Per the Federal Facility Agreement for Iowa Army Ammunition Plant, Article X.B.1, the attached document is the final version of the submitted document.

WORK PLAN ADDENDUM

SUPPLEMENTAL REMEDIAL INVESTIGATION
LINE 800/PINK WATER LAGOON
DRAFT

Prepared for

U. S. Army Corps of Engineers
Omaha District

By

HARZA
Engineering Company

September 1999

RESPONSE TO COMMENTS

REVIEW OF THE DRAFT WORK PLAN ADDENDUM
SUPPLEMENTAL REMEDIAL INVESTIGATION
LINE 800/PINK WATER LAGOON

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

Scott Marquess
USEPA
General Comments

1. Section 3.2, Drilling and Sampling, page 2. The text states that drilling and sampling of monitoring wells will be performed in accordance with the General Geology Scope of Services, Section 5.1 of the approved FSP and this addendum. Section 3.3 states that monitoring wells will be installed, developed, tested and sampled in accordance with Section 5.2 of the approved FSP. Please clarify which reference is correct and appropriate.

   Response: Both are correct. Section 5.1 discusses the till drilling and bedrock coring techniques/procedures, etc. Section 5.2 discusses the well installation procedures such as well construction, development, etc. The WP Addendum has been modified for clarification in the drilling well borings and well installation/construction details.

2. Section 5.1, Drilling and Sampling, page 4. The text indicates no geotechnical samples will be collected. Please provide the rationale for geotechnical sample exclusion when Section 3.0 identifies one of the field programs objectives as acquiring additional data to accurately characterize the groundwater.

   Response: Geotechnical testing was performed on soil samples collected during installation of the previous twenty-one monitoring wells at this site in accordance with USACE's General Scope of Services. These data are judged sufficient for present purposes, considering the overall consistency of site soils. Therefore, no additional testing was proposed. Key data to be collected in these five wells will include boring logs and potentiometric measurements. This statement has been added to Section 5.1.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This Addendum amends the existing Work Plan (WP) approved by the U.S. Army Corps of Engineers Omaha District (USACE) and the U.S. Environmental Protection Agency Region VII (USEPA) for Supplement Remedial Investigation at Line 800/Pink Water Lagoon, Iowa Army Ammunition Plant (IAAAP), Middletown, Iowa[1]. The WP summarizes the general scope and work requirements for the investigation activities and includes a Field Sampling Plan (FSP), a Quality Assurance Project Plan (QAPP) and a Site Safety and Health Plan (SSHP).

The Addendum is required to address installation, development, sampling, and analysis of five (5) additional monitoring wells at the Line 800 area. In addition, the Addendum references the approved Off-Site Groundwater Investigation QAPP[2] to address a change in the laboratory.

2.0 PREVIOUS INVESTIGATION

Field and laboratory activities covered in this Addendum are based on Supplemental Remedial Investigation completed in Fall and Winter of 1998. Work performed during the 1998 Supplemental Remedial Investigation included:

- Drilling, installing, and developing 21 new groundwater monitoring wells.
- Sampling and analyzing groundwater from the 21 new wells and 18 existing wells.
- Sampling and analyzing sludge-like material from a Former Settling Basin area.
- Sampling and analyzing surface water, sediment and shallow groundwater seepage along a tributary stream north of the lagoon.
- Field permeability tests in the new wells.
- Installing a staff gage in the Pink Water Lagoon.
- Surveying the new wells and staff gage.
- Preparation of a new site topographic map.

Preliminary results of the 1998 remedial investigation were reported in a technical memorandum submitted May 10, 1999. The May 10, 1999, Technical Memorandum is a basis for the work covered herein and is provided as Attachment A to this Addendum.

[1] Harza Engineering Company, Inc. 1998: Work Plan, Supplemental Remedial Investigation Line 800/Pink Water Lagoon, Iowa Army Ammunition Plant, Middletown, Iowa. July 1998.
[2] Harza Engineering Company, Inc. 1999: Work Plan, Off-Site Groundwater Investigation (OU3), Iowa Army Ammunition Plant, Middletown, Iowa. June 1999.

3.0 FIELD PROGRAM

Based on the results of the previous activities and analytical data, five (5) additional monitoring wells will be installed to provide additional information on the extent of groundwater contamination, both horizontally and vertically, in the Line 800 area. Additional data is needed to accurately characterize the groundwater hydrology and define the extent of site related groundwater contamination.

3.1 Monitoring Well Locations and Depths

The five (5) proposed monitoring wells include:

- Two (2) Shallow Till wells – to define groundwater gradients and the lateral extent of groundwater contamination in the till, particularly east/northeast and west of the lagoon.
- Three (3) Bedrock wells – to define groundwater gradients and lateral extent of contamination in bedrock.

The proposed locations of the five wells are shown on Figure 1 and defined in Table 1 below. Final locations will be adjusted in the field with consideration of access and surface conditions.

Table 1 Well Objectives, Locations and Depths

Well ID	Location	Objective	Approx. Depth
800-MW22	Bedrock well paired with G-56.	Lateral extent of contamination in bedrock.	70 ft. +
800-MW23	Bedrock well paired with G-48.	Lateral extent of contamination in bedrock.	70 ft. +
800-MW24	Bedrock well upgradient of G-44.	Lateral extent of contamination in bedrock, possible upgradient source, integrity of G44/G45 well pair.	70 ft. +
800-MW25	Shallow till well between G-17, G-18, and 800-MW-21.	Lateral extent of contamination in shallow till east-northeast from the lagoon.	20 ft.
800-MW26	Shallow till well west of G-56.	Lateral extent of contamination in shallow till west of G-56.	20 ft.

+ Bedrock wells will be completed 20 feet into the bedrock.

3.2 Drilling and Sampling

Drilling and soil sampling in monitoring well borings will be performed in accordance with the General Geology Scope of Services, Section 5.1 of the approved FSP and this Addendum. Borings in till will be drilled with Hollow Stem Augers (HSAs). Bedrock wells will be drilled

20 feet into bedrock using continuous coring methods. Depth of borings for monitoring wells will vary and may need to be adjusted in the field. Estimated depths are 20 feet for the shallow till wells and 70 feet for bedrock wells.

3.3 Monitoring Well Construction

Monitoring wells will be installed, developed, and tested and groundwater will be sampled in accordance with Section 5.2 of the approved FSP, except for bedrock wells. None of the bedrock wells will be installed/constructed with double-casing. All wells will be single-cased and constructed using PVC materials. Screen and riser pipe will have a minimum diameter of 2 inches. All monitoring well screens will be 10-feet in length.

3.4 Groundwater Sample Collection

Groundwater samples will be analyzed for explosives and natural attenuation parameters as identified in Section 5.4.3 of the approved FSP.

4.0 ANALYTICAL PROGRAM

Katalyst Analytical Technologies, Inc. (KAT) of Peoria, Illinois has been selected to perform laboratory analysis of samples collected from the five new monitoring wells at Line 800. KAT previously performed analytical services for the Off-Site Ground water Investigation at IAAAP. Allied Research and Development Laboratory (ARDL) had performed analytical services for the previous Supplemental Remedial Investigation. The USACE and USEPA approved the OU3 WP containing details of KAT's laboratory protocols. Therefore, the Line 800 WP is here by amended to include KAT as the analytical laboratory and include KAT's procedures and protocols as identified in the approved OU3 WP. No changes in analytical parameters, analytical methods, or Quality Control (QC) samples for Line 800 activities are proposed in this Addendum.

As originally defined in the approved Line 800 WP, groundwater samples collected during additional remedial investigation will be analyzed for Explosives, and Natural Attenuation Parameters. The methods used for collecting these samples including sample handling, custody, QC samples and sample analysis are presented in Section 5.4 of the FSP and Sections 5.0, 6.0, 8.0 and 9.0 of the QAPP. Analytical Methods to be used are as follows.

Table 2 Analytical Methods	
Parameters	**Method**
Explosive	8330
Alkalinity	310.0
Ammonia	350.2
Chloride	300.0
Kjaldahl Nitrogen	351.2
Nitrate/Nitrite	300.0
Phosphate	300.0
Sulfate	300.0
Sulfide	376.2
Carbon Dioxide	4500 CO2D
TOC	415.1
Metals-Na, Ca, and Mg	6010

5.0 FIELD METHODS

Field methods in the approved WP are hereby amended to address requirements of the new monitoring wells to be constructed during Fall 1999. Refer to the following sections for details regarding the new monitoring well locations and procedures. Section 5.0 of the approved FSP contains more details on the previously approved field operations.

Soil and bedrock borings will be drilled by Aquadrill Inc. under subcontract to Harza and in compliance with local, state and federal regulations for drilling and well installation, relevant provisions of USACE's General Geology Scope of Services, the approved WP and this Addendum.

5.1 Drilling and Sampling

Five additional monitoring wells will be drilled during Fall 1999. These wells will provide additional information on the extent of groundwater contamination, both horizontally and vertically, in the Line 800 area. Drilling and sampling procedures will remain as defined in Section 5.1 of the FSP except that no geotechnical samples will be collected and none of the bedrock wells be double-cased. Geotechnical testing was performed on soil samples collected during installation of the previous twenty-one monitoring wells at this site in accordance with USACE's General Scope of Services. These data are judged sufficient for present purposes, considering the overall consistency of site soils. Therefore, no additional testing was proposed. Key data to be collected in these five wells will include boring logs and potentiometric measurements.

5.2 Monitoring Well Installation Procedures

Well installation procedures will remain as defined in Section 5.2 of the approved FSP, except for the bedrock wells.

The overburden and the upper portion of bedrock will be temporarily sealed by drilling into the bedrock, approximately two feet, using 4 ¼-inch I.D. HSAs. None of the bedrock wells will be double cased. NQ2 wireline, continuous coring equipment will be used to drill/core 20 feet into bedrock. After the core sample has been retrieved, the borehole will be reamed with a 4 1/8-inch O.D. diameter rotary bit to the planned final depth. Water for rotary drilling will be municipal water obtained from the IAAAP fire department.

5.2.1 Monitoring Well Construction

Well construction details will be performed as defined in Section 5.2.4 of the FSP. The 4 ¼-inch ID augers used to drill the wells meet the state regulations for minimum borehole diameter required for constructing a monitoring well with 2-inch diameter screen/riser. However, the borehole diameter is smaller than defined in the USACE' General Geology Scope of Services.

5.2.2 Monitoring Well Development Procedures

Well development will be performed as defined in Section 5.2.5 of the approved FSP.

5.3 Groundwater Sampling Procedures

Groundwater sampling procedures will be performed as defined in Section 5.4 of the approved FSP.

5.4 Sample Handling

Sample handling will remain as defined in Section 5.4.2 of the approved FSP. Section 5.4.2 also contains details regarding labeling, identification, shipment and sample preservation.

6.0 FIELD DECONTAMINATION PROCEDURES

Decontamination procedures will be performed as defined in Section 6.0 of the approved FSP.

9

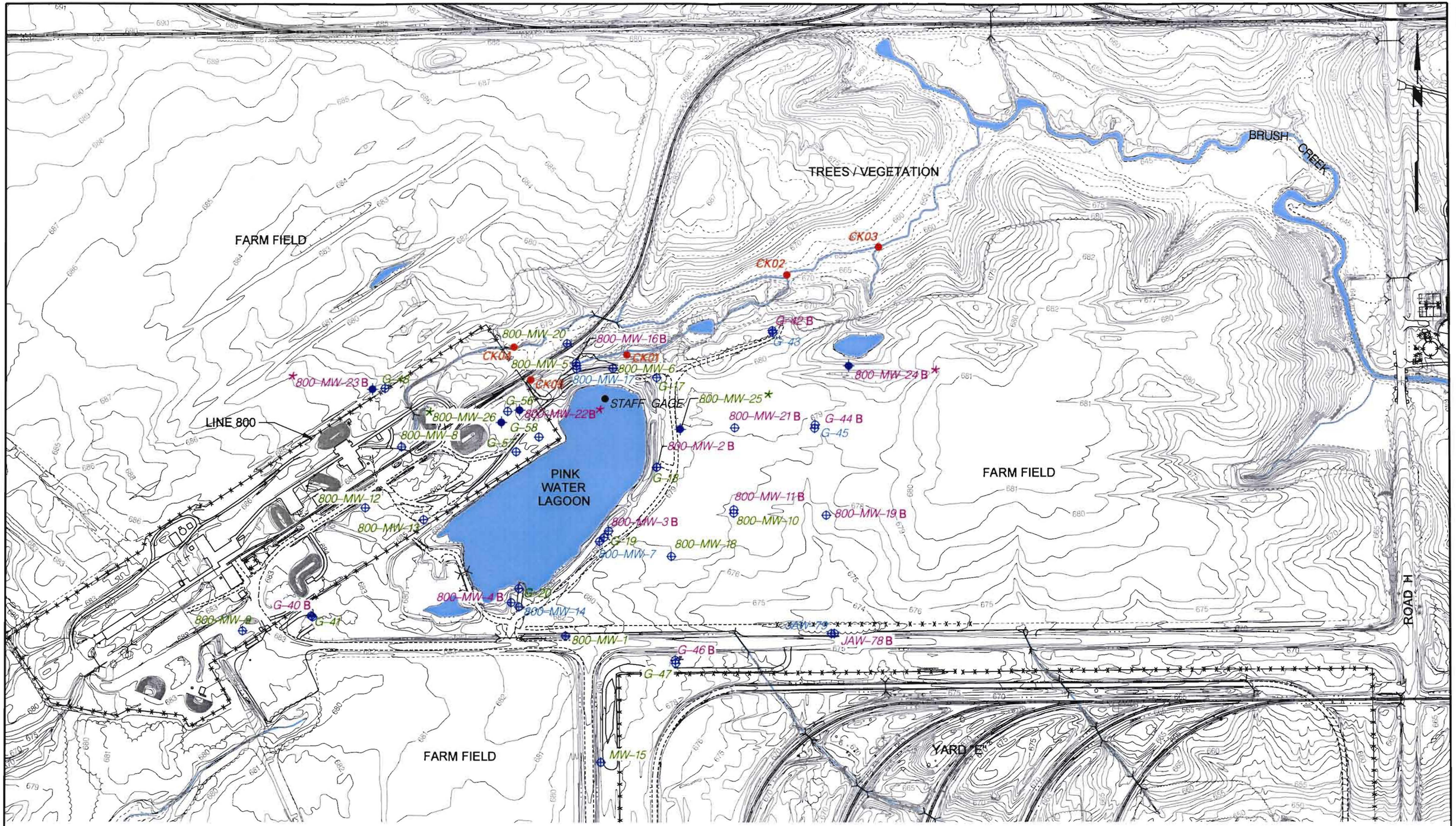
7.0 DOCUMENTATION OF FIELD ACTIVITIES

Documentation procedures will be performed as defined in Section 7.0 of the approved FSP.

8.0 INVESTIGATION DERIVED WASTE MANAGEMENT

Management of investigation derived waste will be performed as defined in Section 8.0 of the approved FSP.

FIGURES



LEGEND:

Scale 0 300 600 Feet

- Proposed Monitoring Well
- Monitoring Well
- CK01 Creek Site Location Map 1
- 800-MW-18 Upper Till Well
- 800-MW-14 Lower Till Well
- 800-MW-19 B Bedrock Well
- * Well numbers were chosen to fill in number gaps.

HARZA ENGINEERING COMPANY
Water & Environment

Figure 1

PROPOSED WELL LOCATIONS
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map5.dgn Sep. 10, 1999 13:22:34

APPENDIX A
TECHNICAL MEMORANDUM

HARZA HARZA ENGINEERING COMPANY

Location: Chicago Office May 10, 1999

To: Distribution

From: Robert P. Kewer, Senior Partner

Subject: Recommendations for Additional Remedial Investigation
Line 800/Pink Water Lagoon
Iowa Army Ammunition Plant, Middletown, Iowa.

This memorandum addresses Harza Engineering Company's (Harza's) recommendations for further groundwater remedial investigations (RI) at the Line 800/Pink Water Lagoon site (Line 800), Iowa Army Ammunition Plant (IAAAP), Middletown, Iowa. The memorandum was prepared by Harza based on discussions with the Omaha District Corps of Engineers (USACE), IAAAP, and the U. S. Environmental Protection Agency, Region 7 (USEPA) so that remaining data gaps can be addressed before submission of a Supplemental RI Report. The memorandum briefly outlines principal results of investigations to date and presents recommendations for further work, with reference to attached tables and draft figures. Data presented herein are preliminary pending finalization in the Supplemental RI Report.

FIELD ACTIVITIES

Supplemental RI activities conducted to date at the Line 800 site have included:

- Drilling, installing, and developing 21 new monitoring wells.
- Sampling and analyzing groundwater from the new wells and 18 existing wells.
- Sampling and analyzing sludge-like material from a Former Settling Basin.
- Sampling and analyzing surface water, sediment and shallow groundwater seepage along a tributary stream just north of the lagoon.
- Installation of a staff gage on the Pink Water Lagoon.
- Preparing a new site topographic map.
- Surveying the new wells and the staff gage.

These activities are briefly described in the following paragraphs and principal results in subsequent sections.

Monitoring Wells

Harza installed twenty-one (21) monitoring wells (800-MW01 through 800-MW21) at locations adjacent, downgradient and lateral to groundwater flow with respect to the lagoon (Figure 1). The 21 new wells were installed to better define hydraulic gradients and the horizontal/vertical extent of groundwater contamination in the glacial till soils near Line 800 and determine impacts on the bedrock aquifer. The new wells supplement eighteen (18) existing wells at the site and were screened variably in the upper till, lower till or bedrock. Table 1 summarizes monitoring well construction data.

Soil samples were collected from the well borings for field headspace screening, physical description and laboratory geotechnical analysis using continuous split spoon sampling methods. Results of headspace screening are summarized in Table 2. Geotechnical test results are summarized in Table 3.

Field hydraulic conductivity tests were performed in 19 of 21 new wells and in 3 of the existing wells. Wells 800-MW04 and 800-MW16 had been purged for sampling a few days prior to the scheduled testing and were still recovering. Therefore, these tests were not valid. Rising head tests were performed in wells 800-MW09, 800-MW15, G-18, G-19 and G-20 as a supplement to falling head tests, which were performed in all tested wells. Data from a rising head test in well 800-MW15 were inconclusive due to rapid recovery and were not used for calculation. Test results are provided later in this memorandum.

Two groundwater sampling rounds were completed during the investigation. In the first round, ten ofthe newly constructed monitoring wells were sampled immediately after development. No additional purging was completed on these wells for this sampling round. The samples were submitted to the laboratory for 24-hr TAT explosive analysis. Results were used to help finalize locations and depths of subsequent wells. In the second round, the 21 new and 18 existing monitoring wells at the site were sampled and analyzed for explosives and natural attenuation parameters. Sampling in this round was completed no less than 2 weeks after development and included appropriate purging activities.

Former Settling Basin

During drilling of well 800-MW17, just north of the Pink Water Lagoon, material described as wet, viscous, dark brown, and sludge-like in appearance was observed between depths of approximately 10 to 14 feet BGS. This material was underlain by several inches of clean medium-grained sand and then in-place silty clay till. To further evaluate this material, an additional boring was completed approximately 4 feet south and one sample (800-MW17-SD-13-14) was collected between depths of 13 and 14 feet BGS and analyzed for explosives.

Sediment, Surface Water and Groundwater Seepage Samples

Sediment, surface water and groundwater seepage sampling evaluated a potential contaminant migration pathway to Brush Creek via groundwater flow to a small stream just north of the lagoon, discharge to local surface water, and subsequent migration with surface water and sediment east to Brush Creek. A total of three sediment samples, five surface water samples and three groundwater seepage samples were collected at locations shown on Figure 1. All samples were analyzed for explosives. Sediment also was analyzed for Target Analyte List (TAL) metals.

Staff Gage

A staff gage was installed at the Pink Water Lagoon to allow measurement of surface water elevations for comparison to groundwater. The staff gage is graduated to hundredths and marked in feet and tenths of feet. It was attached as an extension to an existing hand-made gage, which consisted of a wooden board with a single level line, anchored to the bottom of the Lagoon by a block of concrete.

Surveying

Surveying was performed by American Surveying Consultants (ASC) and included state plane coordinates and elevations (ground and top of casing) of new wells and the staff gage. GPS survey methods were used first to establish a network of control points around the Line 800 Area and provide survey control for monitoring wells. These points were tied into existing National Geodetic Survey (NGS) control stations and were marked with iron pits. GPS surveying utilized Trimble 4000SSI dual frequency geodetic receivers with L1/L2 geodetic antennas. The Fast-Static GPS baseline measuring

technique was used to survey the project control network first. Then the Real Time Kinematic (RTK) survey technique was used to survey the wells, adopting the control points as base stations. Surveyed coordinates and elevations were used in preparation of maps and other figures in this report. Survey data are summarized in Table 4.

Topographic Mapping

A topographic site map was created for the Line 800 area and is used as the base map for most of the figures in this memorandum (i.e. Figure 1). New stereometric color aerial photographs at a normal scale of 1-inch = 300 feet and a new spot color aerial photograph at nominal negative scale of 1-inch = 800 feet were obtained from a December 9, 1998, survey flight of the Line 800 area. Surveyors set panel markers, recovered existing benchmarks and control stations, and established two semi-permanent vertical control stations prior to the scheduled flight over the site. The North American Vertical Datum of 1988-Mean Sea Level for vertical control points and the Iowa State Plane Coordinate System for horizontal points were used. Stereometric compilation of photogrammetric topographic mapping of the site utilized Autocad, version 14, for 3-dimensional data for contour lines and spot elevations and 2-dimensional data for planimetric features at a scale of 1-inch =200 feet, with one foot contour intervals.

GEOLOGY AND HYDROGEOLOGY

This section outlines the overall geologic and hydrogeologic characteristics of the Line 800 site based on data obtained during this and previous investigations. For reference, site subsurface conditions are illustrated schematically by cross-sections A-A' and B-B' on Figures 2 and 3 (section locations are shown on Figure 4).

The Line 800 site is underlain by approximately 40 to 60 feet of unconsolidated deposits overlying carbonate sedimentary bedrock. The unconsolidated deposits consist of glacial till, predominantly brown to gray clay with a trace of sand and gravel. Most soils are classified CL to CL/CH in the United Soil Classification System (USCS). At some locations, the clay was interbedded with clayey silty sand (SM) or fine- to coarse-grained sand (SP or SW) which ranged from 1 foot to as much as 25 feet thick. As a general statement, granular soils appear somewhat more common at this site than most other locations at IAAAP. Lithologic variations from clayey silty sand to sandy clay in the unconsolidated deposits are gradational.

Bedrock at the site consists of thin-bedded, weathered, fossiliferous, fine to medium grained, light gray limestone, interbedded with shale. The bedrock was encountered at depths ranging from 38 to 58 feet, corresponding to elevations between 623 and 639 feet. The bedrock surface can be characterized as an east-west trending central depression with higher areas to the north and south. The configuration of the bedrock surface is illustrated by generalized elevation contours on Figure 4.

Estimated hydraulic conductivities from available slug tests are shown in Table 5. Hydraulic conductivities calculated for the shallow aquifer and intermediate zones range between $1.2x10^{-5}$ and $1.5x10^{-3}$ cm/s. The lower values were from wells in the northern and the eastern ports of the site and the higher values from wells south and west of the lagoon. Lower hydraulic conductivities were calculated for the bedrock aquifer, ranging from $1.2x10^{-6}$ cm/s in 800-MW02 to $9.25x10^{-5}$ cm/s in 800-MW21. Conductivities are higher from bedrock wells located to the east.

Static groundwater levels were measured in all wells at the site on December 5 and 8, 1998, before and after a fairly significant rainfall event. Measurements are provided in Table 6. Groundwater elevations in the Upper Till range from 681 ft above mean sea level (AMSL) west of the lagoon to 674 ft AMSL south of the lagoon, corresponding to depths of about 3 to 7 ft below the surface. Groundwater elevations in the Lower Till similarly were between 671 and 680 ft AMSL. This similarity differs from elsewhere at IAAAP, where downward gradients are more prevalent, and may be due to the influence of the lagoon itself. Potentiometric levels in the bedrock aquifer range from elevation 650 to 644 ft AMSL and are as much as 40 feet above the top of bedrock and generally about 13 feet below levels in the Upper and Lower Tills.

A generalized potentiometric contour map for the Upper Till is shown on Figure 5 and demonstrates that flow within the site area is radial away from the lagoon in all areas except a portion of the west, where flow appears to be toward the lagoon. Flow in the upper till ultimately is toward Brush Creek on the east and Long Creek on the west. The till units are recharged primarily by the lagoon and secondarily by infiltration of precipitation.

A generalized potentiometric contour map for the Bedrock aquifer is shown on Figure 6 and demonstrates groundwater flow from the southeast to the northwest. Thus, the site is on the west flank of a groundwater divide, which separates the Long and Brush Creek watersheds. This divide is significantly closer to Brush than to Long Creek in the site area likely due to preferred flowpaths toward bedrock exposures in the Long Creek valley, which provide discharge points. To the east, adjacent and beneath Brush Creek, the bedrock is covered by comparatively low permeability tills.

ANALYTICAL RESULTS

Groundwater

Two rounds of groundwater samples were collected in this supplemental RI. The first round of sampling was completed between October 12 and 14, 1998 from ten of the newly installed wells (800-MW01 through 800-MW05 and 800-MW07 through 800-MW11). The second round of sampling was completed between November 16 and December 1, 1998 from all of the twenty-one (21) newly installed and eighteen (18) existing monitoring wells.

The first round of groundwater samples were analyzed for explosives only. Results are summarized in Table 7. Four explosive compounds were detected at concentrations exceeding Preliminary Remedial Goals (PRGs) in seven of the samples. Chemicals exceeding PRGs included 1,3-DNB (up to 40J ug/L), 2,4,6-TNT (up to 18,100 ug/L), 2,4-DNT (up to 49 ug/L), and RDX (up to 1,770J ug/L). These initial samples were collected immediately after well development with no additional purging so the information could be made available for finalizing subsequent well locations. In general they should be viewed with caution when compared to the second round of sampling.

The second round of groundwater samples were analyzed for explosives, calcium, sodium, magnesium and natural attenuation parameters. Results are summarized in Table 8. Sample locations and explosives detected in groundwater from upper till, lower till and bedrock wells are shown in Figures 7, 8 and 9, respectively. Six explosive compounds were variably detected at concentrations exceeding PRGs in 12 of the samples. These include 1,3,5-TNB (up to 1,800J ug/L), 2,4,6-TNT (up to 10,000 ug/L), 2,4-DNT (up to 54J ug/L), RDX (up to 14,000J ug/L) and HMX (up to 1,500J ug/L). For comparison, results of sampling in previous investigations are summarized in Table 9.

The highest explosive concentrations are in the Upper Till zone (Figure 7) immediately adjacent to the lagoon, with concentrations decreasing rapidly with distance from the lagoon and with depth (Figures 8 and 9). Upper Till wells with high explosives concentrations include G-18, G-19 and G-20, along the southeast side of the lagoon, and 800-MW05 and 800-MW06, north/northeast of the lagoon. In general, bedrock is not indicated to be impacted, including bedrock wells close to the lagoon. However, the PRG for RDX was slightly exceeded in well G-44, several hundred feet east of the lagoon. Historic records indicate difficulties during the construction of this well, requiring that it be redrilled. No information was available on how or where the redrilled well was located, if different from the original, raising questions as to its integrity. No explosives were detected in other bedrock wells to the north, west and south of G-44.

Former Settling Basin

Analysis of the sludge-like material north of the lagoon indicated the presence of 2,4,6-TNT at a concentration of 43,000 mg/kg (Table 10). No other detections were reported. However, due to the extreme dilution required to quantitate 2,4,6-TNT within the linear range, other detections are likely at lower detection limits.

Surface Water, Sediment and Groundwater Seepage Samples

Five surface water, three sediment, and three groundwater seepage samples were collected from five locations (CK01 through CK05) in the drainage tributary north of the site. All samples were analyzed for explosives. Sediment also was analyzed for TAL metals. Sample locations and explosive chemicals detected are shown on Figure 10. Analytical results are summarized in Tables 11 through 13.

Each of the three sample types were collected at locations CK01, CK02, and CK03. These locations represent the portion of the drainage system closest to the lagoon (CK01), where the former settling basins discharge back into the tributary stream (CK02), and further downstream along the tributary (CK03). Only surface water samples were collected from locations CK04 and CK05, at the north end of Line 800. These represent stormwater discharge to the tributary from Line 800.

Explosive chemicals were detected in surface water at each location except CK03. Concentrations ranged from 4.8 ug/L of RDX at location CK02 to 14 ug/L of RDX at location CK05 and demonstrate contributions from the settling basins near the lagoon (CK02), but also from stormwater discharge from Line 800 (CK04 and CK05). At locations CK01 and CK03, no explosives were detected in either the sediment or groundwater seepage samples collected at the same time. However, explosives also were detected in both sediment (2,4,6-TNT at 1,100 ug/kg) and groundwater seepage (RDX at 3.2 ug/L) at location CK02.

RECOMMENDATIONS

Supplemental remedial investigation at Line 800/Pink Water Lagoon has delineated subsurface geologic and hydrogeologic conditions and the nature and extent of explosives contamination in groundwater, outlined briefly above. Some findings raise further questions suggesting the need for additional exploration before full problem definition and examination of remedial needs. Specific data gaps and consequent recommendations are outlined in the following paragraphs.

1. Groundwater flow in the bedrock aquifer at the site was determined to be toward the west-northwest, rather than toward the southeast as expected. This is explained by a groundwater divide, identified earlier between Brush Creek to the east and Long Creek to the west, being located further eastward than previously thought. Bedrock is exposed in Long Creek near the site providing a discharge pathway in that direction. However, the bedrock is covered by low-permeability tills to the east, inhibiting flow and discharge. Only one monitoring well (G-40) currently is available in bedrock west of the lagoon and none are available directly downgradient. Therefore, initial findings that bedrock is not impacted in most of the site area cannot be fully verified. Two additional bedrock wells are proposed. One would be paired with existing well G-58, an intermediate till well just west of the lagoon which contains significant explosives contamination. The second would be paired with G-48 further west (on the northwest side of Line 800), which is an intermediate till well in which no contaminants were detected in the supplemental RI. Together, these additional wells will identify the presence of any contamination in bedrock downgradient of the lagoon. They also will provide further data on flow patterns in the bedrock.

2. Existing bedrock well G-44, several hundred feet east of the lagoon, is hydraulically upgradient but contained RDX slightly above the PRG and 2,4,6-TNT below the PRG. No explosives were detected in other bedrock wells G-42 to the north, 800-MW-21 and 800-MW-11 to the west, and 800-MW-19 to the south, which form a semi-circle of bedrock wells between the lagoon and G-44. This raises questions as to the source of contamination in G-44. In further evaluating this question for the supplemental RI, it was determined from historic well records that difficulties were encountered in installing G-44, requiring that the well be redrilled. No information was provided on how or where the redrilled well was located, if different from the original, raising further questions as to the integrity of the existing G-44/G-45 well pair. One additional bedrock well is recommended to evaluate the potential for the contamination in G-44 to be from an upgradient source, rather than the lagoon, and to help evaluate the integrity of G-44. The recommended new well would be located 200 to 300 feet east or east-northeast (upgradient) of G-44. If no explosives are detected, an upgradient source would be unlikely and historic data from G-44 would be in question. If explosives are detected at similar concentrations, a source of low concentration contamination in the bedrock upgradient from the Pink Water Lagoon could be postulated.

3. Shallow till wells G-17 and G-18, immediately east-northeast of the lagoon, contain significant concentrations of explosives. No shallow till wells are located further to the east. Shallow wells elsewhere suggest groundwater contamination is contained principally within a narrow band around the lagoon. However, this conclusion cannot be supported to the east-northeast, an important direction of flow since it could result in discharge to the unnamed tributary north of the site or to Brush Creek. A shallow till well is recommended in the general area between G-17, G-18, and 800-MW-21 to address this question.

4. Existing wells G-56, G-57 and G-58, just west of the lagoon, contain significant concentrations of explosives. These wells are completed in the till, but completion records show they are screened to depths of 20 to 30 feet and, therefore, are more representative of the intermediate till than the shallow till. Immediately adjacent to the lagoon, the supplemental RI demonstrates that explosive concentrations are highest in the shallow till and decrease rapidly with depth and distance. This is likely the case to the west, but cannot be verified. Considering the relatively high explosive concentrations in some of the existing wells, it is prudent to further explore the shallow till in this area. One shallow till well is recommended in the general area of G-56 to explore contamination in the shallow till at some distance from the lagoon. This location is preferred to locations nearer the

lagoon, where confirmation of high concentrations in the shallow till would only verify conditions demonstrated repeatedly elsewhere.

Two further recommendations are offered. First, representative soil samples should be obtained from the new well borings and tested for organic carbon content. This will support the natural attenuation data collected for groundwater samples in the supplemental RI. Second, another complete round of sampling for explosives, including the additional wells, should be undertaken. Prior to the supplemental RI, all historic analytical data were obtained by other samplers and laboratories. To provide consistency of data, at least one more complete sampling round is prudent. This round could be coordinated with the planned long-term monitoring.

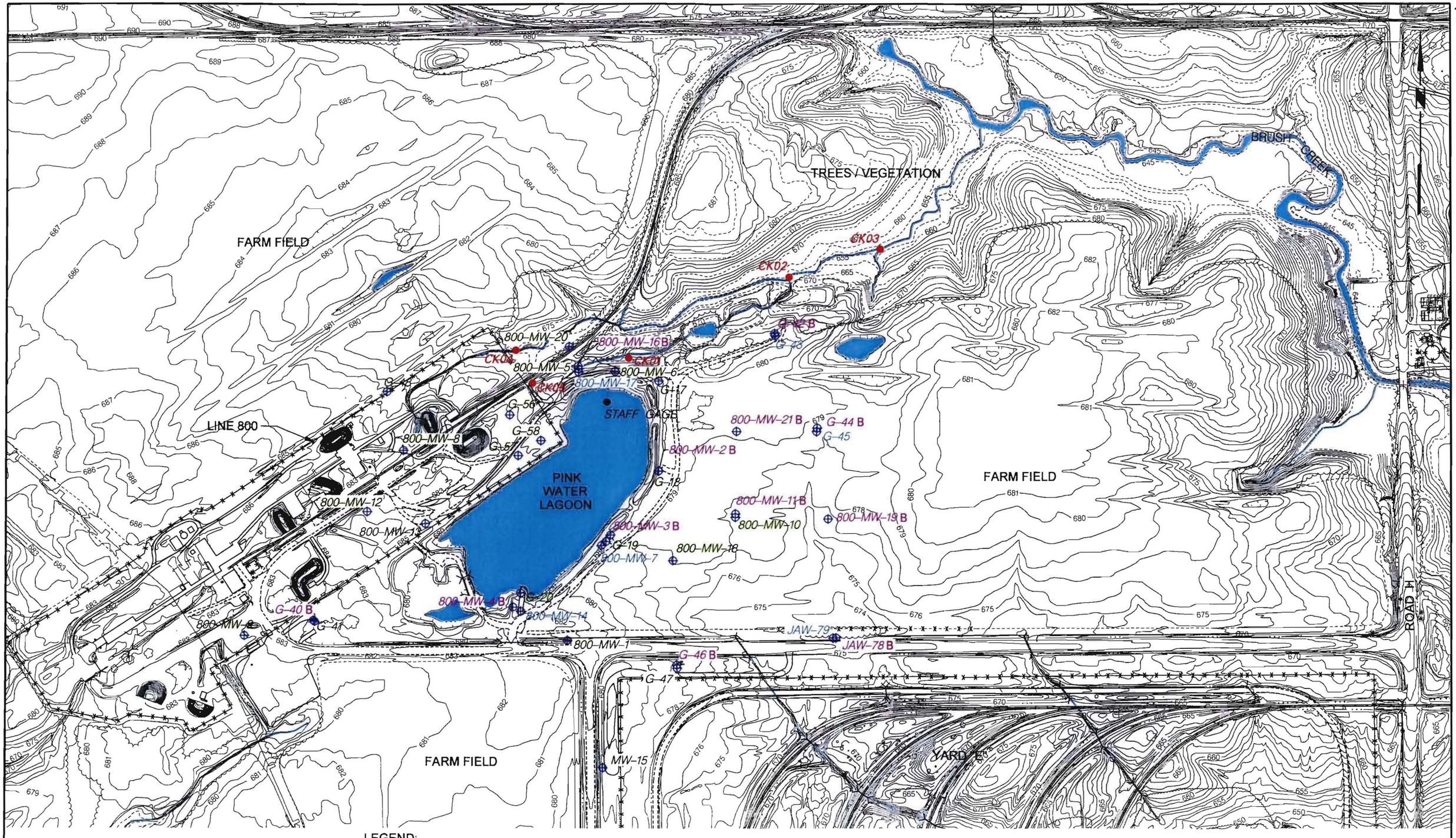
Robert P. Kewer

LAB&RPK/lab

Distribution:

Al Kam - USACE, Omaha Dist. (4 copies)
Scot Marquess – USEPA Region VII (1 copy)
Roger Allison – IAAAP (2 copies)
Derek Romitti – AEC (1 copy)
Lori Landeche – AO/IAAAP (1copy)

FIGURES



Scale 0 300 600 Feet

LEGEND:

- ⊕ Monitoring Well
- 800-MW-18 Upper Till Well
- 800-MW-14 Lower Till Well
- 800-MW-19 B Bedrock Well
- CK01 ● Creek Site Location Map 1

HARZA ENGINEERING COMPANY
Water & Environment

Figure 1

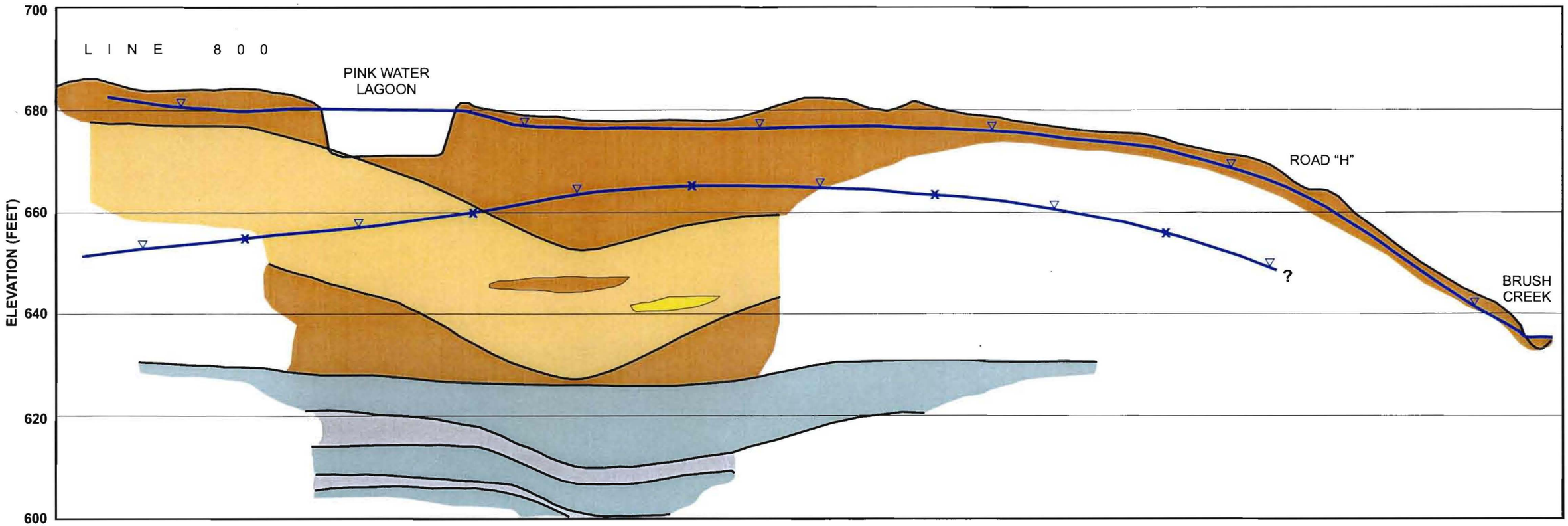
SITE FEATURES

SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map5.dgn May. 05, 1999 09:07:53

A
WEST

A'
EAST



LEGEND:

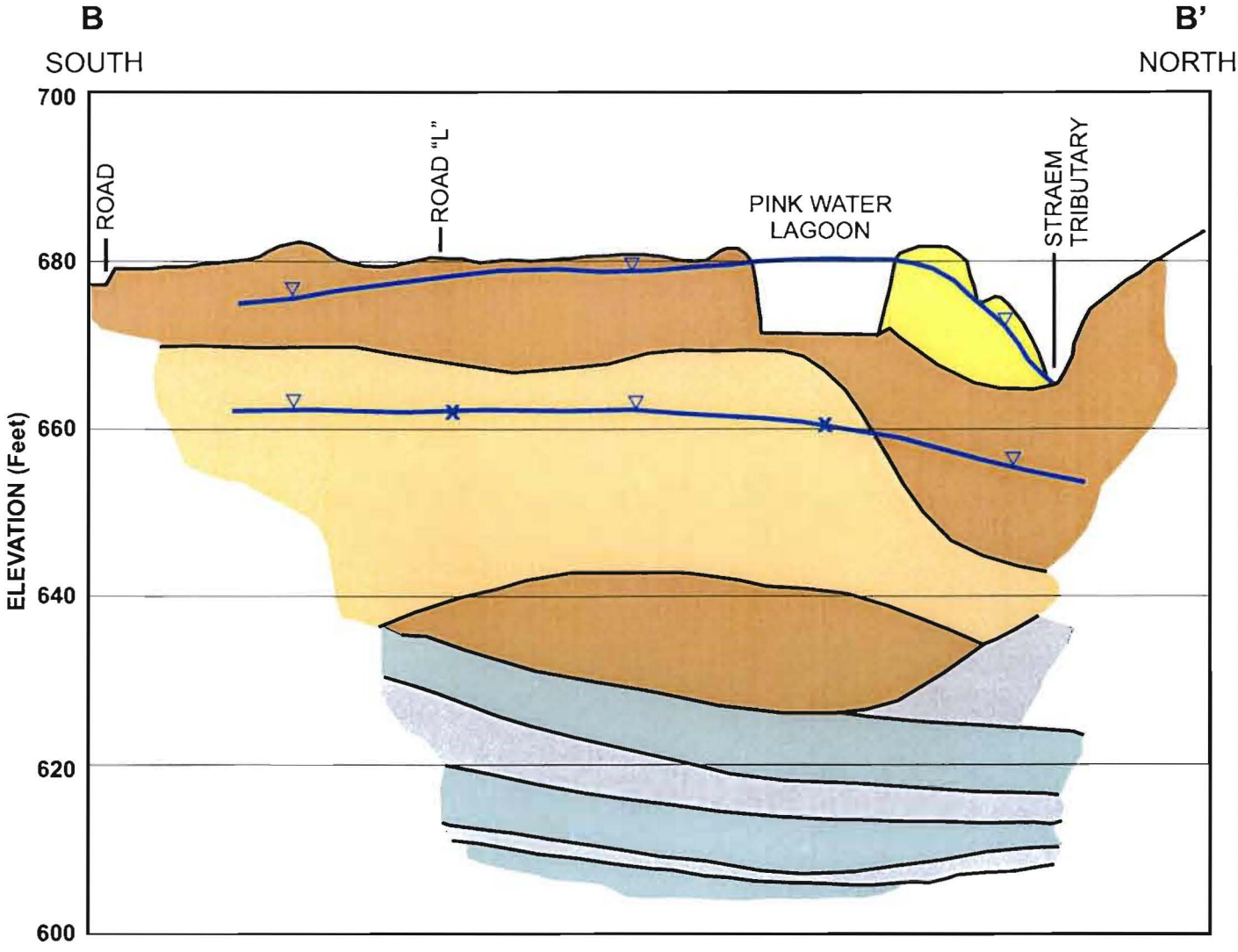
- Shallow Till Potentiometric Surface
- Upper Bedrock Potentiometric Surface
- Sand
- Silty Sand, Sandy Clay
- Silty Clay, Clayey Silt
- BEDROCK
- Limestone
- Shale

Scale 0 300 600 Feet

Figure 2
SECTION A-A'
CONCEPTUAL HYDROGEOLOGIC CROSS SECTION
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT (IAAAP)
Middletown, Iowa

HARZA ENGINEERING COMPANY
WATER & ENVIRONMENT

z:\iowa\geo1.cdr



Scale 0 300 600 Feet

LEGEND:

- Shallow Till Potentiometric Surface
- Upper Bedrock Potentiometric Surface
- Fill
- Silty Sand, Sandy Clay
- Silty Clay, Clayey Silt
- BEDROCK
- Limestone
- Shale

Figure 3

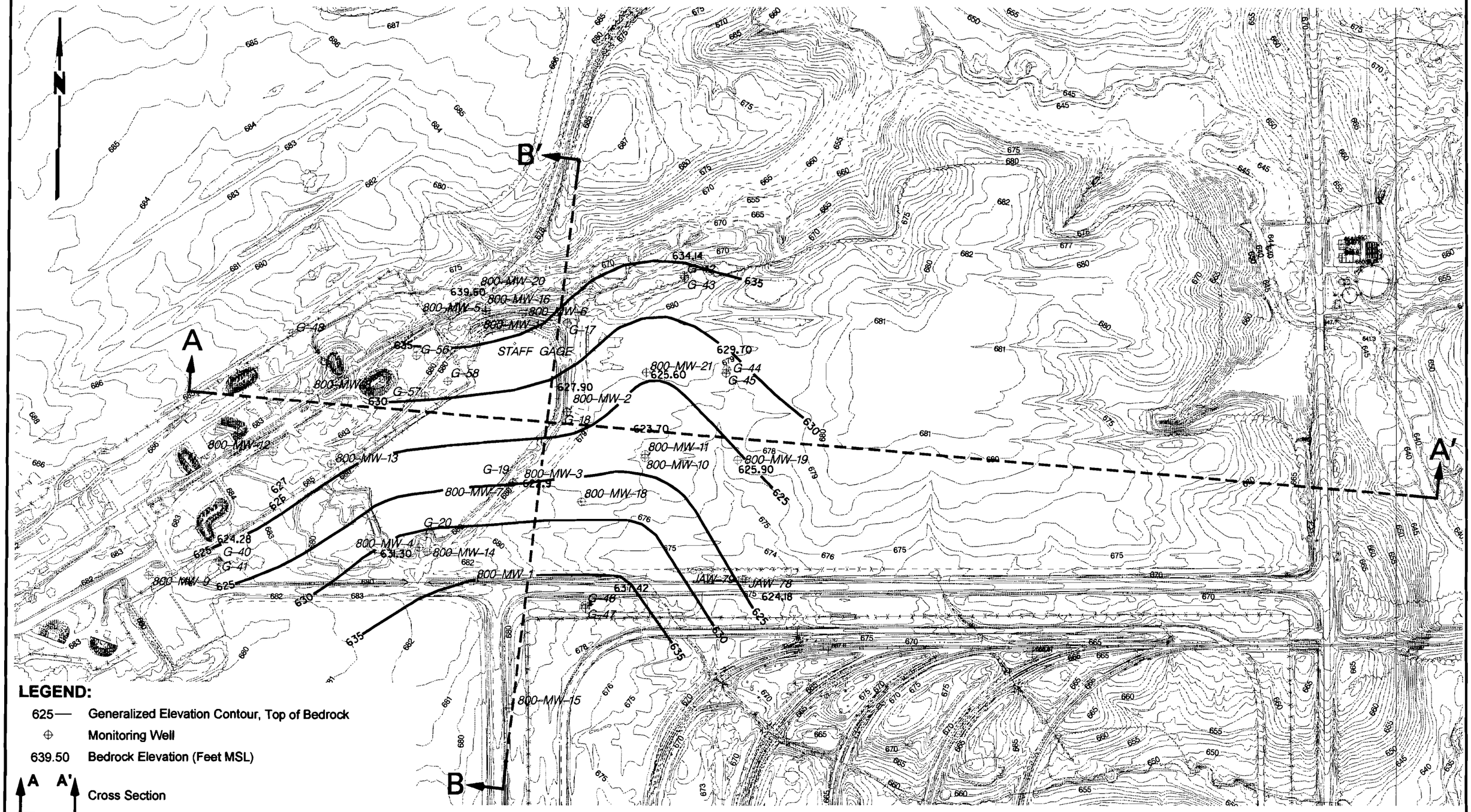
SECTION B-B'

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION

SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT (IAAAP)
Middletown, Iowa

HARZA ENGINEERING COMPANY
WATER & ENVIRONMENT

z:\iowa\geo2.cdr



LEGEND:

- 625 — Generalized Elevation Contour, Top of Bedrock
- ⊕ Monitoring Well
- 639.50 Bedrock Elevation (Feet MSL)
- A A' Cross Section

NOTE:

For Cross Sections A-A' and B-B' see Figure _____.

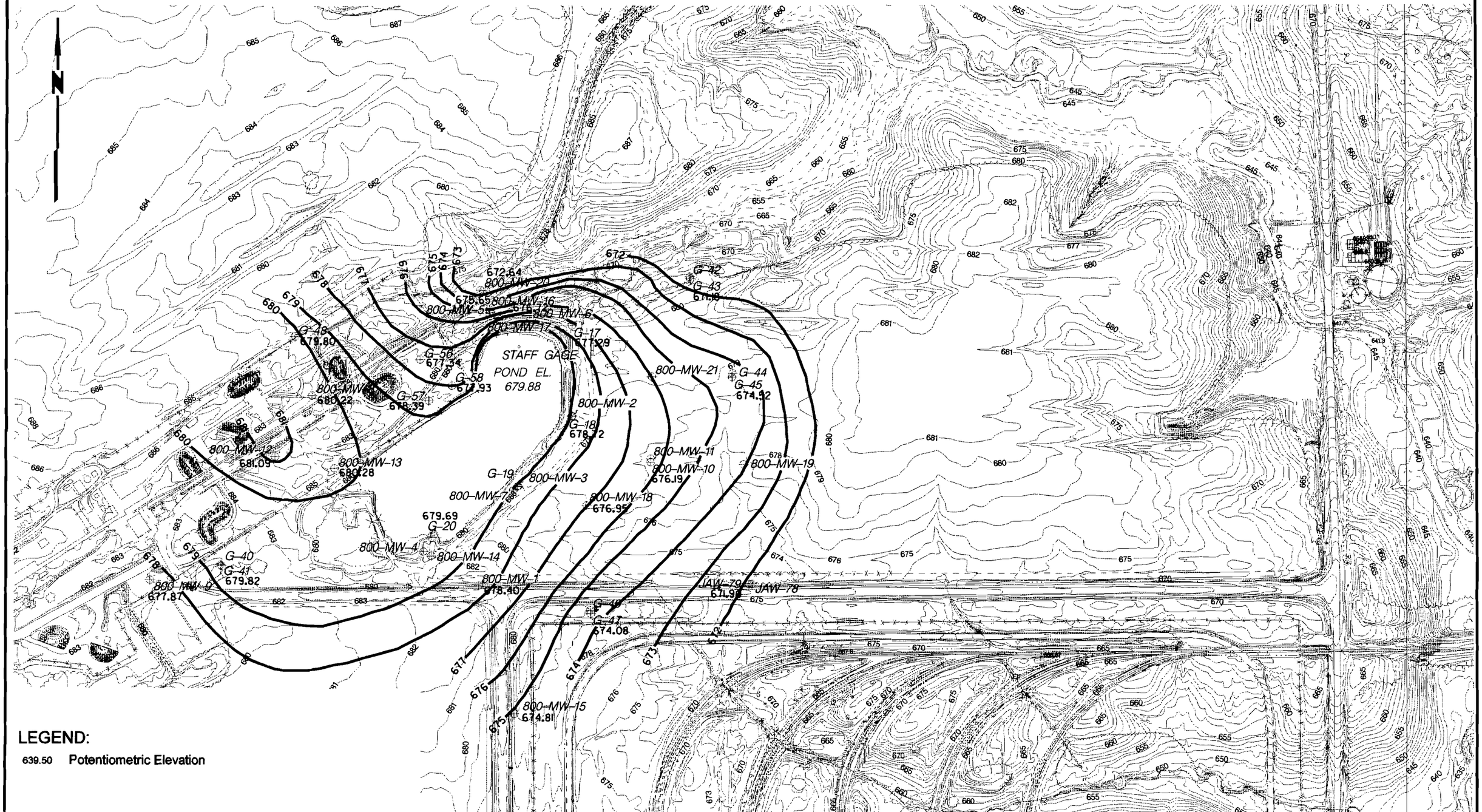
HARZA ENGINEERING COMPANY
WATER & ENVIRONMENT

Scale 0 300 600 Feet

Figure 4
December, 1998

GENERALIZED TOP OF BEDROCK ELEVATION CONTOURS AND HYDROGEOLOGIC CROSS SECTIONS
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

i:\5644gf\fig_a.dgn



LEGEND:

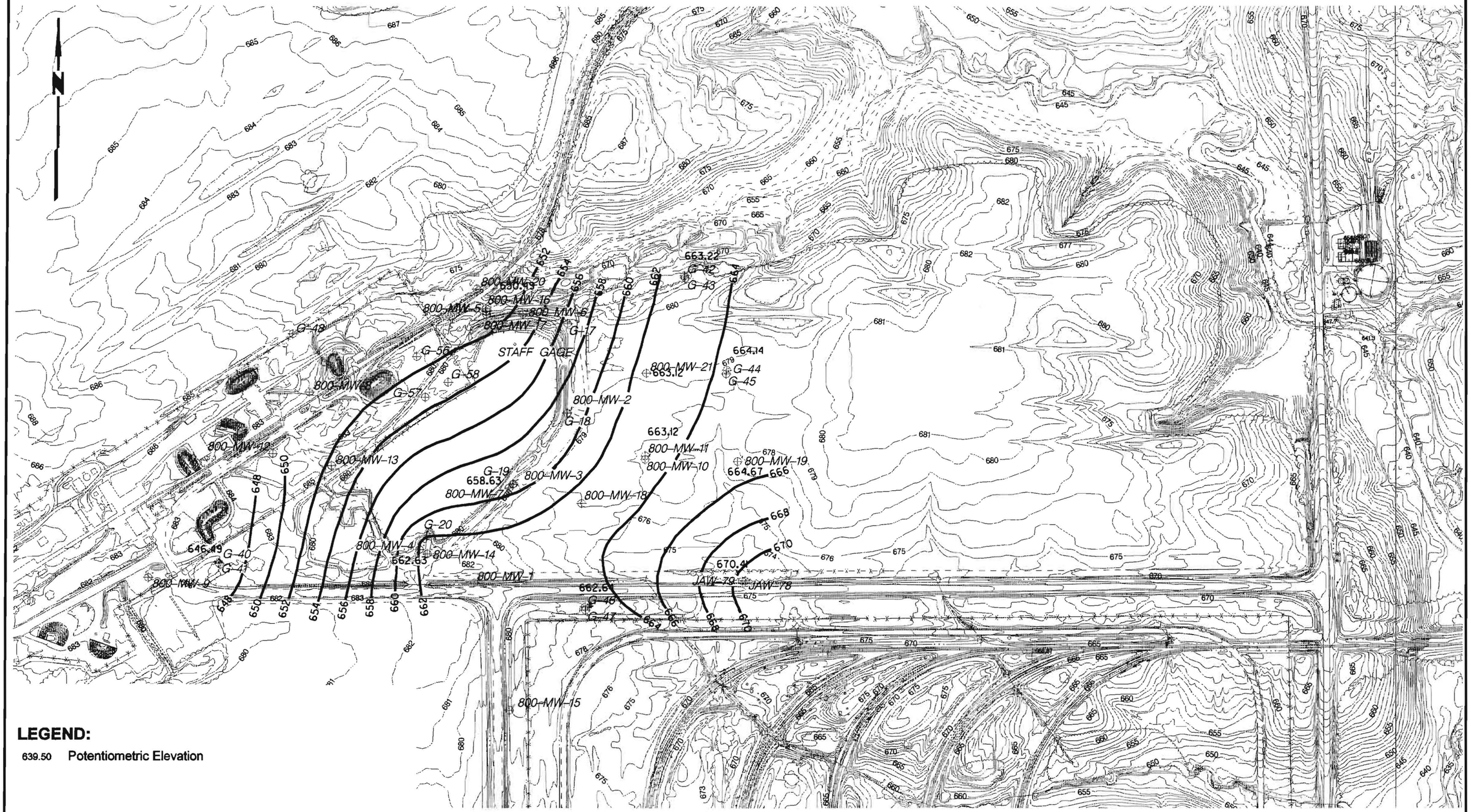
639.50 Potentiometric Elevation

Scale 0 300 600 Feet

HARZA ENGINEERING COMPANY
WATER & ENVIRONMENT

Figure 5
December, 1998
POTENTIOMETRIC CONTOUR MAP, UPPER TILL
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

r:\5644gf\fig_c.dgn



LEGEND:

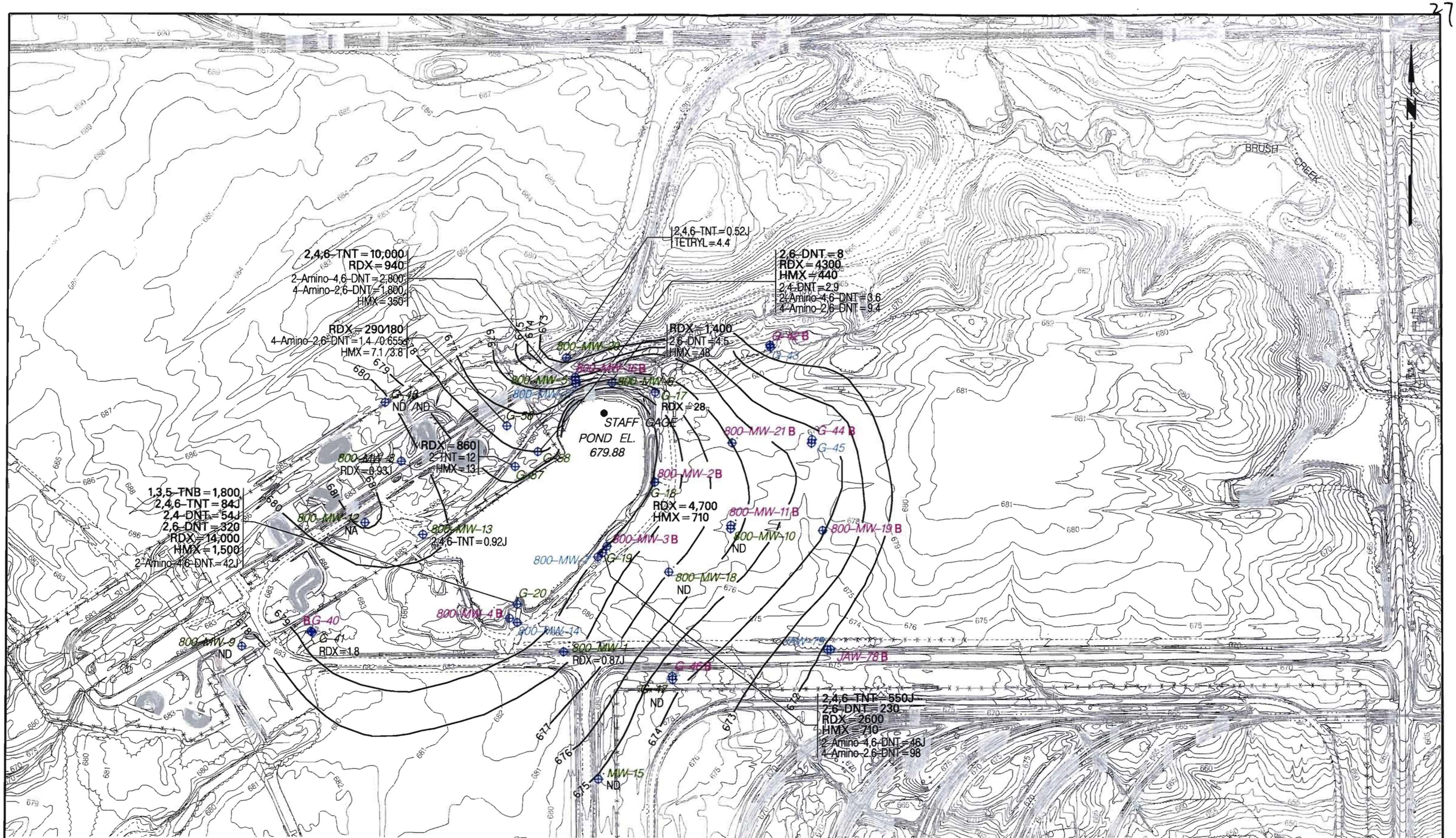
639.50 Potentiometric Elevation

Scale 0 300 600 Feet

HARZA ENGINEERING COMPANY
WATER & ENVIRONMENT

r:\5644gf\fig_b.dgn

Figure 6
December, 1998
POTENTIOMETRIC CONTOUR MAP, BEDROCK
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa



Scale 0 300 600 Feet

HARZA ENGINEERING COMPANY
Water & Environment

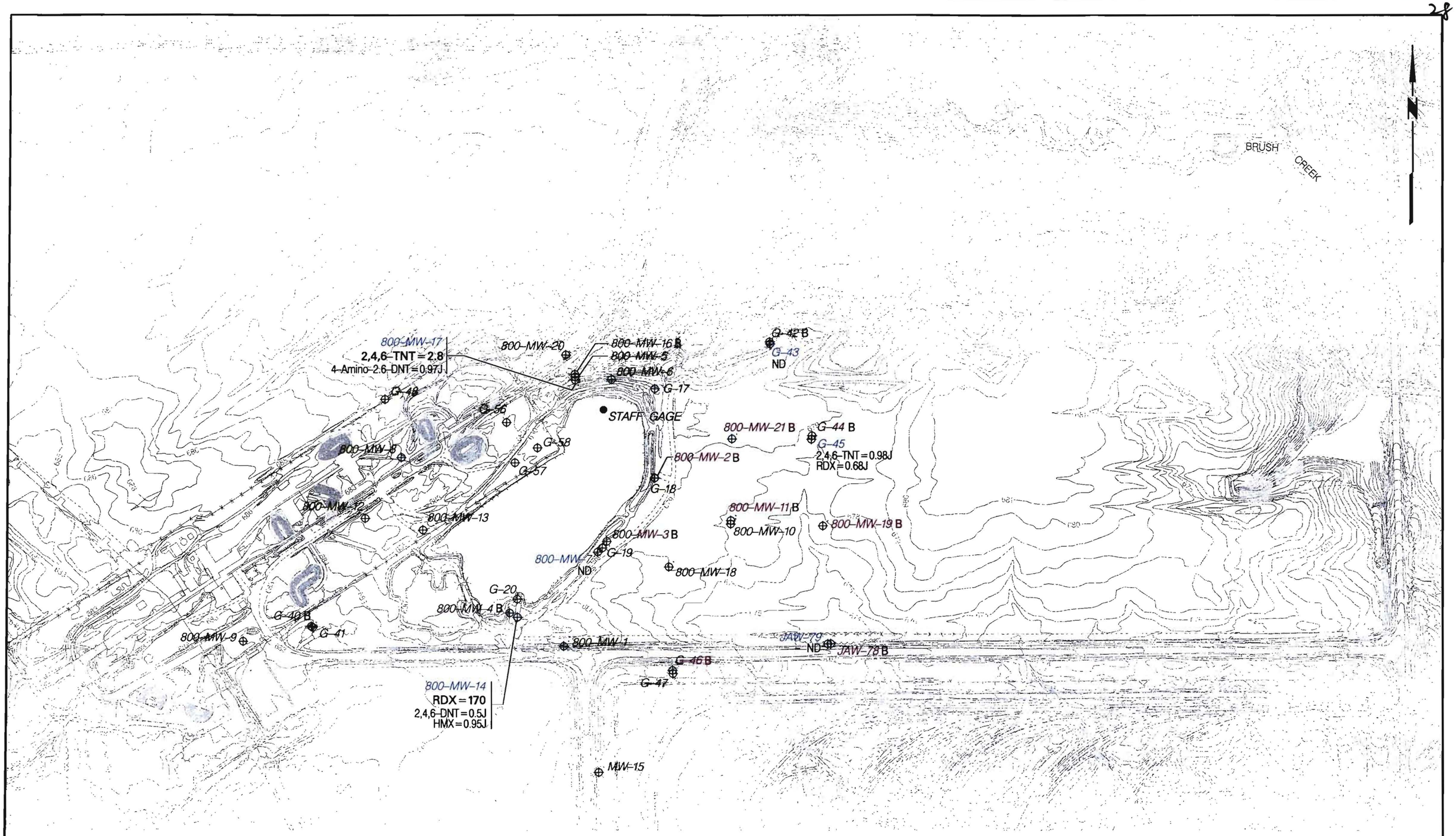
LEGEND:

⊕	Monitoring Well	RDX	Concentration Greater Than PRGs
800-MW-18	Upper Till Well	RDX	Concentration Less Than PRGs
800-MW-14	Lower Till Well	J	Sample Results are Estimated
800-MW-19 B	Bedrock Well	290/180	Sample / Duplicate Results
		NA	Not Available

Figure 7

EXPLOSIVES DETECTED IN GROUNDWATER, UPPER TILL
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map1.dgn Jun. 29, 1999 15:20:41



Scale 0 300 600 Feet

HARZA ENGINEERING COMPANY
Water & Environment

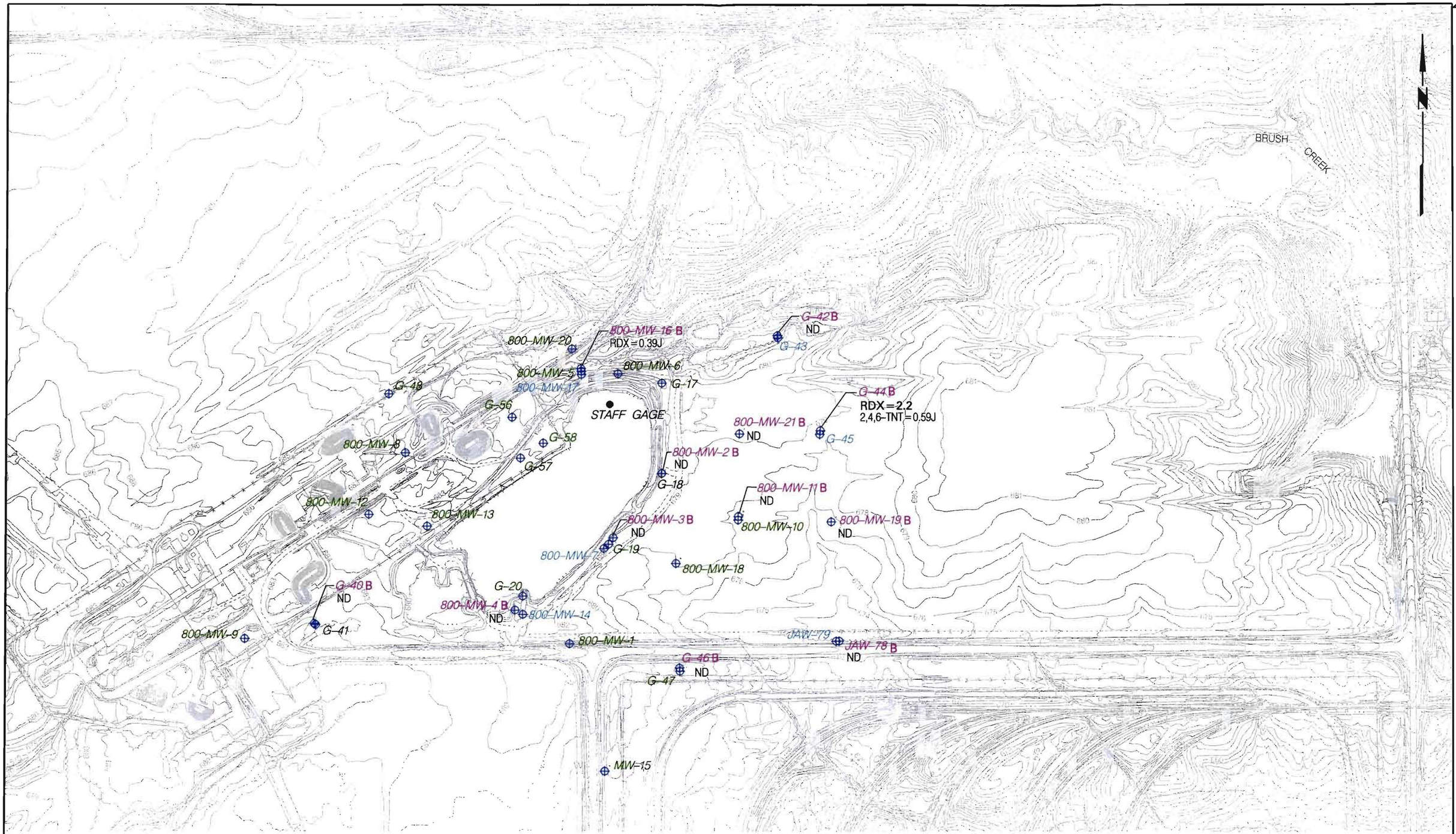
LEGEND:

⊕	Monitoring Well	RDX	Concentration Greater Than PRGs
800-MW-18	Upper Till Well	RDX	Concentration Less Than PRGs
800-MW-14	Lower Till Well	J	Sample Results are Estimated
800-MW-19 B	Bedrock Well		

Figure 8

EXPLOSIVES DETECTED IN GROUNDWATER, LOWER TILL
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map6.dgn May. 06, 1999 16:16:39



Scale 0 300 600 Feet

HARZA ENGINEERING COMPANY
Water & Environment

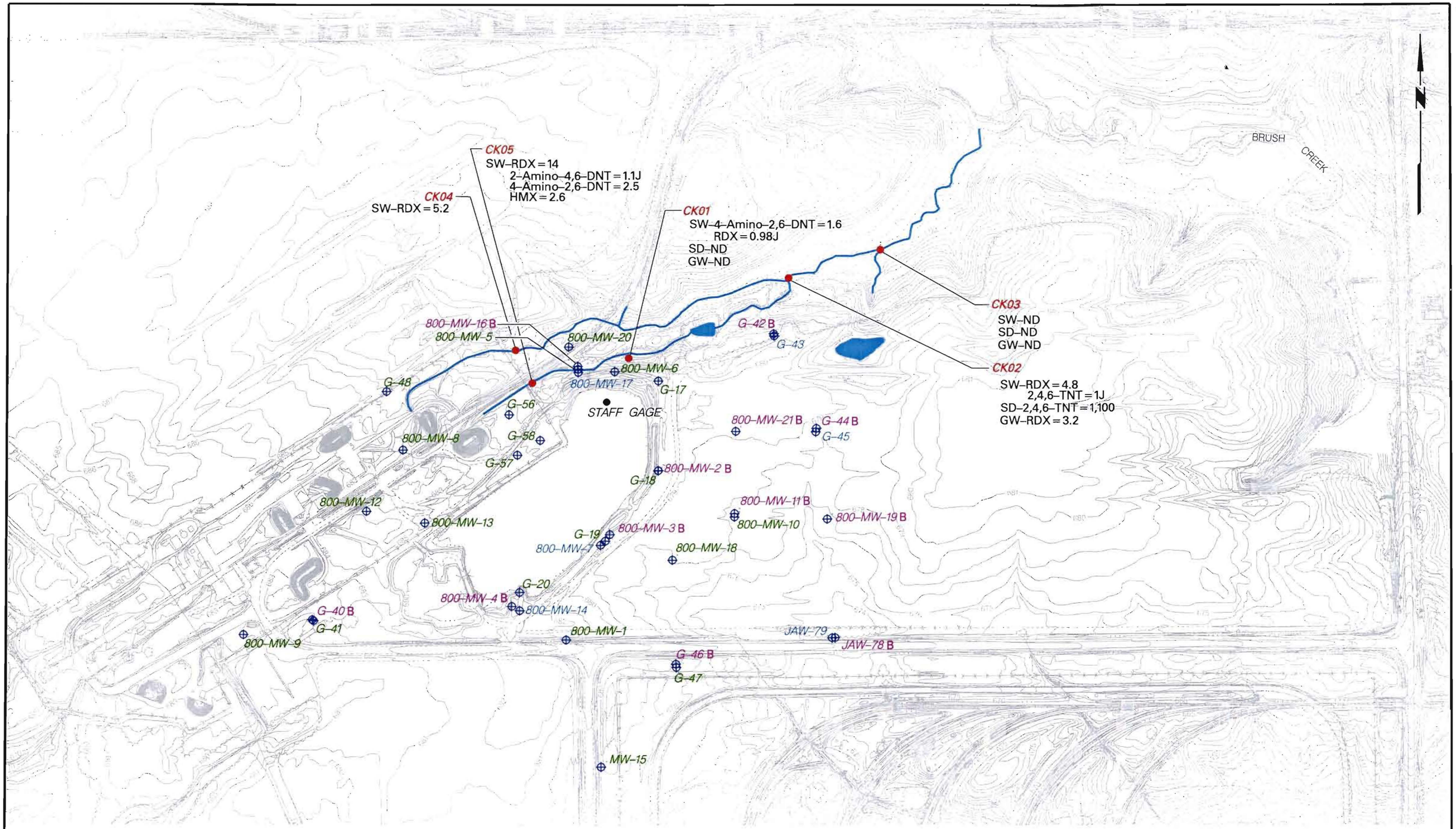
LEGEND:

⊕	Monitoring Well	RDX	Concentration Greater Than PRGs (ug/L)
800-MW-18	Upper Till Well	RDX	Concentration Less Than PRGs (ug/L)
800-MW-14	Lower Till Well	J	Sample Results are Estimated
800-MW-19 B	Bedrock Well	RDX	None Detected

Figure 9

EXPLOSIVES DETECTED IN GROUNDWATER, BEDROCK
SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map3.dgn May. 05, 1999 08:41:50



Scale 0 300 600 Feet

LEGEND:

- Monitoring Well
- CK01 Creek Site Location 1
- ND None Detected
- 800–MW–18 Upper Till Well
- 800–MW–14 Lower Till Well
- 800–MW–19 B Bedrock Well
- SW Surface Water Sample (ug/l)
- SD Sediment Sample (ug/kg)
- GW Groundwater Seepage Sample (ug/l)

HARZA ENGINEERING COMPANY
Water & Environment

Figure 10

SURFACE WATER, SEDIMENT AND GROUNDWATER SEEPAGE SAMPLES ANALYTICAL RESULTS

SUPPLEMENTAL GROUNDWATER REMEDIAL INVESTIGATION REPORT
LINE 800 / PINK WATER LAGOON
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

c:\dgn\5644gf\clr_map2.dgn May. 07, 1999 09:40:06

TABLES

TABLE 1

MONITORING WELL CONSTRUCTION DATA

Well Number	Drilled Depth (ft. bgs)	Screened Interval (ft. bgs)	6-inch Diam. Casing Depth (ft. bgs)	Depth to Bedrock (ft. bgs)	Unit
800-MW01	20	10-20	NA	NA	Upper Till
800-MW02	76	66-76	56	53	Bedrock
800-MW03	79	69-79	59	58	Bedrock
800-MW04	74	64-74	54	52.5	Bedrock
800-MW05	18	7.5-17.5	NA	NA	Upper Till
800-MW06	18	7.5-17.5	NA	NA	Upper Till
800-MW07	38	27.5-37.5	NA	NA	Lower Till
800-MW08	18	7.5-17.5	NA	NA	Upper Till
800-MW09	18	7.5-17.5	NA	NA	Upper Till
800-MW10	18	7.5-17.5	NA	NA	Upper Till
800-MW11	76.2	66.2-76.2	56.5	55.5	Bedrock
800-MW12	18	7.5-17.5	NA	NA	Upper Till
800-MW13	18	7.5-17.5	NA	NA	Upper Till
800-MW14	36	25-35	NA	NA	Lower Till
800-MW15	18	7.5-17.5	NA	NA	Upper Till
800-MW16	70.5	60.5-70.5	22*	38	Bedrock
800-MW17	34.5	24.5-34.5	22	NA	Lower Till
800-MW18	18	7.5-17.5	NA	NA	Upper Till
800-MW19	74	64-74	54	52.5	Bedrock
800-MW20	18	7.5-17.5	NA	NA	Upper Till
800-MW21	77	67-77	56.5	54.5	Bedrock

* - 4-inch diameter PVC casing to 41 feet BGS.

TABLE 2

HEADSPACE SCREENING RESULTS

Well/Boring ID	Sample Interval (feet BGS)	Headspace Results (PPM)	Geotech Sample Collected
800-MW01	0-1	0.2	
	5-6	0.6	YES
	10-11	0.5	
	15-16	0.9	
	19-20	1.5	YES
800-MW02	0-1	11.7	
	5-6	13.7	
	10-11	8.7	
	15-16	3.1	YES
	20-21	2.0	
	25-26	0.0	
	30-31	0.0	
	35-36	0.0	
	40-41	0.0	
	45-56	0.0	YES
	50-51	0.0	
800-MW03	0-1	0.3	
	5-6	0.0	
	10-11	0.1	
	15-16	0.0	
	20-21	0.3	
	25-26	0.0	
	30-31	0.1	
	35-36	0.0	
	40-41	0.0	
	45-46	0.0	YES
	50-51	0.0	YES
	55-56	0.0	
800-MW04	0-1	0.0	
	4.5-5.5	0.0	
	9.5-10.5	0.0	
	14.5-15.5	0.0	
	19.5-20.5	0.0	YES
	24.5-25.5	0.0	
	29.5-30.5	0.0	
	34.5-35.5	0.0	
	39.5-40.5	0.0	
	44.5-45.5	0.0	YES
	49.5-50.5	0.0	
800-MW05	0-1	1.5	YES
	4.5-5.5	0.9	
	9.5-10.5	0.3	YES
	14.5-15.5	1.7	
800-MW06	0-1	1.9	
	5-6	4.6	
	10-11	3.8	YES
	15-16	3.7	YES
800-MW07	0-1	0.0	
	4.5-5.5	18	YES
	9.5-10.5	0.0	
	14.5-15.5	0.0	
	19.5-20.5	1.3	
	24.5-25.5	0.0	
	29.5-30-5	0.0	YES
	34.5-35.5	0.0	
800-MW08	0-1	0.0	
	5-6	0.0	
	10-11	0.0	YES
	15-16	0.0	YES
800-MW09	0-1	0.0	
	5-6	0.0	YES
	10-11	0.0	YES
	15-16	0.0	
800-MW10	0-1	0.5	
	5-6	0.0	
	10-11	0.1	YES
	15-16	0.0	YES
800-MW11	0-1	0.1	
	5-6	0.3	
	10-11	1.1	
	15-16	1.2	
	20-21	0.8	
	25-26	0.2	
	32-33	0.7	YES
	37-38	0.3	YES
	45-46	0.5	
	52-53	0.1	
800-MW12	0-1	0.0	
	5-6	0.0	YES
	10-11	0.0	
	15-16	0.0	YES
800-MW13	0-1	1.1	
	5-6	1.3	YES
	10-11	1.3	YES
	15-16	0.2	
800-MW14	0-1	1.7	
	5-6	1.6	
	10-11	1.7	
	15-16	1.5	
	20-21	0.7	
	25-26	0.0	YES
	30-31	0.0	YES
800-MW15	0-1	0.7	
	5-6	0.1	
	10-11	0.0	YES
	15-16	1.3	YES

TABLE 2

HEADSPACE SCREENING RESULTS

Well/Boring ID	Sample Interval (*feet BGS*)	Headspace Results (*PPM*)	Geotech Sample Collected	Well/Boring ID	Sample Interval (*feet BGS*)	Headspace Results (*PPM*)	Geotech Sample Collected
800-MW16	0-1	0.7		800-MW20	0-1	0.0	
	5-6	1.3			5-6	0.0	
	10-11	0.8			10-11	0.0	YES
	15-16	0.8	YES		15-16	0.0	YES
	23.5-24.5	0.0		800-MW21	0-1	0.2	
	28.5-29.5	0.2	*		5-6	0.1	
800-MW17	0-1	0.6			10-11	0.0	
	5-6	0.7			15-16	0.0	YES
	10-11	1.0	YES		20-21	0.2	
	22.5-23.5	0.0			25-26	0.2	
	24.5-25.5	0.0			30-31	0.1	
	29.5-30.5	0.0	YES		35-36	0.0	YES
800-MW18	0-1	0.8			40-41	0.0	
	5-6	0.8	YES		45-46	0.0	
	10-11	0.8			50-51	0.0	
	15-16	1.2	YES				
800-MW19	0-1	0.6					
	5-6	0.0					
	10-11	0.7					
	15-16	0.3					
	20-21	1.8					
	25-26	1.6	YES				
	30-31	0.8					
	35-36	0.0					
	40-41	0.0					
	45-46	0.0	YES				
	50-51	0.0					

* - Little to no sample recovery. No sample submitted for geotechnical analysis.
BGS – Below ground surface.
ppm – Parts per million.

TABLE 3

GEOTECHNICAL SOIL SAMPLE ANALYTICAL RESULTS

Sample ID	Depth Interval (Feet)	Unified Symbol	Soil Description	LL	PL	PI
800-MW01	0-1	CL/OL	Dark Brown, lean to fat clay, trace sand.	53	18	35
	19-20	CL	Brown, sandy lean clay, trace gravel	31	12	19
800-MW02	15-16	CL	Gray, sandy lean clay, trace gravel	48	16	32
	45-46	CH	Dark Brown, fat clay, trace sand	58	20	38
800-MW03	45-46	SP	Brown, fine to medium sand	-	-	N/P
	50-51	SP	Brown, fine to medium sand	-	-	N/P
800-MW04	19.5-20.5	CL	Brown, sandy lean clay, trace gravel	28	22	6
	44.5-46.5	CH	Gray brown to brown gray, fat clay, trace sand	56	19	37
800-MW05	0-1		Dark Brown and Brown, Fill, lean to fat clay, trace sand, gravel and organics	46	19	27
	9.5-10.5		Brown and Gray Brown, fill, sandy lean to fat clay, trace gravel	50	14	37
800-MW06	9-10	CL/CH	Brown Gray, lean to fat clay, trace sand	47	17	30
	15-16	CL	Brown Gray, sandy lean clay, trace gravel	47	10	31
800-MW07	5-6	CL	Brown Gray, lean clay, trace sand	42	17	25
	29.5-30.5	SP	Brown, fine to medium sand	-	-	N/P
800-MW08	10-11	CL/CH	Brown Gray, lean to fat clay, trace sand and gravel	43	15	28
	15-16	CL/CH	Brown Gray, sandy lean to fat clay, trace gravel	33	13	20
800-MW09	5-6	CH	Brown Gray, fat clay, trace sand	52	18	34
	10-11	CL/CH	Dark Brown, lean to fat clay, trace sand	41	18	23
800-MW10	10-11	CH	Light Gray, fat clay, trace sand	54	14	40
	15-16	CL/CH	Gray Brown, sandy lean to fat clay, trace gravel	35	13	22
800-MW11	32-33	SW	Brown, fine to coarse sand with clay, trace gravel.	-	-	-
	37-38	SM	Gray Brown, silty fine to coarse sand.	-	-	-
800-MW12	5-6	CL/CH	Gray Brown, lean to fat clay, trace sand	42	20	22
	15-16	CL/CH	Gray Brown, lean to fat clay, trace sand and gravel.	44	20	24
800-MW13	5-6	CL	Brown Gray, lean clay, trace sand	40	27	14
	10-11	CL/CH	Gray Brown, sandy lean to fat clay, trace gravel	40	17	23
800-MW14	25-26	CL/CH	Gray Brown, sandy lean to fat clay, trace gravel.	37	14	23
	30-31	SM	Light Gray, silty fine to coarse sand.	-	-	-
800-MW15	10-11	CL/CH	Gray Brown, sandy lean to fat clay, trace gravel.	40	11	29
	15-16	CL	Gray Brown, sandy lean clay, trace gravel	33	17	16
800-MW16	15-16	CH	Gray Brown, sandy fat clay.	52	15	37
800-MW17	10-11	CL	Brown, lean clay, trace sand	36	24	12
	29.5-30.5	CL	Brown, sandy lean clay, trace gravel.	31	17	14
800-MW18	5-6	CL	Brown Gray, lean clay, trace sand	41	15	26
	15-16	CL/CH	Brown Gray, sandy lean to fat clay.	44	13	30
800-MW19	25-26	CL	Brown, sandy lean clay, trace gravel	29	18	11
	45-46	CL	Gray, sandy lean clay, trace gravel	35	16	18
800-MW20	10-11	CL	Brown Gray, sandy lean clay	39	14	26
	15-16	CL/CH	Brown Gray, sandy lean to fat clay, trace gravel	44	14	31
800-MW21	15-16	CL	Gray, sandy lean clay, trace gravel	36	13	23
	35-36	CL	Gray, sandy lean clay, trace gravel	23	13	10

TABLE 4

MONITORING WELL STATE PLANE COORDINATES AND ELEVATIONS

Number	Coordinates		Elevation		Drilled Depth (Ft.)	Screen Depth (ft.)		Aquifer Zone
	North	East	Ground	TOC		Top	Bottom	
JAW-78	293,478.009	2,270,172.146	674.8	677.71	66	50	65	Bedrock
JAW-79	293,477.559	2,270,162.819	674.9	677.74	36	25	35	Lower Till
G-17	294,333.863	2,269,584.447	681.3	684.21	20	9	19	Upper Till
G-18	294,034.566	2,269,584.539	680.1	682.90	20	9	19	Upper Till
G-19	293,799.681	2,269,409.356	680.3	683.44	20	9.5	19.5	Upper Till
G-20	293,628.517	2,269,126.758	683.4	685.78	20	9.5	19.5	Upper Till
G-40	293,536.588	2,268,438.331	682.4	684.25	83	73.25	83.25	Bedrock
G-41	293,533.514	2,268,442.560	682.4	684.08	22	9.8	19.8	Upper Till
G-42	294,492.643	2,269,968.518	683.2	685.19	77	66.5	76.5	Bedrock
G-43	294,485.973	2,269,970.004	683.3	685.60	42	32.1	42.1	Lower Till
G-44	294,176.849	2,270,109.994	679.7	681.82	80	68	78	Bedrock
G-45	294,164.631	2,270,107.737	679.7	681.38	40	30	40	Lower Till
G-46	293,389.085	2,269,644.424	678.3	680.44	68	58	68	Bedrock
G-47	293,377.838	2,293,377.838	678.4	680.51	26	16	26	Upper Till
G-48	294,298.234	2,268,682.812	681.9	684.07	31	20.41	30.42	Lower Till
G-56	294,229.726	2,269,098.661	680.1	681.90	31	18.5	28.51	Lower Till
G-57	294,094.323	2,269,126.728	680.8	682.44	31	19.95	29.96	Lower Till
G-58	294,143.949	2,269,201.794	680.7	683.36	31	20	30	Lower Till
800-MW01	293,478.671	2,269,289.692	682.6	684.71	20	10	20	Upper Till
800-MW02	294,042.387	2,269,592.208	680.9	682.72	76	66	76	Bedrock
800-MW03	293,807.178	2,269,415.630	680.9	682.63	79	69	79	Bedrock
800-MW04	293,590.018	2,269,109.444	683.8	685.92	74	64	74	Bedrock
800-MW05	294,382.728	2,269,326.654	677.5	678.80	18	7.5	17.5	Upper Till
800-MW06	294,373.639	2,269,447.355	679.3	681.54	18	7.5	17.5	Upper Till
800-MW07	293,794.370	2,269,402.619	681.1	682.64	38	27.5	37.5	Lower Till
800-MW08	294,110.949	2,268,745.854	683.3	685.38	18	7.5	17.5	Upper Till
800-MW09	293,494.761	2,268,215.516	683.9	685.59	18	7.5	17.5	Upper Till
800-MW10	293,889.064	2,269,848.233	679.2	681.25	18	7.5	17.5	Upper Till
800-MW11	293,900.526	2,269,848.398	679.2	681.33	76.2	66.2	76.2	Bedrock
800-MW12	293,907.113	2,268,625.643	685.5	687.37	18	7.5	17.5	Upper Till
800-MW13	293,867.742	2,268,818.914	684.0	686.06	18	7.5	17.5	Upper Till
800-MW14	293,575.814	2,269,135.293	683.6	685.72	36	25	35	Lower Till
800-MW15	293,056.535	2,269,406.151	680.2	682.14	18	7.5	17.5	Upper Till
800-MW16	294,391.585	2,269,325.647	677.5	679.59	70.5	60.5	70.5	Bedrock
800-MW17	294,371.812	2,269,327.226	677.7	679.55	34.5	24.5	34.5	Lower Till
800-MW18	293,744.215	2,269,640.329	679.5	681.86	18	7.5	17.5	Upper Till
800-MW19	293,882.737	2,270,154.245	678.4	680.67	74	64	74	Bedrock
800-MW20	294,456.928	2,269,295.746	676.7	678.81	18	7.5	17.5	Upper Till
800-MW21	294,174.463	2,269,851.856	680.1	682.17	77	67	77	Bedrock
Existing gage	294,255.616	2,269,404.119	680.01	NA	NA	NA	NA	Top of gage
New gage	294,255.616	2,269,404.119	683.03	NA	NA	6.70	NA	Top of gage

TABLE 5

HYDRAULIC CONDUCTIVITY

Well Number	Depth to Water Table Ft TOC	Water Table Elevation Ft MSL	Well Depth Ft BG	Screened Zone		Test Date	Hydraulic Conductivity Cm/s	
				Ft BG	Ft MSL BG		Hvorslev	Bouwer-Rice
800-MW01	6.38	678.33	22.15	10-20	672.6-662.6	12-1		$3.79x10^{-4}$
800-MW02	11.59	671.13	78.26	66-76	614.9-604.9	12-1	$1.12x10^{-6}$	
800-MW03	24.06	658.59	78.55	69-79	611.9-601.9	12-2	$6.9x10^{-6}$	
800-MW05	2.7	676.1	20.44	7.5-17.5	670-660	12-4		$1.2x10^{-3}$
800-MW06	4.88	676.66	20.40	7.5-17.5	671.8-661.8	12-3		$1.02x10^{-4}$
800-MW07	5.33	677.31	40.48	27.5-37.5	653.6-643.6	12-2	$1.05x10^{-4}$	
800-MW08	5.16	680.22	20.51	7.5-17.5	675.8-665.8	12-4		$1.03x10^{-3}$
800-MW09	8.71	676.88	19.96	7.5-17.5	676.4-666.4	12-3		$1.48x10^{-3}$
800-MW09 R						12-3		$1.32x10^{-3}$
800-MW10	4.94	676.31	20.25	7.5-17.5	671.4-661.4	12-1		$1.55x10^{-4}$
800-MW11	17.52	663.81	78.5	66.2-76.2	613-603	12-1	$2.05x10^{-5}$	
800-MW12	6.24	681.13	20.0	7.5-17.5	678-668	12-3		$3.83x10^{-4}$
800-MW13	5.82	680.24	20.44	7.5-17.5	676.5-666.5	12-4		$8.45x10^{-4}$
800-MW14	6.55	679.17	36.68	25-35	658.6-648.6	11-30	$2.66x10^{-6}$	
800-MW15	7.36	674.78	20.02	7.5-17.5	672.7-662.7	12-1		$1.19x10^{-3}$
800-MW15	7.32	674.82				12-4		$9.25x10^{-4}$
800-MW15 R						12-4		$1.14x10^{-3}$
800-MW17	2.97	676.58	36.75	24.5-34.5	653.2-643.2	12-2	$1.14x10^{-4}$	
800-MW18	5.11	676.75	20.02	7.5-17.5	672-662	12-1		$1.22x10^{-4}$
800-MW19	16.21	664.46	76.15	64-74	614.4-604.4	12-1	$3.6x10^{-5}$	
800-MW20	6.11	672.7	20.02	7.5-17.5	669.2-659.2	12-3		$4.38x10^{-5}$
800-MW21	19.2	662.97	79.0	67-77	613-603	12-2	$9.25x10^{-5}$	
G-18	4.19	675.71	20	9-19	671.1-661.1	12-5		$3.09x10^{-5}$
G-18 R						12-5		$6.35x10^{-5}$
G-19	4.98	678.46	20	9.5-19.5	670.8-660.8	12-5		$6.4x10^{-5}$
G-19 R						12-5		$4.36x10^{-5}$
G-20	6.09	679.69	20	9.5-19.5	673.9-663.9	12-4		$3.61x10^{-4}$
G-20 R						12-4		$2.79x10^{-4}$

Note: TOC - Top of Casing Cm/s - Centimeters per second BG - Below Ground R - Rising Head Test

TABLE 6

GROUNDWATER MEASUREMENTS AND ELEVATIONS

Well No	Soil Type	Groundwater Level		Groundwater Level	
		Depth (ft. TOC)	Elevation (ft. MSL)	Depth (ft. TOC)	Elevation (ft. MSL)
		December 5, 1998		December 8, 1998	
JAW-78	Lower Till	7.3	670.41	7.31	670.4
JAW-79	Bedrock	5.84	671.90	4.45	673.29
G-17	Upper Till	6.92	677.29	5.90	678.31
G-18	Upper Till	4.13	678.77	3.30	679.6
G-19	Upper Till	4.97	678.47	4.55	678.87
G-20	Upper Till	6.09+	679.69	5.95	679.83
G-40	Bedrock	37.76	646.49	37.33	646.92
G-41	Upper Till	4.46	679.62	2.04	682.04
G-42	Bedrock	21.97	663.22	22.03	663.16
G-43	Lower Till	14.42	671.18	14.12	671.48
G-44	Bedrock	17.68	664.14	17.74	664.08
G-45	Lower Till	6.86	674.52	5.96	675.42
G-46	Bedrock	17.80	662.64	17.11	663.33
G-47	Upper Till	6.43	674.08	4.55	675.96
G-48	Lower Till	4.27	679.8	4.03	680.04
G-56	Lower Till	4.56	677.34	4.46	677.44
G-57	Lower Till	4.05	678.39	3.77	678.67
G-58	Lower Till	5.43	677.93	4.60	678.76
800-MW01	Upper Till	6.31	678.4	5.57	679.14
800-MW02	Bedrock	11.64	671.08	10.97	671.75
800-MW03	Bedrock	24	658.63	24.22	658.41
800-MW04	Bedrock	23.29*	662.63	28.14	657.78
800-MW05	Upper Till	3.15	675.65	2.87	675.93
800-MW06	Upper Till	4.82	676.72	4.83	676.71
800-MW07	Lower Till	5.38	677.26	4.98	677.66
800-MW08	Upper Till	5.16	680.22	4.61	680.77
800-MW09	Upper Till	7.72	677.87	7.32	678.27
800-MW10	Upper Till	5.06	676.19	3.78	677.47
800-MW11	Bedrock	18.21	663.12	18.34	662.99
800-MW12	Upper Till	6.28	681.09	4.42	682.95
800-MW13	Upper Till	5.78	680.28	5.80	680.26
800-MW14	Lower Till	6.76	678.96	6.36	679.36
800-MW15	Upper Till	7.33	674.81	6.71	675.43
800-MW16	Bedrock	29.1*	650.49	35.55	644.04
800-MW17	Lower Till	2.95	676.6	2.74	676.81
800-MW18	Upper Till	4.91	676.95	3.58	678.28
800-MW19	Bedrock	16	664.67	16.09	664.58
800-MW20	Upper Till	6.17	672.64	4.46	674.35
800-MW21	Bedrock	19.05	663.12	19.15	663.02

+ DTW measurement was taken on the day of the hydraulic conductivity test, 12/4/98.
* DTW measurements are those taken prior to well purging. Wells were still recovering on 12/5/98.

TABLE 7

SUMMARY OF GROUNDWATER SCREENING SAMPLES - ANALYTICAL RESULTS

Sample ID Date Collected Type of Well	800-MW01 101298 Upper Till	800-MW02 101498 Bedrock	800-MW03 101498 Bedrock	800-MW04 101498 Bedrock	800-MW05 101498 Upper Till	800-MW07 101398 Lower Till	800-MW08 101398 Upper Till	800-MW09 101398 Upper Till	800-MW10 101298 Upper Till	800-MW11 101498 Bedrock
Explosives (Method 8330) *UG/L*										
1,3,5-Trinitrobenzene	0.443 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	**1.1 J**	**40 J**	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	ND	ND	ND	**2.3**	**18,100**	**2.6**	1.9	ND	**7.7**	**8.9**
2,4-Dinitrotoluene	ND	ND	**49**	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	0.64 J	ND	4.9	ND	3,200	ND	ND	ND	0.546 J	ND
2-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitrotoluene	ND	ND	5.8	ND	ND	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND	ND	2,400 J	ND	ND	ND	ND	ND
4-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RDX	**3.4**	ND	ND	ND	**1,770 J**	ND	**1.4**	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HMX	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetryl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

"J"- An estimated value. Analyte at or above method detection limit but below quantitation limit.

"ND" - None detected.

TABLE 8
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MONITORING WELLS

Sample ID	JAW79	JAW78	G-17	G-18	G-19	G-20	G-40	G-41	G-42	G-43	G-44
Date Collected	111698	111698	112498	112498	111798	111798	120198	120198	113098	113098	112498
Type of Well	Lower Till	Bedrock	Upper Till	Upper Till	Upper Till	Upper Till	Bedrock	Upper Till	Bedrock	Lower Till	Bedrock
Explosives (Method 8330) *UG/L*											
1,3,5-Trinitrobenzene	ND	ND	ND	ND	ND-UJ	**1,800J**	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	ND	ND	ND	ND	**550 J**	**84 J**	ND	ND	ND	ND	0.59 J
2,4-Dinitrotoluene	ND	ND	ND	ND	ND-UJ	**54 J**	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	**230J**	**320J**	ND	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND	ND	46 J	42 J	ND	ND	ND	ND	ND
2-Nitrotoluene	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
3-Nitrotoluene	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND	ND	98	ND-UJ	ND	ND	ND	ND	ND
4-Nitrotoluene	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
RDX	ND	ND	**28**	**4,700**	**2,600J**	**14,000J**	ND	1.8	ND	ND	**2.2**
Nitrobenzene	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
HMX	ND	ND	ND	**710**	**710J**	**1500J**	ND	ND	ND	ND	ND
Tetryl	ND	ND	ND	ND	ND-UJ	ND-UJ	ND	ND	ND	ND	ND
Methane (Method 8015)											
Methane (*UG/L*)	ND	2.9	ND	60	4	ND	ND	1 J	ND	ND	1.2 J
Inorganics (*MG/L*)											
Calcium - Method 6010A	89.3	96.8	46.7	34.1	44.7	139	9.3	60.6	31.4	77.7	54.2
Magnesium - Method 6010A	27.2	35.9	23.4	17.5	16.2	64	2.7	21.4	4.2	21.8	0.17
Sodium - Method 6010A	18.5	21.7	8.8	21.6	15.1	44	26.4	5.8	34.4	13.8	22.2
Alkalinity - Method 310.2	534	492	202	130	167	228	27.4	217	95.4	317	162
Carbon Dioxide - Method 4500CO2D	0.89	0.83	0.14	ND	ND	0.2	9.2	ND	62.1	0.68	57.2
Chloride - Method 300.0	ND	ND	5.9	4.2	3.4	13.1	4.6	22.3	3.9	2.1	10.2
Kjeldahl Nitrogen - Method 351.2	0.52	0.44	ND	1.6	0.78	ND	0.15	0.3	0.46	0.32	0.7
Nitrate Nitrogen - Method 300.0	ND	ND	ND	5	3.7	119	2.9	ND	1	ND	1.3
Nitrite Nitrogen - Method 300.0	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	0.66
Nitrogen, Ammonia - Method 350.1	0.42	0.29	ND	ND	ND	0.38	0.083	0.07	0.32	0.24	0.39
Phosphate, Ortho- Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids - Method 160.2	9.4	5.1	ND	12.5	3.2	ND	10.7	ND	36.6	8.1	8.3
Sulfate - Method 300.0	6.5	11.5	38.2	60.5	32.8	83.5	43.7	30.1	21.3	7.7	25.3
Sulfide, Total - Method 9030	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Organic Carbon - Method 415.1	ND	ND	ND	7.5	3.6	9.4	ND	1.7	ND	ND	ND

"UJ"- The sample results are estimated. Although the analyte is not detected in the sample, quality control checks indicate that the results are inaccurate based on the recoveries for the spikes, surrogates or control standards.

"J"- An estimated value. Analyte at or above method detection limit but below quantitation limit.

NA " - Not available. The explosive sample from well 800-MW12 was broken during transport to the laboratory. This well will be sampled for explosives at a later date. ND - None detected.

TABLE 8
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MONITORING WELLS

Sample ID	G-45	G-46	G-47	G-48	800-D002	G-56	800-D001	G-57	G-58	800-MW01	800-MW02
Date Collected	112498	111798	111798	112098	112098	111898	111898	111898	111898	111798	112498
Type of Well	Lower Till	Bedrock	Upper Till	Lower Till	(dup of G-48)	Lower Till	(dup of G-56)	Lower Till	Lower Till	Upper Till	Bedrock
Explosives (Method 8330) *UG/L*											
1,3,5-Trinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	0.98 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	2.9	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	**8**	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	3.6	ND	ND
2-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND
3-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND	ND	ND	1.4	0.65 J	ND	9.4	ND	ND
4-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RDX	0.68 J	ND	ND	ND	ND	**290**	**180**	**860**	**4,300**	0.87 J	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HMX	ND	ND	ND	ND	ND	7.1	3.8	13	**440**	ND	ND
Tetryl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methane (Method 8015)											
Methane (*UG/L*)	ND	ND	ND	ND	ND	ND	ND	ND	16	ND	ND
Inorganics (*MG/L*)											
Calcium - Method 6010A	75.6	13.8	55.5	86.2	86.8	80.8	76.6	104	74.7	75.5	88.2
Magnesium - Method 6010A	18.9	0.79	21.1	27.7	28	26.6	25.8	35.4	22.1	34.6	35.9
Sodium - Method 6010A	11.1	27.3	13.1	29.2	28.2	16.9	16.8	25.2	36.8	8.5	27.8
Alkalinity - Method 310.2	261	34.3	207	501	425	224	392	289	274	271	482
Carbon Dioxide - Method 4500CO2D	0.18	15.8	0.14	0.67	0.9	0.31	1.3	0.39	0.19	0.46	0.32
Chloride - Method 300.0	14.3	12.4	14.8	ND	ND	2.2	2.2	6	4.8	9.6	6.6
Kjeldahl Nitrogen - Method 351.2	0.29	0.24	ND	0.14	ND	0.36	0.28	ND	0.44	ND	0.45
Nitrate Nitrogen - Method 300.0	ND	ND	2.6	ND	ND	2.6	2.4	47	21.4	17.9	ND
Nitrite Nitrogen - Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen, Ammonia - Method 350.1	0.081	0.041	ND	ND	ND	0.085	ND	ND	0.22	ND	0.25
Phosphate, Ortho- Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids - Method 160.2	17.2	4.1	ND	ND	ND	4.7	3	ND	31	7.8	10.1
Sulfate - Method 300.0	19.7	87.3	31.2	24.1	24.1	25.8	26.1	38.5	43.4	26.2	30.9
Sulfide, Total - Method 9030	ND	ND	ND	ND	1.7	ND	ND	ND	ND	ND	ND
Total Organic Carbon - Method 415.1	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND

"UJ"- The sample results are estimated. Although the analyte is not detected in the sample, quality control checks indicate that the results are inaccurate based on the recoveries for the spikes, surrogates or control standards.

"J"- An estimated value. Analyte at or above method detection limit but below quantitation limit.

NA * - Not available. The explosive sample from well 800-MW12 was broken during transport to the laboratory. This well will be sampled for explosives at a later date. ND - None detected.

TABLE 8
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MONITORING WELLS

Sample ID	800-MW03	800-MW04	800-MW05	800-MW06	800-MW07	800-MW08	800-MW09	800-MW10	800-MW11	800-MW12	800-MW13
Date Collected	112398	112098	113098	112398	112398	111998	111998	112398	112398	111998	111998
Type of Well	Bedrock	Bedrock	Upper Till	Upper Till	Lower Till	Upper Till	Upper Till	Upper Till	Bedrock	Upper Till	Upper Till
Explosives (Method 8330) *UG/L*											
1,3,5-Trinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA *	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
2,4,6-Trinitrotoluene	ND	ND	**10,000**	ND	ND	ND	ND	ND	ND	NA	0.92 J
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
2,6-Dinitrotoluene	ND	ND	ND	4.5	ND	ND	ND	ND	ND	NA	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	2,800	ND	ND	ND	ND	ND	ND	NA	ND
2-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
3-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	1,800	ND	ND	ND	ND	ND	ND	NA	ND
4-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
RDX	ND	ND	**940**	**1,400**	ND	0.93 J	ND	ND	ND	NA	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
HMX	ND	ND	350	48	ND	ND	ND	ND	ND	NA	ND
Tetryl	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND
Methane (Method 8015)											
Methane (*UG/L*)	5.6	ND	14	16	ND	ND	30	ND	25	ND	ND
Inorganics (*MG/L*)											
Calcium - Method 6010A	86.2	71.6	186	85.2	84.1	47.5	52.9	74.8	78.1	54.9	72
Magnesium - Method 6010A	44.5	25.1	65	25.7	23.3	17.8	20.2	22.1	31.1	25.3	29.1
Sodium - Method 6010A	20.7	59.8	35.4	14.7	18	11.5	10.1	17.2	20	8.9	8.9
Alkalinity - Method 310.2	531	411	1,660	357	420	189	226	154	400	239	287
Carbon Dioxide - Method 4500CO2D	0.45	1.4	0.69	ND	1.4	0.41	0.16	ND	1.3	0.26	0.97
Chloride - Method 300.0	1.4	33.3	9.4	3.8	1.4	1.4	7.1	23.7	13	1.7	1.1
Kjeldahl Nitrogen - Method 351.2	0.46	0.32	217	0.42	0.8	ND	0.16	0.14	0.36	0.12	0.18
Nitrate Nitrogen - Method 300.0	ND	1.3	99.7	ND	ND	ND	ND	5.1	ND	2.8	9.1
Nitrite Nitrogen - Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen, Ammonia - Method 350.1	0.32	0.049	111	ND	0.64	ND	ND	ND	0.13	ND	ND
Phosphate, Ortho- Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids - Method 160.2	22.7	16.6	49.2	18.3	3.3	ND	2.1	161	35.1	ND	ND
Sulfate - Method 300.0	5.7	68.5	67	41.7	9.2	24.9	31.5	34.3	22.2	25.6	32.4
Sulfide, Total - Method 9030	1.2	1.2	ND	ND	ND	ND	ND	1.2	ND	1.4	1.4
Total Organic Carbon - Method 415.1	ND	ND	51.1	1.9	ND	ND	ND	ND	ND	ND	ND

"UJ"- The sample results are estimated. Although the analyte is not detected in the sample, quality control checks indicate that the results are inaccurate based on the recoveries for the spikes, surrogates or control standards.

"J"- An estimated value. Analyte at or above method detection limit but below quantitation limit.

NA * - Not available. The explosive sample from well 800-MW12 was broken during transport to the laboratory. This well will be sampled for explosives at a later date. ND - None detected.

TABLE 8
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MONITORING WELLS

Sample ID	800-MW14	800-MW15	800-MW16	800-MW17	800-MW18	800-MW19	800-MW20	800-MW21	DW01	G41-FB
Date Collected	112098	112098	113098	113098	112098	112398	120198	112498	111798	120298
Type of Well	Lower Till	Upper Till	Bedrock	Lower Till	Upper Till	Bedrock	Upper Till	Bedrock	Source Water	Rinseate Blnk
Explosives (Method 8330) *UG/L*										
1,3,5-Trinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	ND	ND	0.39 J	2.8	ND	ND	0.52 J	ND	ND	ND
2,4-Dinitrotoluene	0.50 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND	0.97 J	ND	ND	ND	ND	ND	ND
4-Nitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RDX	170	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HMX	0.95 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetryl	ND	ND	ND	ND	ND	ND	4.4	ND	ND	ND
Methane (Method 8015)										
Methane (*UG/L*)	ND	ND	2.4	1.2 J	ND	41	ND	ND	ND	NA
Inorganics (*MG/L*)										
Calcium - Method 6010A	114	46.3	61	86.6	604	57.9	64.8	77.8	20.7	0.49
Magnesium - Method 6010A	38.4	20.4	23	28.5	16.4	21.9	21.8	31	12.1	ND
Sodium - Method 6010A	17.4	6.5	35.1	17.5	15.6	26.4	14.7	21.1	15	0.42
Alkalinity - Method 310.2	383	187	286	433	205	370	270	349	39.8	NA
Carbon Dioxide - Method 4500CO2D	1	0.26	0.39	0.37	ND	0.5	0.29	0.37	0.8	NA
Chloride - Method 300.0	8.5	5.4	15	2	19.4	15.7	2.3	13.4	33.2	NA
Kjeldahl Nitrogen - Method 351.2	0.34	0.11	0.44	0.56	0.29	0.35	0.34	0.43	0.33	NA
Nitrate Nitrogen - Method 300.0	26	3.4	1.2	ND	2.2	1.1	ND	ND	3.6	NA
Nitrite Nitrogen - Method 300.0	ND	ND	ND	ND	ND	ND	ND	0.64	ND	NA
Nitrogen, Ammonia - Method 350.1	ND	ND	0.14	0.55	ND	0.066	0.16	0.045	ND	NA
Phosphate, Ortho- Method 300.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Total Suspended Solids - Method 160.2	705	6.5	364	3.4	15.8	10.7	224	12.3	ND	NA
Sulfate - Method 300.0	19.6	25.1	45.5	11.4	22.3	28	28.4	40.3	68.6	NA
Sulfide, Total - Method 9030	ND	ND	ND	ND	1.2	ND	ND	ND	ND	NA
Total Organic Carbon - Method 415.1	ND	ND	1.3	ND	ND	14.7	ND	ND	2	NA

"UJ"- The sample results are estimated. Although the analyte is not detected in the sample, quality control checks indicate that the results are inaccurate based on the recoveries for the spikes, surrogates or control standards.

"J"- An estimated value. Analyte at or above method detection limit but below quantitation limit.

NA * - Not available. The explosive sample from well 800-MW12 was broken during transport to the laboratory. This well will be sampled for explosives at a later date. ND - None detected.

TABLE 9

Chemicals Exceeding PRGs, Line 800/Pink Water Lagoon

Chemical	Screening Criteria (ug/L)	Well (ug/L)					
		G-18	G-19	G-20	G-41	G-57	G-58
1,3,5-Trinitrobenzene	1.8 (PRG) [a]	190	63	2,600	--	--	--
1,3-Dinitrobenzene	1 (HAL)	110	110	72	--	--	1.05
2,4,6-Trinitrotoluene	2 (HAL)	2,200	2,000	470	--	--	--
2,4-Dinitrotoluene	5 [b]	95	140	96	--	--	--
2,6-Dinitrotoluene	5 [b]	75	96	--	--	--	--
RDX	2 (HAL)	8,600	8,400	13,000	12.5	470	1,500
Nitrobenzene	3.4 (PRG) [a]	--	--	170	--	--	--
HMX	400 (HAL)	1,100	980	1,700	--	--	--

Source: Jaycor, 1996. (a) USEPA Region IX PRG. (b) 10E-6 Cancer Risk.

TABLE 10
ANALYTICAL RESULTS OF SEDIMENT SAMPLE 800-MW17-SD-13-14

Parameters	Method Limit	Reporting Limit	Results (ug/kg)
1,3,5-Trinitrobenzene	3,120,000	10,000,000	ND
1,3-Dinitrobenzene	2,950,000	9,000,000	ND
2,4,6-Trinitrotoluene	3,140,000	10,000,000	43,000,000
2,4-Dinitrotoluene	3,160,000	10,000,000	ND
2,6-Dinitrotoluene	2,880,000	9,000,000	ND
2-Amino-4,6-Dinitrotoluene	2,630,000	9,000,000	ND
2-Nitrotoluene	2,910,000	9,000,000	ND
3-Nitrotoluene	3,420,000	11,000,000	ND
4-Amino-2,6-Dinitrotoluene	2,830,000	9,000,000	ND
4-Nitrotoluene	2,690,000	9,000,000	ND
RDX	2,730,000	9,000,000	ND
Nitrobenzene	3,290,000	10,000,000	ND
HMX	2,850,000	9,000,000	ND
Tetryl	2,860,000	9,000,000	ND

ND - None detected.

TABLE 11

SUMMARY OF LABORATORY ANALYTICAL RESULTS - SEDIMENT SAMPLES

Sample ID / Date	800-MW17-SD-13-14 102898	CK01 120498	CK02 120498	CK03 120498
Explosives (Method 8330) *UG/KG*				
1,3,5-Trinitrobenzene	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND
2,4,6-Trinitrotoluene	43,000,000	ND	1,100	ND
2,4-Dinitrotoluene	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND	ND
2-Nitrotoluene	ND	ND	ND	ND
3-Nitrotoluene	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND	ND
4-Nitrotoluene	ND	ND	ND	ND
RDX	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND
HMX	ND	ND	ND	ND
Tetryl	ND	ND	ND	ND
Inorganics (*MG/KG*)				
Aluminum	NA	11,000	8,860	3,980
Antimony	NA	ND	ND	ND
Arsenic	NA	6.7	6.3	5.7
Barium	NA	181	104	180
Beryllium	NA	0.73	0.77	0.45
Cadmium	NA	0.7	ND	ND
Calcium	NA	52,400	3,420	4,930
Chromium	NA	14.3	12.6	6.8
Cobalt	NA	7.4	8.6	10.6
Copper	NA	13.7	10.6	5.4
Iron	NA	16,800	16,900	10,800
Lead	NA	10.8	11.8	5.9
Magnesium	NA	3,040	1,860	1,020
Manganese	NA	766	394	955
Mercury	NA	ND	ND	ND
Nickel	NA	16.1	14.6	10.6
Potassium	NA	852	866	335
Selenium	NA	12.5	13.6	8.4
Silver	NA	ND	ND	ND
Sodium	NA	159	133	122
Thallium	NA	ND	ND	ND
Vanadium	NA	27.6	27.2	19.2
Zinc	NA	44.1	38.6	22.2
Total Solids (%)	NA	71.1	69	73.7

ND - None detected.
NA - Not analyzed.

TABLE 12
SUMMARY OF LABORATORY ANALYTICAL RESULTS - SURFACE WATER SAMPLES

Sample ID Date Collected	CK01 120498	CK02 120498	CK03 120498	CK04 120498	CK05 120498
Explosives (Method 8330) *UG/L*					
1,3,5-Trinitrobenzene	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	ND	1 J	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND	ND	1.1 J
2-Nitrotoluene	ND	ND	ND	ND	ND
3-Nitrotoluene	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	1.6	ND	ND	ND	2.5
4-Nitrotoluene	ND	ND	ND	ND	ND
RDX	0.98 J	4.8	ND	5.2	14
Nitrobenzene	ND	ND	ND	ND	ND
HMX	ND	ND	ND	ND	2.6
Tetryl	ND	ND	ND	ND	ND

ND - None detected.
J - An estimated value. Analyte at or above method detection but below quantitation limit.

TABLE 13
SUMMARY OF LABORATORY ANALYTICAL RESULTS - GROUNDWATER SEEPAGE SAMPLES

Sample ID Date Collected	CK01 120498	CK02 120498	CK03 120498
Explosives (Method 8330) *UG/L*			
1,3,5-Trinitrobenzene	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND
2,4,6-Trinitrotoluene	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	ND	ND	ND
2-Nitrotoluene	ND	ND	ND
3-Nitrotoluene	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	ND	ND	ND
4-Nitrotoluene	ND	ND	ND
RDX	ND	3.2	ND
Nitrobenzene	ND	ND	ND
HMX	ND	ND	ND
Tetryl	ND	ND	ND

ND - None detected.