groundwater. This alternative does reduce the mobility of the benzene, lead, and PAHs by containing the on-site groundwater. The volume of benzene, lead and PAHs in the unconsolidated fill zone groundwater would be reduced through extraction of groundwater and treatment prior to discharge. The treatment of the extracted groundwater would reduce the toxicity of the groundwater prior to discharge. However, because of the persistence of the COCs and because pumping systems generally remove very little total mass contaminants, this alternative may have very little effect on volume.

- Short-Term Effectiveness

During construction for implementing this alternative, there is the potential for exposure to on-site construction workers, the environment and the community. The potential exposure would be from the fugitive dust emissions and possibly VOC emissions during the installation of the vertical barriers and during the drilling of the boreholes for the pressure grouting. There are also safety concerns for the on-site workers during the construction. After construction of the alternative, while the alternative is being implemented (operation of the groundwater pumping system) there would be minimal exposure or safety concerns for workers, the environment or the community.

- Implementability

  This alternative would be feasible to implement at the site. The bedrock grouting portion of the alternative would be performed by contractors experienced in this type of work related to civil construction projects. The installation and maintenance of a shallow groundwater pumping trench is a common practice in the environmental field, and uses commonly accepted industry practices. The groundwater treatment and discharge portions of this alternative use widely available equipment and technologies that are commonly employed in the industry. Long-term operation and maintenance of the systems is envisioned, which must be taken into account during design and the selection of equipment for the system.

- Cost

  The basis of the estimated costs of constructing and implementing this alternative is shown is appendix E. The 30-year present worth cost of this alternative, including capital cost of $3,623,100 and an annual O&M and groundwater monitoring program cost of $153,300, is estimated to be $5,979,300 (see table 4-11).

- State Acceptance

  State acceptance of this alternative will be addressed after receipt of State comments to the EPA's proposed remedies.

- Community Acceptance

  Community acceptance of this alternative will be addressed during the public comment period after release of the EPA's proposed remedies.

4.3 Comparative Analysis of Soil Alternatives

In this section, the remedial alternatives developed for soils are evaluated against one another within seven of the nine detailed evaluation criteria. Evaluations are not performed relative to two of the nine criteria: State acceptance and community acceptance. As discussed previously, these two criteria will be evaluated after the State review of the FS (State acceptance), and after the public comment period regarding the selected remedy (community acceptance).

4.3.1 Overall Protection of Human Health and the Environment

The "no action" and the institutional control alternatives would provide the least measure of protection relative to this criterion. Neither would address the elimination of contamination. No action would afford no protection of residents to exposure to the soils. Institutional controls would restrict access, but there would be a potential for exposures to trespassers who ignore the fencing and signs.

Fugitive emissions from excavation activities can be controlled and should not pose a significant threat to human health and the environment.

Each of the remaining alternatives would achieve a greater degree of overall protection, since each attempts to restrict access to contaminated soils. Capping would readily achieve the response objectives, but would not destroy or eliminate contamination. Capping would not significantly reduce contaminant migration to groundwater.

Off-site thermal treatment would significantly reduce the concentration of the contaminants, provided that a test burn indicated acceptable destruction, and would be most protective of the site. However, this would result in fugitive emissions from excavation activities and emissions into the environment from the thermal treatment unit. In addition, there is some risk associated with transportation of the contaminated media to an off-site treatment unit.

Biological treatment would also destroy the contaminants in the soils; however, this would result in on-site emissions from the vapor extraction blower. These emissions must meet appropriate ARARs. *Ex situ* fixation would not destroy the contamination, but would attempt to render it immobile, which would offer a lesser degree of overall protection if the fixed product broke down in the future.

In considering the overall protection to human health and the environment afforded by the soil remediation alternatives, the effect of each alternative on the groundwater system should be evaluated. This not only can help determine which soil remedy to select, but also help guide in the selection of the appropriate groundwater remedy.

Implementation of the no action and institutional control alternatives would have no effect on the groundwater at the site. These actions would not address the soils that can be a source of contamination into the groundwater in the long-term.

Capping would prevent the infiltration of rainfall into the soils on-site, which will reduce the potential for transferring soil contamination into the groundwater. This should have a beneficial effect to the groundwater on-site in the long-term. Capping will not address the horizontal migration of groundwater into or off of the site.

The thermal treatment alternatives will remove the contaminated soils and effectively destroy the contamination. This would effectively eliminate the potential for leaching of organics into the soils, which should have a positive effect on the shallow groundwater.

Biological treatment and fixation would alter the shallow groundwater system on the site. Fixation would convert the now unconsolidated soils into a consolidated mass, making the site in effect a shallow "no-flow" groundwater zone. The biological treatment cell would be surrounded by impermeable membranes, which would also act to eliminate shallow groundwater flow from underneath the site.

Thermal treatment, biological treatment, and fixation alternatives would have a greater impact on reducing contaminant migration to groundwater than the capping alternative.

4.3.2 Compliance with ARARs

The "no action" and institutional control scenarios would invoke no action-specific ARARs. However, these scenarios would not address contaminated soils that are identified based on risk-based cleanup goals.

Capping would involve consideration of the least number of ARARs of the remaining alternatives. Capping would require no coordination with the POTW. No air emissions, either on-site or at the off-site thermal plant, would be involved. No off-site transportation or disposal of waste would be required. Lastly, the construction activities would involve the least amount of contaminated soil earthwork and excavation and would be the easiest to implement. Capping would meet the remedial response objective of preventing contact with contaminated soils.

Excavation and off-site thermal treatment would require compliance with ARARs relating to transportation of wastes, air emissions, water discharge to the POTW, and excavation construction requirements under OSHA. The compliance with air emission ARARs would vary for the thermal treatment options presented. Using a transportable treatment plant would require the issuance of a new permit, while the use of an existing facility (fixed treatment plant, power plant, cement plant) would require that these units remain in compliance with their existing permits. As such, any of the excavation and thermal treatment alternatives would have the most ARARs to be concerned with during implementation

Although OSHA regulations are not ARARs, OSHA regulations related to excavations must be complied with. Excavation and on-site biological treatment would invoke the same ARARs relating to discharge to the POTW as excavation and off-site thermal treatment. No air permit would be required for the soil vapor extraction alternative (on-site action); however, substantive requirements must be met. This alternative would have a lesser concern over off-site disposal of wastes, since a limited amount of unsuitable construction debris would have to be taken off-site during the operation.

Excavation and on-site fixation would invoke the same ARARs relating to OSHA, the POTW, and off-site disposal of unsuitable debris generated during excavation. However, this alternative would not require air permitting.

4.3.3 Long-Term Effectiveness and Permanence

No action and institutional controls would not remove or destroy soil contamination, and would provide minimal protection to potentially exposed populations from the to the soils on site. These alternatives would not satisfy the response objectives and would not pose a permanent remedy to the soil contamination on-site.

Capping would meet the remedial response objective of preventing potential contact with the soils on-site, but would not destroy the contamination. Long term maintenance would be required to ensure that the cap stayed in place in order for this to be an effective solution.

The thermal treatment alternatives would all effectively destroy the contamination on the soils, and as such would pose a permanent remedy. On-site biological treatment would also be a permanent remedy in that the contamination would effectively be destroyed by biological processes. Fixation would require testing to simulate the effectiveness of the treated soils to resist leaching over the long term. There would always be the potential, however, for the fixated soils mixture to break down over time.

4.3.4 Reduction of Toxicity, Mobility, and Volume

The "no action" and institutional control alternatives would not address the toxicity, mobility, or volume of contamination at the site. Capping would provide adequate reduction of the mobility of contamination, but would not address the toxicity or volume of contaminated soils.

Each of the thermal and biological treatment alternatives would reduce the volume of contaminants by destroying the organic constituents in the soils. These alternatives would also reduce the toxicity of the resultant cleaned soils by removing most of the organics. Of these alternatives, thermal destruction would probably be considered a more reliable destruction technique since it is performed on a flow-through process and can be more controlled and measured. Under each of these alternatives, mobility of contamination would not be an issue after the soils are treated. *Ex-situ* fixation would reduce mobility and toxicity, but would increase the volume of contaminated materials.

4.3.5 Short-Term Effectiveness

Because no remedial actions would be taken under the "no action" and the institutional control alternatives, these two alternatives have no short-term effectiveness concerns.

Of the remaining alternatives, capping poses the least threat to workers or the nearby public during construction. With capping, only a limited amount of earthwork would be performed on contaminated material, mostly relating to spreading of the waste pile. Once the preliminary earthwork and grading were done, the cap would be constructed by progressively layering clean material on the site to form the cap. As such, the majority of the operation would be conducted under "clean" conditions and would pose the least threat to local residents.

All of the remaining alternatives involve excavation and, therefore, would involve some potential for worker and/or residential exposure during construction. Of these, the least concerns to workers and residents would be from off-site thermal destruction since the materials would not be processed on-site (except for removal of concrete, brick, and other debris). The thermal destruction alternatives, however, would pose a potential hazard due to the transportation of the materials to the treatment facility.

Both biological treatment and stabilization would require the establishment of an aboveground flow-through treatment process, which would pose the most threat to workers and residents. Dust suppression would be important not only during construction but also during soil processing. Of these two, biological treatment would pose a greater degree of residential exposure concerns since this process would result in an air discharge during the operation of the treatment cell. Air emissions produced from biological treatment and stabilization must comply with applicable ARARs.

The construction period for all of the alternatives would be short, less than one full construction season. After this time, only the biological treatment alternative would require continued operation and monitoring, since under the remaining alternatives the treatment process would be completed during a one-time treatment event.

4.3.6 *Implementability*

Both "no action" and institutional control would have minimal implementability concerns. Institutional controls would require more administrative concerns than no action, since deed restrictions would have to be filed and maintained.

Of the remaining alternatives, capping would have the least implementability concerns. The activities performed would require the simplest construction techniques which could be provided by any number of vendors.

The remaining alternatives all require excavation, but this technology would be widely available in the industry and could be provided by any number of vendors. This technology should pose no unusual implementability concerns.

Of the thermal treatment alternatives, treatment in a power plant would pose the greatest implementability concerns. This is due to the fact that the soils have to be blended and processed to a very tight specification to allow for their burning in a power plant. In addition, there are relatively few power plants which have been modified with the appropriate equipment to allow for soil co-burning, which means there are few vendors available from which to procure the services. Using a fixed or transportable soil treatment plant, or using a cement plant, would pose less implementability concerns since there would be no minimal specifications on the incoming soils and these processes have a greater tolerance for material variability. In addition, under all of the thermal treatment alternatives the soils would have to be established as non-hazardous prior to their shipment, which poses an extra implementability concern compared with the on-site alternatives. If the soils are hazardous, all RCRA provisions must be complied with.

On-site biological treatment and on-site fixation would both entail the establishment of an on-site treatment process, which would be more difficult than the other processes.

4.3.7 *Cost*

Minimal costs would be associated with the no action or the institutional control scenarios. Institutional controls would require administrative efforts related to deed restrictions, but both alternatives would be far less costly than any other option considered.

The capping alternative would be the least costly to implement of the remaining alternatives. Due to the ease of construction and the minimal O&M required (landscaping and inspection), this alternative would meet the response objectives at a substantially lower cost than any of the remaining alternatives.

Of the treatment alternatives, off-site thermal destruction has the highest capital cost. However, this alternative has no O&M cost since the contamination would have been eliminated from the soils during the operation.

On-site biological treatment and *in situ* fixation have very similar capital costs, substantially less than the off-site thermal destruction alternative. The biological treatment alternative has O&M costs relating to the operation of the system during treatment and associated sampling, while the *in situ* fixation alternative has O&M costs similar to the capping alternative (inspections, landscaping).

Of these three treatment alternatives, the off-site thermal destruction alternative has the highest present worth cost. No O&M costs would be incurred, and the operation would be the simplest (and, therefore, the most predictable) to control. The only variable would relate to the total quantity of material treated.

The two on-site treatment options have a lesser present worth cost estimate than the off-site thermal alternative, however, both include long-term O&M. An increase in the quantity of material excavated would pose a lesser relative cost increase than would be realized through off-site thermal destruction, since the unit cost of processing material on-site decreases as a greater quantity of material is processed. The reliability of the cost estimates for these alternatives, however, would depend on the success of the treatment processes on the site-specific soils, which can only be estimated by pilot test burns prior to implementing the operation.

4.3.8 State Acceptance

Distinctions between the State acceptance of the different alternatives will be addressed after reviewing State comments.

4.3.9 Community Acceptance

Distinctions between the community acceptance of the different alternatives will be made after receiving public comments to the FS and/or public comments to the proposed selected remedy.

4.4 Comparative Analysis of Groundwater Alternatives

In this section, the remedial alternatives developed for groundwater are evaluated against one another within seven of the nine detailed evaluation criteria. Evaluations are not performed relative to two of the nine criteria: State acceptance and community acceptance. As discussed previously, these two criteria will be evaluated after the State review of the FS (State acceptance), and after the public comment period regarding the selected remedy (community acceptance).

4.4.1 Overall Protection of Human Health and the Environment

The "no action" and the institutional control alternatives would provide the least measure of protection relative to this criteria. Neither would address the elimination of contamination. No action would afford no protection of residents to exposure to the groundwater. Institutional controls would restrict off-site groundwater withdrawal but there would be a potential for exposure to any off-site resident ignored the well restriction.

The remaining alternatives would all achieve a greater degree of overall protection, since all restrict groundwater flow at the site. Groundwater pumping (Alternative 4) may eventually achieve the response objectives, but would not readily eliminate saturated zone sources of groundwater contamination. Shallow groundwater pumping with fractured bedrock grouting (Alternative 5) would be more protective of human health and the environment because any contamination in the fractured bedrock is treated by rendering it immobile with grout, leaving only contamination in the saturated portion of the unconsolidated fill. Fractured bedrock grouting/unconsolidated fill vertical barrier/groundwater pumping (Alternative 3) would be somewhat more protective than Alternative 5 since permanent vertical barriers would be placed around the unconsolidated fill at the site.

4.4.2 Compliance with ARARs

The "no action" and institutional control scenarios would invoke no action-specific ARARs. However, these scenarios would not address contaminated groundwater, which is identified as a potential future risk to human health.

The remaining alternatives would have the same ARARs with regard to the disposal of fluids generated during construction, disposal of treated water, management and disposal of solid wastes. In addition, OSHA requirements regarding trained field personnel, although not ARARs, must be complied with. Alternatives 3 and 5 would invoke the same ARARs relating to possible permitting of emissions during excavation. Alternatives 4 and 5 would have air permitting requirements for emissions from the stripper. Alternatives 4 and 5 would meet chemical-specific ARARs and remediation goals for the treated water discharged to the POTW.

4.4.3 Reduction of Toxicity, Mobility, and Volume

The "no action" and institutional control alternatives would not address the toxicity, mobility, or volume of groundwater contamination at the site. Mobility would be reduced with Alternatives 3, 4, and 5. The toxicity of the contaminants would be reduced with alternatives 3 and 5 during treatment of the extracted groundwater prior to discharge.

4.4.4 Short-Term Effectiveness

Since no remedial actions would be taken under the "no action" and the institutional control alternatives, these two alternatives have no short-term effectiveness concerns.

Of the remaining alternatives, alternative 4 poses the least threat to workers or the nearby public during construction. Only a limited amount of construction in the form of drilling is required. As such, the majority of the operation would be conducted under "clean" conditions and would pose the least threat to local residents.

Alternatives 3 and 5 involve some type of excavation and, therefore, would involve some potential for worker and/or residential exposure during construction. The construction period for all of the alternatives would be relatively short (less than one full construction season).

4.4.5 Long-Term Effectiveness and Permanence

The "no action" alternative would not meet the requirement of long-term effectiveness and permanence for a groundwater alternative. The institutional controls alternative, which includes monitoring, would have long-term effectiveness with regard to the groundwater. Deed restrictions would prevent the use of groundwater on and in the vicinity of the site. Monitoring would be effective in assessing the condition of the groundwater at specified locations near the site as to whether compounds detected on-site are migrating off-site. This alternative would also be effective on a long-term basis because deed restrictions and groundwater monitoring are simple to maintain without the need for mechanical components that may need to be replaced.

The remaining three alternatives would also provide long-term effectiveness by preventing movement of groundwater that is at the site to off-site locations. Some degree of permanence would be achieved through the withdrawal of the contaminated groundwater. The total mass removed would be minimal because of the projected flow rates and the inherent affinity for PAHs to sorb to a solid matrix rather than dissolve in groundwater.

The controls for Alternative 4 would be the simplest to maintain to ensure that hydraulic control is maintained. Alternatives 3 and 5 would require more extensive maintenance and monitoring to ensure that the grouting of the fractured bedrock does not lose structural integrity. Alternative 5 would require the most maintenance and monitoring because of the two different structural components — the grouting of the fractured bedrock, and the installation of the vertical barriers in the unconsolidated fill.

4.4.6 *Implementability*

Both "no action" and institutional controls would have minimal implementability concerns. Institutional controls would require more administrative concerns than no action, since deed restrictions would have to be filed and maintained.

Of the remaining alternatives, alternative 4 would have the least implementability concerns. The activities performed would require the simplest construction techniques which could be provided by a large number of vendors. The remaining alternatives all require excavation, but this technology is widely available in the industry and could be provided by any number of vendors. This technology should pose no unusual implementability concerns.

Alternatives 3 and 5 have greater degrees of implementability concerns than alternative 4 because multiple technologies are involved with constructing the alternatives. These two alternatives would have longer time frames to implement with more greater potential for construction problems. The treatment technologies for alternatives 4 and 5 are more complex which means longer time frames for implementation and more O&M than alternative 3.

4.4.7 *Cost*

Minimal costs would be associated with the "no action" or the institutional control scenarios. Institutional controls would require administrative effort related to deed restrictions, but both alternatives would be far less costly than any other option considered.

Fractured bedrock grouting/unconsolidated fill vertical barrier/groundwater pumping and fractured bedrock grouting/groundwater pumping are the most expensive alternatives at $6,040,000 and $5,979,300, respectively. The alternative for groundwater pumping/treatment/discharge is estimated at $3,709,300. These costs reflect total present worth and include monitoring and operations costs for thirty years.

The groundwater monitoring alternative involves simply monitoring groundwater conditions for thirty years and is proposed to be combined with the institutional controls alternative for groundwater. It includes quarterly sampling of the five off-site monitoring wells.

4.4.8 *State Acceptance*

Distinctions between the State acceptance of the different alternatives will be addressed after reviewing State comments.

4.4.9 *Community Acceptance*

Distinctions between the community acceptance of the different alternatives will be made after receiving public comments to the FS and/or public comments to the proposed selected remedy.

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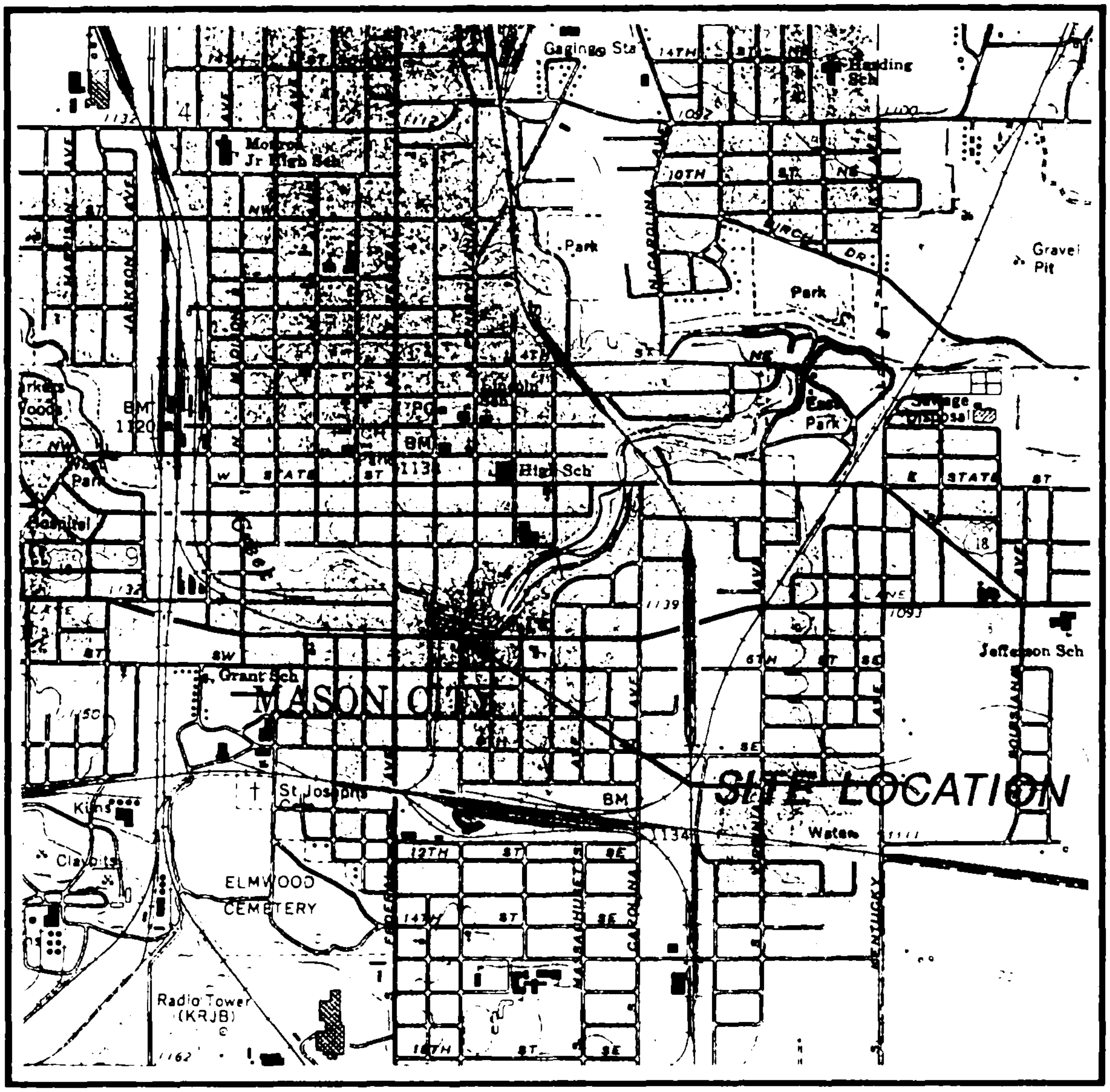

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SEC.10, T.96N., R.20W.

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SCALE FEET

GROUNDWATER TECHNOLOGY

443 N. MAIZE Rd.
WICHITA, KANSAS 67212
(316) 721-2266

DESIGNED:

DETAILED: MCH

CHECKED:

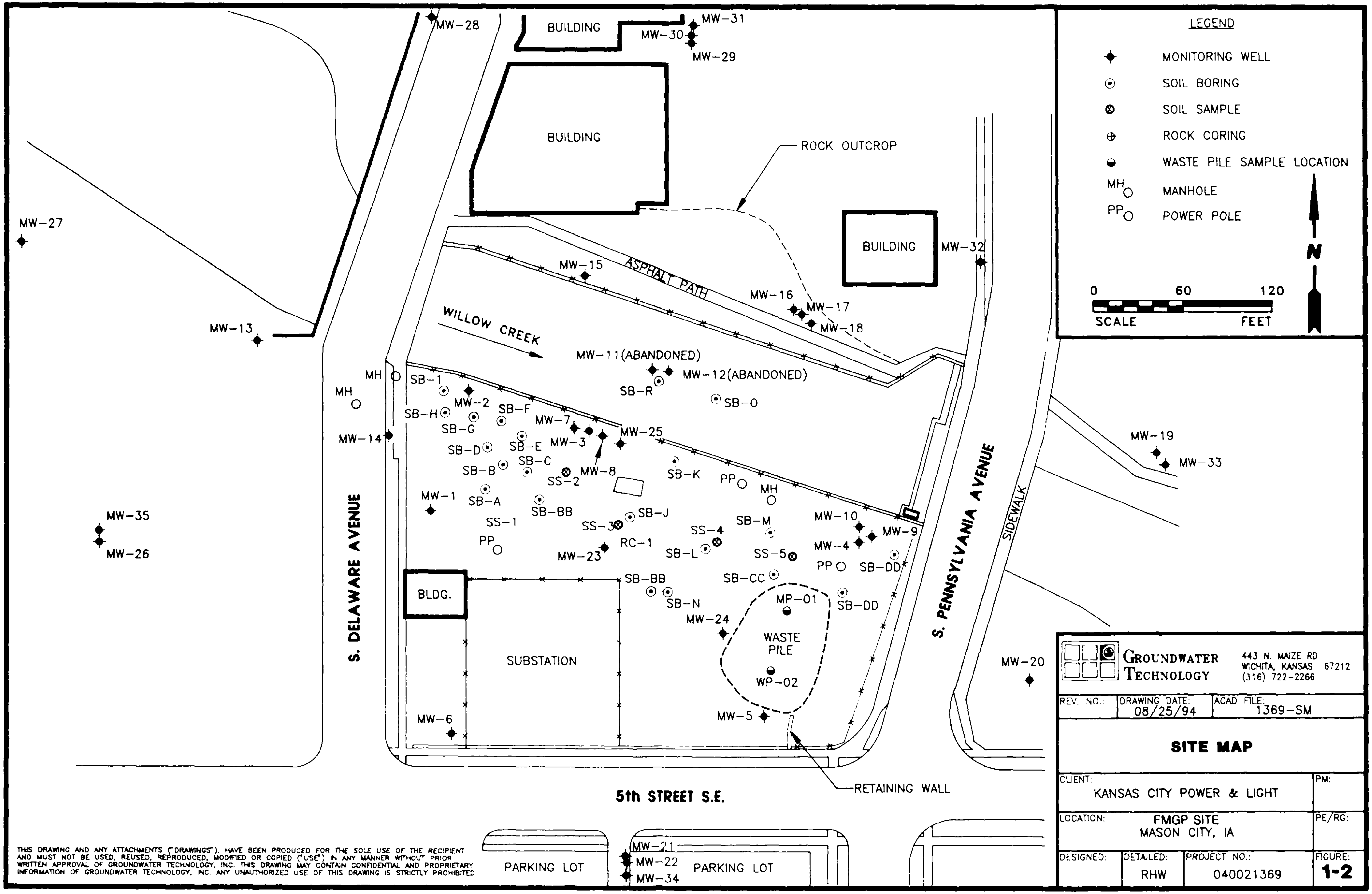
SITE LOCATION MAP

CLIENT: KANSAS CITY POWER & LIGHT

DRAWING DATE: 09/02/94

LOCATION: MASON CITY FMGP SITE

FIGURE: **1-1**



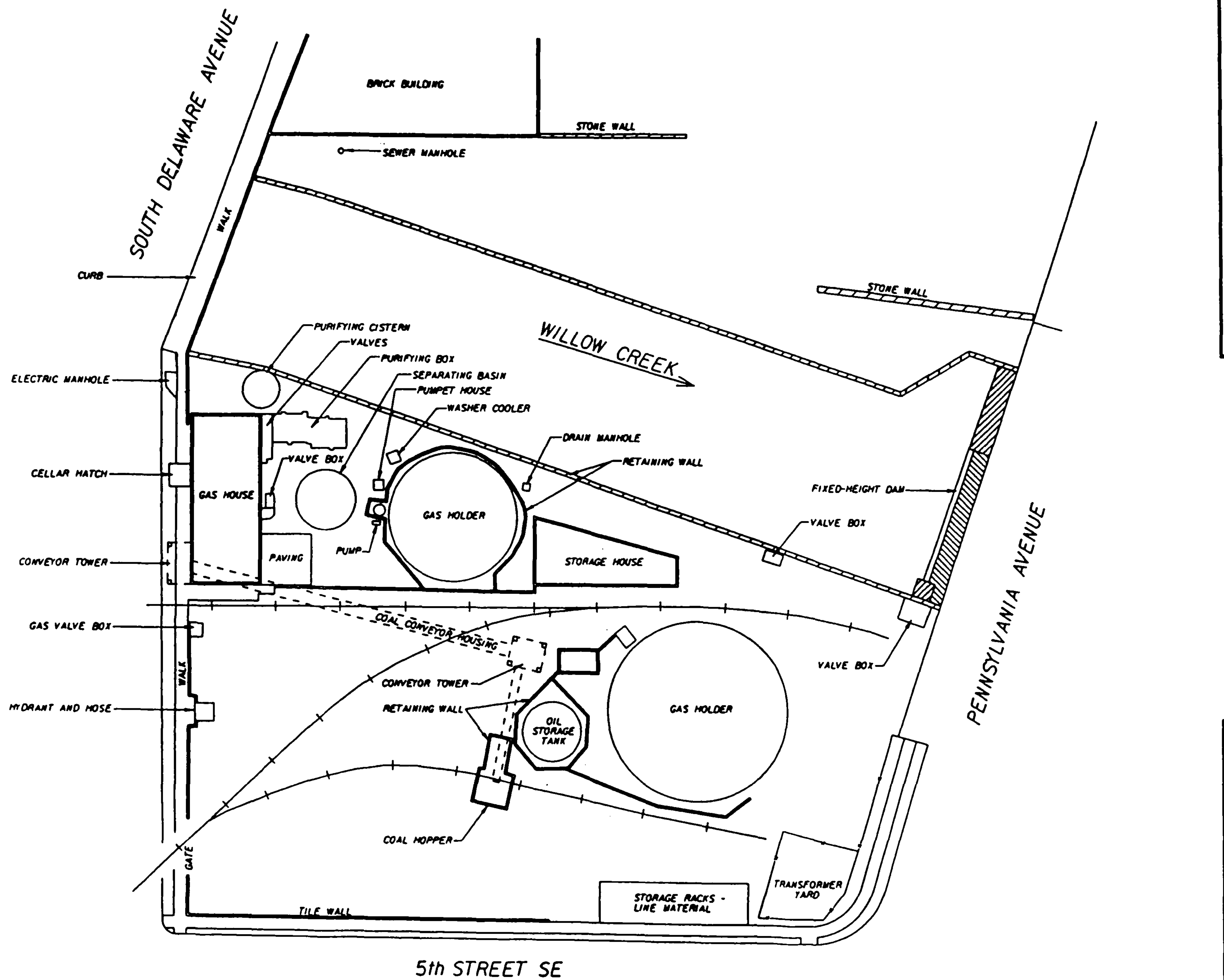
GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
WICHITA, KANSAS 67212
(316) 722-2266

REV. NO.:	DRAWING DATE: 08/25/94	ACAD FILE: 1369-SM

SITE MAP

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: FMGP SITE MASON CITY, IA	PE/RG:

DESIGNED:	DETAILED: RHW	PROJECT NO.: 040021369	FIGURE: 1-2



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NOTE: - CIRCA 1938

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SCALE FEET

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SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

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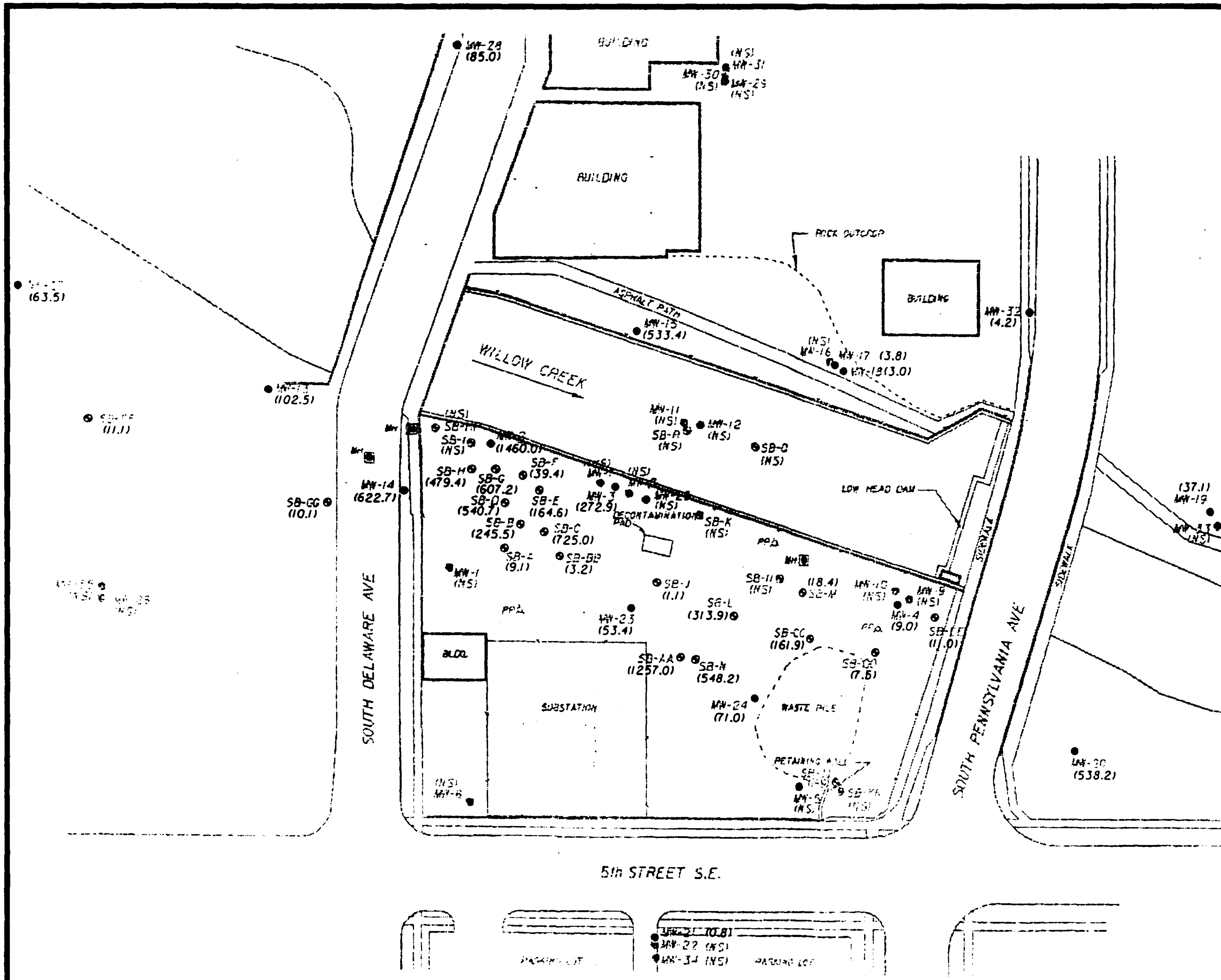
(316) 722-2266

REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-3

POTENTIAL SOURCE AREA (FORMER SITE PLAN)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED:	PROJECT NO.:	FIGURE:
	MCH	040021369	1-3



LEGEND

- ● MONITORING WELL
- ⊗ SOIL BORING
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (70.9) CONCENTRATION OF TOTAL PAHS (mg/kg)

N

NOT TO SCALE

NOTES:

1. MAXIMUM CONCENTRATION SHOWN AT EACH LOCATION
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.1 mg/kg
4. DATA COMPILED FROM ALL PHASES OF REMEDIAL INVESTIGATION

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

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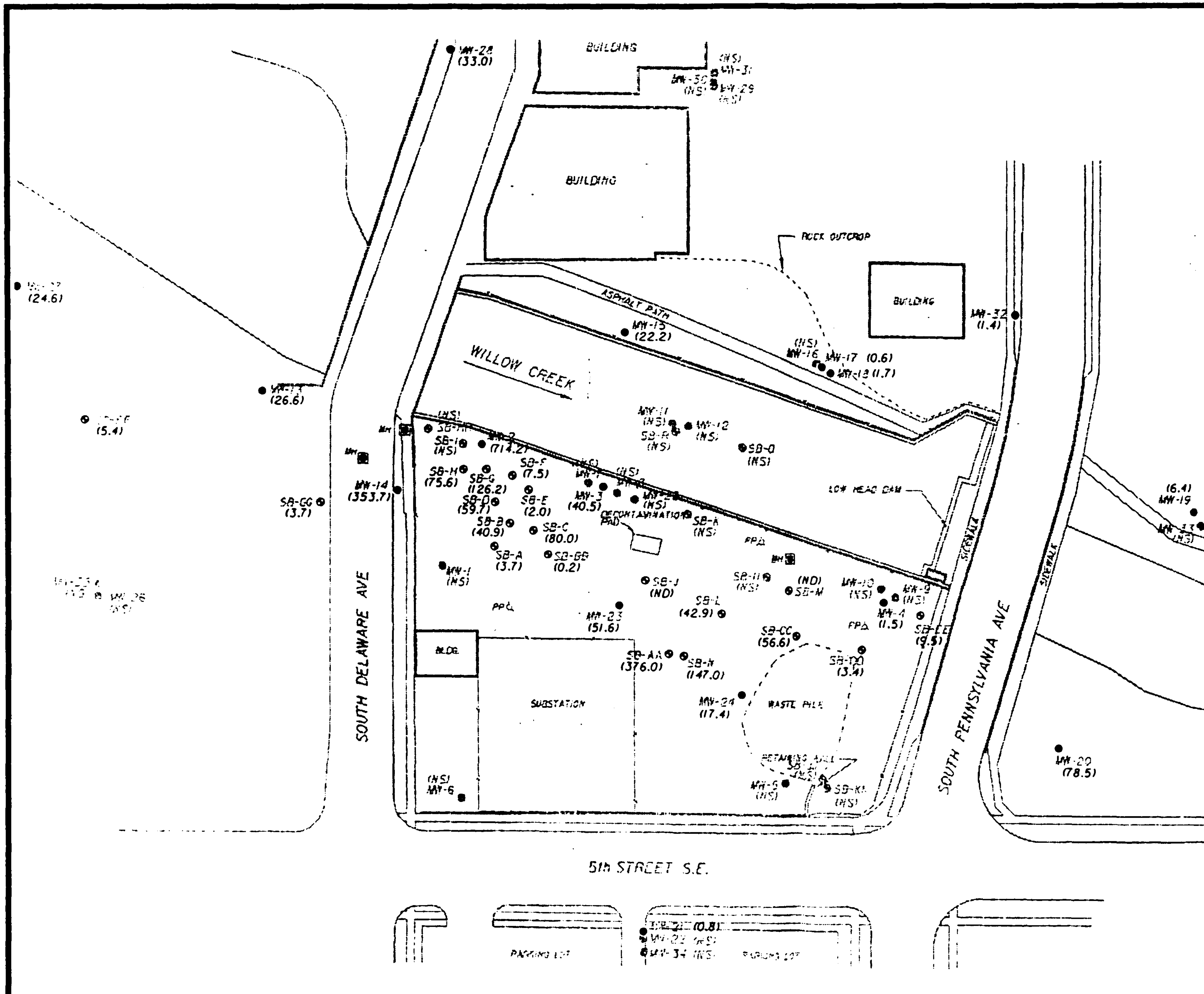
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-4

TOTAL PAHs IN SOIL

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-4



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

- ● MONITORING WELL
- ⊛ SOIL BORING
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (70.9) CONCENTRATION OF TOTAL CARCINOGENIC PAHs (mg/kg)

N

NOT TO SCALE

NOTES:

1. MAXIMUM CONCENTRATION SHOWN AT EACH LOCATION
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.1 mg/kg
4. DATA COMPLIED FROM ALL PHASES OF REMEDIAL INVESTIGATION

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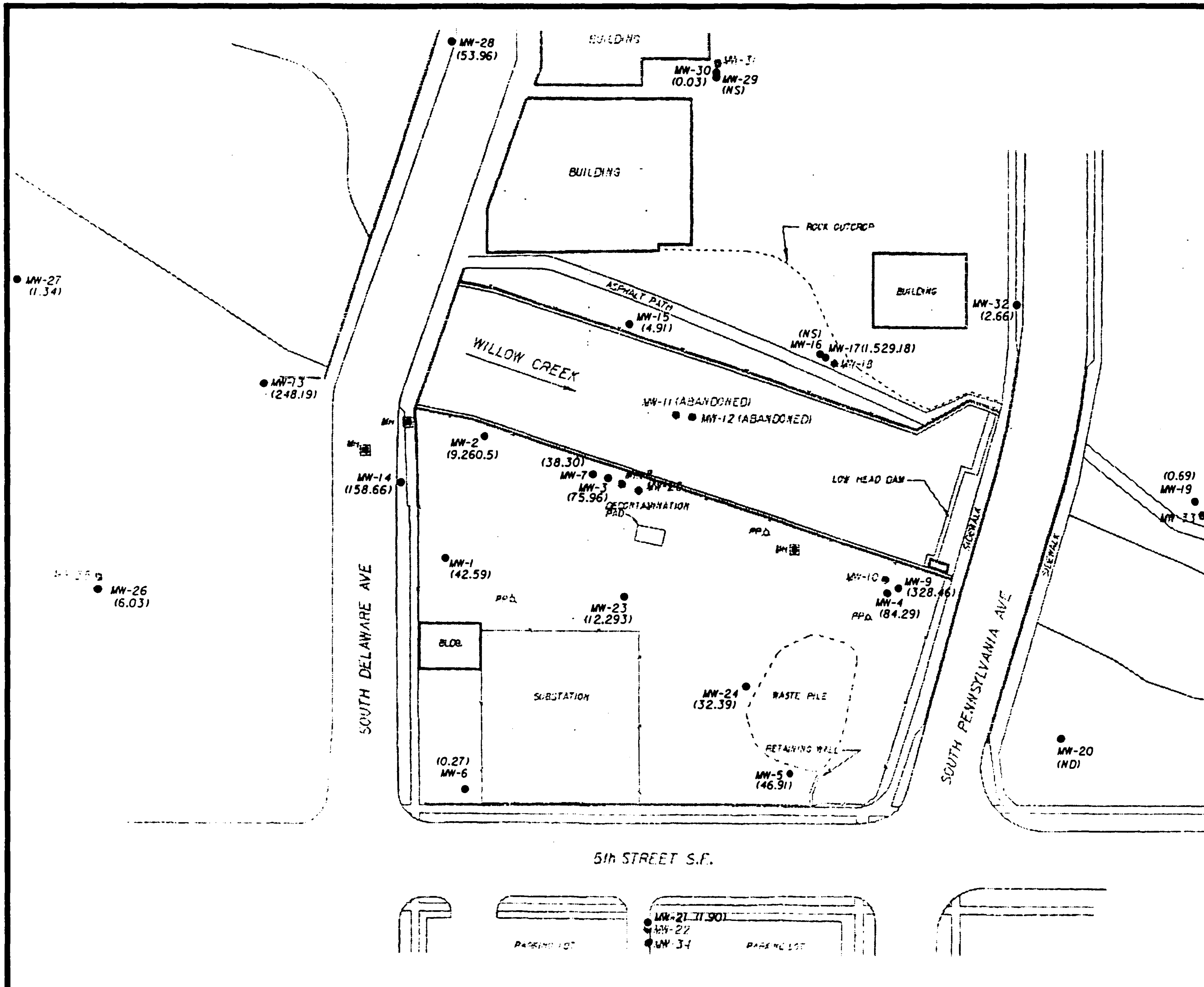
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-5

TOTAL CARCINOGENIC PAHs IN SOIL

CLIENT: KANSAS CITY POWER & LIGHT			PM:
LOCATION: MASON CITY FMGP SITE			PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: **1-5**



LEGEND

- ● MONITORING WELL
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (0.27) CONCENTRATION OF TOTAL PAHs (µg/L)

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.01 µg/L

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

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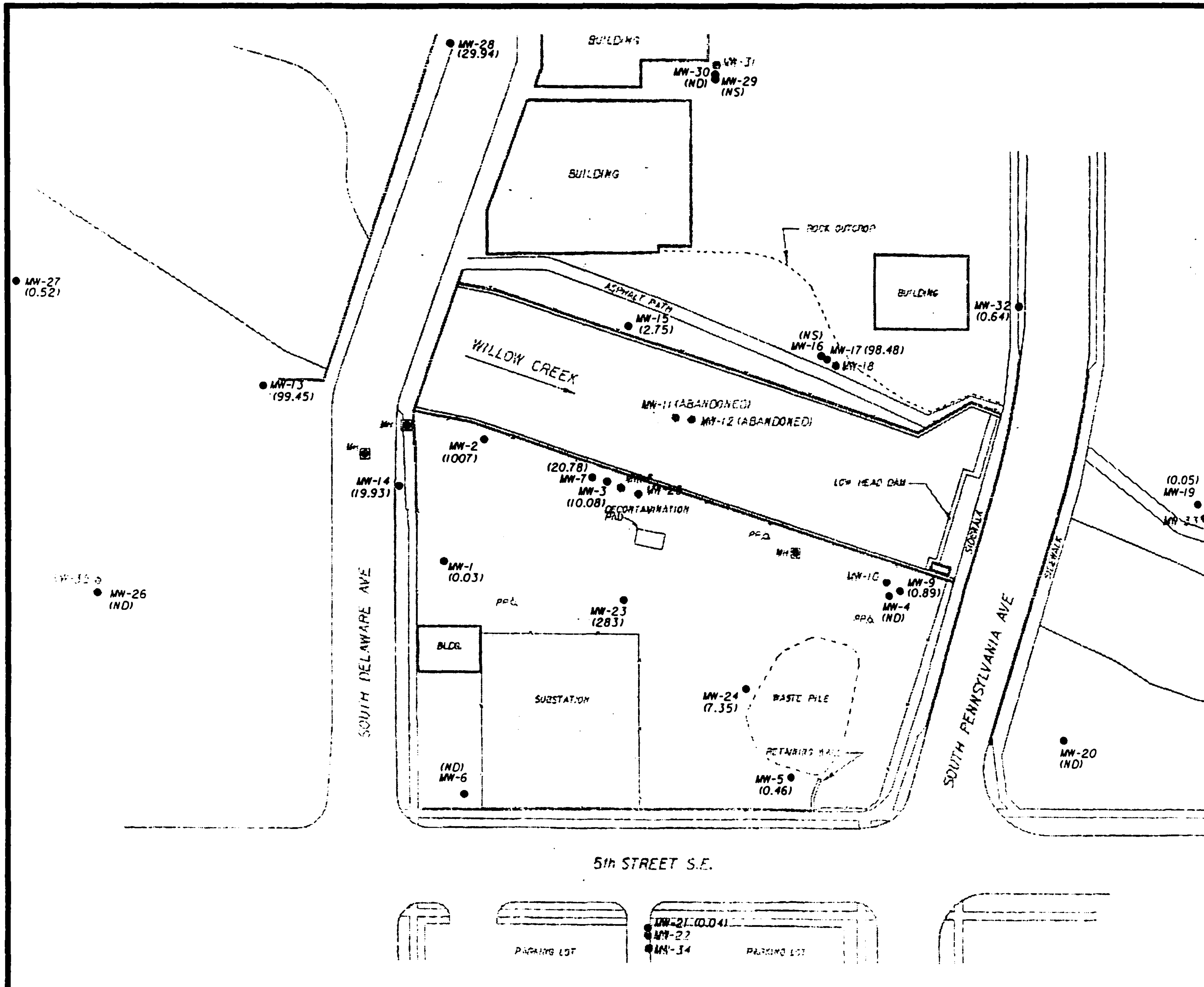
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-6

TOTAL PAHs IN GROUNDWATER (SHALLOW AQUIFER)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED:	PROJECT NO.:	FIGURE:
	MCH	040021369	1-6



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

- ● MONITORING WELL
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (0.46) CONCENTRATION OF TOTAL CARCINOGENIC PAHs (µg/L)

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.01 µg/L

GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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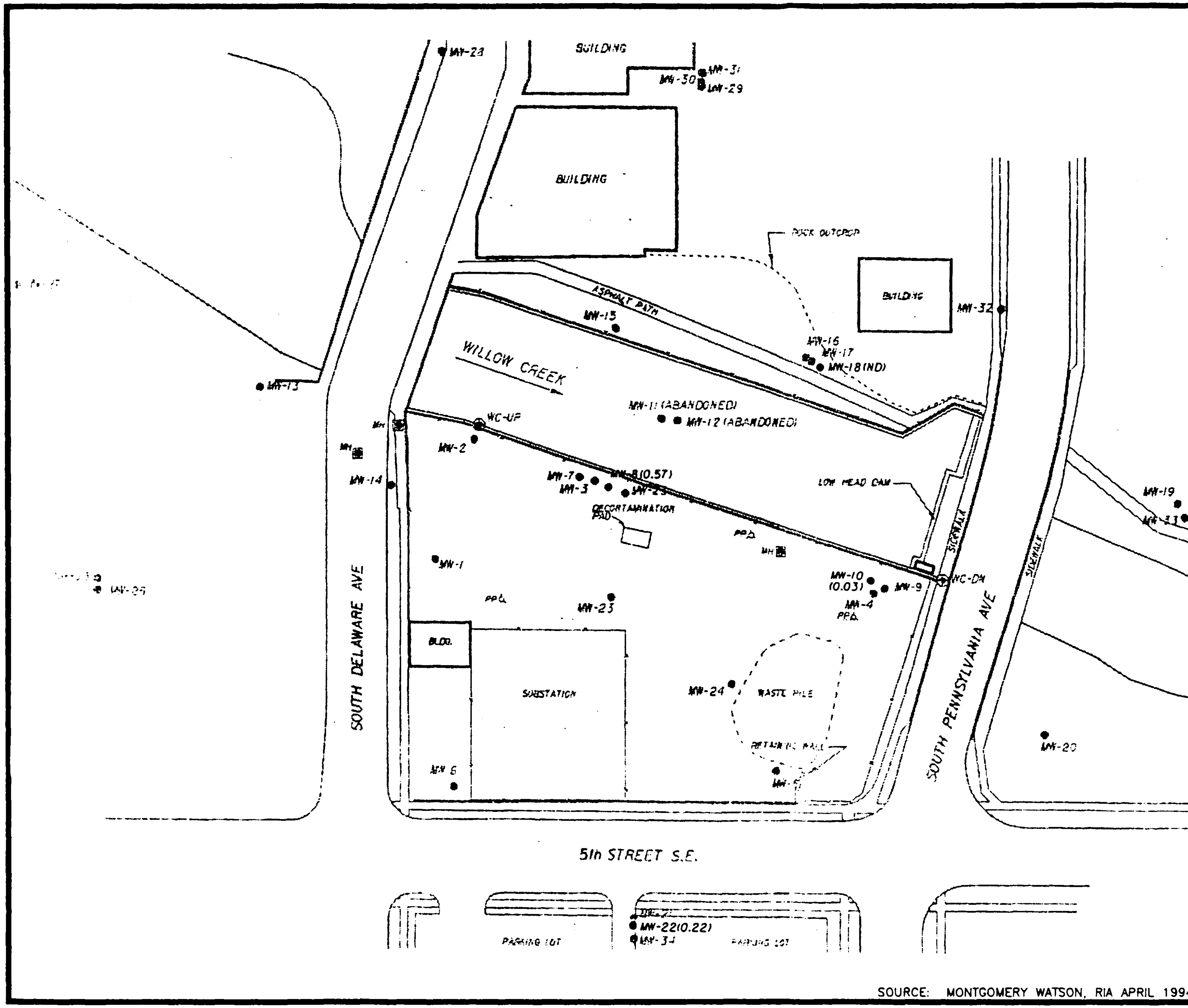
(316) 722-2266

REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-7

TOTAL CARCINOGENIC PAHs IN GROUNDWATER (SHALLOW AQUIFER)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED:	PROJECT NO.:	FIGURE:
	MCH	040021369	1-7



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

- ● MONITORING WELL
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (0.27) CONCENTRATION OF TOTAL PAHs (μg/L)

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.01 μg/L

GROUNDWATER TECHNOLOGY
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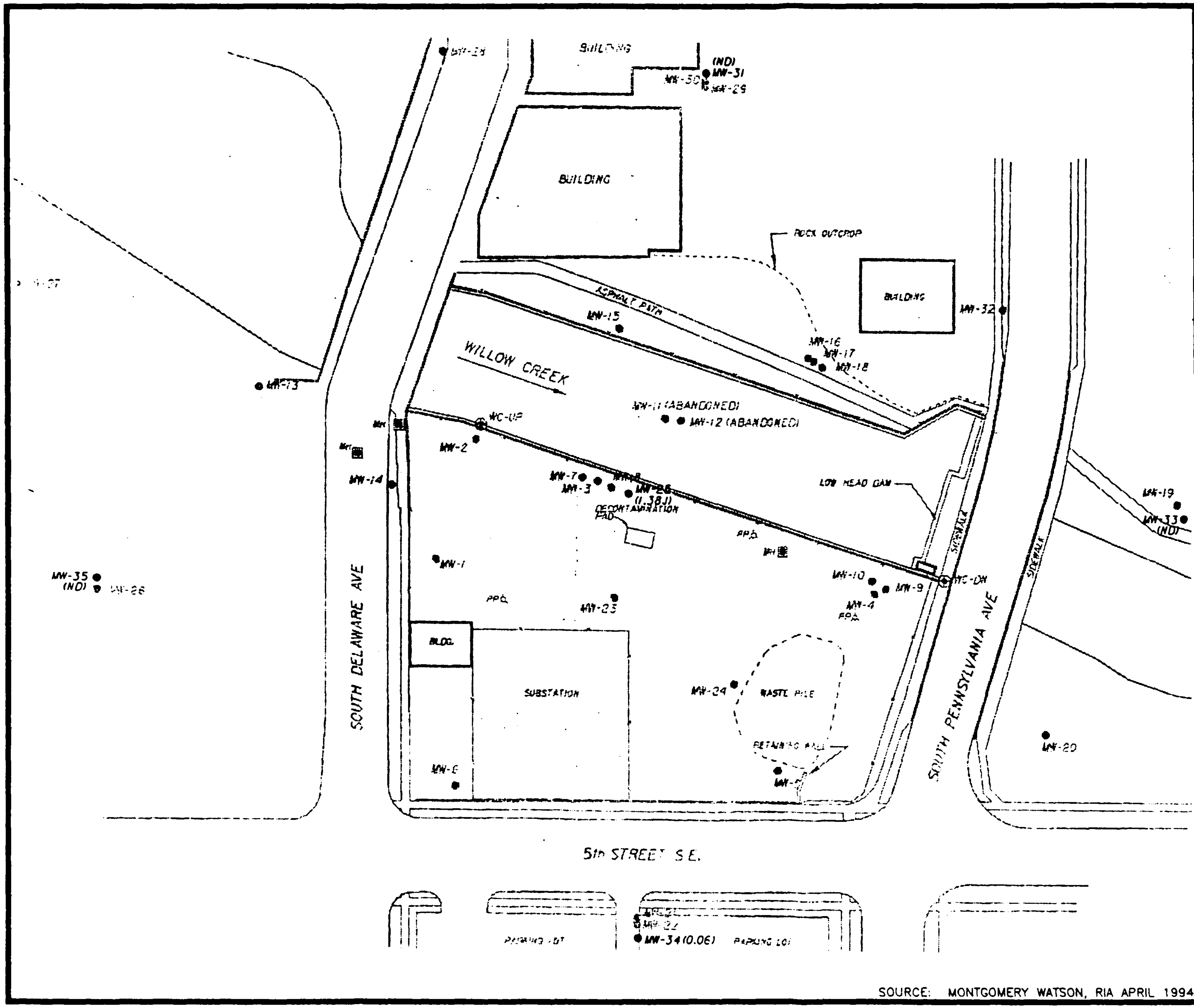
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-8

TOTAL PAHs IN GROUNDWATER (INTERMEDIATE ZONE)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-8



LEGEND

- ● MONITORING WELL
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (0.27) CONCENTRATION OF TOTAL PAHs (μg/L)
- J ESTIMATED VALUE

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.01 μg/L

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

GROUNDWATER TECHNOLOGY
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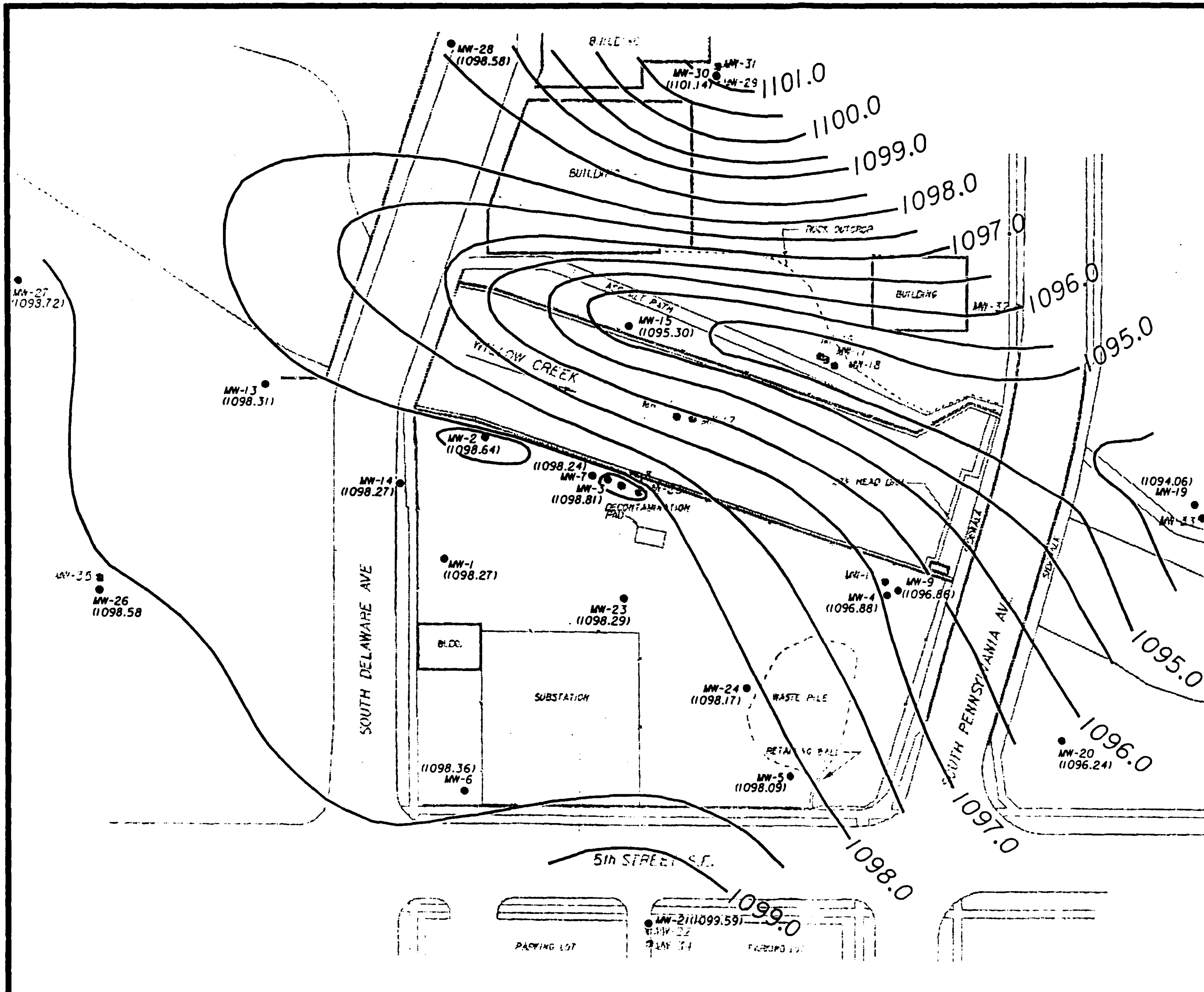
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-9

TOTAL PAHs IN GROUNDWATER (FIRST TRANSMISSIVE ZONE)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-9



LEGEND

● MONITORING WELL

(1098.70) WATER SURFACE ELEVATION IN FEET ABOVE NGVD

N

NOT TO SCALE

NOTES:

1. WILLOW CREEK DAM IN DOWN POSITION
2. WATER LEVEL ELEVATION IS POSTED NEXT TO WELL ID
3. ELEVATIONS IN FEET NGVD
4. CONTOUR INTERVAL = 0.5 FT.

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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(316) 722-2266

REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-10

SHALLOW AQUIFER POTENTIOMETRIC SURFACE (DECEMBER 13, 1994)

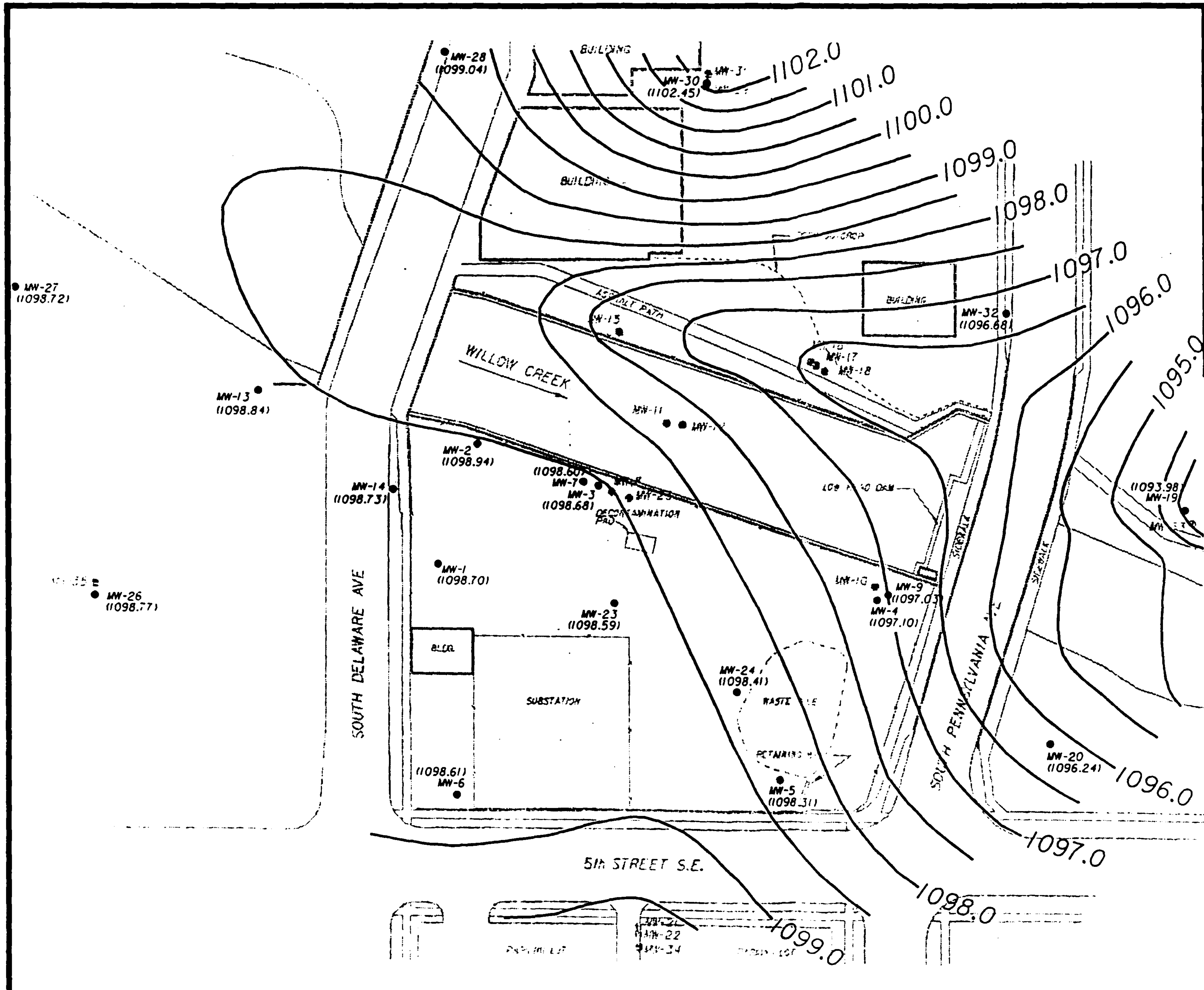
CLIENT: KANSAS CITY POWER & LIGHT

PM:

LOCATION: MASON CITY FMGP SITE

PE/RG:

DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-10



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

● MONITORING WELL

(1098.70) WATER SURFACE ELEVATION IN FEET ABOVE NGVD

N

NOT TO SCALE

NOTES:

1. WILLOW CREEK DAM IN DOWN POSITION
2. WATER LEVEL ELEVATION IS POSTED NEXT TO WELL ID
3. ELEVATIONS IN FEET NGVD
4. CONTOUR INTERVAL = 0.5 FT.

GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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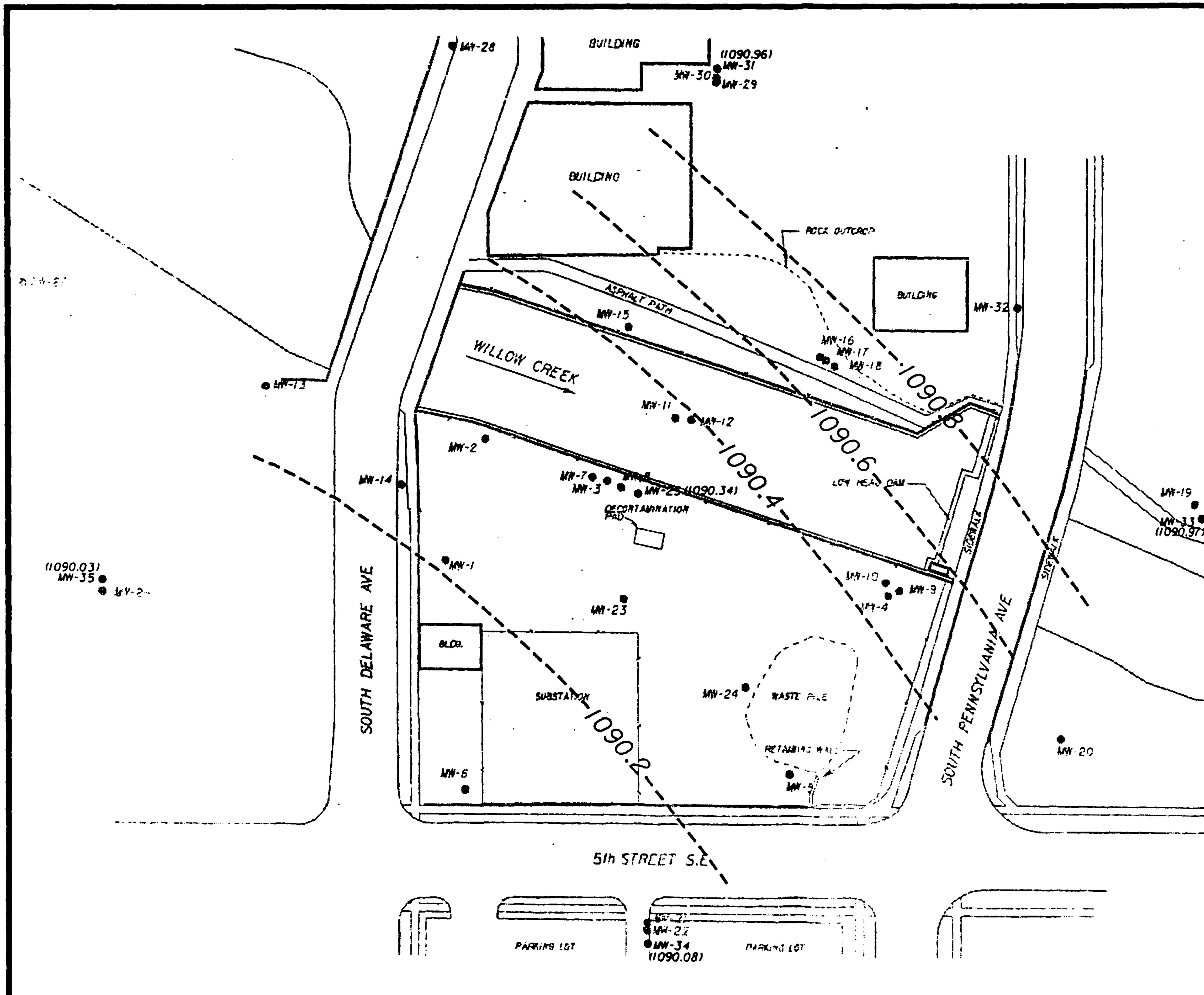
(316) 722-2266

REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-11

SHALLOW AQUIFER POTENTIOMETRIC SURFACE (FEBRUARY 28, 1994)

CLIENT: KANSAS CITY POWER & LIGHT		PM:
LOCATION: MASON CITY FMGP SITE		PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-11



LEGEND

● MONITORING WELL

NOT TO SCALE

N

NOTES:

1. DAM IN DOWN POSITION
2. WATER LEVEL ELEVATION POSTED NEXT TO WELL ID.
3. CONTOUR INTERVAL = 0.2 FT.
4. ELEVATIONS IN FEET NGVD

GROUNDWATER TECHNOLOGY

443 N. MAIZE RD
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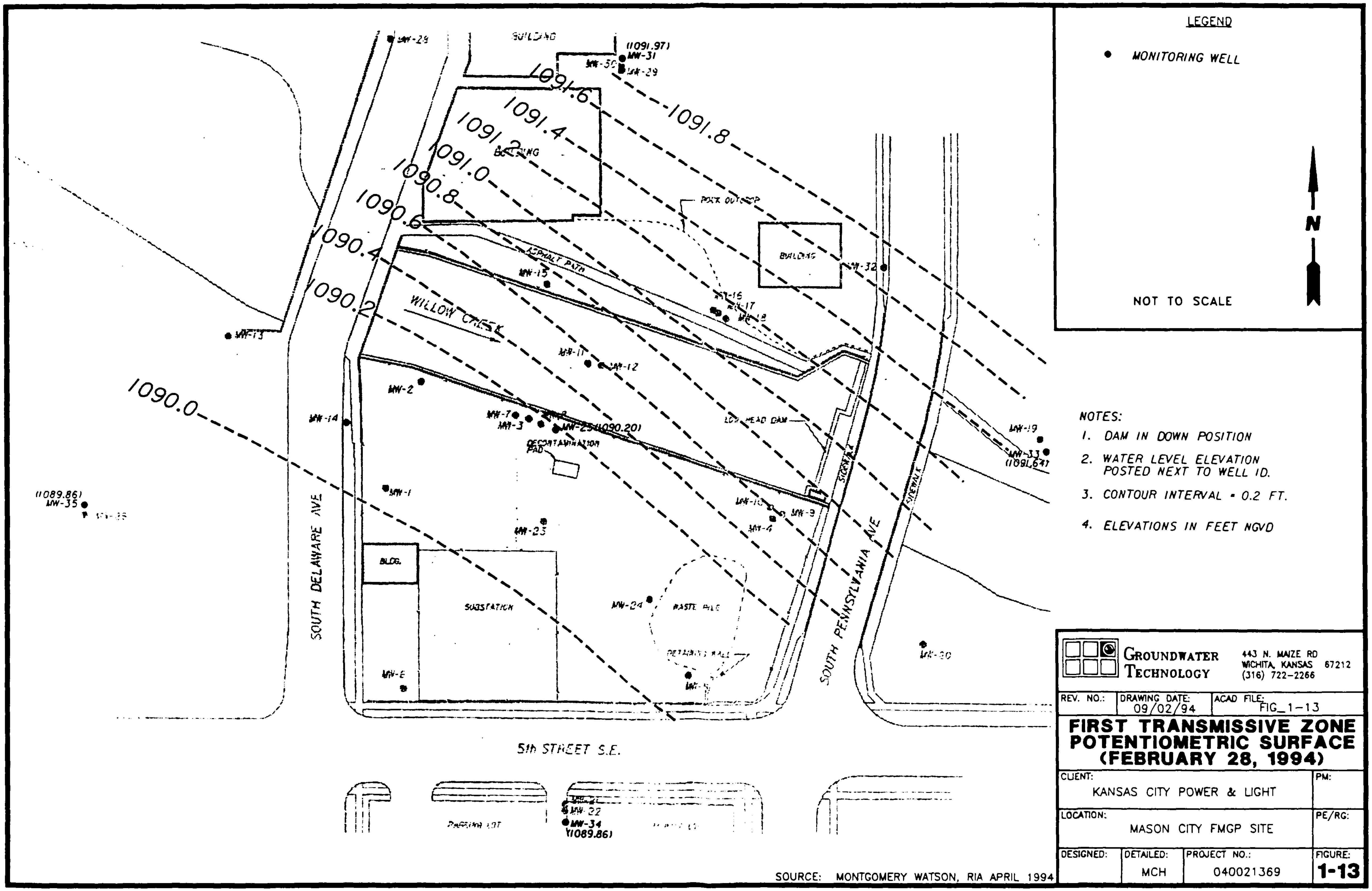
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-12

FIRST TRANSMISSIVE ZONE POTENTIOMETRIC SURFACE (DECEMBER 13, 1993)

CLIENT: KANSAS CITY POWER & LIGHT			PM:
LOCATION: MASON CITY FMGP SITE			PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-12

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994



GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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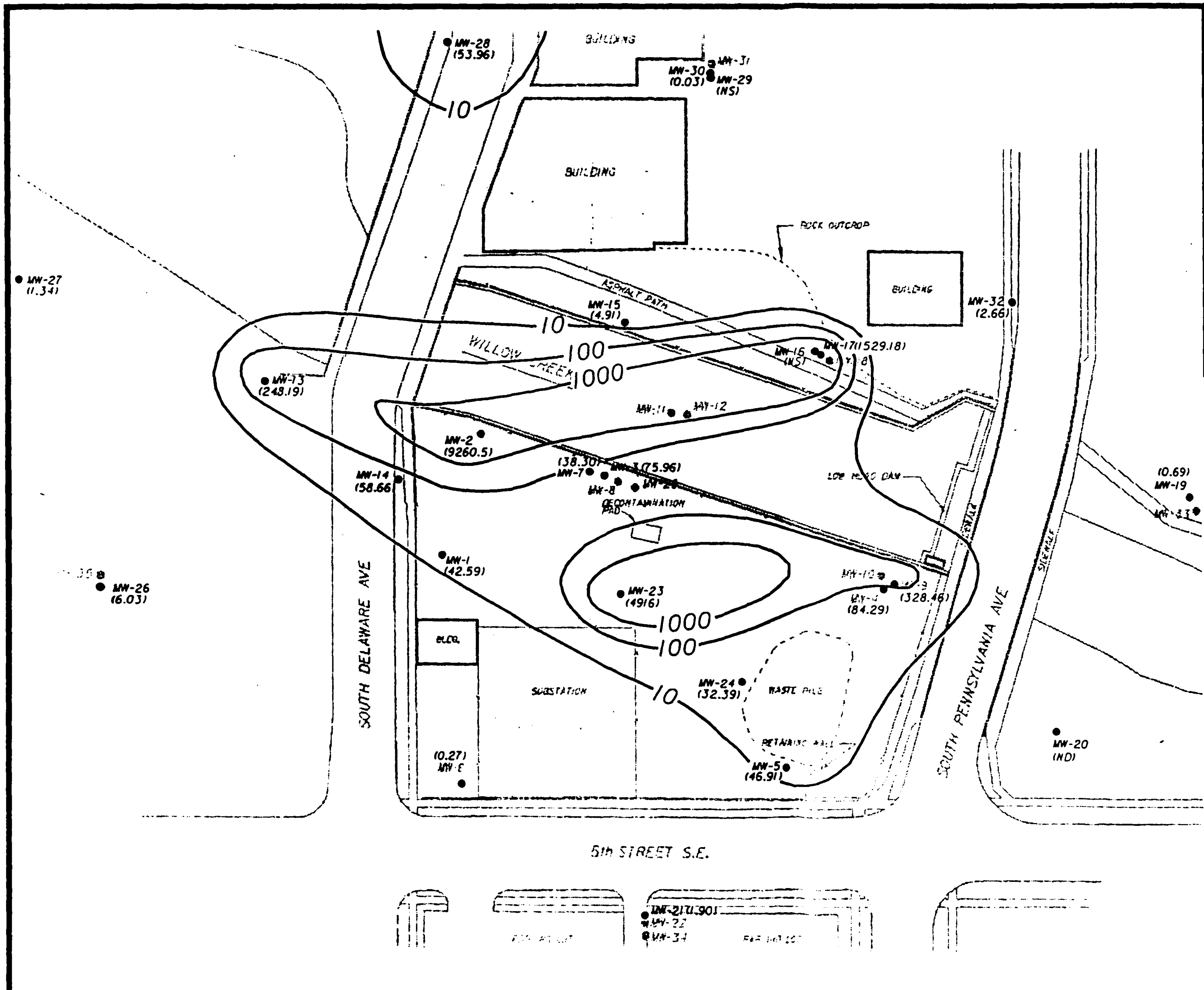
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-13

FIRST TRANSMISSIVE ZONE POTENTIOMETRIC SURFACE (FEBRUARY 28, 1994)

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: MASON CITY FMGP SITE	PE/RG:

DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-13



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

● MONITORING WELL

(ND) NONE DETECTED

(NS) NO SAMPLE COLLECTED

(2.66) CONCENTRATION OF TOTAL PAHs (μg/L)

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. CONTOUR INTERVAL VARIES LOGARITHMICALLY
3. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
4. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.01 μg/L

GROUNDWATER TECHNOLOGY
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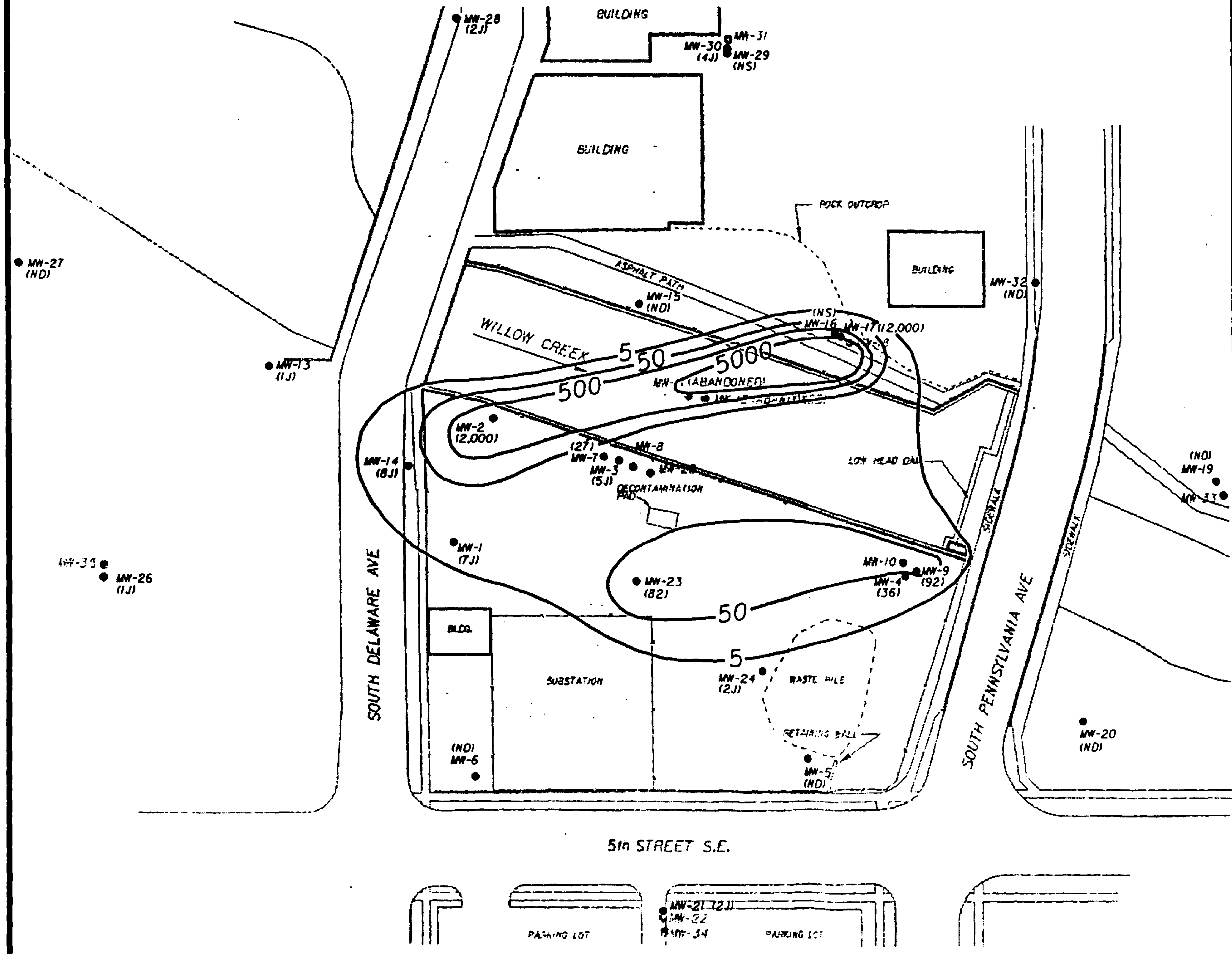
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-14

TOTAL PAH CONCENTRATION CONTOURS (SHALLOW AQUIFER)

CLIENT: KANSAS CITY POWER & LIGHT			PM:
LOCATION: MASON CITY FMGP SITE			PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-14



SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

LEGEND

- ● MONITORING WELL
- (ND) NONE DETECTED
- (NS) NO SAMPLE COLLECTED
- (82) CONCENTRATION OF BENZENE (µg/L)
- (J) ESTIMATED CONCENTRATION

N

NOT TO SCALE

NOTES:

1. WELLS SAMPLED DECEMBER 14-17, 1993
2. CONTOUR INTERVAL VARIES LOGARITHMICALLY

GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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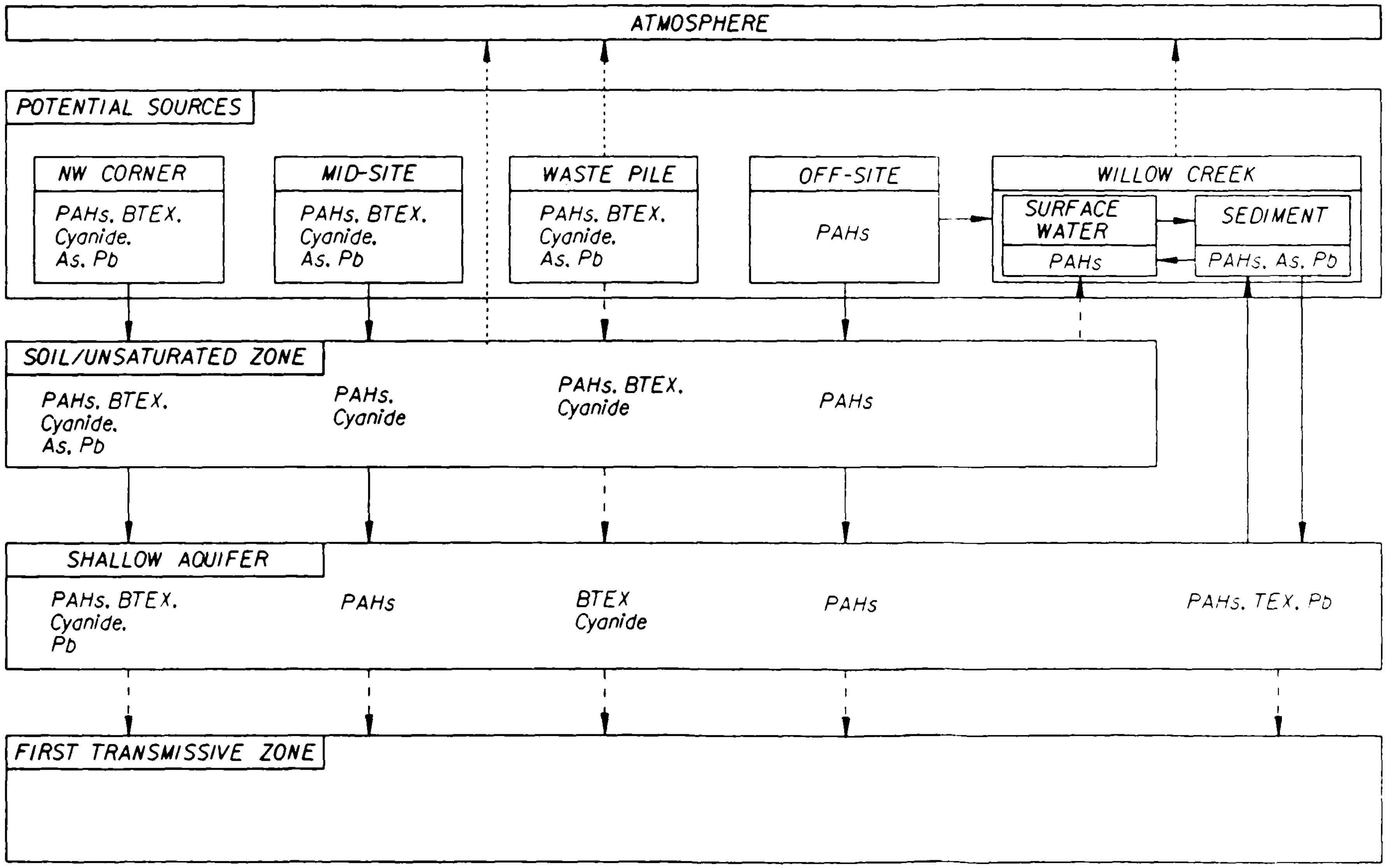
REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-15	

BENZENE CONCENTRATION CONTOURS (SHALLOW AQUIFER)

CLIENT: KANSAS CITY POWER & LIGHT			PM:
LOCATION: MASON CITY FMGP SITE			PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: 1-15



LEGEND

- ········► VOLATILIZATION
- - - - -► POTENTIAL PATHWAY
- ———► PROBABLE PATHWAY

SOURCE: MONTGOMERY WATSON, RIA APRIL 1994

GROUNDWATER TECHNOLOGY
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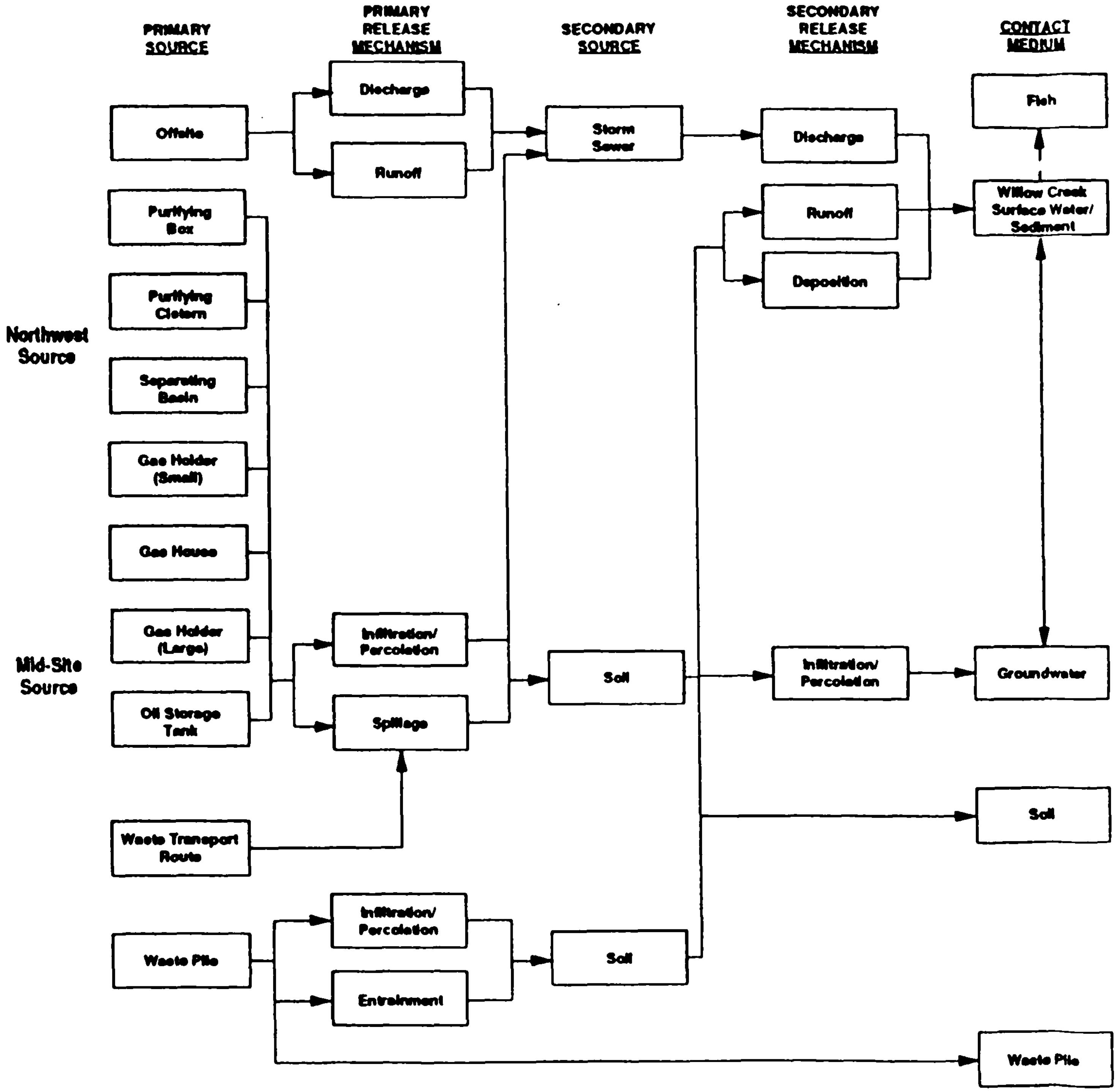
(316) 722-2266

REV. NO.:	DRAWING DATE: 09/02/94	ACAD FILE: FIG_1-16

CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT (MONTGOMERY WATSON RIA)

CLIENT: KANSAS CITY POWER & LIGHT			PM:
LOCATION: MASON CITY FMGP SITE			PE/RG:
DESIGNED:	DETAILED: MCH	PROJECT NO.: 040021369	FIGURE: **1-16**

CONCEPTUAL SITE MODEL
MASON CITY FORMER MANUFACTURED GAS PLANT



POTENTIAL RECEPTORS

Contact Medium	Exposure Route	Human: Offsite Resident	Human: Site Worker	Human: Onsite Trespasser	Human: Offsite Recreational Receptor	Biota: Aquatic	Biota: Terrestrial
Fish	Ingestion				●		
Willow Creek Surface Water/Sediment	Inhalation						
	Ingestion				●	●	●
	Dermal Contact				●	●	●
	Plant Uptake					●	
Groundwater	Inhalation	●					
	Ingestion	●					
	Dermal Contact	●					
	Plant Uptake						
Soil	Inhalation		●	●			
	Ingestion		●	●			
	Dermal Contact		●	●			●
	Plant Uptake						●
Waste Pile	Inhalation			●			
	Ingestion			●			
	Dermal Contact			●			
	Plant Uptake						

SOURCE: JACOBS ENGINEERING, INTERIM BASELINE RISK ASSESSMENT, SEPTEMBER 1993

GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
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(316) 722-2266

REV. NO.: | DRAWING DATE: 08/25/94 | ACAD FILE: 1369-SM

RISK ASSESSMENT CONCEPTUAL SITE MODEL

CLIENT: KANSAS CITY POWER & LIGHT | PM:

LOCATION: FMGP SITE MASON CITY, IA | PE/RG:

DESIGNED: | DETAILED: RHW | PROJECT NO.: 040021369 | FIGURE: 2-1

TABLE 2-1

Types of Compounds Detected[a] (For All Media)

Former Manufactured Gas Plant

Mason City, Iowa

Polynuclear Aromatic Hydrocarbons	Volatile Organic Compounds	Trace Metals	Inorganic Chemicals
Acenaphthene	Benzene	Arsenic	Cyanide[d]
Acenaphthylene	Bromodichloromethane	Chromium[d]	
Anthracene	Ethylbenzene	Copper[d]	
Benzo(a)anthracene[b]	Toluene	Iron[d]	
Benzo(a)pyrene[b]	Vinyl Chloride[c]	Lead	
Benzo(b)fluoranthene[b]	Xylenes	Nickel[d]	
Benzo(g,h,i)perylene		Zinc[d]	
Benzo(k)fluoranthene[b]			
Chrysene[b]			
Dibenzo(a,h)anthracene[b]			
Fluoranthene			
Fluorene			
Indeno(1,2,3-cd)pyrene[b]			
Naphthalene			
Phenanthrene			
Pyrene			

Source: Jacobs Engineering.

[a] As defined in Technical Memorandum No. 7

[b] (Suspected) carcinogenic polynuclear aromatic hydrocarbon compound

[c] Soil only

[d] Groundwater only

TABLE 2-2
Chemicals of Potential Concern by Media

Former Manufactured Gas Plant
Mason City, Iowa

Groundwater[a]	Soils[b]	Willow Creek Sediment[b]	Willow Creek Surface Water[b]
VOCs			
Benzene	Benzene		
Bromodichloromethane	Vinyl Chloride		
Ethylbenzene			
Toluene			
Xylenes			
PAHs			
NONCARCINOGENIC			
Naphthalene	Naphthalene		
Acenaphthylene	Acenaphthylene		
Fluorene	Fluorene		
Phenanthrene	Pyrene		
Anthracene	Benzo(g,h,i)perylene		
Fluoranthene			
Pyrene			
Benzo(g,h,i)perylene			
CARCINOGENIC			
Benzo(k)fluoranthene	Benzo(k)fluoranthene	Phenanthrene	Benzo(a)anthrace
Benzo(a)anthracene	Benzo(a)anthracene	Benzo(k)fluoranthene	
Chrysene	Chrysene	Benzo(a)anthracene	
Benzo(b)fluoranthene	Benzo(b)fluoranthene	Chrysene	
Benzo(a)pyrene	Benzo(a)pyrene	Benzo(b)fluoranthene	
Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene	Benzo(a)pyrene	
Dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene	
Metals			
Lead	Arsenic		

Source: Jacobs Engineering, Baseline Risk Assessment.

[a] Data from RI only; all sampling rounds and locations combined
[b] Data from investigations (1986–1992); all sampling rounds and locations combined

4IX:21369 MC

TABLE 2-3
Federal and State
Potential Chemical-Specific ARARs and TBCs
for Groundwater Drinking Water Use
(All concentrations expressed in micrograms per liter)

Former Manufactured Gas Plant
Mason City, Iowa

Chemicals	ARARs[a]				TBCs[b]				
	MCL[c]	MCLG[c]	IMCL[c]	AWQC[e]	MCL[d]	MCLG[d]	HAL[f]	RSC[g]	RfC[h]
Benzene	5	–	5	0.67	–	–	235 (10 day/10kg)	1.2	–
Ethylbenzene	700	700	–	2,400	–	–	680 (lifetime/70 kg)	–	3,500
Toluene	1,000	1,000	2,420	15,000	–	–	2420 (lifetime/70 kg)	–	7,000
Xylenes (Total)	10,000	10,000	12,000	–	–	–	2200 (lifetime/70 kg)	–	70,000
Acenaphthylene	–	–	–	–	–	–	–	–	2,100
Anthracene	–	–	–	–	–	–	–	–	11,000
Benzo(a)anthracene	–	–	–	0.031	0.1	–	–	0.005	–
Benzo(a)pyrene	–	–	–	0.031	0.2	–	–	0.005	–
Benzo(b)fluoranthene	–	–	–	0.031	0.2	–	–	0.005	–
Benzo(ghl)perylene	–	–	–	0.031	–	–	–	– –	–
Benzo(k)fluoranthene	–	–	–	0.031	0.2	–	–	0.005	–
Chrysene	–	–	–	0.031	0.2	–	–	0.005	–
Dibenzo(a h)anthracene	–	–	–	0.031	0.3	–	–	0.005	–
Fluoranthene	–	–	–	188	–	–	–	–	1,400
Fluorene	–	–	–	–	–	–	–	–	
Indeno(1,2,3-cd)pyrene	–	–	–	0.031	0.4	–	–	0.005	–
Phenanthrene	–	–	–	–	–	–	–	–	–
Pyrene	–	–	–	–	–	–	–	–	1,100
Naphthalene	–	–	–	–	–	–	–	–	1,400

[a] ARARs – Applicable or relevant and appropriate requirements
[b] TBCs – To Be Considered; nonpromulgated criteria.
[c] MCL – Maximum Contaminant Level, MCLG – Maximum Contaminant Level Goal, IMCL – Iowa MCL.
[d] Indicates proposed.
[e] AWQC – Ambient Water Quality Criteria for Human Health – Adjusted to reflect drinking water use only. US EPA, 1986.
[f] HAL – Lifetime Health Advisory Level – US EPA Office of Water (Iowa Chap. 133 references Lifetime HALs. Not available for all COCs).
[g] RSC – Risk-specific concentration at 10^{-6} cancer risk level. Based on cancer slope factor, 2 liter/day water consumption, 70 kg body weight.
[h] Rfc – reference concentration based on RfD, 2 liter/day water consumption, 70 kg body weight.

TABLE 2-4
Federal and State
Potential Chemical-Specific ARARs and TBCs
For Surface Water
(All concentrations expressed in micrograms per liter)

Former Manufactured Gas Plant
Mason City, Iowa

Chemicals	ARARs[a]				TBCs[b]	
	AWQC[c] Human Health		AWQC[d] Freshwater		Lowest Reported Effects Level[e]	
	Water & Fish	Fish	Acute	Chronic	Acute	Chronic
Benzene	0.6	40	5,300	--	235[d]	--
Ethylbenzene	1,400	3,280	32,000	--	32,000[d]	3,400[g]
Toluene	14,300	424,000	17,500	--	20,000[d]	7,000[g]
Xylenes	--	--	--	--	40,000	60,000[g]
Acenaphthylene	0.0028	0.0311	--	--	--	--
Anthracene	0.0028	0.0311	--	--	--	--
Benzo(a)anthracene	0.0028	0.0311	--	--	--	--
Benzo(a)pyrene	0.0028	0.0311	--	--	--	--
Benzo(b)fluoranthene	0.0028	0.0311	--	--	--	--
Benzo(ghl)perylene	0.0028	0.0311	--	--	--	--
Benzo(k)fluoranthene	0.0028	0.0311	--	--	--	--
Chrysene	0.0028	0.0311	--	--	--	--
Dibenzo(ah)anthracene	0.0028	0.0311	--	--	--	--
Fluoranthene	42	54	3,980	--		--
Fluorene	0.0028	0.0311	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.0028	0.0311	--	--	--	--
Phenanthrene	0.0028	0.0311	30	6.3	--	--
Pyrene	0.0028	0.0311	--	--	--	--
Naphthalene	--	--	2,300	620	500	100[g]

[a] Applicable or relevant and appropriate requirements
[b] To be considered
[c] AWQC - Ambient water quality criteria
[d] AWQC - Ambient water quality criteria for aquatic life protection.
[e]No criteria developed. Criteria documents reported lowest reported effects level.
[f] Based on No Observed Adverse Effect Level (NOAEL)
[g] Drinking Water Equivalent Level (DWEL).

Note: If the State of Iowa has promulgated water quality standards (WQS) for specific pollutants and water body at the site, the state's WQSs will generally be the ARARs.

Note: NOAELs are No Observed Adverse Effect Levels, the greatest dose at which a test organism shows no deleterious response to a chemical or agent. These are determined for each animal or epidemiological study of effects of a chemical. There can be different NOAELs listed for a chemical based on the animal used, the route of exposure, and the methods used in the study. A representative NOAEL is selected by EPA based on its evaluation of the studies conducted.

From a NOAEL (or if a NOAEL is not available, from the Lowest Observed Adverse Effect Level, or LOAEL), various uncertainty factors are used to determine a human reference dose (RfD). The RfD is the dose which is assumed to be without appreciable risk of deleterious effects over the course of a lifetime.

From the RfD, the Drinking Water Equivalency Level (DWEL) is determined by multiplying the RfD by a body weight of 70 kg, and dividing by a water consumption rate of 2 liters per day. The DWEL is the concentration of chemical in water that would be without appreciable risk of deleterious effect, if all exposure to the chemical was only due to drinking water.

Maximum Contaminant Level Goals (MCLGs) are determined by factoring the DWEL by the percentage of the total exposure which is assumed to come from drinking water. Commonly this is 20%.

The preceding only applies to non-carcinogenic compounds. It is described in 40 CFR in the explanation of Parts 141, 142, and and 143. These sections are where the National Primary Drinking Water Standards are promulgated.

TABLE 2-4A
Federal
Potential Chemical-Specific ARARs and TBCs
for Air Quality

Former Manufactured Gas Plant
Mason City, Iowa

Particulate Matter	150 mg/m^3, 24-hour average concentrations[a]
	50 mg/m^3, annual arithmetic mean
Lead	1.5 mg/m^3, maximum arithmetic mean averaged over a calender quarter.[b]

The levels of the national primary and secondary 24-hour ambient air quality standards.

[a] – Part 50.6 National Primary and Secondary Ambient Air Quality Standard
[b] – Part 50.12 National Primary and Secondary Ambient Air Quality Standard

TABLE 2-5
Chemical-Specific State ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
National Secondary Drinking Water Standards (SMCLs)	40 CFR Part 143	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels).	No/No	Secondary MCLs may be relevant and appropriate if the state has adopted them. To date, Iowa has not.
Iowa Environmental Quality Act				
Rules for Determining Cleanup Actions and Responsible Parties	Iowa Code Chapter 133 Effective 8/16/89	Establishes cleanup levels for contaminated groundwater and soil.	Yes/—	These regulations are applicable to any soil or groundwater contaminated above Iowa action levels.

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
CLEAN AIR ACT			
National Ambient Air Quality Standards/NESHAP/NSPL/BACT, PSD/LAER 40 CFR 60.1–17, 60.50–54, 60.150–154, 60.480–489 40 CFR 53.1–33 40 CFR 61.01–18, 61.50–112, 61.240–247	Sets treatment technology standards for emissions to air from incinerators and fugitive emissions	Applicable	These requirements are applicable to any alternatives that involve emissions regulated by these standards
National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart C 40 CFR Part 61.30 beryllium Subpart E 40 CFR Part 61.50–56 Mercury Subpart F 40 CFR Part 61.6–71 Vinyl Chloride Subpart I 40 CFR Part 61.100–108 Radio Nuclides Subpart FF 40 CFR Part 61.340–358 Benzene Subpart J 40 CFR Part 61.110–112 Benzene Subpart N 40 CFR Part 61.160–165 Arsenic	The regulation includes emission standards for mercury, vinyl chloride, benzene, beryllium, inorganic arsenic, and radio nuclide from specific sources.	Not an ARAR	

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
CLEAN WATER ACT			
National Pollutant Discharge Elimination System (NPDES) 40 CFR 122.1−64	Regulate the point source discharge of water into surface water bodies. The State of Iowa has authority to administer NPDES in Iowa. Refer to State ARARs. (Table 2-7 and Section 2.2.2.3.3)	Applicable	The remedial action may include the discharge of treated or untreated groundwater to Willow Creek. Substantive requirements will have to be met, although administrative requirements (a permit) may not be required if the discharge is on-site.
DEPARTMENT OF TRANSPORTATION			
Hazardous Materials Transportation Act (HMTA) 49 USC Sect 1801−1813 Hazardous Materials Transportation Regulations 49 CFR Parts 107, 171−177	Regulates transportation of hazardous materials	Applicable	These requirements are applicable to all alternatives involving transport of contaminated materials from the site.
Pretreatment Standards 40 CFR Part 403.1−18	Established pretreatment standards for the control of pollutants' discharge to POTWs. The POTW should have either an EPA-approved program or sufficient mechanism to meet the requirements of the national program in accepting CERCLA waste.	Applicable	Discharge to POTW possible alternative. It is considered an off-site action. The substantive and administrative legally applicable requirements of the national pretreatment program must be met.
Ocean Discharge 40 CFR 227.1−32	NPDES permit required to discharge to marine water.	Not applicable	Not relevant to situation.
Dredge and Fill Requirement 40 CFR 230.1−80	Regulates the discharge of dredged or fill material into the water of the US.	Not applicable	No dredging or filling anticipated.
SAFE DRINKING WATER ACT			
Underground Injection Control Program 40 CFR Part 144.1−70	Controls the underground injection of wastes and treated wastewater.	Not applicable	Not relevant to situation because no underground injection anticipated.

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)			
Hazardous Waste Management	Management of generation, treatment, storage, disposal, and transport of hazardous waste	Coal tar wastes Not applicable May be relevant and appropriate Treatment residues: May be applicable	Coal tar wastes are not listed wastes and do not appear to be RCRA characteristic; therefore, RCRA is not applicable to on-site or off-site actions constituting treatment or disposal.
Definition and identification of hazardous waste 40 CFR Part 261 20—134	Identifies those wastes subject to regulation.	Relevant and appropriate	RCRA requirements are applicable to treatment residues generated from remedial actions that are identified as RCRA hazardous wastes and that are stored, treated, disposed of, and/or transported. RCRA requirements may be relevant and appropriate for on-site actions to waste that is similar to RCRA hazardous waste depending on site-specific circumstances.
Standards for Generators 40 CFR 262.10—40	Establishes regulation covering activities of generators of hazardous wastes. Requirements include ID number, record keeping, and use of uniform national manifest.	Applicable	Applicable to off-site actions if waste or treatment residues are RCRA hazardous. Off-site actions must meet both substantive and administrative legally applicable requirements, but not relevant and appropriate requirements.
Standards for Transport 40 CFR 263.10—31	The transport of hazardous waste is subject to requirements including DST regulations, manifesting, record keeping, and discharge cleanup	Applicable	Applicable to off-site actions if waste or treatment residues are RCRA hazardous. Off-site actions must meet both substantive and administrative legally applicable requirements, but not relevant and appropriate requirements

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
REGULATIONS FOR OWNERS AND OPERATORS OF PERMITTED HAZARDOUS WASTE FACILITIES			
Subpart G – Closure Post-Closure 40 CFR 264.111, 264.117C	Concerns site closure requirements, including operation and maintenance, site monitoring, record keeping, and site use	Not applicable, Relevant and appropriate	Substantive closure and post-closure requirements are applicable to RCRA hazardous wastes, and may be relevant and appropriate to wastes that are similar to RCRA hazardous wastes.
Subpart I – Storage Container 40 CFR 264.171–178	Requirements concern permits on-site storage of hazardous wastes or temporary storage phases during cleanup actions. Requirements for maintenance of storage containers, compatibility with waste, inspection, storage area, location, and closure.	Not applicable; Relevant and appropriate	May be relevant and appropriate to storage of wastes prior to off-site shipment if RCRA is determined relevant and appropriate for wastes. Substantive requirements are applicable to RCRA hazardous wastes stored in containers or piles after November 19, 1980. Waste piles closed in place are regulated under 40 CFR Part 64, Subpart N.
Subpart J – Tank Storage 40 CFR 264.191–198	Requirements apply to tank storage of hazardous materials.	Not applicable	Tank storage is not anticipated.
Subpart K – Surface Impoundments 40 CFR 264.220–231	Requirements for hazardous waste containment using new or existing surface impoundments.	Not applicable	No surface impoundments are anticipated.
Subpart L – Waste Piles 40 CFR 264.251–258	Requirements for hazardous waste kept in piles.	Not applicable; Relevant and appropriate	Temporary waste piles not subject to RCRA; may be relevant and appropriate for long-term storage piles. Substantive requirements are applicable to RCRA hazardous wastes stored in containers or piles after November 19, 1980. Waste piles closed in place are regulated under 40 CFR Part 64, Subpart N.

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
Subpart M – Land Treatment 40 CFR 264.271–283	Requirements pertain to land treatment of hazardous wastes	Not applicable	Land treatment is not an alternative
Subpart N – Landfills 40 CFR 264.301–314 (New landfills)	Requirement for design, operation, and maintenance of a new hazardous waste landfill, includes minimum technology requirements under HSWA	Applicable	Creation of a new landfill is an action considered Substantive requirements are applicable to the on-site disposal os RCRA hazardous wastes in a landfill and may be relevant and appropriate to the on-site disposal of wastes that are similar to RCRA hazardous wastes.
Closure 40 CFR 264.310	Requirement for closure of landfill with waste in place; includes requirement for capping, monitoring	Not applicable Potentially relevant and appropriate	Wastes may be left in place. If RCRA is deemed relevant and appropriate for the waste, closure requirements may be deemed relevant and appropriate
Subpart O – Incinerators 40 CFR 264.340–351	Requirements for hazardous waste incinerators	Not applicable	On-site incinerator is not considered for this site.
Subpart S – Corrective Action for Solid Waste Management Units 40 CFR Part 264.552–553	Requirements for CAMUs and temporary treatment units at RCRA-permitted TSD facilities undergoing corrective action	Not an ARAR, is a TBC	Substantive requirements may be relevant and appropriate to temporary on-site treatment.
Subpart X – Miscellaneous Units 40 CFR Part 264.600-603	Standards for performance of miscellaneous treatment units. Miscellaneous treatment units may include temporary waste holding units or effluent pretreatment units.	Not applicable	Subpart X may apply to use of on-site physical, chemical, or biological treatment technologies if RCRA is determined to be relevant and appropriate overall. Substantive requirements are applicable to RCRA hazardous wastes treated on-site in miscellaneous units, and may be relevant and appropriate to wastes (treated on-site in miscellaneous units) that are similar to RCRA hazardous wastes

TABLE 2-6
Potential Federal Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Federal Regulations	Requirement	Potential ARAR Status	Analysis
Land Disposal Restrictions 40 CFR, Part 268.30–40	The land disposal restrictions and treatment requirements for materials subject to restrictions on land disposal	Appropriate and relevant	On-site land disposal (i.e., new placement) is anticipated; therefore, land ban may be triggered Substantive land disposal restrictions are applicable to the land disposal of RCRA hazardous wastes; and may be relevant and appropriate to wastes that are similar to RCRA hazardous wastes
TOXIC SUBSTANCES CONTROL ACT (TSCA) PCBs			
40 CFR Part 761.60–79	Requirement for disposal of PCBs.	Not applicable	PCBs are not known to be present at the site.

TABLE 2-7
Potential Federal Location-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Location-Specific Concern	Requirement	Prerequisite	Citation	Potential ARAR Determination	Analysis
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	Alternation of terrain that threatens significant scientific, prehistorical, or archaeological data	National Historical Preservation Act (16 USC Section 469); 36 CFR Part 65	Not applicable or relevant and appropriate	There are no known archaeological or historical artifacts on the site.
Historic project owned or controlled by Federal agency	Action to preserve historic properties; planning of action to minimize harm to National Historic Landmarks	Property included in, or eligible for, the National Register of Historic Places	National Historical Preservation Act, Section 106 (16 USC 470 *et seq.*); 36 CFR Part 800	Not applicable or relevant and appropriate	Site not on the National Register of Historic Places
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of Interior	Determination of presence of endangered or threatened species	Endangered Species Act of 1973 (16 USC 1531 *et seq.*); 50 CFR Part 222, 50 CFR Part 402 Fish and Wildlife Coordination Act (16 USC 661 *et seq.*) 33 CFR Parts 320−330	Not applicable or relevant and appropriate	No endangered species are known to exist at the site. No evidence of unique habitat is present.

TABLE 2-8
Potential State Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Iowa Environmental Quality Act	Enacted 1972, as amended, chapter 455B of Iowa Administrative Code Annotated.			
	455B.430	The permission of IDNR's Director is required to change the use of a site on the Registry of abandoned or uncontrolled disposal sites.	Yes/--	The Mason City site is an uncontrolled waste site as defined by the Act. Therefore this section of the law is applicable.
	455B.465 Well Injection Prohibited	Makes it unlawful to inject hazardous or restricted waste into a well.	No/No	No proposed alternative uses on-site injection wells.
Iowa Air Pollution Control Regulations	22.4 or 22.5	Establishes requirements for major stationary sources in attainment/unclassified areas (22.4) or nonattainment areas (22.5)	Yes/--	These regulations (either 22.4 or 22.5) are applicable to any remedial activities taken at the site, such as incineration or excavation.

TABLE 2-8
Potential State Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Iowa Air Pollution Control Regulations (continued)	23.1 Emissions Standards	Establishes emission standards for new sources and for hazardous air pollutants.	Yes/--	These regulations would be applicable to certain new sources such as incinerators and to emissions of hazardous air pollutants.
	23.3 (455B) Specific Contaminants	Establishes standards for various contaminants.	Yes/--	These regulations would apply to remedial actions.
	23.4 (12) Incinerators	Establishes standards for particulate matter and visible emissions.	Yes/--	These standards would apply to any on-site incinerators used in remedial actions.
Iowa Water Pollution Control Regulations	Iowa Water Quality Standards 61.3 (1) and 61.3 (3)	Establishes general water standards and class "B" water standards.	No/No	No alternative involves discharge to surface waters.
	62.1 (6)	Prohibits discharges to POTWs without a pretreatment agreement.	Yes/--	These prohibitions would apply to any off-site discharges to a POTW
	(3), and (4)	Adopts the following Federal regulations: 40 CFR Part 403 and 40 CFR Part 125, Subpart H.	Yes/--	These regulations would be applicable to any discharge from the site to a POTW.

TABLE 2-8
Potential State Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Iowa Water Pollution Control Regulations (continued)	62.6	Establishes how IDNR will set effluent limitations or pretreatment requirements for pollutants for which there are no federal standards.	Yes/--	These regulations would be applicable to discharge from the site to a POTW.
	62.8 (3) and (4)	Establishes how IDNR may set pretreatment requirements which are more stringent than current standards if necessary.	Yes/--	These requirements may be applied to any discharges from the site to a POTW, if IDNR deems it necessary.
	62.9	Prohibits disposal of any pollutant (other than heat) into wells in Iowa after Sept. 1, 1977.	No/No	No alternative considered involves the use of injection wells.
	63 Monitoring, Analytical and Reporting Requirements	This chapter establishes requirements for these activities.	Yes/Yes	Off-site disposal options must comply with all portions of this chapter. On-site disposal options must comply with the substantive requirements (63.3 (1) through 63.3 (4)).

TABLE 2-8
Potential State Action-Specific ARARs

Former Manufactured Gas Plant
Mason City, Iowa

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Iowa Water Pollution Control Regulations (continued)	64.2 (3)	Establishes silting criteria that must be complied with when building a new wastewater disposal system.	Yes/--	These regulations would apply to any treatment system built to remediate the groundwater.
	64.3 (5)	Requirements for industries that discharge to another disposal system.	Yes/--	These regulations would apply to any remedial option that discharged treated water to a POTW.

TABLE 2-9
Summary of Remedial Action Objectives and General Response Actions
Former Manufactured Gas Plant
Mason City, Iowa

Environmental Media	Remedial Action Objectives	General Response Actions	Description
Soil	Prevent ingestion, dermal or inhalation exposure of surface soils contaminated with benzene and arsenic to future site worker above the 1×10^{-6} cancer risk range.	No action	No action is taken to address the contamination problem
	Prevent ingestion, dermal or inhalation exposure of subsurface soils contaminated with benzene and arsenic to future site worker above the 1×10^{-6} cancer risk range.	Institutional action	No remedial action; however, actions are taken to significantly reduce potential for human exposure.
	Prevent ingestion, dermal or inhalation exposure of surface soils, trenches, and waste pile contaminated with benzene, arsenic, and potentially vinyl chloride to current/future trespasser (child) above the 1×10^{-6} cancer risk range	Containment	Contain contaminated soils at confined location
	Prevent ingestion and inhalation exposure of surface soils contaminated with carcinogenic PAHs to future site worker above 1×10^{-6} cancer risk range Prevent ingestion and inhalation exposure of subsurface soils contaminated with carcinogenic PAHs to future site worker above 1×10^{-6} cancer risk range Prevent ingestion and inhalation exposure of surface soils and waste pile contaminated with carcinogenic PAHs to current/future trespasser above 1×10^{-6} cancer risk range.	Excavation/treatment/disposal	Remove contaminated soil for on-site or off-site treatment before disposal
Groundwater	Prevent ingestion, inhalation, and dermal exposure of groundwater contaminated with benzene for future off-site resident (child and adult) above 1×10^{-6} cancer risk range	No action	No action is taken to address the contamination problem.
	Prevent ingestion exposure of groundwater contaminated with benzo(a)pyrene for future off-site resident (child and adult) above SDWA MCL	Institutional action	No remedial action, however, actions are taken to significantly reduce potential for human exposure
	Prevent ingestion exposure of groundwater contaminated with lead for future off-site resident (child) above EPA action level.	Groundwater action	Continuous monitoring and protective actions to reduce potential for human exposure.
	Prevent ingestion exposure of groundwater contaminated with benzo(b)fluoranthene, indeno (1,2,3-cd) pyrene and dibenzo(a,h)anthracene for future off-site resident (child and adult) above proposed SDWA MCLs*.	Containment	Restrict contaminated groundwater to original location and prevent further spread of contamination
	Prevent ingestion exposure of groundwater contaminated with benzo(k)fluoranthene, benzo(a)anthracene, and chrysene for future off-site resident (child and adult) above 1×10^{-6} cancer risk range	Groundwater extraction/treatment/discharge	Extract groundwater to surface for treatment and subsequent discharge

Note: * Calculation of risk-based concentration levels revealed that 1×10^{-6} health risk is below method quantitation limit

TABLE 2-10
Calculated Health Risk-Based Goals for Soil
(Expressed in Micrograms per Kilogram)

Former Manufactured Gas Plant
Mason City, Iowa

Chemical	Current Child Trespasser/Recreational Users				Future Adult Resident/Worker/Recreational			Future Child Resident/Trespasser/Recreational			
	On-site Surface Soil	Trenches	Waste Pile	Willow Creek Sediment	On-site Subsurface Soil	On-site Surface Soil	Willow Creek Sediment & Fish	On-site Surface Soil	Trenches	Waste Pile	Willow Creek Sediment
Benzene	—	—	4.3	—	—	—	—	—	—	4.3	—
Vinyl Chloride	—	—	0.003	—	—	—	—	—	—	0.003	—
Benzo(k)fluoranthene	—	—	—	—	—	—	—	—	—	—	—
Benzo(a)anthracene	—	—	59	—	29	—	—	—	—	59	—
Chrysene	—	—	—	—	—	—	—	—	—	—	—
Benzo(b)fluoranthene	—	—	59	—	—	—	—	—	—	59	—
Benzo(a)pyrene	6.0	6.1	6.0	—	2.8	2.8	—	6.0	6.1	6.0	—
Indeno(1,2,3-c,d)pyrene	—	—	59	—	—	—	—	—	—	59	—
Dibenzo(a,h)anthracene	—	—	6.0	—	2.9	—	—	—	—	6.0	—
Arsenic	—	—	—	—	12	—	—	—	—	—	—

Notes: "—" indicates no goal calculated as calculated risk < $1x10^{-6}$

Lead in soil was not identified in the Baseline Risk Assessment as a hazard. (reference section 5.0, Risk Characterization, BRA, Jacobs Engineering).

TABLE 2-11

Calculated Preliminary Health Risk-Based Remediation Goals for Groundwater
(Expressed as Micrograms per Liter)

Former Manufactured Gas Plant
Mason City, Iowa

Chemical	Future Adult Resident/Worker/Recreational Users	Future Child Resident/Trespasser/Recreational
Benzene	2.9	14
Benzo(k)fluoranthene	1.2	5.8
Benzo(a)anthracene	0.1	0.6
Chrysene	12	56
Benzo(b)fluoranthene	0.1	0.6
Benzo(a)pyrene	0.01	0.1
Indeno(1,2,3-c,d)pyrene	0.1	0.7
Dibenzo(a,h)anthracene	0.01	0.1

Notes: "—" indicates no goal calculated risk $< 1 \times 10^{-6}$

TABLE 2-12

Proposed Remediation Goals for Soil

(Expressed in Milligrams per Kilogram)

Former Manufactured Gas Plant

Mason City, Iowa

Chemical	10^{-6} Carcinogenic Risk Level
Benzene	43
Vinyl Chloride	0.5[a]
Benzo(a)anthracene	29
Benzo(b)fluoranthene	59
Benzo(a)pyrene	2.8
Indeno(1,2,3-c,d)pyrene	59
Dibenzo(a,h)anthracene	2.9
Arsenic	12

[a] Laboratory Reporting Limit.

TABLE 2-13
Proposed Remediation Goals for Groundwater
(Expressed in Micrograms per Liter)

Former Manufactured Gas Plant
Mason City, Iowa

Chemical	Preliminary Health Risk-Based Goal	SDWA Proposed or Final MCL
Benzene	2.9	5[a]
Benzo(k)fluoranthene	1.2	0.2
Benzo(a)anthracene	0.1	0.1
Chrysene	12	0.2
Benzo(b)fluoranthene	0.1[b]	0.2
Benzo(a)pyrene	0.01[b]	0.2[a]
Indeno(1,2,3-c,d)pyrene	0.1[b]	0.4
Dibenzo(a,h)anthracene	0.01[b]	0.3
Lead	—	15[c]

Notes: "—" indicates no datum for the cell.
SDWA = Safe Drinking Water Act
MCL = Maximum Contaminant Level

[a] Final MCL
[b] Less than EPA Method 8310 practical quantitation limit.
[c] EPA action level for treatment (SDWA).

TABLE 2-14
SUMMARY OF TECHNOLOGY SCREENING AND PROCESS OPTIONS FOR SOILS

FORMER MANUFACTURED GAS PLANT
MASON CITY, IOWA

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not applicable	No action.	Required for consideration by NCP.
Institutional Control	Access restriction	Fencing warning signs	Erect a fence around the perimeter of the site to signficantly reduce the potential for direct contact with contaminated soil	Potentially applicable.
	Land use restriction	Deed restriction	Deeds for property in the area of influence would restrict actions such as prohibit future residential development, excavation, and installation of ground water recovery wells.	Potentially applicable.
	Dam restriction	Dam down	Remove operational mechanism to keep dam in down position.	Potentially applicable.
Containment	Capping	**Clay cap**	Place 2 feet of clay with drainage system over the appropriate site areas.	Not feasible due to the potential for failure from erosion over time.
		Asphalt Pavement	Installation of a layer of asphalt pavement over the appropriate site areas.	Not feasible because it may require substantial maintenance to ensure integrity. Freeze-thaw fractures likely, and asphalt is possible source of PAHs.
		Concrete Pavement	Installation of a concrete slab over the appropriate site areas.	Not feasible because it may require substantial maintenance to ensure integrity. Freeze-thaw fractures likely.
		Improved Multi-media cap	Install multi-media cap consisting of drainage system, clay, synthetic membrane, top soil, and vegetative layers over appropriate areas.	Potentially applicable.

[shaded box] Technology or process screened out

TABLE 2-14
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Excavation	Mechanical excavation	Backhoe and other excavation equipment	Remove contaminated materials with common construction equipment.	Potentially applicable.
	Mechanical Conditioning	Vibrating Screens/ shredders/mixers	Remove construction rubble and debris and size/appropriately condition soils for subsequent treatment.	Potentially applicable.
Treatment (In-situ)	Biological	Aerobic degradation (screened out)	Promote aerobic degradation by the introduction of oxygen and nutrients into the subsurface environment.	Not feasible. Requires thorough distribution of oxygen and nutrients to the subsurface. Would not be feasible for site geologic conditions and nature and extent of contaminants present.
		Anaerobic degradation (screened out)	Degradation of organics using micro-organisms in an anaerobic environment.	Not feasible since it involves a slow and incomplete degradation process. Not proven on a large scale.
	Chemical	Soil flushing/ extraction (screened out)	Apply solvents, surfactants, or chemical mixes to the soils to flush/leach contaminants from the soil matrix.	Not technically feasible. Requires intimate contact of contaminants and solvents. Practical on a small scale. Would not be feasible for site geologic conditions and nature and extent of contaminants present.
		Oxidation (screened out)	Injection wells or French drains utilized to introduce recirculated water dosed with a chemical oxidant (e.g., hydrogen peroxide, ozone, etc.) into the contaminated zone.	Not technically feasible. Requires intimate contact of contaminants and oxidant(s). Practical on a small scale. Would not be feasible for site geologic conditions and nature and extent of contaminants present.
	Stabilization	Chemical fixation/ solidification	Contaminated materials are mixed with chemicals (e.g., cement, flyash) which stabilize the contaminants/soil matrix and significantly reduce release potential.	Potentially applicable.
	Thermal	In-situ vitrification (screened out)	Electric current applied to electrodes installed in the soil creates a molten mass which fuses soils and binds contaminants.	Amounts of soils at isolated locations and site geologic conditions make process infeasible. Process also unproven at field level.
		Steam injection (screened out)	Steam is injected into the subsurface to decrease contaminant viscosity and enhance mobility for removal via pumping.	Not technically feasible for site geologic conditions and nature and extent of contaminants present.

(Shaded) Technology or process screened out

TABLE 2-14
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (ex-situ)	Biological aerobic degradation	On-site treatment cell	Promote aerobic degradation by composting or other methods within an appropriately constructed and aerobically controlled on-site treatment cell/ environment.	Potentially applicable.
		Off-site treatment cell	Promote aerobic degradation by composting or other methods within an appropriately constructed off-site treatment cell/environment.	Potentially applicable.
		Liquid/solid bioslurry treatment (screened out)	An aqueous slurry is created by combining contaminated material with water and fed to an aerated bioreactor.	Not feasible given the anticipated quantity of soils to be processed. Process unproven at full-scale field level.
	Chemical	Soil flushing extraction	Apply solvents, surfactants, or chemical mixes to the soils to to flush contaminants from the soil matrix.	Potentially applicable as a pretreatment process to biological treatment.
		Oxidation	Apply chemical oxidants (e.g., hydrogen peroxide, ozone, etc.) to the soils to oxidize the contaminants.	Potentially applicable. In particular as a preparatory step to biological treatment.
	Stabilization	Chemical fixation/ solidifaction	Contaminated materials are mixed with chemicals (e.g., cement, flyash) which stabilize the contaminants/soil matrix and significantly reduce release potential.	Potentially applicable.

(shaded box) Technology or process screened out

TABLE 2-14
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (ex-situ) continued	Thermal	Cement manufacture	Contaminated materials are incorporated with other feed stock materials within a high temperature furnace or kiln for the manufacture of Portland cement.	Potentially applicable.
		Asphalt manufacture	Contaminatned materials are incorporated as feed stock materials within the heated dryer in the production of hot-mix asphalt.	Potentially applicable.
		Co-burning in utility boiler	Contaminated materials are blended with coal and co-fired within utility boilers.	Potentially applicable.
		Thermal desorption with off gas incineration (transportable unit)	Contaminated materials are transported off-site to a transportable thermal desorption unit set up in close proximity to the site.	Potentially applicable.
		Thermal desorption with off gas incineration (fixed/stationary unit)	Contaminated materials are transported to a fixed/stationary thermal desorption unit.	Potentially applicable.
	Off-site treatment	Off-site treatment	Excavated soil transported to appropriate facility off-site for treatment.	Potentially applicable

[shaded box] Technology or process screened out

TABLE 2-14
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Disposal	Disposal	On-site disposal (without treatment)	Excavate contaminated soil and place untreated within an on-site lined and capped landfill.	Potentially applicable.
		On-site disposal (with treatment)	Excavate contaminated soil, treat, and place within an on-site lined and capped landfill.	Potentially applicable.
		Off-site disposal	Excavate contaminated soil and dispose of at an off-site approved permitted landfill/facility.	Eliminated by management directive/policy.

[shaded box] Technology or process screened out.

TABLE 2-15

SUMMARY OF TECHNOLOGY SCREENING AND PROCESS OPTIONS FOR GROUNDWATER

FORMER MANUFACTURED GAS PLANT

MASON CITY, IOWA

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not applicable	No action.	Required for consideration by NCP.
Institutional Control	Access restriction	Fencing warning signs	Erect a fence around the perimeter of the site to significantly reduce the potential for direct contact. Install warning signs to prevent unauthorized access.	Potentially applicable
	Land use restriction	Deed restriction	Deeds for property in the area of influence would restrict groundwater recovery and excavation actions.	Potentially applicable
Ground Water Action	Monitoring	Sampling and analysis of existing wells	Periodically sample to monitor migration, natural degradation, attenuation and restoration. Will not prevent off-site migration of ground water.	Potentially applicable.
		Sampling and analysis of additional wells	Periodically sample to monitor migration, natural degradation, attenuation and restoration. Will not prevent off-site migration of ground water.	Potentially applicable.
	Attenuation/ Dispersion	Sampling and analysis of existing wells	Same as monitoring after source controls implemented.	Potentially applicable.
		Sampling and analysis of additional wells	Same as monitoring after source controls implemented.	Potentially applicable.

[shaded box] Technology or process screened out

TABLE 2-15
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Containment	Capping	Clay cap	Place 2 feet of clay with drainage system over the appropriate site areas.	Not feasible due to the potential for failure from erosion over time.
		Asphalt	Installation of a layer of asphalt pavement over the appropriate site areas.	Not feasible becuase it may require substantial maintenance to ensure integrity. Freeze-thaw fractures likely. Asphalt is also possible source of PAHs.
		Concrete	Installation of a concrete slab over the appropriate site areas.	Not feasible because it may require substantial maintenance to ensure integrity. Freeze-thaw fractures likely.
		Improved Multi-media cap	Install multi-media cap consisting of drainage system, clay, synthetic membrane, top soil, and vegetative layers over appropriate site areas.	Potentially applicable
	Vertical barriers (unconsolidated soils)	Slurry wall	Vertical trench around contaminated soil is filled with a low permeability clay or cement/bentonite slurry.	Potentially applicable
		Grout barriers or curtains	Pressure injection of grout around contaminated soil in a regular pattern of drilled holes.	Potentially applicable
		Sheet piling	Drive sheet piling around areas of contaminated soil.	Potentially applicable
		Vibrating beam	Vibrating force to advance beams into the ground around contaminated soil with injection of slurry as beam is withdrawn.	Potentially applicable
	Vertical barriers (fractured bedrock)	Slurry wall	Vertical trench within and around contaminated areas of the fractured bedrock is filled with a low permeability clay or cement/bentonite slurry.	Not feasible to trench the fractured bedrock at depth.
		Grout injection or curtain	Pressure injection of grout at depth through a pattern of closely spaced holes within the fractured bedrock.	Potentially applicable
		Sheet piling	Drive sheet piling around areas of contaminated fractured bedrock.	Not feasible to drive sheet piling into the fractured bedrock.
		Vibrating beam	Vibrating force to advance beams to the top of competent bedrock with injection of slurry within the fractured bedrock as beam is withdrawn.	Not feasible to advance beams to the fractured bedrock.

(Shaded box) Technology or process screened out

TABLE 2-15
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Collection	Ground Water Extraction	Shallow extraction wells on-site	Series of strategically located recovery wells to extract contaminated water. Utilized to attain hydraulic control on-site.	Potentially applicable
		Interceptor trenches	Perforated pipe in trenches backfilled with porous media. Recovery wells with pumps located at low points in trench to collect contaminated water. Utilized to attain hydraulic control on-site.	Potentially applicable.
Treatment (in-situ)	Biological	Aerobic degradation	System of injection and extraction wells are used to introduce air and nutrients into the groundwater to stimulate the aerobic biological degradation of contaminants.	Not feasible due to the nature and extent of contaminants present, the refractory nature of certain PAHs to biological treatment, and site geologic conditions.
	Sparging	Air sparging	Air is injected into the groundwater, in effect creating an underground (in-situ) air stripper, for the removal of contaminants by volatilization.	Not feasible due to the nature and extent of contaminants and site geologic conditions.
		Air sparging enhanced with ozone	Ozone added to sparge air to enhance the rate of contaminants removal via oxidation.	Not feasible due to the nature and extent of contaminants and site geologic conditions.

Shaded: Technology or process screened out

TABLE 2-15
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Screened out
Treatment (ex-situ)	Biological Treatment	Activated sludge	The activated sludge process mixes a biological slurry containing an active mass of bacteria with the contaminated water in an aeration tank.	Not feasible due to potential for process upsets, excessive oversight to assure acceptable operations, and requirements for sludge handling, dewatering and disposal.	Yes
		Submerged fixed film reactor	Degradation of organics using microoganisms in an aerobically controlled reactor. Reactors incorporate a submerged media for attachment by and growth of the active biofilm.	Not feasible due to potential for process upsets, excessive oversight to assure acceptable operations, and requirements for sludge handling, dewatering and disposal.	Yes
	Physical treatment	Chemical coagulation, flocculation and precipitation	Alteration of chemical equilibria to reduce the stability of colloid contaminants to enhance their removal by sedimentation.	Potentially applicable.	
		Gravity separation/ sedimentation	Settling of insoluble particles heavier than water and separation of liquids of differing densities with gravitational forces.	Potentially applicable.	
		Air stripping	Mixing large volumes of air with water in a packed column to promote transfer of VOCs to air	Potentially applicable.	
		Steam stripping	Use of steam to remove less volatile compounds in the same way as air stripping	Not necessary since conventional air stripping is suitable for VOCs of concern. Not feasible technology for low level semi-volatiles.	Yes
		Filtration	Trapping suspended particles by passing the water through a filter media	Potentially applicable.	
		Carbon adsorption	Adsorption of contaminants onto activated carbon by passing water through a carbon bed	Potentially applicable.	
		Organophilic clay	High molecular weight, low solubility organic contaminants are removed by passing the water through a bed of organophilic clay	Potentially applicable.	

(shaded box) Technology or process screened out

TABLE 2-15
(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (ex-situ) continued	Chemical treatment	UV/chemical oxidation	Use of hydrogen peroxide, ozone, or other strong oxidizer in the presence of ultraviolet (UV) light to destroy organic compounds.	Not feasible due to the potential for fouling and excessive oxidant useage.
		Ion exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Not feasible due to the potential for fouling of the resin. Not applicable to the majority of contaminants.
		pH adjustment	Alteration of pH by the controlled addition of an acid or base.	Potentially applicable prior to and after air stripping to control inorganic precipitation.
	Thermal treatment	Incineration	Thermal treatment at high temperatures to destroy organic waste.	Not feasible for large volumes and low organic concentrations.
	Off-site treatment	Off-site treatment facility	Extracted ground water transported to licensed off-site treatment facility for treatment.	Not feasible because of the large volume of liquids.
		POTW	Extracted ground water discharged to licensed POTW facility for treatment.	Potentially applicable
Discharge	On-site discharge	River	Treated water discharged to the river.	Potentially applicable.
		Reinjection on-site	Treated water reinjected to the upgradient side of site.	Not feasible due to the potential for fouling of reinjection well(s)/trench.
	Off-site discharge	POTW	Extracted water discharged to POTW after treatment.	Potentially applicable.
		Off-site treatment facility discharge	Licensed water treatment facility discharge to POTW or surface water.	Not feasible due to large volumes expected.

Technology or process screened out

TABLE 4-1
Cost Estimate
Improved Multi-Media CAP

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization/Demobilization	$10,000.00 / LS	1	$10,000
Site Preparation/Grading	4,000.00 / LS	1	4,000
Clean Fill with Volclay Added	31.00 / CY	875	27,100
Synthetic Geomembrane Liner	0.55 / ft^2	47,200	26,000
Drainage Material (1 ft.)	18.42 / CY	1,748	33,200
Geotextile Filter Fabric	0.20 / $ft.^2$	47,200	9,500
Clean Fill, Graded (3.5 ft.)	12.00 / CY	6,120	73,400
Top Soil, Graded (0.5 ft.)	16.00 / CY	874	14,000
Grass Cover (Sod)	1.50 / SY	5,245	7,900
Subtotal Facilities/Capital Cost			$205,100
Miscellaneous	10% of Subtotal		20,500
Contingency	25% of Subtotal		51,300
Engineering	15% of Subtotal		30,800
Total Capital Cost			$307,700
Annual Operation Cost			
Maintenance (Mowing) and Inspection	$10,000 / LS	1	$10,000
Subtotal Annual Operation Cost (O&M)			$10,000
Miscellaneous	20% of Subtotal		$2,000
Contingency	20% of Subtotal		$2,000
Total Annual Operation Cost			$14,000
Total Present Worth for 30 Years @ 5%:			$522,900

TABLE 4-2A
Cost Estimate
Excavation/Thermal Treatment (Fixed Treatment Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization/Demobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing/Handling	15.00 / TON	7,440	$111,600
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Backfill Processed Material (placed and compacted)	2.75 / TON	7,440	$20,500
Backfill Overburden	1.60 / TON	2,550	$4,100
Top Dressing Backfill, 2-ft. depth, Graded	8.00 / TON	5,688	$45,500
Grass Cover (sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	450.00 / LD	338	$152,100
Disposal	85.00 / TON	7,440	$632,400
Subtotal Facilities			$1,707,200
Miscellaneous	10% of Subtotal		170,700
Contingency	25% of Subtotal		426,800
Engineering	15% of Subtotal		256,100
Total Capital Cost/Total Present Worth			**$2,560,800**

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TABLE 4-2B
Cost Estimate
Excavation/Thermal Treatment (Fixed Treatment Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing/Handling	25.00 / TON	10,629	$265,700
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Sand Additive	10.00 / TON	3,189	31,900
Shoring	42.00 / ft^2	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60.000
Water Treatment	35,000.00 / LS	1	$35,000
Backfill processed material (placed and compacted)	2.75 / TON	10,629	$29,200
Backfill overburden	1.60 / TON	2,550	$4,100
Top Dressing Backfill, 2 ft. depth, Graded	8.00 / TON	2,500	$20,000
Grass Cover (Sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	450.00 / LD	483	$217,400
Disposal	85.00 / TON	10,629	$903,500
Subtotal Facilities			$2,212,800
Miscellaneous	10% of Subtotal		$221,300
Contingency	25% of Subtotal		$553,200
Engineering	15% of Subtotal		$332,000
Total Capital Cost/Total Present Worth			**$3,319,300**

TABLE 4-3A
Cost Estimate
Excavation/Thermal Treatment (Transportable Treatment Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing/Handling	25.00 / TON	7,440	$186,000
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Backfill Processed Material (placed and compacted)	2.75 / TON	7,440	$20,500
Backfill Overburden	1.60 / TON	2,550	$4,100
Top Dressing Backfill, 2-ft. depth, Graded	8.00 / TON	5,688	$45,500
Grass Cover (Sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	60.00 / LD	338	$20,300
Treatment Unit Mob	30,000.00 / LS	1	$30,000
Disposal	45.00 / TON	7,440	$334,800
Subtotal Facilities			$1,382,200
Miscellaneous	10% of Subtotal		$138,200
Contingency	25% of Subtotal		$345,600
Engineering	15% of Subtotal		$207,300
Total Capital Cost/Total Present Worth			**$2,073,300**

TABLE 4-3B
Cost Estimate
Excavation/Thermal Treatment (Transportable Treatment Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Sand Additive	10.00 / TON	3.189	$31,900
Soil Processing/Handling	25.00 / TON	10.629	$265,700
Shoring	42.00 / ft.^{2}	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Backfill Processed Material (placed and compacted)	2.75 / TON	10,629	$29,200
Backfill Overburden	1.60 / TON	2,550	4,100
Top Dressing Backfill, 2-ft. depth, Graded	8.00 / TON	2,500	$20,000
Grass Cover (Sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	60.00 / LD	483	$29,000
Treatment Unit Mob	30,000.00 / LS	1	$30,000
Disposal	45.00 / TON	10,629	$478,300
Subtotal Facilities			$1,629,200
Miscellaneous	10% of Subtotal		$162,900
Contingency	25% of Subtotal		$407,300
Engineering	15% of Subtotal		$244,400
Total Capital Cost/Total Present Worth			$2,443,800

TABLE 4-4A
Cost Estimate
Excavation/Thermal Treatment (Power Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Rubble Processing/Handling	5.00 / TON	7,490	$37,200
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	6,450	$51,600
Backfill Overburden	1.60 / TON	2,550	$4,100
Top Dressing Backfill, 2 ft. depth, Graded	8.00 / TON	5,688	$45,500
Grass Cover (sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	1,590.00 / LD	338	$537,400
Disposal	75.00 / TON	7,440	$558,000
Subtotal Facilities			$1,941,800
Miscellaneous	10% of Subtotal		194,200
Contingency	25% of Subtotal		485,500
Engineering	15% of Subtotal		291,300
Total Capital Cost/Total Present Worth			$2,912,800

TABLE 4-4B
Cost Estimate
Excavation/Thermal Treatment (Power Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Rubble Processing/Handling	5.00 / TON	7,440	$37,200
Soil Processing/Handling	25.00 / TON	10,629	$265,700
Coal Additive	10.00 / TON	3,189	$31,900
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	6,450	$51,600
Backfill Overburden	1.60 / TON	2,550	$4,100
Top Dressing Backfill, 2 ft. depth, Graded	8.00 / TON	5,688	$45,500
Grass Cover (sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	1,590.00 / LD	483	$768,000
Disposal	75.00 / TON	10,629	$797,200
Subtotal Facilities			$2,709,200
Miscellaneous	10% of Subtotal		270,900
Contingency	25% of Subtotal		677,300
Engineering	15% of Subtotal		406,400
Total Capital Cost/Total Present Worth			**$4,063,800**

TABLE 4-5A
Cost Estimate
Excavation/Thermal Treatment (Cement Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing/Handling	15.00 / TON	7,440	$111,600
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Shoring	42.00 / $ft.^2$	3,750	$157,50C
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	6,450	$51,600
Backfill Overburden	1.60 / TON	2,550	4,100
Top Dressing Backfill, 2 ft. Depth Graded	8.00 / TON	5,688	$45,500
Grass Cover (Sod)	1.50 / SY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	690.00 / LD	338	$233,200
Disposal	35.00 / TON	7,440	$260,400
Subtotal Facilities			$1,447,400
Miscellaneous	10% of Subtotal		$144,700
Contingency	25% of Subtotal		$361,900
Engineering	15% of Subtotal		$217,100
Total Capital Cost/Total Present Worth			**$2,171,100**

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TABLE 4-5B
Cost Estimate
Excavation/Thermal Treatment (Cement Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization	$10,000.00 / LS	1	$10,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing/Handling	25.00 / TON	10,629	$265,700
Rubble Processing Surcharge	20.00 / TON	1,650	$33,000
Sand Additive	10.00 / TON	3,189	$31,900
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	6,450	$51,600
Backfill Overburden	1.60 / TON	2,550	4,100
Top Dressing Backfill, 2 ft. Depth Graded	8.00 / TON	5,688	$45,500
Grass Cover (Sod)	1.50 / CY	5,300	$8,000
Verification Sampling	7,500.00 / LS	1	$7,500
Transportation	690.00 / LD	483	$333,300
Disposal	35.00 / TON	10,629	$372,000
Subtotal Facilities			$1,845,100
Miscellaneous	10% of Subtotal		$184,500
Contingency	25% of Subtotal		$461,300
Engineering	15% of Subtotal		$276,800
Total Capital Cost/Total Present Worth			$2,767,700

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TABLE 4-6
Cost Estimate
Excavation/Biological Treatment (On-Site)

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization/Demobilization	$15,000.00 / LS	1	$15,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing	25.00 / TON	7,440	$186,000
Rubble Processing Surcharge	5.00 / TON	1,650	$8,300
Backfill Processed Material	1.60 / TON	9,990	$16,000
Synthetic Geomembrane Liners	0.55 / ft^2	32,600	$35,900
Drainage Material (1 ft.)	19.00 / CY	1,811	34,500
Geotextile Filter Fabric	0.20 / ft^2	32,600	6,500
Shoring	42.00 / ft^2	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Improved Multi-Media Cap	4.30 / ft^2	21,050	$90,500
Top Dressing Backfill, Graded	14.00 / CY	1,200	$16,800
Grass Cover (sod)	1.50 / SY	2,933	$4,400
Subtotal Facilities			$1,096,400
Biovent Collection			
Vapor Extraction Blowers	$5,500.00 / EA	2	$11,000
Collection Piping	20,000.00 / LS	1	$20,000
Building Enclosure with Foundation	15,000.00 / LS	1	$15,000
Electrical Service	3,500.00 / LS	1	$3,500
Miscellaneous Piping & Controls	4,000.00 / LS	1	$4,000
Instrumentation	4,500.00 / LS	1	$4,500
Valve Access Manholes	800.00 / EA	12	$9,600
Air Permit	7,500.00 / LS	1	$7,500
Subtotal Biovent Collection			$64,100
Subtotal Capital Cost			$1,160,500
Miscellaneous	10% of Subtotal		116,100
Contingency	25% of Subtotal		290,100
Engineering	15% of Subtotal		174,100
Total Capital Cost			$1,740,800
Annual Operation Cost			
Labor and Report Preparation	$60,000.00 / YR	1	$60,000
Electricity	5,000.00 / YR	1	$5,000
Facility O & M	10% of Subtotal	1	$6,400
Analytical	18,000.00 / YR	1	$18,000
Subtotal Annual Operation Cost (O & M)			$89,400
Miscellaneous	20% of Subtotal		$17,900
Contingency	20% of Subtotal		$17,900
Total Annual Operation Cost			$125,200
Total Present Worth for 10 Years @ 5%			$2,708,100

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TABLE 4-7
Cost Estimate
Excavation with Ex Situ Fixation/On-Site Disposal

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Summary			
Capital Cost			
Facilities			
Mobilization/Demobilization	$15,000.00 / LS	1	$15,000
Excavation Covering	340,000.00 / LS	1	$340,000
Excavation	10.00 / TON	9,000	$90,000
Soil Processing	25.00 / TON	7,440	$186,000
Rubble Processing Surcharge	5.00 / TON	1,650	$8,300
Reagent Additive (cement)	90.00 / TON	2,480	$223,200
Backfill Processed Material	1.60 / TON	12,470	$20,000
Shoring	42.00 / $ft.^2$	3,750	$157,500
Wellpoint System/Dewatering	300.00 / LF	200	$60,000
Water Treatment	35,000.00 / LS	1	$35,000
Top Dressing Backfill, Graded	14.00 / CY	3,314	$46,400
Grass Cover (sod)	1.50 / SY	5,300	$8,000
Subtotal Facilities			$1,181,100
Miscellaneous	10% of Subtotal		118,100
Contingency	25% of Subtotal		295,300
Engineering	15% of Subtota'		177,200
Total Capital Cost			**$1,771,700**
Annual Operation Cost			
Maintenance (mowing) and Inspection	$10,000.00 / LS	1	$10,000
Subtotal Annual Operation Cost (O & M)			$10,000
Miscellaneous	20% of Subtotal		$2,000
Contingency	20% of Subtotal		$2,000
Total Annual Operation Cost			**$14,000**
Total Present Worth for 10 Years @ 5%			$1,879,900

TABLE 4-8
Cost Estimate
Groundwater Monitoring Program

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Annual Operation Cost			
Groundwater Sampling	$6,000.00 / LS	1	$6,000
Groundwater Analytical	10,000.00 / LS	1	$10,000
Reporting	5,000.00 / LS	1	$5,000
Subtotal Annual Operating Cost			$21,000
Miscellaneous	20% of Subtotal	1	$4,200
Contingency	20% of Subtotal	1	$4,200
Total Annual Operating Cost			$29,400
Total Present Worth for 30 Years at 5%			$451,900

Notes: (1) Costing based on sampling five (5) monitoring wells

TABLE 4-9
Cost Estimate
Fractured Bedrock Grouting/Unconsolidated Fill Vertical Barrier/Groundwater Pumping

Former Manuafactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Number of Units	Estimated Cost
Summary				
Capital Cost				
Facilities				
Bedrock Grouting, Perimeter Barrier, and Recovery Trench				
Mobilization/Demobilization	$15,000	/ LS	1	$15,000
Fractured Bedrock Grouting	$75	/ CY	29,300	$2,197,500
Groundwater Recovery Trench	$30	/ LF	500	$15,000
Perimeter Grout Barrier/Sheet Piling	$20	/ ft^2	13,650	$273,000
SUBTOTAL GROUTING, BARRIER & TRENCH				$2,500,500
Groundwater Collection & Treatment (2 gpm)				
Collection Wells in Trench	$200	/ EA	3	$600
Recovery Well Access Vaults	$2,500	/ EA	3	$7,500
Groundwater Pumps	$3,500	/ EA	3	$10,500
Yard Piping from Pumps	$5,500	/ LS	1	$5,500
Yard Electrical to Pumps	$5,000	/ LS	1	$5,000
Equipment Bldg & Fndtn (15x20)	$18,000	/ LS	1	$18,000
Electrical Service & Install	$8,000		1	$8,000
Instrumentation	$7,000	/ LS	1	$7,000
Control Panel	$6,000	/ LS	1	$6,000
Principal Process Equipment:				
O/W Separator with Pump	5,000	/ LS	1	$5,000
Transfer Tank with Pump	2,500	/ LS	1	$2,500
pH Control System	11,500	/ LS	1	$11,500
Air Stripper	10,000	/ LS	1	$10,000
Transfer Tank with Mixer	2,500	/ LS	1	$2,500
Parallel Plate Separator	5,500	/ LS	1	$5,500
Overflow Tank with Pump	2,500	/ LS	1	$2,500
Particulate Filter	2,500	/ LS	1	$2,500
Activated Carbon	1,000.	/ EA	2	$2,000
Organophilic Clay Filter	1,500	/ EA	2	$3,000
Solids Dewatering System	9,000	/ LS	1	$9,000
Subcontracotr System Install	18,000	/ LS	1	$18,000
Discharge Line to Sanitary Sewer	3,000	/ LS	1	$3,000
Pre-treatment Permit (Sewer)	5,500	/ LS	1	$5,500
Air Permit	5,500	/ LS	1	$5,500
Subtotal Groundwater Collection Treatment				$156,100
Subtotal Capital Costs				$2,656,600
Miscellaneous	10% of Subtotal			$265,700
Contingency	25% of Subtotal			$664,200
Engineering	15% of Subtotal			$398 500
Total Capital Cost				$3,985,000

4002/1369 MO

TABLE 4-9 — *Continued*

Description	Estimated Unit Cost/		Number of Units	Estimated Cost
Annual Operation Cost				
Groundwater Sampling/Monitoring/Reporting	21,000	/ YR	1	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000	/ YR	1	$10,000
Treatment System Labor and Report Preparation	14,000	/ YR	1	$14,000
Electricity (Treatment System)	8,000	/ YR	1	$8,000
Groundwater Treatment O&M	6% of Groundwater Subtotal		1	$9,400
Treatment Sampling/Analytical	12,000	/ YR	1	$12,000
Labor and Report Preparation	20,000	/ YR	1	$20,000
Sewer Use Fee ($1/1,000 gallons)	1,100	/ YR	1	$1,100
Subtotal Annual Operation Cost (O&M)				$95,500
Miscellaneous	20% of Subtotal			$19,100
Contingency	20% of Subtotal			$14,900
Total Annual Operation Cost				$133,700
Total Present Worth for 30 Years @ 5%				$6,040,000

TABLE 4-10
Cost Estimate
Groundwater Pumping/Treatment
Discharge to Sanitary Sewer

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Number of Units	Estimated Cost
Summary				
Capital Cost				
Facilities				
Groundwater Collection and Treatment (36 gpm)				
Shallow Extraction Wells (6)	75.00 /	ft	180	$13,500
Groundwater Pumps	3,500.00 /	ea	6	$21,000
Recovery Well Access Vaults	2,500.00 /	ea	6	$15,000
Yard Piping from Pumps	8,200.00 /	LS	1	$8,200
Yard Electrical to Pumps	7,500.00 /	LS	1	$7,500
Equipment Bldg & Fndt (20 x30')	36,000.00 /	LS	1	$36,000
Electrical Service and Installation	15,000.00 /	LS	1	$15,000
Instrumentation	8,000.00 /	LS	1	$8,000
Control Panel	10,000.00 /	LS	1	$10,000
Principal Process Equipment				
O/W Separator with Pump	10,000.00 /	LS	1	$10,000
Transfer Tank with Pump	3,200.00 /	LS	1	$3,200
pH Control System	22,500.00 /	LS	1	$22,500
Air Stripper	35,000.00 /	LS	1	$35,000
Transfer Tank with Mixer	3,200.00 /	LS	1	$3,200
Parallel Plate Separator	12,000.00 /	LS	1	$12,000
Overflow Tank with Pump	3,200.00 /	LS	1	$3,200
Particulate Filter	5,000.00 /	LS	1	$5,000
Activated Carbon	7,000.00 /	ea	2	$14,000
Organophilic Clay Filter	7,500.00 /	ea	2	$15,000
Solids Dewatering System	16,000.00 /	LS	1	$16,000
Subcontracotr System Installation	40,000.00 /	LS	1	$40,000
Discharge Line to Sanitary Sewer	4,000.00 /	LS	1	$4,000
Pre-treatment Permit (Sanitary Sewer)	5,500.00 /	LS	1	$5,500
Air Permit	5,500.00 /	LS	1	$5,500
Subtotal Groundwater				$328,300
Subtotal Capital Cost				$328,300
Miscellaneous	10% of Subtotal			38,800
Contingency	25% of Subtotal			82,100
Engineering	15% of Subtotal			49,200
Total Capital Cost				**$492,400**

TABLE 4-10 — *Continued*

Description	Estimated Unit Cost/	Number of Units	Estimated Cost
Annual Operation Cost			
Groundwater Sampling/Monitoring/Reporting	21,000.00 / YR	1	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000 / YR	1	$10,000
Labor and Report Preparation	14,000.00 / YR	1	$14,000
Electricity (Treatment System)	18,000.00 / YR	1	$18,000
Groundwater Treatment O&M	6% of Groundwater Subtotal	1	$25,600
Treatment Sampling/Analytical	12,000.00 / YR	1	$12,000
Labor and Report Preparation	30,000.00 / YR	1	$30,000
Sewer Use Fee ($1/1,000 gallons)	18,900.00 / YR	1	$18,900
Subtotal Annual Operation Cost (O&M)			$149,500
Miscellaneous	20% of Subtotal		$29,900
Contingency	20% of Subtotal		$29,900
Total Annual Operation Cost			$209,300
Total Present Worth for 30 Years @ 5%			$3,709,300

TABLE 4-11
Cost Estimate
Fractured Bedrock Grouting/Shallow Groundwater Pumping

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Number of Units	Estimated Cost
Summary				
Capital Cost				
Facilities				
Bedrock Grouting and Recovery Trench				
Mobilization/Demobilization	$15,000	/ LS	1	$15,000
Fractured Bedrock Grouting	$75	/ CY	29,300	$2,197,500
Groundwater Recovery Trench	$30	/ LF	500	$15,000
Subtotal Facilities (Grouting & Trench)				$2,227,500
Groundwater Collection & Treatment (8 gpm)				
Collection Wells in Trench	$200	/ EA	3	$600
Recovery Well Access Vaults	$2,500	/ EA	3	$7,500
Groundwater Pumps	$3,500	/ EA	3	$10,500
Yard Piping from Pumps	$5,500	/ LS	1	$5,500
Yard Electrical to Pumps	$5,000	/ LS	1	$5,000
Equipment Bldg. & Fndtn (15x25)	$22,500	/ LS	1	$22,500
Electrical Service & Install	$10,000		1	$10,000
Instrumentation	$7,000	/ LS		$7,000
Control Panel	$8,000	/ LS		$8,000
Principal Process Equipment				
O/W Separator with Pump	6,000	/ LS	1	$6,000
Transfer Tank with Pump	3,200	/ LS	1	$3,200
pH Control System	13,500	/ LS	1	$13,500
Air Stripper	10,000	/ LS	1	$10,000
Transfer Tank with Mixer	3,200	/ LS	1	$3,200
Parallel Plate Separator	7,200	/ LS	1	$7,200
Overflow Tank with Pump	3,200	/ LS	1	$3,200
Particulate Filter	3,000	/ LS	1	$3,000
Activated Carbon	2,500	/ EA	2	$5,000
Organophilic Clay Filter	3,000	/ EA	2	$6,000
Solids Dewatering System	12,000	/ LS	1	$12,000
Subcontracotr System Install	24,000	/ LS	1	$24,000
Discharge Line to Sanitary Sewer	4,000	/ LS	1	$4,000
Pre-treatment Permit (Sewer)	5,500	/ LS	1	$5,500
Air Permit	5,500	/ LS	1	$5,500
Subtotal Groundwater Collection Treatment				$187,900
Subtotal Capital Costs				$2,415,400
Miscellaneous	10% of Subtotal			241,500
Contingency	25% of Subtotal			603,900
Engineering	15% of Subtotal			362,300
Total Capital Cost				$3,623,100

4/8/21.996 MO

TABLE 4-11 — *Continued*

Description	Estimated Unit Cost/		Number of Units	Estimated Cost
Annual Operation Cost				
Groundwater Sampling/Monitoring/Reporting	21,000	/ YR	1	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000	/ yr	1	$10,000
Treatment System Labor and Report Preparation	$14,000	/ YR	1	$14,000
Electricity (Treatment System)	12,000	/ YR	1	$12,000
Groundwater Treatment O&M	6% of Groundwater Subtotal		1	$11,300
Treatment Sampling/Analytical	12,000	/ YR	1	$12,000
Labor and Report Preparation	25,000	/ YR	1	$25,000
Sewer Use Fee ($1/1,000 gallons)	4,200	/ YR	1	$4,200
Subtotal Annual Operation Cost (O&M)				$109,500
Miscellaneous	20% of Subtotal			$21,900
Contingency	20% of Subtotal			$21,900
Total Annual Operation Cost				**$153,300**
Total Present Worth for 30 Years @ 5%				$5,979,300

APPENDIX A

RECORDS OF DECISION OF CLEANUP LEVELS FOR PAH CARCINOGENIC RISK

Records of Decisions (RODs)

EPA-ID: WID039052626

MOSS-AMERICAN KERR-MCGEE OIL CO

ROD-DATE: September 27, 1990

ABSTRACT: The 88-acre Moss-American Kerr-McGee Oil site, a former wood preserving facility, is in Milwaukee, Milwaukee County, Wisconsin. The Little Menomonee River, which flows through the facility, lies within the 100-year floodplain and is included as part of the site. A section of the site is wooded, and wetlands are located near the river onsite and downstream. A 23-acre portion of the site is presently used as a railroad loading and storage facility for automobiles, and the remainder of the site is an undeveloped parkland. An unconfined shallow aquifer underlies the site. Beginning in 1921, operations consisted of wood preserving of railroad ties, poles, and fence posts with a mixture of creosote, which is high in PAHs, and No. 6 Fuel Oil. The facility changed names and ownership several times until it ceased operations in 1976. Wastes were discharged to onsite settling ponds until 1971, when wastewater was discharged into the sanitary sewer system. In 1971, several people received chemical burns attributed to creosote while wading three miles downstream of the site. This led to a State order requiring cleanup of onsite settling ponds by the site owner and operator. In 1973, EPA dredged 5,000 feet of the river directly downstream of the site. During 1977 to 1978, 450 cubic yards of contaminated soil were removed during the dismantling of the facility. Studies conducted before 1980 indicated that extensive creosote contamination was present in the soil and groundwater onsite as well as in the sediment of the Little Menomonee River. This record of decision (ROD) provides a final remedy and addresses source and groundwater remediation. The primary contaminants of concern affecting the soil, sediment, and groundwater are VOCs including benzene, toluene, and xylenes; and other organics including PAHs. The selected remedial action for this site includes rerouting 5 miles of the river channel onsite parallel to the existing channel, followed by excavating highly contaminated sediments from the old channel; mitigating wetland areas; treating 5,200 cubic yards of river sediment, and 80,000 cubic yards of contaminated onsite soil using onsite soil washing and bioslurry technologies; separation and dewatering of residues followed by redeposition onsite; covering treated material with 2 feet of clean soil, 6 inches of topsoil, followed by revegetation; recycling or treating slurry water onsite before discharge to a publicly owned treatment works (POTW) or the river; constructing a synthetic geomembrane barrier to prevent movement of contaminated groundwater into the river; collecting groundwater using a drain and interceptor system, followed by treatment using an oil/water separator and granular activated carbon, with discharge of treated water to a POTW or to the river; removing pure-phase liquid wastes for offsite incineration; and groundwater monitoring. The estimated present worth cost for this remedial action is $26,000,000, which includes an annual O&M cost of $130,000 for 10 years.

PERFORMANCE STANDARDS OR GOALS: Goals are designed to reduce the excess lifetime cancer risk for carcinogens to 10^{-4} or less. For non-carcinogens, cleanup levels will reduce the hazard index (HI) to 1 or less. Chemical-specific goals for groundwater include benzene 0.067 μg/L state preventive action level (PAL), toluene 68.6 μg/L (state PAL), and xylenes 124.0 μg/L (state PAL). The chemical-specific goal for soil and sediment is PAHs (carcinogenic) 6.1 mg/kg (state).

Records of Decisions (RODs)

EPA-ID: IAD980852578

PEOPLES NATURAL GAS CO

ROD-DATE: September 16, 1991

ABSTRACT: The 5-acre Peoples Natural Gas site is a former coal gasification plant in Dubuque County, Iowa. The City of Dubuque maintains a public works garage on the eastern portion of the site, and the Iowa Department of Transportation owns the western portion. The site is located 300 feet west of the Mississippi River, and is within the Mississippi River floodplain. In addition, the site overlies a silty sand unit and an alluvial aquifer, which has been determined to be a potential source of drinking water. Surrounding land use is primarily industrial and commercial, with adjacent residential areas. From at least the 1930s to 1954, the site was used to manufacture gas. By-products produced during this process included coal tar, which was stored in an underground tank and an aboveground tank, and cyanide-bearing woodchips, which were buried on the eastern portion of the site. From 1954 to 1964, the site was used as a natural gas distribution, storage, and maintenance facility. In 1986, EPA investigations identified extensive contamination of onsite soil and groundwater at the site. In 1989, the PRPs conducted a removal action that included excavating 5,500 cubic yards of PAH-contaminated soil from the western portion of the site, removing tanks used to store coal tar, installing a leachate collection system to prevent contamination from leaching into the alluvial aquifer; and implementing institutional controls. This record of decision (ROD) addresses both soil and groundwater contamination, as a final remedy. The primary contaminants of concern affecting the soil and groundwater are VOCs including benzene, toluene, and xylenes; and other organics including PAHs. The selected remedial action for this site includes excavating and incinerating an estimated 18,500 cubic yards of contaminated soil offsite; treating the soil and groundwater within the silty sand unit, which are contaminated with coal tar wastes using in-situ bioremediation; pumping and onsite treatment of contaminated groundwater using air stripping followed by offsite and storm sewers discharge to a publicly owned treatment works (POTW); groundwater and air monitoring; and implementing institutional controls such as groundwater and land use restrictions, as well as site access restrictions including fencing. A contingency for groundwater treatment includes engineering controls and an ARAR waiver if the extraction system does not achieve cleanup levels. The estimated present worth cost for this remedial action is $8,000,000, which includes an estimated O&M of $788,000 for 10 years. Performance standards or goals; federal and state cleanup standards for soil have not been established at this time. Therefore, goals for soil cleanup are based on a carcinogenic risk level of (10^{-4}), and include 500 mg/kg for total PAHs and carcinogenic PAHs 100 mg/kg. Remediation levels for groundwater are based on SDWA MCLs, and include benzene at 1 μg/L.

Records of Decisions (RODs)

EPA-ID: MID980794655

TAR LAKE, MI

ROD-DATE: September 29, 1992

EPA-REGION: 5

PB-NUMBER: PB93-964119

ABSTRACT: The 200-acre Tar Lake site is a former manufacturing site in Antrim County, Michigan, located 1 mile south of Mancelona, Michigan, near the village of Antrim. Land use in the area is industrial/residential, with several lakes and ponds in the vicinity of the site. From 1882 to 1945, the site was the location of iron production by the charcoal method. In 1910, Antrim Iron Works Company began producing charcoal in sealed retorts from which pyroligneous liquor was recovered. This liquor was further processed into calcium acetate, methanol, acetone, creosote oil, and wood tar. Wastes from these processes were discharged into Tar Lake, a large natural surface depression. Investigations performed by EPA and responsible parties reveal soil and groundwater contamination with concentrations above federal and state regulatory levels. Groundwater contamination extends 3.5 miles downgradient from the site, and Tar Lake has a strong chemical odor. This ROD addresses a final remedy for the soil and tar sludge, as well as an interim remedy to limit further contamination of groundwater, as OU1. A future ROD will address OU2 as the final remedy for the groundwater contamination. The primary contaminants of concern affecting the soil, tar sludge, and groundwater are VOCs, including benzene, toluene, and xylenes; PAHs; and other organics, including phenols. The selected remedial action for this site includes excavation of approximately 30,000 cubic yards of tar sludge and approximately 40,000 cubic yards of contaminated soil in and around Tar Lake, dewatering via extraction wells to facilitate excavation; consolidation of excavated materials into two adjoining RCRA containment cells to be constructed within the contamination area; and addition of solidification agents, such as bentonite and cement, which will be added to the tar sludge to give it the physical stability to support a RCRA cap. Both containment cells will meet RCRA minimum technology requirements, including double liners, leachate collection systems, and a groundwater monitoring system, and will be capped with RCRA Subtitle C landfill covers. A groundwater pump and treat system will be installed to contain the contaminated groundwater, and a treatability study will be performed during the pre-design stage to determine the effectiveness of carbon adsorption to meet groundwater discharge limits. Treated water will be reinjected upgradient of the extraction wells to perform a closed loop system, and institutional controls to restrict groundwater usage will be implemented. The estimated present worth cost for this remedy is $20,100,000, including an annual O&M cost of $791,800.

PERFORMANCE STANDARDS OR GOALS: All soil and sludge with an excess cancer risk level greater than 1×10^{-4} will be excavated from the site. Chemical-specific soil and sludge cleanup levels were based on the Michigan Environmental Response Act and health-based criteria and include benzene 0.4 μg/kg; xylenes 6,000 μg/kg; toluene 16,000 μg/kg; benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene all at 100 μg/kg; phenols 6,000 μg/kg; and 2-methylphenol 8,000 μg/kg. Because the groundwater containment is an interim measure, groundwater cleanup standards are waived. Chemical-specific cleanup levels will be provided in the final action for groundwater onsite.

Records of Decisions (RODs)

EPA-ID: OHD043730217

ALLIED CHEM & IRONTON COKE

ROD-DATE: December 28, 1990

ABSTRACT: The 95-acre Allied Chemical and Ironton Coke site is comprised of a former Coke plant and an operating tar plant in Ironton, Lawrence County, Ohio. The site is located within a coal mining region, and surrounding land use is predominantly industrial and residential. The Ohio River, a source of drinking water for the city of Ironton, lies approximately 500 feet to the west of the tar plant. On-site lagoons lie within the 100-year floodplain of the Ohio River, with portions of the lagoons inundated sufficiently to maintain wetlands vegetation. From approximately 1920 to the late 1960s, wastewater and solid wastes including coke and coal fines, tank car sludge, boiler ash, and weak ammonia liquor were discharged into swampy areas east of the Coke plant, which are adjacent to Ice Creek, a tributary to the Ohio River. From the early 1970s until the Coke plant closed in 1982, a series of four lagoons in the eastern area of the plant were used to treat process wastewaters, stormwater run-off, and waste sludge; and a fifth lagoon was used to dispose of solid waste. Tar plant operations began on-site in 1945. Types of wastes generated included anthracene residues and salts, coal tar pitch scrap, and phthalic anhydride residues, which were disposed of on-site in the Gold Camp disposal area, a former sand pit adjoining the tar plant. Extensive studies and on-site investigations identified contamination in on-site soil, in the Coke plant and tar plant areas, lagoon sediment, Ice Creek sediment downstream of the site, and groundwater beneath and surrounding the site. A 1988 record of decision (ROD) addressed the Gold Camp disposal area and documented installation of a cap and slurry wall, pumping and treatment of contaminated groundwater, and provisions for supplemental study and remediation of nonaqueous phase contaminants found on top of the bedrock. This ROD addresses contamination at all areas not previously addressed, and provides a final remedy at the site. The primary contaminants of concern affecting the soil, sediment, and groundwater are volatile organic compounds (VOCs) including benzene; other organics including PAHs and phenols; metals including arsenic; and other inorganics including cyanide.

The selected remedial action for this site includes excavating and incinerating on-site approximately 122,000 cubic yards of waste material from lagoon 5, and 31,000 cubic yards of waste coal, followed by on-site waste fuel recovery (re-use of the waste heat generated during incineration), and disposing of the residual ash off-site; *in situ* bioremediation of approximately 475,000 cubic yards of waste material from lagoons 1 through 4, the residual soil of lagoon 5, and the adjacent inner and outer dikes, excavating and on-site bioremediation on a prepared pad of approximately 40,000 cubic yards of soil from the Coke and tar plant soil; pumping and treatment of groundwater at a future site

treatment facility, with on-site reinjection or off-site discharge; monitoring groundwater on-site and downgradient of Ice Creek, and developing a contingency plan in the event that contaminant migration is encountered; pilot testing the effectiveness of *in situ* bioremediation and developing a contingency plan for an alternative remedial action for lagoons 1 through 4, if necessary; and implementing institutional controls including deed restrictions, and site access restrictions such as fencing. The estimated capital cost for this remedial action is $21,000,000, with an estimated total O&M cost of $28,500,000. Total estimated cost is $49,500,000.

PERFORMANCE STANDARDS OR GOALS: The waste fuel recovery system shall be designed and operated to achieve a 99.99 percent destruction of carcinogenic PAHs. Lagoon 5 materials will be excavated until EPA visibly determines that natural stream sediment has been encountered. Bioremediation of soil and lagoon sediment must reduce PAHs to attain a cancer risk level of 10^{-4} to 10^{-6} and a HI less than 1. Chemical-specific levels for bioremediated soil include PAHs 0.97 mg/kg and arsenic 0.56 mg/kg. Chemical-specific goals for soil include PAHs 1.4 mg/kg of organic carbon and benzene 0.485 mg/kg of organic carbon. Leach tests will be performed on the treated waste materials to determine the concentrations of arsenic and cyanide that will be protective of the groundwater. Groundwater cleanup goals are based on site-specific risk assessment, MCLs, and health advisories. Chemical-specific groundwater goals include benzene 0.005 mg/L, phenol 4 mg/L, total PAHs 0.005 mg/L, and arsenic 0.05 mg/L.

Records of Decisions (RODs)

EPA-ID: FLD980728935

BROWN WOOD PRESERVING

ROD-DATE: April 08, 1988

ABSTRACT: The 55-acre Brown Wood Preserving site is located approximately 2 miles west of the city of Live Oak, Suwanee County, Florida. The site is located in Karst terrain in which sinkholes are a common geological feature. The areas surrounding the site are considered rural and light agricultural. There area 4 private wells located along the site periphery that obtain water from an aquifer 20 to 100 feet below the site. The public water supply wells for the city of Live Oak are located less than 2 miles away. The site contains a former wood preserving plant facility, which pressure treated timber products with creosote and some pentachlorophenol (PCP) for 30 years between 1948 and 1978. During this time, several different companies operated the facility. In addition, the facility was rebuilt following a fire in February 1974. Sludge and contaminated soils have been identified in the immediate vicinity of the plant site and an upgradient lagoon. This 3-acre lagoon drains approximately 74 acres and contains water provided above approximately 3,000 cubic yards of creosote sludge and contaminated soil. In addition, small amounts of solidified creosote and PCP are contained in on-site storage tanks and retorts. In 1981, EPA was notified by one of the former facility owners that hazardous waste may have been handled at the site. In July 1982, the Florida Department of Environmental Regulation (FDER) inspected the site and detected a number of organic compounds. An action, completed in February 1988, resulted in the removal of approximately 200,000 gallons of lagoon water and 15,000 tons of contaminated lagoon sludge and soil. The primary contaminants of concern affecting the soil, sediments, sludge, and wastewater are creosote constituents including PAHs.

The selected remedial action for this site includes; removal and treatment, if necessary, of lagoon water with discharge to a POTW; excavation, treatment, and off-site disposal of approximately 1,500 tons of the most severely contaminated soil and sludge; on-site biodegradation of approximately 10,000 tons of the remaining soils in a 14-acre treatment area constructed with a liner and an internal drainage and spray irrigation system; covering of the treatment area with clean fill after bioremediation; and groundwater monitoring. The estimated present worth cost for this remedial action is $2,740,000.

Records of Decisions (RODs)

EPA-ID: FLD980709356

CABOT/KOPPERS

ROD-DATE: September 27, 1990

ABSTRACT: The 99-acre Cabot/Koppers site is a pine tar and charcoal generation facility in Gainesville, Alachua County, Florida. The site is underlain by shallow and intermediate aquifers. Land in the site vicinity is used for commercial and residential purposes. The site is comprised of two distinct areas, the inactive Cabot Carbon property to the southeast, and the industrial zoned and currently operating Koppers area to the west. North Main Street borders the entire site to the west as does a drainage ditch, which drains into nearby Springstead and Hogtown Creeks. Pine tar and charcoal generation operations began at the Cabot Carbon facility in the early 1900s and generated a large number of blended solvents as by-products. Resultant wastewaters were treated on-site in a lagoon. The Koppers portion of the site has been operated since 1916 as a wood preserving operation, primarily for utility poles and timbers. The main processing facilities at the Koppers area include a tank farm, a former cooling water pond, cylinder drip tracks, a wastewater management system comprised of a north and south lagoon, a wood shavings pile, and drying kilns. Between 1980 and 1989, various site investigations by the State, EPA, and private parties identified soil contamination in the three lagoons, the inactive cooling pond, the drip tracks, and a wood shavings pile. Groundwater contamination also was identified in both the on-site shallow and intermediate aquifers. In addition, in 1986 the State identified organics and heavy metal contamination in off-site soil west of the site. This record of decision (ROD) addresses contaminated on-site soil and groundwater. The primary contaminants of concern affecting the soil and groundwater are VOCs including benzene; other organics including oils, phenols, and PAHs; and metals including arsenic and chromium.

The selected remedial action for this site includes excavating 6,400 cubic yards of on-site contaminated soil from the north and south Koppers lagoon areas, treating the soil using soil washing and bioremediation if necessary, followed by solidifying/stabilizing the residual material and disposing of these residuals on-site; treating soil from the cooling pond and drip track areas by *in situ* bioremediation; lining the North Main Street ditch to prevent further discharge of leachate (if the ditch is to remain intact); pumping and treatment of groundwater followed by off-site discharge to a publicly owned treatment works (POTW); operating and maintaining the North Main Street lift station as needed until the groundwater remediation system renders it superfluous; monitoring groundwater and surface water; and implementing institutional controls including land use restrictions. The estimated present worth cost for this remedial action is $4,192,000, which includes an annual O&M cost of $388,000.

PERFORMANCE STANDARDS OR GOALS: Chemical-specific soil cleanup goals were developed based on groundwater protection and include carcinogenic PAHs 0.59 mg/kg, phenol 4.28 mg/kg, arsenic 27 mg/kg, and chromium 92.7 mg/kg. Chemical-specific groundwater cleanup goals include carcinogenic PAHs 0.003 μg/L (health-based), phenol 2,630 μg/L, arsenic 50 μg/L, chromium 50 μg/L (MCL), and benzene 1 μg/L (state). Total noncarcinogenic risk will result in a HI less than 1.0.

Site Name and Location

Cabot Carbon/Koppers Site
Gainesville, Alachua County, Florida

Records of Decisions (RODs)

EPA-ID: WAD980726368

COMMENCEMENT BAY - NEARSHORE/TIDE FLATS

ROD-DATE: December 30, 1987

ABSTRACT: The Tacoma Tar Pits site covers approximately 30 acres within the Commencement Bay—Nearshore/Tide Flats site in Tacoma, Pierce County, Washington. The tar pits lie between the Puyallup River, the city, and Wheeler-Osgood Waterways. These bodies of water are not used as a water supply, but support extensive fish and shellfish populations. Currently there is concern for the site's impact on surface water quality and many local industries that use groundwater from on-site wells. In 1924, a coal gasification plant began operations, and continued until 1956, at which time they were terminated due to the availability of natural gas. During these years, waste materials from the coal gasification process were disposed of on-site. Contained in the waste materials, were a wide variety of organic compounds and heavy metals. From 1965 to 1966, the plant was dismantled and demolished. Most of the metal structures were removed from the site; however, all demolition debris and belowgrade structures were left in place, including tanks and pipelines containing tars. In 1967, a metal recycling company began operating at the site. Recycling of automobile batteries introduced acid, heavy metals, lead, and PCBs to the soil. Several studies conducted by EPA and the Washington State Department of Ecology between 1981 and 1983 found contaminants derived from the coal gasification process. The primary contaminants of concern affecting surface water and soil include: benzene, PAHs, PCBs, and lead.

The selected remedial action for this site includes; excavation of all contaminated soils exceeding 1 percent total PAHs and all surface soils exceeding a 10^{-5} lifetime cancer risk level with stabilization of all excavated soils in a polymer/cement mixture; capping of the stabilized matrix with asphalt; channeling and managing of surface waters; groundwater monitoring; and removal and treatment of ponded water. The estimated present worth cost for this remedial action is $3,400,000.

Records of Decisions (RODs)

EPA-ID: TXD980745574

UNITED CREOSOTING

ROD-DATE: September 30, 1986

ABSTRACT: The United Creosoting site is a 100-acre tract of land located in the city of Conroe, Montgomery County, Texas. The site is an abandoned wood preserving facility over which two new businesses and a residential subdivision have been built. The site operated from 1946 to 1972, treating wood with creosote and pentachlorophenol (PCP). Prior to salvage and removal operations in 1972, the site contained a coal-tar distillation still, a processing building, tanks and pressure cylinders, two waste ponds, and several areas where treated lumber was stored. The only remaining evidence of the operation are remnants of the waste ponds, an office building and a garage structure. During the summer of 1980, Montgomery County obtained soils from the United Creosoting site to be used in improving local roads in a nearby subdivision. Soil material consisted of surface soils and pond backfill from the Clark Distributing Company property. Citizens living on one of the "improved" streets complained of headaches, burns, respiratory problems, and damage to vegetation. Samples indicated that soils were contaminated with PCP in concentrations up to 20.3 mg/L. Montgomery County officials removed the contaminated soils from the affected roadways and disposed of them by landfarming. In early December 1983, EPA initiated an immediate response action at United Creosoting, taking over 25 soil samples. Samples indicated the presence of PCP, chlorinated dioxins (no tetrachlorinated dioxins), and dibenzofurans. EPA ordered Clark Distributing to undertake an immediate response action within the area of the former waste ponds. Work began in November 1983, and consisted of regrading exposed contaminated soils to divert surface water drainage away from the subdivision, capping contaminated soils with a synthetic membrane cap and 6 inches of compacted clay, fencing the capped area, and constructing drainage ditches to channel cap area runoff to the south of the Clark property (vacant land). Work on this activity was completed in April 1984, and the RI/FS for the whole site area was begun in December 1984.

The selected remedial action for the site includes; purchase and demolish six homes located directly above and adjacent to the former pond area; conduct permanent relocations of the persons currently residing in these homes; consolidate surface soils contaminated with greater than 100 ppm of polynuclear aromatic hydrocarbons (PAHs) and surface soils which are visibly contaminated onto the former waste pond area; construct a temporary cap over consolidated soils; periodically evaluate the availability of off-site disposal facilities and emerging alternative technologies; excavate and dispose of the soils contaminated with greater than 100 ppm of PAHs in the former pond area and in the former storage tank area when an appropriate facility or innovative technology becomes

available; backfill excavated areas and restore ground surface with an appropriate cover; and allow groundwater attenuation through natural processes of dilution and adsorption. Estimated capital costs of the remedy range from $4.5 million for future off-site land disposal to $140 million for off-site incineration. Factors such as site preparation, material and energy requirements, and disposal requirements must be evaluated before a cost estimate can be developed. Annual O&M costs are expected to be $43,000 during the interim closure period.

Site Name and Location

United Creosoting Company, Hilbig Road, Conroe, Texas

Records of Decisions (RODs)

EPA-ID: TXD980745574

UNITED CREOSOTING COMPANY

ROD-DATE: September 29, 1989

ABSTRACT: The 100-acre United Creosoting site is in Conroe, Montgomery County, Texas. The site currently is occupied by a distributing company, a construction company, and a residential subdivision. From 1946 to 1972, the United Creosoting Company operated a wood preserving facility at the site which used PCPs and creosote in the wood preservation process. PCP and creosote wastes were stored in two waste ponds on the property of the distributing company. During 1980 the county improved area roads using soil and waste pond backfill from the site. Because residents living near the improved roadways experienced health problems, the county sampled and compared leachate composition from the affected roadways and the site and determined the leachate from both the site and the roadways were contaminated with PCPs. Roadway soil was subsequently removed and disposed of using landfarm treatment. In 1983, due to contaminated stormwater runoff from the former waste pond areas, the property owner was directed under terms of an EPA administrative order to regrade contaminated soil, divert surface water drainage away from the residential portion of the site, and cap contaminated soil. This record of decision (ROD) specifies a final remedy for the contaminated soil and complements a 1986 ROD which determined that no action is necessary to remediate shallow groundwater. The primary contaminants of concern affecting the soil are organics including PAHs, PCPs, and dioxins.

APPENDIX B

RISK-BASED CONCENTRATION LEVEL CALCULATIONS

Calculation of Risk-Based Preliminary Remedial Goals

Preliminary Health Risk-Based Remedial Goals (PHRBRGs) were calculated for exposures to soil, sediment, fish and groundwater at the site. Results of the Interim Baseline Risk Assessment (BRA) were used to derive these PHRBRGs using the following methodology:

- Receptors for which the cumulative risk associated with Reasonable Maximum Exposure exceeded 1×10^{-4} were selected. These receptors included: (1) current child trespasser, recreational user; (2) future child trespasser, off-site resident, recreational user; and (3) future adult on-site construction worker, off-site resident, recreational user (based on table 5-12 of the Interim BRA). PHRBRGs were developed so that the total residual carcinogenic risk for these receptors would be below 1×10^{-4} (as per EPA Region VII Memorandum of April 7, 1993).

- Potential Dose Factors (PDFs) were determined for each chemical, pathway, media combination for each receptor. The PDF is derived by dividing the intake value determined in the Interim BRA by the soil or groundwater concentration used to derive the intake. Therefore, the PDF is the summation of all of the exposure information with the exception of the soil or groundwater concentration. PDFs are determined in Step 1 of the following tables.

- The derived PDFs were validated against the results obtained in the Interim BRA. By multiplying the derived PDFs by the soil or groundwater concentration and the cancer slope factor for each chemical, the resulting risk from that chemical, pathway, receptor combination is determined. These risks and the totals by chemical and pathway were compared to those derived in the Interim BRA to ensure that the calculations of PDFs were valid. These risks are calculated in Step 2 of the following tables and were validated against values in tables 5-1, 5-3, 5-7, and 5-9 of the Interim BRA.

- Chemicals that resulted in greater than 1×10^{-6} risk to a receptor from a medium by a single pathway were selected. These chemical-pathway risks that exceed 1×10^{-6} are shaded in Step 2 of the following tables. PHRBRGs were developed for these chemical and route combinations based on 1×10^{-6} risk (as per EPA Region VII Memorandum of April 7, 1993).

- PHRBRGs are determined by dividing the allowable risk (1×10^{-6}) by the product of the PDF and the cancer slope factor of the chemical. PHRBRGs are calculated in Step 3 of the following tables.

In calculating the PHRBRGs, cancer slope factors for benzo(k)fluoranthene and chrysene were updated. Based on a memo from R. B. Morby, Chief of Superfund Branch, US EPA Region VII, (February 16, 1994), the carcinogenic equivalency factors (CEFs) for benzo(k)fluoranthene and chrysene have been set at 0.01 and 0.001, respectively. In the interim BRA, these CEFs were set at 0.1 and 0.01, based on a June 24, 1993 Region VII guidance memo.

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
On-Site Surface Soil
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	0.3	6.8E-09	1.3E-10	7.2E-12	0	2.27E-08	4.33E-10	2.40E-11	0
vinyl chloride	2.5	5.8E-08	1.3E-09	7.2E-11	0	2.32E-08	5.20E-10	2.88E-11	0
benzo(k)fluoranthene	7.6	1.6E-07	8.1E-09	2.2E-10	0	2.11E-08	1.07E-09	2.89E-11	0
benzo(a)anthracene	5.1	1.2E-07	5.4E-09	1.5E-10	0	2.35E-08	1.06E-09	2.94E-11	0
chrysene	6.1	1.4E-07	6.4E-09	1.7E-10	0	2.30E-08	1.05E-09	2.79E-11	0
benzo(b)fluoranthene	6.3	1.4E-07	6.6E-09	1.8E-10	0	2.22E-08	1.05E-09	2.86E-11	0
benzo(a)pyrene	20	4.6E-07	2.1E-08	5.8E-10	0	2.30E-08	1.05E-09	2.90E-11	0
indeno(1,2,3-c,d)pyrene	0.4	9.6E-09	4.4E-10	1.2E-11	0	2.40E-08	1.10E-09	3.00E-11	0
dibenzo(a,h)anthracene	1.6	3.7E-08	1.7E-09	4.6E-11	0	2.31E-08	1.06E-09	2.88E-11	0
arsenic	7.5	1.7E-07	4.0E-10	2.2E-10	0	2.27E-08	5.33E-11	2.93E-11	0

CS = Concentration in Soil

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
On-Site Surface Soil
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

Chemical	CSF (kg-day/mg) ingestion	CSF (kg-day/mg) dermal	CSF (kg-day/mg) inhalation	Risk ingestion	Risk dermal	Risk inhalation
benzene	0.0292	0.0292	0.0292	2E-10	4E-12	2E-13
vinyl chloride	1.9	1.9	0.29	1E-07	2E-09	2E-11
benzo(k)fluoranthene	0.073	0	0.061	1E-08	0	1E-11
benzo(a)anthracene	0.73	0	0.61	9E-08	0	9E-11
chrysene	0.0073	0	0.0061	1E-09	0	1E-12
benzo(b)fluoranthene	0.73	0	0.61	1E-07	0	1E-10
benzo(a)pyrene	7.3	0	6.1	**3E-06**	0	4E-09
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	7E-09	0	7E-12
dibenzo(a,h)anthracene	7.3	0	6.1	3E-07	0	3E-10
arsenic	1.75	1.75	50	3E-07	7E-10	1E-08

CSF = Cancer Slope Factor

Risk = Cancer Slope Factor * Potential Dose Factor * Concentration in Soil

BOLD = Chemical/Pathway Risks Greater Than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
On-Site Surface Soil
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk	PDF ingestion (1/day)	CSF ingestion (kg-day/mg)	PHRBRG ingestion (mg/kg)
benzo(a)pyrene	1E-06	2.30E-08	7.3	6.0

PDF = Potential Dose Factor

CSF = Cancer Slope Factor

PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$PHRBRGs = \frac{\text{Allowable Risk (1E-6)}}{PDF * CSF}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Trenches
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day)		inhal:	vol. inh.
benzene	0.5	1.2E-08	2.6E-10	1.4E-11	0	2.40E-08	5.20E-10	2.80E-11	0
vinyl chloride	5	1.2E-07	2.6E-09	1.4E-10	0	2.40E-08	5.20E-10	2.80E-11	0
benzo(k)fluoranthene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
benzo(a)anthracene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
chrysene	4	9.2E-08	4.2E-09	1.2E-10	0	2.30E-08	1.05E-09	3.00E-11	0
benzo(b)fluoranthene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
benzo(a)pyrene	8	1.8E-07	8.5E-09	2.3E-10	0	2.25E-08	1.06E-09	2.88E-11	0
indeno(1,2,3-c,d)pyrene	2	4.6E-08	2.1E-09	5.8E-11	0	2.30E-08	1.05E-09	2.90E-11	0
dibenzo(a,h)anthracene	1.6	3.7E-08	1.7E-09	4.6E-11	0	2.31E-08	1.06E-09	2.88E-11	0
arsenic	6.2	1.4E-07	3.3E-10	1.8E-10	0	2.26E-08	5.32E-11	2.90E-11	0

CS = Concentration in Soil

Potential Dose Factor = $\frac{\text{Intake}}{\text{CS}}$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Trenches
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	4E-10	8E-12	4E-13	0
vinyl chloride	1.9	1.9	0.29	2E-07	5E-09	4E-11	0
benzo(k)fluoranthene	0.073	0	0.061	1E-09	0	1E-12	0
benzo(a)anthracene	0.73	0	0.61	1E-08	0	1E-11	0
chrysene	0.0073	0	0.0061	7E-10	0	7E-13	0
benzo(b)fluoranthene	0.73	0	0.61	1E-08	0	1E-11	0
benzo(a)pyrene	7.3	0	6.1	**1E-06**	0	1E-09	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	3E-08	0	4E-11	0
dibenzo(a,h)anthracene	7.3	0	6.1	3E-07	0	3E-10	0
arsenic	1.75	1.75	50	2E-07	6E-10	9E-09	0

CSF = Cancer Slope Factor

Risk = Cancer Slope Factor * Potential Dose Factor * Concentration in Soil

BOLD = Chemical/Pathway Risks Greater Than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk – Based Remediation Goals

Current Child Trespasser/Recreational User
Trenches
Step 3: Calculation of Preliminary Health Risk – Based Remedial Goals (PHRBRGs)

Chemical	Risk	PDF ingestion (1/day)	CSF ingestion (kg – day/mg)	PHRBRG ingestion (mg/kg)
benzo(a)pyrene	1E – 06	2.25E – 08	7.3	6.1

PDF = Potential Dose Factor

CSF = Cancer Slope Factor

PHRBRGs = Preliminary Health Risk – Based Remedial Goals

$$\text{PHRBRGs} = \frac{\text{Allowable Risk (1E-6)}}{\text{PDF} * \text{CSF}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Waste Pile
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	299	6.9E-06	1.6E-07	8.6E-09	2.4E-04	2.31E-08	5.35E-10	2.88E-11	8.03E-07
vinyl chloride	21	4.9E-07	1.1E-08	6.1E-10	2.4E-02	2.33E-08	5.24E-10	2.90E-11	1.14E-03
benzo(k)fluoranthene	211	4.9E-06	2.2E-07	6.1E-09	0	2.32E-08	1.04E-09	2.89E-11	0
benzo(a)anthracene	429	9.9E-06	4.5E-07	1.2E-08	0	2.31E-08	1.05E-09	2.80E-11	0
chrysene	404	9.3E-06	4.3E-07	1.2E-08	0	2.30E-08	1.06E-09	2.97E-11	0
benzo(b)fluoranthene	211	4.9E-06	2.2E-07	6.1E-09	0	2.32E-08	1.04E-09	2.89E-11	0
benzo(a)pyrene	197	4.5E-06	2.1E-07	5.7E-09	0	2.28E-08	1.07E-09	2.89E-11	0
indeno(1,2,3-c,d)pyrene	208	4.8E-06	2.2E-07	6.0E-09	0	2.31E-08	1.06E-09	2.88E-11	0
dibenzo(a,h)anthracene	209	4.8E-06	2.2E-07	6.0E-09	0	2.30E-08	1.05E-09	2.87E-11	0
arsenic	9	2.0E-07	4.6E-10	2.5E-10	0	2.22E-08	5.11E-11	2.78E-11	0

CS = Concentration in Soil

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Waste Pile
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	2E-07	5E-09	3E-10	**7E-06**
vinyl chloride	1.9	1.9	0.29	9E-07	2E-08	2E-10	**7E-03**
benzo(k)fluoranthene	0.073	0	0.061	4E-07	0	4E-10	0
benzo(a)anthracene	0.73	0	0.61	**7E-06**	0	7E-09	0
chrysene	0.0073	0	0.0061	7E-08	0	7E-11	0
benzo(b)fluoranthene	0.73	0	0.61	**4E-06**	0	4E-09	0
benzo(a)pyrene	7.3	0	6.1	**3E-05**	0	3E-08	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	**4E-06**	0	4E-09	0
dibenzo(a,h)anthracene	7.3	0	6.1	**4E-05**	0	4E-08	0
arsenic	1.75	1.75	50	4E-07	8E-10	1E-08	0

CSF = Cancer Slope Factor

Risk = Cancer Slope Factor * Potential Dose Factor * Concentration in Soil

BOLD = Chemical/Pathway Risks Greater Than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Waste Pile
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk	PDF ingestion	CSF ingestion	PHRBRG mg/kg
benzo(a)anthracene	1E-06	2.31E-08	0.73	59.4
benzo(b)fluoranthene	1E-06	2.32E-08	0.73	59.0
benzo(a)pyrene	1E-06	2.28E-08	7.3	6.0
indeno(1,2,3-c,d)pyrene	1E-06	2.31E-08	0.73	59.4
dibenzo(a,h)anthracene	1E-06	2.30E-08	7.3	6.0

Chemical	Risk	PDF vol. inh.	CSF vol. inh.	PHRBRG mg/kg
benzene	1E-06	8.03E-07	0.0292	42.7
vinyl chloride	1E-06	1.14E-03	0.29	0.003

PDF = Potential Dose Factor

CSF = Cancer Slope Factor

PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$\text{PHRBRGs} = \frac{\text{Allowable Risk (1E-6)}}{\text{PDF * CSF}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Willow Creek Sediment
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	4.4	1.0E-08	0	0	0	2.27E-09	0	0	0
chrysene	6.2	1.4E-08	0	0	0	2.26E-09	0	0	0
benzo(b)fluoranthene	6.5	1.5E-08	0	0	0	2.31E-09	0	0	0
benzo(a)pyrene	1.8	4.2E-09	0	0	0	2.33E-09	0	0	0
indeno(1,2,3-c,d)pyrene	2.1	4.9E-09	0	0	0	2.33E-09	0	0	0
dibenzo(a,h)anthracene	0.4	9.4E-10	0	0	0	2.35E-09	0	0	0

CS = Concentration in Sediment

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Current Child Trespasser/Recreational User
Willow Creek Sediment
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	0.73	0	0.61	7E-09	0	0	0
chrysene	0.0073	0	0.0061	1E-10	0	0	0
benzo(b)fluoranthene	0.73	0	0.61	1E-08	0	0	0
benzo(a)pyrene	7.3	0	6.1	3E-08	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	4E-09	0	0	0
dibenzo(a,h)anthracene	7.3	0	6.1	7E-09	0	0	0

CSF = Cancer Slope Factor

Risk = Cancer Slope Factor * Potential Dose Factor * Concentration in Soil

BOLD = Chemical/Pathway Risks Greater Than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk – Based Remediation Goals

Current Child Trespasser/Recreational User
Willow Creek Sediment
Step 3: Calculation of Preliminary Health Risk – Based Remedial Goals (PHRBRGs)

NONE

Mason City, Iowa
Determination of Preliminary Health Risk–Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On–Site Subsurface Soil
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg–day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	0.8	4.0E–08	6.8E–09	3.7E–10	0	5.0E–08	8.5E–09	4.6E–10	0
vinyl chloride	2.5	1.2E–07	2.1E–08	1.1E–09	0	4.8E–08	8.4E–09	4.4E–10	0
benzo(k)fluoranthene	11.8	5.7E–07	4.9E–07	5.3E–09	0	4.8E–08	4.2E–08	4.5E–10	0
benzo(a)anthracene	34	1.6E–06	1.4E–06	1.5E–08	0	4.7E–08	4.1E–08	4.4E–10	0
chrysene	30	1.4E–06	1.2E–06	1.3E–08	0	4.7E–08	4.0E–08	4.3E–10	0
benzo(b)fluoranthene	19.5	9.4E–07	8.1E–07	9.3E–09	0	4.8E–08	4.2E–08	4.8E–10	0
benzo(a)pyrene	70	3.4E–06	2.9E–06	3.2E–08	0	4.9E–08	4.1E–08	4.6E–10	0
indeno(1,2,3–c,d)pyrene	6.1	2.9E–07	2.6E–07	2.8E–09	0	4.8E–08	4.3E–08	4.6E–10	0
dibenzo(a,h)anthracene	12.5	6.0E–07	5.1E–07	5.6E–09	0	4.8E–08	4.1E–08	4.5E–10	0
arsenic	35.4	1.7E–06	2.9E–08	1.6E–08	0	4.8E–08	8.2E–10	4.5E–10	0

CS = Concentration in Soil

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk–Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On–Site Subsurface Soil
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg–day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	2.9E–02	2.9E–02	1.2E–09	2.0E–10	1.1E–11	0
vinyl chloride	1.9	1.9E+00	2.9E–01	2.3E–07	4.0E–08	3.2E–10	0
benzo(k)fluoranthene	0.073	0	6.1E–02	4.2E–08	0	3.2E–10	0
benzo(a)anthracene	0.73	0	6.1E–01	**1.2E–06**	0	9.2E–09	0
chrysene	0.0073	0	6.1E–03	1.0E–08	0	7.9E–11	0
benzo(b)fluoranthene	0.73	0	6.1E–01	6.9E–07	0	5.7E–09	0
benzo(a)pyrene	7.3	0	6.1E+00	**2.5E–05**	0	2.0E–07	0
indeno(1,2,3–c,d)pyrene	0.73	0	6.1E–01	2.1E–07	0	1.7E–09	0
dibenzo(a,h)anthracene	7.3	0	6.1E+00	**4.4E–06**	0	3.4E–08	0
arsenic	1.75	1.8E+00	5.0E+01	**3.0E–06**	5.1E–08	8.0E–07	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On-Site Subsurface Soil
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk Ingestion	PDF ingestion	CSF ingestion	PHRBRG ingestion
benzo(a)anthracene	1E-06	4.7E-08	7.3E-01	2.9E+01
benzo(a)pyrene	1E-06	4.9E-08	7.3E+00	2.8E+00
dibenzo(a,h)anthracene	1E-06	4.8E-08	7.3E+00	2.9E+00
arsenic	1E-06	4.8E-08	1.8E+00	1.2E+01

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$\text{PHRBRGs} = \frac{\text{Allowable Risk (1E-6)}}{\text{PDF * CSF}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On-site Surface Soil
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	0.3	1.2E-08	2.1E-09	1.1E-10	0	4.0E-08	7.0E-09	3.7E-10	0
vinyl chloride	2.5	1.2E-07	2.1E-08	1.1E-09	0	4.8E-08	8.4E-09	4.4E-10	0
benzo(k)fluoranthene	7.6	3.7E-07	3.1E-07	3.4E-09	0	4.9E-08	4.1E-08	4.5E-10	0
benzo(a)anthracene	6.1	2.5E-07	2.1E-07	2.3E-09	0	4.1E-08	3.4E-08	3.8E-10	0
chrysene	6.1	2.9E-07	2.5E-07	2.7E-09	0	4.8E-08	4.1E-08	4.4E-10	0
benzo(b)fluoranthene	6.3	3.0E-07	2.6E-07	2.8E-09	0	4.8E-08	4.1E-08	4.4E-10	0
benzo(a)pyrene	20	9.7E-07	8.2E-07	9.0E-09	0	4.9E-08	4.1E-08	4.5E-10	0
indeno(1,2,3-c,d)pyrene	0.4	2.0E-08	1.7E-08	1.9E-10	0	5.0E-08	4.3E-08	4.8E-10	0
dibenzo(a,h)anthracene	1.6	7.7E-08	6.6E-08	7.2E-10	0	4.8E-08	4.1E-08	4.5E-10	0
arsenic	7.5	3.6E-07	6.2E-09	3.4E-09	0	4.8E-08	8.3E-10	4.5E-10	0

CS = Concentration in Soil

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On-site Surface Soil
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

Chemical	CSF (kg-day/mg) ingestion	dermal	inhalation	Risk ingestion	dermal	inhalation
benzene	0.0292	2.9E-02	2.9E-02	3.5E-10	6.1E-11	3.2E-12
vinyl chloride	1.9	1.9E+00	2.9E-01	2.3E-07	4.0E-08	3.2E-10
benzo(k)fluoranthene	0.073	0	6.1E-02	2.7E-08	0	2.1E-10
benzo(a)anthracene	0.73	0	6.1E-01	1.8E-07	0	1.4E-09
chrysene	0.0073	0	6.1E-03	2.1E-09	0	1.6E-11
benzo(b)fluoranthene	0.73	0	6.1E-01	2.2E-07	0	1.7E-09
benzo(a)pyrene	7.3	0	6.1E+00	**7.1E-06**	0	5.5E-08
indeno(1,2,3-c,d)pyrene	0.73	0	6.1E-01	1.5E-08	0	1.2E-10
dibenzo(a,h)anthracene	7.3	0	6.1E+00	5.6E-07	0	4.4E-09
arsenic	1.75	1.8E+00	5.0E+01	6.3E-07	1.1E-08	1.7E-07

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risks Greater than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk–Based Remediation Goals

Future Adult Resident\Worker\Recreational User
On–site Surface Soil
Step 3: Calculation of Preliminary Health Risk–Based Remedial Goals (PHRBRGs)

Chemical	Risk Ingestion	PDF ingestion	CSF ingestion	PHRBRG ingestion
benzo(a)pyrene	1E–06	4.9E–08	7.3E+00	2.8E+00

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk–Based Remedial Goals

$$\text{PHRBRGs} = \frac{\text{Allowable Risk (1E–6)}}{\text{PDF * CSF}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Sediment
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	4.4	2.9E-08	0	0	0	6.6E-09	0	0	0
chrysene	6.2	4.2E-08	0	0	0	6.8E-09	0	0	0
benzo(b)fluoranthene	6.5	4.4E-08	0	0	0	6.8E-09	0	0	0
benzo(a)pyrene	1.8	1.2E-08	0	0	0	6.7E-09	0	0	0
indeno(1,2,3-c,d)pyrene	2.1	1.4E-08	0	0	0	6.7E-09	0	0	0
dibenzo(a,h)anthracene	0.4	2.7E-09	0	0	0	6.8E-09	0	0	0

CS = Concentration in Sediment

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Sediment
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	0.73	0	6.1E-01	2.1E-08	0	0	0
chrysene	0.0073	0	6.1E-03	3.1E-10	0	0	0
benzo(b)fluoranthene	0.73	0	6.1E-01	3.2E-08	0	0	0
benzo(a)pyrene	7.3	0	6.1E+00	8.8E-08	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	6.1E-01	1.0E-08	0	0	0
dibenzo(a,h)anthracene	7.3	0	6.1E+00	2.0E-08	0	0	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

Mason City, Iowa
Determination of Preliminary Health Risk – Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Sediment
Step 3: Calculation of Preliminary Health Risk – Based Remedial Goals (PHRBRGs)

NONE

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Fish
Step 1: Calculation of Potential Dose Factors

Chemical	CF (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	60.1	2.2E-09	0	0	0	3.7E-11	0	0	0
chrysene	84.7	3.1E-09	0	0	0	3.7E-11	0	0	0
benzo(b)fluoranthene	64.7	2.3E-09	0	0	0	3.6E-11	0	0	0
benzo(a)pyrene	20.8	7.5E-10	0	0	0	3.6E-11	0	0	0
indeno(1,2,3-c,d)pyrene	27	9.8E-10	0	0	0	3.6E-11	0	0	0

CF = Concentration in Fish

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CF}}$$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Fish
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	0.73	0	6.1E-01	1.6E-09	0	0	0
chrysene	0.0073	0	6.1E-03	2.3E-11	0	0	0
benzo(b)fluoranthene	0.73	0	6.1E-01	1.7E-09	0	0	0
benzo(a)pyrene	7.3	0	6.1E+00	5.5E-09	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	6.1E-01	7.2E-10	0	0	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

Mason City, Iowa
Determination of Preliminary Health Risk–Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Willow Creek Fish
Step 3: Calculation of Preliminary Health Risk–Based Remedial Goals (PHRBRGs)

NONE

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Groundwater - MW-23
Step 1: Calculation of Potential Dose Factors

Chemical	CW ug/L	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	193	2.3E-03	4.2E-04	0	1.8E-03	1.2E-05	2.2E-06	0	9.3E-06
benzo(k)fluoranthene	17	1.9E-04	4.0E-04	0	1.5E-04	1.1E-05	2.4E-05	0	8.8E-06
benzo(a)anthracene	184	2.2E-03	3.0E-03	0	1.7E-03	1.2E-05	1.6E-05	0	9.2E-06
chrysene	387	4.5E-03	6.3E-03	0	3.6E-03	1.2E-05	1.6E-05	0	9.3E-06
benzo(b)fluoranthene	35	4.1E-04	8.3E-04	0	3.2E-04	1.2E-05	2.4E-05	0	9.1E-06
benzo(a)pyrene	64	7.5E-04	1.5E-03	0	5.9E-04	1.2E-05	2.3E-05	0	9.2E-06
indeno(1,2,3-c,d)pyrene	3	3.0E-05	9.6E-05	0	2.3E-06	1.0E-05	3.2E-05	0	7.7E-07
dibenzo(a,h)anthracene	1.4	1.6E-05	7.5E-05	0	1.3E-05	1.1E-05	5.4E-05	0	9.3E-06

CW = Concentration in Groundwater

Potential Dose Factor = $\frac{\text{Intake}}{\text{CW}}$

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Groundwater - MW-23
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	2.9E-02	2.9E-02	**6.7E-05**	**1.2E-05**	0	**5.3E-05**
benzo(k)fluoranthene	0.073	0	6.1E-02	**1.4E-05**	0	0	0
benzo(a)anthracene	0.73	0	6.1E-01	**1.6E-03**	0	0	0
chrysene	0.0073	0	6.1E-03	**3.3E-05**	0	0	0
benzo(b)fluoranthene	0.73	0	6.1E-01	**3.0E-04**	0	0	0
benzo(a)pyrene	7.3	0	6.1E+00	**5.5E-03**	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	6.1E-01	**2.2E-05**	0	0	0
dibenzo(a,h)anthracene	7.3	0	6.1E+00	**1.2E-04**	0	0	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risks Greater than 1E-6

Mason City, Iowa
Determination of Preliminary Health Risk-Based Remediation Goals

Future Adult Resident\Worker\Recreational User
Groundwater - MW-23
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk ingestion	PDF ingestion	CSF ingestion	PHRBRG ug/L
benzene	1E-06	1.2E-05	2.9E-02	2.9E+00
benzo(k)fluoranthene	1E-06	1.1E-05	7.3E-02	1.2E+00
benzo(a)anthracene	1E-06	1.2E-05	7.3E-01	1.1E-01
chrysene	1E-06	1.2E-05	7.3E-03	1.2E+01
benzo(b)fluoranthene	1E-06	1.2E-05	7.3E-01	1.2E-01
benzo(a)pyrene	1E-06	1.2E-05	7.3E+00	1.2E-02
indeno(1,2,3-c,d)pyrene	1E-06	1.0E-05	7.3E-01	1.4E-01
dibenzo(a,h)anthracene	1E-06	1.1E-05	7.3E+00	1.2E-02

Chemical	Risk dermal	PDF dermal	CSF dermal	PHRBRG ug/L
benzene	1E-06	2.2E-06	2.9E-02	1.6E+01

Chemical	Risk vol. inh.	PDF vol. inh.	CSF vol. inh.	PHRBRG ug/L
benzene	1E-06	9.3E-06	2.9E-02	3.7E+00

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$PHRBRGs = \frac{\text{Allowable Risk (1E-6)}}{PDF * CSF}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
On-Site Surface Soil
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	0.3	6.8E-09	1.3E-10	7.2E-12	0	2.27E-08	4.33E-10	2.40E-11	0
vinyl chloride	2.5	5.8E-08	1.3E-09	7.2E-11	0	2.32E-08	5.20E-10	2.88E-11	0
benzo(k)fluoranthene	7.6	1.6E-07	8.1E-09	2.2E-10	0	2.11E-08	1.07E-09	2.89E-11	0
benzo(a)anthracene	5.1	1.2E-07	5.4E-09	1.5E-10	0	2.35E-08	1.06E-09	2.94E-11	0
chrysene	6.1	1.4E-07	6.4E-09	1.7E-10	0	2.30E-08	1.05E-09	2.79E-11	0
benzo(b)fluoranthene	6.3	1.4E-07	6.6E-09	1.8E-10	0	2.22E-08	1.05E-09	2.86E-11	0
benzo(a)pyrene	20	4.6E-07	2.1E-08	5.8E-10	0	2.30E-08	1.05E-09	2.90E-11	0
indeno(1,2,3-c,d)pyrene	0.4	9.6E-09	4.4E-10	1.2E-11	0	2.40E-08	1.10E-09	3.00E-11	0
dibenzo(a,h)anthracene	1.6	3.7E-08	1.7E-09	4.6E-11	0	2.31E-08	1.06E-09	2.88E-11	0
arsenic	7.5	1.7E-07	4.0E-10	2.2E-10	0	2.27E-08	5.33E-11	2.93E-11	0

CS = Concentration in Soil

Potential Dose Factor = $\frac{\text{Intake}}{\text{CS}}$

Mason City, Iowa
Determination of Risk–Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
On–Site Surface Soil
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg–day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	2E–10	4E–12	2E–13	0
vinyl chloride	1.9	1.9	0.29	1E–07	2E–09	2E–11	0
benzo(k)fluoranthene	0.073	0	0.061	1E–08	0	1E–11	0
benzo(a)anthracene	0.73	0	0.61	9E–08	0	9E–11	0
chrysene	0.0073	0	0.0061	1E–09	0	1E–12	0
benzo(b)fluoranthene	0.73	0	0.61	1E–07	0	1E–10	0
benzo(a)pyrene	7.3	0	6.1	**3E–06**	0	4E–09	0
indeno(1,2,3–c,d)pyrene	0.73	0	0.61	7E–09	0	7E–12	0
dibenzo(a,h)anthracene	7.3	0	6.1	3E–07	0	3E–10	0
arsenic	1.75	1.75	50	3E–07	7E–10	1E–08	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risk Greater than 1E–6

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
On-Site Surface Soil
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk ingestion	PDF ingestion	CSF ingestion	PHRBRG ingestion
benzo(a)pyrene	1E-06	2.30E-08	7.3	6.0

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$PHRBRGs = \frac{\text{Allowable Risk (1E-6)}}{PDF * CSF}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Trenches
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	0.5	1.2E-08	2.6E-10	1.4E-11	0	2.40E-08	5.20E-10	2.80E-11	0
vinyl chloride	5	1.2E-07	2.6E-09	1.4E-10	0	2.40E-08	5.20E-10	2.80E-11	0
benzo(k)fluoranthene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
benzo(a)anthracene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
chrysene	4	9.2E-08	4.2E-09	1.2E-10	0	2.30E-08	1.05E-09	3.00E-11	0
benzo(b)fluoranthene	0.8	1.8E-08	8.5E-10	2.3E-11	0	2.25E-08	1.06E-09	2.88E-11	0
benzo(a)pyrene	8	1.8E-07	8.5E-09	2.3E-10	0	2.25E-08	1.06E-09	2.88E-11	0
indeno(1,2,3-c,d)pyrene	2	4.6E-08	2.1E-09	5.8E-11	0	2.30E-08	1.05E-09	2.90E-11	0
dibenzo(a,h)anthracene	1.6	3.7E-08	1.7E-09	4.6E-11	0	2.31E-08	1.06E-09	2.88E-11	0
arsenic	6.2	1.4E-07	3.3E-10	1.8E-10	0	2.26E-08	5.32E-11	2.90E-11	0

CS = Concentration in Soil

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Trenches
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	4E-10	8E-12	4E-13	0
vinyl chloride	1.9	1.9	0.29	2E-07	5E-09	4E-11	0
benzo(k)fluoranthene	0.073	0	0.061	1E-09	0	1E-12	0
benzo(a)anthracene	0.73	0	0.61	1E-08	0	1E-11	0
chrysene	0.0073	0	0.0061	7E-10	0	7E-13	0
benzo(b)fluoranthene	0.73	0	0.61	1E-08	0	1E-11	0
benzo(a)pyrene	7.3	0	6.1	**1E-06**	0	1E-09	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	3E-08	0	4E-11	0
dibenzo(a,h)anthracene	7.3	0	6.1	3E-07	0	3E-10	0
arsenic	1.75	1.75	50	2E-07	6E-10	9E-09	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risk Greater than 1E-6

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Trenches
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk ingestion	PDF ingestion	CSF ingestion	PHRBRG ingestion
benzo(a)pyrene	1E-06	2.25E-08	7.3	6.1

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$PHRBRGs = \frac{\text{Allowable Risk (1E-6)}}{PDF * CSF}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Waste Pile
Step 1: Calculation of Potential Dose Factors

	CS	Intake (mg/kg-day)				Potential Dose Factor (1/day)			
Chemical	(mg/kg)	ingestion	dermal	inhalation	vol. inh.	ingestion	dermal	inhalation	vol. inh.
benzene	299	6.9E-06	1.6E-07	8.6E-09	2.4E-04	2.31E-08	5.35E-10	2.88E-11	8.03E-07
vinyl chloride	21	4.9E-07	1.1E-08	6.1E-10	2.4E-02	2.33E-08	5.24E-10	2.90E-11	1.14E-03
benzo(k)fluoranthene	211	4.9E-06	2.2E-07	6.1E-09	0	2.32E-08	1.04E-09	2.89E-11	0
benzo(a)anthracene	429	9.9E-06	4.5E-07	1.2E-08	0	2.31E-08	1.05E-09	2.80E-11	0
chrysene	404	9.3E-06	4.3E-07	1.2E-08	0	2.30E-08	1.06E-09	2.97E-11	0
benzo(b)fluoranthene	211	4.9E-06	2.2E-07	6.1E-09	0	2.32E-08	1.04E-09	2.89E-11	0
benzo(a)pyrene	197	4.5E-06	2.1E-07	5.7E-09	0	2.28E-08	1.07E-09	2.89E-11	0
indeno(1,2,3-c,d)pyrene	208	4.8E-06	2.2E-07	6.0E-09	0	2.31E-08	1.06E-09	2.88E-11	0
dibenzo(a,h)anthracene	209	4.8E-06	2.2E-07	6.0E-09	0	2.30E-08	1.05E-09	2.87E-11	0
arsenic	9	2.0E-07	4.6E-10	2.5E-10	0	2.22E-08	5.11E-11	2.78E-11	0

CS = Concentration in Soil

Potential Dose Factor = $\frac{\text{Intake}}{\text{CS}}$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Waste Pile
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	2E-07	5E-09	3E-10	**7E-06**
vinyl chloride	1.9	1.9	0.29	9E-07	2E-08	2E-10	**7E-03**
benzo(k)fluoranthene	0.073	0	0.061	4E-07	0	4E-10	0
benzo(a)anthracene	0.73	0	0.61	**7E-06**	0	7E-09	0
chrysene	0.0073	0	0.0061	7E-08	0	7E-11	0
benzo(b)fluoranthene	0.73	0	0.61	**4E-06**	0	4E-09	0
benzo(a)pyrene	7.3	0	6.1	**3E-05**	0	3E-08	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	**4E-06**	0	4E-09	0
dibenzo(a,h)anthracene	7.3	0	6.1	**4E-05**	0	4E-08	0
arsenic	1.75	1.75	50	4E-07	8E-10	1E-08	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risk Greater than 1E-6

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Waste Pile
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk ingestion	PDF ingestion	CSF ingestion	PHRBRG mg/kg
benzo(a)anthracene	1E-06	2.31E-08	0.73	59.4
benzo(b)fluoranthene	1E-06	2.32E-08	0.73	59.0
benzo(a)pyrene	1E-06	2.28E-08	7.3	6.0
indeno(1,2,3-c,d)pyrene	1E-06	2.31E-08	0.73	59.4
dibenzo(a,h)anthracene	1E-06	2.30E-08	7.3	6.0

Chemical	Risk vol. inh.	PDF vol. inh.	CSF vol. inh.	PHRBRG mg/kg
benzene	1E-06	8.03E-07	0.0292	42.7
vinyl chloride	1E-06	1.14E-03	0.29	0.003

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$\text{PHRBRGs} = \frac{\text{Allowable Risk (1E-6)}}{\text{PDF * CSF}}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Willow Creek Sediment
Step 1: Calculation of Potential Dose Factors

Chemical	CS (mg/kg)	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	4.4	1.0E-08	0	0	0	2.27E-09	0	0	0
chrysene	6.2	1.4E-08	0	0	0	2.26E-09	0	0	0
benzo(b)fluoranthene	6.5	1.5E-08	0	0	0	2.31E-09	0	0	0
benzo(a)pyrene	1.8	4.2E-09	0	0	0	2.33E-09	0	0	0
indeno(1,2,3-c,d)pyrene	2.1	4.9E-09	0	0	0	2.33E-09	0	0	0
dibenzo(a,h)anthracene	0.4	9.4E-10	0	0	0	2.35E-09	0	0	0

CS = Concentration in Sediment

$$\text{Potential Dose Factor} = \frac{\text{Intake}}{\text{CS}}$$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Willow Creek Sediment
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzo(a)anthracene	0.73	0	0.61	7E-09	0	0	0
chrysene	0.0073	0	0.0061	1E-10	0	0	0
benzo(b)fluoranthene	0.73	0	0.61	1E-08	0	0	0
benzo(a)pyrene	7.3	0	6.1	3E-08	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	4E-09	0	0	0
dibenzo(a,h)anthracene	7.3	0	6.1	7E-09	0	0	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

Mason City, Iowa
Determination of Risk – Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Willow Creek Sediment
Step 3: Calculation of Preliminary Health Risk – Based Remedial Goals (PHRBRGs)

NONE

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Groundwater - MW-23
Step 1: Calculation of Potential Dose Factors

Chemical	CW ug/L	Intake (mg/kg-day) ingestion	dermal	inhalation	vol. inh.	Potential Dose Factor (1/day) ingestion	dermal	inhalation	vol. inh.
benzene	193	4.7E-04	7.9E-05	0	4.0E-04	2.44E-06	4.09E-07	0	2.07E-06
benzo(k)fluoranthene	17	4.0E-05	7.4E-05	0	3.4E-05	2.35E-06	4.35E-06	0	2.00E-06
benzo(a)anthracene	184	4.4E-04	5.6E-04	0	3.8E-04	2.39E-06	3.04E-06	0	2.07E-06
chrysene	387	9.4E-04	1.2E-03	0	8.0E-04	2.43E-06	3.10E-06	0	2.07E-06
benzo(b)fluoranthene	35	8.4E-05	1.6E-04	0	7.2E-05	2.40E-06	4.57E-06	0	2.06E-06
benzo(a)pyrene	64	1.5E-04	2.8E-04	0	1.3E-04	2.34E-06	4.38E-06	0	2.03E-06
indeno(1,2,3-c,d)pyrene	3	6.1E-06	1.8E-05	0	5.2E-06	2.03E-06	6.00E-06	0	1.73E-06
dibenzo(a,h)anthracene	1.4	3.4E-06	1.4E-05	0	2.9E-06	2.43E-06	1.00E-05	0	2.07E-06

CW = Concentration in Groundwater

Potential Dose Factor = $\frac{\text{Intake}}{\text{CW}}$

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Groundwater - MW-23
Step 2: Validation of Potential Dose Factors to Baseline Risk Estimates

	CSF (kg-day/mg)			Risk			
Chemical	ingestion	dermal	inhalation	ingestion	dermal	inhalation	vol. inh.
benzene	0.0292	0.0292	0.0292	**1E-05**	**2E-06**	0	**1E-05**
benzo(k)fluoranthene	0.073	0	0.061	**3E-06**	0	0	0
benzo(a)anthracene	0.73	0	0.61	**3E-04**	0	0	0
chrysene	0.0073	0	0.0061	**7E-06**	0	0	0
benzo(b)fluoranthene	0.73	0	0.61	**6E-05**	0	0	0
benzo(a)pyrene	7.3	0	6.1	**1E-03**	0	0	0
indeno(1,2,3-c,d)pyrene	0.73	0	0.61	**4E-06**	0	0	0
dibenzo(a,h)anthracene	7.3	0	6.1	**2E-05**	0	0	0

CSF = Cancer Slope Factor

Risk = CSF * PDF

BOLD = Chemical/Pathway Risk Greater than 1E-6

Mason City, Iowa
Determination of Risk-Based Preliminary Remediation Goals

Future Child Resident\Trespasser\Recreational User
Groundwater - MW-23
Step 3: Calculation of Preliminary Health Risk-Based Remedial Goals (PHRBRGs)

Chemical	Risk ingestion	PDF ingestion	CSF ingestion	PHRBRG ug/L
benzene	1E-06	2.44E-06	0.0292	14.1
benzo(k)fluoranthene	1E-06	2.35E-06	0.073	5.8
benzo(a)anthracene	1E-06	2.39E-06	0.73	0.6
chrysene	1E-06	2.43E-06	0.0073	56.4
benzo(b)fluoranthene	1E-06	2.40E-06	0.73	0.6
benzo(a)pyrene	1E-06	2.34E-06	7.3	0.1
indeno(1,2,3-c,d)pyrene	1E-06	2.03E-06	0.73	0.7
dibenzo(a,h)anthracene	1E-06	2.43E-06	7.3	0.1

Chemical	Risk dermal	PDF dermal	CSF dermal	PHRBRG ug/L
benzene	1E-06	4.09E-07	0.0292	83.7

Chemical	Risk vol. inh.	PDF vol. inh.	CSF vol. inh.	PHRBRG ug/L
benzene	1E-06	2.07E-06	0.0292	16.5

PDF = Potential Dose Factor
CSF = Cancer Slope Factor
PHRBRGs = Preliminary Health Risk-Based Remedial Goals

$$PHRBRGs = \frac{\text{Allowable Risk (1E-6)}}{PDF * CSF}$$

APPENDIX C

SOIL VOLUME CALCULATIONS

The volumes of soil requiring remedial action were calculated. The calculations were performed for three risk levels (10^{-4}, 10^{-5}, and 10^{-6} carcinogenic health risk) based on three different risk-based, compound-specific remediation goals for benzene, vinyl chloride, and carcinogenic PAHs. Benzene, vinyl chloride, and PAHs were previously identified as the primary compounds of concern for soils. These goals were developed in detail in section 2 of this report.

The areas with impacted soils with concentration levels exceeding the three different remediation goals were first located and outlined on a base map of the site. Historical soil results for PAHs which were summarized in the RIA Report dated April 1994 were used to identify the vertical and horizontal locations of soils with PAH concentrations in excess of of the three different risk-based remediation goals. Figures C-1, C-2, and C-3 show the areas to be excavated at the site for each of the three risk levels.

The thickness of the soils from the surface to bedrock was determined using cross section AA-AA' (RIA Report, April 1994). The depth to bedrock is irregular across the site, so the soil thickness at regular intervals was averaged. The average thickness of the soils along the cross section was 12 feet. Since excavation will occur in the area of the soil waste pile at some risk levels, the average soil thickness along Willow Creek was compared to the information in the MW-5 well log. Auger refusal on what is assumed to be bedrock occurred at 14.5 feet below grade. This was within the range of observed depths to bedrock on cross section AA-AA'.

The surface area of each of the three different areas to be excavated was calculated. This surface area for the 10^{-6} and the 10^{-5} risk scenarios was multiplied by:

- 4 feet to determine the volume of uncontaminated overburden that would have to be removed in order to reach the contaminated soils which were generally found at depth,
- 8 feet to determine the volume of contaminated soils at depth that would be excavated for treatment, and
- 1 foot to determine the volume of bedrock that can potentially be excavated and treated.

The thickness of the contaminated soils was reduced to 6 feet in the 10^{-4} risk scenario because the concentrations in soil samples from 10 to 12 feet in SS-AA were less than the calculated remediation goals. When the soil waste pile footprint overlapped an area to be excavated, no adjustment to the volume of overburden was calculated. In addition, the upper 1 foot of soil beneath and about the soil waste pile (soil waste pile footprint) is assumed to be impacted due to the long term presence of the waste pile. This value was used to calculate the volume of soil in the area of the soil waste pile when the soil waste pile did not overlap with other areas.

Many of the well logs note that concrete rubble, bricks, and limestone gravel are present in the subsurface. The volume of soils to be treated thermally (fines) was reduced by 15% because this material is generally too large for thermal treatment equipment to handle. The volume of rubble, bricks, and gravel was added to the volume of bedrock that was estimated for excavation. This volume of material will be mechanically treated to remove PAHs from the surface.

Soil Volume at 10^{-6} Risk Level

Figure C-1 illustrates the area of the site containing soils with PAH concentrations in excess of this risk-based goal. The volumes of each type of material that will require treatment as described above are:

Soil Type	Volume of Soil (in cubic yards)
overburden	1,700
PAH-impacted soils	3,900
excavated bedrock	430
large material for mechanical treatment*	1,100

* includes the excavated bedrock and 15% of PAH impacted soils, soil waste pile, and soil waste pile footprint.

Soil Volume at 10^{-5} Risk Level

Figure C-2 illustrates the area of the site containing soils with PAH concentrations in excess of this risk based goal. The volumes of each type of material that will require treatment as described above are:

Soil Type	Volume of Soil (in cubic yards)
overburden	560
PAH-impacted soils	1,750
excavated bedrock	140
large material for mechanical treatment*	445

* includes the excavated bedrock and 15% of PAH impacted soils, soil waste pile, and soil waste pile footprint.

Soil Volume at 10^{-4} Risk Level

Figure C-3 illustrates the area of the site containing soils with PAH concentrations in excess of this risk-based goal. The volumes of each type of material that will require treatment as described above are:

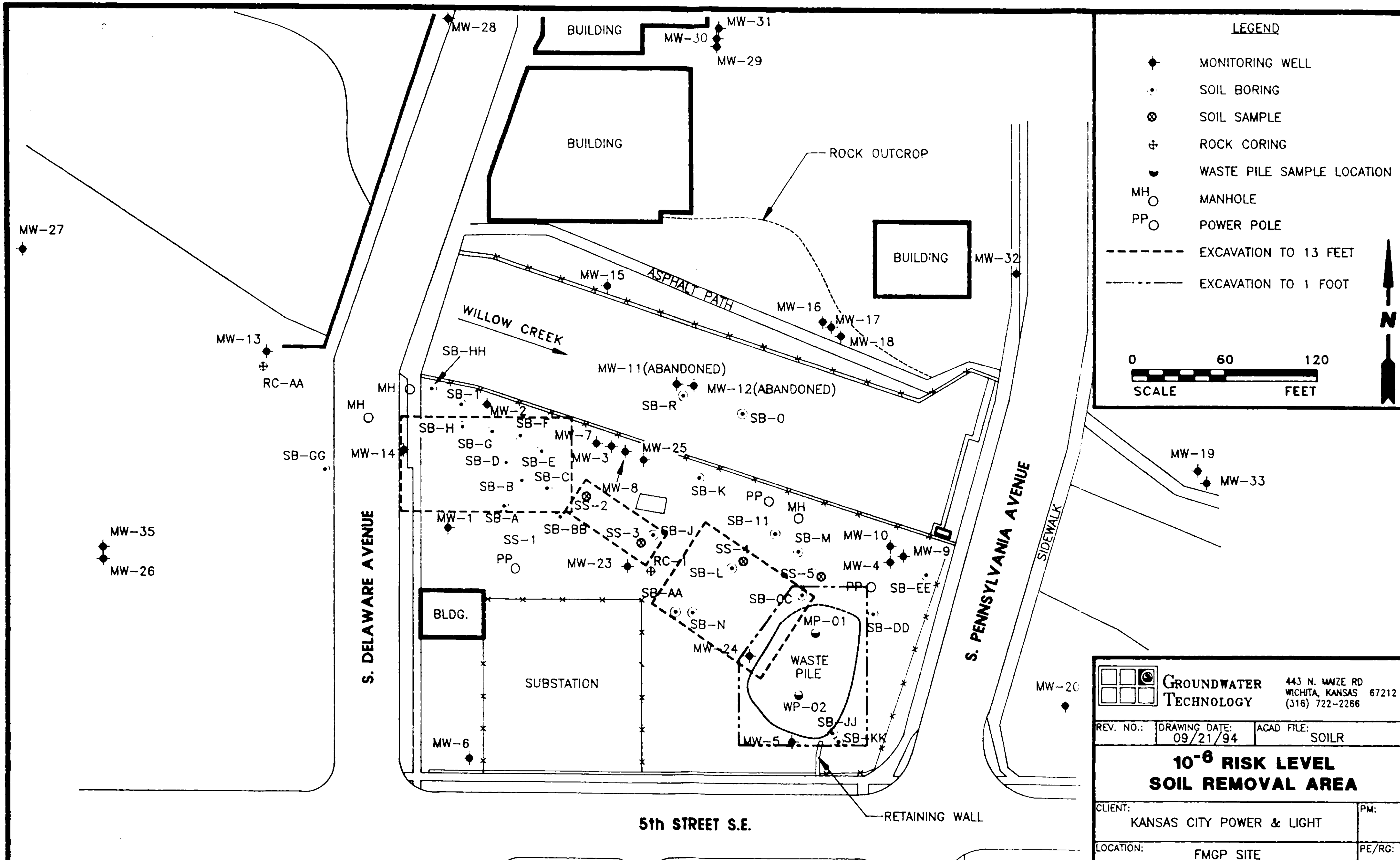
Soil Type	Volume of Soil (in cubic yards)
overburden	60
PAH-impacted soils	880
excavated bedrock	0
large material for mechanical treatment*	150

* includes the excavated bedrock and 15% of PAH-impacted soils, soil waste pile, and soil waste pile footprint.

Assumptions used in these calculations include:

- The upper 4 feet of fill is clean with the exception of the upper foot beneath the soil waste pile.
- 15% of the excavated soil will be composed of brick and concrete rubble large enough to be mechanically cleaned.
- 1 foot of the weathered limestone bedrock can be excavated without resorting to ripping or rock excavation techniques. The excavated bedrock will be large enough to be mechanically cleaned.

**{Remove this page and insert appropriate figures (C-1, C-2, C-2) for this section and any tables for apppendix C.}



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WICHITA, KANSAS 67212
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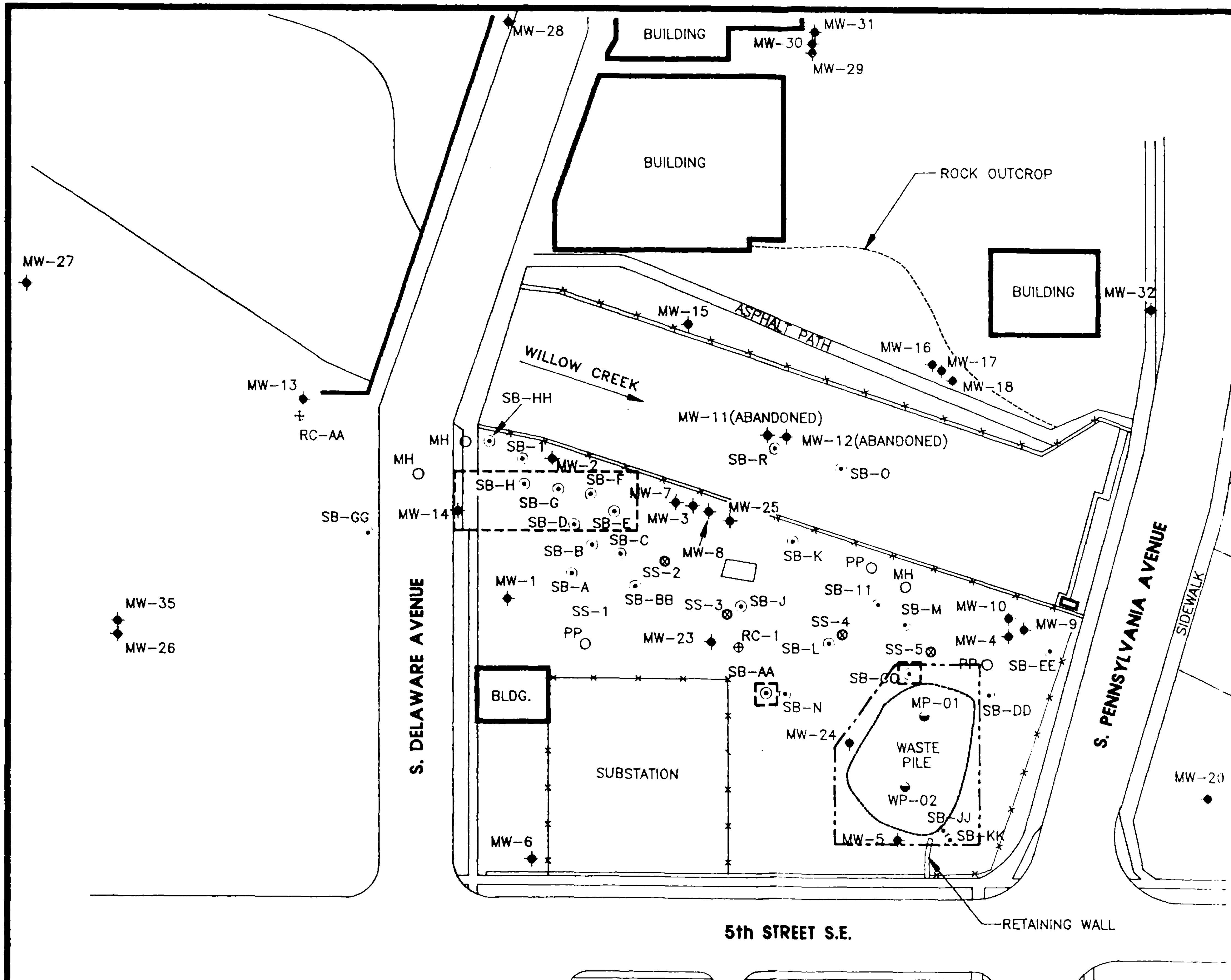
10^{-6} RISK LEVEL SOIL REMOVAL AREA

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: FMGP SITE MASON CITY, IA	PE/RG:

DESIGNED:	DETAILED: RHW	PROJECT NO.: 040021369	FIGURE: C-1



LEGEND

- MONITORING WELL
- SOIL BORING
- SOIL SAMPLE
- ROCK CORING
- WASTE PILE SAMPLE LOCATION
- MH MANHOLE
- PP POWER POLE
- EXCAVATION TO 13 FEET
- EXCAVATION TO 1 FOOT

N

0 60 120
SCALE FEET

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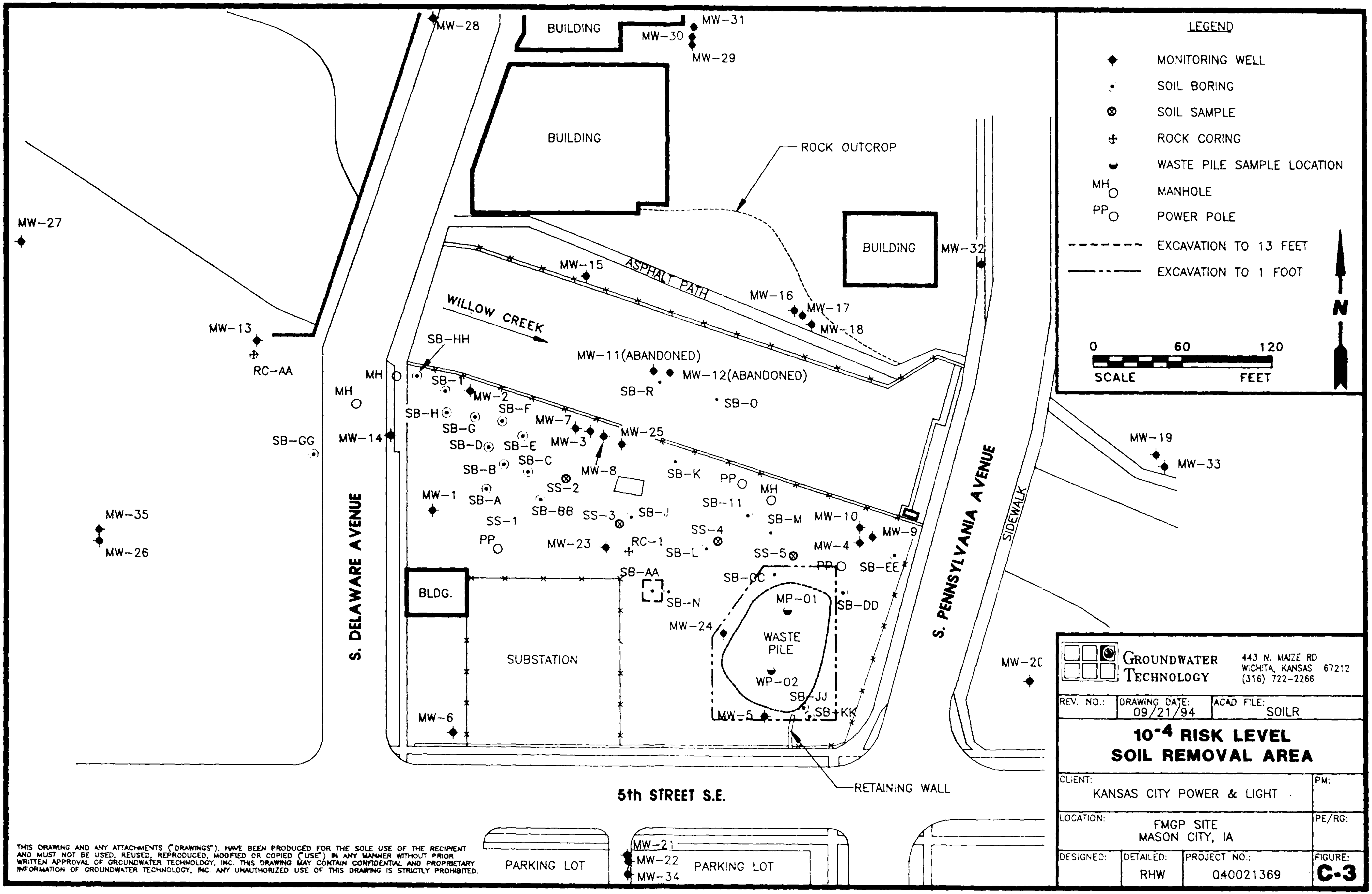
REV. NO.:	DRAWING DATE: 09/21/94	ACAD FILE: SOILR

10^{-5} RISK LEVEL SOIL REMOVAL AREA

CLIENT: KANSAS CITY POWER & LIGHT	PM:
LOCATION: FMGP SITE MASON CITY, IA	PE/RG:

DESIGNED:	DETAILED: RHW	PROJECT NO.: 040021369	FIGURE: C-2



LEGEND
MONITORING WELL
SOIL BORING
SOIL SAMPLE
ROCK CORING
WASTE PILE SAMPLE LOCATION
MH MANHOLE
PP POWER POLE
EXCAVATION TO 13 FEET
EXCAVATION TO 1 FOOT
0 60 120
SCALE FEET
N
BUILDING
BUILDING
BUILDING
BLDG.
SUBSTATION
ROCK OUTCROP
ASPHALT PATH
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
SIDEWALK
5th STREET S.E.
PARKING LOT
PARKING LOT
RETAINING WALL
WASTE PILE
MP-01
WP-02
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11(ABANDONED)
MW-12(ABANDONED)
MW-13
MW-14
MW-15
MW-16
MW-17
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
MW-24
MW-25
MW-26
MW-27
MW-28
MW-29
MW-30
MW-31
MW-32
MW-33
MW-34
MW-35
RC-AA
RC-1
SB-A
SB-B
SB-C
SB-D
SB-E
SB-F
SB-G
SB-H
SB-I
SB-J
SB-K
SB-L
SB-M
SB-N
SB-O
SB-R
SB-11
SB-AA
SB-BB
SB-CC
SB-DD
SB-EE
SB-GG
SB-HH
SB-JJ
SB-KK
SS-1
SS-2
SS-3
SS-4
SS-5
MH
PP
GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
WICHITA, KANSAS 67212
(316) 722-2266
REV. NO.:
DRAWING DATE: 09/21/94
ACAD FILE: SOILR
10^{-4} RISK LEVEL
SOIL REMOVAL AREA
CLIENT: KANSAS CITY POWER & LIGHT
PM:
LOCATION: FMGP SITE
MASON CITY, IA
PE/RG:
DESIGNED:
DETAILED: RHW
PROJECT NO.: 040021369
FIGURE: C-3
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APPENDIX D

GROUNDWATER REMOVAL RATE CALCULATIONS

Shallow Aquifer Description

The shallow aquifer consists of the saturated portion of the unconsolidated fill and approximately the upper 30 feet of the fractured limestone, shale, and dolomite bedrock. The lower bounds of the shallow aquifer is not clearly defined. However, the differences in potentiometric pressure and hydraulic conductivity between shallow bedrock and deeper bedrock become more pronounced with depth. The decreases in hydraulic conductivity with depth are attributed to a decrease in porosity and fractures as well as an increase in the frequency that shale is encountered in the boreholes.

Tables 2-10, 2-11, and 5-2 from the RIA Report dated April 1994 and table 3-16 from the RI Report dated January 1993 depict the results of slug, baildown (Skubitzke evaluation), and aquifer pumping tests performed at the site.

Conductivity in the fill material ranged from 0.0000029 centimeters per second (cm/sec) at MW-2 to 0.022 cm/sec at MW-3 with the majority of the reported hydraulic conductivities in the 0.01 to 0.001 cm/sec range. The range of hydraulic conductivity is consistent with the descriptions of the fill material.

The hydraulic conductivity of the shallow fractured bedrock ranges from 0.0086 cm/sec at MW-7 (aquifer pumping test) to 0.00047 cm/sec at MW-7 (slug test). MW-8 and MW-10 are deeper in the fractured bedrock and have hydraulic conductivities of 0.00013 cm/sec and 0.000048 cm/sec respectively.

The transmissivity of the shallow aquifer was determined by the analysis of aquifer pumping test data. The well used for the pumping test was MW-23. The average transmissivity was calculated to be 0.20 cm^2/sec or 3,100 gallons per day per foot. The average storativity from the pumping test was 0.02 (dimensionless). The values for hydraulic conductivity and storativity calculated from MW-23 data (the pumped well) were not used for the averages.

Estimated Flow Rates for Alternatives

Alternative 3 — For this alternative in which the fractured bedrock is grouted and the unconsolidated material has a containment barrier installed around it, groundwater pumping is used to reduce the head within the contained area to mitigate migration through the vertical barrier. The amount of groundwater pumped will be determined by the quantity flowing through the vertical barrier around the site, the quantity flowing vertically upward through the grouted bedrock, and the amount of recharge from surface infiltration into the area within the barrier. If the area is capped, the recharge will be reduced.

To estimate the quantity of water that would flow through the containment barrier per day, the following assumptions were made:

The water is flowing through 3 saturated feet of the barrier.

The conductivity of the barrier is 10^{-7} cm/second or 0.002 gpd/ft^2.

The gradient across the barrier is one which assumes the thickness of the barrier is negligible

The length of the barrier is 1,035 linear feet.

Under these circumstances, using standard equations, about 6 gallons of water per day (0.0042) will infiltrate through the containment barrier.

The quantity of water infiltrating vertically through the grouted bedrock was calculated in a similar fashion. It was assumed that water could flow through 27,000 square feet of area with a gradient of 1 and a conductivity of 0.002 gallon per day per square foot. Under these circumstances, about 55 gallons of water per day (0 038 gpm) will flow into the containment area.

The average annual precipitation for Mason City for the years 1951-73 was 30.23 inches. Assuming that 3 inches (one-tenth of the annual precipitation) infiltrates per year, then about 50,000 gallons of water per year will infiltrate through the surface of the area being contained. This is 140 gallons per day or 0.095 gallon per minute.

These quantities yield an estimated 0.137 gallon per day to be pumped from within the contained area. Pumping at 1 gpm or less could be accomplished using a single-sump configuration with periodic pumping The estimate should be verified prior to design and installation of pumping system.

Alternative 4 — Alternative 4 is containment of contaminated groundwater through groundwater extraction Examination of data presented in the following figures from the RI Report (January

1993): figure 3-65 — Shallow Aquifer Potentiometric Surface during the MW-23 Aquifer Pumping Test at t=36 hours; figure 3-66 — Drawdown in The Shallow Aquifer during the MW-23 Aquifer Pumping Test; and figure 3-43 — MW-23 Step Test Drawdown, suggest that the maximum pumping rate for a single recovery well completed in the shallow aquifer will be about 6 gallons per minute (gpm).

Figure D-2 depicts the predicted effect on the February 28, 1994, shallow aquifer potentiometric surface from the pumping of six recovery wells at 6 gpm. The figure was produced by subtracting the predicted drawdown of the six pumping wells from the observed potentiometric surface. The drawdown of each of the six pumping wells was estimated using the analytical computer program Dream. Dream uses the Thies equation, transmissivity, storativity, pumping rate, and pumping time to predict the drawdown due to pumping at various distances from a pumping wall. Dream is subject to the same limitations as the Thies equation.

For this simulation, the following assumptions were used:

Transmissivity = 3,100 gpd/ft
Storage Coefficient = 0.02
Pumping Rate = 6 gpm per well
Pumping Duration = 7 days

This scenario assumed the dam was in the down position and it is possible that the dam will be in the up position periodically. The next pumping simulation attempts to predict the effects of groundwater pumping while the dam was in the up position.

In order to make this simulation, the water level data for groundwater and Willow Creek during the period June 8, 1992, through June 18, 1992, was examined (figures D-3 through D-8). In this period, the dam appears to have been raised with a sudden rise in the surface elevation of Willow Creek.

While the elevation of Willow Creek remained fairly constant over the following 10 days, the groundwater elevations increased. The increase in groundwater elevation was greatest west of South Delaware Avenue (about 5 feet) and least along the south and east sides of the subject property (2 to 2½ feet). This suggests that the infiltration of water from Willow Creek is the result of water flowing from the creek into the alluvium west of South Delaware Avenue where the creek banks are not shored by concrete retaining walls.

The lower groundwater elevation changes adjacent to the dam suggest that vertical leakage through the base of the creek is much less than horizontal leakage through the alluvium. Where the creek banks are lined by the concrete retaining wall, horizontal leakage is severely restricted.

Injection wells were used to simulate the dam-up groundwater elevation on the February 1994 base data used for the previous simulation. The injection rates for the wells were varied with one injection rate used for the areas where the banks have concrete retaining walls and a higher injection rate where the banks where not lined by concrete retaining walls. The rate of injection was found by performing several different simulations. In these simulations, the injection rates and well locations ere varied to produce a figure that approaches the water table surface observed on June 18, 1992, (dam-up position).

In the best situation, injection rates for injection wells A through G were at 2 gpm while the injection rates for injection wells H through K were at 6 gpm (figure D-9). Additional simulations were performed at on half these values (figure D-10) and at double these values (figure D-11). The period for the simulations was 10 days which was equal to the period of time between the dam raising and the final observed water table elevations. The transmissivity was set at 3,100 gpd/ft. The storage coefficient was 0.02.

The final figure, (D-12), simulates groundwater pumping in a dam-up scenario. In this simulation, recharge from Willow Creek is as simulated in figure D-9 and the groundwater pumping is as simulated in figure D-2. Input parameters are as identified on these respective figures. The result of the addition of recharge from Willow Creek is a decrease in the magnitude of the cone of depressions for the individual recovery wells. However, hydraulic control of the site remains intact.

Alternative 5 — Alternative 5 includes a groundwater collection trench for the unconsolidated fill material. Collection trenches seem to be the best method of containing the groundwater in the unconsolidated fill because the saturated thickness in the unconsolidated fill material is very small ranging from near zero to less than 4 feet. In this alternative, it is assumed that the retaining wall along Willow Creek is keyed into the fractured bedrock which would reduce the rate of infiltration of water from the creek into the unconsolidated fill material. The assumption would require verification before implementation of the alternative.

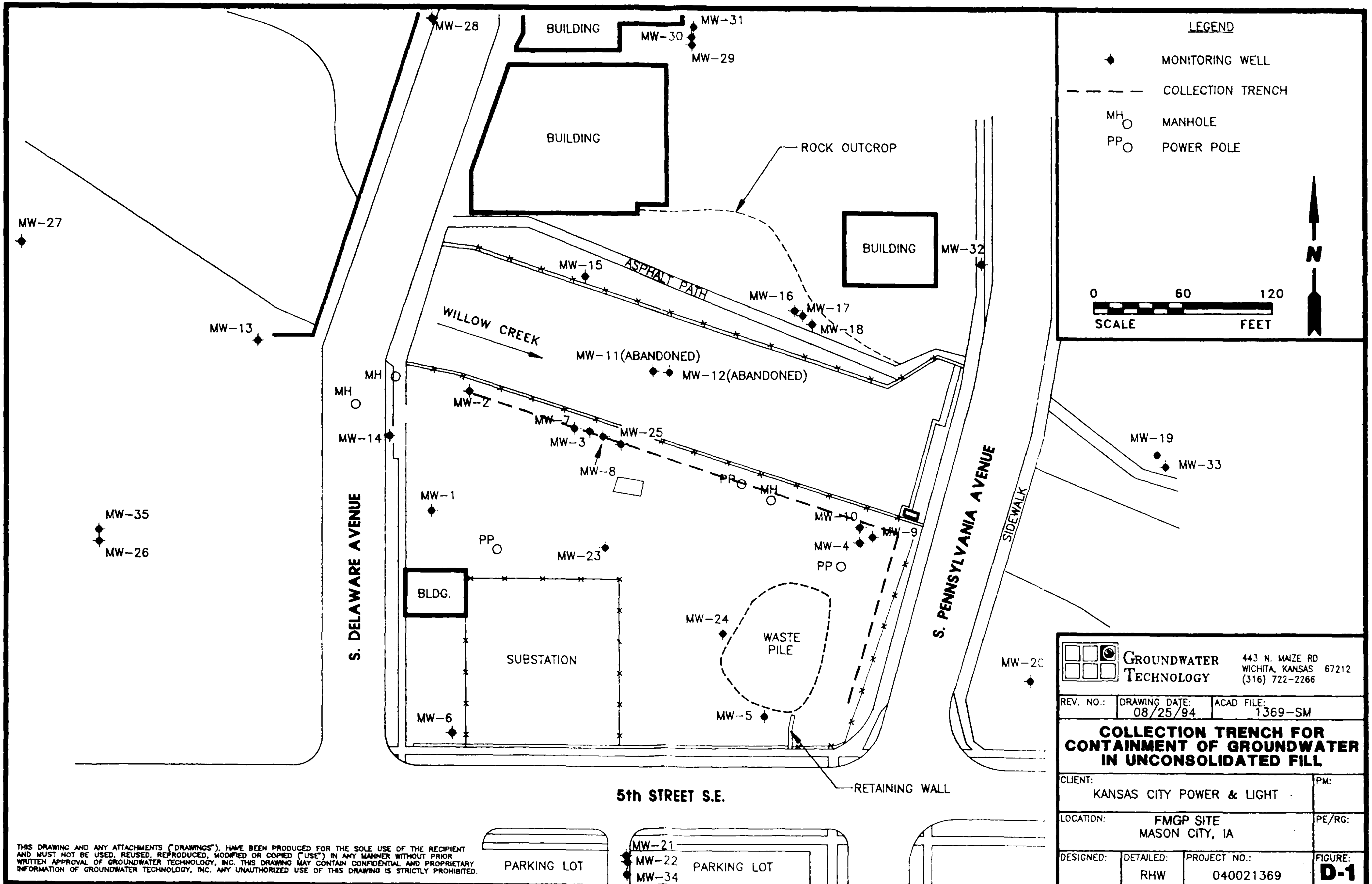
A collection trench could extend from near MW-3 for 370 feet southeastward along Willow Creek to near MW-9 and from near MW-9 120 southward to near the southeast corner of the site as depicted on figure D-1. If the bottom of the trench is at about 1,094 feet (about 1 foot into bedrock) and the groundwater can be extracted to an elevation of 1,095 feet, the gradient across the site from MW-6 to MW-2 will be 0.016 foot per foot. The gradient from MW-6 to the MW-9 area will be less because it is further from MW-6

The volume (Q) of water that a collection trench could produce is calculated by multiplying the hydraulic conductivity (k) by the gradient (I) and the area (A) through which water will flow. In this calculation the volume of water flowing through an area between MW-2 to near MW-5 is calculated. This line is approximately perpendicular to groundwater flow and parallels the 1098.5 contour on the February 28, 1994, potentiometric surface map. The length of this line is about 300 feet. Other standard calculations of groundwater flow from a collection trench are more difficult to use because of the irregularity of the groundwater surface, and variability in the hydraulic conductivity at the site.

The bedrock along this line is at an elevation of approximately 1,095 feet. This yields a saturated water thickness of 3.5 feet. The area of the aquifer through which water would flow to the trench under this scenario is 1,050 square feet. The hydraulic conductivity is variable in the unconsolidated fill at the site. For this calculation, a hydraulic conductivity of 0.022 cm/sec or 0.32 gallon per minute per square foot. The gradient between MW-6 and MW-9 is 0.011 foot per foot. Under these conditions, the trench is estimated to produce about 4 gallons of water per minute.

This calculation does not take into consideration groundwater flow into the back side of a trench if it is adjacent to South Pennsylvania Avenue and the Willow Creek retaining wall. To be conservative, the estimated groundwater production rate is estimated to be 10 gpm for planning purposes. To achieve a condition in which water is flowing into the trench only in the lower 1 foot, higher flow rates will be required. Verification of the parameters used in this calculation during pre-design investigations is suggested.

Because the bedrock is very resistant to standard excavation and the bedrock surface is somewhat irregular, up to four sumps may be required to extract groundwater efficiently from the trench and maintain a uniform water elevation in the trench.



GROUNDWATER TECHNOLOGY
443 N. MAIZE RD
WICHITA, KANSAS 67212
(316) 722-2266

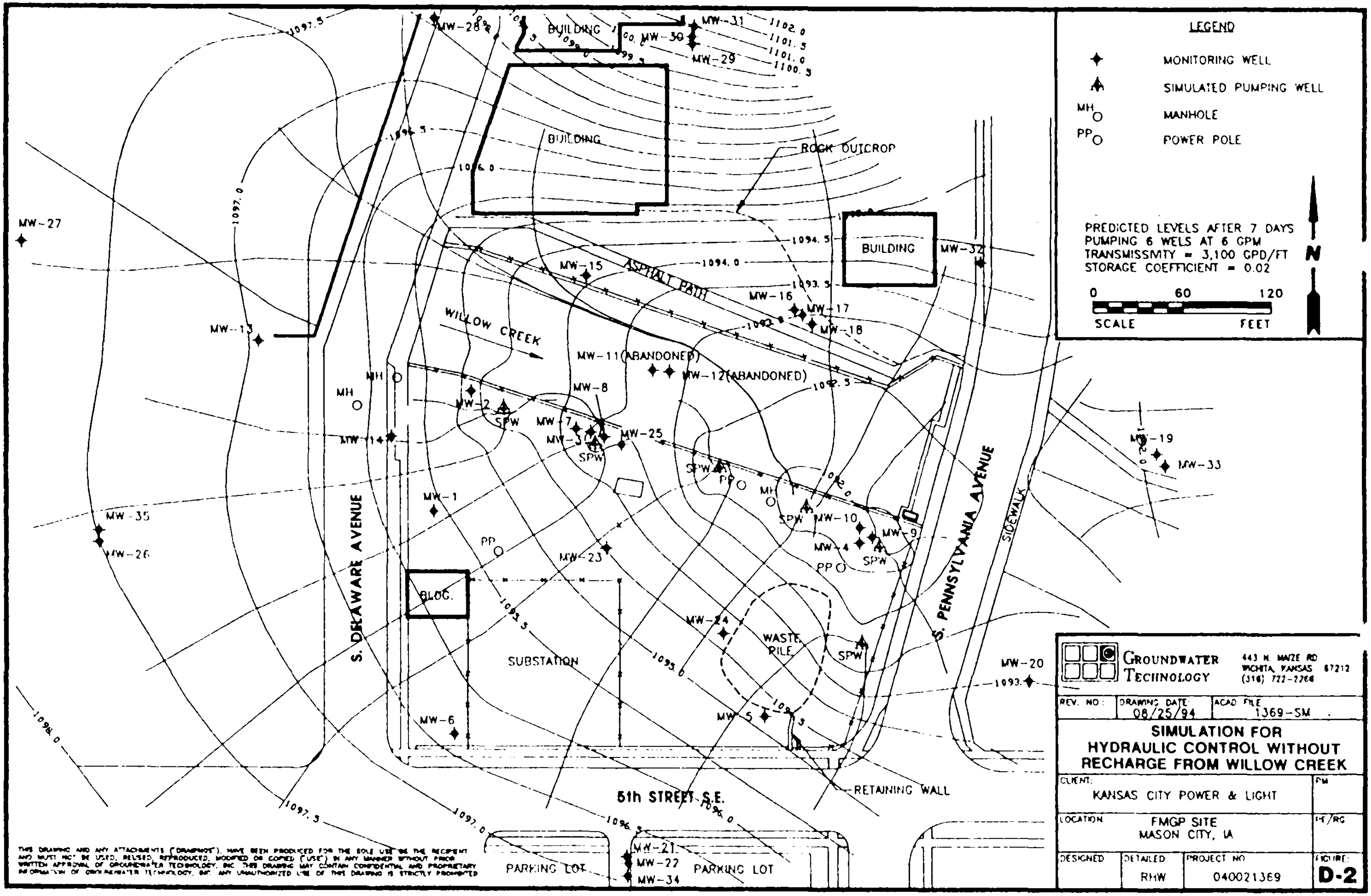
REV. NO.:	DRAWING DATE: 08/25/94	ACAD FILE: 1369-SM

COLLECTION TRENCH FOR CONTAINMENT OF GROUNDWATER IN UNCONSOLIDATED FILL

CLIENT: KANSAS CITY POWER & LIGHT — PM:

LOCATION: FMGP SITE, MASON CITY, IA — PE/RG:

DESIGNED:	DETAILED: RHW	PROJECT NO.: 040021369	FIGURE: D-1


LEGEND
MONITORING WELL
SIMULATED PUMPING WELL
MH MANHOLE
PP POWER POLE
PREDICTED LEVELS AFTER 7 DAYS
PUMPING 6 WELS AT 6 GPM
TRANSMISSIVITY = 3,100 GPD/FT
STORAGE COEFFICIENT = 0.02
0 60 120
SCALE FEET
N
BUILDING
BUILDING
BUILDING
BLDG.
ROCK OUTCROP
ASPHALT PATH
WILLOW CREEK
SUBSTATION
WASTE PILE
RETAINING WALL
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
SIDEWALK
5th STREET S.E.
PARKING LOT
PARKING LOT
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11(ABANDONED)
MW-12(ABANDONED)
MW-13
MW-14
MW-15
MW-16
MW-17
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
MW-24
MW-25
MW-26
MW-27
MW-28
MW-29
MW-30
MW-31
MW-32
MW-33
MW-34
MW-35
SPW
1102.0
1101.5
1101.0
1100.5
1097.5
1097.0
1096.5
1096.0
1095.0
1094.5
1094.0
1093.5
1093.0
1092.5
1098.0
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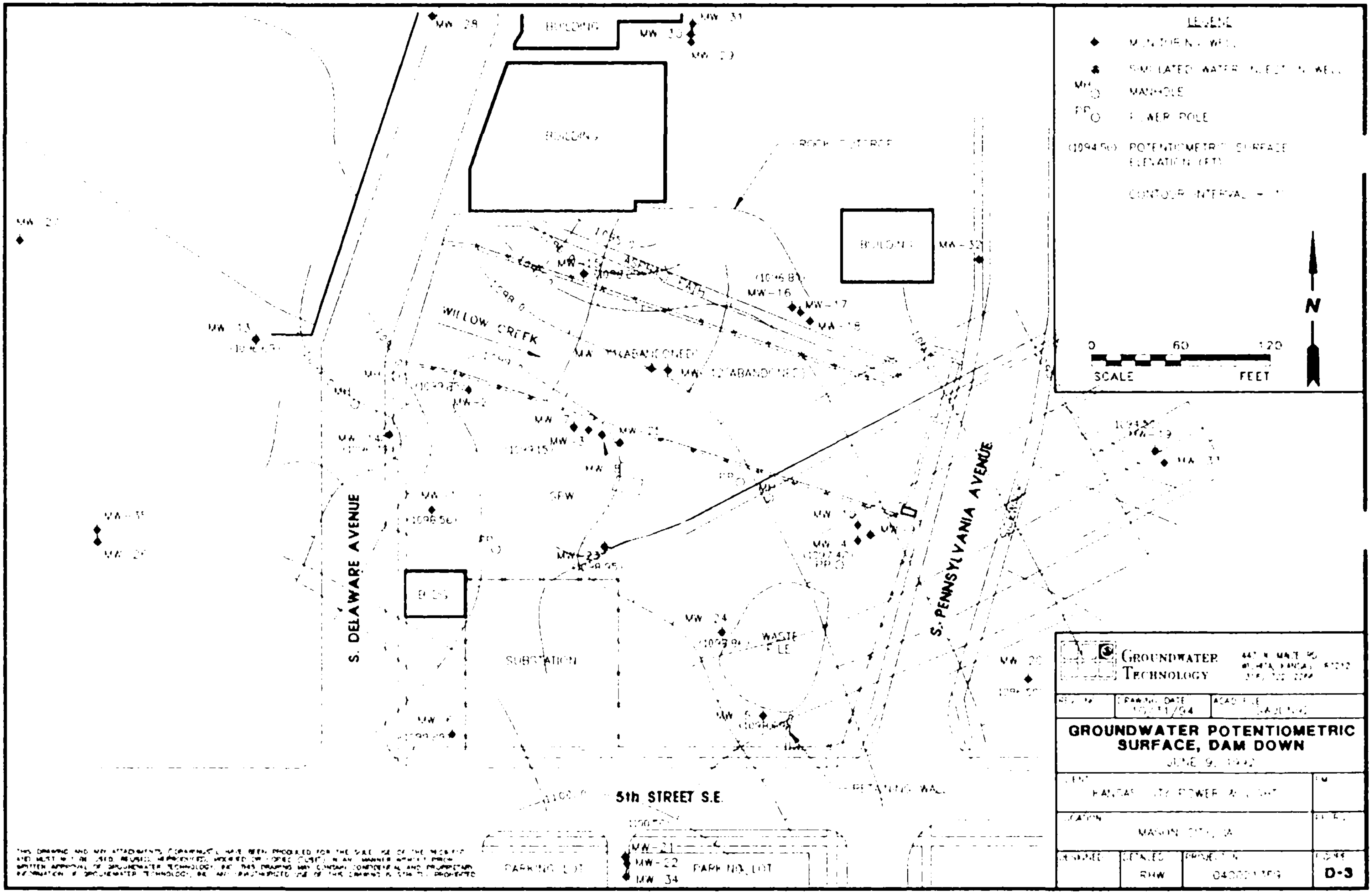
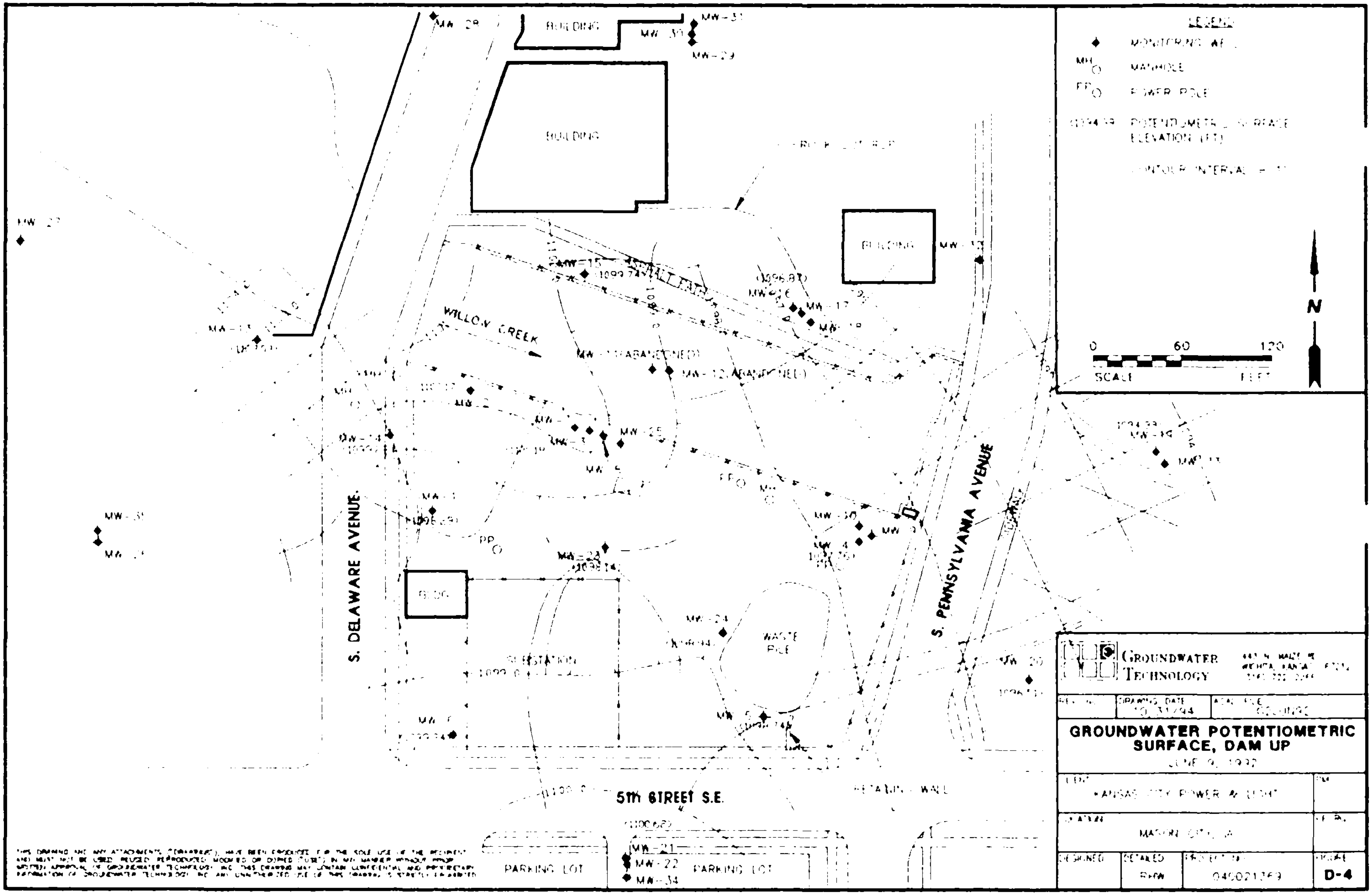
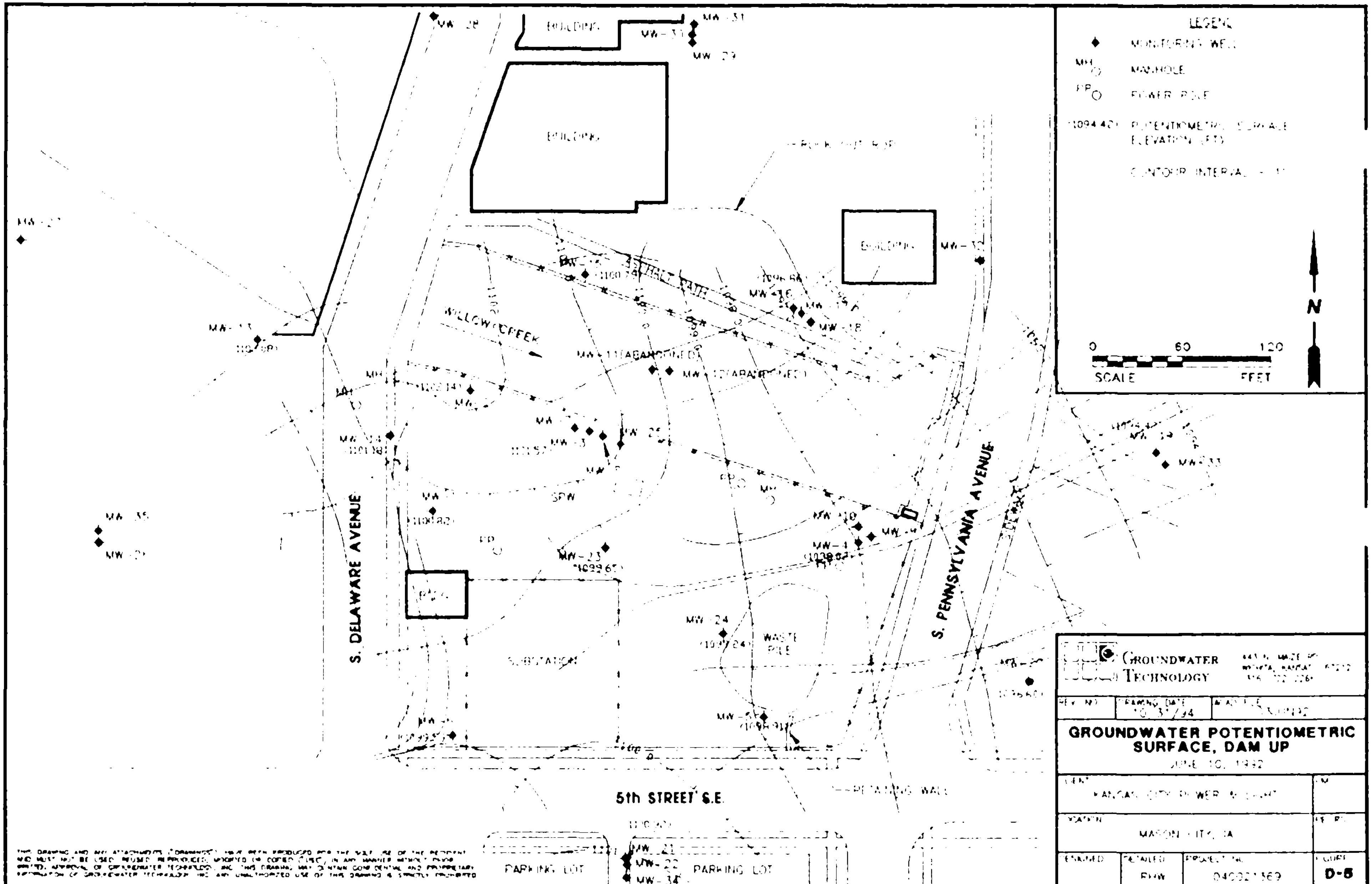
REV. NO.:
DRAWING DATE: 08/25/94
ACAD FILE 1369-SM
SIMULATION FOR
HYDRAULIC CONTROL WITHOUT
RECHARGE FROM WILLOW CREEK
CLIENT: KANSAS CITY POWER & LIGHT
PM
LOCATION FMGP SITE
MASON CITY, IA
DESIGNED
DETAILED RHW
PROJECT NO 040021369
FIGURE: D-2



LEGEND
MONITORING WELL
MANHOLE
POTENTIOMETRIC SURFACE ELEVATION (FT)
SCALE
FEET
0
60
120
N
BUILDING
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
SUBSTATION
WASTE PILE
RETAINING WALL
PARKING LOT
MW-28
MW-30
MW-31
MW-13
MW-16
MW-17
MW-18
MW-2
MW-3
MW-23
MW-24
MW-19
MW-21
MW-22
MW-34
(1096.81)
(1099.56)
GROUNDWATER TECHNOLOGY
GROUNDWATER POTENTIOMETRIC SURFACE, DAM DOWN
RHW
D-3



LEGEND
MONITORING WELL
MANHOLE
POWER POLE
POTENTIOMETRIC SURFACE ELEVATION (FT)
SCALE
FEET
0
60
120
N
BUILDING
BUILDING
BUILDING
BLDG.
SUBSTATION
WASTE PILE
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
PARKING LOT
PARKING LOT
RETAINING WALL
MW-12 (ABANDONED)
MW-15
MW-17
MW-18
MW-25
MW-24
MW-23
MW-21
MW-22
MW-34
MW-29
MW-30
MW-31
1099.74
GROUNDWATER TECHNOLOGY
GROUNDWATER POTENTIOMETRIC SURFACE, DAM UP
KANSAS CITY POWER & LIGHT
MASON CITY, IA
D-4



GROUNDWATER TECHNOLOGY

DRAWING DATE 10/31/94

GROUNDWATER POTENTIOMETRIC SURFACE, DAM UP

JUNE 10, 1992

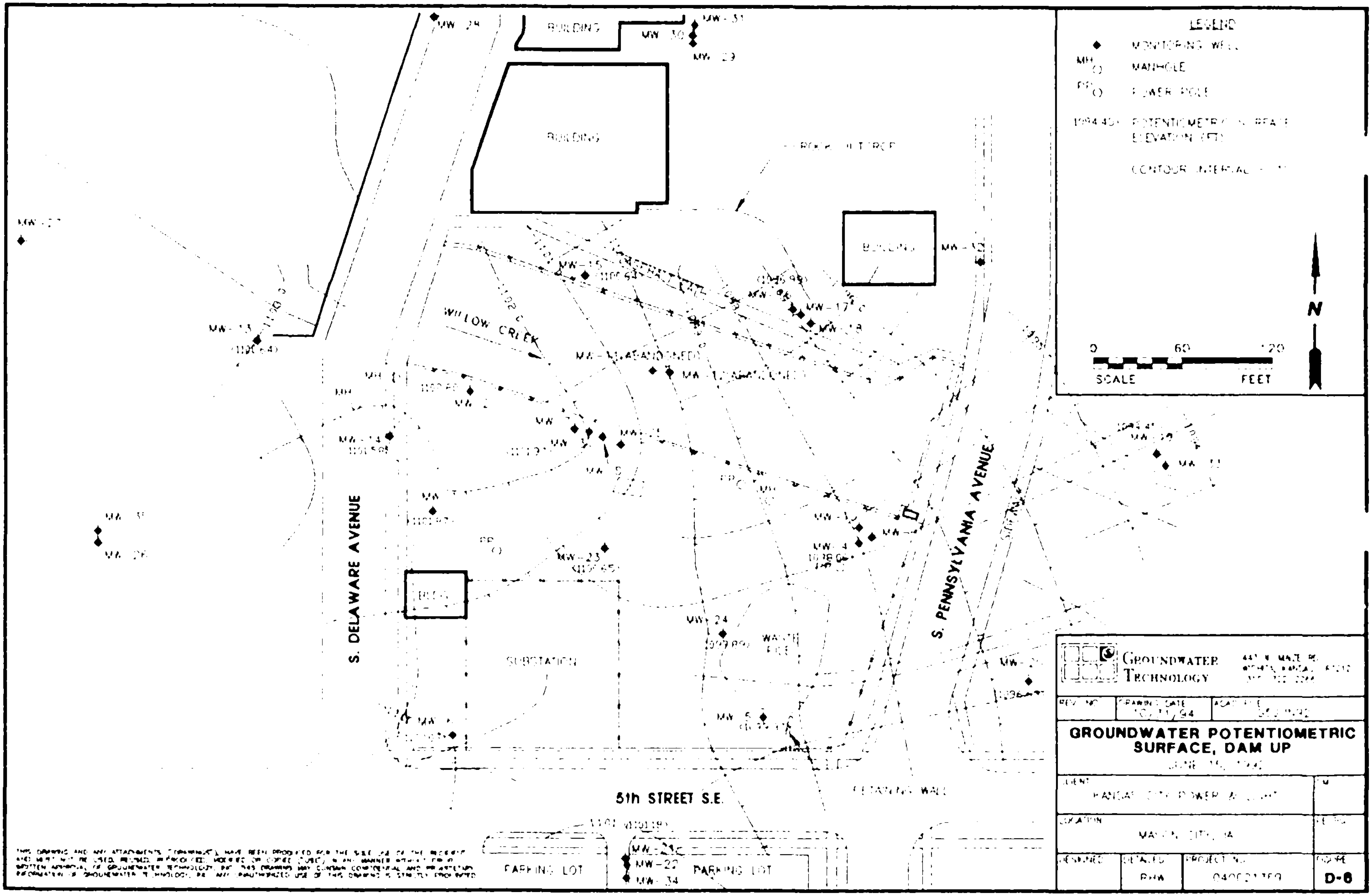
CLIENT: KANSAS CITY POWER & LIGHT

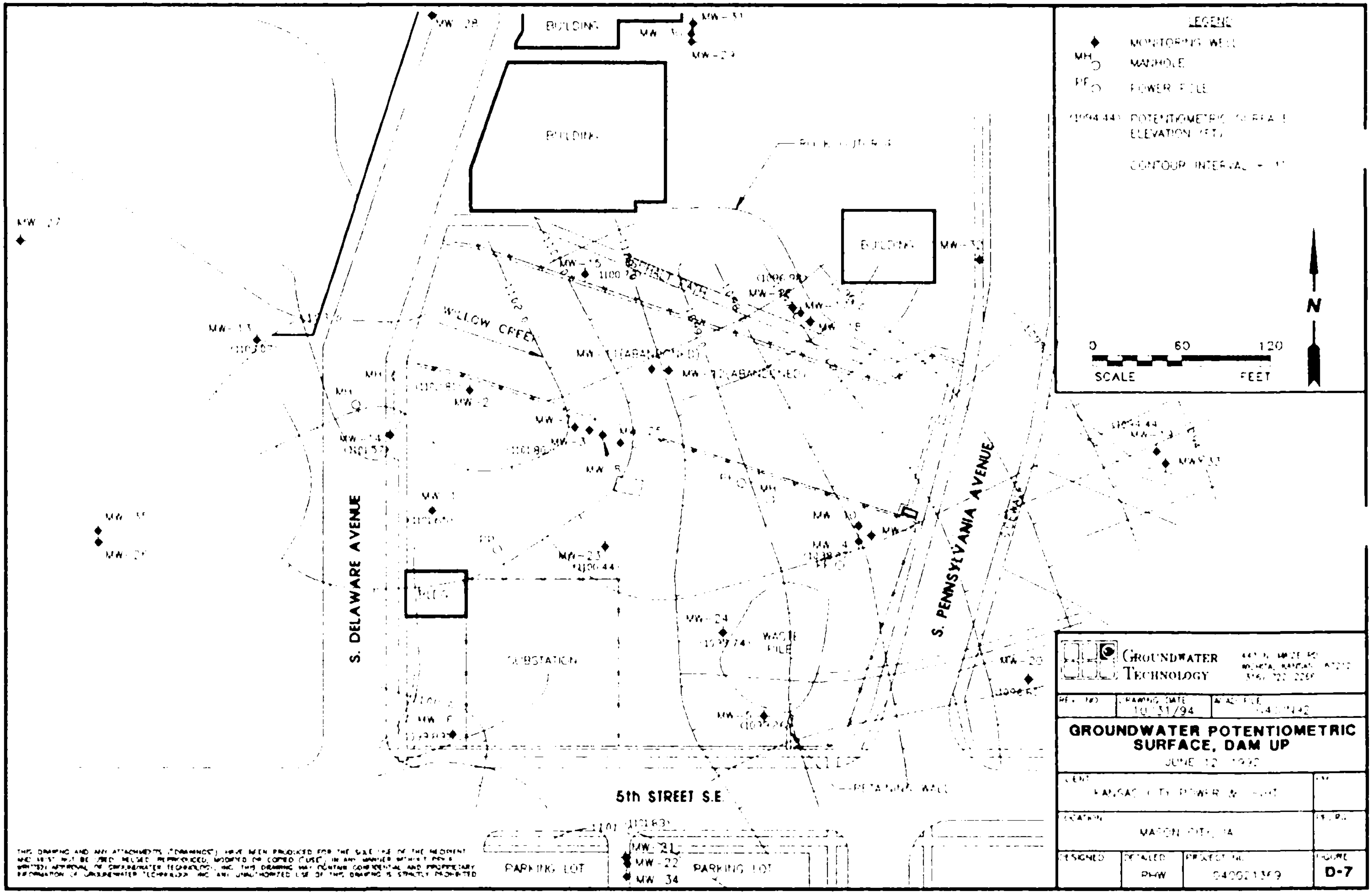
LOCATION: MASON CITY, IA

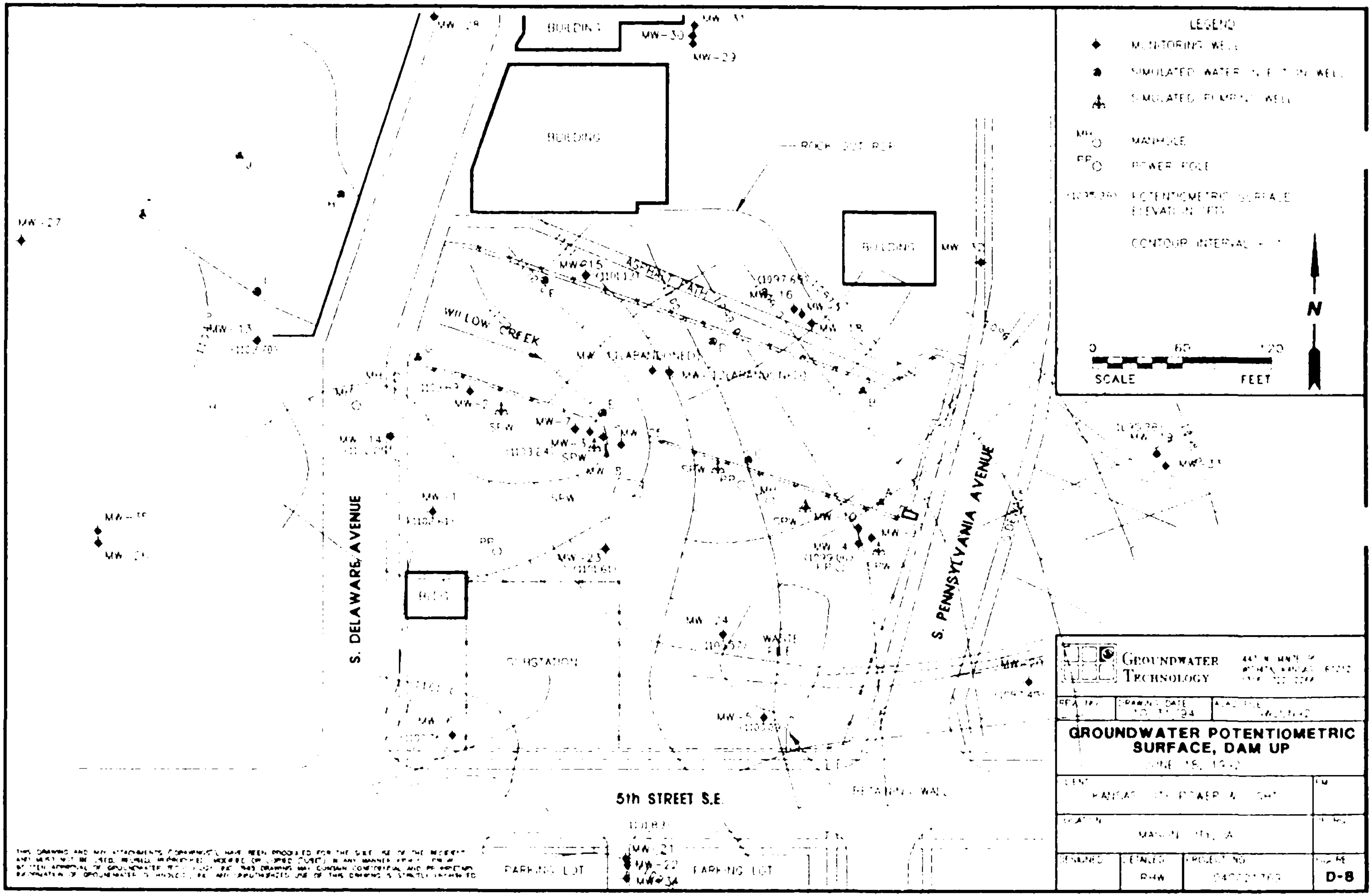
DETAILED: RHW

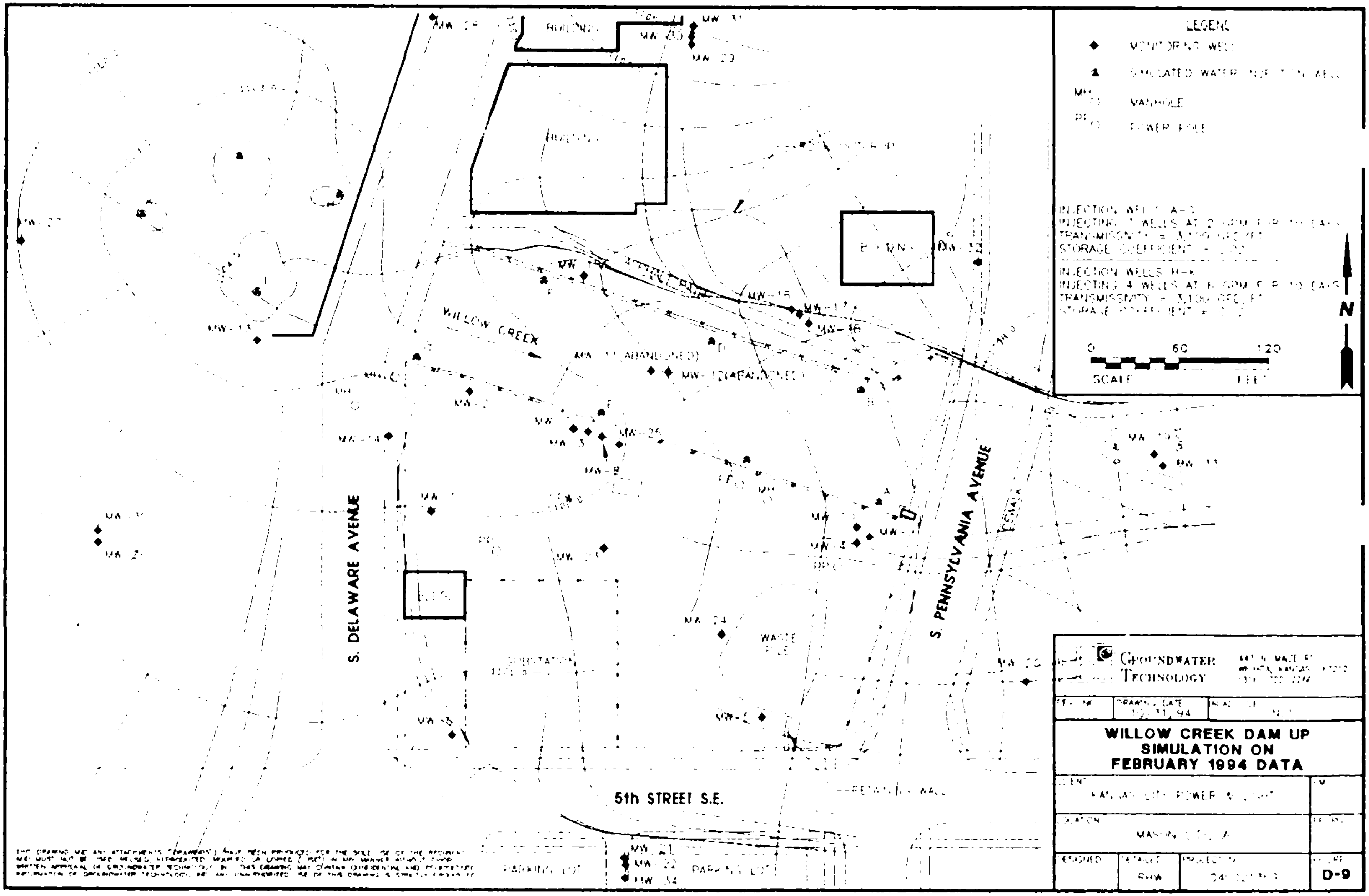
PROJECT NO. 040021369

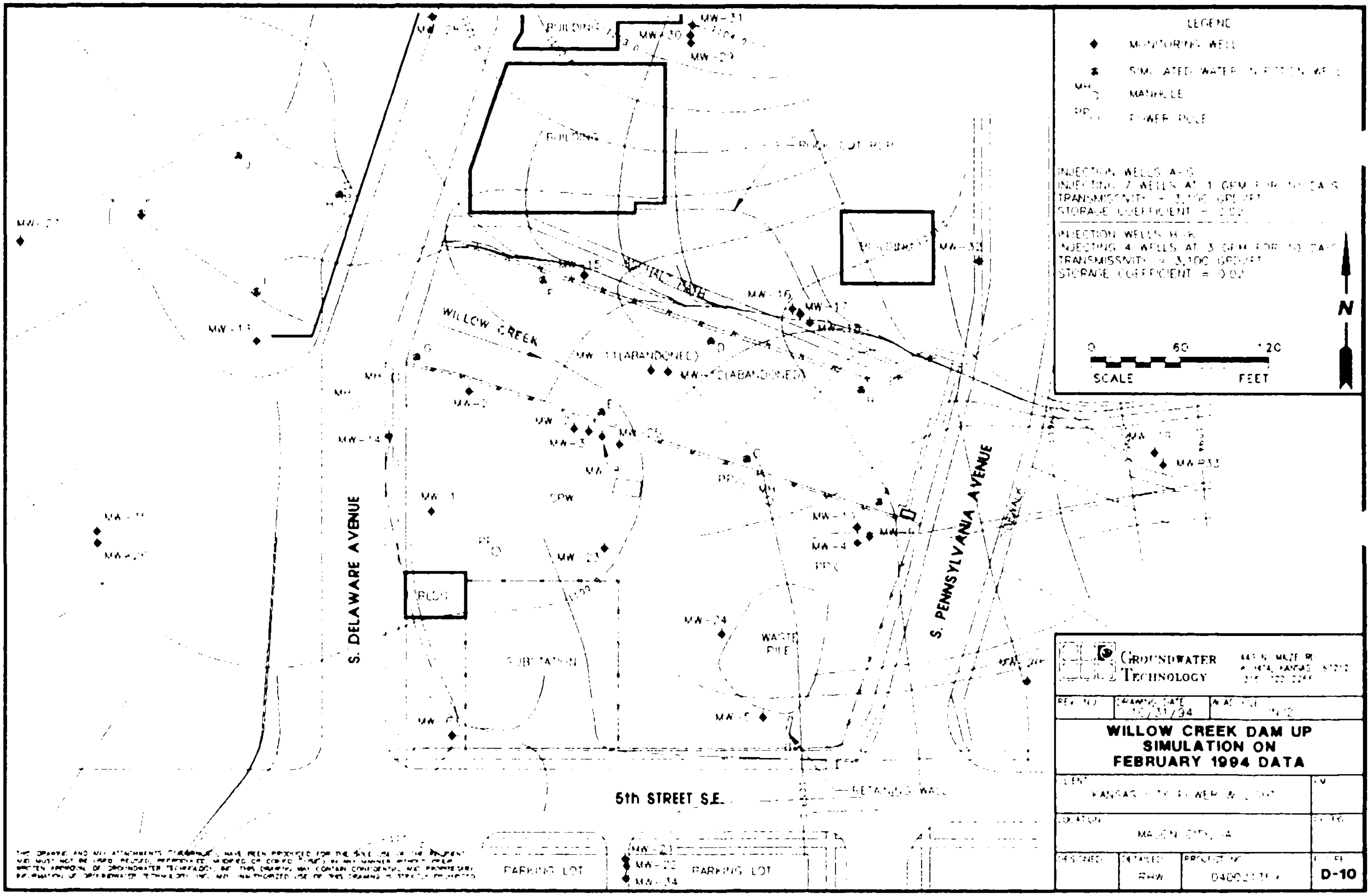
FIGURE D-5

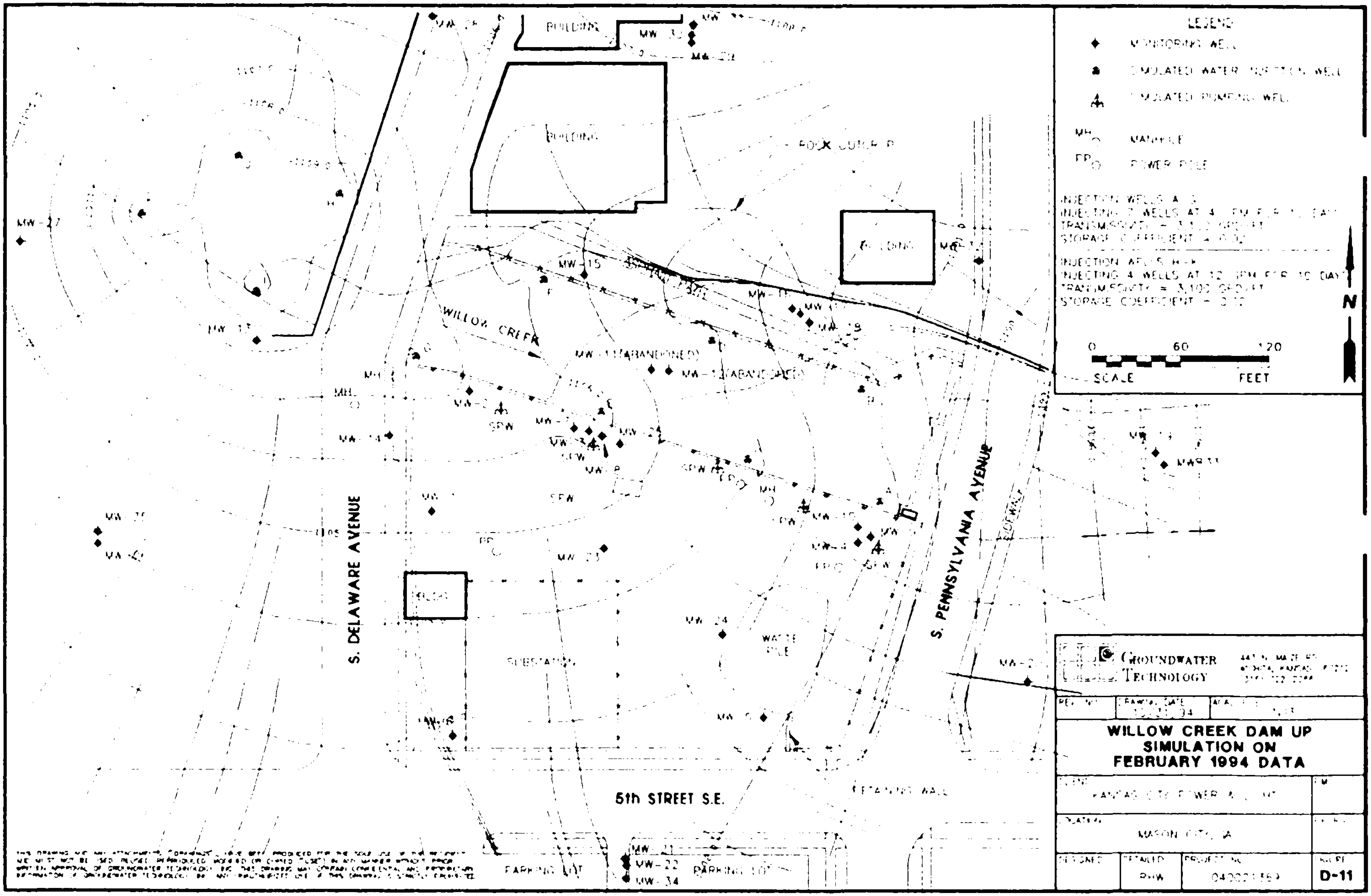

LEGEND
MONITORING WELL
MANHOLE
POTENTIOMETRIC SURFACE ELEVATION (FT)
SCALE
FEET
N
BUILDING
ROCK OUTCROP
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
SUBSTATION
5th STREET S.E.
RETAINING WALL
PARKING LOT
MW-13
MW-14
MW-15
MW-17
MW-18
MW-23
MW-24
MW-22
MW-34
MW-4
MW-5
GROUNDWATER TECHNOLOGY
GROUNDWATER POTENTIOMETRIC SURFACE, DAM UP
RHW
D-6

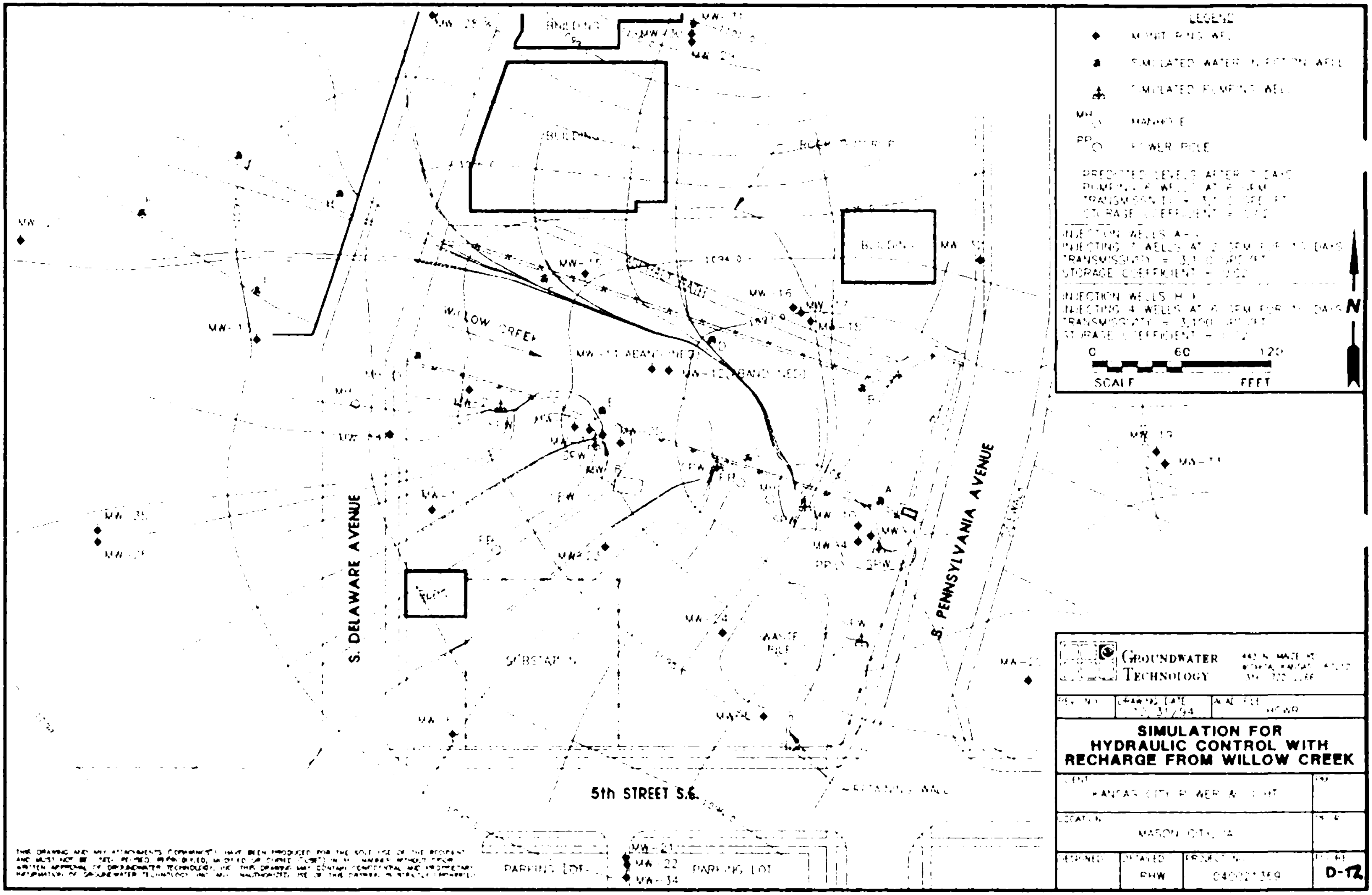

LEGEND
MONITORING WELL
MANHOLE
POWER POLE
POTENTIOMETRIC SURFACE ELEVATION (FT)
CONTOUR INTERVAL
N
0 60 120
SCALE FEET
BUILDING
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
SUBSTATION
PARKING LOT
PARKING LOT
RETAINING WALL
MW-28
MW-27
MW-13
MW-14
MW-2
MW-3
MW-23
MW-24
MW-22
MW-34
MW-11 (ABANDONED)
MW-12 (ABANDONED)
(1100.44)
(1098.44)
GROUNDWATER TECHNOLOGY
GROUNDWATER POTENTIOMETRIC SURFACE, DAM UP
10/31/94
KANSAS CITY POWER & LIGHT
MASON CITY, IA
PHW
D-7


LEGEND
MONITORING WELL
MANHOLE
POWER POLE
SCALE
FEET
N
BUILDING
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
PARKING LOT
RETAINING WALL
GROUNDWATER TECHNOLOGY
GROUNDWATER POTENTIOMETRIC SURFACE, DAM UP
RHW
D-8


LEGEND
MONITORING WELL
MANHOLE
POWER POLE
N
SCALE
FEET
0
60
120
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
WILLOW CREEK
MW-14
MW-24
MW-25
MW-32
MW-21
MW-22
MW-34
MW-11(ABANDONED)
PARKING LOT
WASTE PILE
GROUNDWATER TECHNOLOGY
WILLOW CREEK DAM UP
SIMULATION ON
FEBRUARY 1994 DATA
D-9


LEGEND
MONITORING WELL
MANHOLE
INJECTION WELLS H-K
INJECTING 4 WELLS AT 3 GPM
TRANSMISSIVITY = 3,100
STORAGE COEFFICIENT = 0.02
0
60
120
SCALE
FEET
N
WILLOW CREEK
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
PARKING LOT
PARKING LOT
MW-1
MW-2
MW-3
MW-4
MW-5
MW-14
MW-15
MW-16
MW-17
MW-18
MW-21
MW-24
MW-29
MW-30
MW-31
MW-34
MW-11 (ABANDONED)
MW-12 (ABANDONED)
BUILDING
BLDG
SUBSTATION
WASTE PILE
RETAINING WALL
GROUNDWATER TECHNOLOGY
DRAWING DATE
WILLOW CREEK DAM UP
SIMULATION ON
FEBRUARY 1994 DATA
RHW
D-10


LEGEND
MONITORING WELL
SIMULATED PUMPING WELL
MANHOLE
POWER POLE
INJECTION WELLS H-K
INJECTING 4 WELLS AT 12 GPM FOR 10 DAYS
TRANSMISSIVITY = 3,100 GPD/FT
0
60
120
SCALE
FEET
N
S. DELAWARE AVENUE
S. PENNSYLVANIA AVENUE
5th STREET S.E.
WILLOW CREEK
BUILDING
SUBSTATION
WASTE PILE
PARKING LOT
ROCK OUTCROP
RETAINING WALL
MW-27
MW-15
MW-11 (ABANDONED)
MW-12 (ABANDONED)
MW-24
MW-22
MW-34
MW-21
MW-23
MW-14
SPW
GROUNDWATER TECHNOLOGY
WILLOW CREEK DAM UP
SIMULATION ON
FEBRUARY 1994 DATA
MASON CITY, IA
RHW
D-11



GROUNDWATER TECHNOLOGY

DRAWING DATE: 12/31/94

SIMULATION FOR HYDRAULIC CONTROL WITH RECHARGE FROM WILLOW CREEK

CLIENT: KANSAS CITY POWER AND LIGHT

LOCATION: MASON CITY, IA

DETAILED: RHW

PROJECT NO.: 040021369

FIGURE: D-12

APPENDIX E

COST JUSTIFICATIONS

TABLE E4-1
Cost Justification
Improved Multi-Media CAP

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization/Demobilization	$10,000.00 / LS	3	1	3	$10,000
Site Preparation/Grading	4,000.00 / LS	3	1	3	4,000
Clean Fill with Volclay Added	31.00 / CY	3	875	3	27,100
Synthetic Geomembrane Liner	0.55 / ft^2	3	47,200	3	26,000
Drainage Material (1 ft.)	18.42 / CY	3	1,748	3	33,200
Geotextile Filter Fabric	0.20 / ft^2	3	47,200	3	9,500
Clean Fill, Graded (3.5 ft.)	12.00 / CY	3	6,120	3	73,400
Top Soil, Graded (0.5 ft.)	16.00 / CY	3	874	3	14,000
Grass Cover (Sod)	1.50 / SY	3	5,245	3	7,900
Subtotal Facilities/Capital Cost					$205,100
Miscellaneous	10% of Subtotal				20,500
Contingency	25% of Subtotal				51,300
Engineering	15% of Subtotal				30,800
Total Capital Cost					$307,700
Annual Operation Cost					
Maintenance (Mowing) and Inspection	$10,000 / LS	3	1	3	$10,000
Subtotal Annual Operation Cost (O&M)					$10,000
Miscellaneous	20% of Subtotal				$2,000
Contingency	20% of Subtotal				$2,000
Total Annual Operation Cost					$14,000
Total Present Worth for 30 Years @ 5%:					$522,900

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to the remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-2A
Cost Justification
Excavation/Thermal Treatment (Fixed Treatment Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization/Demobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 /TON	3	9,000	1	$90,000
Soil Processing/Handling	15.00 /TON	3	7,440	1	$111,600
Rubble Processing Surcharge	20.00 /TON	3	1,650	1	$33,000
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Backfill Processed Material (placed and compacted)	2.75 /TON	2	7,440	3	$20,500
Backfill Overburden	1.60 /TON	2	2,550	3	$4,100
Top Dressing Backfill, 2-ft depth, Graded	8.00 /TON	3	5,688	3	$45,500
Grass Cover (sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	450.00 / LD	3	338	3	$152,100
Disposal	85.00 /TON	3	7,440	3	$632,400
Subtotal Facilities					$1,707,200
Miscellaneous	10% of Subtotal				170,700
Contingency	25% of Subtotal				426,800
Engineering	15% of Subtotal				256,100
Total Capital Cost/Total Present Worth					**$2,560,800**

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to the remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

4002/1950.F5

TABLE E4-2B
Cost Justification
Excavation/Thermal Treatment (Fixed Treatment Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Soil Processing/Handling	25.00 / TON	3	10,629	1	$265,700
Rubble Processing Surcharge	20.00 / TON	3	1,650	1	$33,000
Sand Additive	10.00 / TON	3	3,189	3	31,900
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Backfill processed material (placed and compacted)	2.75 / TON	2	10,629	3	$29,200
Backfill overburden	1.60 / TON	2	2,550	3	$4,100
Top Dressing Backfill, 2 ft depth, Graded	8.00 / TON	3	2,500	3	$20,000
Grass Cover (Sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	450.00 / LD	3	483	3	$217,400
Disposal	85.00 / TON	3	10,629	3	$903,500
Subtotal Facilities					$2,212,800
Miscellaneous	10% of Subtotal				$221,300
Contingency	25% of Subtotal				$553,200
Engineering	15% of Subtotal				$332,000
Total Capital Cost/Total Present Worth					**$3,319,300**

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-3A
Cost Justification

Excavation/Thermal Treatment (Transportable Treatment Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Source	Number of Units	Source	Estimated Cost
Summary						
Capital Cost						
Facilities						
Mobilization	$10,000.00 /	LS	3	1	3	$10,000
Excavtion Covering	340,000.00/	LS	3	1	3	$340,000
Excavation	10.00	/ TON	3	9,000	1	$90,000
Soil Processing/Handling	25.00	/ TON	3	7,440	1	$186,000
Rubble Processing Surcharge	20.00	/ TON	3	1,650	1	$33,000
Shoring	42.00 /	ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 /	LF	2	200	3	$60,000
Water Treatment	35,000.00 /	LS	3	1	3	$35,000
Backfill Processed Material (placed and compacted)	2.75	/ TON	2	7,440	3	$20,500
Backfill Overburden	1.60	/ TON	2	2,550	3	$4,100
Top Dressing Backfill, 2-ft depth, Graded	8.00	/ TON	3	5,688	3	$45,500
Grass Cover (Sod)	1.50 /	SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 /	LS	3	1	3	$7,500
Transportation	60.00 /	LD	3	338	3	$20,300
Treatment Unit Mob	30,000.00 /	LS	3	1	3	$30,000
Disposal	45.00	/ TON	3	7,440	3	$334,800
Subtotal Facilities						$1,382,200
Miscellaneous	10% of Subtotal					$138,200
Contingency	25% of Subtotal					$345,600
Engineering	15% of Subtotal					$207,300
Total Capital Cost/Total Present Worth						**$2,073,300**

Notes: (1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

4IIU/1.W/IL-

TABLE E4-3B
Cost Justification
Excavation/Thermal Treatment (Transportable Treatment Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Rubble Processing Surcharge	20.00 / TON	3	1,650	1	$33,000
Sand Additive	10.00 / TON	3	3,189	3	$31,900
Soil Processing/Handling	25.00 / TON	3	10,629	1	$265,700
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Backfill Processed Material (placed and compacted)	2.75 / TON	2	10,629	3	$29,200
Backfill Overburden	1.60 / TON	2	2,550	3	4,100
Top Dressing Backfill, 2-ft depth, Graded	8.00 / TON	3	2,500	3	$20,000
Grass Cover (Sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	60.00 / LD	3	483	3	$29,000
Treatment Unit Mob	30,000.00 / LS	3	1	3	$30,000
Disposal	45.00 / TON	3	10,629	3	$478,300
Subtotal Facilities					$1,629,200
Miscellaneous	10% of Subtotal				$162,900
Contingency	25% of Subtotal				$407,300
Engineering	15% of Subtotal				$244,400
Total Capital Cost/Total Present Worth					$2,443,800

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

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TABLE E4-4A
Cost Justification
Excavation/Thermal Treatment (Power Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Rubble Processing/Handling	5.00 / TON	3	7,490	1	$37,200
Shoring	42.00 / ft.^{2}	2	3,750	1	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	3	6,450	3	$51,600
Backfill Overburden	1.60 / TON	2	2,550	3	$4,100
Top Dressing Backfill, 2 ft depth, Graded	8.00 / TON	3	5,688	3	$45,500
Grass Cover (sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	1,590.00 / LD	3	338	3	$537,400
Disposal	75.00 / TON	3	7,440	3	$558,000
Subtotal Facilities					$1,941,800
Miscellaneous	10% of Subtotal				194,200
Contingency	25% of Subtotal				485,500
Engineering	15% of Subtotal				291,300
Total Capital Cost/Total Present Worth					$2,912,800

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-4B
Cost Justification
Excavation/Thermal Treatment (Power Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Rubble Processing/Handling	5.00 / TON	3	7,440	1	$37,200
Soil Processing/Handling	25.00 / TON	3	10,629	1	$265,700
Coal Additive	10.00 / TON	3	3,189	3	$31,900
Shoring	42.00 / ft ^{2}	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	3	6,450	3	$51,600
Backfill Overburden	1.60 / TON	2	2,550	3	$4,100
Top Dressing Backfill, 2 ft depth, Graded	8.00 / TON	3	5,688	3	$45,500
Grass Cover (sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	1,590.00 / LD	3	483	3	$768,000
Disposal	75.00 / TON	3	10,629	3	$797,200
Subtotal Facilities					$2,709,200
Miscellaneous	10% of Subtotal				270,900
Contingency	25% of Subtotal				677,300
Engineering	15% of Subtotal				406,400
Total Capital Cost/Total Present Worth					**$4,063,800**

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-5A
Cost Justification
Excavation/Thermal Treatment (Cement Plant)
Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavtion Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Soil Processing/Handling	15.00 / TON	3	7,440	1	$111,600
Rubble Processing Surcharge	20.00 / TON	3	1,650	1	$33,000
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	3	6,450	3	$51,600
Backfill Overburden	1.60 / TON	2	2,550	3	4,100
Top Dressing Backfill, 2 ft Depth Graded	8.00 / TON	3	5,688	3	$45,500
Grass Cover (Sod)	1.50 / SY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	690.00 / LD	3	338	3	$233,200
Disposal	35.00 / TON	3	7,440	3	$260,400
Subtotal Facilities					$1,447,400
Miscellaneous	10% of Subtotal				$144,700
Contingency	25% of Subtotal				$361,900
Engineering	15% of Subtotal				$217,100
Total Capital Cost/Total Present Worth					<u>$2,171,100</u>

Notes. (1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-5B
Cost Justification
Excavation/Thermal Treatment (Cement Plant)
Rendered Nonhazardous

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization	$10,000.00 / LS	3	1	3	$10,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Soil Processing/Handling	25.00 / TON	3	10,629	1	$265,700
Rubble Processing Surcharge	20.00 / TON	3	1,650	1	$33,000
Sand Additive	10.00 / TON	3	3,189	3	$31,900
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Replacement Backfill (placed and compacted)	8.00 / TON	3	6,450	3	$51,600
Backfill Overburden	1.60 / TON	2	2,550	3	4,100
Top Dressing Backfill, 2 ft. Depth Graded	8.00 / TON	3	5,688	3	$45,500
Grass Cover (Sod)	1.50 / CY	3	5,300	3	$8,000
Verification Sampling	7,500.00 / LS	3	1	3	$7,500
Transportation	690.00 / LD	3	483	3	$333,300
Disposal	35.00 / TON	3	10,629	3	$372,000
Subtotal Facilities					$1,845,100
Miscellaneous	10% of Subtotal				$184,500
Contingency	25% of Subtotal				$461,300
Engineering	15% of Subtotal				$246,800
Total Capital Cost/Total Present Worth					**$2,767,700**

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

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TABLE E4-6
Cost Justification
Excavation/Biological Treatment (On-Site)

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization/Demobilization	$15,000.00 / LS	3	1	3	$15,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Soil Processing	25.00 / TON	3	7,440	1	$186,000
Rubble Processing Surcharge	5.00 / TON	3	1,650	1	$8,300
Backfill Processed Material	1.60 / TON	2	9,990	3	$16,000
Synthetic Geomembrane Liners	0.55 / ft.^{2}	3	32,600	3	$35,900
Drainage Material (1 ft.)	19.00 / CY	3	1,811	3	34,500
Geotextile Filter Fabric	0.20 / ft.^{2}	3	32,600	3	6,500
Shoring	42.00 / ft^2	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Improved Multi-Media Cap	4.30 / ft^2	3	21,050	1	$90,500
Top Dressing Backfill Graded	14.00 / CY	3	1,200	3	$16,800
Grass Cover (sod)	1.50 / SY	3	2,933	3	$4,400
Subtotal Facilities					$1,096,400
Biovent Collection					
Vapor Extraction Blowers	$5,500.00 / EA	3	2	3	$11,000
Collection Piping	20,000.00 / LS	3	1	3	$20,000
Building Enclosure with Foundation	15,000.00 / LS	3	1	3	$15,000
Electrical Service	3,500.00 / LS	3	1	3	$3,500
Miscellaneous Piping & Controls	4,000.00 / LS	3	1	3	$4,000
Instrumentation	4,500.00 / LS	3	1	3	$4,500
Valve Access Manholes	800.00 / EA	3	12	3	$9,600
Air Permit	7,500.00 / LS	3	1	3	$7,500
Subtotal Biovent Collection					$64,100
Subtotal Capital Cost					$1,160,500
Miscellaneous	10% of Subtotal				116,100
Contingency	25% of Subtotal				290,100
Engineering	15% of Subtotal				174,100
Total Capital Cost					$1,740,800
Annual Operation Cost					
Labor and Report Preparation	$60,000.00 / YR	3	1	3	$60,000
Electricity	5,000.00 / YR	3	1	3	$5,000
Facility O&M	10% of Subtotal	3	1	3	$6,400
Analytical	18,000.00 / YR	3	1	3	$18,000
Subtotal Annual Operation Cost (O&M)					$89,400
Miscellaneous	20% of Subtotal				$17,900
Contingency	20% of Subtotal				$17,900
Total Annual Operation Cost					$125,200
Total Present Worth for 10 Years @ 5%					$2,708,100

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

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TABLE E4-7
Cost Justification
Excavation with *Ex Situ* Fixation/On-Site Disposal

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Summary					
Capital Cost					
Facilities					
Mobilization/Demobilization	$15,000.00 / LS	3	1	3	$15,000
Excavation Covering	340,000.00/ LS	3	1	3	$340,000
Excavation	10.00 / TON	3	9,000	1	$90,000
Soil Processing	25.00 / TON	3	7,440	1	$186,000
Rubble Processing Surcharge	5.00 / TON	3	1,650	1	$8,300
Reagent Additive (cement)	90.00 / TON	3	2,480	3	$223,200
Backfill Processed Material	1.60 / TON	2	12,470	3	$20,000
Shoring	42.00 / ft ^{2}	2	3,750	3	$157,500
Wellpoint System/Dewatering	300.00 / LF	2	200	3	$60,000
Water Treatment	35,000.00 / LS	3	1	3	$35,000
Top Dressing Backfill, Graded	14.00 / CY	3	3,314	3	$46,400
Grass Cover (sod)	1.50 / SY	3	5,300	3	$8,000
Subtotal Facilities					$1,181,100
Miscellaneous	10% of Subtotal				118,100
Contingency	25% of Subtotal				295,300
Engineering	15% of Subtotal				177,200
Total Capital Cost					$1,771,700
Annual Operation Cost					
Maintenance (mowing) and Inspection	$10,000.00 / LS	3	1	3	$10,000
Subtotal Annual Operation Cost (O&M)					$10,000
Miscellaneous	20% of Subtotal				$2,000
Contingency	20% of Subtotal				$2,000
Total Annual Operation Cost					$14,000
Total Present Worth for 10 Years @ 5%					$1,879,900

Note
(1) Best engineering judgment based upon August 19, 1994, revisions to the remedial investigations addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-8
Cost Justification
Groundwater Monitoring Program

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Annual Operation Cost					
Groundwater Sampling	$6,000.00 / LS	3	1	3	$6,000
Groundwater Analytical	10,000.00 / LS	3	1	3	$10,000
Reporting	5,000.00 / LS	3	1	3	$5,000
Subtotal Annual Operating Cost					$21,000
Miscellaneous	20% of Subtotal		1		$4,200
Contingency	20% of Subtotal		1		$4,200
Total Annual Operating Cost					$29,400
Total Present Worth for 30 Years at 5%					$451,900

Notes
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects
(4) Costing Based on Sampling five (5) monitoring wells

TABLE E4-9
Cost Justification
Fractured Bedrock Grouting/Unconsolidated Fill Vertical Barrier/Groundwater Pumping

Former Manuafactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/			Source	Number of Units	Source	Estimated Cost
Summary							
Capital Cost							
Facilities							
Bedrock Grouting, Perimeter Barrier, and Recovery Trench							
Mobilization/Demobilization	$15,000	/	LS	3	1	3	$15,000
Fractured Bedrock Grouting	$75	/	CY	3	29,300	1	$2,197,500
Groundwater Recovery Trench	$30	/	LF	3	500	1	$15,000
Perimeter Grout Barrier/Sheet Piling	$20	/	ft^2	3	13,650	1	$273,000
SUBTOTAL GROUTING, BARRIER & TRENCH							$2,500,500
Groundwater Collection & Treatment (2 gpm)							
Collection Wells in Trench	$200	/	EA	3	3	3	$600
Recovery Well Access Vaults	$2,500	/	EA	3	3	3	$7,500
Groundwater Pumps	$3,500	/	EA	3	3	3	$10,500
Yard Piping from Pumps	$5,500	/	LS	3	1	3	$5,500
Yard Electrical to Pumps	$5,000	/	LS	3	1	3	$5,000
Equipment Bldg & Fndtn (15x20)	$18,000	/	LS	3	1	3	$18,000
Electrical Service & Install	$8,000			3	1	3	$8,000
Instrumentation	$7,000	/	LS	3	1	3	$7,000
Control Panel	$6,000	/	LS	3	1	3	$6,000
Principal Process Equipment							
O/W Separator with Pump	5,000	/	LS	3	1	3	$5,000
Transfer Tank with Pump	2,500	/	LS	3	1	3	$2,500
pH Control System	11,500	/	LS	3	1	3	$11,500
Air Stripper	10,000	/	LS	3	1	3	$10,000
Transfer Tank with Mixer	2,500	/	LS	3	1	3	$2,500
Parallel Plate Separator	5,500	/	LS	3	1	3	$5,500
Overflow Tank with Pump	2,500	/	LS	3	1	3	$2,500
Particulate Filter	2,500	/	LS	3	1	3	$2,500
Activated Carbon	1,000	/	EA	3	2	3	$2,000
Organophilic Clay Filter	1,500	/	EA	3	2	3	$3,000
Solids Dewatering System	9,000	/	LS	3	1	3	$9,000
Subcontracotr System Install	18,000	/	LS	3	1	3	$18,000
Discharge Line to Sanitary Sewer	3,000	/	LS	3	1	3	$3,000
Pre-treatment Permit (Sewer)	5,500	/	LS	3	1	3	$5,500
Air Permit	5,500	/	LS	3	1	3	$5,500
Subtotal Groundwater Collection Treatment							$156,100
Subtotal Capital Costs							$2,656,600
Miscellaneous	10% of Subtotal						$265,700
Contingency	25% of Subtotal						$664,200
Engineering	15% of Subtotal						$398,500
Total Capital Cost							$3,985,000

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TABLE E4-9 — *Continued*

Description	Estimated Unit Cost/		Source	Number of Units	Source	Estimated Cost
Annual Operation Cost						
Groundwater Sampling/Monitoring/Reporting	21,000	/ YR	3	1	3	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000	/ YR	3	1	3	$10,000
Treatment System Labor and Report Preparation	14,000	/ YR	3	1	3	$14,000
Electricity (Treatment System)	8,000	/ YR	3	1	3	$8,000
Groundwater Treatment O&M	6% of Groundwater Subtotal		3	1	3	$9,400
Treatment Sampling/Analytical	12,000	/ YR	3	1	3	$12,000
Labor and Report Preparation	20,000	/ YR	3	1	3	$20,000
Sewer Use Fee ($1/1,000 gallons)	1,100	/ YR	3	1	3	$1,100
Subtotal Annual Operation Cost (O&M)						$95,500
Miscellaneous	20% of Subtotal					$19,100
Contingency	20% of Subtotal					$19,100
Total Annual Operation Cost						$133,700
Total Present Worth for 30 Years @ 5%						$6,040,000

Notes
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects.

TABLE E4-10
Cost Justification
Groundwater Pumping/Treatment
Discharge to Sanitary Sewer

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Source	Number of Units	Source	Estimated Cost
Summary						
Capital Cost						
Facilities						
Groundwater Collection and Treatment (36 gpm)						
Shallow Extraction Wells (6)	75.00 /	ft	3	180	3	$13,500
Groundwater Pumps	3,500.00 /	ea	3	6	3	$21,000
Recovery Well Access Vaults	2,500.00 /	ea	3	6	3	$15,000
Yard Piping from Pumps	8,200.00 /	LS	3	1	3	$8,200
Yard Electrical to Pumps	7,500.00 /	LS	3	1	3	$7,500
Equipment Bldg & Fndt (20'x30')	36,000.00 /	LS	3	1	3	$36,000
Electrical Service and Installation	15,000.00 /	LS	3	1	3	$15,000
Instrumentation	8,000.00 /	LS	3	1	3	$8,000
Control Panel	10,000.00 /	LS	3	1	3	$10,000
Principal Process Equipment						
O/W Separator with Pump	10,000.00 /	LS	3	1	3	$10,000
Transfer Tank with Pump	3,200.00 /	LS	3	1	3	$3,200
pH Control System	22,500.00 /	LS	3	1	3	$22,500
Air Stripper	35,000.00 /	LS	3	1	3	$35,000
Transfer Tank with Mixer	3,200.00 /	LS	3	1	3	$3,200
Parallel Plate Separator	12,000.00 /	LS	3	1	3	$12,000
Overflow Tank with Pump	3,200.00 /	LS	3	1	3	$3,200
Particulate Filter	5,000.00 /	LS	3	1	3	$5,000
Activated Carbon	7,000.00 /	ea	3	2	3	$14,000
Organophilic Clay Filter	7,500.00 /	ea	3	2	3	$15,000
Solids Dewatering System	16,000.00 /	LS	3	1	3	$16,000
Subcontracotr System Installation	40,000.00 /	LS	3	1	3	$40,000
Discharge Line to Sanitary Sewer	4,000.00 /	LS	3	1	3	$4,000
Pre-treatment Permit (Sanitary Sewer)	5,500.00 /	LS	3	1	3	$5,500
Air Permit	5,500.00 /	LS	3	1	3	$5,500
Subtotal Groundwater						$328,300
Subtotal Capital Cost						$328,300
Miscellaneous	10% of Subtotal					32,800
Contingency	25% of Subtotal					82,100
Engineering	15% of Subtotal					49,200
Total Capital Cost						**$492,400**

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TABLE E4-10 — *Continued*

Description	Estimated Unit Cost/	Source	Number of Units	Source	Estimated Cost
Annual Operation Cost					
Groundwater Sampling/Monitoring/Reporting	21,000.00 / YR	3	1	3	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000 / YR	3	1	3	$10,000
Treatment System Labor and Report Preparation	14,000.00 / YR	3	1	3	$14,000
Electricity (Treatment System)	18,000.00 / YR	3	1	3	$18,000
Groundwater Treatment O&M	6% of Groundwater Subt3tal		1	3	$25,600
Treatment Sampling/Analytical	12,000.00 / YR	3	1	3	$12,000
Labor and Report Preparation	30,000.00 / YR	3	1	3	$30,000
Sewer Use Fee ($1/1,000 gallons)	18,900.00 / YR	3	1	3	$18,900
Subtotal Annual Operation Cost (O&M)					$149,500
Miscellaneous	20% of Subtotal				$29,900
Contingency	20% of Subtotal				$29,900
Total Annual Operation Cost					$209,300
Total Present Worth for 30 Years @ 5%					$3,709,300

Notes (1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

TABLE E4-11
Cost Justification
Fractured Bedrock Grouting/Shallow Groundwater Pumping

Former Manufactured Gas Plant
Mason City, Iowa

Description	Estimated Unit Cost/		Source	Number of Units	Source	Estimated Cost
Summary						
Capital Cost						
Facilities						
Bedrock Grouting and Recovery Trench						
Mobilization/Demobilization	$15,000	/ LS	3	1	3	$15,000
Fractured Bedrock Grouting	$75	/ CY	3	29,300	1	$2,197,500
Groundwater Recovery Trench	$30	/ LF	3	500	1	$15,000
Subtotal Facilities (Grouting & Trench)						$2,227,500
Groundwater Collection & Treatment (8 gpm)						
Collection Wells in Trench	$200	/ EA	3	3	3	$600
Recovery Well Access Vaults	$2,500	/ EA	3	3	3	$7,500
Groundwater Pumps	$3,500	/ EA	3	3	3	$10,500
Yard Piping from Pumps	$5,500	/ LS	3	1	3	$5,500
Yard Electrical to Pumps	$5,000	/ LS	3	1	3	$5,000
Equipment Bldg & Fndtn (15x25)	$22,500	/ LS	3	1	3	$22,500
Electrical Service & Install	$10,000		3	1	3	$10,000
Instrumentation	$7,000	/ LS	3		3	$7,000
Control Panel	$8,000	/ LS	3		3	$8,000
Principal Process Equipment						
O/W Separator with Pump	6,000	/ LS	3	1	3	$6,000
Transfer Tank with Pump	3,200	/ LS	3	1	3	$3,200
pH Control System	13,500	/ LS	3	1	3	$13,500
Air Stripper	10,000	/ LS	3	1	3	$10,000
Transfer Tank with Mixer	3,200	/ LS	3	1	3	$3,200
Parallel Plate Separator	7,200	/ LS	3	1	3	$7,200
Overflow Tank with Pump	3,200	/ LS	3	1	3	$3,200
Particulate Filter	3,000	/ LS	3	1	3	$3,000
Activated Carbon	2,500	/ EA	3	2	3	$5,000
Organophilic Clay Filter	3,000	/ EA	3	2	3	$6,000
Solids Dewatering System	12,000	/ LS	3	1	3	$12,000
Subcontracotr System Install	24,000	/ LS	3	1	3	$24,000
Discharge Line to Sanitary Sewer	4,000	/ LS	3	1	3	$4,000
Pre-treatment Permit (Sewer)	5,500	/ LS	3	1	3	$5,500
Air Permit	5,500	/ LS	3	1	3	$5,500
Subtotal Groundwater Collection Treatment						$187,900
Subtotal Capital Costs						$2,415,400
Miscellaneous	10% of Subtotal					241,500
Contingency	25% of Subtotal					603,900
Engineering	15% of Subtotal					362,300
Total Capital Cost						$3,623,100

40021390 F·

TABLE E4-11 — *Continued*

Description	Estimated Unit Cost/		Source	Number of Units	Source	Estimated Cost
Annual Operation Cost						
Groundwater Sampling/Monitoring/Reporting	21,000	/ YR	3	1	3	$21,000
Treatment System, Performance and Compliance Sampling/Monitoring	10,000	/ YR	3	1	3	$10,000
Treatment System Labor and Report Preparation	$14,000	/ YR	3	1	3	$14,000
Electricity (Treatment System)	12,000	/ YR	3	1	3	$12,000
Groundwater Treatment O&M	6% of Groundwater Subtotal		3	1	3	$11,300
Treatment Sampling/Analytical	12,000	/ YR	3	1	3	$12,000
Labor and Report Preparation	25,000	/ YR	3	1	3	$25,000
Sewer Use Fee ($1/1,000 gallons)	4,200	/ YR	3	1	3	$4,200
Subtotal Annual Operation Cost (O&M)						$109,500
Miscellaneous	20% of Subtotal					$21,900
Contingency	20% of Subtotal					$21,900
Total Annual Operation Cost						**$153,300**
Total Present Worth for 30 Years @ 5%						**$5,979,300**

Notes:
(1) Best engineering judgment based upon August 19, 1994, revisions to remedial investigation addendum
(2) Means site works and landscape cost data, 1992
(3) Best engineering judgment based upon vendor information and/or previous projects

APPENDIX F

LABORATORY FEASIBILITY TESTING REPORT

FINAL REPORT

TECHNOLOGY SCREENING EVALUATION

SURFACTANT ADDITION, BIOREMEDIATION AND OZONE TREATMENT OF CONTAMINATED SOIL

KANSAS CITY POWER AND LIGHT
MASON CITY, IA

JULY 20, 1994

Prepared by:

GROUNDWATER TECHNOLOGY, INC.
REMEDIATION TECHNOLOGY LABORATORY
CONCORD, CA

FINAL REPORT

TECHNOLOGY SCREENING EVALUATION

SURFACTANT ADDITION, BIOREMEDIATION AND OZONE TREATMENT OF CONTAMINATED SOIL

Kansas City Power and Light
Mason City, Iowa

GTI Project No. 040021369

JULY 21, 1994

Prepared for:
Chester Covert, Project Manager
Groundwater Technology, Inc.
Lenexa, Kansas

Groundwater Technology, Inc.
Prepared by:

David A. Cacciatore, M.S.
Research Engineer
Remediation Technology Laboratory
Concord, California

Groundwater Technology, Inc.
Reviewed by:

Carol A. Daly
Project Scientist
Remediation Technology Laboratory
Concord, California

GROUNDWATER TECHNOLOGY, INC.

TABLE OF CONTENTS

TABLES

EXECUTIVE SUMMARY

Groundwater Technology's Remediation Technology Laboratory (RTL) performed a laboratory screening evaluation of bioremediation, bioremediation with surfactant addition and ozone sparging of contaminated soil from the Kansas City Power and Light (KCP&L) Site in Mason City, Iowa.

Soil samples received from KCP&L were screened and composited for the evaluation. Initial characterization of the soil composite showed polynuclear aromatic hydrocarbon (PAH) levels of 2,800 mg/kg. The total organic carbon detected in the soil was 34,000 mg/kg. The initial total petroleum hydrocarbon (TPH) levels ranged from 2,100 to 12,000 mg/kg.

The bioremediation evaluations were performed in sacrificial, slurry test systems. Three experimental conditions were investigated:

1. non-nutrified, microbial poison condition;
2. nutrified condition;
3. nutrified, surfactant addition condition.

The ozone treatment evaluation was performed by passing a stream of ozone through soil composite samples in sealed glass reactors. Ozone treatment alone and ozone treatment with soil amendments were investigated.

The results of the bioremediation screening were favorable. Nutrified systems showed a PAH reduction of 69% and a TPH reduction of 57% in 45 days of treatment. Surfactant addition in combination with bioremediation resulted in negligible changes in both PAHs and TPH.

Ozone treatment had limited effect in reducing PAHs or TPH in the KCP&L soil composite.

1.0 INTRODUCTION

Groundwater Technology's Remediation Technology Laboratory (RTL) performed a laboratory screening evaluation of three technologies: bioremediation, bioremediation with surfactant addition and ozone sparging. The purpose of this evaluation was to validate these alternative technologies as remedial options for contaminated soil at the Kansas City Power and Light (KCP&L) Site located in Mason City, Iowa. The laboratory screening was designed as a quick and inexpensive means of increasing the confidence in the feasibility of bioremediation and ozone sparging. The study was not designed to quantify the extent of remediation or the rates of removal.

The three technologies screened during this evaluation are briefly described below.

Bioremediation is a proven technique for the amelioration of contaminated soils and groundwater. The ultimate goal of bioremediation is to convert organic contaminants into biomass and harmless by-products of microbial metabolism including carbon dioxide, water, and inorganic salts. The process involves stimulating the indigenous microbial population by providing favorable chemical and physical conditions. The applicability of bioremediation depends upon existing site-specific microbial, chemical and physical factors.

Surfactants, or surface activators, are used to enhance the mobilization of contaminants adsorbed to the soil. Surfactants are often used in soil washing or soil flushing procedures as part of a treatment train, where an additional technology is used to treat the aqueous surfactant/contaminant solution. Some organic surfactants have been used in connection with bioremediation.

Ozone treatment is a proven and commonly applied method of waste water treatment. The powerful oxidizing effects of ozone have been successfully applied for many years in the removal of organic pollutants from municipal and industrial waste waters. More recently, the technique has been investigated as a method for decontaminating soils and groundwater that have been impacted by hazardous wastes. Organic contaminants that are highly stable and resistant to the standard treatments of volatilization or bioremediation, may be susceptible to chemical oxidation with ozone. These contaminants include petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyl compounds and phenols.

2.0 EXPERIMENTAL APPROACH

2.1 Sampling and Initial Characterization

Soil and groundwater samples were collected according to standard sampling protocol and shipped on ice to the RTL located in Concord, California. Soil samples (four 8-ounce containers) were received by the RTL on 4/22/94 under Chain of Custody Record Number 34603. A copy of the Chain of Custody Record for this shipment is included in the Appendix.

A soil composite sample was generated by mixing equal portions of soil samples. Prior to compositing, the individual soil samples were passed through a 4.75 mm sieve to remove larger stones and debris, in order to generate a more homogenous sample.

The soil composite was tested for a range of parameters as indicated in Table 1. The data collected during the initial characterization were used to provide information on the chemical, physical, and microbial status of the site soil in order to determine optimum conditions for effective implementation of the bioremediation and ozone treatment technologies.

TABLE 1 INITIAL CHARACTERIZATION PERFORMED ON KCP&L SOIL COMPOSITE

Analysis	Method Reference
Contaminant Screen	
total organic carbon (TOC)	Environmental Protection Agency (EPA) Method 415.1
total petroleum hydrocarbon(TPH) by IR[1]	EPA 418.1
PAHs by GC/FID[2]	EPA 8100 (modified)
TPH by GC/FID	EPA 8100 (modified)
Background Nutrient Levels	
ammonia-nitrogen	EPA 350.3
nitrate-nitrogen	EPA 300.0
total phosphate	EPA 365.3
Physical Parameters	
moisture content	Standard Methods (SM) 209A
pH	SM 4500-H^+
Microbiological Testing	
total heterotrophic bacteria (THB)	SM 9215 C
naphthalene utilizing bacteria (NUB)	SM 9215 C (modified)

(1) Infrared spectroscopy.
(2) Gas chromatography with flame ionization detector.

2.2 Slurry Biodegradation Study

A slurry biodegradation study was conducted to assess the feasibility of bioremediation with and without surfactant addition. Soil slurry test systems were designed to determine the biodegradation potential under optimum conditions with respect to oxygen, nutrients and moisture content.

Three experimental systems were tested in this study to evaluate biodegradation:

1. non-nutrified, microbial poison condition (poison);
2. nutrified condition (nutrified);
3. nutrified, surfactant addition condition (nutrified + surfactant)

The systems consisted of a series of sealed, 160 mL glass reactors, each containing 2 grams of soil composite mixed with 50 mL of deionized water. Amendments initially added to the reactors in each system are listed in Table 2. Each reactor had a headspace volume of 110 mL, containing 21% (mole basis) oxygen to support the biodegradation. Approximately 10 mL of oxygen was injected into the nutrified and nutrified + surfactant system every 10 days during the study as a supplement to the headspace oxygen.

The poison condition (System 1) was designed to measure abiotic contaminant losses, i.e. losses due to volatilization, adsorption and/or other non-biological processes. System 2, the nutrified condition, was designed to model contaminant degradation when excess nutrients and oxygen are provided. The nutrified + surfactant condition (System 3) was designed to model degradation when surfactants are used to remove adsorbed contaminants from the soil in a nutrient- and oxygen-rich environment.

The reactors were incubated on a reciprocating shaker at room temperature for the duration of the study. Reactors from each test system were sacrificed for analysis of PAHs and TPH by GC/FID on Days 0, 15, 30 and 45, and for analysis of TPH by IR on Days 0 and 45. NUB counts in the 3 systems were determined on Days 0, 15 and 30.

TABLE 2 SYSTEM SET-UP FOR SLURRY BIODEGRADATION STUDY

System	Soil Added	Deionized Water Added	Nutrients Added	Microbial Poison	Surfactant Added
1. poison	2 grams	50 mL	NONE	0.3% $HgCl_2$	NONE
2. nutrified	2 grams	50 mL	N: 2.4 mg P: 2.1 mg	NONE	NONE
3. nutrified + surfactant	2 grams	50 mL	N: 2.4 mg P: 2.1 mg	NONE	0.5% Tween 80[(1)]

(1) polyoxyethylene (20) sorbitan monolaurate

2.3 Ozone Treatment Study

A screening test was performed to evaluate the effectiveness of ozone treatment on the KCP&L soil composite. Ozone treatment alone, Treatment #1, and ozone treatment with soil amendments, Treatment #2 and Treatment #3, were evaluated.

The three ozone tests were conducted by delivering a gas stream of 5% by weight ozone (66 mg/L) in oxygen upward through a vertical glass column (3 inch I.D.) containing 200 grams (wet weight) of soil composite. The gas stream was delivered at a flow rate of 1.0 L/minute for a period of 40 hours. This corresponds to a loading rate of 4 grams of ozone per hour or 0.21 pounds of ozone per day.

The systems were analyzed in duplicate for PAHs and TPH by GC/FID initially and after the 40-hour treatment.

3.0 RESULTS

3.1 Initial Characterization of Soil and Groundwater

Results of the initial characterization tests performed on the KCP&L site soil composite are presented in Table 3. The contaminant screen results are widely varying. The TOC concentration was 34,000 mg/kg. The TPH by GC/FID was 12,000 mg/kg, which is six times greater than the TPH by IR at 2,100 mg/kg. The PAHs by GC/FID amounted to 2,800 mg/kg, 23% of the TPH detected by GC/FID.

The nutrient levels in the KCP&L soil composite were low, requiring supplementation for bioremediation. The soil was slightly acidic with a pH of 6.28. The moisture content in the soil composite was 36% and the bacteria counts (THB and NUB) were greater than 10^6 colony forming units per gram (cfu/g) in the initial soil composite.

The background nutrient concentrations provided in Table 3 were summarized from analytical reports which are included in the Appendix.

TABLE 3 INITIAL ANALYSIS RESULTS (dry weight basis)

Analysis	Units	Result
CONTAMINANT SCREEN		
TOC	mg/kg	34,000
TPH by IR	mg/kg	2,100
PAHs by GC/FID	mg/kg	2,800
TPH by GC/FID	mg/kg	12,000
NUTRIENT STATUS(1)		
ammonia-nitrogen	mg/kg	0.03
nitrate-nitrogen	mg/kg	< 0.23
total phosphate	mg/kg	< 3.0
PHYSICAL PARAMETERS		
moisture content	%	36
pH	pH units	6.28
MICROBIOLOGICAL TESTING		
THB	cfu/g	9.1×10^6
NUB	cfu/g	3.8×10^6

(1) Analysis performed by analytical laboratory; detailed results are provided in the Appendix.

3.2 Slurry Biodegradation Study

Results of the slurry biodegradation study are provided in Tables 4 through 7.

Tables 4 and 5 provide the results of the PAHs and TPH analyses by GC/FID, respectively. Day 0 sampling showed 24% higher levels of PAHs and TPH in the nutrified + surfactant system than in the nutrified or poison systems. These initial results indicate an immediate effectiveness of the surfactant in making the PAH and TPH contaminants more available. Day 15 sampling showed significant reductions in the nutrified system, 40% and 46%, for PAHs and TPH, respectively. The nutrified + surfactant and poison systems showed increases in PAHs and TPH at Day 15. Day 30 sampling did not show much change in any system from the Day 15 data. Day 45 sampling showed additional reductions in the nutrified system, whereas the nutrified + surfactant and poison systems showed negligible reductions or increases.

Over the 45 day study, PAH and TPH concentrations in the nutrified systems were reduced by 69% and 57%, respectively. The PAH levels in the nutrified + surfactant systems showed negligible change, and the TPH levels showed a 17% increase. The poison systems showed increases of 16% and 25% in PAHs and TPH, respectively, over the 45 day study. These results suggest that biodegradation will occur in the KCP&L soil composite through aeration and nutrient addition.

Data from the TPH by IR analysis are provided in Table 7. The TPH by IR results are less than the TPH by GC/FID results. After the 45 day incubation, the IR analyses showed a TPH reduction of 7.2% in the nutrified systems. The nutrified + surfactant and poison systems showed TPH by IR increases of 75% and 96%, respectively. Day 0 TPH by IR concentrations are lower than expected based on the initial TPH by IR analysis. The low results for the Day 0 sampling are possibly due to freon extraction inefficiencies from the initial, undisturbed systems and/or sample heterogeneity.

The bacterial enumeration results are provided in Table 7. The Day 0 bacterial populations are quite a bit lower than the initial analysis. These results are questionable because less than the statistically acceptable number of colonies were countable due to spreader-type bacteria covering the plates and hindering colony detection. The Day 15 results show that there were substantial microbial populations in the nutrified and nutrified + surfactant systems. The nutrified system showed slightly larger populations than the nutrified + surfactant system. The poison control system was effectively inhibited, showing microbial populations less than 100 cfu/g both initially and after 15 days.

The laboratory test conditions were designed to provide optimum conditions for biodegradation.

Excess levels of mineral nutrients and oxygen were provided in the test reactors to ensure sufficient levels were maintained throughout the testing. In addition, the test reactors were mixed continuously to maximize contaminant dispersion and microbial activity. The rates of biodegradation observed in the laboratory study may not be achievable in a field-scale system where there may be less control over these process variables.

TABLE 4 PAHs BY GC/FID (mg/kg soil - dry weight basis)[1]

System	Day 0	Day 15	Day 30	Day 45	% Change
Poison	2,500	3,200	2,600	2,900	+16
Nutrified	2,500	1,500	1,600	770	-69
Nutrified + Surfactant	3,100	3,400	3,200	3,100	0

TABLE 5 TPH (diesel) BY GC/FID (mg/kg soil - dry weight basis)[1]

System	Day 0	Day 15	Day 30	Day 45	% Change
Poison	12,000	14,400	12,600	15,000	+25
Nutrified	12,000	6,500	7,900	5,200	-57
Nutrified + Surfactant	15,000	17,300	19,200	17,500	+17

TABLE 6 TPH BY IR (mg/kg soil - dry weight basis)[1]

System	Day 0	Day 45	% Change
Poison	970	1,900	+96
Nutrified	970	900	-7.2
Nutrified + Surfactant	970	1,700	+75

(1) Results based on duplicate analysis.

TABLE 7 NAPHTHALENE-UTILIZING BACTERIA (cfu/mL - dry weight basis)[1]

System	Day 0	Day 15	Day 30
Poison	< 100	< 100	< 100
Nutrified	(2.2×10^3)	4.0×10^6	3.3×10^6
Nutrified + Surfactant	(2.9×10^3)	9.4×10^5	8.2×10^5

(1) Results based on duplicate analysis.
Results in parentheses do not fall within the range of 30 to 300 colonies per mL and are therefore reported as estimated counts.

3.3 Ozone Treatment Study

The results of the ozone treatment study are provided in Tables 8 and 9. The PAH results in Table 8 and the TPH by GC/FID results in Table 9 show the limited effectiveness of ozone treatment. Ozone treatment alone yielded increases in PAHs and TPH, 32% and 8.3%, respectively. One of the ozone treatments with soil amendment resulted in a 7.1% decrease in PAHs and a 17% decrease in TPH. The other ozone treatment with soil amendment resulted in an 18% increase in PAHs and an 8.3% decrease in TPH.

TABLE 8 RESULTS OF OZONE TREATMENT: PAHs BY GC/FID (mg/kg dry weight basis)[1]

System	Before	After 40 hour treatment	% Change
Ozone Treatment #1	2,800	3,700	+ 32
Ozone Treatment #2	2,800	2,600	- 7.1
Ozone Treatment #3	2,800	3,300	+ 18

(1) Results based on duplicate analysis.

TABLE 9 RESULTS OF OZONE TREATMENT: TPH BY GC/FID (mg/kg dry weight basis)[1]

System	Before	After 40 hour treatment	% Change
Ozone Treatment #1	12,000	13,000	+ 8.3
Ozone Treatment #2	12,000	10,000	- 17
Ozone Treatment #3	12,000	11,000	- 8.3

(1) Results based on duplicate analysis

4.0 CONCLUSIONS

A soil composite from the KCP&L site in Mason City, Iowa was characterized and screened for bioremediation, bioremediation with surfactant addition and ozone treatment feasibility. The soil composite was found to contain 2,800 mg/kg PAHs, 34,000 mg/kg TOC, 2,100 mg/kg TPH by IR and 12,000 mg/kg TPH by GC/FID. The nutrient levels within the soil were low. The pH of the soil composite was found to be slightly acidic at 6.28. Substantial THB and NUB populations (10^6 cfu/g) were found in the soil composite.

The results of the bioremediation screening were favorable for aerobic biodegradation. The nutrified system showed a 69% reduction in PAHs and a 57% reduction in TPH after 45 days of bioremediation monitoring. The surfactant enhanced bioremediation system showed a negligible reduction in PAHs and TPH after the 45 days. The poison control system also showed negligible changes in PAHs and TPH, indicating losses observed in the nutrified system were likely due to biodegradation.

Ozone treatment screening exhibited limited success. The 40 hour treatment yielded negligible reductions in PAHs and TPH perhaps being influent by the relatively high contaminant and TOC level.

APPENDICES

(A) CHAIN OF CUSTODY
(B) EXTERNAL (GTEL) ANALYTICAL RESULTS

GTEL

4211 MAY AVE.
WICHITA, KS 67209
(316) 945-2624
(800) 633-7936

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

34603

Company Name: Groundwater Technology
Phone #: ~~515-252-0234~~ 913-599-0262
FAX #: 913-599-1043
Company Address: 15010 W. 106th, Lenexa, KS
Site Location: Mason City, IA
Project Manager: Chester Covert
Client Project ID: (#) 04002-1367
(NAME) KCP&L - Mason City
I attest that the proper field sampling procedures were used during the collection of these samples.
Sampler Name (Print): Mark Brooks

ANALYSIS REQUEST: BTEX 602 ☐ 8020 ☐ with MTBE ☐; BTEX/Gas Hydrocarbons PID/FID ☐ with MTBE ☐; Hydrocarbons GC/FID Gas ☐ Diesel ☐ Screen ☐; Hydrocarbon Profile (SIMDIS) ☐; Oil and Grease 413.1 ☐ 413.2 ☐ SM-503 ☐; TPH/IR 418.1 ☐ SM 503 ☐; EDB by 504 ☐ DBCP by 504 ☐; EPA 503.1 ☐ EPA 502.2 ☐; EPA 501 ☐ EPA 8010 ☐; EPA 602 ☐ EPA 8020 ☐; EPA 608 ☐ 8080 ☐ PCB only ☐; EPA 624/PPL ☐ 8240/TAL ☐ NBS (+15) ☐; EPA 625/PPL ☐ 8270/TAL ☐ NBS (+25) ☐; EPA 610 ☐ 8310 ☐; EP TOX Metals ☐ Pesticides ☐ Herbicides ☐; TCLP Metals ☐ VOA ☐ Semi-VOA ☐ Pest ☐ Herb ☐; EPA Metals - Priority Pollutant ☐ TAL ☐ RCRA ☐; CAM Metals TTLC ☐ STLC ☐; Lead 239.2 ☐ 200.7 ☐ 7420 ☐ 7421 ☐ 6010 ☐; Organic Lead ☐; Corrosivity ☐ Flash Point ☐ Reactivity ☐

OTHER: Bio-Treatability Study

Field Sample ID	~~GTEL~~ RTL Lab # (Lab Use only)	# CONTAINERS	Matrix: WATER	SOIL	AIR	SLUDGE	PRODUCT	OTHER	Method Preserved: HCl	HNO_3	H_2SO_4	ICE	UNPRESERVED	OTHER (Specify)	Sampling: DATE	TIME	Analysis Request	Other: Bio-Treatability Study
Composite Sample	6962	4		X								X			4/20/94	12:00		X

TAT	Special Handling
Priority (24 hr) ☐	GTEL Contact ____
Expedited (48 hr) ☐	Quote/Contract # ____
7 Business Days ☐	Confirmation # ____
Other ____ Business Days ☐	P.O. # ____

QA/QC Level: Blue ☐ CLP ☐ Other ☐ ____

SPECIAL DETECTION LIMITS

SPECIAL REPORTING REQUIREMENTS

FAX ☐

REMARKS: 4-22 NO DIRECTION ON HOW TO PROCEED YET — ON H[illegible]

Lab Use Only Lot #:
Storage Location
Work Order #: R6962

CUSTODY RECORD

Relinquished by	Date	Time	Received by
Relinquished by Sampler: Mark Brooks	4-20-94	4:25	Received by:
Relinquished by:			Received by:
Relinquished by:	4-21-94		Received by Laboratory: [signature] Waybill #

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Western Region
4080 Pike Lane, Suite C
Concord, CA 94520
(510) 685-7852
(800) 544-3422 Inside CA
FAX (510) 825-0720

Client Number: 040021369
Project ID: KCP&L-Mason City
Mason City, IA
Work Order Number: C4-04-0434

May 9, 1994

David Cacciatore
Groundwater Technology, Inc., RTL
4080-B Pike Lane
Concord, CA 94520

Enclosed please find the analytical results for samples received by GTEL Environmental Laboratories, Inc. on 04/25/94, under chain of custody record 31923.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria, unless otherwise stated in the footnotes.

GTEL is certified by the California State Department of Health Services, Laboratory certification number E1075, to perform analyses for drinking water, wastewater, and hazardous waste materials according to EPA protocols.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,
GTEL Environmental Laboratories, Inc.

Rashmi Shah
Laboratory Director

Client Number: 040021369
Project ID: KCP&L-Mason City
Mason City, IA
Work Order Number: C4-04-0434

ANALYTICAL RESULTS
Matrix: Soil

				Sample Number	01	042894		
				Sample Identification	SOIL COMP	METHOD BLANK		
				Date Sampled	--	--		
Test Description	Units	Detection Limit	Method	Date Analyzed	Test Result			
Ammonia NH_3-N*	mg/Kg	0.02	EPA 350.1	04/28/94	0.03	<0.02		
Nitrate-N	mg/Kg	0.23	EPA 300.0	04/30/94	<0.23	<0.23		
Total Phosphate	mg/Kg	3	CFA 12.0	05/06/94	<3	<3		

Note: Test Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, March, 1983.
Note: California Fertilizer Association, "California Soil Testing Procedures".
* This value represents water extractable analyte.

GTEL ENVIRONMENTAL LABORATORIES INC

4080 PIKE LANE, SUITE C
CONCORD, CA 94520
(510) 685-7852
(800) 423-7143

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

31923

Company Name: Remediation Technology Lab

Phone #: 510-671-2116

FAX #: 510-687-0843

Company Address: 4095 Pike Lane, Suite B, Concord

Site Location: Mason City, IA

Project Manager: David Cacciatore

Client Project ID: (#) 04002-1369

(NAME) KCP&L - Mason City

I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler Name (Print): D. Cacciatore

Field Sample ID	GTEL Lab # (Lab Use only)	# CONTAINERS	Matrix: WATER	Matrix: SOIL	Matrix: AIR	Matrix: SLUDGE	Matrix: PRODUCT	Matrix: OTHER	Method Preserved: HCl	Method Preserved: HNO_3	Method Preserved: H_2SO_4	Method Preserved: ICE	Method Preserved: UNPRESERVED	Method Preserved: OTHER (Specify)	Sampling: DATE	Sampling: TIME
SOIL COMP	01	1		✓									✓			

ANALYSIS REQUEST

Field Sample ID	BTEX 602 / 8020 / with MTBE	BTEX/Gas Hydrocarbons PID/FID / with MTBE	Hydrocarbons GC/FID Gas / Diesel / Screen	Hydrocarbon Profile (SIMDIS)	Oil and Grease 413.1 / 413.2 / SM-503	TPH/IR 418.1 / SM 503	EDB by 504 / DBCP by 504	EPA 503.1 / EPA 502.2	EPA 601 / EPA 8010	EPA 602 / EPA 8020	EPA 608 / 8080 / PCB only	EPA 624/PPL / 8240/TAL / NBS (+15)	EPA 625/PPL / 8270/TAL / NBS (+25)	EPA 610 / 8310	EP TOX Metals / Pesticides / Herbicides	TCLP Metals / VOA / Semi-VOA / Pest / Herb	EPA Metals - Priority Pollutant / TAL / RCRA	CAM Metals TTLC / STLC	Lead 239.2 / 200.7 / 7420 / 7421 / 6010	Organic Lead	Corrosivity / Flash Point / Reactivity	OTHER: NH_3-N	OTHER: NO_3-N	OTHER: [illegible]
SOIL COMP																						✓	✓	✓

4/30/94

TAT	Special Handling
Priority (24 hr) [ ]	GTEL Contact
Expedited (48 hr) [ ]	Quote/Contract #
7 Business Days [ ]	Confirmation #
Other Business Days [ ]	P.O. #

QA/QC Level: Blue [ ] CLP [ ] Other [ ]

SPECIAL DETECTION LIMITS

SPECIAL REPORTING REQUIREMENTS

FAX ☐

REMARKS: Results on dry wt basis

Lab Use Only Lot #:

Storage Location: D 2/3

Work Order #: C404434

CUSTODY RECORD

Relinquished by	Date	Time	Received by
Relinquished by Sampler: David A. Cacciatore	4/25/94	18:00	Received by:
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Relinquished by:	4-25-94	6:30	Received by Laboratory: Ken Malondo

MEMORANDUM from the Remediation Technology Laboratory

TO:	Chester Covert Chris Nelson Don Shosky
cc:	Nathan Hicks
FROM:	David Cacciatore
DATE:	August 16, 1994
SUBJECT:	Addendum to the KCP&L Final Report - v.3

The Day 62 results of the KCP&L biotreatability study are presented in Tables 4 and 5, following the numbering in the Technology Screening Evaluation Final Report (issued 7/20/94).

The results of the PAH analyses are provided in Table 4. The concentration of PAHs increased in all of the systems from Day 45 to Day 62. The overall PAH reductions are provided and show a 44% reduction in the nutrified system compared to increases of 72% and 35% for the poison and nutrified + surfactant systems, respectively.

The results of the TPH analyses are listed in Table 5. Each of the systems showed reductions in TPH after the 62-day study. The nutrified system yielded the greatest TPH reduction at 83% after the 62 days.

The results suggest that biodegradation of the PAHs and TPH will occur in the KCP&L composite soil with aeration and nutrient addition. Surfactant addition under the conditions investigated did not enhance the bioremediation.

The apparent increase in PAHs in the poison and nutrified + surfactant systems at the end of the 62 day study may be due to analytical difficulties caused by the high TPH levels in the soil composite. The trend in the results suggests that the high initial levels of TPH hindered the PAH detection by GC/FID. As the TPH was reduced by >18%, more of the PAHs were resolved. This trend suggests that the initial concentrations of PAHs may be higher than those reported which would make the changes observed in the poison and nutrified + surfactant systems minimal and the reduction observed in the nutrified system >44%.

Analytical testing for PAHs by EPA 8270 (GC/MS) and EPA 8310 (HPLC) in addition to retesting by GC/FID will be performed on the initial soil composite to check for analytical interferences caused by the high TPH levels. Samples of the soil after the 62-day biotreatablity study will also be tested by EPA 8310 to check for post-treatment interferences.

The ozone treatment of the KCP&L soil composite will be continued for another 40 hours. Ozone treatment is expected to have more of an effect on the soil than indicated by the 40-hour ozonation results.

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TABLE 4 PAHs BY GC/FID (mg/kg soil - dry weight basis)[1]

System	Day 0	Day 15	Day 30	Day 45	Day 62	% Change
Poison	2,500	3,200	2,600	2,900	4,300	+72
Nutrified	2,500	1,500	1,600	770	1,400	-44
Nutrified + Surfactant	3,100	3,400	3,200	3,100	4,200	+35

TABLE 5 TPH (diesel) BY GC/FID (mg/kg soil - dry weight basis)[1]

System	Day 0	Day 15	Day 30	Day 45	Day 62	% Change
Poison	12,000	14,400	12,600	15,000	9,900	-18
Nutrified	12,000	6,500	7,900	5,200	2,000	-83
Nutrified + Surfactant	15,000	17,300	19,200	17,500	10,800	-28

(1) Results based on duplicate analysis.

MEMORANDUM from the Remediation Technology Laboratory

TO: Chester Covert
Chris Nelson

cc: Ron Hicks
Nathan Hicks

FROM: David Cacciatore

DATE: September 13, 1994

SUBJECT: Addendum to the KCP&L Final Report - PAH Analysis Study v.2

The results of the PAH analysis study on the Kansas City Power and Light (KCP&L) soil composite samples are presented. This study represents an addendum to the Technology Screening Evaluation Final Report issued 7/20/94. The overall results from this study confirm the findings reported in the Screening Evaluation.

The purpose of the screening evaluation was to evaluate bioremediation, bioremediation with surfactant addition and ozone sparging as individual remedial options for the KCP&L site. The contaminants of concern were polynuclear aromatic hydrocarbons (PAHs) and total petroleum hydrocarbon (TPH) which were monitored by gas chromatography with a flame-ionization detector (GC/FID) in the screening. Previous treatability studies on the remediation of PAHs have shown that their detection and quantification can be affected by other soil contaminants, including TPH.

The purpose of this study as an addendum to the screening evaluation was to check for analytical interferences potentially caused by the high TPH levels in the KCP&L composite. The KCP&L soil composite was analyzed for PAHs by three different methods:

- High Performance Liquid Chromatography (HPLC) by Environmental Protection Agency (EPA) Method 8310;
- Gas Chromatography with Mass Spectrometry (GC/MS) by EPA Method 8270;
- and GC/FID by EPA Method (modified) 8100.

Slurry systems representing Day 0 and Day 62 of the biodegradation study were analyzed. Three new Day 0 systems were prepared and tested by HPLC, GC/MS and GC/FID. Two remaining Day 62 systems, nutrified and nutrified + surfactant, were tested by HPLC. The results of the Day 62 HPLC analyses were compared to the Day 62 GC/FID analyses previously reported.

Each system contained 2 grams of soil composite and 50 milliliters (mL) of water. The systems were shake-extracted with 40 mL of methylene chloride. The GC/FID analyses were performed by the Remediation Technology Laboratory (RTL), the GC/MS analysis was performed by the Groundwater Technology Environmental Laboratory (GTEL) in Concord, CA and the HPLC analyses were performed by GTEL in Wichita, KS.

The PAH analysis results are provided in Tables 1, 2 and 3. Table 1 provides the comparison of the

PAH analysis by HPLC, GC/MS and GC/FID on the initial slurry systems. The total PAHs (mg/kg) measured by HPLC, GC/MS and GC/FID were 780, 1,900 and 2,900, respectively. The large variation in results between the different analytical methods makes comparison difficult. Pyrene was detected as the highest individual PAH contaminant by all three methods. Most of the PAH contamination detected was the 3-ring and 4-ring compounds.

Tables 2 and 3 provide the results of the PAH analysis by HPLC for the nutrified and the nutrified + surfactant systems, respectively, on Day 62 of the slurry bioremediation study. The GC/FID results from the Screening Evaluation Report are provided for comparison. The HPLC analysis shows the same trends as the GC/FID analysis. Large total PAH reductions were observed on Day 62 for the nutrified system whereas the nutrified + surfactant system showed moderate increases. The results suggest that biodegradation of the PAHs in the KCP&L soil composite will occur if nutrients and oxygen are supplemented. Surfactant addition under the conditions investigated did not enhance the bioremediation.

The PAH reduction in the nutrified system as measured by HPLC was 89% compared to a reduction of 67% as measured by GC/FID. By HPLC the individual PAH reductions ranged from 56% to 99%. Reductions of the 3-ring and 4-ring compounds by HPLC was greater than 89% and reductions of the 5-ring and greater compounds was greater than 65%, with the exception of dibenzo (a,h) anthracene which showed an increase of roughly 4-fold. By GC/FID, the individual PAH changes ranged from a decrease of 80% to an increase of 6-fold. Reductions of the 3-ring and 4-ring compounds by GC/FID were greater that 41%. However the 5-ring and greater compounds showed increases greater than 64% by GC/FID. The results by HPLC are more reasonable. The biodegradation of PAHs is expected to result in reductions of the individual PAHs, with higher degradation rates for the 3-4 ring compounds as compared to the 5-ring and larger compounds.

The total PAHs in the nutrified + surfactant systems on Day 62 increased 12% by HPLC and 45% by GC/FID. This apparent increase in PAHs in the nutrified + surfactant systems may still be attributed to analytical difficulties caused by the high TPH levels in the KCP&L composite, despite the confirmatory analyses. The increase may be due to the effect of the surfactant which may be hindering the biodegradation yet causing the release of more PAHs from the soil. The increase observed could also be due to sample heterogeneity.

TABLE 1 PAH ANALYSIS RESULTS - INITIAL SLURRY SYSTEMS (Results as mg/kg)

COMPOUND	HPLC[A]		GC/MS[B]		GC/FID	
	Detection Limits	Analysis	Detection Limits	Analysis	Detection Limits	Analysis
naphthalene	2	6.8	140	<140	39	<39
acenaphthylene	0.7	56[C]	140	203	39	290
acenaphthene	0.7	20	140	<140	39	71
fluorene	0.3	36	140	145	39	170
phenanthrene	0.3	96	140	384	39	430
anthracene	0.3	20	140	<140	39	190
fluoranthene	0.7	120	140	301	39	420
pyrene	0.3	180	140	438	39	510
benzo (a) anthracene	0.2	52	140	160	39	200
chrysene	0.3	34	140	150	39	200
benzo (b) fluoranthene	0.2	38	140	150	39	53
benzo (k) fluoranthene	0.07	16	140	<140	39	170
benzo (a) pyrene	0.2	43	140	<140	39	110
dibenzo (a,h) anthracene	0.3	1.3	140	<140	39	64
benzo (g,h,i) perylene	0.2	48	140	<140	39	41
indeno (1,2,3-cd) pyrene	0.3	15	140	<140	na	na
TOTAL	7	780	2,200	1,900	585	2,900

(A) The HPLC(mg/kg) results were obtained from the HPLC(ug) results provided by GTEL-Wichita.
(B) The GC/MS(mg/kg) results were obtained from the GC/MS(ug/L) results provided by GTEL-Concord.
(C) Qualitative identification is uncertain due to matrix interferences.

TABLE 2 PAH ANALYSIS RESULTS - DAY 62 NUTRIFIED SLURRY SYSTEMS
(Results as mg/kg)

COMPOUND	HPLC[A]		GC/FID[D]	
	Detection Limits	Analysis	Detection Limits	Analysis
naphthalene	1	3.0	100	<100
acenaphthylene	0.4	<0.5[B]	100	<100
acenaphthene	0.4	<0.3	100	<100
fluorene	0.2	0.68	100	<100
phenanthrene	0.2	3.9	100	<100
anthracene	0.2	0.75	100	<100
fluoranthene	0.4	7.5	100	<100
pyrene	0.2	8.2	100	<100
benzo (a) anthracene	0.1	5.5	100	110
chrysene	0.2	3.6	100	<100
benzo (b) fluoranthene	0.1	6.8	100	<100
benzo (k) fluoranthene	0.04	3.5	100	280
benzo (a) pyrene	0.1	14	100	200
dibenzo (a,h) anthracene	0.2	4.7	100	120
benzo (g,h,l) perylene	0.1	15	100	250
indeno (1,2,3-cd) pyrene	0.2	5.3	na	na
TOTAL PAHs (% Change)[C]	4	82 (-89)	1,500	960 (-67)

(A) The HPLC(mg/kg) results were obtained from the HPLC(ug) results provided by GTEL-Wichita.
(B) Qualitative identification is uncertain due to matrix interferences.
(C) Percent change relative to initial analysis by the same analytical method.
(D) Results reported are from the Screening Evaluation Final Report; only the PAHs greater than the detection limit are included here, thus the total PAHs reported is less than in the Screening Report.

TABLE 3 PAH ANALYSIS RESULTS - DAY 62 NUTRIFIED+SURFACTANT SLURRY SYSTEMS
(Results as mg/kg)

COMPOUND	HPLC[(A)]		GC/FID[(D)]	
	Detection Limits	Analysis	Detection Limits	Analysis
naphthalene	2	9.6	100	<100
acenaphthylene	0.7	25[(B)]	100	120
acenaphthene	0.7	22	100	<100
fluorene	0.3	44	100	140
phenanthren	0.3	130	100	360
anthracene	0.3	28	100	160
fluoranthene	0.7	120	100	450
pyrene	0.3	200	100	550
benzo (a) anthracene	0.2	68	100	320
chrysene	0.3	53	100	270
benzo (b) fluoranthene	0.2	37	100	<100
benzo (k) fluoranthene	0.07	18	100	470
benzo (a) pyrene	0.2	47	100	350
dibenzo (a,h) anthracene	0.3	6.6	100	390
benzo (g,h,i) perylene	0.2	47	100	570
indeno (1,2,3-cd) pyrene	0.3	14	na	na
TOTAL (% Change)[(C)]	7	670 (+12)	1,500	4,200 (+45)

(A) The HPLC(mg/kg) results were obtained from the HPLC(ug) results provided by GTEL-Wichita.
(B) Qualitative identification is uncertain due to matrix interferences.
(C) Percent change relative to initial analysis by the same analytical method.
(D) Results reported are from the Screening Evaluation Final Report; only the PAHs greater than the detection limit are included here, thus the total PAHs reported is less than in the Screening Report.