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REGION VII

September 30, 1994

Ms. Diana Engeman
EPA Project Coordinator
Superfund Branch, Wastemanagement Division
US Environmental Protection Agency, Region VII
726 Minnesota Avenue
Kansas City, KS 66101

RE: Mason City Coal Gasification Plant Site
Docket No. 85-F-0032

Dear Ms. Engeman:

Enclosed are three copies of the final revisions to the Remedial Investigation Addendum (RIA) for the Mason City Coal Gasification Plant Site. These revisions in conjunction with the revisions dated August 19, 1994, address all of EPA's comments in their letter date May 17, 1994. In addition these revisions include all information relating to the additional sampling conducted in June, July and August of 1994.

This completes the RIA work.

Please contact me if you have any questions or need additional information.

Very truly yours,

Michael R. Chase
Vice President - Power Production

MRC:clr
Encl.

cc: Randy Kroneman
Todd Trometer
Johansir Golchin
John E. Horn

Interstate Power Company
Remedial Investigation Addendum Report
Former Manufactured Gas Plant Site
Mason City, Iowa
September 1994 Revision

Instructions for Page Replacement

This packet contains revised pages for the Remedial Investigation Addendum Report for the former manufactured gas plant site in Mason City, Iowa. The revised pages replace those in the existing volumes of the report. All affected pages within each section are enclosed.

In addition to text changes, revised figures, tables, and appendices are also enclosed and are to replace the existing pages of the same number and title. A revised table of contents is also enclosed. Detailed replacement instructions are presented below. The revised pages are packaged in the order in which they occur in the report and are separated by a sheet of colored paper. These changes reflects the additional information gathered and conclusions generated from the verification sampling of MW-25, MW-28, and MW-34 and the changes related to the water level elevations in Willow Creek after raising the Willow Creek dam.

Volume 1

- Remove and replace the report cover in the binder pocket.
- Remove and replace the volume cover sheet.
- Table of Contents
  --Replace the entire section with the revised copy.
- Executive Summary
  -Replace the entire section with the revised copy.
- Section 1
  -Replace the entire section with the revised copy.
- Section 2
  -Replace the entire section with the revised copy.
- Section 3
  -Replace the entire section with the revised copy.
- Section 4
  -Replace the entire section with the revised copy.
- Section 5
  -Replace the entire section with the revised copy.

Instructions for Page Replacement (continued)

Volume 1 (continued)

- Tables
  - -Remove and replace Tables 2-7 and 2-8.
  - -Add Table 4-1.

- Figures
  - -Remove and replace Figures 2-14 through 2-26.

Volume 2

- Remove and replace the report cover in the binder pocket.

- Remove and replace the volume cover sheet.

- Appendix H
  - -Add Groundwater Sampling Collection Records for MW-25, MW-28, and MW-34.

- Appendix I
  - -Remove and replace the water level measurements table.

- Appendix L
  - -Remove and replace Table L-6.

- Appendix M
  - -Add the NET laboratory QC narrative for the August 1994 verification samples.

Volume 3

- Remove and replace the report cover in the binder pocket.

- Remove and replace the volume cover sheet.

- Appendix N
  - -Add the LDC data validation report for the August 1994 verification samples.

- Appendix R
  - - Remove and replace the analytical data base for MW-25, MW-28, and MW-34.

VOLUME 1

REMEDIAL INVESTIGATION ADDENDUM

FOR

FORMER MANUFACTURED GAS PLANT SITE
MASON CITY, IOWA

Prepared for

INTERSTATE POWER COMPANY
DUBUQUE, IOWA

Project No. 2334.0218

April 1994
Revised September 1994

Prepared by

Montgomery Watson
11107 Aurora Avenue
Des Moines, Iowa 50322
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REMEDIAL INVESTIGATION ADDENDUM

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TEXT, TABLES, AND FIGURES

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This Remedial Investigation Addendum (RIA) was undertaken by Interstate Power Company (IPW) of Dubuque, Iowa to supplement the information gathered and presented in the January 1993 (Revised August 1993) Remedial Investigation Report for the Mason City, Iowa Former Manufactured Gas Plant Site (RI Report). These activities were performed in response to comments offered by the U.S. Environmental Protection Agency (EPA) in response to the RI Report. The tasks performed were outlined in the October 6, 1993 Technical Memorandum No. 7 (Tech Memo 7) prepared by Montgomery Watson. The purpose of this additional investigation was to collect the information necessary to complete the assessment of the site characteristics and extent of soil and groundwater contamination originating from the site, and collect information regarding general remedial parameters that will be useful in evaluating remedial alternatives in a feasibility study.

This RIA is the last of a series of site investigations performed by IPW to assess the extent of contamination at the site. The RIA report has been revised in response to comments presented by the EPA in a May 17, 1994 letter to IPW. The revisions consist of (1) the presentation and evaluation of supplemental sampling and water level data and (2) clarifications and corrections noted in the EPA comments.

The RI, three previous investigations, and other related site work were performed to assess the site in a phased approach in an attempt to fulfill the requirements set forth in two consent orders entered into with the EPA. The three initial investigations and other associated work were performed under the original consent order dated June 3, 1986. The RI and this RIA have been performed in compliance with the superseding consent order dated October 1, 1991.

Soil samples were collected from soil boring and monitoring well locations on and around the site for determination of contamination off site and evaluation of several general remedial parameters on site. The type and thickness of soil and fill encountered in the borings are consistent with the findings of the previous investigations. On the site and adjacent to Willow Creek are 9 to 14 feet of unconsolidated soil and fill. West of Willow Creek the amount of soil decreases to the south and west as the elevation of the bedrock surface rises to near the ground surface. North of Willow Creek little or no soil is present above the bedrock surface.

The bedrock at the site is the upper portion of the Cedar Valley Formation. Cores collected from four of the monitoring well locations indicated that the general rock type is a dolomitic limestone which dips approximately 1 degree to the west. The rock exhibits an increase in competency and a decrease in the frequency of fractures with increasing depth. Only one nearly vertical fracture was encountered in the cores collected from the site. All other naturally occurring fractures were along bedding planes of the rock, approximately perpendicular to the cores.

Five monitoring wells were screened in the first transmissive zone below the shale zone identified in the previous investigations. This transmissive zone is characterized by greater porosity and water yield. The vertical permeability of the competent rock measured from core samples collected from within and immediately below the shale zone is extremely low. The low hydraulic conductivity and the lack of significant vertical fractures indicate the rock below the shale zone provides an effective barrier to downward migration to free phase contamination or contaminated groundwater.

Water level information gathered from the newly installed wells indicates that shallow groundwater north of Willow Creek flows toward Willow Creek and the site. Shallow groundwater south of Willow Creek generally flows to the northeast when the Willow Creek dam is in the lowered position. The two directions of shallow groundwater flow converge at or immediately north of Willow Creek, then flow to the east. When the dam is in the up position, water enters the shallow groundwater system from Willow Creek upstream of the retaining walls, flows around the retaining walls and dam, and likely resumes an easterly course downstream of the dam. Groundwater in the first transmissive zone flows to the southwest and does not appear to be in direct hydraulic connection with the shallow aquifer.

The principal contaminants of concern for this RIA included polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) (primarily benzene, toluene, ethyl benzene, and xylenes [BTEX]), lead, and arsenic. Soil sample analysis revealed that significant concentrations of PAHs exist off site north of Willow Creek and west of the site at locations which are topographically higher than the ground surface of the site. The topographic separation and the direction of shallow groundwater flow indicate that these compounds are representative of background concentrations or are the result of off-site sources, but they have not migrated from the site. The highest concentrations of site-related soil contamination are in the northwest corner and central portion of the site. The extent of soil contamination originating from the site is confined to the site and extends under South Delaware Avenue adjacent to the northwest corner of the site.

The distribution of PAHs and BTEX in groundwater support the conclusions of the RI that two principal source areas exist on the site, which coincide with the areas of greatest soil contamination (the northwest corner and the central portion of the site). In addition to the site-related source areas, other off-site contaminant sources appear to exist which are not related to the site. Off-site contamination not related to the site was detected north, south, and west of the site. The extent of shallow groundwater contamination from the source in the northwest corner of the site is defined by the wells north of Willow Creek. The presence of benzene and naphthalene at MW-17 (two of the more mobile contaminants of concern) and the apparent direction of shallow groundwater flow from the site under Willow Creek indicate that the plume has reached this location. Contaminants originating from the central portion of the site appear to be migrating to the northeast across the site. Continued migration in this direction would allow the contamination to be detected north of Willow Creek at MW-19. Low level concentrations of PAHs were detected at MW-19; however, the source of these PAHs is not known since MW-19 could also experience influence from groundwater flows originating north of the site. The extent of VOC contamination in groundwater is also defined. Site derived VOC contamination follows the same distribution patterns as the PAHs. Off-site VOCs were also detected which are not related to previous site activities.

The vertical extent of groundwater contamination has been defined by the wells screened in the first transmissive zone. Low level concentrations of PAHs were initially detected in two of the first transmissive zone wells. However, these contaminants were thought to have been carried down during the drilling and well installation process (or are representative of background conditions), since there is no evidence of downward migration of the contaminants based on the water level data and the observed competency of the rock. These two wells were resampled to determine if the PAHs detected were representative of the groundwater conditions. The verification samples from these wells did not contain PAHs at concentrations at or above the analytical method detection limits.

Based on the additional information gathered during this investigation, adequate site characterization and contaminant evaluation has been performed to assess the nature and extent of contamination related to previous on-site activities. Therefore, the remedial investigation of the site is considered complete. It is recommended that the project now move into a phase of determining appropriate contaminant cleanup goals and evaluating feasible remedial alternatives.

SECTION 1

1.0 INTRODUCTION

This remedial investigation addendum (RIA) report has been prepared to document the activities and results of the additional investigation performed at the former manufactured gas plant (FMGP) site in Mason City, Iowa, currently owned by Interstate Power Company (IPW) and the City of Mason City. These activities were performed in response to comments offered by the U. S. Environmental Protection Agency (EPA) regarding the January 1993 (Revised August 1993) Remedial Investigation (RI) Report and in accordance with the October 6, 1993 Technical Memorandum No. 7 (Tech Memo 7) prepared by Montgomery Watson. This investigation was tailored to provide additional data which would complement the results of the previous remedial investigation as summarized in the RI Report, and to provide additional information needed to fully evaluate the site and support feasibility study efforts.

The site was occupied by a manufactured gas plant site beginning in the early 1900s which generated "town gas" for lighting and heating purposes in the Mason City area. Following the availability of natural gas, the plant was decommissioned and subsequently torn down in the early 1950s. The property is now essentially vacant, with the exception of the presence of an IPW electrical substation and storage building.

Soil and groundwater contamination was initially discovered in 1984 during a city sanitary sewer construction project on site. Several investigations have subsequently been performed to characterize and determine the extent of the contamination.

This RIA report has been revised to incorporate Montgomery Watson's responses to comments offered by the EPA and to present information gathered subsequent to the original issuance of the RIA. Changes in the conclusions or recommendations for the site as a result of the additional information have also been incorporated.

1.1 PURPOSE OF THE REMEDIAL INVESTIGATION ADDENDUM

The previous RI generated a substantial amount of valuable information regarding the extent and migration characteristics of the contamination at and around the FMGP site. However, the full vertical and horizontal extent of contamination was not defined. The purpose of this addendum, therefore, was to complete the characterization of the distribution of contamination as well as to provide data necessary to address comments and concerns presented by the EPA. Other objectives fulfilled by this addendum include evaluation of contaminant fate and transport processes for risk assessment, exploration of the geologic environment, and collection of additional data for completion of a feasibility study. Although prepared as a "stand-alone" document, this RIA report should be viewed as an addendum to the RI Report.

1.2 OBJECTIVES

The specific objectives of this investigation consisted of the following:

1. Define the extent of soil and fill material west of the site which may have been contaminated by FMGP site activities or site-derived contamination.

2. Define the western extent of shallow groundwater contamination related to FMGP site activities.

3. Determine the extent of shallow groundwater contamination north and northeast of the site related to FMGP site activities.

4. Locate and characterize the first transmissive geologic zone below the shale zone aquitard. This characterization will include a physical evaluation of the bedrock and an assessment of groundwater quality.
5. Evaluate the physical and geologic conditions of the bedrock geology at the site, including rock competency, fracture frequency, and stratigraphic correlation.
6. Evaluate current groundwater contaminant levels across the site.
7. Collect site-specific geochemical data relevant to contaminant fate and transport in soil and groundwater.
8. Determine whether or not polychlorinated biphenyl (PCB) compounds are present in the soil under a former transformer yard in the southeast corner of the site.

To meet these objectives, several additional soil borings and groundwater monitoring wells were installed, and soil and groundwater samples were collected for laboratory analysis. In addition, soil samples were field screened for volatile organic compound (VOC) content and the presence of polynuclear aromatic hydrocarbons (PAHs). Rock cores were collected for visual and laboratory characterization, and geophysical instruments were used to provide a better understanding of the shallow bedrock at the site.

Sample collection protocol, field screening and laboratory procedures, quality assurance/quality control (QA/QC) activities, and health and safety procedures were all performed in accordance with Tech Memo 7 and the December 1991 Remedial Investigation Work Plan (WP), Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HSP) prepared for this site.

1.3 SITE DESCRIPTION

1.3.1 Location

The site is located near the center of Mason City, Iowa near the western edge of Section 10, T96N, R20W, as shown in Figure 1-1. The site is bounded on three sides by city streets: South Pennsylvania Avenue to the east, 5th Street Southeast (SE) to the south, and South Delaware Avenue to the west. The northern edge of the site is bounded by Willow Creek which flows easterly past the site and over a low head dam at the downstream end of the site.

1.3.2 Site Description

As shown on the general site layout presented in Figure 1-2, the property is essentially vacant, with the exception of an IPW electrical substation and storage building. A waste pile, consisting of contaminated soil and debris excavated during the 1984 sanitary sewer construction project, is located in the southeastern portion of the site and is covered by an impermeable tarp. Much of the site is covered by a thin layer of gravel, with the remaining areas vegetated with grasses. The site generally slopes slightly from southwest to northeast and is fenced to restrict unauthorized access.

1.3.3 Operational History

The original manufactured gas plant was built on the site between 1897 and 1901 in the northwestern portion of the site. At that time there were several private dwellings located along the southern edge of the site, along what is now 5th Street SE. As discussed in the RI Report, the gas plant was replaced or enlarged by 1909, and the residential structures were removed. By

1915, a new large capacity gas holder had been constructed near the east end of the site for commercial gas storage. With the exception of gas plant refinements and control structures in the Willow Creek channel, the site remained largely unchanged until 1951 when the gas plant was decommissioned; and in 1952, it was demolished. The locations of major FMGP structures at the site are shown in Figure 1-3.

1.4 PROJECT HISTORY

1.4.1 Previous Investigations

During the previous site investigations, numerous trenches, soil borings, and monitoring wells were installed across the site to provide information regarding the soil, fill material, and bedrock as well as providing sample collection avenues for laboratory analysis. Each phase of investigation built on the knowledge gained from the previous events to provide an understanding of the site characteristics and the extent of contamination. The reports compiled in the course of the previous investigations are summarized in Table 1-1. The locations of soil borings and monitoring wells installed during the previous investigations up to and including the RI are shown in Figure 1-4. The first three investigations, and other related site work prior to the RI, were performed to assess the site in a phased approach in an attempt to fulfill the requirements of the EPA's original Consent Order with IPW. Following those efforts, a second Consent Order, which superseded the original, was entered into between IPW and the EPA. The RI and all subsequent work to date has been performed in compliance with the second Consent Order.

1.4.2 Contaminants of Concern

Contaminants of concern identified at the site include PAHs, VOCs (primarily benzene, ethylbenzene, toluene, and xylenes[BTEX]), acid-extractable organic compounds, and cyanide. Other contaminants of lesser concern that have been detected at the site are various naturally occurring heavy metals.

A more complete discussion of the physical/chemical characteristics of the contaminants of concern as well as their fate and transport mechanisms was presented in the RI Report. The contaminants of concern targeted for this phase of the investigation are listed in Table 1-2. This list is an abbreviation of the contaminants of concern presented in the RI but is consistent with the chemicals of potential concern (COPC) presented by Jacobs Engineering Group, Inc. in their September 1993 Interim Baseline Risk Assessment for the site. These COPCs were proposed as the primary analytical parameters for the RIA sampling activities in Tech Memo 7, and were subsequently approved by the EPA.

1.4.3 Results of Previous Investigations

The sum of the information garnered during these efforts revealed that the site contains 9 to 14 feet of unconsolidated soil and fill material directly above a limestone and dolomite bedrock. The upper portions of the bedrock are relatively fractured and weathered and lie above a zone of interbedded shales. Below the shale zone, the bedrock is much more competent and intact.

The highest concentrations of the soil contamination at the site were encountered in the northwest corner of the site and in a second area near the center of the site. These areas generally coincide with the location of the gas plant, tar well, and purifying cistern in the northwestern corner of the site and with the location of the large gas holder and an aboveground oil storage tank near the center of the site.

Shallow groundwater is first encountered in the soil and fill and flows to the north-northeast until encountering the retaining wall along Willow Creek. Flow is then diverted around and under the retaining wall before continuing to the north-northeast. Groundwater below the shale zone likely does not migrate laterally a great distance due to the low hydraulic conductivities and flat gradients observed in the previous work. Groundwater contamination was detected in the shallow aquifer across all but the southern portion of the site as well as north of Willow Creek. However, Willow Creek does not appear to be significantly impacted by the site.

A more detailed account of the results of each investigation and the other associated work is contained in the RI Report.

1.4.4 Data Gaps

The principal gaps in the data which limited a full evaluation of the vertical and horizontal extent of contamination consisted of the extent of soil and shallow groundwater contamination west of the site, the lateral extent of shallow groundwater contamination north of the site, and an evaluation of the first viable transmissive zone below the shale zone. These gaps were the primary targets of this additional investigation and, when filled, will allow the project to proceed to the next step toward remediation.

Additional informational data gaps needing to be filled were those items which would support efforts to complete the risk assessment, feasibility study, and any treatability studies which might be necessary. These items consisted of general information such as the carbon content of the soil, bedrock structure and competence, bedrock composition, and direction of deep groundwater flow.

The investigation of the former substation or transformer yard in the southeastern corner of the site completed the general investigation of former structures and activities at the site.

SECTION 2

2.0 RIA ACTIVITIES

This section presents a brief summary of the tasks performed at the Mason City FMGP site and related methodologies, observations, and analytical results.

2.1 SUMMARY OF PROPOSED ACTIVITIES

The sampling activities were conducted to provide the additional information necessary to complete the site characterization. These activities consisted of the collection and analysis of soil and groundwater samples from both on- and off-site locations. Additional information was gathered for the evaluation of the hydrogeologic conditions, effects of Willow Creek water levels on the surrounding groundwater, and site-specific factors influencing the fate and transport of the contaminants of concern.

2.2 RIA SAMPLING STRATEGIES

The additional data requirements were developed to provide additional information that would integrate into the existing database to close the data gaps and support the preparation of the risk assessment and feasibility study.

2.2.1 Soil Contamination West of the Site

Based on the previous soil sample results from MW-13 and MW-14, the western lateral extent of site-derived soil contamination had not been fully established. Therefore, additional soil samples were collected from two soil boring and two monitoring well locations west of South Delaware Avenue. These sampling locations are identified as SB-FF, SB-GG, MW-26, and MW-27 in Figure 2-1. SB-FF, MW-26, and MW-27 were located west of the former power plant, while SB-GG was located within the foundation of the former power plant. All of these sampling locations were limited to property currently owned by the City of Mason City.

2.2.2 Bedrock Coring

Bedrock coring was originally planned for monitoring wells MW-25, MW-33, and MW-34. The purpose of collecting the cores was to provide a method for thorough evaluation of the potentially impacted bedrock at the site. Collection and analysis of the cores allowed Montgomery Watson personnel to determine the rock quality designation (RQD), visually identify the first transmissive zone below the shale zone, and collect rock samples suitable for laboratory determination of the vertical hydraulic conductivity in the proximity of the shale zone. These three wells were originally selected because each was intended to penetrate the first transmissive zone (and, therefore, would yield a substantial length of core). The proposed coring location network also traversed a large portion of the area of investigation and allowed triangulation of the lithologic elevations. However, with the ready availability of the coring equipment, a core was also collected from MW-31, north of the site. This additional information allowed for a much more accurate evaluation of the bedrock conditions and facilitated an evaluation of the general strike and dip of the major bedding planes.

Also, in response to the EPA's concern on whether or not the contamination detected in groundwater at MW-13 during the RI was due to contaminated soil or the presence of free phase material in bedrock, an additional rock coring (RC-AA) was advanced adjacent to MW-13 for visual inspection.

2.2.3 Borehole Geophysics

Caliper, density (gamma-gamma), and natural gamma geophysical tools were utilized in each of the boreholes penetrating the first transmissive zone (MW-25, MW-31, MW-33, MW-34, and

MW-35). The geophysical logs were compared to the rock cores in the field to aid in the determination of the first transmissive zone (below the shale zone), lithologic boundaries, aquifer/aquitard locations, and clay layers. This information was also used to more accurately log the boreholes that were not cored and determine the proper depth for the well screens. In addition, the data generated by the geophysical logging was used to correlate rock types between holes and generate more detailed understanding of the bedrock conditions.

The caliper tool measures the average diameter of the borehole, which may vary when a new rock type is encountered. The caliper also provides a supporting measurement which allows corrections to other geophysical data, compensating for varying distances between the geophysical tool and the rock surface.

The density, or gamma-gamma tool, allows an estimation of the porosity of the formation when the data is compared to the bulk density of the rock. This information is useful in targeting transmissive zones in the stratigraphic column.

The natural gamma tool measures the naturally occurring gamma radiation from the bedrock. Natural gamma radiation is released from the rock as it decays to clay. Areas of high gamma radiation may indicate high clay content and, therefore, zones of limited transmissivity.

2.2.4 Hydrogeologic Investigation

Additional monitoring wells were installed on and around the site to further define the extent of contamination and the hydrogeologic characteristics of the area. At the well or well cluster locations where adequate soil volumes were present, soil samples were collected to provide additional information regarding the lateral distribution and background concentrations of the contaminants of concern. The additional hydrogeologic investigation was subdivided into three primary areas, as discussed below.

2.2.4.1 Shallow Groundwater West. Two monitoring wells, MW-26 and MW-27, were installed west of the site to determine the western lateral extent of groundwater contamination and provide water level data for evaluating groundwater flow direction. Depending on the direction of groundwater flow, these wells may provide additional background concentration data or allow detection of off-site contamination migrating toward the site. Both wells were installed in the fill and upper bedrock and screened to intersect the groundwater surface.

2.2.4.2 Shallow Groundwater North. In order to determine the extent of shallow groundwater contamination north of Willow Creek, monitoring wells MW-28, MW-30, and MW-32 were installed in the shallow bedrock immediately above the shale zone. In addition, MW-29 was installed adjacent to MW-30 and screened to intersect the groundwater surface. These wells were intended to allow collection of groundwater samples from above the shale zone and provide water level information to determine shallow groundwater flow direction north of Willow Creek.

2.2.4.3 First Transmissive Zone Below the Shale Zone. Five monitoring wells were installed in the first transmissive zone below the shale zone in order to determine the direction of groundwater flow and whether or not site-derived contamination had impacted the groundwater in this zone. The wells installed in this zone were MW-25, MW-31, MW-33, MW-34, and MW-35. MW-25 was installed near the center of the site, under an area of known soil and groundwater contamination. The remaining first transmissive zone wells were each installed in one of the four cardinal compass directions from MW-25 to provide information covering the entire area of investigation. In addition, each of the wells was located adjacent to shallower wells to provide data relating to the vertical hydraulic gradient and potential for vertical groundwater and contaminant movement.

2.2.4.4 Aquifer Testing. Hydraulic conductivity evaluations were performed on each of the newly installed wells to provide information concerning the ability of the soil and bedrock to transmit water. The evaluations were performed using slug tests on the wells which exhibited moderate to fast recoveries, and bail-down tests on the wells exhibiting low yield. Field data was then evaluated using appropriate methodologies.

2.2.4.5 Willow Creek Influences. In response to the EPA's comments and to expand upon the information generated during the RI, water level measurements were again collected after the dam on Willow Creek had been raised. These measurements were used to evaluate the effect of Willow Creek water levels at the newly installed wells in the shallow and first transmissive zones. This information is also useful for evaluating potential historical contaminant migration routes.

2.2.5 Groundwater Sampling

To document the current extent and magnitude of groundwater contamination in each of the hydrologic zones, one set of groundwater samples was collected from all of the wells. This "snapshot" of the groundwater conditions could then be compared to historic data for an evaluation of the distribution and movement of contamination over time. The sampling was also intended to document that the extent of contamination has been defined.

The results of the December 1993 snapshot sampling indicated low-level PAH contamination in the first transmissive zone in monitoring wells MW-25 and MW-34. To determine whether the apparent contamination was representative of groundwater quality or possibly the result of outside influences, the wells were purged and resampled. Monitoring well MW-28 was also resampled to verify the results of the initial sampling, which revealed a significant concentration of PAHs. The verification samples from these wells were analyzed for PAHs only. The results of the groundwater sampling and analysis, when combined with information concerning groundwater flow directions, also aided identification of potential source areas resulting from FMGP site uses or other off-site activities.

2.2.6 Geochemical Data and Remedial Parameters

To provide supporting information for risk assessment and feasibility study tasks, additional data was collected regarding the site-specific parameters influencing the fate and transport characteristics of the contaminants. These parameters included pH, total organic carbon (TOC), cation exchange capacity (CEC), percent clay, and bulk density for selected soil and bedrock samples. Groundwater samples were analyzed for total cations/anions, total dissolved solids, and TOC.

2.2.7 Former Transformer Yard

Historic maps of the site indicate that a small substation or transformer yard was formerly located on the southeastern portion of the site. To determine whether or not contamination had resulted from the previous use of this area, soil samples were collected and analyzed for polychlorinated biphenyl (PCB) compounds, solvents, and other petroleum-based byproducts.

2.3 RIA FIELD DATA COLLECTION AND RESULTS

The field investigation began in early November 1993, with the last of the complete round of groundwater samples being collected on December 21, 1993. Minor additional site cleanup work was performed and additional water level data was gathered periodically until the end of February 1994. In March 1994, the final cleaning of the 21,000-gallon storage tank was completed. Dam-up water level measurements were collected periodically during June and July

1994. Resampling of monitoring wells MW-25, MW-28, and MW-34 was performed on August 11 and 12, 1994.

2.3.1 Soil/Fill Investigation

Soil and fill samples were collected from several locations on and around the site for field screening and laboratory analysis. These samples were intended to fill the data gaps of the previous investigations.

2.3.1.1 Boring Procedures. Borings advanced in the soil and fill for sample collection were generally completed in accordance with the procedures outlined in the FSP and detailed in the RI Report. Due to large amounts of rock, brick, or other debris, a backhoe was utilized to collect soil from locations SB-JJ and SB-KK. A backhoe was also used at location SB-FF. However, an abandoned telephone conduit was encountered, and a hand auger was subsequently used to advance the boring alongside the conduit. A hand auger was also used at location MW-27 for soil sample collection where rubble prevented recovery of soil in the split-barrel sampler during drilling.

At the locations where monitoring wells were to be installed but no soil sampling had been proposed, the borings were advanced directly to the top of the bedrock using hollow-stem augers. When competent bedrock was encountered before the desired total depth was reached, the borings were completed using air rotary drilling methods. The materials encountered in each boring were logged by Montgomery Watson personnel. Copies of the resulting boring logs are contained in Appendix A.

The cuttings from drilling in the soil and fill were placed in U.S. Department of Transportation (DOT) 17-H drums. The drums were labeled and transported back to the site and stored next to the waste pile.

2.3.1.2 Soil Sampling. Soil samples were collected at the boring locations shown in Figure 2-1. Soil samples were collected in two-foot increments by pounding a split-barrel sampler into the unconsolidated material to the top of bedrock. The split-barrel sampling method consists of pounding a 3-inch inner diameter (ID) barrel sampler in general accordance with the procedures outlined in ASTM:D-1586. As the split-barrel sampler was driven into the unconsolidated material, the blow counts were recorded by the driller. The driller's report is presented in Appendix B.

The soil samples were collected from the designated borings by driving the 2-foot long split-barrel sampler into the soil and/or fill. The barrel was then opened, exposing the soil core from the interval. A composited portion of the soil was placed directly into laboratory-supplied jars. The jars were labeled and placed in an iced cooler for shipment to the laboratory. A second soil composite from the split-barrel sampler was collected for on-site screening. The composite samples for on-site field screening consisted of several segments of the soil core collected from along its length and placed in a clean sampling bag. The bag was then sealed and the soil portions crumbled prior to in-field headspace analysis.

This sample collection protocol was used at all locations where soil samples were collected, with the exception of SB-FF, SB-JJ, SB-KK, and MW-27. As discussed in Section 2.3.1.1 above, the soil samples from these locations were collected using a backhoe or stainless steel hand auger. Each soil sample collected at these locations was placed in a stainless steel bowl and covered with aluminum foil to minimize volatilization. The samples were then mixed to provide a uniform composite sample and placed in the laboratory-supplied jars and plastic bags for laboratory and field-screening analysis, respectively. The stainless steel bowl and hand auger were thoroughly washed with Alconox® and rinsed with distilled water between each sample collection.

2.3.1.2.1 Field Screening and Observations

Field screening was conducted on the bagged soil samples after collection. Field screening for VOCs was conducted utilizing a Photovac, Incorporated MicroTIP™ Model HL-2000 hand-held air monitor/photoionization detector (PID). Each sample was also screened for PAH compounds using the ultraviolet fluorescence (UVF) method described in the FSP. Selected samples were also screened for hydrogen sulfide and hydrogen cyanide gas using a Mine Safety Appliances Samplair® hand pump and colorimetric detector tubes. Table 2-1 presents the results of the VOC and PAH field screening and also indicates which samples were submitted for laboratory analysis.

VOC screening at the soil sampling locations generally yielded low PID responses. Only the soils at SB-HH generated VOC screening results greater than 10 meter units. (One meter unit is the approximate equivalent of one part per million benzene.) UVF screening results for PAH compounds indicated the presence of PAH compounds at most of the sampling locations.

Visual contamination and olfactory detection of odors were noticed only at on-site boring locations MW-25 and SB-HH.

Soil samples to be submitted for laboratory analysis were selected based on the field screening results and other in-field observations. In general, the samples selected for analysis correspond to depth intervals exhibiting the highest PID reading and positive UVF screening results. Other factors, including visible contamination, moisture content, and any suspicious materials, were also considered. Up to two sample intervals per boring were selected for laboratory analysis.

2.3.1.2.2 Chemical Analyses

Laboratory samples were submitted to National Environmental Testing, Inc. of Cambridge, Massachusetts (NET - Cambridge) for analysis accompanied by signed chain of custody forms. Copies of the completed chain of custody forms are included in Appendix C. All of the soil samples submitted were analyzed for the complete list of RIA laboratory analytical parameters stated in Tech Memo 7. Table 2-2 lists the primary contaminants of concern and the related concentrations found at each soil sampling location during the RIA. The data presented in the tables and related figures in this chapter are accompanied by applicable data qualification flags. These qualifiers and any limitations on the data will be discussed in detail in Section 3.

PAH compounds were detected above reporting limits in all samples. The highest level of total PAHs for each location sampled during the RIA and in the previous investigations are summarized in Figure 2-2. Similarly, the highest total carcinogenic PAH level from each location is presented in Figure 2-3.

Benzene was detected in low concentrations in samples collected from MW-27, SB-FF, and SB-JJ. The maximum concentration detected in these samples was 6 µg/kg, in the sample from SB-JJ. In each case, the concentration detected has been qualified with a J flag, indicating an estimated value. Toluene was detected at estimated concentrations of 1 µg/kg at SB-FF and 2 µg/kg in samples collected from

MW-28 and SB-KK. Xylenes were detected at an estimated concentration of 2 µg/kg in a duplicate sample collected from SB-JJ.

Other VOCs detected in the soil samples consist of 2-butanone in soil samples collected from MW-27, SB-FF, and SB-KK (14, 7, and 6 µg/kg, respectively); methylene chloride in samples from MW-28, SB-FF, SB-JJ, SB-KK (2,1,1 and 2 µg/kg, respectively), and field blanks from MW-32 and SB-FF (1 µg/kg each); acetone at MW-27 and SB-KK (51 and 5 µg/kg, respectively); and tetrachloroethene at SB-KK (3 µg/kg).

Detectable concentrations of arsenic and lead were reported for each of the soil samples subjected to those analyses. However, no detectable concentrations of polychlorinated biphenyls (PCBs) were noted in the samples collected from the former transformer yard (SB-JJ and SB-KK).

2.3.1.2.3 Geochemical and Remedial Parameters

The soil samples from SB-HH and SB-II were collected from three depth intervals within each boring to provide a vertical section of the parameters. The samples were analyzed only for the geochemical and remedial parameters listed in Tech Memo 7 (pH, CEC, TOC, percent clay, and bulk density). The results of these analyses are summarized in Table 2-3.

Chemical analysis of the samples indicated that the pH of the soil samples ranged from 7.24 to 7.88, CEC ranged from 2,200 µg/g to 5,300 µg/g, and the TOC ranged from 11,000 mg/kg to 150,000 mg/kg. The physical analysis revealed the percent clay of the samples ranged from 5.5 to 14.0 percent, and the bulk density of the soil ranged from 72.8 to 127.8 pounds per cubic foot. Copies of the particle size gradation curves are contained in Appendix D.

2.3.2 Bedrock Investigation

An integral part of the RIA effort was to assess the bedrock conditions both on and off site, and at depths greater than the shale zone. These efforts consisted of collecting and examining rock cores and cuttings, inspecting surface exposures, quantifying rock quality, and evaluating geophysical and geotechnical data. The procedures and results of this portion of the investigation are discussed in the following subsections.

2.3.2.1 Drilling/Coring Procedures. Competent rock in monitoring well locations MW-25, MW-31, MW-33, MW-34, and RC-AA were continuously cored using 3-inch ID core barrels. The core barrels lock inside the coring bit and advance with the drill stem in 5-foot increments. After a 5-foot section of rock was cored, the core barrel and rock core were extracted from the boring. The rock core was then removed from the core barrel and stored in a labeled wood core box for subsequent examination. A small amount of potable water was added to the boring as a lubricant and coolant for the core barrel and drill bit. The potable water used during rock drilling activities was obtained from the Mason City Water Department. The water was hauled by tank trucks to each drill location.

Monitoring wells MW-26 through MW-30, MW-32, and MW-35 were drilled in bedrock using air rotary methods and a 6-inch outside diameter tricone bit. A small amount of potable water was also added to these borings as a lubricant and coolant for the drill bit.

The cuttings produced by both coring and air rotary drilling methods were initially discharged by the drill rig into a steel trough. The cuttings were then shoveled from the trough into DOT 17-H drums. The drums were labeled and transported back to the site where they were stored in a similar manner to the cuttings from the soil/fill material. The water generated during drilling was also placed in drums for transport back to the site. The water was pumped from the drums to the 2,500-gallon interim storage tank on the site. The water was then pumped through the on-site granular activated carbon (GAC) treatment system and into the 21,000-gallon storage tank, where it was stored until ultimate discharge to the Mason City publicly-owned treatment works (POTW).

2.3.2.2 Geology. The additional geologic investigation was performed to evaluate the condition of the bedrock and to identify the first groundwater transmissive zone below the shale zone. To meet these objectives of the RIA, rock coring and geophysical logging was performed. Based on the cores generated and the geophysical data, a better understanding of the type and quality of bedrock was achieved.

2.3.2.2.1 Shell Rock/Cedar Valley Contact

Montgomery Watson personnel reviewed literature containing regional geologic data relating to the Upper Devonian Shell Rock and Cedar Valley Formations. All of the references reviewed indicated that the Shell Rock Formation is the uppermost bedrock member in the northern portion of Mason City, but the southern boundary of the Shell Rock Formation is not accurately defined. Area well logs, including the former Swift and Company well located south of the site, listed the Shell Rock Formation as the uppermost bedrock encountered. These logs indicated that the Shell Rock Formation extended to a depth of 75 feet.

However, in a more recent investigation performed by Koch (1970), the Shell Rock/Cedar Valley contact was identified in a rock cut along Calmus Creek, near the northern edge of Mason City. The portion of the Shell Rock Formation exposed in this rock cut consists of a limestone biostrome comprised of tabular stromatoporoids overlying a thin layer of dolomite. Below the Shell Rock Formation, the Cedar Valley Formation is exposed in a limestone biostrome comprised primarily of subspherical stromatoporoids overlying a thick-bedded, blocky limestone.

This same sequence of rock and fossils is visible in the outcrop north of Willow Creek, near monitoring wells MW-16 through MW-18. Based on this information, Montgomery Watson believes that the Shell Rock Formation is not present below the site, and that the uppermost bedrock at the site is actually the Cedar Valley Formation.

2.3.2.2.3 Bedrock Surface

Borings advanced to the top of bedrock and beyond allowed for the production of the bedrock surface map presented in Figure 2-4. The surface depicted in Figure 2-4 represents the top of the competent bedrock, which generally underlies approximately 0 to 4 feet of weathered bedrock.

2.3.2.2.4 Stratigraphy

The consolidated rock encountered during drilling in bedrock consisted primarily of dolomitic limestone with interbedded shale layers. This finding was consistent with the RI results. The specific lithology encountered at each location is presented in the boring logs in Appendix A. The additional bedrock and soil boring logs were used in conjunction with the previous drilling data to construct several geologic cross sections traversing the site. The locations of the cross sections are shown in Figure 2-5. Cross sections AA-AA', BB-BB', CC-CC', and DD-DD' are presented in Figures 2-6 through 2-9, respectively.

2.3.2.2.4 Strike and Dip

In an attempt to establish the strike and dip of the bedrock, Montgomery Watson personnel examined outcrops north of Willow Creek and correlated elevations of formations and the first transmissive zone below the shale zone and local well logs. Visual observations and measurements using a pocket transit on the outcrops north of Willow Creek indicated small undulations in the bedding planes, resulting in irregular strike and dip orientations that mask the dip of the formation. The elevations of the first transmissive zone indicate a strike of approximately north 5 degrees east and a dip of approximately 1 degree to the west.

A brief review of the elevations of the contact of the Shell Rock and Cedar Valley Formations, based on local well logs, was also performed. However, this proved to be unreliable due to the fact that the top of the Cedar Valley Formation was an erosional surface prior to deposition of the Shell Rock Formation.

Regionally, the stratigraphic sequences in northern Iowa dip slightly to the southwest.

2.3.2.3 Geophysical Measurements. Borehole geophysical measurements were collected in accordance with Tech Memo 7. Logs were generated from MW-25, MW-31, MW-33, MW-34, and MW-35. The logs consisted of caliper, natural gamma, and density (gamma-gamma) measurements. Copies of the logs are contained in Appendix E.

Peaks noted on the logs were correlated to the proper depths of core samples recovered from MW-25, MW-31, MW-33, and MW-34 in an attempt to determine the reasons for the responses. Responses that correlated to zones of greater porosity, based on visual observation, were noted and the corresponding elevations were recorded on the logs for MW-35. This information was then used as an aid in locating the first transmissive zone in MW-35.

2.3.2.4 Geotechnical and Chemical Analysis. Selected sections of core samples were taken from within and immediately below the shale zone from MW-25, MW-33, and MW-34. The samples were then submitted for laboratory analysis for several physical and chemical parameters to help determine the ability of the rock to transmit water and contaminants.

The chemical analysis consisted of pH, CEC, and TOC. The physical evaluation consisted of mineral and clay composition (by weight percent), vertical permeability, and bulk density. The results of these analyses are summarized in Table 2-4.

The percent recovery and the RQD of each core were determined as a semi-quantitative evaluation of the competency of the rock. The RQD is a measure of the quality of a rock mass based on the fracture frequency, and is defined in percentage as the sum of the lengths of core fragments greater than 4 inches relative to the total length of the core run. Cores were collected in 5-foot nominal length sections. Therefore, the percent recovery and core run RQD were calculated as a percentage of 5 feet. However, since slight variations in the actual length of each core run may result in percent recovery and RQD errors of several percent, the RQD was also calculated relative to the total length of rock recovered in a core run. The results of these evaluations are summarized in Table 2-5.

2.3.2.5 Packer Testing. Packer tests were performed on several intervals of the boreholes drilled for MW-25, MW-31, MW-33, MW-34, and MW-35. These tests were performed to determine the approximate yield of specific intervals of the bedrock to help identify the first transmissive zone. The packer assembly consisted of two inflatable bladders, approximately

10 feet apart, with a pump located in between. The assembly was lowered to the desired depth and the bladders inflated to isolate the section of the borehole exposed to the pump. The pump was then activated and the discharge measured over time. Initially, suspected transmissive zones were isolated and pumped. Subsequent tests were then performed to identify any more highly transmissive zones as well as to evaluate nonproductive zones overlying the productive zones. The results of the borehole packer tests are summarized in Table 2-6.

2.3.3 Groundwater Investigation

Additional hydrogeologic investigation was performed to further identify the extent of groundwater contamination and subsurface hydraulic conditions. Eleven new wells (MW-25 through MW-35) were installed on and around the site. Slug tests and bail-down recovery tests were conducted, and a complete set of groundwater samples was collected for laboratory analysis.

2.3.3.1 Identification of the First Transmissive Zone. The task of identifying the first transmissive zone in the five deep borings was accomplished by visual examination of the rock cores, correlation of the geophysical logs to the cores, and verification of targeted intervals through the packer testing program. Initially, Montgomery Watson personnel independently examined the rock cores and selected zones of greater visual porosity. These zones were then compared to observed water production during the drilling. Following this independent selection of target intervals, Montgomery Watson personnel collaborated to initially identify potentially transmissive zones.

The geophysical logs were also compared to the rock cores. The tentatively identified transmissive zones and peaks on the geophysical logs were cross-referenced in an attempt to identify trends and correlate responses. Based on this evaluation, target intervals were selected for the packer testing. The packer tests in each borehole were initially performed on the target zone. Where the target zone was productive, subsequent packer tests were performed at higher elevations to verify that the identified zone was the first transmissive zone. In some cases, the principal target zone did not yield sustainable water. In those situations, packer tests were also performed at lower elevations to identify the first transmissive zone.

2.3.3.2 Well Construction. The wells completed during the RIA were constructed of 2-inch inner diameter stainless steel well screen and low carbon steel riser pipe. The well screens consisted of 0.010-inch, factory-slotted well screens with threaded couplings. Unimin® #20 washed silica sand was utilized as the filter pack material for the newly constructed monitoring wells. A minimum of 1 foot of sand pack was placed above and below the well screen. A minimum of 1 foot of bentonite was placed above the filter pack and hydrated. A bentonite/Portland cement grout was then placed in the well with the aid of a tremie pipe from the top of the bentonite seal to the ground surface. Construction details for the newly installed wells are presented in Appendix F. Well specifications for all of the monitoring wells are presented in Table 2-7. Figure 2-10 presents a schematic of the relative depths and water levels of all monitoring wells constructed at the site.

2.3.3.3 Well Development. Wells installed during the RIA were developed using an airlift pump. Development of the wells continued until pH, specific conductance, and temperature stabilized. If the discharged water failed to stabilize after the removal of several well volumes, visual clarity of the water was used as the measure of proper development. Development records are presented in Appendix G.

2.3.3.4 Groundwater Sampling. Following the development and stabilization of the newly installed monitoring wells, a complete round of groundwater sampling was conducted on December 14 through 16, 1993. Because of slow water level recovery at MW-32, it was necessary to collect the remainder of the MW-32 sample set on December 21. The resampling of

MW-25, MW-28, and MW-34 was conducted on August 11 and 12, 1994. For all of the groundwater sampling events, purging and sample collection was completed using the Waterra HydroLift pumping system, as described in Tech Memo 7. The Waterra tubing and foot valves were dedicated to each well. The wells were purged at a rate of approximately 1,000 milliliters per minute. The purge rate was maintained until a minimum of three well volumes were removed, and the temperature, pH, and specific conductance were relatively stable. Low yield wells were pumped to near dryness and allowed to recharge prior to sampling.

2.3.3.4.1 Stabilization Parameters

During the purging process, several parameters were periodically recorded in order to monitor the stabilization process, including temperature, pH, specific conductance, oxidation-reduction potential (Eh), color, volume of water removed, and elapsed time. The well purging data is included on the groundwater sample collection records presented in Appendix H.

2.3.3.4.2 Chemical Analysis

Chemical analyses were conducted by NET - Cambridge. EPA Contract Laboratory Program (CLP) methods were used, except for the PAH analysis which utilized high performance liquid chromatography (HPLC). It was necessary to utilize the HPLC method in order to achieve lower detection limits for the PAH compounds. Groundwater samples collected during the RIA were analyzed for groups of constituents dependent upon the well locations and screened intervals. All of the newly installed wells screened in the first transmissive zone below the shale zone were analyzed for the entire suite of parameters (PAHs, acid-extractable organics, VOCs, total metals, and total cyanide) identified in the FSP. All of the existing monitoring wells and those wells screened above the shale zone were analyzed for PAHs, benzene, bromodichloromethane, ethylbenzene, toluene, total xylenes, and total metals (as identified in the FSP).

PAH compounds were detected in all but three of the monitoring wells. Concentrations of total PAHs ranged from below detection levels at MW-18, MW-20, and MW-31 to a high of approximately 9,260 µg/L at MW-2. Considering only the shallow aquifer (above the shale zone) on-site concentrations ranged from approximately 0.27 µg/L at MW-6 to approximately 9,260 µg/L at MW-2. Off-site concentrations of PAH compounds in the shallow aquifer ranged from below detection levels at MW-20 to approximately 1,529 µg/L at MW-17. All of the newly installed monitoring wells in the shallow aquifer contained detectable concentrations of PAHs. These concentrations ranged from 0.032 µg/L at MW-30 to approximately 54 µg/L at MW-28. Because of the high concentration of PAHs detected, MW-28 was resampled. The results of the resampling revealed a total PAH concentration of 9.989 µg/L. It should be noted that the second sample was collected from MW-28 when the Willow Creek dam was in the up position. During the initial sampling, the dam was in the down position. The total PAH concentrations for the shallow aquifer monitoring wells with the dam in the down position are shown in Figure 2-11.

Carcinogenic PAHs were detected in 9 of the 11 on-site shallow wells. Carcinogenic PAHs were not detected in MW-4 and MW-6. Detected concentrations in on-site shallow wells ranged from 0.027 µg/L at MW-1 to 1,007 µg/L at MW-2.

Off-site concentrations of total carcinogenic PAHs in shallow wells ranged from below detection levels at MW-20, MW-26 and MW-30 to approximately 99.5 µg/L at MW-13. In the newly installed shallow wells, total carcinogenic PAHs were detected in MW-27, MW-28, and MW-32 at concentrations ranging from approximately

0.5 µg/L at MW-27 to 29.9 µg/L at MW-28. The concentration of total carcinogenic PAHs in MW-28 during the resampling decreased to 4.572 µg/L. The concentrations of carcinogenic PAH compounds in the shallow aquifer with the dam in the down position are shown in Figure 2-12.

In the four intermediate depth wells (MW-8, MW-10, MW-18, and MW-22), total PAHs were detected in MW-8, MW-10, and MW-22. Concentrations ranged from 0.032 µg/L at MW-10 to 0.57 µg/L at MW-8. No carcinogenic PAH compounds were detected in any of the intermediate depth wells. The concentrations of the total PAHs in the intermediate zone groundwater are shown in Figure 2-13.

PAHs were detected in two of the wells screened in the first transmissive zone. The concentrations of total PAHs detected were 1.38 µg/L at MW-25 and 0.064 µg/L at MW-34. Carcinogenic PAHs were detected only in MW-34 at 0.025 µg/L. The apparent presence of the PAHs in these wells prompted purging and resampling to determine whether these concentrations are representative of groundwater quality or due to outside influences such as contaminant carry-down during the drilling process or cross-contamination from drilling equipment, sample containers, or the atmosphere. No PAH compounds were detected in either MW-25 or MW-34 during the verification sampling. Based on the results of the verification sampling, neither carcinogenic nor noncarcinogenic PAHs were detected in the first transmissive zone.

The specific PAH compounds detected at each location are summarized in Table 2-8.

For characterization of the distribution of VOCs in groundwater, a full VOC scan was performed on samples collected from the newly installed wells, while only an abbreviated scan was completed for samples from existing wells. Benzene, ethylbenzene, toluene, and xylenes were the major target constituents in these analyses. The results of these analyses indicated that benzene was detected both on- and off-site, and in all three hydrogeologic zones. Detected concentrations in the shallow aquifer ranged from estimated values of 1 µg/L at MW-13 and MW-26 to 12,000 µg/L at MW-17. In the intermediate depth wells, benzene was detected at 130 µg/L at MW-8 and an estimated concentration of 3 µg/L at MW-22. In the first transmissive zone, benzene was detected only at MW-35 at an estimated concentration of 4 µg/L.

Ethylbenzene was detected in MW-2, MW-17, and MW-23. Concentrations detected ranged from 45 µg/L at MW-23 to an estimated concentration of 420 µg/L at MW-17. No ethylbenzene was detected in the intermediate or first transmissive zone wells.

Toluene was also detected only in MW-2, MW-17, and MW-23. Concentrations ranged from an estimated value of 3 µg/L at MW-23 to 6,000 µg/L at MW-17. No toluene was detected in the intermediate or first transmissive zone wells.

Xylenes were detected in MW-1, MW-2, MW-3, MW-14, MW-17, and MW-23. The detected concentrations ranged from an estimated value of 2 µg/L at MW-1 to 1,000 µg/L at MW-17. No xylenes were detected in the intermediate depth wells or those screened in the first transmissive zone.

The distribution of BTEX in the shallow and intermediate aquifers is shown in Figures 2-14 and 2-15. The analytical results are also summarized in Table 2-8.

No cyanide was detected in groundwater collected from any of the newly installed wells. Cyanide analysis was not proposed for the existing wells.

The metals analysis revealed varying concentrations of each of the target metals across the site. The metals results, as well as summaries of the PAH and VOC analyses, are presented in Table 2-8.

2.3.3.4.3 Remedial Parameters

Several remedial parameters in groundwater were evaluated in the field and in laboratory samples. Oxidation-reduction (redox) potential was measured in the field during the well purging prior to sample collection. The results of these measurements are recorded on the groundwater sample collection records in Appendix H. The final measurements are summarized in Table 2-9 and Figure 2-16.

Laboratory analysis of TOC was performed on all groundwater samples submitted for analysis. The results of these analyses are also summarized in Table 2-9. Graphic presentations of the results are shown for the shallow aquifer, intermediate zone, and first transmissive zone wells in Figures 2-17, 2-18, and 2-19, respectively.

Analysis for major cations and anions was performed on the selected samples as specified in Tech Memo 7; with the exception of MW-32, which did not yield an adequate amount of water for both the site characterization analyses and the remedial parameters. The results of the major cation/anion analyses are summarized in Table 2-9.

Total dissolved solids (TDS) analysis was also performed on the samples selected for major cations and anions. The results of these analyses are summarized in Table 2-9 and Figure 2-20.

2.3.4 Hydrogeologic Investigation

In order to further evaluate the hydrogeologic systems present at the site, Montgomery Watson conducted field activities to evaluate the groundwater flow dynamics and hydraulic properties of the aquifers present at the site.

2.3.4.1 Water Level Measurements. Four rounds of static water level measurements were made at each of the site monitoring wells with the Willow Creek dam in the down position. The water level measurements were made on December 8 and December 13, 1993, and January 21 and February 28, 1994. Due to the extreme cold during portions of the field activities, not all of the flush-mount wells were accessible for water level measurements because of ice buildup in the well heads. The surface of Willow Creek was also frozen on several occasions, preventing measurements of Willow Creek water levels. One round of water level measurements was collected on June 2, 1994 prior to raising the Willow Creek dam. With the dam in the up position, four additional rounds of water level measurements were collected. The elevations of groundwater and Willow Creek for the measurement events are summarized in Appendix I. The potentiometric surfaces for the shallow aquifer and first transmissive zone generated by the December 13, 1993, February 28, 1994, and July 15, 1994 water level data are presented in Figures 2-21 through 2-26.

Due to the unseasonably wet spring and summer of 1993, Willow Creek exhibited high flow rates on several occasions. None of these flows were measured at the site; however, the U.S. Geological Survey maintains a gauging station on Willow Creek near the western edge of Mason City. This station measures only peak flows and is not a continuous reading station. During the period of high flows, a water stage of 91.75 feet (relative to a local datum) was recorded on April 1, 1993. This stage is equivalent to a flow rate of approximately 1,090 cubic feet per second (cfs). Prior to this event, the most recent flow of this magnitude was approximately 1,100 cfs on July 8, 1969. Both of these events fall between 10-year (999 cfs) and 25 year

(1,190 cfs) flood frequencies at the gauging station. Average flow for Willow Creek at this location is approximately 41 cfs.

The actual elevation of Willow Creek at the site or the impacts on water elevations and flow directions during those high flows is not known.

2.3.4.2 Slug Tests. Following completion and development of the new monitoring wells, slug tests were conducted in order to estimate the hydraulic conductivity of the material in the immediate vicinity of the well screens. All of the newly installed monitoring wells (MW-25 to MW-35) were slug tested. MW-10, a previously installed monitoring well, was also slug tested at this time. A slug test is an in-situ measurement of the hydraulic conductivity (K) of the material in the vicinity of the well screen. The hydraulic conductivity of each of the slug-tested monitoring wells is summarized in Table 2-10. The slug test data and computer generated solutions are contained in Appendix J.

2.3.4.3 Bail Down Tests. Bail down tests were conducted on several monitoring wells at the site which exhibited slow recharge rates. Specifically, the bail down tests were conducted on monitoring wells MW-18, MW-30, and MW-32. Bail down tests are better suited for evaluating the transmissivity of formations with slow water level recoveries than are slug tests. Transmissivity was estimated using the evaluation presented by Skibitzke (1963). Skibitzke's method involves a nongraphical solution that allows for nonsteady water withdrawal from the well in low transmissivity formations. The calculated transmissivities of these wells are summarized in Table 2-11. Copies of the data are included in Appendix J.

2.4 RIA WORK PLAN VARIANCES

During the implementation of the RIA field activities, minor changes in the activities and procedures scoped in Tech Memo 7 were required to obtain the desired data. When changes or clarifications became necessary, a Field Change Request form was completed by the Field Supervisor. The proposed changes were then presented to the Project Manager for review and approval.

Field Change Request forms were submitted to the Project Manager for four variances from Tech Memo 7. The changes consisted of (1) conducting the borehole geophysical survey prior to the packer testing program to improve the efficiency of the packer testing program; (2) advancing an additional rock core near MW-13 to evaluate the extent of visible contamination in bedrock, if any; (3) increasing the screen length in the deep wells from 5 to 10 feet to improve water yield; and (4) backfilling boreholes below the well casings with a combination of gravel (silica sand) and bentonite rather than a bentonite slurry only. Copies of the completed Field Change Request forms are contained in Appendix K.

2.5 SUBCONTRACTOR SERVICES

Several subcontractors were utilized for the completion of the RIA activities. These outside contractors provided equipment and personnel to support the efforts of soil sample collection, monitoring well construction and development, geophysical borehole logging, laboratory analysis, and independent data validation.

2.5.1 Drilling and Well Construction

Drilling and well construction services were provided by Bergerson-Caswell, Inc. (BCI) of Maple Plain, Minnesota. BCI also provided all well construction materials, decontaminated large sampling equipment, containerized soil cuttings, developed the newly installed wells, performed the packer testing, and cleaned the 21,000-gallon on-site storage tank. BCI is a licensed Iowa well drilling company and used only licensed personnel for operation of the drill rigs at the Mason City FMGP site.

2.5.2 Geophysical Logging

The geophysical logging of the deep bedrock borings was performed by BPB Slimline Services of Evansville, Indiana.

2.5.3 Laboratory Analysis

Chemical analysis of soil and groundwater samples was coordinated or performed by NET - Cambridge. Additional NET laboratories utilized in this project include NET of Santa Rosa, California (NET - Santa Rosa) for the performance of thiocyanate and thiosulfate analysis, and NET of Cedar Falls, Iowa (NET - Cedar Falls). A sample of water collected from the on-site storage tank was submitted to NET - Cedar Falls for priority pollutant scans, as requested by the Mason City Wastewater Treatment plant before accumulated water would be allowed to be discharged to the sanitary sewer system.

Physical analysis of the soil samples was performed by GeoTesting Express of Concord, Massachusetts. Core Laboratories, Inc. in Dallas and Houston, Texas performed all physical and chemical analysis on the rock cores submitted for analysis.

2.5.4 Data Validation

Laboratory Data Consultants, Inc. (LDC) of Carlsbad, California performed a third-party validation of a portion of the laboratory analytical work. LDC reviewed a representative subset of the raw laboratory data to determine whether or not appropriate quality assurance protocols had been adhered to and to evaluate the general reliability of the data.

SECTION 3

3.0 QUALITY ASSURANCE

This section summarizes the QA/QC activities that were undertaken by Montgomery Watson to ensure that the Data Quality Objectives of the project were met. QA/QC activities during the RIA were focused to assure that the activities were being performed in accordance with the goals and objectives identified in the FSP, QAPP, HSP, and Tech Memo 7, and to ensure that the analytical data collected was validated for use.

3.1 DATA VALIDATION

This section presents data validation of analytical results for environmental samples collected during site characterization activities. Data validation responsibilities were shared by Montgomery Watson and NET - Cambridge. A representative cross section (approximately 10 percent) of the raw laboratory data was validated by LDC, as proposed in the QAPP. All field QA data were validated by Montgomery Watson. The information presented in this section includes an evaluation of the following:

- Field Quality Assurance Samples
- Laboratory Quality Assurance Samples and Data
- Data Quality Objectives and Evaluations
- Raw Laboratory Data
- August 1994 Verification Sampling Event Data

3.1.1 Field Quality Assurance Samples

Results of the field QA samples were used to assess the accuracy and precision of both sampling and laboratory activities and to determine if project QA objectives were met. The results of QA sample analyses were evaluated using established QC limits, as stated in the QAPP and the CLP Statement of Work (SOW). The QA program for the Mason City FMGP Site RIA evaluated the following field QA samples:

- Trip Blanks
- Field Equipment Rinsate Blanks
- Blind Field Duplicates

A description and summary of results for each type of field QA sample collected are presented below. Results that deviated from the applicable limits are identified.

<u>3.1.1.1 Trip Blanks</u>. Trip blanks were used to identify any VOCs introduced to samples during transit to or storage at the laboratory. The trip blanks, prepared at the laboratory with deionized water, were sent from the laboratory with the shipping containers and then returned with the shipment of samples for analysis. The trip blanks remained sealed until analysis of the groundwater samples, at which time they were analyzed as well. The QAPP requires that a VOC trip blank accompany every cooler that contains samples for VOC analysis. Trip blanks were shipped with four of the five coolers that contained soil samples intended for VOC analysis. The November 23, 1993 sample shipment which contained sample SBGG-SL-006-112393 did not contain a trip blank as required by the QAPP. Trip blanks were shipped with all four of the coolers containing groundwater samples for VOC analysis. Summaries of the analyses for soil and groundwater trip blank samples are presented in Table L-1 of Appendix L.

The information presented in Appendix L indicates:

- Some VOC analytes were detected in trip blank samples during November and December. Acetone concentrations of 7 µg/L and 3 µg/L were detected in trip blanks MW28-SL-903 on November 11, 1993 and MW02-GW-903 on December 16, 1993, respectively. A 2-hexanone concentration of 26 µg/L was detected in trip blank DP02-SL-901 on November 15, 1993.

- Estimated quantities of methylene chloride were reported for trip blanks MW27-SL-903 on November 5, 1993 (1 µg/L), DP02-SL-901 on November 15, 1993 (1 µg/L), MW32-SL-902 on November 18, 1993 (1 µg/L), and MW02-GW-903 on December 16, 1993 (2 µg/L).

The parameters detected in the trip blanks are most likely indicative of laboratory contamination, either in the original trip blank water itself or during the actual analysis.

3.1.1.2 Equipment Blanks. Equipment rinsate blanks were collected to detect contamination originating from field sampling equipment. Immediately prior to sampling, sampling equipment was decontaminated and an equipment blank was collected. The equipment blank was collected by pouring distilled water over the decontaminated sampling equipment and collecting the rinse water in the appropriate sample container.

The QAPP called for a frequency of one equipment blank per 15 samples or one equipment blank per day. Due to the duration of the soil sampling effort and the number of days in which only a few soil samples were collected, Montgomery Watson collected one equipment blank per 15 samples. As a result, two equipment blanks were collected during the soil sampling activities, which meets the frequency specified in the QAPP. Although collection of equipment blanks was not required during groundwater sampling because dedicated sampling equipment was used, a single equipment blank sample was collected during groundwater sampling to evaluate the potential for contamination from the dedicated equipment.

The QAPP proposed that the equipment blank analyses show no constituents over two times the method detection limit (MDL). Summaries of the equipment blank analyses for soil and groundwater samples are presented in Table L-2 of Appendix L.

QA limits were exceeded in the soil and groundwater equipment blanks by three compounds (iron, lead, and zinc). The associated sample results have been noted as estimated values (J flagged). The following deficiencies are noted:

- Methylene chloride was detected in both equipment blanks (MW32-SL-802 and SBFF-SL-803) associated with soil samples. The methylene chloride, detected at a concentration of 1 µg/L in both cases, is attributed to laboratory contamination. There were no VOC analytes detected in the MW18-GW-803 equipment blank associated with groundwater samples.

- There were no PAH analytes detected in any of the equipment blanks collected during the RIA.

- Low concentrations of some metals were detected in the soil and groundwater equipment blank samples. Soil equipment blank SBFF-SL-803 contained a lead concentration of 4.2 mg/L and a zinc concentration of 33 mg/L. Iron concentrations of 102 mg/L and 21 mg/L were detected in SBFF-SL-803 and groundwater equipment blank MW18-GW-803, respectively. Zinc was detected in MW18-GW-803 at a concentration of 9.4 µg/L. No metals were detected in soil equipment blank MW32-SL-802.

3.1.1.3 Sample Duplicates. Blind field duplicates were prepared to assess the precision of field collection and laboratory analytical methods. Duplicate soil samples were collected simultaneously with primary samples by removing small portions of soil from the split-barrel sampler and dividing the material between the primary and duplicate soil sample containers. This method was employed instead of an active homogenization of the samples in an attempt to reduce the amount of volatilization from the sample. However, the duplicate from MW-27 was collected with a hand auger, which required homogenization in a stainless steel bowl because of the inability of the sampling equipment to recover the entire sample interval desired. The soil was covered with aluminum foil to minimize volatilization during sample collection.

From each duplicate set, one sample was labeled with the correct sample identification, while the other was labeled differently to disguise its identity to the laboratory. The QAPP requires that one duplicate sample set be collected per day or one per 15 samples. Due to the long duration of soil and groundwater sampling efforts, duplicates were collected on a schedule of one per fifteen samples. A total of three groundwater and three soil sample duplicate sets were collected, meeting the frequency specified in the QAPP.

Duplicate samples that were split with the EPA representatives are discussed in Section 3.2.

Duplicate precision was assessed based on the relative percent difference (RPD) between the two data sets. RPD was calculated for each data set as:

$$\text{RPD} = \frac{|A - B|}{([A + B]/2)} \times 100$$

where:

A and B are the reported concentrations of the individual pairs of compounds for duplicate sample analyses.

The QAPP proposed that the RPD for the duplicate samples not exceed 50 percent, unless the analytical results were less than five times the MDL. If the analytical results for either the sample or duplicate were less than five times the MDL, the RPD was not to exceed 100 percent.

Duplicate summaries for soil and groundwater samples are shown in Tables L-3 and L-4 in Appendix L, respectively.

The following information is noted:

- VOCs: Duplicate groundwater samples MW08-GW-003/DP02-GW-003 contained benzene, ethylbenzene, and xylene RPDs greater than 50 percent; duplicate groundwater samples MW33-GW-003/DP01-GW-003 contained acetone and xylene RPDs greater than 50 percent. Duplicate VOC soil samples collected during the RIA were within the allowable limits identified in the QAPP.

- PAHs: Duplicate soil samples MW27-SL-003/DP01-SL-000 contained anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene RPDs greater than 50 percent. Duplicate groundwater samples MW08-GW-003/DP02-GW-003 contained anthracene and phenanthrene RPDs greater than 100 percent. Duplicate groundwater samples MW23-GW-003/DP03-GW-003 contained acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene; benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene RPDs greater than 50 percent.

- Metals: Duplicate soil samples MW27-SL-003/DP01-SL-000 contained a lead RPD slightly greater than 50 percent. All other soil and groundwater duplicate pairs were within acceptable limits for trace metals.
- General Chemistry: Duplicate groundwater samples MW33-GW-003/ DP01-GW-003 contained manganese and potassium RPDs greater than 50 percent.

In general, the majority of groundwater analytical results showed an acceptable degree of precision. Duplicate soil sample analytical results showed many variations. Differences exceeding QC criteria were noted for both matrices. The high RPDs in the soil matrix can be attributed to the site characteristics. Homogeneous soil samples were very difficult to obtain due to the presence of clay, gravel, and other materials. Thorough homogenization of the soil samples by extensive mixing and stirring would have allowed volatile components to be released, resulting in inaccurate VOC analyses. When analyzing PAHs in soils, the organics must first be extracted from the soil samples. Laboratory comments were noted regarding the resultant tar-like extract, which is difficult to analyze. The analytical instruments require liquid extracts to be free from solids and highly viscous materials.

3.1.2 Laboratory Quality Assurance Samples and Data

Results of the laboratory QA samples were used to determine whether or not project QA objectives were met. The results of the QA sample analyses were evaluated using established QC limits, which are determined by the analytical methods. The data from the laboratory QA sample evaluations were then used to assess the quality of the data from the field samples analyzed in association with the QA samples. The QC program for this project evaluated the following laboratory QA samples and data:

- Holding Times
- Method Blanks
- Matrix Spikes and Matrix Spike Duplicates
- Surrogate Spikes
- Laboratory Control Sample and Laboratory Control Sample Duplicate Data
- Initial and Continuing Calibration Verification Data

A description of each type of laboratory QA sample taken or data evaluated is presented below.

3.1.2.1 Holding Times. Holding time limits reflect the length of time a sample and/or its extract remains representative of the environmental conditions at the time of sample collection. Depending on the analyses, either one or two holding times are evaluated. For those analyses which did not include a sample extraction, only one holding time was evaluated (the amount of time between sampling and analysis). Two sets of holding times were evaluated for acid-extractable organics and PAHs which require an extraction process prior to the analyses. The length of time from sampling to extraction and from extraction to analysis as required by SW-846 were evaluated. Holding times for soil and groundwater samples are summarized in Appendix L.

All water and soil sample holding times for VOCs, metals, and cyanide were met. VOC, metals, and cyanide sampling dates, analysis dates, and required and actual holding times for soil and groundwater are presented in Table L-5 (Appendix L). Extraction and analysis holding times for the PCB samples were met.

Two PAH extraction holding times were exceeded for soil samples. All other acid-extractable and PAH holding times were met. Acid-extractable and PAH sampling dates, analysis dates, and required and actual holding times are presented in Table L-6 (Appendix L).

The following holding time exceedances were noted:

- PAH extraction holding times were exceeded for MW28-SL-003 and MW32-SL-002 soil samples by 11 and 4 days, respectively.

The sample analytical results where holding times were exceeded for PAHs were considered estimated (J flagged). However, Montgomery Watson does not expect the usability of the data from these samples to be severely impacted from exceeded holding times due to the relatively stable nature of these compounds.

3.1.2.2 Method Blanks. Method blanks were generated and analyzed at the laboratory. Method blank analytical results were evaluated to determine the existence and magnitude of cross-contamination problems, contaminated analytical equipment, or contamination of laboratory deionized water. The QAPP proposed that the blank analytical results show no compounds over the MDL. Methylene chloride, acetone, and 2-butanone concentrations in method blanks were to show no more than five times the MDL.

A review of the method blank information shows that all soil and water method blank analyses fell within acceptable QA/QC limits. The blanks indicated that laboratory contamination did not affect the field sample analytical results for the contaminants of concern.

3.1.2.3 Matrix Spikes and Matrix Spike Duplicates. Matrix spikes are additions of known quantities of compounds to the sample matrix. Matrix spikes and matrix spike duplicates (MS/MSDs) are individually assessed using percent recovery. Spike recoveries are an indication of accuracy, but can be affected by matrix interferences and cannot be evaluated on samples requiring dilutions. Percent recovery was calculated using the following equation:

$$\frac{(A - B)}{C} \times 100$$

where:

A = the measured concentration of the spiked analyte in a spiked sample.
B = the measured concentration of the spiked analyte in an unspiked sample.
C = the concentration of the analyte used for spiking.

The MS/MSD pair percent recoveries were evaluated in terms of RPD to measure precision. The acceptance criteria for MS/MSD RPDs for metals, cyanide, PAHs, acid-extractable organics, and VOCs vary as stated in the SOW. When MS/MSDs were not able to be performed adequately, laboratory control standards/laboratory control standard duplicates (LCS/LCSDs) were evaluated.

A total of five MS/MSD sets were analyzed during this project phase. Because of inadequate sample volume, no MS/MSD data was obtained for the verification sampling. The MS/MSD data indicates:

- Cyanide: All MS/MSD analyses results fell within acceptable QC limits.

- Metals: All MS/MSD analyses results fell within acceptable QC limits.

- VOCs: For MS/MSD analyses conducted for the December 14 and 15, 1993 samples, 1 out of 10 spike recoveries fell outside the QC limits; however, all RPDs were within the required limits. Therefore, no corrective action was required. For MS/MSD analyses conducted for November 4 and 5, 1993 and December 11, 12, 15 and 16, 1993 samples, 2 out of 10 spike recoveries fell outside QC limits. In addition, 4 out of 5 RPDs fell outside the required limits. However, no corrective action was required as per the SOW.

- Acid-Extractables: All MS/MSD analyses results fell within acceptable QC limits.

- PAHs: For MS/MSD analyses conducted for December 14 and 15, 1993, samples, all spike recoveries and RPDs were within QC limits except acenaphthene. However, no corrective action was required as per the SOW.

  According to NET summary reports, for MS/MSD analyses conducted for November 4 and 5, 1993 and December 11, 12, 15 and 16, 1993 samples:

  > "MS information can't be used, as sample concentrations are greater than four times the spiking concentrations and/or samples and their MS/MSDs had to be diluted to bring compounds under their quantification range."

In summary, the accuracy of analyses on VOC and PAH samples was hindered by matrix interferences. MS/MSD recoveries were out of range for some samples. Overall, MSD precision was acceptable for the samples submitted during the RIA.

3.1.2.4 Surrogate Spikes. Samples were spiked with surrogate compounds (constituents not expected to be found in the sample) to determine laboratory performance on individual samples. Surrogate spikes are added to the samples prior to analysis. A review of the surrogate spike information indicates:

- Cyanide: All cyanide surrogate spike recoveries fell within acceptable QC limits.

- Metals: All metal surrogate spike recoveries fell within acceptable QC limits.

- VOCs: All system monitoring compound recoveries fell within QC limits except for the surrogate spike performed on MW10-GW-003MS. However, the native sample and MSD fell within QC limits for this sample.

- Acid-Extractables: All acid-extractable surrogate spike recoveries fell within acceptable QC limits.

- PAHs: Surrogate recoveries for soil samples collected during the RIA could not be used because the samples had to be analyzed at a minimum 10x dilution in order to bring compounds within their quantification range. However, surrogate recoveries for all blanks and LCSs fell within control limits.

  Groundwater samples MW02-GW-003, MW09-GW-003, and MW13-GW-003 had surrogate recoveries that fell outside advisory limits due to compound levels requiring sample dilutions. Samples MW14-GW-003, MW17-GW-003, MW23-GW-003, and DP03-GW-003 also had surrogate recoveries that fell outside advisory limits due to compound levels requiring sample dilutions. Surrogate spike recoveries for the verification sampling were all within advisory limits.

- PCBs: For samples collected during the RIA, one of the laboratory's method blank samples had surrogate recoveries just below the advisory lower limit of 60 percent on both columns.

Overall, greater than 95 percent of the surrogate spike recoveries met QC criteria. The samples with surrogate sample analytes beyond control limits were qualified (J flagged). The surrogate recoveries that were beyond the control limits were apparently caused by matrix interferences.

3.1.2.5 Laboratory Control Standards and Laboratory Control Standard Duplicates. LCS/LCSDs are synthetic laboratory samples containing known concentrations of the constituents for which the field samples are being analyzed. The LCS/LCSDs are produced and analyzed by the laboratory and are evaluated in terms of percent recovery to determine the accuracy of the laboratory analytical methods. All LCS/LCSD analytical results fell within the target recovery ranges.

3.1.2.6 Initial and Continuing Calibration Verification. An initial calibration verification (ICV) was run immediately after instrument calibration, which typically occurs at the beginning of project startups and after instrument downtime. A continuing calibration verification (CCV) was completed every 20 samples and at the end of every sample batch analyses.

A summary of ICV and CCV data is presented below. Laboratory ICV data were generated in accordance with the frequency required.

- Cyanide: All cyanide calibration verifications fell within acceptable QC limits.
- Metals: All metals calibration verifications fell within acceptable QC limits.
- VOCs: All VOC calibration verifications fell within acceptable QC limits.
- Acid-Extractables: All acid-extractable calibration verifications fell within acceptable QC limits.
- PAHs: All initial calibration standards fell within acceptable QC limits. Some of the CCV standards for soil contained compounds with calculated concentrations greater than 15 percent different than the true value. No sample quantifications were affected.

  For the December 16, 1993 groundwater samples, some of the continuing calibration standards contained compounds with calculated concentrations greater than 15 percent different than the true value. Reanalysis was performed for all compounds in which a quantification was needed, except for the following samples and compounds: fluoranthene in MW02-GW-003 (26 percent) and acenaphthene in MW13-GW-003 (24 percent).

  For the December 17, 1993 groundwater samples, some of the continuing calibration standards contained compounds with calculated concentrations greater than 15 percent different than the true value. Reanalysis was performed for all compounds in which a quantification was needed, except for fluoranthene for DP03-GW-003 (28 percent).

  All ICV and CCV criteria were met for the August 1994 groundwater verification samples.
- PCBs: All initial calibration standards fell within acceptable QC limits.

3.1.2.7 Digestion Spikes. Digestion spikes are used to establish the precision and accuracy of individual analytical determinations. The digestion spike recoveries are to fall within the 25 percent control limit established in the SOW. However, an exception is granted where the sample concentration exceeds the spike concentration by a factor of four or more. In this case, the value is reported as unflagged. A review of the digestion spike information reveals that:

- The iron and lead digestion spikes for NET job numbers 93.04551 and 93.04582 were outside the 25 percent control limit.
- The iron digestion spike for NET job number 93.04620 was outside the 25 percent control limit.
- The cyanide and lead digestion spikes for NET job numbers 93.04629 and 93.04663 were outside the 25 percent control limit.

All of the analytes that did not meet the established criteria were flagged with an N.

3.1.3 Data Quality Objectives and Evaluations

The data quality objectives are quantitative and qualitative statements which specify the quality of data required to support decisions during the RI process. Data quality objectives specific to data validation are expressed in terms of precision, accuracy, representativeness, comparability, completeness, and traceability.

The data quality objectives for the Mason City, Iowa FMGP site are to obtain environmental data that are representative of the potential sources of contamination, to provide information on current conditions at the site, to gather information to assess risks, and to evaluate potential remedial alternatives.

A summary of the evaluation parameters and associated evaluation criteria is provided in Table 3-1. A summary of each parameter and an assessment of the RIA results according to each parameter follows.

3.1.3.1 Precision. Precision measures the reproducibility of measurements under a given set of conditions and is expressed as an RPD. RPDs were evaluated for the field duplicates and MS/MSD pairs.

A total of approximately 170 MS/MSD pairs were analyzed during this project phase, with an acceptability rate of greater than 90 percent. Precision for this project was good, except for PAH soil data, where 75 percent of the PAH soil RPDs did not meet QC criteria. Over 84 percent of all of the calculated field duplicate RPDs were within the limits established in the QAPP. As described previously, precision was difficult to maintain for the soil samples due to inhomogeneity of the samples. Many of the extracts from the PAH samples were difficult to analyze due to their tar-like consistency.

3.1.3.2 Accuracy. Accuracy measures the bias of a method or the level of agreement of a measurement with a known true value. Accuracy was assessed using CCV data and percent recovery of MS/MSDs and surrogate spikes.

A total of 124 data points were evaluated for percent recovery for matrix spike samples and, of these data points, 4 did not meet established QC criteria.

The accuracy of VOC and acid-extractable analyses appears to be good; however, the requirement for sample dilutions reduced the available QC database for assessing the accuracy of results. The data accuracy was also sacrificed due to the numerous occurrences of matrix interferences. The high viscosity of the extracts probably had a negative impact on the accuracy of the PAH data in the soil.

<u>3.1.3.3 Representativeness</u>. Representativeness is a qualitative parameter which evaluates how well the data represent the actual environmental conditions. Representativeness is evaluated from the analytical results of trip blanks, method blanks, equipment blanks, and field duplicates. Blanks are used to identify sources of contamination not associated with the environmental conditions. Duplicates are used to evaluate the sampling procedures and laboratory performance.

The representativeness of the data for this project was good. Aside from periodic observations of the laboratory contaminants acetone, methylene chloride, and 2-butanone, no sources of cross-contamination were identified. When evaluating the data to determine the actual environmental conditions at the site, it should be noted that the detection limits that the laboratory was able to achieve for some samples was elevated. The elevated detection limits occurred when dilutions were required.

<u>3.1.3.4 Comparability</u>. Comparability is an expression of the confidence with which one data set can be compared to another and is achieved through the use of standard sampling procedures, analytical methods, and units of measurement. Procedures, methods, units, and field duplicate analytical results were used to evaluate comparability.

The comparability of the data for this project was good. As stated below in Section 3.3, the field audits recognized that work plan procedures were followed.

<u>3.1.3.5 Completeness</u>. Completeness is defined as the percentage of usable data relative to the total number of data points. The completeness goal for this project, as specified in the QAPP, is 90 percent, while CLP data is typically 80-85 percent complete. Completeness was evaluated for usability. For the purposes of this site investigation, estimates were considered usable data. There were over 1,524 data points resulting from RIA site characterization activities. None of the collected data points were considered unusable, resulting in a 99 percent complete set of data. Based on the high percentage of valid data obtained during the RIA, the data quality objectives of the sampling and analysis program were achieved.

<u>3.1.3.6 Traceability</u>. Traceability is the extent to which data can be substantiated by hard-copy documentation. The chain of custody (COC) forms were examined to trace the history of each sample from collection to analysis. Laboratory reports were also examined for sample identification (ID) and date errors. The overall traceability of the data gathered during the RIA project was excellent.

3.1.4 Raw Laboratory Data

The results of the analyses and NET - Cambridge's internal review of the raw data and QA requirements were summarized in case narratives for each sample delivery group. The case narratives are presented in Appendix M.

Approximately 10 percent of the raw laboratory data for both the soil and groundwater matrices were validated by LDC. Copies of LDC's data validation reports are presented in Appendix N. Results of this validation process were adopted and are reflected in the data base, data tables, and discussions presented in the RIA report.

The data validation performed independently by NET - Cambridge and LDC did not result in any data being flagged as unusable. It should be noted that LDC's data validation process identified a PAH compound (benzo(a)pyrene) that was incorrectly reported as being present in the groundwater sample from MW-25. Benzo(a)pyrene was actually not present at or above the detection limit of 0.017 µg/L. LDC also noted that the concentration of dibenz(a,h)anthracene in the sample collected from MW-28 on August 11, 1994 was incorrectly calculated. The recalculated concentration is 0.022 µg/L less than initially reported by NET. Additional flagging of RIA data was conducted and is discussed in detail in the LDC reports (Appendix N).

3.2 EPA SPLIT SAMPLING EVENTS

In order to meet the goals of its internal QC program, the EPA routinely requests that potentially responsible parties (PRPs) conducting Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site investigations provide the agency with duplicate aliquots of certain key samples. Typically, these duplicate samples (or splits) are created by the PRPs' representatives in the field, and the EPA then arranges for a contract laboratory to provide the analytical workup. Split sample analytical results by the EPA and PRP laboratories are then compared to assess the precision of the data sets.

During the RI, the EPA's on-site representative, Jacobs Engineering Group (JEG), obtained split samples from Montgomery Watson for selected soil and groundwater samples. Specific samples for splitting were pre-selected by the EPA and communicated to Montgomery Watson prior to the field sampling events. Under the observation of the EPA contractor's on-site personnel, Montgomery Watson collected the samples with its equipment and prepared the duplicates. Individual Montgomery Watson and JEG sample containers were filled alternately from the cores, bailers, stainless steel mixing bowl, or other sampling apparatus. Montgomery Watson was not included in the chain-of-custody documentation for the EPA's split samples.

Tables 3-2 and 3-3 present the analytical results and RPDs of the EPA soil and groundwater split samples side by side with those determined by Montgomery Watson's laboratory subcontractor (NET). None of the EPA laboratory's QC sample results are presented in the summary since Montgomery Watson had no split QC data of its own to compare with the EPA data. The EPA's laboratory also reported analytical results for significantly more organic compounds and metals than appeared on the approved list of analytes for the RIA. The complete analytical data packages for the EPA split samples, including their QC data, are presented in Appendix O.

It was noted that the constituent MDLs reported by the two respective laboratories were often different by orders of magnitude. For some of the laboratory work, different analytical methods and equipment were used by the respective laboratories. For PAH analyses, the EPA's subcontractor laboratory used gas chromatography/mass spectrometry (GC/MS) while NET - Cambridge used HPLC.

3.3 FIELD AUDITS

Field audits were conducted during the field investigation portion of the RIA. The purpose of these audits was to ensure that the activities were being performed in accordance with industry standards and applicable work plan documents and that the appropriate health and safety protocols were being observed.

3.3.1 Technical Audit

Two technical audits were performed during the field investigation and sample collection. The first audit was conducted on November 12, 1993. The primary purpose of this audit was to observe the drilling and well construction procedures for consistency with Tech Memo 7 and standard industry practice. Record keeping, documentation, and general adherence to Tech Memo 7 were also evaluated. Following the audit, a memorandum was prepared which documented the findings of the audit and the opinions of the auditor. A copy of this memorandum is included in Appendix P.

The second technical audit was performed during the groundwater sampling activities. The purpose of this audit was to observe the sampling procedures and compare them to the proposed methodology as stated in Tech Memo 7. This audit was conducted on December 15, 1993. The results of this audit were also summarized in a memorandum. A copy of the memorandum is also contained in Appendix P.

3.3.2 Health and Safety Audit

A health and safety audit was performed on November 16, 1993 by Montgomery Watson personnel. This audit concentrated on compliance with the site HSP for on-site activities. The audit considered several aspects of site safety procedures, including hazards associated with the site, general site conditions, personnel knowledge of the HSP, and use of personal protective and monitoring equipment. This audit was also summarized in a memorandum, a copy of which is included in Appendix Q.

SECTION 4

4.0 SITE CHARACTERIZATION

This section summarizes the results of the RIA in greater detail and discusses the significance of the data. Conclusions and the supporting rationale are also presented.

4.1 SOILS

The soils encountered in the RIA drilling locations exhibited similar characteristics to those encountered during the previous phases of investigation. In general, the soils of the FMGP site and former electric power plant site to the west 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 at the off-site RIA drilling locations was limited. To the west of the site, the bedrock surface remains at the same approximate elevation along Willow Creek but rises to only two feet below the ground surface at MW-26 and MW-35. Similarly, at most of the other off-site RIA drilling locations, 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, with no soil cover.

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 to bring the ground surface up to grade with the nearby streets.

The on-site drilling locations revealed thicknesses of soil and fill consistent with those reported during previous investigations, i.e., typically 9 to 14 feet.

4.2 GEOLOGY

4.2.1 Shell Rock/Cedar Valley Contact

As previously discussed, a sequence of bedrock exposed in a rock cut approximately 2 miles north of the site contains the lower portion of the Shell Rock Formation and the upper portion of the Cedar Valley Formation. The contact of the two formations exposed in this rock cut was identified by Donald Koch in 1970. An identical sequence of rock is exposed north of Willow Creek immediately north of monitoring wells MW-16 through MW-18. The series exposed in the outcrop at the site indicates that the contact of the Shell Rock and Cedar Valley Formations is topographically higher than the FMGP site. Therefore, the uppermost bedrock unit on the FMGP site itself is the Cedar Valley Formation.

4.2.2 Structural Geology Evaluation

Since the surface of the Cedar Valley Formation is an erosional surface, the contact with the Shell Rock Formation is unconformable. Therefore, the erosional irregularities in the Cedar Valley surface prevent it from being useful in determining the strike and dip of the formation. Visual observation of the exposures of the Cedar Valley Formation along Willow Creek and in the walls of the former rock quarry east of Pennsylvania Avenue reveal some small, localized undulations in the layers and bedding planes. These localized undulations, combined with the limited exposure of bedrock around the site, prevented a reliable compilation of strike and dip measurements. Visual observation of the bedrock exposures creates the impression that the rock units are approximately horizontal with no continuous discernible dip. However, correlating the elevations of the first transmissive zones in the 5 deep wells revealed a slight westward dip. Regionally, the Cedar Valley Formation dips toward the southwest.

4.2.3 Geophysical Evaluation

The primary purpose in performing the geophysical survey was to aid in locating the first transmissive zone in the wells that were not cored. The secondary purpose was to identify zones that may indicate barriers to downward migration of the contaminants from the site.

Each of the geophysical logs show an abrupt response where the tools passed from the open borehole to the steel overshot casing. While in the open borehole, the caliper logs indicated a relatively smooth boring wall for the cored holes with minor variations at apparent clay seams. The caliper log for MW-35 indicates a much rougher wall surface caused by abrasion from the air rotary drilling technique as well as wash-outs of clay seams or other poorly consolidated materials. None of the caliper logs indicated large areas of significant borehole diameter changes. The absence of significant changes is indicative of relatively uniform rock types and quality. This relative uniformity was also verified in the core sections collected.

Given that the specific gravity of limestone, dolomite, and many clays are similar (typically 2.7 to 2.8), the density log alone was not able to distinguish clay-rich zones from those of more competent rock. The density log did, however, detect variations in density resulting from changes in porosity, a useful feature in locating potential transmissive zones for packer testing. Those depth intervals with a lower density were originally identified as potential transmissive zones.

The logs from the natural gamma tool were intended to aid in identification of changes in stratigraphy at the site. Since the natural gamma radiation detected by this tool generally increases with increasing clay content of the formation, peaks in the logs typically indicate zones or layers with a high clay content. Peaks from the natural gamma tool correlating to peaks in the density log generally indicated that the change in density was due to a clay or shale seam. These depth intervals were deleted as potential transmissive zones.

Each of the geophysical logs were visually compared to the actual rock core in the field to aid in locating the first transmissive zone. Based on the responses noted in the logs, visual observations of porosity, and the production of water during the drilling process, the assumed first transmissive zone was noted for each of the 5 deep wells and later verified by the packer testing.

The results of the geophysical logging 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.

4.2.4 Rock Quality Designation

In the upper portion of each of the cored holes, the calculated RQD increased with depth and reached 100 percent in sections of each of the cores. This indicates that the fracture frequency of the rock decreases with depth. Below the uppermost fractured zone of bedrock, the RQDs were typically greater than 75 percent. This gives the majority of the rock an RQD description of good (75-90 percent) or excellent (90-100 percent). The RQD values for the RIA cores are consistent with the determination from RC-1 during the Phase III Investigation.

One naturally occurring, near-vertical fracture was observed in the cores. The fracture was observed in the core from MW-31 from approximately 73 to 75 feet below grade. The top of the 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). While these observations do not eliminate the possibility of more significant vertical fractures, the integrity of the core samples does indicate that the general consistency of the rock is predominantly competent, rather than highly fractured or fragmented. This increased competency with depth and the low permeability of the rock demonstrated across the site is instrumental in limiting the lower extent of contaminant migration.

4.2.5 Geotechnical Evaluation

The physical evaluation of the bedrock cores consisted of measurement of the bulk density of the rock, percent clay by weight, and vertical hydraulic conductivity. The core samples from MW-25 and MW-33 had the same bulk density of 2.79 grams per cubic centimeter (g/cc) and percent total clays by weight of 2 and 3 percent, respectively. The sample from MW-34 had a bulk density of 2.54 g/cc and a total percent clay of 12 percent.

The clay content of each of the samples consisted of illite and smectite. Since these clays have densities similar to limestone and dolomite, the lower bulk density in the sample from MW-34 is not related to the higher percentage of clay in the sample. Reviewing the hydraulic conductivities of these samples indicates that the samples from MW-25 and MW-33 are of the same order of magnitude, while the hydraulic conductivity of the sample collected from MW-34 is two orders of magnitude greater. This information implies that the lower bulk density of the rock at MW-34 is actually a function of the porosity rather than the mineralogical composition.

The vertical hydraulic conductivity of each of the core sections analyzed indicated that the rock in and immediately below the shale zone will effectively prevent downward migration of the contaminants or contaminated groundwater at the site through the rock structure. Therefore, the only potential for vertical migration would be restricted to vertical fractures, which have not been specifically identified. Vertical leakage of groundwater to the first transmissive zone is also not supported by the water level data, as will be discussed in Section 4.4.4.3.

4.3 HYDROGEOLOGY

The hydrogeology of the Mason City, IA FMGP site and the immediately surrounding area is discussed in this section. Investigations during the RIA included four rounds of water level measurements from the site monitoring wells and the determination of aquifer properties by several methods. The results and subsequent evaluation of these investigative activities are discussed in the following subsections.

4.3.1 Potentiometric Surfaces

In the area of the site, groundwater flow in the shallow aquifer appears to be generally to the northeast. Groundwater flow in the first transmissive zone below the shale zone was consistently to the southwest during the RIA.

4.3.1.1 Shallow Aquifer. Groundwater flow in the shallow aquifer in the vicinity of the site is partially controlled by water levels in Willow Creek. In turn, water levels in Willow Creek can be controlled by the variable-height, low-head dam at the east end of the site near Pennsylvania Avenue. When the dam is in the down position, shallow groundwater flows onto the site from the southwest. The groundwater flows generally to the northeast until it encounters the retaining wall. The flow then splits and flows around and under the retaining wall prior to resuming a northeasterly course.

When the dam is in the raised position, or 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. Groundwater entering the site from the south is diverted to the east around the retaining wall and dam. As a result of these two flow regimes entering the site from different sides during dam up or high precipitation events, a groundwater trough forms in the vicinity of MW-6 and MW-24. This trough identifies the extent to which the influence of water from Willow Creek directly impacts the site.

Under dam-up or high water conditions, groundwater surface elevations in nearly all of the shallow aquifer wells increase due to the influx of water from Willow Creek and the resulting convergence of flow from the south. Monitoring wells on the eastern edge of the site (MW-4, MW-9, MW-19, and MW-20) appear to be largely unaffected by the increase in water levels upstream of the dam. However, the water levels in these wells closely coincide with variations in the surface elevation of Willow Creek downstream of the dam. The areal extent to which an increase in the surface elevation of Willow Creek impacts the direction of groundwater flow north of Willow Creek is not known.

The variable height dam remained in the down position during initial RIA field activities. Groundwater flow in the shallow aquifer on December 13, 1993 and February 28, 1994 is illustrated in Figures 2-21 and 2-22, respectively. The dam was later placed in the up position to evaluate the effects of the change in Willow Creek elevations on water levels in the newly installed wells. Shallow groundwater flow with the dam in the up position on July 15, 1994 is shown in Figure 2-23.

Under dam-up and dam-down conditions, groundwater flow on the eastern side of the FMGP site flows northeasterly, toward Willow Creek. The gradient steepens somewhat in the northeastern corner of the site because the flow is no longer restricted by the retaining wall. Based on data collected during the RI, it has been shown that the shallowest portion of groundwater may discharge to Willow Creek below the dam. The retaining wall along Willow Creek acts as an impediment to shallow groundwater flow and restricts groundwater interaction with Willow Creek. This results in small groundwater mounds in the area of MW-3 under some flow conditions and a downward component of flow under the retaining wall.

Additional wells north of Willow Creek have allowed a greater understanding of shallow groundwater flow in the area immediately north of Willow Creek. The northernmost monitoring wells have allowed the identification of 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. The two components of flow then join to bring about an easterly flow towards 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 Willow Creek. This general flow scenario applies both with the dam in the up and down positions.

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 impacted by groundwater flow from the downtown Mason City area. VOC and PAH groundwater contamination was documented during the RIA at MW-28, MW-30, and MW-32. VOC and PAH contamination in soils at MW-28 were also detected at concentrations above background levels. Groundwater elevation data indicates that MW-30 and MW-32 are not downgradient of the site under dam-up or dam-down conditions. These two wells are located in a distinctly different component of shallow groundwater flow, which flows in a southerly direction toward Willow Creek, regardless of the position of the dam. As shown in Figures 2-21 and 2-22, the groundwater surface elevation in MW-28 is higher than the water surface of Willow Creek when the dam in the down position. However, as shown in Figure 2-23, when the dam is raised, the rapid increase in water level in Willow Creek exceeds the rate of increase at MW-28. Under such conditions, the apparent groundwater trough north of Willow Creek extends out to MW-28, such that water may flow toward MW-28 from the north as well as from Willow Creek. Figures 2-21 through 2-23 indicate that monitoring wells MW-15, MW-17, and MW-19 are located in areas that may be impacted by both the northeasterly and southerly components of groundwater flow regardless of the position of the dam.

Water level data gathered from the two additional shallow wells west of the site indicated that the groundwater surface is nearly horizontal across the former power plant site and western portion of the site. Overall, the direction of groundwater flow appears to be to the northeast; however, fluctuations in the level of Willow Creek have a nearly immediate effect on the water levels in the wells immediately along the creek.

Horizontal gradients in the shallow aquifer vary significantly across the study area. However, the horizontal gradients in a given area of the shallow aquifer have remained fairly constant based on the data collected during the RIA. The western portion of the study area has exhibited an extremely flat gradient of approximately 0.001 ft/ft during the RIA. The eastern portion of the FMGP site has a somewhat steeper gradient than does the western portion. Gradients on the east side of the site are typically on the order of 0.01 to 0.02 ft/ft with the dam in the down and up positions, respectively. These gradients on the south side of Willow Creek are similar to the gradients observed during the RI phase. Gradients on the north side of Willow Creek, which are the steepest in the study area, were observed to range from 0.03 ft/ft with the dam in the down position to approximately 0.05 ft/ft with the dam in the up position.

__4.3.1.2 First Transmissive Zone__. Across the study area, groundwater flow in the first transmissive zone is to the southwest. The potentiometric surfaces on December 13, 1993, February 28, 1994, and July 15, 1994 are presented in Figures 2-24, 2-25 and 2-26, respectively. Groundwater elevations in the first transmissive zone were significantly higher during the July 1994 measurements than the previous series of measurements. Water levels in the first transmissive zone increased approximately 4 to 6 feet between the measurements collected during the winter months (December 8, 1993, December 13, 1993, January 21, 1994, and February 28, 1994) and the June 1994 series of measurements (June 2, 10, and 23, 1994). Water levels again increased significantly prior to the July 5 and 15, 1994 measurements. These increases are likely due to seasonal variations in the first transmissive zone rather than a result of changes in the level of Willow Creek, since water levels in the first transmissive zone were actually slightly lower after the dam was raised on June 2, 1994. Rainfall records for Mason City for May 25, 1994 through July 15, 1994 revealed rainfall events of greater than 1 inch occurred on June 12, 24, and 30, 1994 and on July 12, 1994. These events may have resulted in a regional influx into the first transmissive zone, which was observed in the July 5 and 15, 1994 water level measurements. Rainfall data for May 25, 1994 through July 15, 1994 is presented in Table 4-1.

Horizontal gradients in the first transmissive zone vary significantly across the study area. As stated earlier, groundwater flow in the first transmissive zone is to the southwest at the site. Based on the water level information collected during the RIA, the horizontal gradient to the northeast of the site is significantly steeper than it is to the southwest. Observed gradients in the northeast portion of the first transmissive zone have ranged from 0.003 to 0.013 ft/ft. Observed gradients in the southwest portion of the first transmissive zone have ranged from approximately 0.001 ft/ft to 0.006 ft/ft.

All of the monitoring wells screened in the first transmissive zone are clustered with wells screened in the shallow aquifer. The presence of these well clusters allows the calculation of vertical gradients across the shale zone. At four of the five clustered locations, the vertical gradient was consistently observed to be downward. The downward vertical gradients observed during the RIA ranged from a low of 0.02 ft/ft at the MW-30/MW-31 cluster to a high of 0.28 ft/ft at the MW-21/MW-34 cluster. At the MW-19/MW-33 cluster, an upward gradient was observed for each of the June and July 1994 water level measurements. On July 5 and 15, 1994, water was flowing from MW-33 onto the ground surface. Since the well was flowing, the actual potentiometric elevation of MW-33 could not be measured. However, using the top-of-casing elevation as the groundwater surface elevation for MW-33 results in an upward gradient of 0.147 ft/ft at the MW-19/MW-33 cluster. Although the vertical hydraulic gradient is generally downward across the shale zone, it is important to note that the extremely low hydraulic conductivity of this zone severely restricts flow. The shallow aquifer and the first transmissive zone are not in direct hydraulic connection.

4.3.2 Aquifer Properties

Slug tests and bail down tests were conducted during the RIA to provide in situ measurements of the horizontal hydraulic conductivities in the vicinity of the screened intervals of site monitoring wells.

4.3.2.1 Slug Tests. Slug tests were completed on all of the newly installed monitoring wells with the exception of MW-29 which was dry. A summary of the slug test data is presented in Table 2-10. The computer software program AQTESOLV™ was utilized for analysis of the slug test data. Slug tests for wells screened in the shallow, unconfined aquifer were evaluated using the Bouwer-Rice method. Wells screened in confined zones were evaluated using the Cooper, Bredehoeft, and Papadopoulos method. Slug-in tests were conducted and evaluated for all wells except MW-30; slug-out tests were conducted and evaluated on all wells except MW-33, MW-34 and MW-35.

Hydraulic conductivity values for wells screened in the shallow aquifer ranged from 3.1 x 10^{-4} cm/sec to 5.4 x 10^{-6} cm/sec. These values are similar to what was determined during the RI for wells screened in similar intervals. Wells screened in the first transmissive zone exhibited hydraulic conductivities ranging from a high of 1.3 x 10^{-3} cm/sec at MW-25 to a low of 2.3 x 10^{-5} cm/sec at MW-34.

4.3.2.2 Skibitzke Evaluations. Bail down tests were conducted during the RIA and evaluated using the Skibitzke method. The Skibitzke evaluation was conducted on MW-18, MW-30, and MW-32. The Skibitzke evaluation yields results in units of transmissivity (gpd/ft); for ease of comparison with the slug test results the units have been converted to hydraulic conductivity (cm/sec). The tested aquifer thickness was assumed to be equal to the screen length of the well. The results of the bail down tests are presented in Table 2-11. Results of the Skibitzke evaluation ranged from a high of 2.6 x 10^{-6} cm/sec at MW-30 to a low of 2.7 x 10^{-7} cm/sec at MW-32.

The hydraulic conductivity estimates from the Skibitzke evaluations are consistent with the values obtained during the RI for wells screened in similar geologic zones. Hydraulic conductivities in the range of 10^{-6} to 10^{-7} cm/sec are indicative of rock with very little primary or secondary porosity.

4.3.2.3 Bedrock Permeability. Sections of core from within the shale zone from borings at MW-25, MW-33, and MW-34 were submitted to Core Laboratories, Inc. The vertical hydraulic conductivity was measured in the lab using ASTM:D 5084-90. The hydraulic conductivity values obtained from these falling head tests are presented in Table 2-4. Hydraulic conductivity values of this order of magnitude represent rock which has virtually no porosity and is essentially impermeable to water and contaminant flow. Visual inspection of the bedrock cores provides further evidence that the bedrock in the vicinity of the shale zone is an effective aquitard preventing downward contaminant migration.

4.4 NATURE AND EXTENT OF CONTAMINATION

This section discusses the extent of soil, bedrock, and groundwater contamination at the site and the contamination's relationship to the site and historic on-site activities.

4.4.1 Basis for Evaluation

The determination of the extent of soil and groundwater contamination at and around the site was based on a comparison of the laboratory data and method detection limits to the target compound concentrations found at assumed background and upgradient locations. Field screening results and visual observations have also been considered in the evaluation of contamination. As a reference, an analytical results database is included in Appendix R. This database presents all of the results of chemical analysis performed on soil and groundwater samples collected throughout the investigative phases, including the RIA.

4.4.2 Soils

The results of the field screening and soil sample analyses revealed that PAH compounds are present in the soil at each of the RIA locations sampled. At some of the off-site locations, PAHs exist in significant concentrations at elevations which are topographically higher than the FMGP site. Soil samples collected from MW-27, MW-28, and MW-32 each contained PAH concentrations from sample intervals which are topographically higher than the ground surface at the site. The most notable of these concentrations was detected at MW-28, where the total PAH concentration equaled 85 mg/kg at 4 to 6 feet below grade, or the equivalent of an elevation of approximately 1,115 feet National Geodetic Vertical Datum (NGVD) for the sampled interval. The average surface elevation of the northwest corner of the FMGP site is approximately 1,108 feet NGVD. Therefore, the contamination was detected at an elevation approximately 7 feet higher than the ground surface of the FMGP site. This elevation is also higher than would likely be impacted by an increase in the shallow aquifer water levels resulting from an increase in the Willow Creek water level. Examination of the water level data for Willow Creek and MW-28 indicates that MW-28 tends to be slightly lower than the elevation of Willow Creek. The predicted 100-year flood elevation for Willow Creek was recently revised to 1,107 NGVD at the Delaware Avenue bridge. Assuming that the groundwater elevation at MW-28 would reflect the same elevation, and that the capillary fringe would be approximately 3 to 4 feet, the contamination remains approximately 4 to 5 feet above the saturated zone. Similarly, the sample from MW-32 was collected from an approximate elevation of 1,126 feet NGVD. This elevation is 19 feet higher than the predicted 100-year flood elevation for Willow Creek.

The fact that these samples were collected from an elevation higher than the ground surface at the FMGP site and above the saturated zone indicates that these PAH compounds have not migrated from the site and are the result of unidentified off-site sources. This information casts doubt on the source of all PAH contamination identified north of Willow Creek.

The sample from MW-27 was collected from an approximate elevation of 1,109 feet NGVD. While this elevation is higher than the ground surface of the FMGP site and the predicted 100-year flood elevation for Willow Creek, it would likely be reached by the capillary fringe for such an event. This would allow dissolved or free-phase contamination in the groundwater to adsorb to the soil and result in apparent soil contamination after the water levels receded. The source of the contamination detected at this location is unknown, but since (1) much of the former power plant foundation is still in place, (2) the bedrock elevation increases from the site to the west, (3) the groundwater flow conditions noted during this investigation do not support migration from the site to MW-27, and (4) extended periods of high groundwater are not common for Willow Creek, it is unlikely that a migration pathway exists or that the contamination is a result of activities at the site. Evaluation of the groundwater flow patterns with the dam in the raised position will provide additional information regarding the potential for contaminant migration from the site. However, if a flow reversal or significant change in direction occurs due to a change in the level of Willow Creek, it is likely that the direction of groundwater flow will become east-southeasterly, away from Willow Creek and toward the site, opposing migration of contaminants from the site.

PAH compounds were also detected west of the site in soil samples collected from SB-FF and SB-GG. Soil samples had also been originally proposed for location MW-26; however, due to a lack of soil at that location, samples could not be collected. Therefore, the extent of available soil for the investigation of contamination is limited to the northern portion of the former power plant site.

The location of SB-FF is west of any previous IPW activities or property ownership. The location of SB-GG is within the foundation of the former power plant and does not consist of native soil. Based on the concentrations detected at both boring locations (which are within the range of background concentrations noted in the RI Report), the western extent of contaminated soil which contains PAH compounds potentially derived from the site appears to extend under South Delaware Avenue between SB-GG and MW-14, extending northwest to around MW-13. This western extent of PAH contamination and the lack of additional soil beyond the RI sampling locations in the remaining three directions together define the extent of soil contamination at the site in this area.

PAHs were also detected in the 10 to 16 foot depth interval (approximately 1,097.5 to 1,091.5 feet NGVD) at MW-15. PAHs were not detected in any of the intervals screened from nearby MW-17 and MW-18. Due to the concentration of PAHs at MW-15 relative to the northwest corner of the site, and the presence of the two retaining walls which reportedly extend to bedrock, it is unlikely that the contamination has directly migrated from the site to MW-15. The highest PAH concentrations in groundwater on site are an order of magnitude less than the soil concentration at MW-15. Discounting adsorption, dispersion, diffusion, and transformation, it is still unlikely that the PAHs could travel down into the bedrock, flow under Willow Creek, and reemerge into the soil/fill at MW-15 The fill material placed behind the retaining wall after construction may have been obtained from a contaminated source or may have become contaminated subsequent to placement from an unknown source.

PAHs were also detected at MW-20 (538.19 mg/kg) at a depth of 24 to 26 feet below ground surface. This elevation corresponds to the normal water level elevation of Willow Creek below the dam. This location does not appear to be downgradient of any known contaminant sources, but due to the apparent hydraulic connection with Willow Creek, this location may be heavily influenced by storm sewer discharges. IDNR records contain several reports of documented releases of petroleum products through the storm sewer.

The principal VOC contaminant of concern at the site is benzene. Benzene was detected in low concentrations in soil samples collected from MW-27, SB-FF, and SB-JJ. The maximum concentration detected was 6 µg/kg at SB-FF, and all RIA benzene detections in soils at these locations were flagged as estimated values. As discussed regarding the PAH compounds at MW-27, the sample interval containing the maximum benzene concentration was topographically higher than the FMGP site and normally located in the unsaturated zone. Therefore, the presence of benzene at this location is not likely due to migration from the site. Also as previously discussed, SB-FF is located beyond any areas that IPW owned and, although this sample was collected from an interval which is topographically below the surface elevation of the FMGP site, the sample was collected from unsaturated soils, again making migration from the site extremely difficult to support. On site, benzene was detected during the RIA only at SB-JJ. This sample was collected from the upper 2 feet of unsaturated soils under the location of the former transformer yard. During the excavation for sample collection, a concrete foundation with railroad tracks was discovered. Benzene was not likely used in the transformer yard but may be the residual of a minor spill or leakage from a piece of railroad equipment.

In addition to benzene, toluene and xylenes were detected in soils at very low concentrations. Toluene was detected in estimated concentrations both on site and off site at depth intervals above the saturated zone. Xylenes were detected only at SB-JJ. The maximum estimated concentration of toluene and xylenes was 2 µg/kg. The concentrations of benzene, ethylbenzene, toluene, and xylenes detected in soils on the FMGP site are similar to those detected off site, at locations without a demonstrated transport mechanism to the site. Therefore, these off-site concentrations are apparently due to alternate sources or represent background concentrations for the area.

Vinyl chloride was not detected in any of the samples analyzed during the RIA. Vinyl chloride has been detected during only one groundwater sampling event, in groundwater samples collected from MW-6 and MW-10 on November 21, 1988. In a solid matrix, vinyl chloride has been detected in only one sample collected from the waste pile on October 26, 1988. Therefore, the actual presence or apparent extent of vinyl chloride contamination is not supported by the repeated sampling events of both groundwater and the waste pile.

Other VOCs detected in soil samples included 2-butanone, methylene chloride, acetone, and tetrachloroethene. With the exception of tetrachloroethene, each of these compounds is commonly associated with cleaning of laboratory equipment and other activities. None of these constituents have been detected in the previous investigations and are not commonly associated with FMGP sites. Therefore, these compounds are not likely to have been derived from the site.

Arsenic and lead were the only metals analyzed in the soil samples collected during the RIA. The concentration of lead detected in the soil at SB-GG was an order of magnitude greater than the concentrations detected at the remaining locations. Given that the concentration of lead in the soil at SB-GG was higher than that detected in the area of the FMGP, the source of the fill material sampled at SB-GG is unknown, and the concrete foundation of the former power plant creates a physical barrier between SB-GG and the site, the source of the lead is unclear. However, considering that lead is a common contaminant at FMGP sites, these circumstances do not rule out the possibility that the lead contamination was derived from the site.

No PCBs were detected in the area of the former transformer yard. Therefore, no additional investigation of this area is warranted.

The presence of PAH and VOC contamination detected during the RI and RIA in soils surrounding the site indicates the widespread distribution of these contaminants in the vicinity of the site. Contaminants detected at locations not accessible by natural contaminant migration processes provide data points which can be used as background concentrations or indicators of other sources. Given that concentrations of these contaminants are of the same order of magnitude around the site, the extent of soil impacted by the site-derived contaminants can be assessed. The data gathered throughout the various investigations has shown, therefore, that the extent of soil contamination is restricted to the central and northwestern portions of the site. Additional contaminated soil likely extends under South Delaware Avenue, adjacent to the northwest corner of the site.

4.4.3 Bedrock

Since laboratory analysis of bedrock samples was not performed for the major contaminants of concern for the site, the extent of contamination in bedrock is based primarily on visual observation. Each of the newly installed monitoring wells required drilling into at least the upper portion of the bedrock to achieve the desired depth. In addition, rock core RC-AA was advanced for the sole purpose of visually investigating the possibility of bedrock contamination at that location.

Of all of the rock coring and air rotary drilling locations, visible contamination 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. This depth is approximately 15 feet below the bedrock surface. The visible contamination does not extend below the top of the shale zone.

These observations, combined with the data presented in the RI Report, indicate that the extent of visible bedrock contamination north, east, and south of the site is limited to the IPW property. The lack of visible contamination at RC-AA indicates that the western extent of contamination in the bedrock is likely under Delaware Avenue between MW-14 and RC-AA. The vertical extent of visible contamination in the bedrock is confined to the upper, more highly fractured portions of the bedrock and does not penetrate the shale zone.

4.4.4 Groundwater

In this section, the extent of groundwater contamination is discussed relative to the hydrologic zones at the site. The shallow aquifer includes the upper unconfined aquifer down to the shale zone. The intermediate zone was monitored by the wells screened below the shale zone but above the first transmissive zone.

4.4.4.1 Shallow Aquifer. During the RIA, laboratory analysis for contaminants in the shallow groundwater above the shale zone included PAHs, VOCs, and selected metals. PAH compounds were detected in all of the shallow groundwater wells containing available water, with the exception of MW-20. The concentrations for total PAHs detected ranged from 0.27 µg/L at MW-6 to approximately 9,260 µg/L at MW-2. Notable increases in PAH concentrations were observed in several wells on site when compared to the dam-down sampling event of the RI. In the northwest corner, MW-2 showed an increase from 56 µg/L to 9,260 µg/L, and MW-14 increased from 8 µg/L to approximately 158 µg/L. However, the wells surrounding MW-2 and MW-14 did not show dramatic changes in PAH concentrations. The PAH concentrations detected in other shallow aquifer wells in and around the northwest corner (MW-1, MW-3, and MW-13) remained virtually unchanged from the RI dam-down sampling event. The PAH concentration increases at MW-2 and MW-14 may be due to the following reasons: (1) higher rates of infiltration through contaminated soil in the northwest corner due to 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. The concentration at MW-5 increased from approximately 2.1 µg/L to 46.9 µg/L. At MW-24, PAHs were not detected in the RI dam-down sampling event but were detected at approximately 32.4 µg/L during the RIA. It is suspected that these increases are due to flood effects in the groundwater flow regime, which resulted in contamination from a source area near the center of the site being mobilized to the southeast as groundwater flowed around the dam, sweeping a wide arc around the site. Alternately, this contamination may be due to an off-site source south of the site. Infiltration of contaminants from the waste pile is not likely, since the cover is impermeable and routinely inspected for cracks or tears which are immediately repaired upon discovery during the quarterly inspections.

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

PAHs were detected in each of the new shallow wells installed north of Willow Creek. The highest total PAH concentrations were detected in MW-28 at nearly 54 µg/L. This sample was collected with the dam in the down position. The potentiometric contours for dam down conditions indicate that the direction of groundwater flow is toward Willow Creek at each of these locations and, therefore, none of these locations are downgradient of the FMGP site. With the dam in the up position, MW-28 appears to be located so as to potentially receive groundwater from the northeast as well as from Willow Creek, west of the Delaware Avenue bridge. Resampling of MW-28 with the dam in the up position showed a decrease in the total PAH concentration to approximately 10 µg/L, suggesting that the influx of water from the southwest results in a dilution of the PAH concentration. Therefore, it appears unlikely that the contamination at MW-28 has migrated from the site under dam-up or high-water conditions. The other newly installed shallow wells remain clearly upgradient of the site when the dam is raised. The water levels observed for these wells and sample results indicate that the contamination in these shallow wells may be from a source other than the FMGP site.

In further support of the contamination being derived from a source other than the FMGP site is the fact that MW-32, which is located only about 130 feet to the northeast of MW-17, does not contain detectable concentrations of naphthalene. If, in fact, the contamination was coming from the FMGP site, naphthalene should have been detected at MW-32 before the less soluble PAHs that were present, since naphthalene is one of the fastest moving PAH compounds in the subsurface environment. A number of potential sources of contamination north of Willow Creek have existed over the years. A review of Sanborn maps for the area which is bounded on the east and west by South Delaware and South Federal Avenues, respectively, and which lies between Willow Creek and Second Street S.E., indicates that this area formerly housed a steam laundry; carriage factory with a blacksmith shop; coal storage; a manufacturer of steel gutters, skylights, and ceilings; an auto garage with at least three underground gasoline storage tanks and an oil room; and a bus garage. The area between South Delaware and Pennsylvania Avenues, Willow Creek, and Second Street S.E. was the site of a bakery (with a known release from an underground storage tank), commercial laundry, wholesale photo finishing facility, mattress factory, and printing, auto repair, and truck storage facilities. Although the only known, documented release is from the gasoline tank at the bakery, fuel oil, quench oils, lubricating oils, gasoline, solvents, and inorganic chemicals may have been released into the environment from one or more of these facilities. The groundwater flow directions north of Willow Creek with the dam in the up or down position support the possibility that contaminants from areas north of the site could result in the migration of contaminants to MW-28 or the other northern tier wells.

West of the site, monitoring wells MW-26 and MW-27 revealed low level total PAH contamination at 6.03 µg/L and 1.34 µg/L, respectively. These locations also provided water level data which indicates that, under dam down conditions, groundwater flow at both wells is toward Willow Creek and not downgradient of the FMGP site. Groundwater contamination in the vicinity of MW-13 under dam down conditions may be temporarily dispersed to the south when the dam is raised, or when Willow Creek water levels rise from runoff or storm events. However, migration toward Willow Creek would resume upon lowering the dam or when high water levels in Willow Creek decreased. It should be noted that the groundwater flow directions do not support migration of contaminants from the site or from MW-13 to MW-27 with the dam in the up or down positions. Also, when the dam is in up position, groundwater migration along the western portion of the site is to the south-southeast and would not provide a mechanism for contaminant migration to the former power plant property. The low concentrations and the direction of groundwater flow suggest that the contamination detected in these wells is not from the FMGP site. The contamination detected at MW-26 and MW-27 may be related to the site if a viable migration pathway exists. Since much of the former power plant foundation is still in place, the bedrock elevation increases from the site toward these locations and there appears to be little to no hydraulic gradient to drive the contamination from the site to these wells, it is unlikely that such a pathway exists. A flow reversal or significant change in direction that occurs because of a change in the level of Willow Creek is likely to change the direction of groundwater flow to a south-southeasterly direction, away from Willow Creek and toward the site, opposing migration of contaminants from the site. Therefore, the extent of shallow site-derived groundwater contamination to the west of the FMGP site likely does not extend beyond MW-26 and MW-27 and, in consideration of the groundwater flow direction, is likely much closer to the site.

The extent of groundwater contamination to the south and east is also defined by the low level concentrations of total PAHs. The northern extent of groundwater contamination potentially originating from the site is limited by the northern tier of wells. In these wells, the direction of groundwater flow has been shown to be southerly toward Willow Creek. Contaminants detected in these wells must be due to a source adjacent to or north of these wells. The extent of contamination originating from the site would not extend further north than the zone where the two directions of groundwater flow converge, which, based on water level data, is immediately north of Willow Creek. The extent of PAH contamination in the shallow aquifer is summarized in the contaminant contours presented in Figure 4-1.

Benzene was detected both on- and off-site during the RIA sampling event, with the highest concentrations detected at MW-2 and MW-17. MW-2 contained 2,000 µg/L, while the sample from MW-17 contained 12,000 µg/L. The next highest concentrations were detected on site at MW-23 and MW-4 where the concentrations were 82 µg/L and 36 µg/L, respectively. MW-2 and MW-17 have traditionally had the highest concentrations of benzene. At MW-2, the concentration remained virtually unchanged from the RI dam-down sampling event, while the concentration at MW-17 nearly doubled. As with the sudden appearance of substantial amounts of naphthalene at MW-17, the benzene may also be within the leading edge of a plume of contamination.

Other concentrations of benzene were detected at approximately the same levels as in previous sampling events, with one exception. The concentration at MW-4 decreased from approximately 98 µg/L to 36 µg/L. This decrease may be the result of natural attenuation, biological action, or dilution, or it may reflect the inherent variability of the samples.

Estimated low level concentrations of benzene were detected in several of the new wells. These concentrations, combined with the direction of groundwater flow as previously discussed, indicate that the estimated concentrations are likely due to off-site sources or are background concentrations for the area. The distribution of wells and the low-level or nondetected concentrations provide a sufficient boundary around the site to define the extent of site-derived benzene contamination in groundwater. Benzene contamination contours for the shallow aquifer are shown in Figure 4-2.

The distribution of ethylbenzene, toluene, and xylenes follows the same general trends as benzene. Elevated concentrations of ethylbenzene, toluene, and xylenes were encountered in MW-2 and MW-17. Moderate concentrations of ethylbenzene and xylenes were detected at MW-23. Ethylbenzene and toluene were detected at low level, estimated concentrations in MW-14 and MW-23, respectively. In addition, xylenes were detected in MW-1, MW-3, and MW-14. The extent of these constituents, which have potentially originated from the site, is also defined by the same distribution and groundwater flow conditions that define the extent of the benzene contamination.

With respect to the metals analyses, lead was detected at elevated concentrations at MW-13 and MW-14. Moderate lead concentrations have been detected at several wells both on and off site. The remaining well locations revealed variable results ranging down to the detection limit. The concentrations at MW-13 and MW-14 were 1,060 µg/L and 2,590 µg/L, respectively. The source of the lead is unclear based on the data. However, the extent of elevated concentrations is adequately defined by the existing suite of wells.

4.4.4.2 Intermediate Zone. 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. PAHs were not detected in any of these wells during the previous RI sampling event. In each case, the detection limit for the individual PAH compounds was higher during the RI, and the concentrations detected during this sampling event would not have been detected under those conditions. PAHs have been detected in MW-8 and MW-10 during previous sampling events and, in the case of MW-8, were attributed to downward migration of dissolved concentrations. The PAHs detected at MW-22 may also be the result of downward migration. However, since MW-22 is upgradient of the site, the source of the PAHs is apparently an off-site source. Alternatively, these low concentrations may represent background concentrations at this location.

Benzene has also been previously detected at MW-8 and was again quantified in the RIA sample from that location at 130 µg/L. This concentration of benzene is the highest ever detected in this well but is less than previous concentrations detected in the shallower wells at this location (MW-3 and MW-7). This apparent downward migration may be due to leakage around the well casing. Benzene was also detected at MW-22 at an estimated concentration of 3 µg/L.

Other VOCs detected in the intermediate zone wells were limited to ethylbenzene, toluene, and xylenes in MW-8.

Metals were generally not detected in the wells in high concentrations. Iron was detected in the highest concentration of any of the metals in each of the wells.

4.4.4.3 First Transmissive Zone Below the Shale Zone. Analysis of the December 1993 groundwater samples collected from the first transmissive zone below the shale zone detected low level concentrations of PAH compounds only 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 the specific PAHs detected in the samples from MW-25 and MW-34 are only slightly greater than the detection levels and are likely background concentrations or the result of outside influences. The contamination detected in the sample from MW-25 may be the result of contamination carried down during the drilling and well construction process. The soil and shallow bedrock at that location contained visible contamination and generated a strong hydrocarbon odor when brought to the surface. However, although there is a downward vertical gradient at this location, the vertical hydraulic conductivity of the rock is very low, and the shallow aquifer is not directly connected to the first transmissive zone. Also, the overall quality of the rock improves considerably with depth. Preferential leakage along vertical fractures from the upper, contaminated aquifer is not supported by the data. If there were downward leakage in the vicinity of MW-25, the measured water levels would result in some deviation from or deflection of the potentiometric contours. In each of the water level measurements, the elevations of the water in the first transmissive zone revealed decreasing potential to the southwest. Also indicative of the lack of leakage from above is the occurrence of a steeper gradient upgradient of MW-25 rather than downgradient. If there were leakage or mounding of the groundwater in this zone, the gradient would be flatter upgradient of the mound due to the reduced change in elevation and would be steeper downgradient, away from the mound. Therefore, it is unlikely that the groundwater contamination in MW-25 is the result of downward migration.

Similarly, the PAH concentrations detected in the groundwater at MW-34 may also reflect background conditions or be the result of off-site influences. Although there is no contaminated soil at the surface for the augers to pass through, carry down of the PAH compounds detected in groundwater at MW-21 and MW-22 is possible. The presence of PAH compounds in MW-34 also does not appear to be due to leakage of groundwater from higher elevations. As with MW-25, the potentiometric surfaces do not indicate that downward leakage or mounding of groundwater is occurring. Also, the actual presence of the apparent low-level PAH contamination in the first transmissive zone is questionable based on data quality concerns noted by LDC.

To verify the results of the initial sampling effort, MW-25 and MW-34 were resampled. Prior to sampling, the wells were purged in an attempt to remove residual water which may have been contaminated during or after well installation. No PAHs were detected in either of the verification samples. Therefore, it is likely that the original samples were not truly representative of the groundwater quality and that the first transmissive zone has not been impacted by contaminants from the site.

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

The principal metals constituents detected in the first transmissive zone were calcium, magnesium, and sodium. The calcium and magnesium are likely due to dissolution of the limestone and dolomite. The sodium content is likely due to dissolution of the clay (montmorillonite/smectite) in the rock. Iron and potassium were also consistently detected in the samples. However, none of these constituents or their distributions indicate that elevated concentrations exist as a result of former site uses.

4.5 GEOCHEMICAL AND REMEDIAL PARAMETERS

The results of the geochemical and remedial parameter analyses will be briefly discussed relative to trends and consistency of the values rather than their specific application to remedial technologies, since the need for remediation and the applicability of the various types of remedial technologies will be evaluated later in a separate document.

4.5.1 Soils

The soil samples collected from SB-HH and SB-II were analyzed for basic physical and chemical parameters which are useful in determining appropriate alternatives for remedial activities. The chemical parameters consisted of pH, CEC, and TOC. The pH of the samples collected from the two borings ranged from 7.24 to 7.88. Given the general nonhomogeneous nature of the soil and fill at the site, these values are rather consistent. The CEC values for the soils analyzed, ranged from 2,200 to 5,400.

The TOC results for the soil samples revealed that the content of organic carbon at SB-II in the surface and intermediate depth intervals is nearly three times the content of organic carbon in the same general intervals at SB-HH (86,000 mg/kg and 26,000 mg/kg in the surface intervals and 150,000 mg/kg and 59,000 mg/kg in the intermediate intervals for SB-II and SB-HH, respectively). These results could indicate that the soil at SB-HH is backfill from the construction of the sanitary sewer and is not the highly contaminated soil and fill expected in that vicinity. The results also indicate that the soil at SB-II contains higher concentrations of hydrocarbon contamination than anticipated from earlier sampling events.

The physical analyses of the soil samples (percent clay and bulk density) for SB-II indicate a higher clay content at the soil/weathered bedrock interface than in the overlying soils. The clay is likely due to the decomposition of the bedrock. This indicates that at least the lower sample interval was collected from natural materials rather that fill material placed during the development of the site. The bulk and dry density results reveal that the soil at SB-HH has a lower bulk density and dry density than at SB-II. Although the samples were disturbed during sample collection, the lower densities may be the result of the excavation and backfilling of the soil near the sanitary sewer.

4.5.2 Bedrock

The chemical analysis of the bedrock samples yielded pH measurements of 8.2 to 10.5 for the samples submitted. These values are typical for limestone and dolomitic rock. CEC values for the samples ranged from 0.53 and 0.76 millequivalents per 100 grams (meq/100g) at MW-25 and MW-33, respectively to 4.74 meq/100g at MW-34. The higher CEC at MW-34 corresponds to the higher clay content of that section of core. TOC results for the rock samples ranged from 0.16 mg/kg to 0.65 mg/kg. These values are typical for carbonate rocks.

As previously mentioned, the clay content at MW-34 was approximately four times that of the MW-25 and MW-33 samples. This difference is reflected in the CEC and may be contributing to the differences in the bulk density of the three samples.

Bulk density results for the bedrock samples revealed identical results for MW-25 and MW-33 at 2.79 g/cc. The bulk density of MW-34 was slightly lower at 2.54 g/cc. This is likely due to the increased porosity noted in the geophysical logs as well as the higher clay content.

4.5.3 Groundwater

In addition to the general stabilization parameters, the remedial parameters for the groundwater included TOC, oxidation-reduction (redox) potential (Eh), TDS, and total cations/anions. Organic carbon was detected in each of the samples submitted for analysis, with concentrations ranging from 1.1 mg/L at MW-6 to 49 mg/L at MW-2. The TOC measurements for the groundwater did not reveal a consistent trend of higher TOC at wells with elevated PAH concentrations as may have been expected. Although MW-2 had the highest TOC and total PAH results, the well with the next highest total PAH and the highest VOC concentration, MW-17, had a lower TOC result than MW-18, which did not contain any detectable concentrations of PAHs or VOCs. Therefore, TOC analysis is not clearly indicative of PAH or VOC contamination and should be viewed with caution.

The Eh readings were taken throughout each well purging event. The final reading, which was taken immediately prior to sample collection, was recorded as the basis for this evaluation. A review of the readings does not indicate a trend of numerical values. However, all of the wells yielded negative Eh readings (reducing conditions) with the exception of MW-5 and MW-6. The Eh readings in MW-14 were initially greater than zero, but upon purging of the well, the Eh reading dropped below zero. The water extracted from all three of these wells was rust colored at the beginning of the purging process, indicating an oxidizing environment in the vicinity of those wells.

TDS was measured in samples collected from each of the wells proposed in Tech Memo 7, with the exception of MW-32, where a lack of available water prevented the sample from being collected. The highest concentration was measured in MW-6 at 1,100 mg/L. The lowest concentration was in MW-31 at 410 mg/L. The remaining TDS analyses resulted in similar concentrations in each of the wells, between 560 mg/L and 690 mg/L, regardless of the zone the well was screened in. The water in MW-6 was an opaque rust color throughout most of the purge. The water became more translucent near the end of the purge but remained rust colored for the sample collection. It is likely that the color and high TDS was due to iron oxides in the water. Water purged from the other wells was visually clear to slightly cloudy.

In response to EPA's request, analysis for major cations and anions was performed on selected groundwater samples from the shallow, intermediate, and first transmissive zones. The results of these analyses are summarized in Table 2-9. A review of these results did not indicate distinctive trends in the concentrations of cations or anions with respect to the screened interval of the wells or the areas of identified contamination. The information gathered may, however, be useful if remedial alternatives for groundwater are being considered.

4.6 FATE AND TRANSPORT OF CONTAMINANTS

In consideration of the newly acquired data, it was prudent to reevaluate the fate and transport scenarios at the site and the conceptual model presented in the RI Report. No new observations or information were gathered during the RIA that would indicate there were any other contaminants of concern at the site. In addition, the negotiated analytical parameters approved in Tech Memo 7 adequately provide the additional information necessary. Therefore, the information presented in the RI Report regarding the physical and chemical characteristics and the potential routes of exposure accurately represent the shallow subsurface conditions at the site.

The additional information regarding the first transmissive zone, groundwater flow directions north of Willow Creek, contaminant distribution, and evidence of off-site sources of contamination prompted some revisions to the conceptual model. The revised conceptual model is presented in Figure 4-3. This model was revised to reflect the contaminants of concern negotiated for the RIA analytical work for the existing monitoring wells and include 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 as probable or potential.

Potential sources identified in the original model remained the same. In addition, a category identified as "off-site sources" was added due to the elevated concentration of PAHs detected at MW-28 (north of Willow Creek and topographically higher than the site). This category encompasses the possibility of other, unidentified contaminant sources potentially releasing contaminants to surface or groundwater upgradient of the site. Based on the shallow groundwater contours, off-site sources north of Willow Creek may be impacting the area around MW-17 as well as potential migration from the site. Off-site sources upstream of the site may also contribute to surface water and sediment contamination via Willow Creek.

SECTION 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the major conclusions reached from the data gathered during the RIA and the previous RI at the Mason City FMGP site. Recommendations for continuing the RI and/or feasibility study (FS) process are also included in this section.

5.1 CONCLUSIONS

The primary purpose in pursuing the additional investigation activities of this RIA was to fill gaps in the site characterization data which precluded a complete evaluation of the site. These gaps principally concerned the horizontal extent of contamination west and north of the site and the vertical extent of groundwater contamination under the site. Additional information was also needed to further evaluate the hydraulic conditions north of Willow Creek and below the shale zone underlying the site. Other data collection activities were intended to provide a foundation for remedial action feasibility and treatability studies. These activities consisted of data collection to support future evaluations of contaminant migration, attenuation, and, in the case of groundwater, treatability. The data gathered in the RIA effort fulfilled the goals of the investigation and provided enough information to conclude the investigation and characterization of the site. A summary of the specific conclusions drawn from the information available is presented in the following sections.

5.1.1 Site Characteristics

5.1.1.1 Soil and Fill. Soil samples collected from the soil boring and monitoring well locations verified the type of soil and fill material distributed on and around the site. Most of the lower elevations adjacent to Willow Creek contained 9 to 14 feet of unconsolidated sands, silts, and gravels. Large amounts of fill material were also encountered in the borings. The fill material consisted of bricks and brick fragments, rock, concrete fragments, cinders, and wood. The type of soil and fill encountered is consistent with the findings of the previous investigations.

5.1.1.2 Bedrock. Core samples collected during the rock coring program provided additional information regarding the type and quality of the bedrock, particularly below the shale zone. The general rock type is a dolomitic limestone of the upper portion of the Cedar Valley Formation. Bedding planes of the cores indicate that the rock dips to the west at approximately 1 degree. The competency of the rock increased dramatically below the shale zone, showing a significant reduction in the number of fractures. As a result, many of the individual 5 foot core runs exhibited an RQD of 100 percent. Only one naturally occurring vertical fracture was encountered in the cores. The top of the fracture terminated in the core and did not completely cross the core.

Vertical permeability tests on competent core samples collected from within and immediately below the shale zone generated hydraulic conductivities of 10^{-11} cm/sec. The competency of the rock and the notable lack of fractures, particularly vertical fractures, demonstrate that the rock between the shale zone and the first transmissive zone provides an effective barrier to downward migration of free phase contamination and contaminated groundwater.

5.1.1.3 Hydrogeology. Water level data from the monitoring wells at the site with the Willow Creek dam in the down position has continually shown that the direction of shallow groundwater flow across the site is generally to the northeast, with flow diverging around and under the concrete retaining wall. The northeasterly flow direction across the site was confirmed again during these investigative efforts. Additional water level information from the newly installed wells on the uplands north of Willow Creek revealed that shallow groundwater north of the creek is flowing toward the creek valley. In the vicinity of the site, shallow groundwater from the north and south of Willow Creek converges at or immediately north of Willow Creek and proceeds to the east-northeast.

Water level data gathered during the RIA investigation with the dam in the up position demonstrated that water from Willow Creek enters the shallow groundwater system upstream of the retaining walls and flows around the dam. South of Willow Creek, groundwater flows across the site in an arc from west to east, reentering Willow Creek downstream of the dam. Groundwater entering the site from the south merges with the flow entering from the west and leaves the site to the east. North of Willow Creek, groundwater flows parallel to the retaining wall and likely continues on an east/northeasterly course downstream of the dam along the Willow Creek channel. These flow patterns are consistent with the findings of the RI.

Observation of the rock cores, geophysical logs, and packer testing results were used to identify the first transmissive zone below the shale zone. This zone is characterized by a visual increase in the porosity and a significant increase in the production of groundwater during the packer testing. Sections of the first transmissive zone produced water at up to 19 gallons per minute, while sections of the rock above and below this zone typically produced little or no water during the tests. Initial water production during the packer tests ranged from 3 to 19 gallons per minute. The ability of the screened zone to produce water (as opposed to the overlying rock) and the continuity of the potentiometric surface indicate that this zone is continuous across the site and represents the first transmissive zone of bedrock below the shale zone.

Water level elevations in the wells screened in the first transmissive zone consistently showed that groundwater in that zone flows to the southwest. The relatively uniform gradient and lack of apparent groundwater mounding in the vicinity of MW-25, combined with the competency and hydraulic conductivity of the overlying rock, indicates that there is no significant leakage of groundwater into the first transmissive zone beneath the site.

5.1.2 Nature and Extent of Contamination

In order to evaluate the extent of contamination at the site, the results of laboratory analyses for all locations on and around the site as well as the physical characteristics of the site were reviewed. In addition, the sampled intervals were evaluated with respect to transport mechanisms necessary for the contaminants detected to migrate to the sampling location from the FMGP site. Contaminants at locations which lacked a viable migration pathway were determined to be indicative of local background conditions or due to an off-site source not related to the FMGP site.

5.1.2.1 Soil Contamination. Soil samples were collected from soil boring and monitoring well locations west of the site and north of Willow Creek and submitted for laboratory analysis for the constituents noted in Tech Memo 7. The results of the soil sample analyses revealed that PAH compounds were present at all sampling locations, with total PAHs ranging from 4.2 µg/kg to 85.0 µg/kg. The results also revealed that PAH contamination exists in significant concentrations at off-site locations and sample intervals which are topographically higher than the ground surface of the FMGP site. Soil samples collected from MW-27, MW-28, and MW-32 each contained PAH concentrations from sampling intervals which are topographically higher than, and hydraulically upgradient of, the site. The direction of groundwater flow, and the fact that these samples were collected from an elevation higher than the ground surface of the FMGP site, suggests that these PAH compounds are indicative of background concentrations or the result of an unidentified off-site source, but have not migrated from the FMGP site. Evaluation of the groundwater flow patterns with the dam in the raised position will provide additional information regarding the potential for contaminant migration from the site.

The extent of soil contamination west of the site was evaluated by the boring and monitoring well locations placed west of South Delaware Avenue. PAHs in soil samples collected from SB-FF and SB-GG were detected at concentrations less than those detected in MW-27 and MW-28, and at concentrations within the range of background concentrations identified in the RI Report. Elevated concentrations of lead were detected in the soil at SB-GG. Since SB-GG is located within the foundation of the former power plant, and the material present at this location did not consist of native soils, the source of this contamination is not clear. However, since lead is a contaminant associated with FMGP wastes, this contamination may be related to the site. These results indicate that the soil west of Delaware Avenue, with the exception of the area around SB-GG and MW-13, has not been impacted by activities at the FMGP site.

Soil sampling from well locations northeast and south of the site was not conducted, since the additional wells in these directions were adjacent to existing wells where samples had previously been collected.

Soil samples collected from the off-site RIA sampling locations did contain evidence of PAH contamination, but no viable mechanism exists for migration or transport of these compounds from the FMGP site to the sample locations. Therefore, the extent of site-derived soil contamination appears to be limited to the central portion of the site and the northwest corner of the site, extending under South Delaware Avenue toward MW-13, as identified in the RI Report.

5.1.2.2 Former Transformer Yard. Soil samples collected from the former transformer yard area in the southeast corner of the site did not contain any detectable concentrations of PCBs. Low level concentrations of benzene were detected in one sample. However, this sample was collected from the unsaturated zone and, therefore, is not a product of migration from one of the suspected source areas on the site. Based on the previous use of this area and the results of the analysis, no additional characterization of this area is warranted.

5.1.2.3 Bedrock Contamination. Visual bedrock contamination was observed only in the rock core collected from MW-25. The vertical extent of this contamination was observed to a depth of approximately 29 feet below the ground surface but did not enter or penetrate the shale zone. The remainder of the rock cores did not show any indications of visible contamination. Therefore, the extent of bedrock contamination is as described in the RI Report.

5.1.2.4 Groundwater Contamination. Groundwater samples were collected from each of the monitoring wells associated with the site, except MW-16 and MW-29, which were dry at the time of the RIA sampling. The samples were submitted for laboratory analysis for the contaminants of concern identified in Tech Memo 7.

The distribution of PAH and VOC compounds support the conclusion of the RI that two principal source areas exist on the site: the northwest corner and the central portion of the site. Shallow groundwater is impacted by these sources, and migration of the contaminants is to the northeast from both source areas. The extent of the shallow groundwater contamination from the source in the northwest corner of the site is defined by the wells north of Willow Creek. At MW-17, the presence of benzene and naphthalene, two of the more mobile contaminants of concern, indicates that the plume has reached this location. Based on the potentiometric contours, the flow of groundwater at MW-17 would be to the east, toward MW-19. The results of the analysis of the sample collected from MW-19 revealed low levels of naphthalene but no benzene, indicating that if the contaminants originating from the site have migrated past MW-17, the leading edge of the plume may now just be arriving at MW-19. However, as discussed in the RI Report, the source of PAH compounds downstream of the dam is questionable due to the presence of the storm sewer outlet on the south side of Willow Creek. Therefore, the PAHs detected at MW-19 may not have originated from the FMGP site. The northern extent of potentially site-derived contamination is defined by MW-32. The results of the samples collected from MW-32 did not contain either naphthalene or benzene but did contain other, less mobile constituents. Combined with the southerly direction of shallow groundwater flow at MW-32 and the lack of similar contaminants, the water at MW-32 is not being impacted by the FMGP site.

Contaminants originating from the central portion of the site appear to be migrating across the site to the northeast. Continued migration to the northeast would allow the contaminants to be detected at MW-19 which, as discussed previously, contained only low level concentrations of PAH compounds from an unidentifiable source. Therefore, the horizontal extent of this contamination is also defined.

Other shallow groundwater contamination was detected west and north of the site at MW-27 and MW-28. As indicated by the potentiometric contours, shallow groundwater flow at MW-28 is toward Willow Creek and the FMGP site. Similarly, the direction of groundwater flow at MW-27 is toward Willow Creek, or cross-gradient to the site. Therefore, the migration of the contaminants to these sampling locations is not possible via groundwater under dam down conditions. With the dam in the up position, groundwater flow between MW-27 and Willow Creek is reversed, but the location of MW-27 remains cross-gradient to the site. North of Willow Creek, water flows toward MW-28 from both the northeast and southwest (Willow Creek) when the dam is raised. Resampling of MW-28 with the dam in the up position revealed lower PAH concentrations than when the well was sampled with the dam in the down position. This indicates that the influx of water from Willow Creek dilutes the contamination in the well and does not promote migration of contaminants from the site to MW-28. As previously discussed, contaminated soils were detected at MW-27 and MW-28 at elevations higher than the ground surface of the FMGP site. Reviewing groundwater flow directions and elevations as well as potential flood stage elevations indicates that the contaminants in the soil could not have migrated to these locations from the site. The presence of contaminants in the soil at these locations may be providing a source for localized groundwater contamination through infiltration of groundwater.

The vertical extent of contamination is defined by laboratory analysis of samples from the intermediate and first transmissive zones. Analysis of these samples indicated the presence of low-level PAH concentrations in the intermediate zone at MW-8, MW-10, and MW-22. In the first transmissive zone, PAHs were detected in MW-25 and MW-34. However, due to a reporting error by the laboratory, benzo(a)pyrene was not actually present in MW-25 as reported. And acenaphthene is J-flagged due to violation of QC indicators, which potentially caused the concentration to be reported unrealistically high. Given the continuity of the potentiometric surface and the competency of the bedrock as previously discussed, the low concentration of acenaphthene at MW-25 is likely due to minor contaminant carry-down during drilling and construction of the well rather than actual contamination. High recovery of matrix spike data for MW-34 resulted in a violation of the QA criteria. This violation jeopardizes the accuracy of the concentration reported. To resolve these data quality issues and to verify the presence or absence of the PAHs in MW-25 and MW-34, both wells were purged and resampled. No PAHs were detected in either of the verification samples. These results support the previous conclusion that the original samples were not truly representative of groundwater conditions in the first transmissive zone below the shale zone.

5.1.3 Data Limitations

The evaluations and conclusions presented within this report must be weighed along with the inherent data limitations present in an investigation of this complexity and magnitude. Temporal, economic, and practical considerations influence the conduct of site investigation activities. Factors such as using single sets of data to characterize nonhomogeneous materials and distributions of materials, sample quality control indicators not meeting the stated criteria, lack of definitive historical records, and other items must be considered.

Specific analytical limitations were discussed in detail in Section 3 of this report and in Appendices L and M. All of the data collected during the RIA was considered usable based on the approved quality assurance and quality control procedures.

5.2 RECOMMENDATIONS

Based on the additional data collected during this investigation, the characterization of the site and evaluation of the extent of site-derived contamination have been substantially completed. Therefore, it is recommended that the project move from the investigation phase into a determination of appropriate remedial or corrective actions consistent with the existing Consent Order. Site-specific remediation goals for soil and groundwater should be established for the major contaminants of concern which will be protective of human health and the environment. A feasibility study should also be completed to evaluate applicable remedial technologies.

TABLES

TABLE 2-7

MONITORING WELL SPECIFICATIONS

Location	Total Boring Depth (ft)	Total Depth of Well Below Surface (ft)	Surface Elevation (ft NGVD)	TOC Elevation (ft NGVD)	Screened Interval (ft NGVD)	Filter Pack Interval (ft NGVD)	Bentonite Seal Interval (ft NGVD)
MW-1	15.25	14.9	1,108.5	1,111.32	1,098.8-1,093.8	1,101.7-1,093.5	1,103.7-1,101.7
MW-2	16.0	15.5	1,107.6	1,110.57	1,097.3-1,092.3	1,102.2-1,092.8	1,103.5-1,102.2
MW-3	13.8	12.0	1,106.5	1,109.65	1,099.7-1,094.7	1,101.5-1,093.6	1,102.5-1,101.5
MW-4	14.5	14.0	1,106.8	1,109.74	1,098.0-1,093.0	1,100.5-1,092.5	1,102.0-1,100.5
MW-5	20.5	20.0	1,111.9	1,114.83	1,096.9-1,091.9	1,098.4-1,091.9	1,101.9-1,098.4
MW-6	17.5	17.5	1,110.1	1,111.87	1,097.6-1,092.6	1,099.1-1,092.6	1,101.1-1,099.1
MW-7	24.25	24.25	1,106.8	1,108.13	1,089.8-1,082.6	(Open Hole In Bedrock)	-
MW-8	35.0	35.0	1,106.6	1,109.22	1,076.6-1,071.6	1,078.6-1,071.6	1,089.6-1,078.6
MW-9	25.0	25.0	1,106.8	1,109.08	1,086.8-1,081.1	1,088.8-1,081.1	1,093.8-1,088.8
MW-10	37.0	36.0	1,106.8	1,110.26	1,075.9-1,070.9	1,077.9-1,069.9	1,085.9-1,077.9
MW-11	11.5	11.5	1,097.9	1,100.24	1,088.9-1,086.4	(Open Hole In Bedrock)	-
MW-12	19.2	19.2	1,097.6	1,100.32	1,081.9-1,078.4	(Open Hole In Bedrock)	-
MW-13	18.5	18.0	1,110.4	1,110.48	1,102.4-1,092.9	1,103.4-1,091.9	1,106.4-1,103.4
MW-14	16.0	16.0	1,110.5	1,110.15	1,104.5-1,094.5	1,105.5-1,093.5	1,106.5-1,105.5
MW-15	16.8	16.8	1,107.6	1,106.67	1,100.9-1,090.9	1,101.4-1,090.9	1,102.9-1,101.4
MW-16	10.5	10.5	1,107.6	1,107.05	1,101.2-1,096.2	1,102.6-1,096.2	1,103.6-1,102.6
MW-17	25.5	24.5	1,108.0	1,107.46	1,089.0-1,084.0	1,090.0-1,083.0	1,093.0-1,090.0
MW-18	37.5	37.5	1,108.1	1,107.91	1,076.1-1,071.1	1,077.1-1,070.6	1,086.1-1,077.1
MW-19	14.0	14.0	1,101.6	1,101.34	1,092.6-1,087.6	1,093.6-1,086.6	1,096.1-1,093.6
MW-20	39.5	39.2	1,122.7	1,122.34	1,088.5-1,083.5	1,096.7-1,083.2	1,095.7-1,096.7
MW-21	41.0	41.0	1,116.6	1,116.00	1,080.3-1,075.3	1,082.3-1,075.3	1,887.3-1,082.3
MW-22	54.0	54.0	1,116.7	1,116.65	1,067.7-1,062.7	1,069.2-1,062.7	1,073.7-1,069.2
MW-23	25.0	24.5	1,108.1	1,111.09	1,094.6-1,084.6	1,097.1-1,084.1	1,099.1-1,097.1
MW-24	14.5	14.5	1,109.2	1,111.16	1,099.7-1,094.7	1,100.7-1,094.7	1,105.2-1,100.7
MW-25	101.5	71.0	1,107.1	1,106.86	1,047.1-1,037.1	1,048.6-1,036.1	1,052.1-1,048.1
MW-26	18.0	18.0	1,108.9	1,108.74	1,100.9-1,090.9	1,102.9-1,100.9	1,104.9-1,102.9
MW-27	22.0	22.0	1,113.1	1,112.95	1,101.1-1,091.1	1,102.1-1,091.1	1,109.1-1,102.1
MW-28	37.3	37.3	1,121.5	1,121.32	1,089.2-1,084.2	1,091.5-1,084.2	1,093.5-1,091.5
MW-29	21.0	21.0	1,127.8	1,127.47	1,118.1-1,106.8	1,119.9-1,106.8	1,126.8-1,119.9
MW-30	42.0	42.0	1,127.6	1,127.37	1,090.6-1,085.5	1,092.6-1,085.6	1,095.1-1,092.6

TABLE 2-7 (CONTINUED)

MONITORING WELL SPECIFICATIONS

Location	Total Boring Depth (ft)	Total Depth of Well Below Surface (ft)	Surface Elevation (ft NGVD)	TOC Elevation (ft NGVD)	Screened Interval (ft NGVD)	Filter Pack Interval (ft NGVD)	Bentonite Seal Interval (ft NGVD)
MW-31	96.5	90.0	1,127.9	1,127.66	1,047.9-1,037.9	1,049.8-1,037.3	1,052.9-1,049.8
MW-32	45.0	45.0	1,128.7	1,128.51	1,088.7-1,083.7	1,091.2-1,083.7	1,093.7-1,091.2
MW-33	77.0	58.0	1,101.4	1,101.19	1,053.4-1,043.4	1,055.5-1,042.4	1,058.7-1,055.5
MW-34	84.5	78.0	1,117.5	1,117.20	1,049.5-1,039.5	1,051.4-1,038.2	1,055.5-1,051.4
MW-35	87.5	79.0	1,108.8	1,108.66	1,039.9-1,029.9	1,041.6-1,028.8	1,045.0-1,041.6

<u>Note</u>: MW-6 TOC elevation has been corrected to reflect a previous survey error.

NGVD = National Geodetic Vertical Datum
TOC = Top of Casing

TABLE 2-8

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-1 12-15-93	MW-2 12-16-93	MW-3 12-16-93	MW-4 12-15-93	MW-5 12-15-93	MW-6 12-17-93	MW-7 12-17-93	MW-8 12-16-93	MW-8/DP 12-16-93	MW-9 12-16-93
VOCs (µg/L)										
Acetone	-	-	-	-	-	-	-	-	-	-
Acrolein	-	-	-	-	-	-	-	-	-	-
Acrylonitrile	-	-	-	-	-	-	-	-	-	-
Benzene	7 J	2,000 J	5 J	36	10 U	10 U	27	130	74	92
Bromomethane	-	-	-	-	-	-	-	-	-	-
Bromodichloromethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bromoform	-	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-
Chloromethane	-	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	-	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	-	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	10 U	220 J	10 U	10 U	10 U	10 U	82	10 U	42	6 J
2-Hexanone	-	-	-	-	-	-	-	-	-	-
Hexanone	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	-	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-
Tetrachloroethane	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-	-
Toluene	10 U	100 J	10 U	10 U	10 U	10 U	10	3 J	3 J	10 U
1,1,1-Trichloroethane	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	-	-	-	-	-	-	-	-	-	-
Trichloroethene	-	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	-	-	-	-	-	-	-	-	-	-
Xylenes, Total	2 JY	370 JY	3 JY	10 U	10 U	10 U	71 Y	10 U	52 Y	6 J
PAHs (µg/L)										
Acenaphthene	0.269 U	582 EJ	0.322 U	1.47 U	0.284 U	0.376 U	0.271 U	0.28 U	0.275 U	156
Acenaphthylene	40.1	1,360 EJ	12.5	38.9	32.8	0.302 U	3.24	0.221 U	0.221 U	117
Anthracene	0.646	295 EJ	6.25	0.172	1.62	0.058	1.11	0.124	0.039	1.75
Benzo(a)anthracene	0.027	345 EJ	2.03	0.026 U	0.262	0.034 U	3.99	0.026 U	0.025 U	0.525
Benzo(a)pyrene	0.015 U	223 EJ	1.69	0.017 U	0.053	0.019 U	6.1	0.024 U	0.016 U	0.071
Benzo(b)fluoranthene	0.048 U	104	0.924	0.052 U	0.051 U	0.061 U	2.12	0.05 U	0.049 U	0.049 U
Benzo(g,h,i)perylene	0.048 U	144 U	2.14	0.052 U	0.051 U	0.067 U	1.31	0.041 U	0.04 U	0.04 U
Benzo(k)fluoranthene	0.025 U	57.5	0.962	0.027 U	0.026 U	0.032 U	1.53	0.026 U	0.025 U	0.027

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-1 12-15-93	MW-2 12-16-93	MW-3 12-16-93	MW-4 12-15-93	MW-5 12-15-93	MW-6 12-17-93	MW-7 12-17-93	MW-8 12-16-93	MW-8/DP 12-16-93	MW-9 12-16-93
PAHs (µg/L) (continued)										
Chrysene	0.024 U	277 EJ	2.48	0.026 U	0.151	0.03 U	4.17	0.025 U	0.025 U	0.264
Dibenz(a,h)anthracene	0.048 U	182 U	0.734	0.052 U	0.051 U	0.067 U	0.967	0.052 U	0.051 U	0.051 U
Fluoranthene	0.848	398 EJ	6.2	0.118	0.87	0.087 U	4.36	0.092	0.075	4.08
Fluorene	0.053 U	675 EJ	13.4	4.95	0.056 U	0.074 U	0.995	0.062	0.055	23
Indeno(1,2,3-cd)pyrene	0.024 U	112 U	1.26	0.026 U	0.025 U	0.034 U	1.9	0.032 U	0.031 U	0.031 U
Naphthalene	0.229 U	2,940 EJ	6.95	38	9.58	0.319 U	0.23 U	0.238 U	0.233 U	11.6 U
Phenanthrene	0.040	1,050 EJ	8.49	2.01	0.365	0.208	0.817	0.165	0.090	20.5
Pyrene	0.93	954 EJ	9.95	0.142	1.21	0.034 U	5.69	0.123	0.088	5.24
Total Carcinogenic PAHs	0.027	1,007	10.08	0	0.466	0	20.78	0	0	0.89
Total PAHs	42.6	9,261	75.96	84	46.91	0.266	38	0.566	0.347	328.46
Acid Extractables (µg/L)										
2,4,5-Trichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4,6-Trichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-	-
2,4-Dinitrophenol	-	-	-	-	-	-	-	-	-	-
2-Chlorophenol	-	-	-	-	-	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-	-	-	-	-
2-Nitrophenol	-	-	-	-	-	-	-	-	-	-
4,6-Dinitro-2-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Chloro-3-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Nitrophenol	-	-	-	-	-	-	-	-	-	-
Benzoic Acid	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-
Metals (µg/L)										
Arsenic	2.5 B	7.4 B	2.3 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.5 B
Chromium, Total	12.1	22.4	4.6 B	4.0 U	18.1	21.3	4.0 U	4.0 U	4.0 U	14
Copper	18.9 B	35.2	4.8 B	4.7 B	13.0 B	4.2 B	4.0 U	4.0 U	4.0 U	5.9 B
Iron	137,000 N	61,100 NJ	24,800 N	8,770 N	65,800 N	14,900	1,540	15,200 N	18,700 N	31,800 N
Lead	86.9 N	69.0	20.2	3.5 N	188 N	16.5 N	2.0 U	2.0 U	2.0 U	2.0 U
Magnesium	46,600	-	22,200	26,300	34,000	29,200	-	-	-	26,900
Manganese	3,140	-	269	830	1,270	149	-	-	-	585
Nickel	29.7 B	61.4	37.9 B	15.0 U	24.6 B	37.6 B	15.0 U	15.0 U	15.0 U	15.0 U
Zinc	660	784	82.3	5.0 U	2,060	631	13.4 B	9.5 B	7.5 B	14 B
Cyanides (µg/L)										
Cyanide, Total	-	-	-	-	-	-	-	-	-	-

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-10 12-16-93	MW-13 12-16-93	MW-14 12-17-93	MW-15 12-17-93	MW-17 12-17-93	MW-18 12-16-93	MW-19 12-15-93	MW-20 12-15-93	MW-21 12-15-93	MW-22 12-17-93
VOCs (ug/L)										
Acetone	-	-	-	-	-	-	10 U	-	-	-
Acrolein	-	-	-	-	-	-	10 U	-	-	-
Acrylonitrile	-	-	-	-	-	-	10 U	-	-	-
Benzene	10 UJ	1 J	8 J	10 U	12,000	10 U	10 U	10 U	2 J	3 J
Bromomethane	-	-	-	-	-	-	10 U	-	-	-
Bromodichloromethane	10 U	10 U	10 U	10 U	500 U	10 U	10 U	10 U	10 U	10 J
Bromoform	-	-	-	-	-	-	10 U	-	-	-
2-Butanone	-	-	-	-	-	-	10 U	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	-	-	-	-	-	-	10 U	-	-	-
Chlorobenzene	-	-	-	-	-	-	10 U	-	-	-
Chloroethane	-	-	-	-	-	-	10 U	-	-	-
Chloromethane	-	-	-	-	-	-	10 U	-	-	-
Chloroform	-	-	-	-	-	-	10 U	-	-	-
1,1-Dichloroethane	-	-	-	-	-	-	10 U	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	10 U	-	-	-
1,1-Dichloroethene	-	-	-	-	-	-	10 U	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	-	-	10 U	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	10 U	-	-	-
1,2-Dichloropropane	-	-	-	-	-	-	10 U	-	-	-
cis-1,3-Dichloropropene	-	-	-	-	-	-	10 U	-	-	-
trans-1,3-Dichloropropene	-	-	-	-	-	-	10 U	-	-	-
Dibromochloromethane	-	-	-	-	-	-	10 U	-	-	-
Ethylbenzene	10 U	10 U	4 J	1 J	420 J	10 U	10 U	10 U	10 U	10 U
2-Hexanone	-	-	-	-	-	-	10 U	-	-	-
Hexanone	-	-	-	-	-	-	10 U	-	-	-
Methylene Chloride	-	-	-	-	-	-	10 U	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-
Tetrachloroethane	-	-	-	-	-	-	10 U	-	-	-
Tetrachloroethene	-	-	-	-	-	-	10 U	-	-	-
Toluene	10 UJ	10 U	10 U	10 U	6,000	10 U	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane	-	-	-	-	-	-	10 U	-	-	-
1,1,2-Trichloroethane	-	-	-	-	-	-	10 U	-	-	-
Trichloroethene	-	-	-	-	-	-	10 U	-	-	-
Trichlorofluoromethane	-	-	-	-	-	-	10 U	-	-	-
Vinyl Chloride	-	-	-	-	-	-	10 U	-	-	-
Xylenes, Total	10 U	10 U	18 Y	10 U	1,000 Y	10 U	10 U	10 U	10 U	10 U
PAHs (ug/L)										
Acenaphthene	0.271 U	9.37	3.08 U	0.331 U	33.1 U	0.301 U	0.297 U	0.280 U	0.294 U	0.342 U
Acenaphthylene	0.217 U	5.32	75.2	0.266 U	26.6 U	0.242 U	0.239 U	0.225 U	0.236 U	0.275 U
Anthracene	0.018 U	5.28	9.68	0.186	25.1	0.02 U	0.02 U	0.019 U	0.02 U	0.023 U
Benzo(a)anthracene	0.025 U	18.2	5.49	0.506	31.4	0.028 U	0.026 U	0.025 U	0.042	0.032 U
Benzo(a)pyrene	0.015 U	20.5	4.68	0.879	21.2	0.017 U	0.020	0.016 U	0.017 U	0.02 U
Benzo(b)fluoranthene	0.048 U	16.4	2.02	0.307	7.77	0.054 U	0.053 U	0.050 U	0.052 U	0.061 U
Benzo(g,h,i)perylene	0.04 U	20.9	0.79	0.097 U	4.85 U	0.044 U	0.053 U	0.05 U	0.052 U	0.05 U
Benzo(k)fluoranthene	0.025 U	8.25	1.19	0.223	6.92	0.028 U	0.028 U	0.026 U	0.027 U	0.032 U

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-10 12-16-93	MW-13 12-16-93	MW-14 12-17-93	MW-15 12-17-93	MW-17 12-17-93	MW-18 12-16-93	MW-19 12-15-93	MW-20 12-15-93	MW-21 12-15-93	MW-22 12-17-93
PAHs (ug/L) (continued)										
Chrysene	0.024 U	20.8	3.73	0.569	25.2	0.287 U	0.034	0.025 U	0.026 U	0.031 U
Dibenz(a,h)anthracene	0.05 U	1.23 U	0.987	0.123 U	6.15 U	0.056 U	0.053 U	0.05 U	0.052 U	0.064 U
Fluoranthene	0.069 U	39.8	13.2	0.548	27.6	0.076 U	0.075 U	0.071 U	0.074 U	0.176
Fluorene	0.053 U	3.77	6.26	0.149	65	0.059 U	0.058 U	0.055 U	0.058 U	0.067 U
Indeno(1,2,3-cd)pyrene	0.031 U	15.3	1.83	0.269	5.99	0.034 U	0.026 U	0.025 U	0.026 U	0.039 U
Naphthalene	0.23 U	5.63 U	2.62 U	0.282 U	1,190	0.256 U	0.495	0.238 U	1.73	0.291 U
Phenanthrene	0.032	18.7	20.6	0.172	75	0.027 U	0.076	0.025 U	0.125	0.043
Pyrene	0.05 U	45.6	13	1.1	48.1	0.056 U	0.068	0.025 U	0.026 U	0.064 U
Total Carcinogenic PAHs	0	99.45	19.93	2.75	98.48	0	0.054	0	0.042	0
Total PAHs	0.032	248.19	158.66	4.91	1,329.28	0	0.693	0	1.90	0.219
Acid Extractables (ug/L)										
2,4,5-Trichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4,6-Trichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-	-
2,4-Dinitrophenol	-	-	-	-	-	-	-	-	-	-
2-Chlorophenol	-	-	-	-	-	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-	-	-	-	-
2-Nitrophenol	-	-	-	-	-	-	-	-	-	-
4,6-Dinitro-2-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Chloro-3-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-	-	-
4-Nitrophenol	-	-	-	-	-	-	-	-	-	-
Benzoic Acid	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-
Metals (ug/L)										
Arsenic	2.0 U	4.7 B	2.0 U	7.3 B	3.8 B	2.4 B	6.2 B	2.0 U	2.0 U	2.0 U
Chromium, Total	5.1 B	66.3	42.7	44.4	25.8	8.1 B	38.2	20.0	31.9	36.6
Copper	4.0 U	164	83.7	55.9	47.1	21.6 B	56.8	22.1 B	25.8	144
Iron	2,250 NJ	98,600 N	225,000	41,900	17,300	4,820 NJ	44,300 N	24,700 N	50,600 N	16,300
Lead	2.0 U	1,060	2,590 N	82.7 N	6.6 N	18.0	33.7 N	2.2 NB	4.7 N	9.9 N
Magnesium	-	-	-	-	-	-	126,000	47,000	26,000	-
Manganese	-	-	-	-	-	-	1,140	687	246	-
Nickel	15.0 U	47.9	85.4	58.7	41.7	15.0 U	73.7	16.4 B	23.0 B	40.8
Zinc	5.0 U	3,030	8,790	282	50.1	22.3 J	42.2	23.7	52.7	52.6
Cyanides (ug/L)										
Cyanide, Total	-	-	-	-	-	-	-	-	-	-

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-23 12-17-93	MW-23/DP 12-17-93	MW-24 12-15-93	MW-25 12-14-93	MW-25 08-11-94	MW-26 12-15-93	MW-27 12-15-93	MW-28 12-16-93	MW-28 08-11-94	MW-30 12-14-93
VOCs (ug/L)										
Acetone	-	-	-	10 UJ	-	10 U	10 U	10 U	-	12
Acrolein	-	-	-	-	-	-	-	-	-	-
Acrylonitrile	-	-	-	-	-	-	-	-	-	-
Benzene	82	-	2 J	10 U	-	1 J	10 U	2 J	-	4 J
Bromomethane	-	-	-	10 UJ	-	10 U	10 U	10 U	-	10 U
Bromodichloromethane	10 U	-	10 J	10 U	-	10 U	10 U	10 U	-	10 U
Bromoform	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2-Butanone	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Carbon Disulfide	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Carbon Tetrachloride	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Chlorobenzene	-	-	-	10 U	-	10 U	10 U	10 UJ	-	10 U
Chloroethane	-	-	-	10 UJ	-	10 U	10 U	10 U	-	10 U
Chloromethane	-	-	-	10 U	-	10 U	10 U	10 UJ	-	10 U
Chloroform	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
1,1-Dichloroethane	-	-	-	10 U	-	10 U	10 U	10 UJ	-	10 U
1,2-Dichloroethane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
1,1-Dichloroethene	-	-	-	10 UJ	-	10 U	10 U	10 U	-	10 U
cis-1,2-Dichloroethene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
trans-1,2-Dichloroethene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
1,2-Dichloropropane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
cis-1,3-Dichloropropene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
trans-1,3-Dichloropropene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Dibromochloromethane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Ethylbenzene	45	-	10 U	10 U	-	10 U	10 U	10 U	-	10 U
2-Hexanone	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Hexanone	-	-	-	10 U	-	-	-	-	-	-
Methylene Chloride	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
4-Methyl-2-Pentanone	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Styrene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Tetrachloroethane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Tetrachloroethene	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Toluene	3 J	-	10 U	10 UJ	-	10 U	10 U	10 UJ	-	1 J
1,1,1-Trichloroethane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
1,1,2-Trichloroethane	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Trichloroethene	-	-	-	10 U	-	10 U	10 U	10 UJ	-	10 U
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Xylenes, Total	55 Y	-	10 U	10 U	-	10 U	10 U	10 U	-	10 U
PAHs (ug/L)										
Acenaphthene	770	518	1.47 U	1.38 JN	0.280 U	0.288 U	0.291 U	0.301 UJN	0.280 U	0.299 U
Acenaphthylene	1,000	2,030	14.3	0.239 U	0.225 U	3.77	0.234 U	0.242 U	0.225 U	0.24 U
Anthracene	240	850	0.838	0.02 U	0.019 U	0.02 U	0.04	0.398 N	0.083	0.02 U
Benzo(a)anthracene	91.9	497	1.63	0.026 U	0.026 U	0.026 U	0.112	5.1 N	0.854	0.028 U
Benzo(a)pyrene	71.1	233	1.61	0.017 U	0.016 U	0.017 U	0.114	7.65	1.130 E	0.017 U
Benzo(b)fluoranthene	20	97.7	0.866	0.053 U	0.050 U	0.051 U	0.06 U	4.3 N	0.663	0.053 U
Benzo(g,h,i)perylene	13.9 U	146 U	0.215 U	0.053 U	0.041 U	0.051 U	0.054	0.44 U	0.915	0.044 U
Benzo(k)fluoranthene	16.1	69.8	0.604	0.028 U	0.026 U	0.027 U	0.048	2.17	0.384	0.028 U

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-23 12-17-93	MW-23/DP 12-17-93	MW-24 12-15-93	MW-25 12-14-93	MW-25 08-11-94	MW-26 12-15-93	MW-27 12-15-93	MW-28 12-16-93	MW-28 08-11-94	MW-30 12-14-93
PAHs (µg/L) (continued)										
Chrysene	83.9	303	1.55	0.026 U	0.025 U	0.026 U	0.155	5.36 N	0.840	0.027 U
Dibenz(a,h)anthracene	17.6 U	146 U	0.384	0.051 U	0.052 U	0.051 U	0.052 U	0.56 U	0.122 J	0.056 U
Fluoranthene	162	644	3.72	0.075 U	0.071 U	0.076	0.261	8.34 N	1.350	0.076 U
Fluorene	651	2,030	1.23	0.058 U	0.055 U	0.057 U	0.057 U	0.059 U	0.055 U	0.059 U
Indeno(1,2,3-cd)pyrene	10.8 U	72.8 U	0.709	0.026 U	0.032 U	0.026 U	0.093	5.36	0.579	0.034 U
Naphthalene	841	1,860	1.25 U	0.252 U	0.258 U	2.13	0.247 U	0.256 U	0.677	0.254 U
Phenanthrene	733	1,920	0.131 U	0.026 U	0.025 U	0.026 U	0.201	1.18 N	0.182	0.032
Pyrene	236	1,240	4.95	0.026 U	0.052 U	0.056	0.264	14.1 N	2.210 E	0.056 U
Total Carcinogenic PAHs	283	1,200.5	7.35	0	0	0	0.522	29.94	4.572	0
Total PAHs	4,916	12,293	32.39	1.38	0	6.03	1.342	53.96	9.989	0.032
Acid Extractables (µg/L)										
2,4,5-Trichlorophenol	-	-	-	25 U	-	25 U	25 U	25 U	-	25 U
2,4,6-Trichlorophenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2,4-Dichlorophenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2,4-Dimethylphenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2,4-Dinitrophenol	-	-	-	25 U	-	25 U	25 U	25 UJ	-	25 U
2-Chlorophenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2-Methylphenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
2-Nitrophenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
4,6-Dinitro-2-Methylphenol	-	-	-	25 U	-	25 U	25 U	25 UJ	-	25 U
4-Chloro-3-Methylphenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
4-Methylphenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
4-Nitrophenol	-	-	-	25 U	-	25 U	25 U	25 UJ	-	25 U
Benzoic Acid	-	-	-	50 U	-	50 U	50 U	50 U	-	50 U
Pentachlorophenol	-	-	-	25 U	-	25 U	25 U	25 U	-	25 U
Phenol	-	-	-	10 U	-	10 U	10 U	10 U	-	10 U
Metals (µg/L)										
Arsenic	2.0 U	2.0 U	12.6	2.0 U	-	2.0 U	3.4 B	5.1 B	-	2.0 U
Chromium, Total	4.0 U	4.0 U	94.8	4.0 U	-	75.2	82.4	51.8	-	181
Copper	4.0 U	4.0 U	69.6	4.0 U	-	40.6	40.9	25.4	-	107
Iron	28,300	27,600	127,000 N	958 NJ	-	1,500 N	39,300 N	27,900 NJ	-	22,600
Lead	2.0 U	2.0 U	83.0 N	9.6 NJ	-	2.9 NB	151 N	99	-	9.5 N
Magnesium	-	-	76,000	39,600	-	11,000	-	34,100	-	-
Manganese	-	-	5,460	25.7	-	933	-	670	-	-
Nickel	15.0 U	18.1	122	15.0 U	-	55.9	55.6	74.5	-	208
Zinc	574	579	9,970	5.0 U	-	39.5	300	159	-	55.5
Cyanides (µg/L)										
Cyanide, Total	-	-	-	10.0 U	-	10.0 U	10.0 U	10 U	-	10.0 U

TABLE 3-4 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-31 12-14-93	MW-32 12-16-93	MW-33 12-21-93	MW-33 12-14-93	MW-33/DP 12-14-93	MW-34 12-15-93	MW-34 08-12-94	MW-35 12-15-93
VOCs (µg/L)								
Acetone	10 U	9 J	-	10 U	5 J	10 U	-	10 U
Acrolein	-	-	-		-	-	-	-
Acrylonitrile	-	-	-		-	-	-	-
Benzene	10 U	10 U	-	10 U	10 U	10 U	-	4 J
Bromomethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Bromodichloromethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Bromoform	10 U	10 U	-	10 U	10 U	10 U	-	10 U
2-Butanone	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Carbon Disulfide	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Carbon Tetrachloride	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Chlorobenzene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Chloroethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Chloromethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Chloroform	10 U	10 U	-	10 UJ	10 U	10 U	-	10 U
1,1-Dichloroethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
1,2-Dichloroethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
1,1-Dichloroethene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
cis-1,2-Dichloroethene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
trans-1,2-Dichloroethene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
1,2-Dichloropropane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
cis-1,3-Dichloropropene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
trans-1,3-Dichloropropene	10 U	10 U	-	10 UJ	10 U	10 U	-	10 U
Dibromochloromethane	10 U	10 U	-	10 UJ	10 U	10 U	-	10 U
Ethylbenzene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
2-Hexanone	10 U	10 U	-	10 U	10 U	10 UJ	-	10 U
Hexanone	-	-	-	-	-	-	-	-
Methylene Chloride	10 U	10 U	-	10 U	10 U	10 U	-	10 U
4-Methyl-2-Pentanone	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Styrene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Tetrachloroethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Tetrachloroethene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Toluene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
1,1,1-Trichloroethane	10 U	10 U	-	10 UJ	10 U	10 UJ	-	10 U
1,1,2-Trichloroethane	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Trichloroethene	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Trichlorofluoromethane	-	-	-	-	-	-	-	-
Vinyl Chloride	10 U	10 U	-	10 U	10 U	10 U	-	10 U
Xylenes, Total	10 U	10 U	-	1 J	10 U	10 U	-	10 U
PAHs (µg/L)								
Acenaphthene	0.297 U	-	0.28 U	0.288 UJ	0.297 UJ	0.269 UJ	0.280 U	0.28 U
Acenaphthylene	0.239 U	-	0.836	0.232 U	0.239 U	0.216 U	0.225 U	0.225 U
Anthracene	0.02 U	-	0.019 U	0.02 U	0.02 U	0.018 U	0.019 U	0.019 U
Benzo(a)anthracene	0.026 U	-	0.134	0.026 U	0.026 U	0.025 JN	0.026 U	0.026 U
Benzo(a)pyrene	0.017 U	-	0.185	0.017 U	0.017 U	0.015 U	0.016 U	0.016 U
Benzo(b)fluoranthene	0.053 U	-	0.101	0.051 U	0.053 U	0.048 U	0.050 U	0.05 U
Benzo(g,h,i)perylene	0.053 U	-	0.041 U	0.051 U	0.053 U	0.048 U	0.041 U	0.041 U
Benzo(k)fluoranthene	0.028 U	-	0.06	0.027 U	0.028 U	0.025 U	0.026 U	0.026 U
Chrysene	0.026 U	-	0.16	0.026 U	0.026 U	0.024 U	0.025 U	0.025 U

TABLE 2-8 (CONTINUED)

GROUNDWATER ANALYTICAL RESULTS SUMMARY

Parameter	MW-31 12-14-93	MW-32 12-16-93	MW-32 12-21-93	MW-33 12-14-93	MW-33/DP 12-14-93	MW-34 12-15-93	MW-34 08-11-94	MW-35 12-15-93
PAHs (ug/L) (continued)								
Dibenz(a,h)anthracene	0.053 U	-	0.052 U	0.051 U	0.053 U	0.048 U	0.052 U	0.052 U
Fluoranthene	0.075 U	-	0.29	0.071 U	0.075 U	0.068 UJ	0.071 U	0.071 U
Fluorene	0.058 U	-	0.055 U	0.057 U	0.058 U	0.053 U	0.055 U	0.055 U
Indeno(1,2,3-cd)pyrene	0.026 U	-	0.032 U	0.026 U	0.026 U	0.024 U	0.032 U	0.032 U
Naphthalene	0.252 U	-	0.238 U	0.245 U	0.252 U	0.229 U	0.238 U	0.238 U
Phenanthrene	0.026 U	-	0.191	0.026 U	0.026 U	0.024 U	0.025 U	0.025 U
Pyrene	0.026 U	-	0.703	0.026 U	0.026 U	0.039 N	0.052 U	0.052 U
Total Carcinogenic PAHs	0	-	0.64	0	0	0.030	0	0
Total PAHs	0	-	2.66	0	0	0.069	0	0
Acid Extractables (ug/L)								
2,4,5-Trichlorophenol	25 U	-	26 U	24 U	24 U	25 U	-	25 U
2,4,6-Trichlorophenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
2,4-Dichlorophenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
2,4-Dimethylphenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
2,4-Dinitrophenol	25 U	-	26 U	24 U	24 U	25 UJ	-	25 U
2-Chlorophenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
2-Methylphenol	10 U	-	26 U	10 U	10 U	10 U	-	10 U
2-Nitrophenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
4,6-Dinitro-2-methylphenol	25 U	-	26 U	24 U	24 U	25 UJ	-	25 U
4-Chloro-3-methylphenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
4-Methylphenol	10 U	-	52 U	10 U	10 U	10 U	-	10 U
4-Nitrophenol	25 U	-	26 U	24 U	24 U	25 UJ	-	25 U
Benzoic Acid	10 U	-	26 U	49 U	49 U	50 U	-	50 U
Pentachlorophenol	25 U	-	26 U	24 U	24 U	25 U	-	25 U
Phenol	10 U	-	10 U	10 U	10 U	10 U	-	10 U
Metals (ug/L)								
Arsenic	2.0 U	-	8.2 B	2.0 U	2.0 U	2.0 U	-	2.0 U
Chromium, Total	4.0 U	-	146	4.0 U	4.0 U	34.2	-	7.7 B
Copper	4.5 B	-	83.9	4.0 U	4.2 B	18.1 B	-	4.4 B
Iron	1,080 N	-	40,200	1,570 NJ	1,270 NJ	88,700 NJ	-	19,900 N
Lead	8.2 N	-	65.7 N	6.0 NJ	2.0 UJ	4.6 NJ	-	2.0 U
Magnesium	29,900	-	-	15,400	31,000	31,700	-	-
Manganese	48.2	-	-	90.5	51.8	392	-	-
Nickel	15.0 U	-	267	28.2 B	15.0 U	41.9	-	20.1 B
Zinc	5.0 U	-	188	9.2 U	5.0 U	30.1 U	-	15.7 B
Cyanides (ug/L)								
Cyanide, Total	10.0 U	10.0 U	-	10.0 U	10.0 U	10.0 U	-	10 U

U = The material was analyzed but not detected at or above the stated limit.
J = The associated numerical value is an estimated concentration.
N = Presumptive evidence of the presence of the constituent.
B = Reported value is less than the contract required detection limit but above instrument detection limit.
E = The reported value is estimated due to the presence of interference.

- Indicates not analyzed

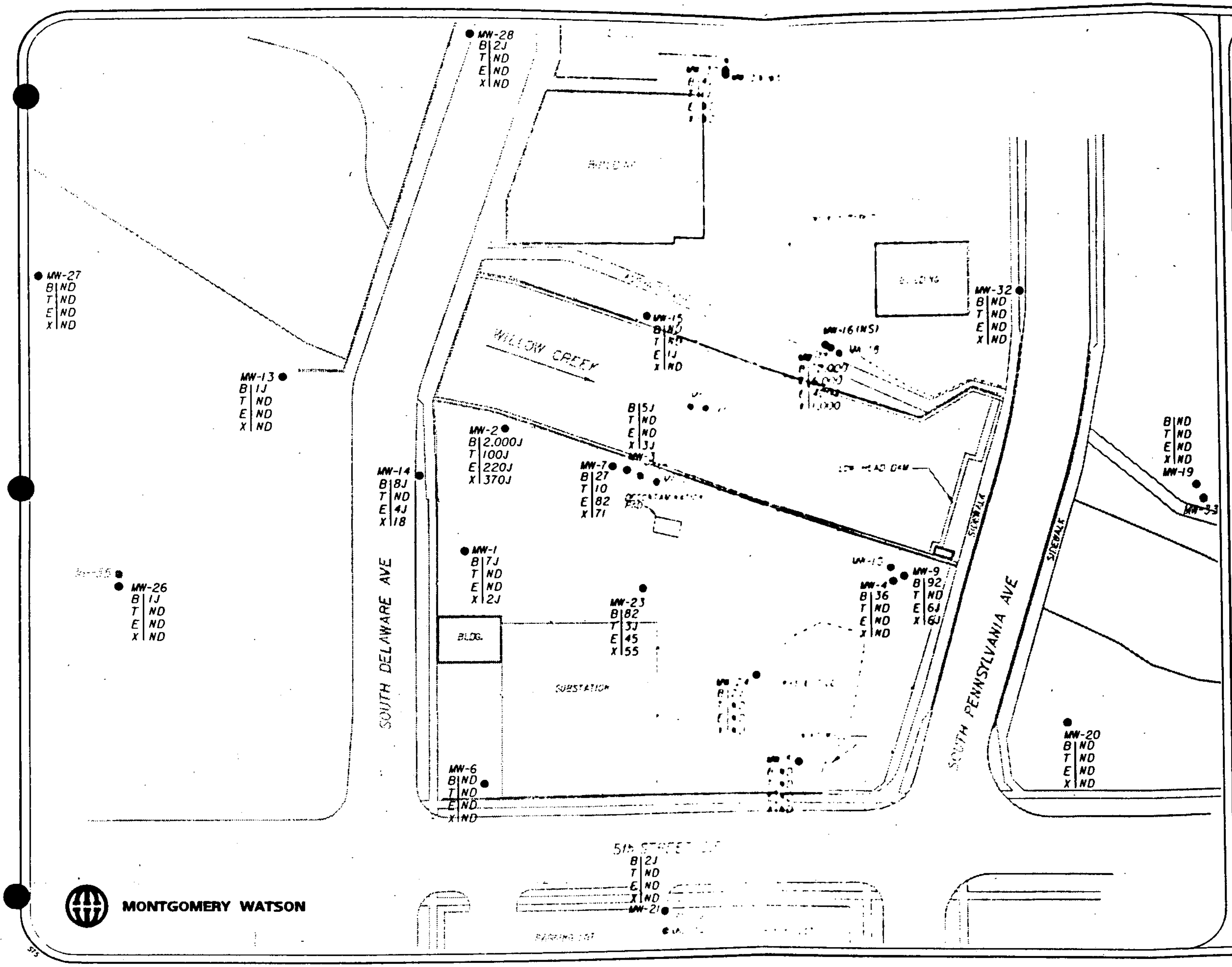
TABLE 4-1

RAINFALL IN MASON CITY
(Measured in Inches)

Date	Amount	Date	Amount
05/25/94	-	06/20/94	.55
05/26/94	-	06/21/94	-
05/27/94	-	06/22/94	.09
05/28/94	-	06/23/94	2.40
05/29/94	.06	06/24/94	Trace
05/30/94	Trace	06/25/94	-
05/31/94	-	06/26/94	-
06/01/94	.01	06/27/94	-
06/02/94	.01	06/28/94	.01
06/03/94	-	06/29/94	-
06/04/94	-	06/30/94	1.16
06/05/94	.99	07/01/94	.02
06/06/94	.03	07/02/94	-
06/07/94	.10	07/03/94	.04
06/08/94	-	07/04/94	.13
06/09/94	-	07/05/94	Trace
06/10/94	.30	07/06/94	Trace
06/11/94	-	07/07/94	0.26
06/12/94	1.35	07/08/94	Trace
06/13/94	-	07/09/94	Trace
06/14/94	-	07/10/94	-
06/15/94	-	07/11/94	Trace
06/16/94	-	07/12/94	0.56
06/17/94	.20	07/13/94	2.28
06/18/94	.09	07/14/94	.01
06/19/94	-	07/15/94	.50

- Indicates no rainfall.

FIGURES



MONTGOMERY WATSON

LEGEND:

- ● MONITORING WELL
- B BENZENE
- T TOLUENE
- E ETHYLBENZENE
- X XYLENES
- J ESTIMATED CONCENTRATION
- ND NOT DETECTED

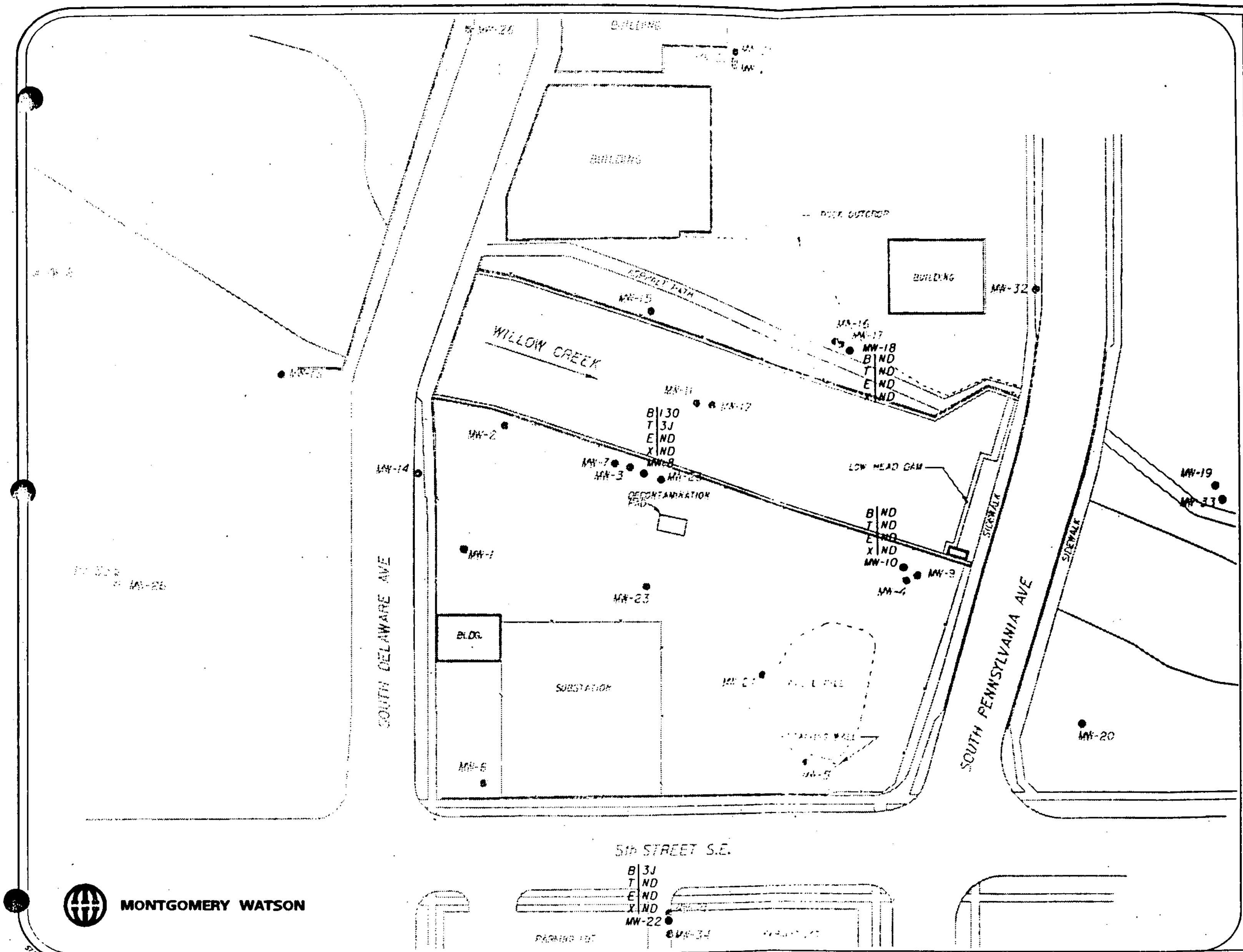
NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. CONCENTRATIONS IN μg/L

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

BTEX IN GROUNDWATER – SHALLOW AQUIFER

FIGURE 2-14



MONTGOMERY WATSON

N

0 60
SCALE IN FEET

LEGEND:

●	MONITORING WELL
B	BENZENE
T	TOLUENE
E	ETHYLBENZENE
X	XYLENES
J	ESTIMATED CONCENTRATION
ND	NOT DETECTED

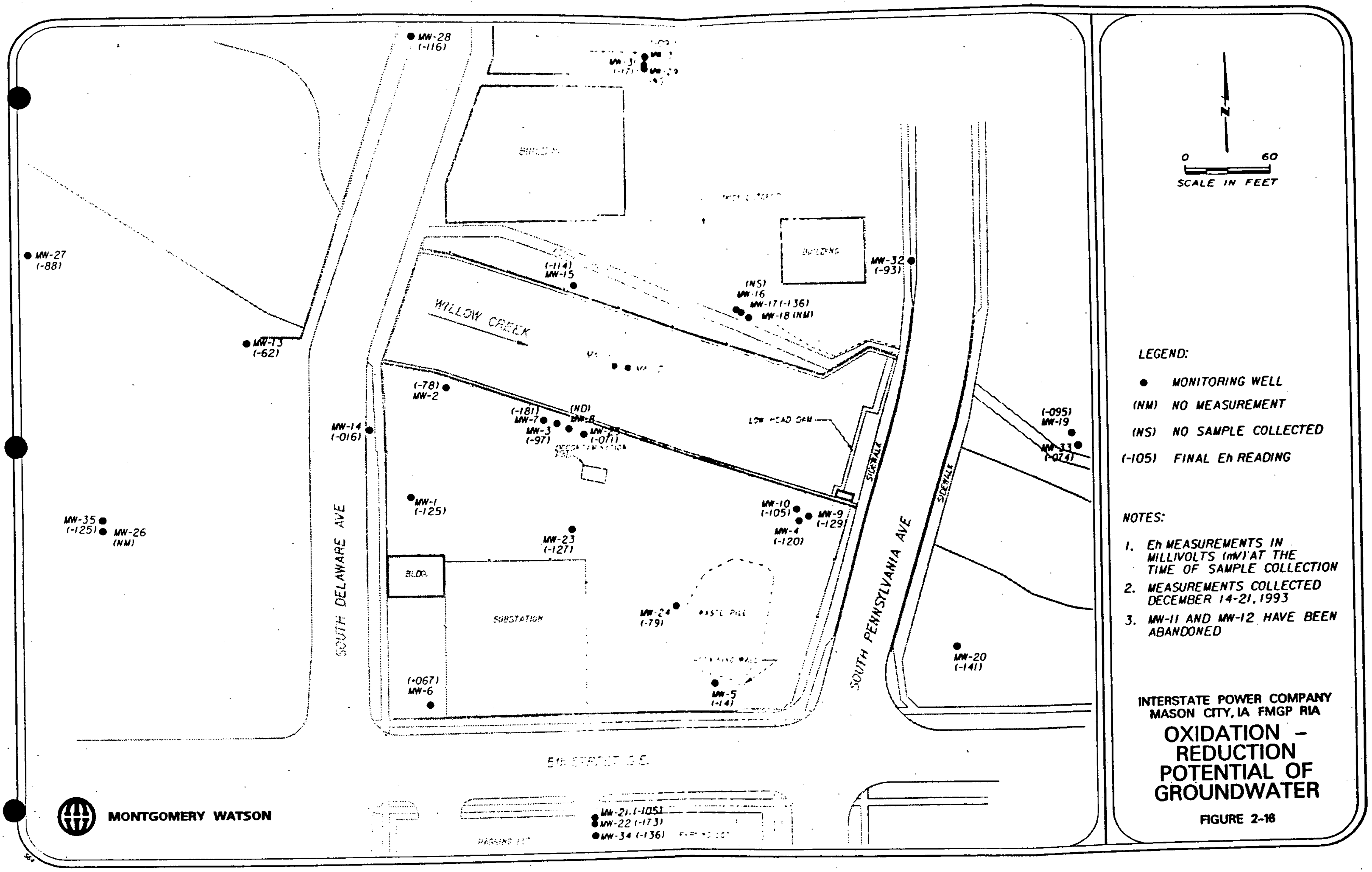
NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS IN µg/L

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

BTEX IN GROUNDWATER – INTERMEDIATE AQUIFER

FIGURE 2–15



MONTGOMERY WATSON

LEGEND:

●	MONITORING WELL
(NM)	NO MEASUREMENT
(NS)	NO SAMPLE COLLECTED
(-105)	FINAL Eh READING

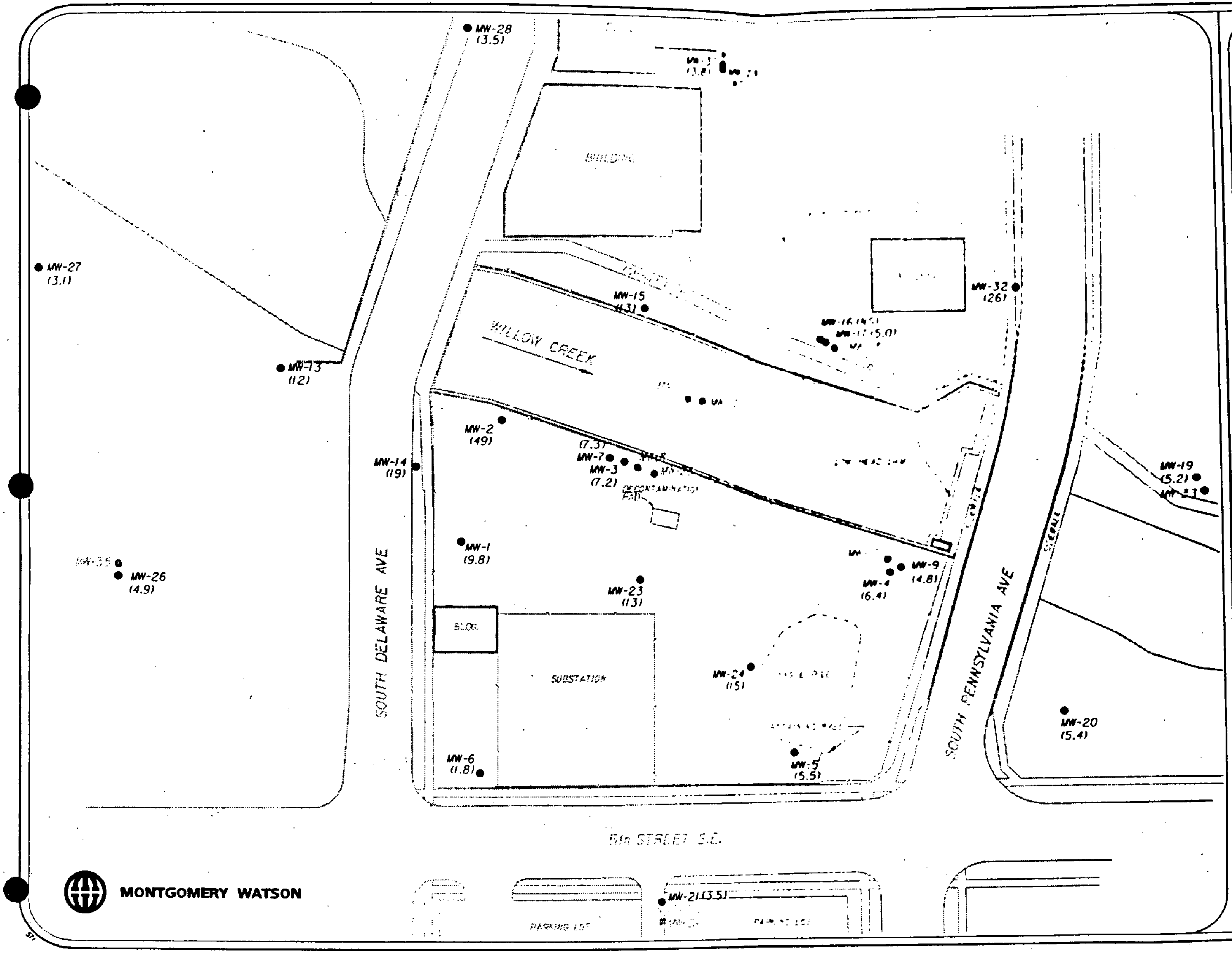
NOTES:

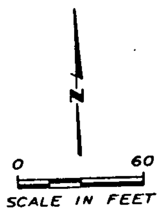
1. Eh MEASUREMENTS IN MILLIVOLTS (mV) AT THE TIME OF SAMPLE COLLECTION
2. MEASUREMENTS COLLECTED DECEMBER 14-21, 1993
3. MW-11 AND MW-12 HAVE BEEN ABANDONED

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

OXIDATION – REDUCTION POTENTIAL OF GROUNDWATER

FIGURE 2-16





MONTGOMERY WATSON

LEGEND:

●	MONITORING WELL
(5.2)	TOTAL ORGANIC CARBON IN mg/l
(NS)	NO SAMPLE COLLECTED

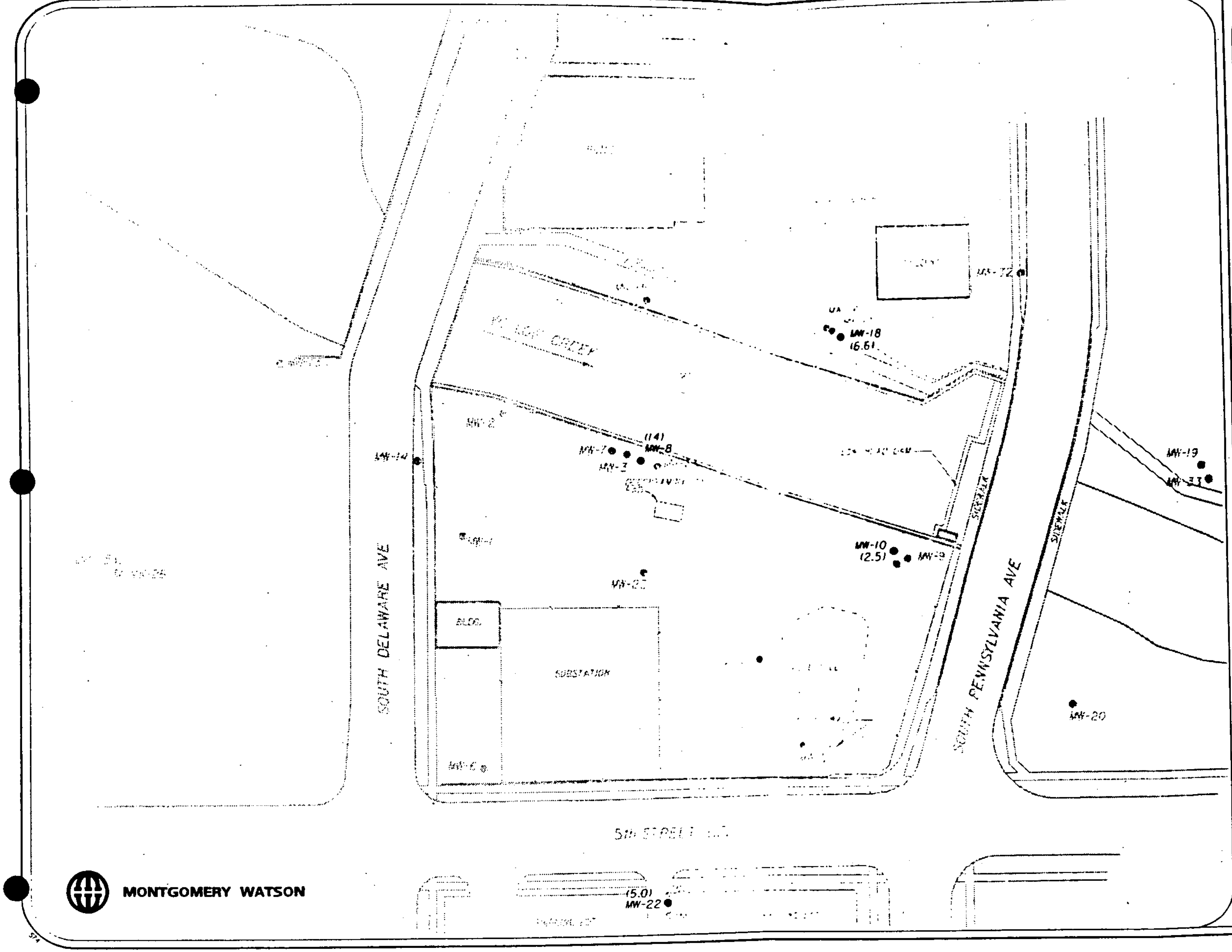
NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. MAXIMUM CONCENTRATION SHOWN AT EACH LOCATION
3. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
4. CONCENTRATIONS ARE ROUNDED TO THE NEAREST 0.1 mg/l

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

TOTAL ORGANIC CARBON IN GROUNDWATER SHALLOW AQUIFER

FIGURE 2-17



LEGEND:

- ● MONITORING WELL
- (2.5) TOTAL ORGANIC CARBON IN mg/l

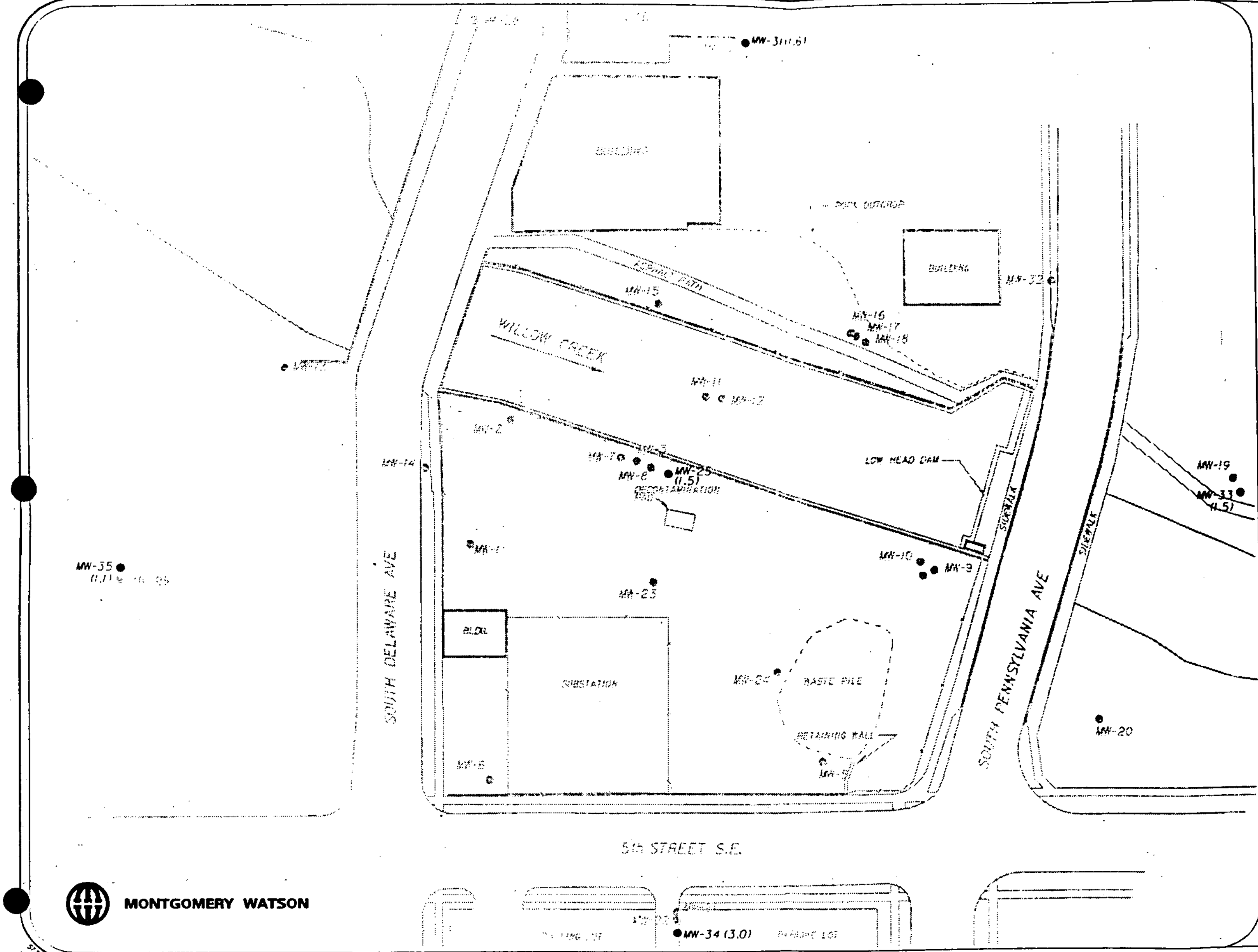
NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS IN mg/l

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

TOTAL ORGANIC CARBON IN GROUNDWATER INTERMEDIATE ZONE

FIGURE 2-18



MONTGOMERY WATSON

LEGEND:

● MONITORING WELL

(570) TOTAL ORGANIC CARBON IN mg/l

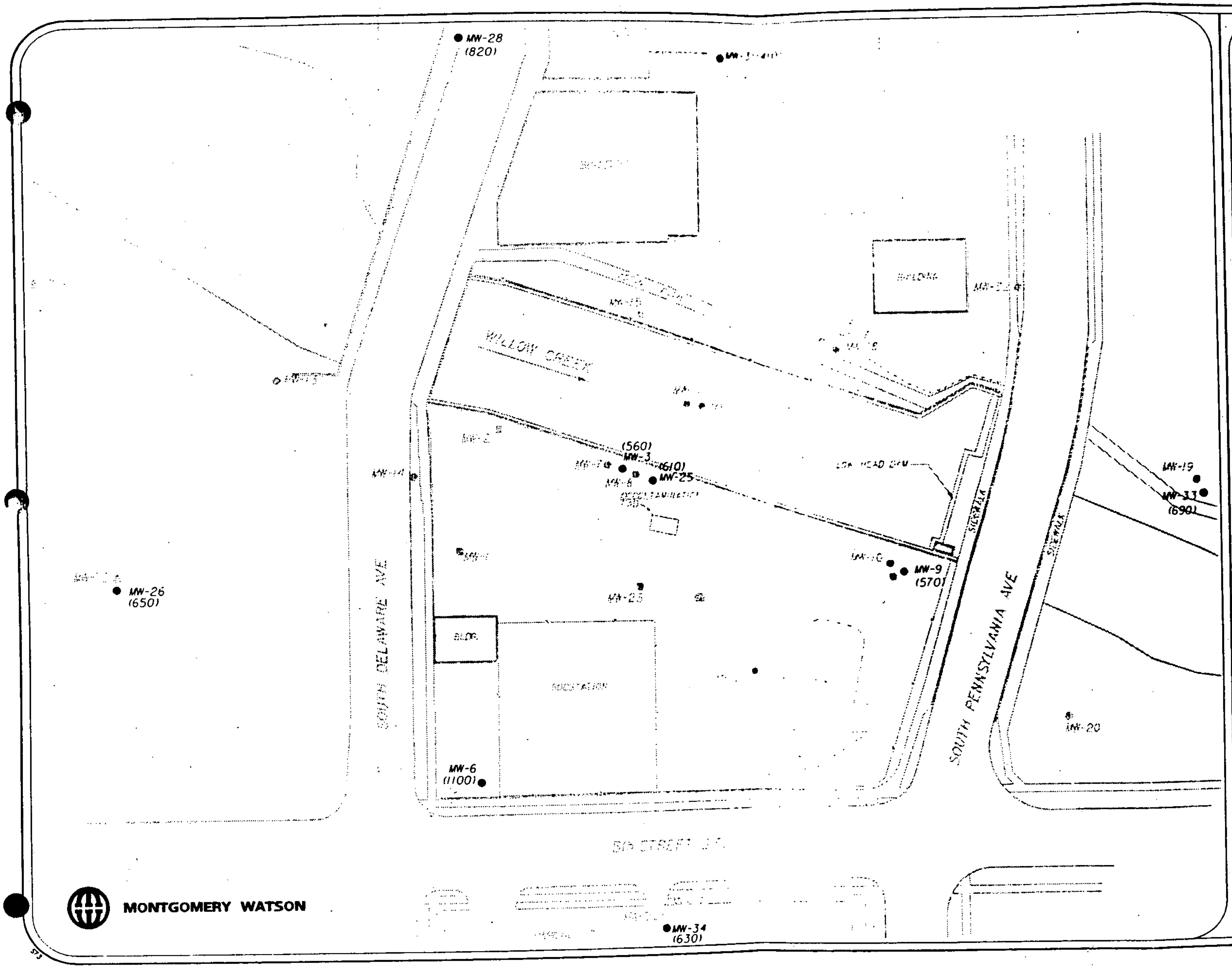
NOTES:

1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS IN mg/l

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

TOTAL ORGANIC CARBON IN GROUNDWATER – FIRST TRANSMISSIVE ZONE

FIGURE 2-19



MONTGOMERY WATSON

N

0 60
SCALE IN FEET

LEGEND:

● MONITORING WELL

(570) TOTAL DISSOLVED SOLIDS IN mg/l

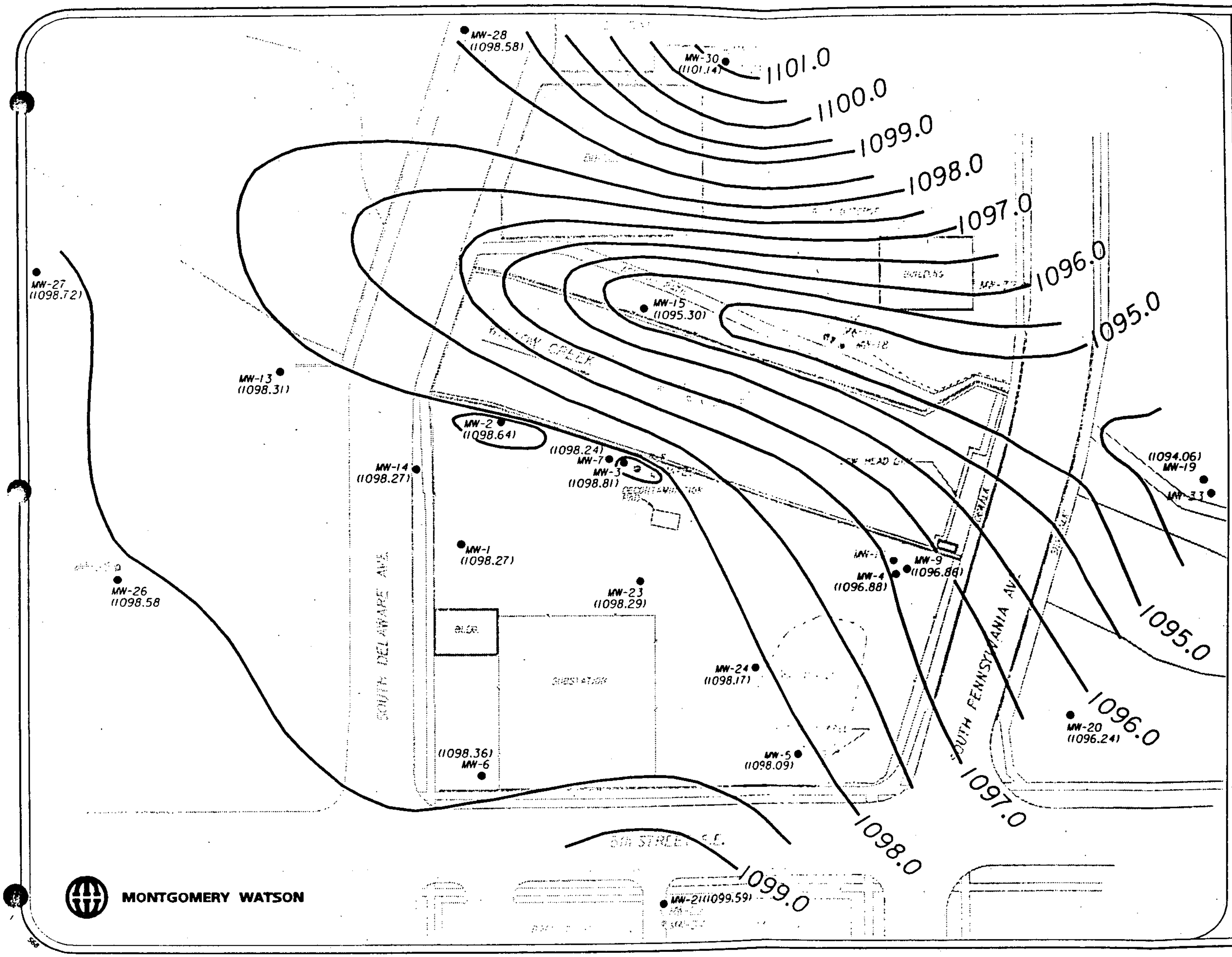
NOTES:

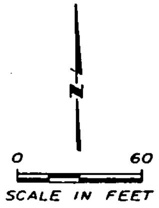
1. WELLS SAMPLED DECEMBER 14-21, 1993
2. SUMS SHOWN MAY INCLUDE ESTIMATED VALUES
3. CONCENTRATIONS IN µg/L

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

TOTAL DISSOLVED SOLIDS IN GROUNDWATER

FIGURE 2-20





LEGEND:

● MONITORING WELL

(1098.70) WATER SURFACE ELEVA
IN FEET ABOVE NGVD

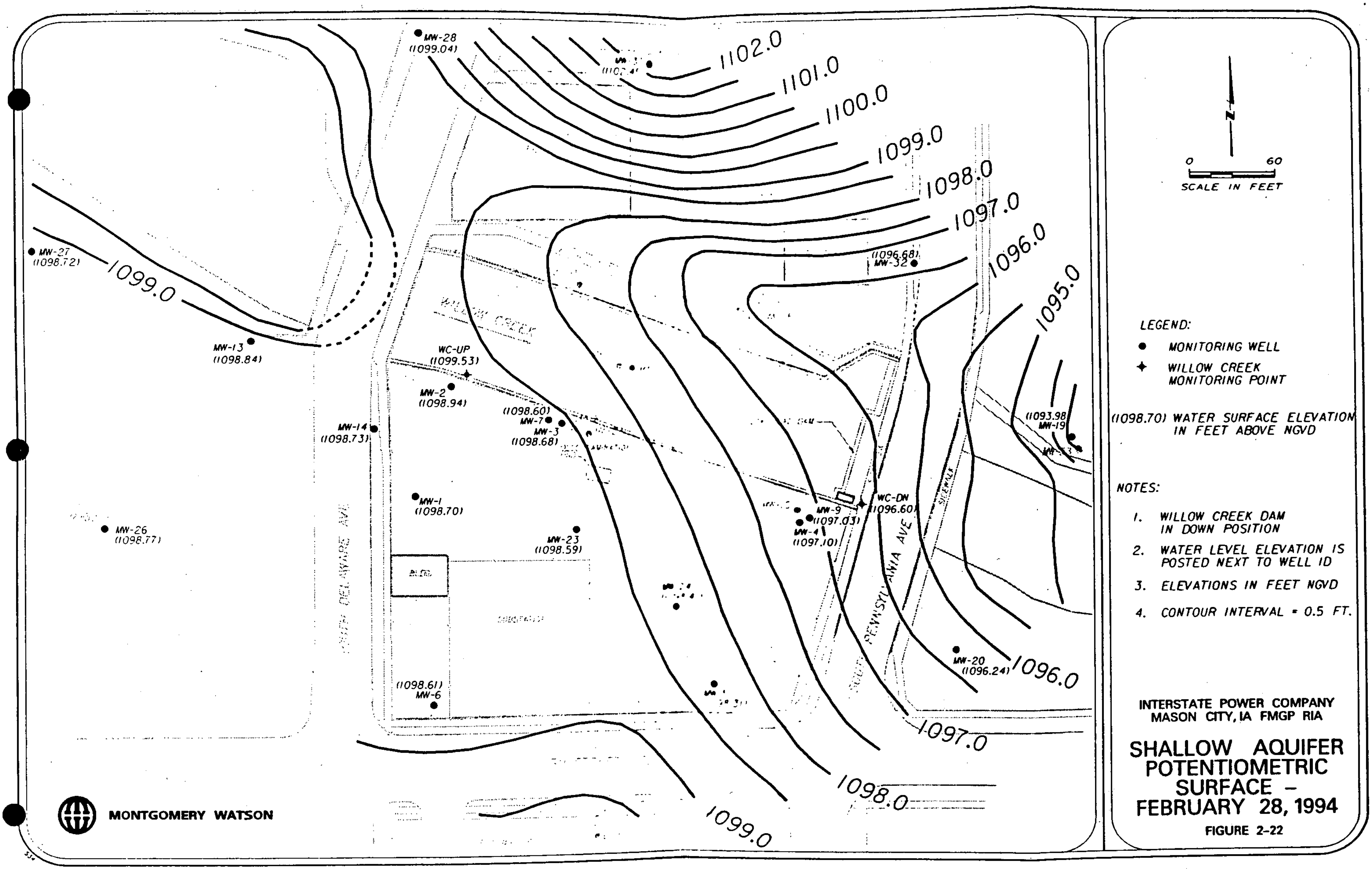
NOTES:

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

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

SHALLOW AQUIFE POTENTIOMETRIC SURFACE – DECEMBER 13, 199

FIGURE 2–21



MONTGOMERY WATSON

LEGEND:

- ● MONITORING WELL
- ✦ WILLOW CREEK MONITORING POINT
- (1098.70) WATER SURFACE ELEVATION IN FEET ABOVE NGVD

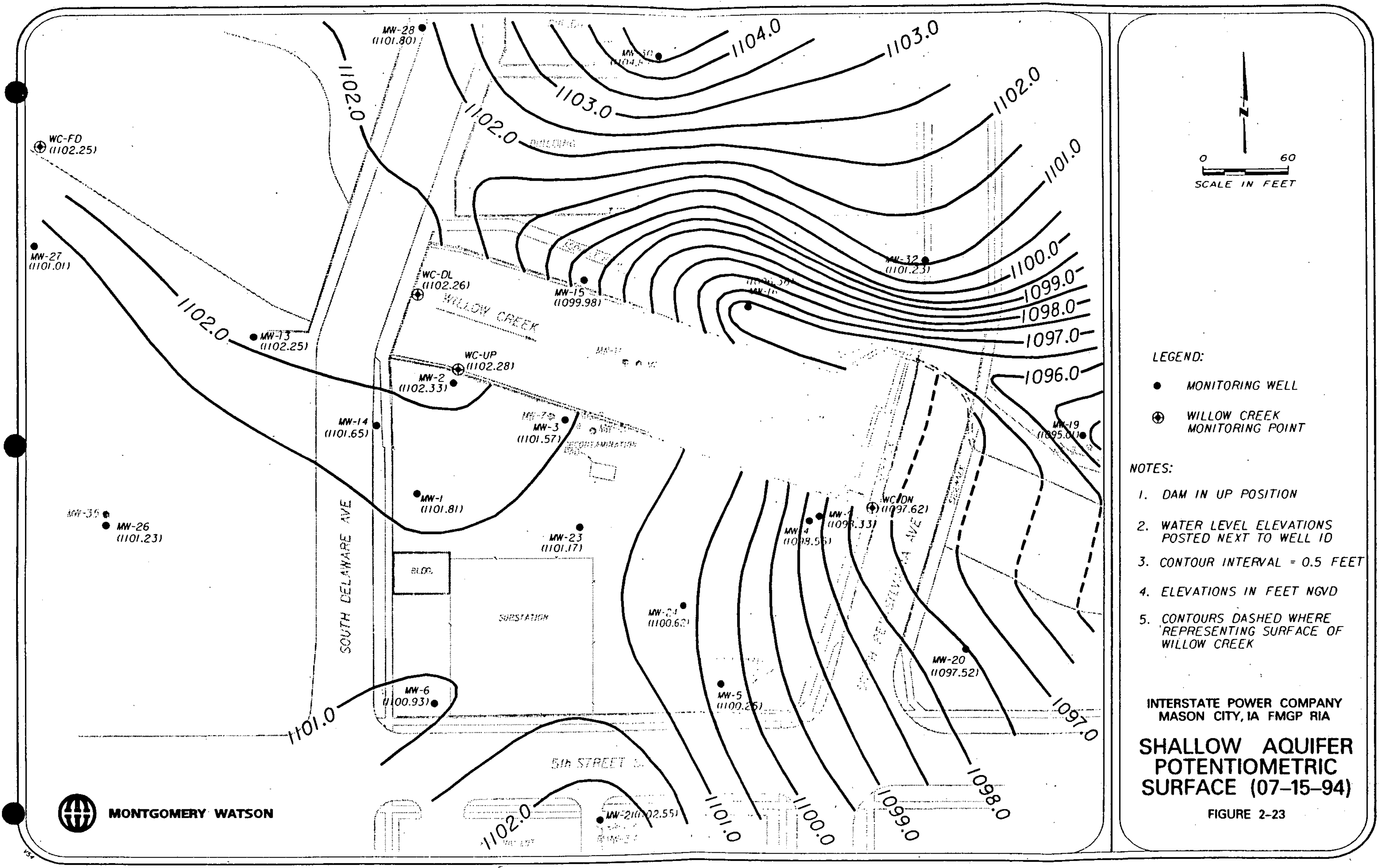
NOTES:

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.

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

SHALLOW AQUIFER POTENTIOMETRIC SURFACE – FEBRUARY 28, 1994

FIGURE 2-22



MONTGOMERY WATSON

LEGEND:

- ● MONITORING WELL
- ⊕ WILLOW CREEK MONITORING POINT

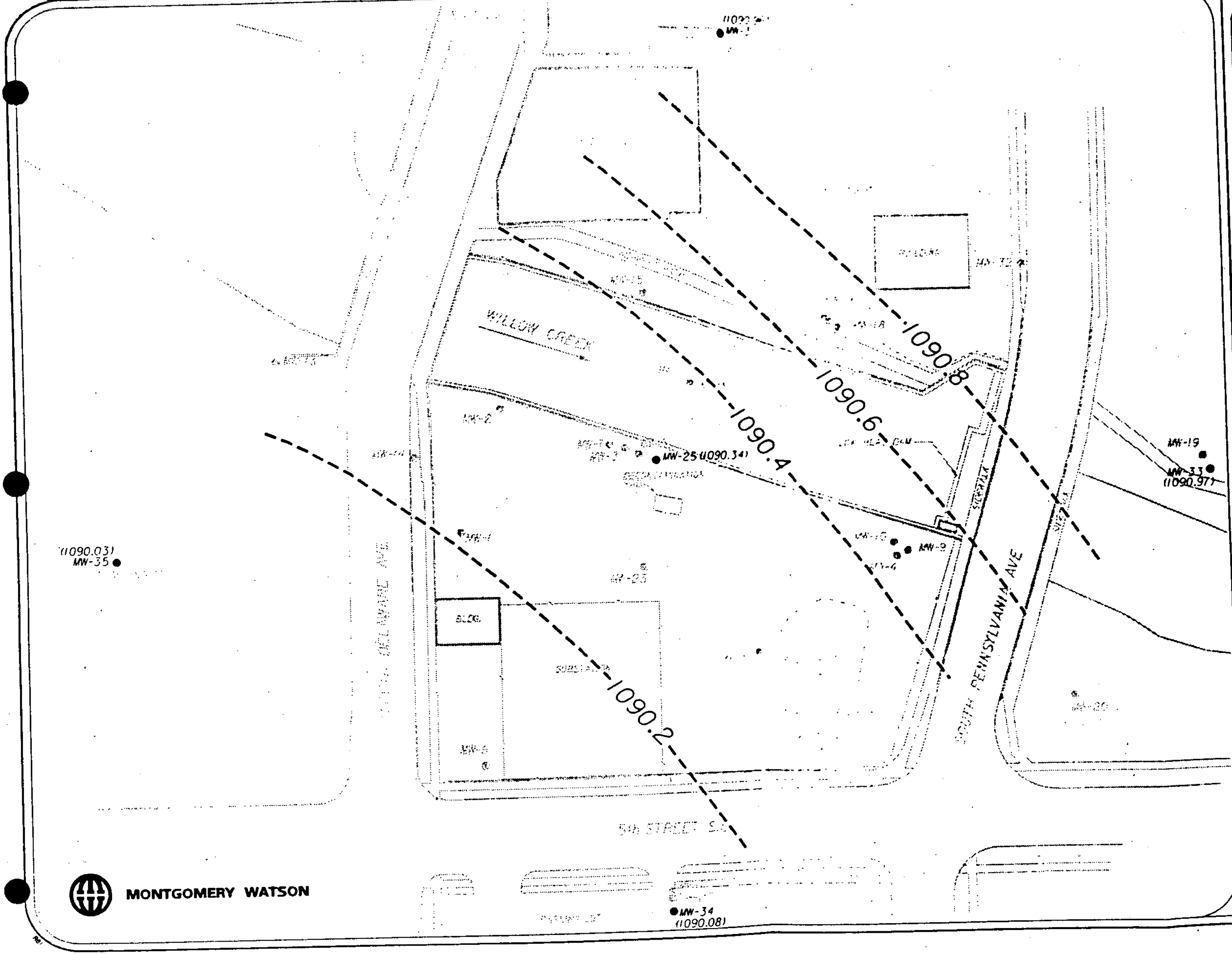
NOTES:

1. DAM IN UP POSITION
2. WATER LEVEL ELEVATIONS POSTED NEXT TO WELL ID
3. CONTOUR INTERVAL = 0.5 FEET
4. ELEVATIONS IN FEET NGVD
5. CONTOURS DASHED WHERE REPRESENTING SURFACE OF WILLOW CREEK

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

SHALLOW AQUIFER POTENTIOMETRIC SURFACE (07-15-94)

FIGURE 2-23



MONTGOMERY WATSON

N

0 60
SCALE IN FEET

LEGEND:

● MONITORING WELL

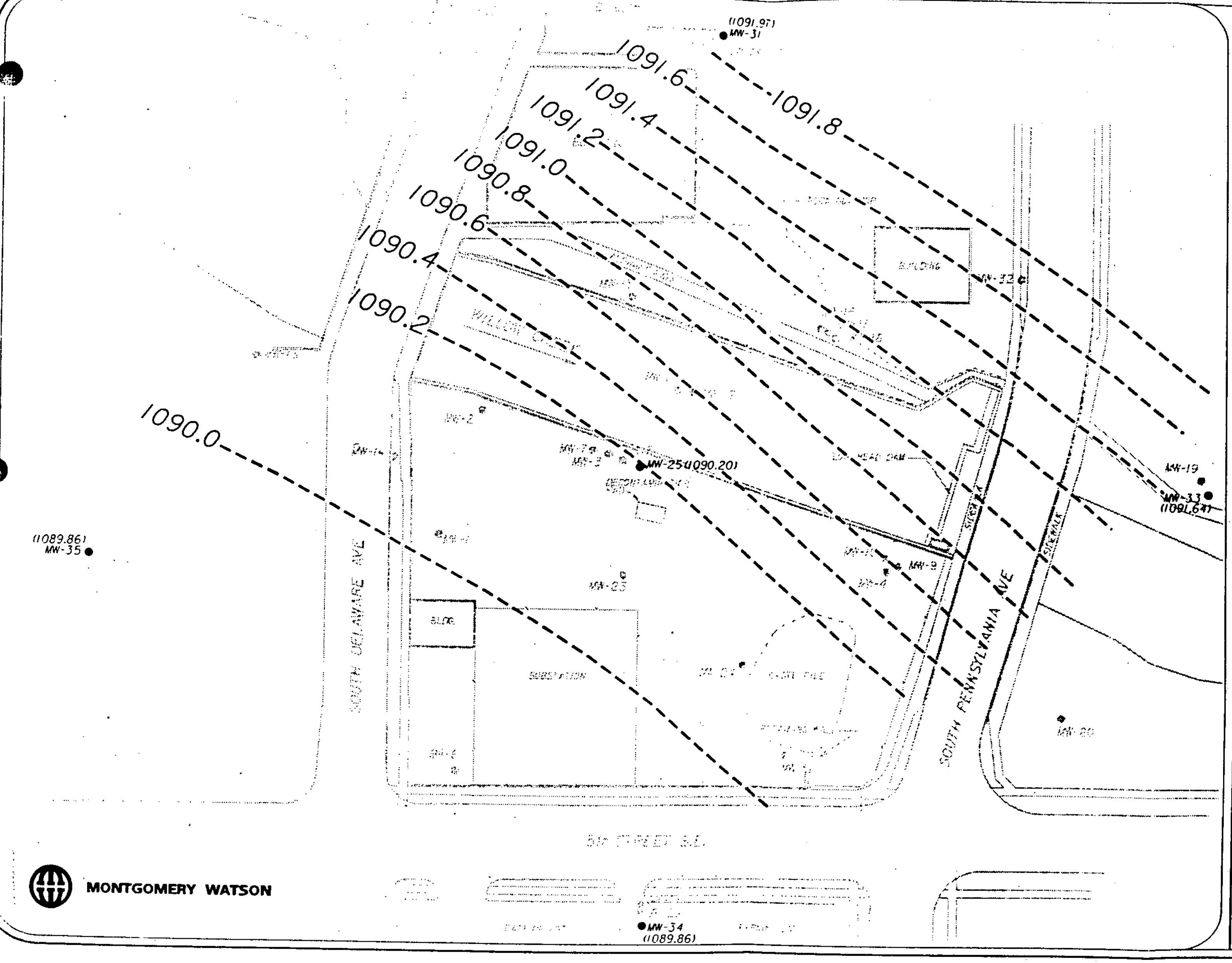
NOTES:

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

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

FIRST TRANSMISSIVE ZONE POTENTIOMETRIC SURFACE DECEMBER 13, 1993

FIGURE 2–24



MONTGOMERY WATSON

N

0 60
SCALE IN FEET

LEGEND:

● MONITORING WELL

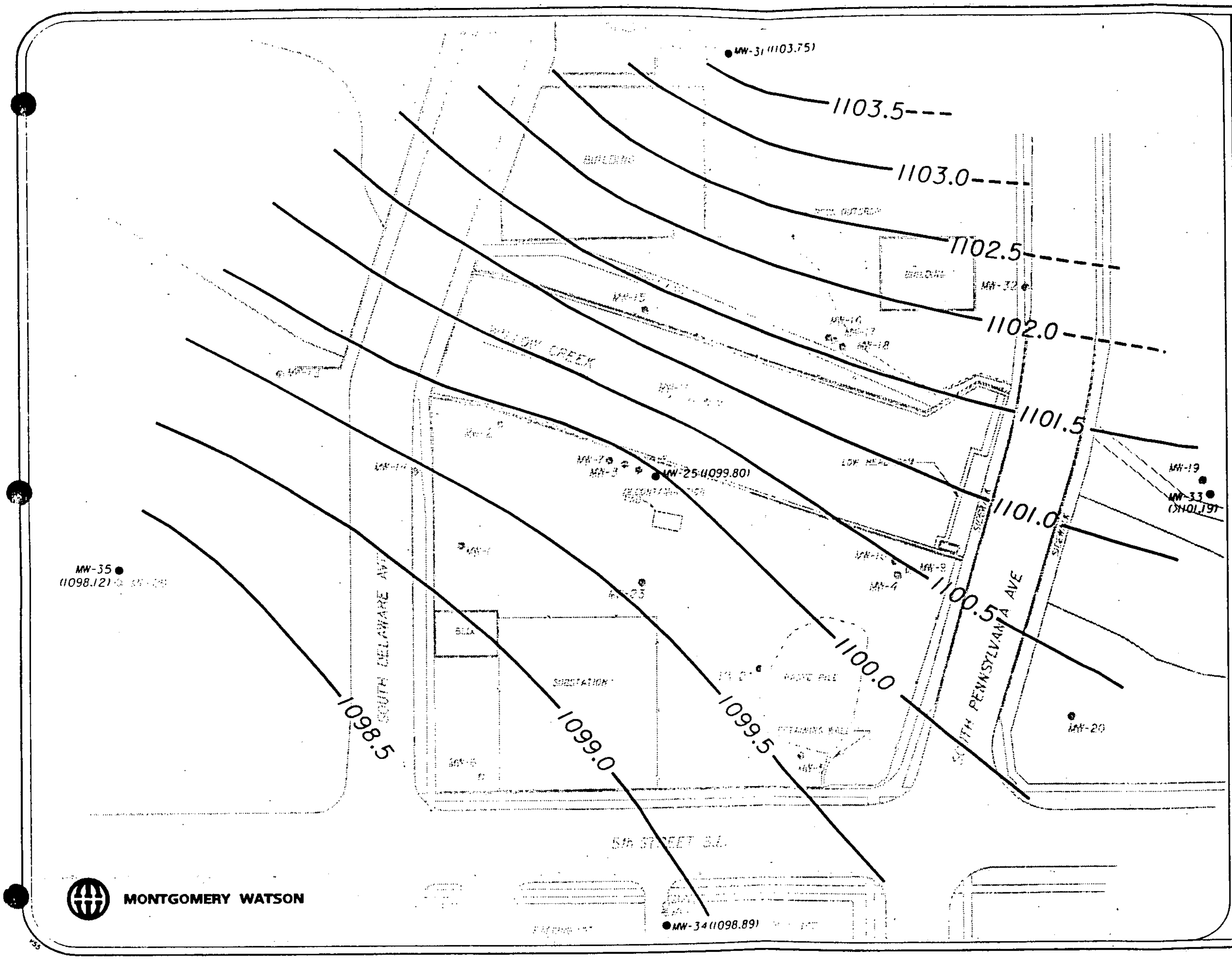
NOTES:

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

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

FIRST TRANSMISSIVE ZONE POTENTIOMETRIC SURFACE FEBRUARY 28, 1994

FIGURE 2-25



MONTGOMERY WATSON

N

0 60
SCALE IN FEET

LEGEND:

● MONITORING WELL

NOTES:

1. DAM IN UP POSITION
2. WATER LEVEL ELEVATIONS POSTED NEXT TO WELL ID
3. CONTOUR INTERVAL = 0.5 FEET
4. ELEVATIONS IN FEET NGVD
5. WILLOW CREEK SURFACE ELEVATION UPSTREAM OF THE DAM = 1102.28

INTERSTATE POWER COMPANY
MASON CITY, IA FMGP RIA

FIRST TRANSMISSIVE ZONE POTENTIOMETRIC SURFACE 07-15-94

FIGURE 2-26

VOLUME 2

REMEDIAL INVESTIGATION ADDENDUM

FOR

FORMER MANUFACTURED GAS PLANT SITE
MASON CITY, IOWA

Prepared for

INTERSTATE POWER COMPANY
DUBUQUE, IOWA

VOLUME 2
APPENDICES

Project No. 2334.0218

April 1994
Revised September 1994

Prepared by

Montgomery Watson
11107 Aurora Avenue
Des Moines, Iowa 50322
515-253-0830

APPENDIX H

MONTGOMERY WATSON

GROUNDWATER SAMPLE COLLECTION RECORD

Well No. MW-25

Job No.: 2334.0218
Location: Mason City FMGP Site
Weather Conditions: Cloudy, ~65°F

Client: Interstate Power Company
Date: 08-11-94

1. WATER LEVEL DATA: (from ToC)

a. Total Well Length (+TC) 70.19 (Known, Meas.) ToC Elevation 1,106.86
b. Water Table Elev. (+TC) 12.11 Well Dia. 2"
c. Length of Water Column 58.08

2. WELL PURGING DATA:

a. Purge Method Waterra Tubing
b. Required Purge Volume (@ 3 Well Volumes) 28.5 gallons
c. Field Testing: Equipment Used Myron L Co. pH/Cond. meter, standard thermometer

Time	Volume Removed	Temp. (°C)	pH	Spec. Cond. (m℧/cm)	Turbidity
11:09	0 gal.	19°	6.65	954 µs	Clear
11:28	2.5 gal.	16°	5.94	921 µs	Cloudy
11:41	5 gal.	15°	5.82	937 µs	Clear (few solids)
12:00	10 gal.	15°	7.04	958 µs	Clear
12:16	15 gal.	15°	7.09	988 µs	Clear
12:31	20 gal.	15°	7.08	935 µs	Clear
12:44	25 gal.	15°	7.09	932 µs	Clear
12:52	27.5 gal.	15°	7.07	932 µs	Clear
12:52	Sample Collected				

3. SAMPLE COLLECTION: Method Waterra Tubing

Container Type: 1000 ml Amber Preservation: None Analysis Req.: PAH
Sample ID #: MW25-GW-004-081194 Chain of Custody #:

4. COMMENTS:

Randy
Sampler (Signature)

Randy Kroneman
(Print Name)

MONTGOMERY WATSON

GROUNDWATER SAMPLE COLLECTION RECORD

Well No. MW-28

Job No.: 2334.0218
Location: Mason City FMGP Site
Weather Conditions: Cloudy, ~65°F

Client: Interstate Power Company
Date: 08-11-94

1. WATER LEVEL DATA: (from ToC)

a. Total Well Length (+TC) 36.72 (Known, Meas.) ToC Elevation 1,121.32
b. Water Table Elev. (+TC) 22.58 Well Dia. 2"
c. Length of Water Column 14.14

2. WELL PURGING DATA:

a. Purge Method Waterra Tubing
b. Required Purge Volume (@ 3 Well Volumes) 7 gallons
c. Field Testing: Equipment Used Myron L Co. pH/Cond. meter, standard thermometer

Time	Volume Removed	Temp. (°C)	pH	Spec. Cond. (m℧/cm)	Turbidity	Color
11:46	1 gal.	15.0°	6.90	1,315	Cloudy	Light reddish brown
11:55	2	14.5°	7.02	1,313	Cloudy	Light reddish brown
12:03	3	14.5°	7.07	1,297	Cloudy	Light reddish brown
12:09	4	14.0°	7.09	1,324	Cloudy	Light reddish brown
12:16	5	14.0°	7.09	1,311	Cloudy	Light reddish brown
12:23	6	14.0°	7.09	1,336	Cloudy	Light reddish brown
12:31	7	Sample collected				

3. SAMPLE COLLECTION: Method Waterra Tubing

Container Type: 1000 ml Amber Preservation: None Analysis Req.: PAH
Sample ID #: MW28-GW-004-081194 Chain of Custody #:

4. COMMENTS:

Sampler (Signature)

Randy Kroneman
(Print Name)

MONTGOMERY WATSON

GROUNDWATER SAMPLE COLLECTION RECORD

Well No. MW-34

Job No.: 2334.0218
Location: Mason City FMGP Site
Weather Conditions: Cloudy, ~75°F

Client: Interstate Power Company
Date: 08-11-94

1. WATER LEVEL DATA: (from ToC)

a. Total Well Length (+TC) 78.48 (Known, Meas.) ToC Elevation 1,117.20
b. Water Table Elev. (+TC) 23.17 Well Dia. 2"
c. Length of Water Column 55.31

2. WELL PURGING DATA:

a. Purge Method Waterra Tubing
b. Required Purge Volume (@ 3 Well Volumes) 27 gallons
c. Field Testing: Equipment Used Myron L Co. pH/Cond. meter, standard termometer

Time	Volume Removed	Temp. (°C)	pH	Spec. Cond. (m℧/cm)	Turbidity
2:20	0 gal.	16.5°	7.06	608 μs	Cloudy
2:34	2.5 gal.	16.0°	7.23	510 μs	Cloudy
2:44	5.0 gal.	15.5°	7.44	480 μs	Cloudy
3:07	10.0 gal.	16.0°	7.56	496 μs	Cloudy
8-12-94 12:20	Sample Collected				

3. SAMPLE COLLECTION: Method Waterra Tubing

Container Type: 1000 ml Amber Preservation: None Analysis Req.: PAH
Sample ID #: MW34-GW-004-081194 Chain of Custody #:

4. COMMENTS:

Purged dry - allowed to recharge overnight

Randy
Sampler (Signature)

Randy Kroneman
(Print Name)

APPENDIX I

MASON CITY FMGP SITE STATIC WATER LEVEL MEASUREMENTS

	TOC elev.	11/14/1986	11/19/1986	01/05/1987	08/03/1987	12/01/1987	01/11/1988	02/22/1988	02/26/1988	08/22/1988	09/06/1988	09/16/1988	09/28/1988
MW-1	1111.37	1099.13	1099.44	1098.84	1098.57	1097.60	1097.99	1097.62	1097.62	1097.80	1097.16	1096.96	1098.34
MW-2	1110.63	1098.67	1098.79	1098.61	1098.49	1097.27	1097.64	1097.13	1097.05	1097.05	1096.75	1096.64	1097.02
MW-3	1109.69	1099.61	1099.25	1098.39	1098.17	1098.21	1097.52	1097.10	1097.09	1099.03	1096.92	1096.64	1098.88
MW-4	1109.76	1097.41	1097.49	1097.24	1097.10	1096.80	1096.99	1096.80	1096.91	1097.60	1096.54	1096.47	1096.93
MW-5	1114.90	-	-	-	-	-	1098.06	1097.82	1097.93	1098.42	1098.18	1097.84	1098.41
MW-6	1111.87	-	-	-	-	-	1098.92	1098.83	1098.93	1099.28	1099.49	1098.89	1099.71
MW-7	1108.18	-	-	-	-	-	1097.52	1097.08	1097.10	1098.08	1096.74	1096.55	1097.28
MW-8	1109.27	-	-	-	-	-	1093.98	1094.14	1094.10	1094.67	1093.91	1094.43	1094.82
MW-9	1109.11	-	-	-	-	-	1095.57	1095.14	1095.18	1095.86	1095.74	1096.28	1096.78
MW-10	1110.32	-	-	-	-	-	-	-	-	-	-	1094.40	1094.85
MW-11	1100.24	-	-	-	-	-	-	-	-	-	-	1094.99	1095.72
MW-12	1100.32	-	-	-	-	-	-	-	-	-	-	1094.42	1094.97
MW-13	1110.48	-	-	-	-	-	-	-	-	-	-	-	-
MW-14	1110.15	-	-	-	-	-	-	-	-	-	-	-	-
MW-15	1106.67	-	-	-	-	-	-	-	-	-	-	-	-
MW-16	1107.05	-	-	-	-	-	-	-	-	-	-	-	-
MW-17	1107.46	-	-	-	-	-	-	-	-	-	-	-	-
MW-18	1107.91	-	-	-	-	-	-	-	-	-	-	-	-
MW-19	1101.34	-	-	-	-	-	-	-	-	-	-	-	-
MW-20	1122.34	-	-	-	-	-	-	-	-	-	-	-	-
MW-21	1116.00	-	-	-	-	-	-	-	-	-	-	-	-
MW-22	1116.65	-	-	-	-	-	-	-	-	-	-	-	-
MW-23	1111.09	-	-	-	-	-	-	-	-	-	-	-	-
MW-24	1111.16	-	-	-	-	-	-	-	-	-	-	-	-
MW-25	1106.86	-	-	-	-	-	-	-	-	-	-	-	-
MW-26	1108.74	-	-	-	-	-	-	-	-	-	-	-	-
MW-27	1112.95	-	-	-	-	-	-	-	-	-	-	-	-
MW-28	1121.32	-	-	-	-	-	-	-	-	-	-	-	-
MW-29	1127.47	-	-	-	-	-	-	-	-	-	-	-	-
MW-30	1127.37	-	-	-	-	-	-	-	-	-	-	-	-
MW-31	1127.66	-	-	-	-	-	-	-	-	-	-	-	-
MW-32	1128.57	-	-	-	-	-	-	-	-	-	-	-	-
MW-33	1101.19	-	-	-	-	-	-	-	-	-	-	-	-
MW-34	1117.20	-	-	-	-	-	-	-	-	-	-	-	-
MW-35	1108.66	-	-	-	-	-	-	-	-	-	-	-	-
WC-UP	1108.78	-	1098.90	1098.60	1098.60	1097.10	1097.60	Frozen	Frozen	-	1086.61	1096.52	1096.90
WC-DN	1107.78	-	-	-	-	-	-	-	-	-	-	-	-
WC-DL	1116.51	-	-	-	-	-	-	-	-	-	-	-	-
WC-FD	1115.83	-	-	-	-	-	-	-	-	-	-	-	-

MASON CITY FMGP SITE STATIC WATER LEVEL MEASUREMENTS

	10/27/1988	11/21/1988	06/16/1989	06/29/1989	04/07/1992	04/13/1992	04/16/1992	04/20/1992	05/04/1992	05/04/1992	05/05/1992	05/05/1992	05/05/1992
MW-1	1097.14	1097.41	1100.57	1100.92	1099.42	1100.27	1100.41	1100.36	1101.96	1101.57	1100.87	1100.73	1100.63
MW-2	1096.77	1097.05	1101.79	1102.24	1099.33	1099.44	1099.58	1099.90	1102.90	1101.23	1099.88	1099.75	1099.67
MW-3	1097.16	1097.93	1100.95	1101.00	1100.30	1100.16	1100.50	1100.47	1102.16	1101.55	1100.62	1100.46	1100.38
MW-4	1096.50	1096.74	1098.18	1098.21	1097.80	1097.83	1098.24	1098.37	1098.32	1098.06	1097.93	1097.90	1097.89
MW-5	1097.91	1098.17	1098.09	1099.09	1098.98	1099.22	1099.36	1099.64	1099.62	1099.56	1099.46	1099.44	1099.44
MW-6	1097.38	1099.35	1099.80	1100.06	1099.77	1100.05	1100.09	1100.30	1100.49	1100.44	1100.31	1100.29	1100.25
MW-7	1096.67	1097.00	1100.51	1100.80	1099.32	1099.50	1099.90	1100.01	1101.98	1101.11	1100.36	1100.19	1100.07
MW-8	1094.80	1095.10	1094.68	1094.73	1095.92	1095.90	1096.17	1096.75	1095.75	1095.58	1095.63	1095.63	1095.66
MW-9	1095.81	1096.20	1097.82	1097.85	1097.54	1097.53	1098.08	1098.20	1098.26	1098.00	1097.86	1097.82	1097.81
MW-10	1094.71	1095.02	1094.49	1094.56	1096.30	1096.24	1096.29	1096.80	1095.98	1095.88	1095.90	1095.89	1095.89
MW-11	1095.41	1095.66	-	-	-	-	-	-	-	-	-	-	-
MW-12	1094.77	1095.07	-	-	-	-	-	-	-	-	-	-	-
MW-13	-	-	-	-	-	-	1099.36	1099.80	1103.09	1100.71	1099.60	1099.57	1099.54
MW-14	-	-	-	-	-	-	1099.12	1099.96	1101.69	1101.24	1100.47	1100.29	1100.18
MW-15	-	-	-	-	-	-	1098.28	1098.58	1100.55	1099.72	1098.81	1098.66	1098.47
MW-16	-	-	-	-	-	-	-	-	1097.07	1097.05	1097.07	1097.06	1097.06
MW-17	-	-	-	-	-	-	-	1091.61	1092.08	1091.40	1091.07	1091.05	1091.04
MW-18	-	-	-	-	-	-	1085.97	1089.35	1088.25	1088.37	1088.67	1088.78	1088.89
MW-19	-	-	-	-	-	-	-	-	1094.74	1094.78	1094.73	1094.72	1094.72
MW-20	-	-	-	-	-	-	1097.30	1097.32	1096.74	1096.80	1096.73	1096.71	1096.71
MW-21	-	-	-	-	-	-	1101.40	1101.55	1101.88	1101.80	1101.64	1101.56	1101.48
MW-22	-	-	-	-	-	-	1098.63	1084.29	1095.81	1095.79	1095.80	1095.81	1095.81
MW-23	-	-	-	-	-	-	-	-	1100.92	1100.76	1100.46	1100.39	1100.35
MW-24	-	-	-	-	-	-	1099.73	1099.84	1100.10	1100.04	1099.92	1099.90	1099.88
MW-25	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-26	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-27	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-28	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-29	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-30	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-31	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-32	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-33	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-34	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-35	-	-	-	-	-	-	-	-	-	-	-	-	-
WC-UP	1096.67	1097.00	1102.06	-	1099.44	1099.32	1099.88	1100.02	1103.08	1099.32	1099.29	1099.29	1099.30
WC-DN	-	-	-	-	1097.12	1097.05	1097.50	1097.60	1097.04	1097.05	1097.04	1097.02	1097.03
WC-DL	-	-	-	-	-	-	-	-	-	-	-	-	-
WC-FD	-	-	-	-	-	-	-	-	-	-	-	-	-

MASON CITY FMGP SITE STATIC WATER LEVEL MEASUREMENTS

	05/06/1992	05/07/1992	05/11/1992	05/12/1992	05/18/1992	05/19/1992	05/20/1992	06/09/1992	06/09/1992	06/09/1992	06/09/1992	06/10/1992	06/10/1992
MW-1	1100.21	1100.03	1099.40	1099.29	1100.58	1100.28	1100.14	1098.56	1098.99	1099.29	1099.84	1100.82	1101.00
MW-2	1099.43	1099.37	1099.17	1099.14	1100.92	1100.46	1100.18	1099.25	1099.49	1100.17	1101.04	1102.14	1102.31
MW-3	1100.14	1100.04	1099.76	1099.72	1100.60	1100.38	1100.27	1099.15	1099.25	1100.18	1101.19	1101.57	1101.61
MW-4	1097.80	1097.74	1097.57	1097.55	1098.79	1098.46	1098.30	1097.42	1097.14	1097.76	1097.93	1098.02	1098.04
MW-5	1099.33	1099.26	1099.01	1098.94	1099.96	1099.60	1099.59	1098.69	1098.71	1098.74	1098.79	1098.91	1098.96
MW-6	1100.10	1100.03	1099.70	1099.63	1100.41	1100.28	1100.22	1099.29	1099.31	1099.34	1099.41	1099.59	1099.63
MW-7	1099.65	1099.51	1099.07	1099.02	1100.45	1100.06	1099.91	1098.73	1099.24	1099.79	1100.41	1101.22	1101.36
MW-8	1095.66	1095.59	1095.39	1095.34	1097.70	1097.14	1096.79	1095.12	1095.28	1095.27	1095.17	1095.07	1095.08
MW-9	1097.70	1097.65	1097.46	1097.46	1098.79	1098.42	1098.26	1097.32	1097.10	1097.75	1097.86	1098.00	1098.02
MW-10	1095.88	1095.84	1095.59	1095.56	1097.75	1097.28	1096.99	1095.33	1095.45	1095.47	1095.38	1095.28	1095.27
MW-11	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-12	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-13	1099.27	1099.19	1098.89	1098.87	1101.00	1100.41	-	1098.69	1100.96	1103.03	1103.07	1103.08	1103.08
MW-14	1099.72	1099.58	1099.11	1099.08	1100.47	1100.13	-	1098.79	1098.86	1099.28	1100.23	1101.18	1101.30
MW-15	1097.45	1097.11	1096.87	1096.60	1099.19	1098.93	-	1096.29	1099.07	1099.74	1100.41	1100.79	1100.81
MW-16	1097.04	1097.02	1096.95	1096.93	1097.07	1097.13	-	1096.80	1096.81	1096.87	1096.87	1096.86	1096.85
MW-17	1090.99	1090.93	1090.94	1091.30	1090.92	1090.88	-	1090.53	1090.72	1091.23	1091.41	1091.64	1091.72
MW-18	1089.52	1089.88	1091.92	1092.26	1072.36	1072.06	-	1082.23	1082.31	1082.43	1082.52	1082.76	1082.83
MW-19	1094.69	1094.67	1094.57	1094.53	1097.65	1097.16	-	1094.50	1094.40	1094.39	1094.40	1094.42	1094.41
MW-20	1096.68	1096.65	1096.50	1096.51	-	-	-	1096.50	1096.10	1096.51	1096.58	1096.60	1096.60
MW-21	1101.36	1101.34	1100.99	1100.95	1101.84	1101.71	-	1100.50	1100.47	1100.62	1100.74	1100.92	1100.96
MW-22	1095.82	1095.82	1095.65	1095.62	1084.89	1088.43	-	1095.41	1095.34	1095.40	1095.40	1095.37	1095.37
MW-23	1100.10	1099.96	1099.49	1099.38	1100.35	-	-	1098.95	1099.02	1099.14	1099.30	1099.65	1099.77
MW-24	1099.77	1099.68	1099.35	1099.26	1100.02	1099.72	1099.77	1098.86	1098.89	1098.94	1099.03	1099.24	1099.32
MW-25	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-26	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-27	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-28	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-29	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-30	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-31	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-32	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-33	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-34	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-35	-	-	-	-	-	-	-	-	-	-	-	-	-
WC-UP	1099.27	1099.26	1099.18	1099.20	1100.90	1100.36	1100.08	1099.18	1102.23	1103.09	1103.08	1103.08	1103.08
WC-DN	1097.03	1097.01	1096.94	1096.95	1098.28	1097.87	-	1096.83	1096.23	1096.86	1096.86	1096.84	1096.84
WC-DL	-	-	-	-	-	-	-	-	-	-	-	-	-
WC-FD	-	-	-	-	-	-	-	-	-	-	-	-	-

MASON CITY FMGP SITE STATIC WATER LEVEL MEASUREMENTS

	06/10/1992	06/12/1992	06/15/1992	06/16/1992	06/18/1992	06/24/1992	06/25/1992	07/07/1992	08/21/1992	10/20/1992	12/08/1993	12/13/1993	01/21/1994
MW-1	1101.11	1101.65	1101.87	1102.53	1102.81	1102.28	1102.22	1101.76	1102.13	1101.83	1098.31	1098.27	1098.27
MW-2	1102.42	1102.81	1102.80	1103.39	1103.69	1102.95	1102.89	1102.07	1102.75	1102.47	1098.64	1098.64	1098.67
MW-3	1101.65	1101.90	1101.97	1103.15	1103.24	1102.19	1102.13	1101.41	1102.12	1101.68	1098.96	1098.81	1098.48
MW-4	1098.05	1098.07	1098.06	1099.10	1099.06	1098.26	1098.19	1097.82	1098.15	1098.10	1096.98	1096.88	1096.76
MW-5	1099.01	1099.26	1099.37	1100.00	1100.09	1099.91	1099.87	1099.68	1099.92	1099.72	1098.13	1098.09	1098.01
MW-6	1099.69	1099.89	1100.03	1100.33	1100.76	1100.66	1100.60	1100.24	1100.43	1100.12	1098.41	1098.36	-
MW-7	1101.45	1101.81	1101.85	1103.03	1103.12	1102.08	1102.01	1101.41	1102.01	1101.58	1098.27	1098.24	1098.24
MW-8	1095.09	1095.05	1094.94	1096.28	1096.71	1095.49	1095.37	1094.64	1094.74	1094.84	1094.65	1094.52	1094.28
MW-9	1098.04	1098.09	1098.08	1099.23	1099.19	1098.32	1098.26	1098.02	1098.07	1097.95	1096.92	1096.86	1096.72
MW-10	1095.28	1095.21	1095.09	1096.20	1096.79	1095.73	1095.60	1095.90	1094.84	1094.94	1094.48	1094.39	1094.21
MW-11	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-12	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-13	1103.08	1103.07	1103.02	1103.73	1103.70	1103.12	1103.06	1102.54	1102.94	1102.62	1098.31	1098.31	1098.31
MW-14	1101.35	1101.57	1101.58	1102.05	1102.29	1101.91	1101.87	1101.49	1101.71	1101.67	1098.29	1098.27	1098.24
MW-15	1100.82	1100.72	1100.64	1101.35	1101.13	1100.46	1100.41	1100.10	1100.50	1100.01	1095.40	1095.30	1095.47
MW-16	1096.85	1096.91	1096.98	1097.81	1097.68	1097.39	1097.35	1096.91	1096.97	1096.81	Dry	Dry	-
MW-17	1091.75	1091.81	1091.62	1092.30	1092.33	1091.58	1091.57	1091.20	1091.41	1091.76	1091.59'	1091.20	1091.14
MW-18	1082.91	1083.80	1084.96	1085.48	1086.16	1088.63	1088.95	1073.41	1086.10	1094.94	1094.84	1074.50	1082.25
MW-19	1094.39	1094.44	1094.45	1094.71	1095.38	1095.27	1095.15	1094.35	1094.06	1094.46	1094.05	1094.06	1093.79
MW-20	1096.61	1096.60	1096.63	1096.99	1097.45	1097.13	1096.95	1093.25	1095.90	1096.65	1096.26	1096.24	1096.01
MW-21	1100.99	1101.15	1101.18	1101.58	1101.83	1101.81	1101.67	1101.16	1101.52	1102.01	1099.65	1099.59	-
MW-22	1095.36	1095.29	1095.14	1095.10	1095.70	1095.75	1095.74	1091.81	1095.03	1095.59	1094.57	1094.57	-
MW-23	1099.88	1100.44	1100.65	1101.34	1101.61	1101.40	1101.35	1100.93	1101.24	1100.93	1098.36	1098.29	-
MW-24	1099.38	1099.74	1099.89	1100.33	1100.57	1100.63	1100.60	1100.36	1100.59	1100.44	1098.22	1098.17	1098.09
MW-25	-	-	-	-	-	-	-	-	-	-	1090.63	1090.34	1089.33
MW-26	-	-	-	-	-	-	-	-	-	-	1098.74	1098.58	1098.34
MW-27	-	-	-	-	-	-	-	-	-	-	1098.06	1098.09	1098.10
MW-28	-	-	-	-	-	-	-	-	-	-	1098.64	1098.58	1098.67
MW-29	-	-	-	-	-	-	-	-	-	-	Dry	Dry	Dry
MW-30	-	-	-	-	-	-	-	-	-	-	1101.17	1101.14	1101.18
MW-31	-	-	-	-	-	-	-	-	-	-	1091.20	1090.96	1090.48
MW-32	-	-	-	-	-	-	-	-	-	-	1087.09	1085.71	1090.84
MW-33	-	-	-	-	-	-	-	-	-	-	1091.20	1090.97	1090.37
MW-34	-	-	-	-	-	-	-	-	-	-	1090.35	1090.08	1089.08
MW-35	-	-	-	-	-	-	-	-	-	-	1090.24	1090.03	1089.07
WC-UP	1103.07	1103.07	1103.06	1103.81	1103.82	1103.16	1103.10	1102.59	1102.94	1102.65	-	-	Frozen
WC-DN	1096.83	1096.81	1096.74	1097.92	1097.88	1097.02	1096.91	1096.42	1096.54	1096.70	-	-	Frozen
WC-DL	-	-	-	-	-	-	-	-	-	-	-	-	-
WC-FD	-	-	-	-	-	-	-	-	-	-	-	-	-

MASON CITY FMGP SITE STATIC WATER LEVEL MEASUREMENTS

	02/28/1994	06/02/1994	06/10/1994	06/20/1994	07/05/1994	07/15/1994
MW-1	1098.70	1100.49	1101.66	1101.06	1101.94	1101.81
MW-2	1098.94	1100.61	1102.20	1101.26	1102.60	1102.33
MW-3	1098.68	1100.30	1101.44	1101.23	1101.81	1101.57
MW-4	1097.10	1097.69	1097.91	1098.55	1098.09	1098.55
MW-5	1098.31	1099.36	1099.59	1099.97	1099.95	1100.25
MW-6	1098.61	1100.02	1100.33	1100.41	1100.81	1100.93
MW-7	1098.60	1100.15	1101.25	1101.46	1101.64	1101.37
MW-8	1094.65	1094.87	1094.81	1095.72	1095.35	1096.21
MW-9	1097.03	1097.46	1097.65	1098.23	1097.87	1098.33
MW-10	1094.52	1094.91	1094.78	1095.69	1095.58	1096.44
MW-11	-	-	-	-	-	-
MW-12	-	-	-	-	-	-
MW-13	1098.84	1100.38	1102.28	1101.48	1102.69	1102.25
MW-14	1098.73	1100.33	1101.52	1100.89	1101.80	1101.65
MW-15	-	1099.54	1101.08	1100.78	1101.01	1099.98
MW-16	Dry	Dry	Dry	Dry	1096.47	1096.36
MW-17	1091.15	1091.85	1092.29	1092.80	1093.39	1093.29
MW-18	1086.67	1095.70	1095.86	1096.27	1097.80	1098.41
MW-19	1093.98	1094.10	1094.01	1095.02	1094.42	1095.01
MW-20	1096.24	1096.46	1096.43	1097.40	1096.71	1097.52
MW-21	-	1101.52	1101.75	1102.08	1102.43	1102.55
MW-22	1094.46	1094.95	1094.77	1095.09	1095.77	1096.16
MW-23	1098.59	1100.16	1100.82	1100.79	1101.14	1101.17
MW-24	1098.41	1099.91	1100.22	1100.33	1100.49	1100.62
MW-25	1090.20	1094.80	1093.62	1094.22	1099.81	1099.80
MW-26	1098.77	1100.65	1100.97	1101.64	1101.25	1101.23
MW-27	1098.72	1099.86	1100.97	1100.33	1101.25	1101.01
MW-28	1099.04	1100.36	1101.52	1101.35	1101.88	1101.80
MW-29	Dry	1109.86	1109.71	1109.78	1109.57	1109.96
MW-30	1102.45	1104.00	1104.21	1104.19	1104.64	1104.89
MW-31	1091.97	1097.89	1096.72	1097.81	1103.58	1103.75
MW-32	1096.68	1100.62	1100.56	1100.67	1101.09	1101.23
MW-33	1091.64	1097.17	1095.72	1095.25	>1101.19	>1101.19
MW-34	1089.86	1094.25	1093.20	1093.58	1099.21	1098.89
MW-35	1089.86	1093.90	1092.90	1093.36	1098.43	1098.12
WC-UP	1099.53	1100.62	1102.29	1101.42	1102.78	1102.28
WC-DN	1096.60	1096.77	1096.69	1097.56	1096.95	1097.62
WC-DL	-	1100.63	1102.31	-	-	1102.26
WC-FD	-	1100.61	1102.28	-	-	1102.25

APPENDIX L

TABLE L-6
SAMPLE HOLDING TIME SUMMARY
ACID EXTRACTABLE AND PAH COMPOUNDS

Sample	Date Sampled	Acid Ext. Date	Holding Time Max=14d	Acid Analysis Date	Holding Time Max=40d	PAH Ext. Date	Holding Time Max=14d	PAH Analysis Date	Holding Time Max=40d
Soil:									
DP01-SL-000	11/05/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	14
DP02-SL-000	11/15/1993	Analysis Not Requested				Analysis Not Requested			
DP03-SL-001	11/16/1993	Analysis Not Requested				Analysis Not Requested			
MW27-SL-003	11/05/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	14
MW27-SL-003MS	11/05/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	14
MW27-SL-003MSD	11/05/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	14
MW28-SL-003	11/11/1993	Analysis Not Requested				12/06/1993	**25**	12/09/1993	28
MW32-SL-002	11/18/1993	Analysis Not Requested				12/06/1993	**18**	12/09/1993	21
MW32-SL-802	11/18/1993	Analysis Not Requested				11/23/1993	5	12/03/1993	15
SBFF-SL-001	11/04/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	15
SBFF-SL-003	11/05/1993	Analysis Not Requested				11/11/1993	6	12/03/1993	28
SBFF-SL-803	11/05/1993	Analysis Not Requested				11/11/1993	6	11/19/1993	14
SBGG-SL-006	11/23/1993	Analysis Not Requested				11/29/1993	6	12/03/1993	10
SBHH-SL-001	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBHH-SL-004	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBHH-SL-006	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBII-SL-001	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBII-SL-005	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBII-SL-006	11/23/1993	Analysis Not Requested				Analysis Not Requested			
SBJJ-SL-001	11/05/1993	Analysis Not Requested				Analysis Not Requested			
SBKK-SL-001	11/15/1993	Analysis Not Requested				Analysis Not Requested			
SBKK-SL-002	11/15/1993	Analysis Not Requested				Analysis Not Requested			
Groundwater:									
DP01-GW-003	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
DP02-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
DP03-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/24/1994	38
MW01-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW02-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/24/1994	39

TABLE L-6
SAMPLE HOLDING TIME SUMMARY
ACID EXTRACTABLE AND PAH COMPOUNDS

Sample	Date Sampled	Acid Ext. Date	Holding Time Max=14d	Acid Analysis Date	Holding Time Max=40d	PAH Ext. Date	Holding Time Max=14d	PAH Analysis Date	Holding Time Max=40d
MW03-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/20/1994	34
MW04-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW05-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW06-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW06-GW-003MS	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW06-GW-003MSD	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW07-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW08-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
MW09-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
MW10-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
MW10-GW-003MS	12/16/1993	Analysis Not Requested				12/22/1993	6	01/05/1994	20
MW10-GW-003MSD	12/16/1993	Analysis Not Requested				12/22/1993	6	01/05/1994	20
MW13-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/20/1994	35
MW14-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW15-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW17-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/20/1994	34
MW18-GW-003	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
MW18-GW-803	12/16/1993	Analysis Not Requested				12/20/1993	4	01/12/1994	27
MW19-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW20-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW21-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW22-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW23-GW-003	12/17/1993	Analysis Not Requested				12/21/1993	4	01/12/1994	26
MW24-GW-003	12/15/1993	Analysis Not Requested				12/17/1993	2	01/12/1994	28
MW25-GW-003	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
MW25-GW-003MS	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
MW25-GW-003MSD	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
MW25-GW-004	08/11/1994	Analysis Not Requested				08/18/1994	7	08/22/1994	11
MW26-GW-003	12/15/1993	12/20/1993	5	01/05/1994	21	12/17/1993	2	01/12/1994	28
MW27-GW-003	12/15/1993	12/20/1993	5	01/05/1994	21	12/17/1993	2	01/12/1994	28

TABLE L-6
SAMPLE HOLDING TIME SUMMARY
ACID EXTRACTABLE AND PAH COMPOUNDS

Sample	Date Sampled	Acid Ext. Date	Holding Time Max=14d	Acid Analysis Date	Holding Time Max=40d	PAH Ext. Date	Holding Time Max=14d	PAH Analysis Date	Holding Time Max=40d
MW28-GW-003	12/16/1993	12/21/1993	5	01/06/1994	21	12/20/1993	4	01/12/1994	27
MW28-GW-004	08/11/1994		Analysis Not Requested			08/18/1994	7	08/22/1994	11
MW30-GW-003	12/17/1993	12/21/1993	4	01/06/1994	20	12/21/1993	4	01/12/1994	26
MW31-GW-003	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
MW32-GW-003	12/21/1993	12/27/1993	6	01/06/1994	16	12/22/1993	1	01/12/1993	22
MW33-GW-003	12/14/1993	12/16/1993	2	12/21/1993	7	12/17/1993	3	01/12/1994	29
MW34-GW-003	12/15/1993	12/20/1993	5	01/05/1994	21	12/17/1993	2	01/12/1994	28
MW34-GW-004	08/12/1994		Analysis Not Requested			08/18/1994	6	08/22/1994	10
MW35-GW-003	12/16/1993	12/21/1993	5	01/06/1994	21	12/20/1993	4	01/12/1994	27

NOTE:
Maximum holding time before extraction of water samples for acid extractable organic compounds is 7 days from sampling date.

APPENDIX M

ANALYTICAL REPORT

Report To: Mr. Randy Kroneman
Montgomery Watson Americas
11107 Aurora Avenue
DesMoines, IA 50322

Project: Interstate Power

Section One

NET Job Number: 94.02534

National Environmental Testing

NET Atlantic, Inc.
Cambridge Division
12 Oak Park
Bedford, MA 01730

Massachusetts Certification Number
M MA023

TABLE OF CONTENTS

Page Number

Section 1. Report Front

NET®
NATIONAL
ENVIRONMENTAL
TESTING, INC.

Cambridge Division
12 Oak Park
Bedford, MA 01730
Tel: (617) 275-3535
Fax: (617) 275-7411

September 1, 1994

Mr. Randy Kroneman
Montgomery Watson Americas
11107 Aurora Avenue
DesMoines, IA 50322

RE: Interstate Power
HPLC Project

Dear Mr. Randy Kroneman:

Enclosed please find the results of the chemical analyses performed by NET Cambridge Division for the Interstate Power HPLC project, NET job number 94.02534.

This narrative addresses all comments for all samples as listed below:

NET JOB NUMBER: 94.02534

SAMPLE ID	NET ID	DATE TAKEN	TIME TAKEN	DATE REC'D	MATRIX
MW25-GW-004-081194	108278	08/11/1994	12:32	08/13/1994	GROUND WATER
MW28-GW-004-081194	108279	08/11/1994	12:33	08/13/1994	GROUND WATER
MW34-GW-004-081194	108280	08/11/1994	12:20	08/13/1994	GROUND WATER

NET®
NATIONAL
ENVIRONMENTAL
TESTING, INC.

Cambridge Division
12 Oak Park
Bedford, MA 01730
Tel: (617) 275-3535
Fax: (617) 275-7411

All laboratory comments for the data packages have been summarized in the following tables:

Sample Receipt and Login	TABLE 1
HPLC Organics Analyses	TABLE 2
Volatile Organics Analyses	No Analyses Requested
Semi-Volatile Organics Analyses	No Analyses Requested
Pesticide/PCB Organics Analyses	No Analyses Requested
Herbicides Analyses	No Analyses Requested
General Chemistry Analyses	No Analyses Requested

These narrative tables are also enclosed with each data package section.

Please find enclosed a diskette of the results for this case.

Thank you for this opportunity to be of service to you. Please do not hesitate to call or write if you have any questions or require further information.

Sincerely,

Alison P. Darrow
Project Manager

enclosures

TABLE 1
LOGIN AND SAMPLE RECEIPT SUMMARY
94.02534

No comments are necessary.

TABLE 2

HPLC ORGANICS NARRATIVE SUMMARY

94.02534

GENERAL COMMENTS: Compound calibration was performed by linear regression. The calibration report is contained in the Standards Data (7C) section. A dilution was required for sample MW28 (NET ID 108279 1:2 dilution) to bring several compounds into linear range. Both analyses are reported.

SURROGATES: All sample surrogate recoveries were within the advisory limits.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE(s): The laboratory was unable to perform a matrix spike/matrix spike duplicate due to limited sample volume. A Laboratory control sample (spiked blank) was extracted and analyzed and found to be within the advisory limits.

BLANKS: Analysis dates for all method blanks and associated samples are summarized on Form(s) 4C. No PAH compounds were detected above the Method Detection Limits.

HOLDING TIMES: All samples were extracted and analyzed within the holding times specified for the methods used.

INITIAL CALIBRATIONS: All initial calibration acceptance criteria were met.

CONTINUING CALIBRATIONS: All continuing calibration standards were acceptable.

NET Cambridge Division

ANALYTICAL REPORT

Report To:

Mr. Randy Kroneman
Montgomery Watson Americas
11107 Aurora Avenue
DesMoines, IA 50322

Reported By:

National Environmental Testing
NET Atlantic, Incorporated
Cambridge Division
12 Oak Park
Bedford, MA 01730

Report Date: 09/01/1994
NET Job Number: 94.02534

Project: Interstate Power
NET Client No: 55500

P.O. No: 2334.0210
Collected By: CLIENT
Shipped Via: FEDEX

Job Description: HPLC Project
Airbill No: 8819868492

This report has been approved and certified for release by the following staff. Please feel free to call the NET Project Manager at 617-275-3535 with any questions or comments.

Alison P. Darrow
NET Project Manager

Report prepared by
NET Reports Group

Analytical data for the following samples are included in this data report.

SAMPLE ID	NET ID	DATE TAKEN	TIME TAKEN	DATE REC'D	MATRIX
MW25-GW-004-081194	108278	08/11/1994	12:32	08/13/1994	GROUND WATER
MW28-GW-004-081194	108279	08/11/1994	12:33	08/13/1994	GROUND WATER
MW34-GW-004-081194	108280	08/11/1994	12:20	08/13/1994	GROUND WATER

94-0[illegible]534

NET NATIONAL ENVIRONMENTAL TESTING, INC.®

CHAIN OF CUSTODY RECORD

COMPANY Montgomery Watson
ADDRESS 11107 Aurora Ave. Des Moines, IA
PHONE 515-253-0830 FAX 515-255-9572
PROJECT NAME/LOCATION Interstate Power Mason City FMGP
PROJECT NUMBER 2334.0210
PROJECT MANAGER Randy Kroneman

REPORT TO:
INVOICE TO:
P.O. NO.
NET QUOTE NO.

SAMPLED BY
Randy Kroneman
(PRINT NAME)
Randy J. K
SIGNATURE

(PRINT NAME)
SIGNATURE

						# and Type of Containers					ANALYSES										
											PAHs by HPLC										COMMENTS
8/11	12:32	MW25-GW-004-081194	60	X						2	2										
8/11	12:33	MW28-GW-004-081194	"	X						2	2										
8/12	1240	MW34-GW-004-081194	"	X						2	2										

CONDITION OF SAMPLE: BOTTLES INTACT? YES / NO
FIELD FILTERED? YES / NO
COC SEALS PRESENT AND INTACT? YES / NO
VOLATILES FREE OF HEADSPACE? YES / NO
TEMPERATURE UPON RECEIPT:
Bottles supplied by NET? YES / NO

NOTE; THERE MAY BE A CHARGE FOR NET DISPOSAL OF SAMPLE REMAINDERS.

SAMPLE REMAINDER DISPOSAL: RETURN SAMPLE REMAINDER TO CLIENT VIA
I REQUEST NET TO DISPOSE OF ALL SAMPLE REMAINDERS
DATE

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	RELINQUISHED BY:	DATE/TIME	RECEIVED FOR NET BY:
Randy Kr	8/12/94 1:10	Fedex 8819868492	Fedex 8819868492	8/13 12:00	Michael McCormack

METHOD OF SHIPMENT
Federal Express

REMARKS:

ORGANIC FLAGS AND SAMPLE SUFFIXES

The following qualifiers have been used for reporting results:

B - The "B" flag indicates that the analyte was found in the associated blank as well as in the sample.

E - The "E" flag indentifies compound concentrations that exceed the calibration range of the GC/MS instrument. For Benzo (b) and Benzo (k) Flouranthene, the calibration range of <u>each peak</u> will be considered separately. Ortho, para, and meta xylene are quantified as two peaks, the calibration range of <u>each peak</u> will be considered separately.

D - If a sample is re-analyzed due to high concentrations and both the original analysis and re-analysis have been reported, the diluted analysis will have the "DL" suffix. All concentration values reported for the diluted analysis will be flagged with a "D".

U - The "U" flag indicates that the compound was analyzed for but not detected. The reported "U" value is the detection limit for the given compound. The value is corrected for dilution and for percent moisture.

J - The "J" flag indicates an estimated value. The flag is used for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral or chromatographic data indicate the presence of a compound that meets the identification criteria but the quantitated value is less than the method quantitation limit.

P - The "P" flag indicates that the quantitated value of a target pesticide/PCB differs by more than 25% on the two GC columns that were reported.

Y - Compound values that are flagged with a "Y" have been edited on our RTE/MS data system.

X - Compound values that are flagged with a "X" have been edited on our Foremaster data reporting system.

C - This flag applies to pesticide or GC parameters where the identification has been confirmed by GC/MS.

The following sample suffixes have been used:

XXXXX = sample number
XXXXXMS = matrix spike sample
XXXXXMSD = matrix spike duplicate sample
XXXXXRE = re-analyzed sample
XXXXXDL = sample analyzed at a secondary dilution

HPLC ANALYSIS
EPA CLP 3/90 Deliverables Inventory

Project Name: Montgomery Watson Interstate Power Project
NET Job Numbers: 94.02534
FD Number: 02534

	ITEM		PAGE
2.	HPLC Organics Data		2 0000
2A.	QC Summary	-Forms II, III, IV, V	2 0001
2B.	Sample Data	-Forms I, Ib, Raw Data	2 0007
2C.	Standards Data	-Forms VI, VII, VIII, Raw Data	2 0032
[illegible]	Raw QC Data		
2D2.	Blank Data	-Form I, Ib, Raw Data	2 0111
2D4.	LCS Spike -Form I, Raw Data		2 0117
2D4.	Matrix Spike Duplicate - Form I, Raw Data		NR

VOLUME 3

REMEDIAL INVESTIGATION ADDENDUM

FOR

FORMER MANUFACTURED GAS PLANT SITE
MASON CITY, IOWA

Prepared for

INTERSTATE POWER COMPANY
DUBUQUE, IOWA

VOLUME 3
APPENDICES

Project No. 2334.0218

April 1994
Revised September 1994

Prepared by

Montgomery Watson
11107 Aurora Avenue
Des Moines, Iowa 50322
515-253-0830

APPENDIX N

LABORATORY DATA CONSULTANTS, INC.
7750 El Camino Real, Suite 2C, Carlsbad, CA 92009 Phone: 619/634-0437 Fax: 619 634-0439

LDC# 1377A

September 28, 1994

Montgomery Watson
11107 Aurora Avenue
Des Moines, IA 50322
Attn: Mr. Randy Kroneman

SUBJECT: Interstate Power Company, Data Validation

On September 9, 1994 one data package containing a laboratory report and data deliverables were received by Laboratory Data Consultants, Inc. from Montgomery Watson for data validation. The data packages were generated by NET Bedford MA.

Enclosed are the final validation reports for the fractions listed below.

LDC Project # 1377:

SDG #	**Fraction**
94.02534**	Polynuclear Aromatic Hydrocarbons

** Indicates SDG underwent EPA Level IV review.

The following is a list of the analyses performed and the method used for analyses:

- Polynuclear Aromatic Hydrocarbons (EPA SW 846 Method 8310)

The analyses were validated using the following documents, as applicable to each method:

- USEPA, National Functional Guidelines for Evaluating Organic Analyses, Draft June 1991.

The data validators did utilize their professional judgement when evaluating the data to achieve the most complete and accurate assessment of the data.

The data packages were reviewed according to the above stated validation procedures.

Sincerely,
Stacey Murakami for

Beth A. Lantz
Staff Chemist

Richard M. Amano
President/Principal Chemist

LDC #1377 (Montgomery Watson/Interstate Power FMGP Site)

Sent 9-28-94

LDC	SDG#	DATE REC'D	DATE DUE	HPLC PNAs																																			
Matrix: Water/Soil				W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
A	94.02534	9-9-94	10-7-94	4	0																																		
Total				4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Shaded cells indicate EPA Level IV validation (all other cells are EPA Level III validation)

1377ST.JMM

LDC Report# 1377A9

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name:	Interstate Power Company
Collection Date:	August 11, 1994
LDC Report Date:	September 28, 1994
Matrix:	Water
Parameters:	Polynuclear Aromatic Hydrocarbons
Laboratory:	NET, Bedford
Sample Delivery Group (SDG):	94.02534**

Sample Numbers:

MW25-GW-004-081194
MW28-GW-004-081194
MW28-GW-004-081194DL
MW34-GW-004-081194

** Indicates SDG underwent EPA Level IV review.

Introduction

This data review covers 4 water samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8310 for Polynuclear Aromatic Hydrocarbons.

This review follows a modified outline of the EPA Functional Guidelines for Organic Data Review (Revised, June 1991) as there are no current guidelines for EPA SW 846 Method 8310. The modifications were based on EPA SW 846 Method 8310.

A table summarizing all data qualification flags is provided at the end of this report.

Blank results are summarized in Section III.

Field duplicates are summarized in Section VIII.

I. Technical Holding Times

All technical holding time requirements were met.

II. Calibration

a. Initial Calibration

Initial calibration of analytes was performed as required by EPA SW 846 Method 8310.

A curve fit, based on the initial calibration, was established for quantitation. The coefficient of determination (r^2) was greater than or equal to 0.990.

Retention time windows were established according to the method and were within validation criteria with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 94.02534.	All TCL compounds	Retention time windows incorrectly established.	Retention time windows to be established according to the method.	None	P

b. Calibration Verification

Calibration verification was performed at required frequencies.

The relative percent difference (RPD) of amount in continuing standard mixtures were within the 15% QC limits.

Retention times (RT) of all compounds in the calibration standards were evaluated as acceptable.

III. Blanks

Method blank analyses were performed for each matrix and at the required frequencies. No polynuclear aromatic hydrocarbon contaminants were found in the method blanks.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to the samples as required by the method. All surrogate recoveries were within QC limits.

b. Matrix Spike/Matrix Spike Duplicates

The laboratory has indicated that there was insufficient sample volume for analysis.

c. Laboratory Control Samples

Laboratory control samples were analyzed for each matrix and at the required frequencies. Percent recoveries were within QC limits.

V. Target Compound Identification

All target compound identifications were within validation criteria.

VI. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria with the following exceptions:

Sample	Compound	Reported Concentration	Recalculated Concentration	Flag	A or P
MW28-GW-004-081194	Dibenz(a,h)anthracene	0.144 ug/L	0.122 ug/L	J	P

VII. System Performance

The system performance was acceptable.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

No field duplicates were identified in this SDG.

X. Field Blanks

No field blanks were identified in this SDG.

Interstate Power Company
Polynuclear Aromatic Hydrocarbons - Data Qualification Summary - SDG 94.02534**

SDG	Sample	Compound	Flag	A or P	Reason
94.02534	MW25-GW-004-081194 MW28-GW-004-081194 MW28-GW-004-081194DL MW34-GW-004-081194	All TCL compounds	None	P	Initial calibration (RT)
94.02534	MW28-GW-04-081194	Dibenz(a,h)anthracene	J	P	Compound quantitation and CRQLs

Interstate Power Company
Polynuclear Aromatic Hydrocarbons - Laboratory Blank Data Qualification Summary - SDG 94.02534**

No Laboratory Blank Data Qualified in this SDG.

SDG# 94.02534 POLYNUCLEAR AROMATIC HYDROCARBONS DATA QUALIFICATION
LDC# 1377A9

Compound	MW25-GW-004-081194	MW28-GW004-081194	MW28-GW-004-081194DL	MW34-GW-004-081194			
Naphthalene							
Acenaphthylene							
Acenaphthene							
Fluorene							
Phenanthrene							
Acethracene							
Fluoranthene							
Pyrene							
Benzo(a)anthracene							
Chrysene							
Benzo(b)fluoranthene							
Benzo(k)fluoranthene							
Benzo(a)pyrene							
Indeno(1,2,3-cd)pyrene							
Dibenz(a,h)anthracene		J					
Benzo(g,h,i)perylene							

LDC #: 1377A9

SDG #: 94.02534

boratory: NET, Bedford

VALIDATION COMPLETENESS WORKSHEET

X EPA Level IV __NEESA Level D

Date: 9/18/94

Page: 1 of 1

Reviewer: ARH

2nd Reviewer:

THOD: GC Polynuclear Aromatic Hydrocarbons (EPA SW 846 Method 8310)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Technical holding times	A	Sampling dates: 8/11/94
IIa.	Initial calibration	SW	
IIb.	Calibration verification		
III.	Blanks	A	
IVa.	Surrogate recovery	A	
IVb.	Matrix spike/Matrix spike duplicates	N	
IVc.	Laboratory control samples	A	
V.	Target compound identification		
VI.	Compound Quantitation and CRQLs	SW	
VII.	System Performance	A	
VIII.	Overall assessment of data	A	
IX.	Field duplicates	N	
X.	Field blanks	N	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet
ND = No compounds detected
R = Rinsate
FB = Field blank
D = Duplicate
TB = Trip blank
EB = Equipment blank

Validated Samples:

1	MW25-GW-004-081194 AQ	11		21	
2	MW28-GW-004-081194	12		22	
3	MW28-GW-004-081194DL	13		23	
4	MW34-GW-004-081194	14		24	
5	PBLK0818	15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	

Notes:

PAH.IV

LDC #: 1377A9
SDG #: 94.02534

VALIDATION FINDINGS WORKSHEET
Technical Holding Times

Page: 1 of 1
Reviewer: AZH
2nd Reviewer:

Circled dates have exceeded the technical holding times.

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310

Sample ID	Matrix	Preserved	Sampling Date	Extraction date	Analysis date	Qualifier
1	water	N/A	8-11-94	8-18-94	8-22-94	No Qual
2	↓	↓	↓	↓	↓	↓
3	↓	↓	↓	↓	↓	↓
4	↓	↓	↓	↓	↓	↓

TECHNICAL HOLDING TIME CRITERIA

VOLATILES:	Water unpreserved:	Aromatic within 7 days, non-aromatic within 14 days of sample collection.
	Water preserved:	Both within 14 days of sample collection.
	Soils:	Both within 14 days of sample collection.
EXTRACTABLES:		
	Water:	Extracted within 7 days, analyzed within 40 days.
	Soil:	Extracted within 14 days, analyzed within 40 days.

LDC #: 137[redacted]9
SDG #: 9[redacted]534

VALIDATION FIN[redacted]GS WORKSHEET
Initial C[redacted]ration

P[redacted] 1 of 1
Re[redacted] AZH
2nd Reviewer: L

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y [✓ N] N/A Were the retention time windows properly established for all standards?
[✓ Y] N N/A Were the correct number of standards run in the initial calibration?
[✓ Y] N N/A Was a linear fit used for evaluation? If yes, the acceptance criteria for each compound is %RSD less than or equal to 20.0%.
[✓ Y] [✓ N] N/A AZH Was a curve fit used for evaluation? If yes, what was the acceptance criteria used for evaluation? r ≥ 0.995
[✓ Y] N N/A Did the initial calibration meet the acceptance criteria? $r^2 \geq 0.990$

Level IV Only

[✓ Y] N N/A Were the calibration factor and linearity results recalculated for selected compounds? (Please see Initial Calibration calculation verification worksheet.)
[✓ Y] N N/A Were the calibration factor and linearity reported results within 10.0% of the recalculated results?

#	Date	Standard ID	Column / Detector	Compound	Finding	Associated Samples	Qualifications
1	-	RT windows not established according to SW 846 Method 8000.				All samples method blanks	NA / P
		Analyst evaluates RT's against bracketing stds.					

A. ____________ D. ____________
B. ____________ E. ____________
C. ____________ F. ____________

Comments ____________

LDC #: 13[illegible]9
SDG #: 94.02534

VALIDATION FIND[illegible]S WORKSHEET
Initial Calibration Calculation Verification

P[illegible] 1 of 1
Revie[illegible]r: ARH
2nd Reviewer: ~

METHOD: ___ GC ___ HPLC (EPA SW846 Method 8310)

The ✓ coefficient of determination (r^2) ___ Correlation coefficient (r) value for a linear regression curve fit was recalculated for Acenaphthene & Pyrene

50 ul

Calibration Date	Column	Compound	Standard	(x) Standard Amount ~~(ng)~~ (ug/mL)	(y) Area	Recalculated	Reported
						(r^2)	(r^2)
8/22/94	uv	Acenaphthene	Point 1	10.0	1596010	0.9994662	0.9994661
			Point 2	7.5	1222755 ~~9473199~~ ARH		
			Point 3	2.0	317566		
			Point 4	1.0	155566		
			Point 5	0.5	109735		
			Point ~~5~~ 6	0.25	38370		
↓	Fluor.	Pyrene	Point 1	1.00	1728879	0.9979085	0.9979085
			Point 2	0.75	1386761		
			Point 3	0.20	362128		
			Point 4	0.10	181351		
			Point 5	0.05	128117		
			Point ~~5~~ 6	0.025	48622		

Comments: Refer to Initial Calibration findings worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 12[illegible]9
SDG #: 9[illegible]534

VALIDATION FIN[illegible]GS WORKSHEET

Continuin[illegible]alibration

P[illegible] 1 of 1
Re[illegible] AeH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846) Method 8310

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

What type of continuing calibration calculation was performed? ___%D or ✓ RPD

[✓ Y] N N/A Were continuing calibration standards analyzed at the required frequencies?

Y N [✓ N/A] Were the retention times for all calibrated compounds within their respective acceptance windows? UPDATED DAILY.

[✓ Y] N N/A Did the continuing calibration standards meet the %D / RPD validation criteria of ≤15.0%?

Level IV Only

[✓ Y] N N/A Were the percent difference (%D) results recalculated for selected compounds? (Please see Continuing Calibration Results Verification worksheet.)

[✓ Y] N N/A Were the (%D) reported results within 10.0% of the recalculated results?

#	Date	Standard ID	Column / Detector	Compound	%D / RPD (Limit ≤ 15.0)	RT (Limits)	Associated Samples	Qualifications
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
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						( )		
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						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		
						( )		

A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
K.
L.
M.
O.
P.

LDC #: 13 [illegible]
SDG #: 94.02534

VALIDATION FIND[illegible]S WORKSHEET
Continuing Calibration Results Verification

[illegible] 1 of 1
Reviewer: RD it
2nd Reviewer: A

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

The continuing calibration percent difference (%D) values were recalculated for Acenaphthene and Pyrene using the following calculation:

Percent difference (%D) = 100 * (N - C)/N

Where: N = ~~Initial Calibration Factor~~ ~~(average)~~ ARH Nominal amount,
C = ~~Calibration Factor~~ from Continuing Verification Standard ARH calculated amount

						Recalculated	Reported
Standard ID	Calibration Date/Time	Detector ~~Column~~ ARH	Compound	C	N	%D	%D
STD C20	8/22/94, 17:08	UV	Acenaphthene	4.980 ~~160101~~	5.000 ~~168323~~ ARH	0.40	0.40
↓	↓	Fluor.	Pyrene	0.510	0.500	2.00	-2.08

Comments: Refer to Continuing Calibration findings worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 1[illegible]49
SDG #: 94.02534

VALIDATION FINL[illegible]S WORKSHEET
Blanks

Pa[illegible] of 1
Reviewer: ARH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

[✓ Y] N N/A Were all samples associated with a given method blank?
[✓ Y] N N/A Was a method blank performed for each matrix and whenever a sample extraction procedure was performed?
[✓ Y] N N/A Was a method blank performed with each extraction batch?
Y [✓ N] N/A Were any contaminants found in the method blanks? If yes, please see findings below.

Blank analysis date: 8/22/94
Conc. units: ug/L

Compound	Blank ID	Sample Identification								
▨	PBLK0818									
None Detected										

ALL CIRCLED RESULTS WERE NOT QUALIFIED. ALL RESULTS NOT CIRCLED WERE QUALIFIED BY THE FOLLOWING STATEMENT:
All contaminants within five times the method blank concentration were qualified as not detected, "U".

LDC #: 137[illegible]9
SDG #: 94[illegible]34

VALIDATION FIND[illegible]S WORKSHEET
Surrogate [illegible]covery

F[illegible] 1 of 1
Re[illegible]: ARH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310
Are surrogates required by the method? Yes____ or No____.
Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".
[✓ Y] N N/A Were surrogates spiked into all samples and blanks?
[✓ Y] N N/A Did all surrogate recoveries (%R) meet the QC limits stated below?

#	Date	Lab ID/Reference	Column	Surrogate Compound	%R (Limits)	Associated Samples	Qualifications
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		

Letter Designation	Surrogate Compound	Recovery QC Limits (Soil)	Recovery QC Limits (Water)	Comments
A	p-Terphenyl	30 ~~40~~ -140 ARH	40 ~~30~~ -140 ARH	
B				

SUR.GC

LDC #: 137[illegible]9
SDG #: 94[illegible]4

VALIDATION FINDINGS WORKSHEET
Matrix Spike/Mat[illegible]pike Duplicates

Page: 1 of 1
Rev[illegible]: ARH
2nd Reviewer: ✓

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y [✓ N] N/A Were all samples associated with a matrix spike (MS) and matrix spike duplicate (MSD)?
Y [✓ N] N/A Were a matrix spike (MS) and matrix spike duplicate (MSD) analyzed for each matrix?
Y N [✓ N/A] Were the MS/MSD percent recoveries (%R) and relative percent differences (RPD) within QC limits stated below?

Level IV/D Only

Y N [✓ N/A] Were a MS/MSD analyzed for each analytical extraction batch of ≤20 samples?
Y N [✓ N/A] Were the percent recoveries (%R) and relative percent differences (RPD) recalculated for all spiked compounds?
Y N [✓ N/A] Were the percent recoveries (%R) and relative percent differences (RPD) reported results within 10.0% of the recalculated results?

#	Date	MS/MSD ID	Compound	MS %R (Limits)	MSD %R (Limits)	RPD (Limits)	Associated Samples	Qualifications
1	—	No MS/MSD	All	( )	( )	( )	All Samples	No Qual
				( )	( )	( )		
				( )	( )	( )		(insufficient sample
				( )	( )	( )		submitted per
				( )	( )	( )		case narrative)
				( )	( )	( )		
				( )	( )	( )		
				( )	( )	( )		
				( )	( )			
				( )	( )	( )		
				( )	( )	( )		
				( )	( )	( )		

Letter Designation	Compound	Soil QC Limits		Water QC Limits	
		% Recovery	RPD	% Recovery	RPD
A	Naphthalene			40-140	
B	Acenaphthylene			↓	
C	Acenaphthene				
D	Fluorene				
E	Phenanthrene				
F	Anthracene				
G					
H					
I					
J					

LDC #: 137[illegible]9
SDG #: 94[redacted]534

VALIDATION FIND[redacted]GS WORKSHEET
Matrix Spike/Matrix Spike D[redacted]cates Results Verification

P[redacted] 1 of 1
Rev[redacted] ARH
2nd Reviewer:

METHOD: GC__ ✓HPLC (EPA SW846 Method 8310)

The percent recoveries (%R) and relative percent differences (RPD) of the matrix spike and matrix spike duplicate were recalculated for the compounds identified below using the following calculation:

%Recovery = 100 * (SSC - SC)/SA Where SSC = Spiked concentration SC = Sample concentration
SA = Spike added

RPD = | MS - MSD | * 2/(MS + MSD) MS = Matrix spike percent recovery MSD = Matrix spike duplicate percent recovery

MS/MSD samples: No MS/MSD

Compound	Spike Added ( )		Sample Concentration ( )	Spike Sample Concentration ( )		Matrix spike Percent Recovery		Matrix Spike Duplicate Percent Recovery		MS/MSD RPD	
	MS	MSD	—	MS	MSD	Reported	Recalc.	Reported	Recalc.	Reported	Recalculated

Comments: Refer to Matrix Spike/Matrix Spike Duplicates findings worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 13[illegible]9
SDG #: 94[illegible]34

VALIDATION FIND[illegible]GS WORKSHEET
Laboratory Cont[illegible]Samples (LCS)

P[illegible] 1 of 1
Re[illegible] [illegible]
2nd Reviewer:

METHOD: ___ GC ___ HPLC (EPA SW846 Method 8310)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

[✓ Y] N N/A Was a blank spike analyzed for each matrix or whenever a sample extraction was performed?

[✓ Y] N N/A Were the blank spike percent recoveries (%R) and relative percent differences (RPD) within the QC limits stated below?

#	Date	Lab ID/Reference	Compound	%R (Limits)	RPD (Limits)	Associated Samples	Qualifications
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		
				( )	( )		

Letter Designation	Compound	Water ~~Soil~~ [illegible] QC Limits		Water QC Limits	
		% Recovery	Compound ~~RPD~~ [illegible]	% Recovery	RPD
A	Naphthalene	40-140	K Benzo(b)fluoranthene	40-140	
B	Acenaphthylene	↓	L Benzo(k)fluoranthene	↓	
C	Acenaphthene		M Benzo(a)pyrene		
D	Fluorene		N Indeno(123cd)pyrene		
E	Phenanthrene		O Dibenzo(ah)anthracene		
F	Anthracene		P Benzo(ghi)perylene		
G	Fluoranthene				
H	Pyrene				
I	Benzo(a)anthracene				
J	Chrysene				

LDC #: 137[redacted]
SDG #: 94[redacted]34

VALIDATION FIND[redacted]GS WORKSHEET
Target Compou[redacted]dentification

Pr[redacted] 1 of ___
Revi[redacted] ACH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846) Method 8310

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

[✓ Y] N N/A Were the retention times for detected target compounds within their retention time windows?

#	Date	Standard ID	Column / Detector	Compound	RT (Limits)	Associated Samples	Qualifications
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		
					( )		

A.___
B.___
C.___
D.___
E.___

Comments:___

LDC #: 13779
SDG #: 94. [redacted] 4

VALIDATION FINDINGS WORKSHEET
Compound Quantitatio [redacted] d Reported CRQLs

Page 1 of 1
Revir [redacted] ACH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846) Method 8310

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Level IV/D Only

[✓ Y] N N/A Were CRQLs adjusted for sample dilutions, dry weights, etc.?
Y [✓ N] N/A Did the reported results for detected target compounds agree within 10.0% of the recalculated results?

#	Date	Sample ID	Finding	Associated Samples	Qualifications
1	8/22/94	#2	Dibenzo(a,h)anthracene	#2	J/P compound
			reported as 0.144 µg/L		
			recalc as 0.122 µg/L		

Comments: See sample calculation verification worksheet for recalculations

LDC #: 1377A9
SDG #: 94.02534

VALIDATION FINDINGS WORKSHSHEET
Sample Calculation Verification

Page: 1 of 4
Reviewer: RCH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846) Method 8310

Compound results for All Level IV samples reported with a positive detect were recalculated and verified using the following equation:

Concentration = $\dfrac{(B + [M(A_x)](DF)}{((V_o/V_t)(V_i))}$

B = ~~slope~~ y-intercept RCH of linear equation
m = slope of linear equation
A_x = area of compound
V_o = initial sample volume (mL)
V_t = concentrated extract volume (mL)
V_i = volume injected (mL)

Example:

Sample I.D. #2 → Naphthalene

Conc. = $\dfrac{(-2.191094) + [1.088030 \times 10^{-4} (321870)](1)}{(970\text{ mL})/(1\text{ mL})(0.050)(\text{—})}$

= 0.677

#	Sample ID	Compound	Reported Concentration (µg/L)	Calculated Concentration (µg/L)	Acceptable (Y/N)
1	#2	V_o = 970 mL	~~0.677 µg/L~~		
		V_t = 1 mL			
		V_i = 0.050 mL			
		DF = 1			
		Naphthalene	~~0.667~~ 0.677 RCH	0.677	Y
		$B = 1.088030 \times 10^{-4}$			
		$M = -2.191094$			
		$A_x = 321870$			
		Phenanthrene	0.182	0.182	Y
		$B = 8.705594 \times 10^{-6}$			
		$M = 3.014690 \times 10^{-2}$			
		$A_x = 1011667$			
		Anthracene	0.083	0.083	Y
		$B = 3.80\overset{2}{\cancel{8}}392 \times 10^{-6}$			
		$M = -3.932476 \times 10^{-1}$			
		$A_x = 1159942$			

Note:

LDC #: 1377A9
SDG #: 94.0534

VALIDATION FINDINGS WORKSHEET
Sample Calculation Verification (additional page)

Page: 2 of 4
Reviewer:
2nd Reviewer:

METHOD: ___ GC _✓_ HPLC (EPA ________________)

#	Sample ID	Compound	Reported Concentration (µg/L)	Calculated Concentration (µg/L)	Acceptable (Y/N)
1	# 2-cont	Fluoranthene	1.350	1.347	Y
		$B = 1.585479 \times 10^{-5}$			
		$M = -5.883919 \times 10^{-1}$			
		$A_x = 4156287$			
		Pyrene	2.210 E	2.211	Y
		$B = 2.854480 \times 10^{-5}$			
		$M = -5.415852 \times 10^{-1}$			
		$A_x = 3776229$			
		Benzo(a)anthracene	0.854	0.854	Y
		~~Chr~~ $_{AAH}$ $B = 8.858859 \times 10^{-6}$			
		$M = -4.365640 \times 10^{-1}$			
		$A_x = 4722632$			
		Chrysene	0.840	0.840	Y
		$B = 8.48025 \times 10^{-6}$			
		$M = -3.214210 \times 10^{-1}$			
		$A_x = 4844080$			
		Benzo(b)fluoranthene	0.663	0.663	Y
		$B = 6.060009 \times 10^{-6}$			
		$M = -6.234109 \times 10^{-1}$			
		$A_x = 5412721$			
		Benzo(k)fluoranthene	0.384	0.384	Y
		$B = 3.054253 \times 10^{-6}$			
		$M = -2.479126 \times 10^{-1}$			
		$A_x = 6179847$			
		Benzo(a)pyrene	1.130 E	1.126	Y
		$B = 5.711803 \times 10^{-6}$			
		$M = -2.422619 \times 10^{-1}$			
		$A_x = 9605646$			
		Indeno(123cd)pyrene	0.579	0.579	Y
		$B = 1.936953 \times 10^{-5}$			
		$M = -6.415246 \times 10^{-1}$			

$A_x = 1482416$

LDC #: 1377A9
SDG #: 94.0534

VALIDATION FINDINGS WORKSHEET
Sample Calculation Verification (additional page)

Page: 3 of 4
Reviewer:
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

#	Sample ID	Compound	Reported Concentration (µg/L)	Calculated Concentration (µg/L)	Acceptable (Y/N)
1	#2-cont	Dibenzo(ah)anthracene	0.144	0.122	N
		$B = 2.293891 \times 10^{-5}$ ✓			
		$M = -4.022541 \times 10^{-1}$ ✓			
		$A_x = 275537$ ✓			
		Benzo(ghi)perylene	0.915	0.915	Y
		$B = 2.759806 \times 10^{-5}$			
		$M = -1.574578 \times 10^{-1}$			
		$A_x = 1613896$			
2	#3	$V_0 = 970$ mL			
		$V_E = 1$ mL			
	(see #2 for	$V_i = 0050$ mL			
	B & M constants)	DF = 2			
		Naphthalene	0.615	0.615	Y
		$A_x = 157315$			
		Phenanthrene	0.191	0.191	Y
		$A_x = 529429$			
		Anthracene	0.073	0.073	Y
		$A_x = 566490$			
		Fluoranthene			
		$A_x = 2109200$	1.350	1.355	Y
		Pyrene			
		$A_x = 1761465$	2.050	2.051	Y

LDC #: 1377A9
SDG #: 94.0534

VALIDATION FINDINGS WORKSHEET
Sample Calculation Verification (additional page)

Page: 4 of 4
Reviewer: AEH
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310

#	Sample ID	Compound	Reported Concentration (µg/L)	Calculated Concentration (µg/L)	Acceptable (Y/N)
2	#3-cont.	Benzo(a)anthracene A_x = 2300765	0.822	0.822	Y
		Chrysene A_x = 2446974	0.842	0.842	Y
		Benzo(b)fluoranthene A_x = 2716308	0.653	0.653	Y
		Benzo(k)fluoranthene A_x = 3135779	0.385	0.385	Y
		Benzo(a)pyrene A_x = 4833940	1.130	1.129	Y
		Indeno(123cd)pyrene A_x = 968625	0.747	0.747	Y
		Dibenzo(ah)anthracene A_x = 127202	0.104 J	0.104	Y
		Benzo(ghi)perylene A_x = 709416	0.801	0.801	Y

LDC #: 137[illegible]29
SDG #: 94[illegible]34

VALIDATION FIND[illegible]GS WORKSHEET
System P[illegible]rmance

Pag[illegible] 1 of 1
Reviev[illegible]
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846) Method 8310

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

[✓ Y] N N/A Was the system performance acceptable?

Professional judgement was applied to assess system performance as there are no specific criteria for system performance evaluation.

#	Date	Lab ID/Reference	Finding	Associated Samples	Qualifications

Comments: ______

LDC #: 137[illegible]4
SDG #: 94,[illegible]4

VALIDATION FINDINGS WORKSHEET
Overall Assessment of Data

Page: 1 of 1
Reviewer: [illegible]
2nd Reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

All available information pertaining to the data were reviewed using professional judgement to compliment the determination of the overall quality of the data.

[✓ Y] N N/A Was the overall quality and usability of the data acceptable?

#	Date	Sample ID	Finding	Associated Samples	Qualifications

Comments: ______

LDC #: 1377A9
SDG #: 94.02534

VALIDATION FINDINGS WORKSHEET
Field Duplicates

Page: 1 of 1
Reviewer:
2nd reviewer:

METHOD: ___ GC [✓] HPLC (EPA SW846 Method 8310)

Y [✓ N] N/A Were field duplicate pairs identified in this SDG?
Y N [✓ N/A] Were target compounds detected in the field duplicate pairs?

Compound	Concentration ( )		RPD

Compound	Concentration ( )		RPD

Compound	Concentration ( )		RPD

Compound	Concentration ( )		RPD

LDC #: 1377A9
SDG #: 94.02534

VALIDATION FINDINGS WORKSHEET
Field Blanks

Page: 1 of 1
Reviewer: ACM
2nd reviewer:

METHOD: ___ GC ✓ HPLC (EPA SW846 Method 8310)

Y [✓ N] N/A Were field blanks identified in this SDG?
Y N [✓ N/A] Were target compounds detected in the field blanks?

Sample: ______________________ Field Blank / Trip Blank / Rinsate (circle one)

Compound	Concentration Units ( )

Sample: ______________________ Field Blank / Trip Blank / Rinsate (circle one)

Compound	Concentration Units ( )

Sample: ______________________ Field Blank / Trip Blank / Rinsate (circle one)

Compound	Concentration Units ( )

APPENDIX R

MW-25	GROUNDWATER				
	14-Dec-93		11-Aug-94		
VOCs	**ug/L**				
Acetone	10	UJ			
Acrolein					
Acrylonitrile					
Benzene	10	U			
Bromomethane	10	UJ			
Bromodichloromethane	10	U			
Bromoform	10	U			
2-Butanone	10	U			
Carbon disulfide	10	U			
Carbon tetrachloride	10	U			
Chlorobenzene	10	U			
Chlorodibromomethane					
Chloroethane	10	UJ			
Chloromethane	10	U			
2-Chloroethyl vinyl ether					
Chloroform	10	U			
1,2-Dibromoethane					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
1,1-Dichloroethane	10	U			
1,2-Dichloroethane	10	U			
1,1-Dichloroethene	10	UJ			
cis-1,2-Dichloroethene	10	U			
trans-1,2-Dichloroethene	10	U			
1,2-Dichloropropane	10	U			
cis-1,3-Dichloropropene	10	U			
trans-1,3-Dichloropropene	10	U			
1,3-Dichloropropylene					
Dichlorobromomethane					
Dibromochloromethane	10	U			
Dichlorodifluoromethane					
Ethylbenzene	10	U			
2-Hexanone	10	U			
Hexanone					
Methyl Bromide					
Methyl Chloride					
Methylene chloride	10	U			
4-Methyl-2-pentanone	10	U			
Styrene	10	U			
Tetrachloroethane	10	U			
Tetrachloroethene	10	U			
Tetrahydrofuran					
Toluene	10	UJ			
1,1,1-Trichloroethane	10	U			
1,1,2-Trichloroethane	10	U			
Trichloroethene	10	U			
Trichlorofluoromethane					
Vinyl acetate					
Vinyl chloride	10	U			
Xylenes	10	U			
PAHs	**ug/L**		**ug/L**		
Acenaphthene	1.38	JN	0.28	U	
Acenaphthylene	0.239	U	0.225	U	
Anthracene	0.02	U	0.019	U	
Benzo(a)anthracene	0.026	U	0.026	U	
Benzo(a)pyrene	0.017	U	0.016	U	
Benzo(b)fluoranthene	0.053	U	0.05	U	
Benzo(g,h,i)perylene	0.053	U	0.041	U	
Benzo(k)fluoranthene	0.028	U	0.026	U	
Chrysene	0.026	U	0.025	U	
Dibenz(a,h)anthracene	0.053	U	0.052	U	
Fluoranthene	0.075	U	0.071	U	
Fluorene	0.058	U	0.055	U	
Indeno(1,2,3-cd)pyrene	0.026	U	0.032	U	
Naphthalene	0.252	U	0.238	U	
Phenanthrene	0.026	U	0.025	U	
Pyrene	0.026	U	0.052	U	
Total Carcinogenic PAHs	0		0		
Total PAHs	1.38		0		

MW-25	GROUNDWATER				
	14-Dec-93		11-Aug-94		
ACID EXTRACTABLES	**ug/L**				
2,4,5-Trichlorophenol	25	U			
2,4,6-Trichlorophenol	10	U			
2,4-Dichlorophenol	10	U			
2,4-Dimethylphenol	10	U			
2,4-Dinitrophenol	25	U			
2-Chlorophenol	10	U			
2-Methylphenol	10	U			
2-Nitrophenol	10	U			
4,6-Dinitro-2-methylphenol	25	U			
4-Chloro-3-methylphenol	10	U			
4-Methylphenol	10	U			
4-Nitrophenol	25	U			
Benzoic Acid	50	U			
Pentachlorophenol	25	U			
Phenol	10	U			
Cresols, Total					
Phenolics					
METALS	**ug/L**				
Arsenic	2.0	U			
Barium					
Cadmium					
Calcium	10300				
Chromium, Total	4.0	U			
Chromium, Hexavalent					
Copper	4.0	U			
Iron	958	NJ			
Lead	9.6	NJ			
Magnesium	39600				
Manganese	25.7				
Mercury					
Nickel	15.0	U			
Potassium	2210	B			
Selenium					
Silver					
Sodium	23800				
Zinc	5.0	U			
CYANIDES	**ug/L**				
Cyanide, Total	10.0	U			
Cyanide, Amenable					
Cyanide, after chlorination					
OTHER PARAMETERS	**mg/L**				
Bromide	0.5	U			
Chloride	46				
Fluoride	1.9				
Iodine	0.1	U			
Solids, dissolved (TDS)	610				
Sulfate	140				
Sulfide	1	U			
Thiocyanate	0.1	U			
Thiosulfate	1.0	U			
Percent solids, Total					
Total Organic Carbon (TOC)	1.5				

MW-28	**GROUNDWATER**						**SOIL**					
	12/16/93		8/11/94				11/11/93					
							SL-003					
VOCs	**ug/L**						**ug/kg**					
Acetone	10	U					18	U				
Acrolein												
Acrylonitrile												
Benzene	2	J					18	U				
Bromomethane	10	U					18	U				
Bromodichloromethane	10	U					18	U				
Bromoform	10	U					18	U				
2-Butanone	10	U					18	U				
Carbon disulfide	10	U					18	U				
Carbon tetrachloride	10	U					18	U				
Chlorobenzene	10	UJ					18	U				
Chlorodibromomethane												
Chloroethane	10	U					18	U				
Chloromethane	10	UJ					18	U				
2-Chloroethyl vinyl ether												
Chloroform	10	U					18	U				
1,2-Dibromoethane												
1,2-Dichlorobenzene												
1,3-Dichlorobenzene												
1,4-Dichlorobenzene												
1,1-Dichloroethane	10	UJ					18	U				
1,2-Dichloroethane	10	U					18	U				
1,1-Dichloroethene	10	U					18	U				
cis-1,2-Dichloroethene	10	U					18	U				
trans-1,2-Dichloroethene	10	U					18	U				
1,2-Dichloropropane	10	U					18	U				
cis-1,3-Dichloropropene	10	U					18	U				
trans-1,3-Dichloropropene	10	U					18	U				
1,3-Dichloropropylene												
Dichlorobromomethane												
Dibromochloromethane	10	U					18	U				
Dichlorodifluoromethane												
Ethylbenzene	10	U					18	U				
2-Hexanone	10	U					18	U				
Hexanone												
Methyl Bromide												
Methyl Chloride												
Methylene chloride	10	U					2	J				
4-Methyl-2-pentanone	10	U					18	U				
Styrene	10	U					18	U				
Tetrachloroethane	10	U					18	U				
Tetrachloroethene	10	U					18	U				
Tetrahydrofuran												
Toluene	10	UJ					2	J				
1,1,1-Trichloroethane	10	U					18	U				
1,1,2-Trichloroethane	10	U					18	U				
Trichloroethene	10	UJ					18	U				
Trichlorofluoromethane												
Vinyl acetate												
Vinyl chloride	10	U					18	U				
Xylenes	10	U					18	U				
PAHs	**ug/L**		**ug/L**				**ug/kg**					
Acenaphthene	0.301	UJN	0.28	U			562	UJ				
Acenaphthylene	0.242	U	0.225	U			1290	UJ				
Anthracene	0.398	N	0.083				3330	J				
Benzo(a)anthracene	5.1	N	0.854				6320	J				
Benzo(a)pyrene	7.65		1.13	E			6730	J				
Benzo(b)fluoranthene	4.3	N	0.663				5470	J				
Benzo(g,h,i)perylene	0.44	U	0.915				6860	J				
Benzo(k)fluoranthene	2.17		0.384				2660	J				
Chrysene	5.36	N	0.84				7690	J				
Dibenz(a,h)anthracene	0.56	U	0.122	J			143	UJ				
Fluoranthene	8.34	N	1.35				13600	J				
Fluorene	0.059	U	0.055	U			1150	J				
Indeno(1,2,3-cd)pyrene	5.36		0.579				4090	J				
Naphthalene	0.256	U	0.677				478	UJ				
Phenanthrene	1.18	N	0.182				12500	J				
Pyrene	14.1	N	2.21	E			14600	J				
Total Carcinogenic PAHs	29.94		4.572				32960					
Total PAHs	53.96		9.989				85000					

MW-28	**GROUNDWATER**						**SOIL**					
	12/16/1993		08/11/1994				11/11/1993					
							SL-003					
ACID EXTRACTABLES	**ug/L**											
2,4,5-Trichlorophenol	25	U										
2,4,6-Trichlorophenol	10	U										
2,4-Dichlorophenol	10	U										
2,4-Dimethylphenol	10	U										
2,4-Dinitrophenol	25	UJ										
2-Chlorophenol	10	U										
2-Methylphenol	10	U										
2-Nitrophenol	10	U										
4,6-Dinitro-2-Methylphenol	25	UJ										
4-Chloro-3-Methylphenol	10	U										
4-Methylphenol	10	U										
4-Nitrophenol	25	UJ										
Benzoic Acid	50	U										
Pentachlorophenol	25	U										
Phenol	10	U										
METALS	**ug/L**						**mg/kg**					
Arsenic	5.1	B					8.8					
Barium												
Cadmium												
Calcium	174000											
Chromium, Total	51.8											
Chromium, Hexavalent												
Copper	25.4											
Iron	27900	NJ										
Lead	99						157					
Magnesium	34100											
Manganese	670											
Mercury												
Nickel	74.5											
Potassium	9210											
Selenium												
Sodium	90600											
Silver												
Zinc	159											
CYANIDES	**ug/L**											
Cyanide, Total	10	U										
Cyanide, Amenable												
Cyanide, after chlorination												
OTHER PARAMETERS	**mg/L**											
Particle size distribution												
Bromide	0.50	U										
Chloride	210											
Fluoride	1.2											
Sufate	100											
Sulfide	1.0	U										
Iodine	0.3											
Total Dissolved Solids	820											
Total Organic Carbon (TOC)	3.5											

MW-34	GROUNDWATER					
	15-Dec-93		12-Aug-94			
VOCs	ug/L					
Acetone	10	U				
Acrolein						
Acrylonitrile						
Benzene	10	U				
Bromomethane	10	U				
Bromodichloromethane	10	U				
Bromoform	10	U				
2-Butanone	10	U				
Carbon disulfide	10	U				
Carbon tetrachloride	10	U				
Chlorobenzene	10	U				
Chlorodibromomethane						
Chloroethane	10	U				
Chloromethane	10	U				
2-Chloroethyl vinyl ether						
Chloroform						
1,2-Dibromoethane						
1,2-Dichlorobenzene						
1,3-Dichlorobenzene						
1,4-Dichlorobenzene						
1,1-Dichloroethane	10	U				
1,2-Dichloroethane	10	U				
1,1-Dichloroethene	10	U				
cis-1,2-Dichloroethene	10	U				
trans-1,2-Dichloroethene	10	U				
1,2-Dichloropropane	10	U				
cis-1,3-Dichloropropene	10	U				
trans-1,3-Dichloropropene	10	U				
1,3-Dichloropropylene						
Dichlorobromomethane						
Dibromochloromethane	10	U				
Dichlorodifluoromethane						
Ethylbenzene	10	U				
2-Hexanone	10	UJ				
Hexanone						
Methyl Bromide						
Methyl Chloride						
Methylene chloride	10	U				
4-Methyl-2-pentanone	10	U				
Styrene	10	U				
Tetrachloroethane	10	U				
Tetrachloroethene	10	U				
Tetrahydrofuran						
Toluene	10	UJ				
1,1,1-Trichloroethane	10	U				
1,1,2-Trichloroethane	10	U				
Trichloroethene	10	U				
Trichlorofluoromethane						
Vinyl acetate						
Vinyl chloride	10	U				
Xylenes	10	U				
PAHs	ug/L		ug/L			
Acenaphthene	0.269	UJ	0.28	U		
Acenaphthylene	0.216	U	0.225	U		
Anthracene	0.018	U	0.019	U		
Benzo(a)anthracene	0.030	JN	0.026	U		
Benzo(a)pyrene	0.015	U	0.016	U		
Benzo(b)fluoranthene	0.048	U	0.05	U		
Benzo(g,h,i)perylene	0.048	U	0.041	U		
Benzo(k)fluoranthene	0.025	U	0.026	U		
Chrysene	0.024	U	0.025	U		
Dibenz(a,h)anthracene	0.048	U	0.052	U		
Fluoranthene	0.068	UJ	0.071	U		
Fluorene	0.053	U	0.055	U		
Indeno(1,2,3-cd)pyrene	0.024	U	0.032	U		
Naphthalene	0.229	U	0.238	U		
Phenanthrene	0.024	U	0.025	U		
Pyrene	0.039	N	0.052	U		
Total Carcinogenic PAHs	0.030		0			
Total PAHs	0.069		0			

MW-34	**GROUNDWATER**					
	15-Dec-93		12-Aug-94			
ACID EXTRACTABLES	**ug/L**					
Benzoic Acid	50	U				
4-Chloro-3-methylphenol	10	U				
2,4-Dichlorophenol	10	U				
2,4-Dimethylphenol	10	U				
4,6-Dinitro-2-methylphenol	25	UJ				
2,4-Dinitrophenol	25	UJ				
2-Methylphenol	10	U				
4-Methylphenol	10	U				
2-Nitrophenol	10	U				
4-Nitrophenol	25	UJ				
Pentachlorophenol	25	U				
Phenol	10	U				
2,4,5-Trichlorophenol	25	U				
2,4,6-Trichlorophenol	10	U				
2-Chlorophenol	10	U				
Cresols, Total						
Phenolics						
METALS	**ug/L**					
Arsenic	2.0	U				
Barium						
Cadmium						
Calcium	81300					
Chromium, Total	34.2					
Chromium, Hexavalent						
Copper	18.1	B				
Iron	88700	NJ				
Lead	4.6	NJ				
Magnesium	31700					
Manganese	392					
Mercury						
Nickel	41.9					
Potassium	3010	B				
Selenium						
Silver						
Sodium	12500					
Zinc	30.1	U				
CYANIDES	**ug/L**					
Cyanide, Total	10.0	U				
Cyanide, Amenable						
Cyanide, after chlorination						
OTHER PARAMETERS	**mg/L**					
Bromide	0.5	U				
Chloride	5.4					
Fluoride	2.1					
Iodine	0.1	U				
Solids, dissolved (TDS)	630					
Sulfate	66					
Sulfide	1	U				
Thiocyanate	0.1	U				
Thiosulfate	1.0	U				
Percent solids, Total						
Total Organic Carbon (TOC)	3.0					