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HORSEHEAD CORPORATION
Leading the World in Zinc Recycling

March 14, 2016

Hand Delivery

Stephen Baldridge, Esq.
Oklahoma Department of Environmental Quality
707 N Robinson Avenue
Oklahoma City, OK 73102

Re: Horsehead Corp. - Bartlesville Post-Closure Permit Renewal Application

Dear Mr. Baldridge:

Enclosed you will find two (2) copies of Horsehead Corp.'s Post-Closure Permit Renewal Application for its Bartlesville, Oklahoma facility ("Application"). We certainly appreciate ODEQ's cooperation with Horsehead Corp. on the timing of submitting the Application.

In support of the Application, Horsehead would like to bring a couple of items to ODEQ's attention. First, since the Application seeks renewal of an existing permit, and since certain required information in this Application already exists in ODEQ's files, in certain instances the Application may make reference to such existing information as opposed to providing copies of such existing documentation. Secondly, Horsehead Corp. is in the process of reviewing and considering updates and other modifications to other plans in place for its Bartlesville, Oklahoma facility. By way of example, Horsehead Corp.'s Stormwater Pollution Prevention Plan and its Post-Closure Plan are currently under review in this regard. In the event that it is decided that updates and modifications are necessary or appropriate, Horsehead Corp. will submit such documents to ODEQ for review and consideration in accordance with applicable procedural requirements.

Again, we appreciate ODEQ's cooperation and look forward to working with ODEQ.

Sincerely,

Thomas W Johnston

Enclosure

POST - CLOSURE PERMIT RENEWAL APPLICATION
HORSEHEAD CORPORATION
BARTLESVILLE, OKLAHOMA FACILITY

PERMIT #000829440-PC

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March 14, 2016

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POST–CLOSURE PERMIT RENEWAL APPLICATION
HORSHEAD CORPORATION
BARTLESVILLE, OKLAHOMA FACILITY
PERMIT #000829440-PC
MARCH 14, 2016

1.0 INTRODUCTION

This Post-Closure Permit Renewal Application (Application) is submitted by Horsehead Corporation (HC) in relation to its Bartlesville, Oklahoma facility (Facility), seeking renewal of Permit #000829440-PC, which was issued by the Oklahoma Department of Environmental Quality (ODEQ) on April 10, 2006. This Application has been prepared in compliance with 40 CFR Part 270, Subpart B.

The original Application for a Post-Closure Permit was filed with the ODEQ by Zinc Corporation of America (ZCA) on August 2, 2001 and subsequently revised on August 1, 2002 and October 29, 2004. The October 29, 2004 revision reflected that the Facility was conveyed to HC through a bankruptcy court proceeding; however, all historical references to ZCA prior ownership, were retained where appropriate. This Application likewise retains those references.

ZCA completed closure activities at the Facility under the requirements specified in the RCRA Operations Permit (#OKD000829440) (Permit) issued to ZCA by the ODEQ.

The Permit allowed operation of one landfill (Landfill LF.1) to dispose of wastes generated at the Facility and the use of a Corrective Action Management Unit (CAMU) which was established to facilitate management of stormwater and other remediation waste at the Facility.

The corrective measures implemented during corrective action at the Facility focused on the following:

- Elimination of possible human exposures to soils and waste with lead, cadmium, and arsenic levels above industrial use soil standards
- Elimination of stormwater impacts associated with runoff contacting impacted Facility soils and waste

For the purposes of corrective action, the Facility was divided into five distinct "Class Areas" as follows:

- Northeast Area
- Class I Area
- Class II Area
- Class III Area
- Class IV Area

The corrective action design and construction activities were performed in phases by Class Area. The permitted RCRA unit, Landfill LF.1 is closed. The remaining areas, encompassed by the five Class Areas described above (which include the permitted CAMU) are also closed. This Application addresses the post-closure activities that will continue to be implemented for Landfill LF.1, Class Areas I, II, III, and IV, and the Northeast Area. The areas identified below were not covered by the expiring post-closure permit and are not addressed in this Application:

- Areas of the Facility that were operating at the time of the submittal of the prior permit application, and which have since been idled
- The Underground Injection Control System – separately permitted by the ODEQ
- No-Name Creek Off-Site Flow Improvements (Described below)

As part of the overall corrective action, the off-site upper reaches of No-Name Creek, located south of the Facility, were improved. Channel improvements were necessary in No-Name Creek in order for the Facility drainage area to handle the increased surface water runoff generated subsequent to corrective measures implementation. However, No-Name Creek is not within the boundary of the RCRA-permitted area and it does not contain any regulated units (including CAMU) that will require post-closure care; therefore, it is not included as part of this Application. The Facility has a separate Operation and Maintenance Plan for the off-site upper reaches of No-Name Creek and an agreement with the City of Bartlesville to ensure that the improved portions of No-Name Creek are maintained.

The corrective measures implemented during closure of the Facility included the elimination of several surface impoundments previously used for collection of impacted on-site surface water and construction of a new surface water management system. Management of surface water runoff from former operational areas (aka Storm Water Management Areas or SWMAs), which have been idled since the former application was submitted, is discussed below.

Constructed physical controls direct surface water runoff from SWMAs at the former HC Process Area, aka Equidae, (Process Area) and the process water treatment facility (PWTF) into Process Containment Areas (PCAs). The PCAs were designed to continuously pump water during a storm event for recycling, treatment, and/or injection, so that during a storm event, the stormwater runoff with the greatest potential to be impacted during Facility operations could be contained and/or removed from the SWMAs and PCAs as necessary. Water was removed from the PCAs for reuse in operations or for treatment at the PWTF prior to disposal by injection into one of the Facility's two permitted non-hazardous injection wells.

Because the Facility has now been idled, thereby mitigating the potential for surface water runoff to be impacted during Facility operations, runoff is allowed to accumulate in the PCAs and evaporate, and is no longer pumped from the PCAs. Excess stormwater

generated during precipitation events automatically bypasses the PCAs and discharges to the Central Drainage System (CDS) that was constructed as part of the Facility corrective measures. BMPs will be employed as set forth in the Facility's SWPPP to reduce the potential for impacts to stormwater, as required by the OPDES Storm Water Industrial General Permit OKR05 issued for the Facility.

The Facility surface water runoff generated outside the two operating areas will flow over vegetated or paved areas and will, in some instances, discharge directly from the site. However, the majority of this surface water runoff will be routed through the CDS to No-Name Creek.

As specified in 40 CFR 270.28, Part B information requirements for post-closure permits, HC is submitting the following information to the ODEQ in this Application:

- 40 CFR 270.14(b)(1): general description of the Facility
- 40 CFR 270.14(b)(4): description of the security procedures and equipment
- 40 CFR 270.14(b)(5):· copy of the general inspection schedule
- 40 CFR 270.14(b)(6): preparedness/prevention requirements
- 40 CFR 270.14(b)(11): Facility location information
- 40 CFR 270.14(b)(13): a copy of the post-closure plan
- 40 CFR 270.14(b)(14): documentation of post-closure notice filing
- 40 CFR 270.14(b)(16): most recent post-closure cost estimate
- 40 CFR 270.14(b)(18): proof of financial assurance
- 40 CFR 270.14(b)(19): topographic map
- 40 CFR 270.14(c): groundwater protection information on SWMUs
- 40 CFR 270.14(d): information on SWMUs

The remaining sections of this Application address the items listed above.

2.0 GENERAL FACILITY DESCRIPTION [40 CFR 270.14(B)(1)]

The Facility name is Horsehead Corporation, which is owned and operated by HC. The Facility is located adjacent to the city limits of Bartlesville, Oklahoma. The Facility's street address is 11th and Virginia Avenue, Bartlesville, Oklahoma, 74003, and its mailing address is P.O. Box 579, Bartlesville, Oklahoma 74005.

The Facility encompasses parts of Sections 11 and 14 of Township 26N, Range 12E, in Western Washington County, Oklahoma. The city limits border upon a portion of the Facility to the north and are within several hundred feet to the east and south. The Facility property is approximately 150 acres in area and extends roughly 2,300 feet north to south and 3,000 feet east to west. State Highway 123 runs parallel to the western edge of the property and, at the Facility location, divides Washington and Osage counties. The property to the west of the Facility is an unincorporated portion of Osage County. A complete legal description is provided in Appendix A.

During the zinc smelting and refining operations, the Facility produced various metals from the smelting and refining of zinc concentrates, secondary materials, and other zinc rich materials. The Facility had nine surface impoundments, four waste piles, and two landfills. The Facility underwent closure and corrective action of all of these units as required by the Permit.

Surface features remaining at the Facility after closure, and depicted as "Idled Active Areas" in Figure 2-1, include the following:

- Administrative Building
- Storage Building
- Boiler House
- Rail System
- HC Plant Process Building (Process Building) and associated facilities, including a storm water management area (SWMA) and process containment area (PCA)
- Bin 18

- Scale House
- Machine Shop (wastewater formerly generated from the machine shop was pumped to the process water treatment facility (PWTF))
- Bath House (no wastewater production)
- PWTF complex, including rail loading and PCA
- Permitted Non-Hazardous Underground Injection Control system including two deep injection wells and two lined impoundments

Utility systems which were in service during Facility operations included sanitary sewer, fire protection and potable water, natural gas, process water streams, stormwater, gray water and electrical service. An aboveground utility corridor was constructed to convey the process and gray water. Potable and fire water lines were constructed above corrective action caps in a soil mound to provide freeze protection. Natural gas lines were co-located in the soil mound. The sanitary sewer system includes two separate septic systems constructed on-site in proximity to the Administrative Building and the Process Area. The sanitary sewer fields and septic tanks were also constructed above the corrective measures cover system in soil mounds to provide absorption media and freeze protection.

Stormwater runoff originating from the Facility is routed off-site, primarily through the CDS to No-Name Creek. However, some stormwater exits the site at several other locations, such as the northwest corner, the west- central area near the Administrative building, the southwest corner, the southeast corner, and from vegetated slopes all around the perimeter of the site. Stormwater conveyance is by gravity flow using swales, above ground concrete channels, and a central subsurface 54-inch diameter HOPE drainage pipe (CDS) that flows to No-Name Creek.

Individual stormwater containment facilities were constructed for the Process Area and the PWTF, both of which are currently idled. The Process Area also includes two (2) storage/transfer tanks. When the Process Area was in operation, Stormwater was typically collected within the Process Area and then combined with gray water and

boiler sump water before being pumped to the blend tank at the PWTF for treatment and deep well injection via the underground injection control (UIC) system.

The UIC system consists of aboveground piping to transfer PWTF discharges to two lined impoundments. When the UIC system is operating, treated water is pumped from the lined impoundments to the two disposal wells.

On-site railroad tracks provide rail access to BIN 18, the PWTF, and the Process Areas. There are various paved surfaces at the site including roadways, maintenance areas and parking areas.

In general, all surfaces at the site that are not paved or occupied by buildings or railroad tracks have a soil cover system. All soil surfaces are vegetated. Trees and/or shrubs, and sod were planted along certain boundaries of the site as part of site-wide beautification. Access to the Facility is through a west entrance that is controlled by security personnel and/or automated gates. The entire Facility is secured by a chain-link fence. The closed Facility is depicted on Figure 2-1.

3.0 DESCRIPTION OF SECURITY PROCEDURES [40 CFR 270.14(B)(4)]

Security measures at the Facility include one controlled entry/exit Facility gate, six-foot high chain-link perimeter fencing, and warning signs posted on the fencing. The fencing and gate system provide an artificial barrier which completely surrounds the Facility as required by 40 CFR 264.14(b). The location of the Facility's West Gate and fencing is shown on Figure 2-1.

Warning signs are posted at the West Gate, and along the fence in sufficient numbers to be seen from any approach to the Facility. These signs are visible from a distance of at least 25 feet and bear the legend "Danger-Unauthorized Personnel Keep Out".

The security measures employed at the Facility are designed to prevent the unauthorized entry, and minimize the possibility for the unknowing entry, of persons or livestock onto the Facility property. The corrective action implemented at the Facility eliminated the potential for physical contact with the waste; however, at a minimum, the fence and gate systems will be retained during the post-closure period in order to ensure the long-term effectiveness of the corrective measures.

4.0 GENERAL INSPECTION SCHEDULE [40 CFR 270.14(B)(5)]

HC inspects, and will continue to inspect, the Facility during post-closure for malfunctions and deterioration of the corrective measures implemented during closure and corrective action. HC has developed and will follow a written schedule for inspecting monitoring wells and structural equipment that are important to preventing, detecting, or responding to environmental or human health hazards.

Section 3.0 of the Post-Closure Plan (see Appendix B) outlines the inspection schedule for the Facility. The items that will require inspection during the post-closure period include:

- monitoring wells
- stormwater drainage structures
- utility structures
- fencing
- paved areas
- Portland cement concrete structures
- railroads
- soil cover system
- landscaped areas

5.0 PREPAREDNESS AND PREVENTION REQUIREMENTS [40 CFR 270.14(B)(6)]

The regulatory requirements regarding preparedness and prevention are contained in Subpart C of 264. These requirements are addressed in this section.

5.1 Design and Operation of Facility [40 CFR 264.31]

The corrective measures implemented at the Facility were designed to minimize the possibility· of a fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste or hazardous constituents to air, soil, or surface water which could threaten human health or the environment. Specifically, the actions were designed to eliminate possible human exposure to soils and waste with lead, cadmium, and arsenic levels above industrial use soil standards and eliminate stormwater impacts occurring from Facility soils and waste. Inspection and maintenance of the Facility during post-closure is designed to ensure that the structures created to eliminate potential impacts will remain intact and will be repaired when needed. Also, the Facility SWPPP includes best management practices which will serve to protect the environment from potential impacts.

5.2 Required Equipment [40 CFR 264.32 and 264.33]

Emergency equipment, including fire control, spill control, and personal protective equipment is no longer maintained at the closed Facility. This equipment is unnecessary since the Facility no longer has active waste management units that pose hazards requiring such equipment. All of the former units have protective covers.

Internal communication is provided utilizing personal cell phones and/or radio communications within the Facility. External communication equipment is provided by the Facility telephone system located at the Guard Building and the Administrative Building. This equipment will be maintained as necessary to assure proper operation in times of emergency.

5.3 Required Aisle Space [40 CFR 264.35]

Adequate spacing is maintained around the structures that were built during corrective action to allow movement of personnel and safety or emergency equipment.

5.4 Arrangements with Local Authorities [40 CFR 264.37]

Although it is unlikely that an emergency situation would arise at the closed Facility, arrangements have been made with several organizations to provide assistance in emergency situations. These organizations include:

- Bartlesville Police Department
- Washington County Sheriff's Department
- Bartlesville Fire Department
- Jane Phillips Hospital

These organizations are represented by the Local Emergency Planning Committee (LEPC) and the LEPC have been provided with copies of the Facility Post-Closure Plan. Updates of appropriate information will be provided to the LEPC as necessary.

6.0 FACILITY LOCATION INFORMATION (40 CFR 270.14(B)(11)]

6.1 Seismic Standard

Appendix VI of 40 CFR Part 264 lists those political jurisdictions (counties, townships, election districts) having geological faults that have had displacement in Holocene time. The Facility is located in Washington County, Oklahoma. This county is not listed in Appendix VI; therefore, no seismic standard applies to the Facility.

6.2 Floodplain Standard

It has been determined that the Facility is not located in a 100-year floodplain. This determination was made following a review of the National Flood Insurance Program maps (Figure 6-1).

7.0 POST-CLOSURE PLAN [40 CFR 270.14(B)(13)]

The Post-Closure Plan is included in this Application in Appendix B.

8.0 DOCUMENTATION OF POST-CLOSURE NOTICE FILING [40 CFR 270.14(8)(14)]

In accordance with 40 CFR 264.119, a notice of filing was completed within 60 days of certification of closure and should be on file with the ODEQ.

9.0 POST-CLOSURE COST ESTIMATE [40 CFR 270.14(B)(16)]

The post-closure cost estimate, completed in 2001 and included in the original Post-Closure Permit Application, is included in the Post-Closure Plan in Appendix B. An inflation factor of 1.34 should be applied to the numbers presented in the cost estimate to adjust the 2001 costs to 2016 costs, as calculated using the Bureau of Labor Statistics web-based inflation calculator.

10.0 PROOF OF FINANCIAL ASSURANCE [40 CFR 270.14(B)(18)]

Financial assurance documentation for the Permit and post-closure care is on file with the ODEQ.

11.0 TOPOGRAPHIC MAP [40 CFR 270.14(B)(19)]

An as-designed topographical map is provided in this Application as Drawing 11-1.

In accordance with 40 CFR 270.14(b)(19), an additional topographic map (Drawing 11-2) was prepared for the Facility upon completion of closure. The topographic map shows a distance of 1,000 feet around the Facility at a scale of 1 inch equals 200 feet. The contours shown on the map are at intervals of five feet. The topographic map clearly shows the following:

- Map scale and date
- A statement that the Facility is not located in the 100-year floodplain
- No-Name Creek- the only intermittent stream
- Surrounding land uses (residential, commercial, industrial)
- A wind rose
- Orientation of the map using a north arrow
- Legal description and boundaries of the Facility
- Access control (fencing and gates)
- Injection wells
- Significant Facility structures
- Barriers for drainage control (i.e., berms)
- Location of operational units (currently idled)
- Location of closed areas

12.0 GROUNDWATER PROTECTION INFORMATION [40 CFR 270.14(C)]

12.1 Summary of the Groundwater Monitoring Data [40 CFR 270.14(c)(1)]

A summary of the analytical data for groundwater samples collected at the Facility from 1992 through June of 2001 is presented on Table 12-1. A copy of the 2015 Groundwater Monitoring Report for the Facility is provided in Appendix C and provides a compilation of groundwater data generated since June of 2003.

12.2 Identification of the Uppermost Aquifer [40 CFR 270.14(c)(2)]

12.2.1 Regional Geology

The surface geology in the Bartlesville area consists of Quaternary-age unconsolidated materials and Pennsylvanian-age sedimentary formations of shale, siltstone, sandstone, and limestone. Formations which outcrop in the Bartlesville area, in ascending order, include the Nellie Bly Formation, the Dewey Formation, and the Chanute Formation, which are locally overlain by Quaternary-age unconsolidated materials. A geological cross-section map showing the lithology beneath the Facility is shown on Figure 12-1.

Quaternary-age materials occur as a thin veneer of residuum (weathered bedrock) and slopewash deposits on upland areas. Quaternary-Age materials are intermixed with fill material at the Facility and are collectively referred to herein as unconsolidated material. Underlying the Quaternary-age materials are over 2,000 feet of sedimentary bedrock units of Cambrian through Pennsylvanian age.

As shown on Figure 12-1, the uppermost Pennsylvanian-age formation at the Facility is the Chanute Formation, which consists of thin to thick bedded, fine-to-coarse grained sandstone (sandstone has not been encountered in the Chanute Formation beneath the Facility) and shale. The upper portion of the Chanute Formation typically yields only small amounts of fair to poor quality groundwater.

The Dewey Formation underlies the Chanute Formation. The Dewey Formation consists of limestone with some shale. The Dewey Formation typically yields only small amounts of fair to poor quality groundwater.

Beneath the Dewey Formation is the Nellie Bly Formation consisting of calcareous shale, limestone, and thin sandstone interbeds. Groundwater yield from the Nellie Bly is small and of fair (upper part) to poor quality (lower part) according to the reconnaissance of the water resources of the Tulsa Quadrangle, northeastern Oklahoma.

12.2.2 Regional Groundwater

Shallow groundwater in the Bartlesville area occurs in the Quaternary-age alluvium (none present beneath the Facility) and bedrock residuum. Groundwater also occurs in the Pennsylvanian-age Chanute Formation, the Dewey Formation, and the Nellie Bly Formation. Beneath the Facility, groundwater in the Nellie Bly Formation becomes brackish or saline below a depth of about 125 feet, according to the Oklahoma Corporation Commission (OCC, 1983). Recharge to both alluvial and bedrock groundwater systems likely occurs by infiltration of precipitation over outcrop areas of these formations. Regional discharge of groundwater from the shallow groundwater system occurs along streams in the area, through evapotranspiration, and by recharge to underlying bedrock units.

Shallow groundwater at the Facility flows toward and discharges to Eliza Creek, which is located approximately 2,300 feet west of the Facility and to No-Name Creek approximately 200 feet south of the Facility. According to published data, the Facility is not located in the vicinity of a major bedrock groundwater system and is not located above a major alluvial groundwater system. Published data also indicate that the Facility area is not favorable for development of groundwater supplies. The quality of groundwater in the Facility area is described as generally poor to fair (Marcher and Bingham, 1971). These regional findings are consistent with the data developed during the RCRA Facility Investigation (RFI) for the Facility.

Additionally, the Corrective Measures Study Report (RSA, 1997) stated that the shallow groundwater system beneath the Facility was not a potential source of drinking water based on the EPA groundwater classification system (EPA, 1988). This finding is

consistent with the National Zinc Site Operable Unit 1 Record of Decision that stated the groundwater at the National Zinc Site is not used for drinking water because it yields only small amounts of poor quality water due to natural geological conditions and historical oil production activities.

12.2.3 Groundwater Flow Direction and Rate

A map of the groundwater table elevations as of September 12, 1995, in unconsolidated material, is shown on Figure 12-2. The groundwater table map for September 12, 1995, shows that groundwater flow was predominantly towards the west and northwest beneath the northwestern part of the Facility. Beneath the southern half of the Facility, the groundwater flow direction was generally towards the south. The map also shows that mounding was occurring at the northeast portion of the Facility. Groundwater gradients in the unconsolidated material groundwater system were found to range from approximately 0.006 to 0.02 ft/ft, averaging 0.013 ft/ft. The direction of groundwater flow was determined during the 2015 groundwater monitoring events to be consistent with those observed in 1995, as was the gradient (0.008 ft/ft). More recent groundwater information is found in the 2015 Annual Groundwater Monitoring Report, which is included in Appendix C.

Rising head and/or falling head slug tests were conducted on 36 groundwater monitoring wells during the RFI to determine the horizontal hydraulic conductivities of the unconsolidated material and bedrock groundwater systems. These results were evaluated by the Bouwer and Rice (1976) method, and were discussed in the Phase 1 RFI Work Plan (RSA, 1994b).

The results for the wells completed in unconsolidated material show that horizontal hydraulic conductivities ranged from 1.6×10^{-5} to 6.4×10^{-3} ft/min. The average horizontal conductivity of the unconsolidated material was calculated to be 1.03×10^{-3} ft/min.

The horizontal hydraulic conductivity for the Chanute Formation bedrock system was calculated to range from 1.2 x 10^{-5} to 8.9 x 10^{-3} ft/min (wells completed in both the Chanute and the Dewey Formations were considered Chanute wells for these evaluations). The average horizontal conductivity for the Chanute Formation was calculated to be 2.12 x 10-4 ft/min.

Darcy's Seepage Velocity Equation, which was presented in the Phase 1 RFI Work Plan, was utilized to calculate the average groundwater flow velocity. Utilizing horizontal hydraulic conductivity values for the unconsolidated material of 1.6 x 10^{-5} to 6.4 x 10^{-3} ft/min, an average hydraulic gradient of 0.013 ft/ft, and an effective porosity of 10%, the groundwater flow velocity was estimated to range from 3 x 10^{-3} ft/day to 1.20 ft/day (0.19 ft/day average).

Based on hydraulic conductivity values for the Chanute formation of 1.2 x 10^{-5} and 8.9 x 10^{-3} ft/min, an average hydraulic gradient of 0.013 ft/ft, and an effective porosity of 10%, the groundwater flow velocity in the Chanute Formation was estimated to range from 2 x 10^{-3} to 1.54 ft/day (0.037 ft/day average).

12.3 Topographic Map Summary [40 CFR 270.14(c)(3)]

The Facility boundary, groundwater flow directions (6/28/00) and proposed groundwater monitoring well locations are shown on Figure 2-2 in Appendix B. The Facility's groundwater monitoring system was previously approved by ODEQ and the groundwater monitoring wells were installed and comprise the Facility's groundwater monitoring system. The most recent discussion of groundwater monitoring is found in the 2015 Groundwater Monitoring Report for the Facility, which is provided in Appendix C. The Facility waste management boundary is shown on Figure 1-1 in Appendix B. The topographic map does not show point of compliance. See Section 12.6.4 for discussion of proposed point of compliance under the Flexible Closure Rule.

12.4 Contaminant Plume Description [40 CFR 270.14(c)(4)]

12.4.1 Extent [40 CFR 270.14(c)(4)(i)]

The extent of zinc, cadmium, and lead in groundwater at the Facility as demonstrated in the original Post-Closure Permit Application are shown on Figures 12-3, 12-4, and 12-5, respectively. The 2015 Groundwater Monitoring Report for the Facility (Appendix C) presents groundwater monitoring data generated since June of 2003.

12.4.2 Appendix IX Constituents [40 CFR 270.14(c)(4)(ii)]

Levels of Appendix IX constituents detected in groundwater at the Facility are summarized on Table 12-2, as reported in the original Post-Closure Permit Application.

12.5 Groundwater Monitoring Program [40 CFR 270.14(c)(5]

Groundwater monitoring at the Facility has consistently taken place in accordance with the Post-Closure Permit (#000829440-PC) and HC's approved Post-Closure Plan. The groundwater monitoring program presented in Section 2.0 of the Post-Closure Plan (see Appendix B) has been implemented and a copy of the 2015 Groundwater Monitoring Report is provided in Appendix C.

12.6 Compliance Monitoring Program [40 CFR 270.14(c)(7)1

12.6.1 Description of the Wastes Previously Handled [40 CFR 270.14(c)(7)(i)]

The following areas were identified in the RFI as containing wastes that were representative of wastes produced or stored at the Facility. Each of these areas was investigated during the RFI.

Goethite

Two materials piles, known as the South Goethite Pile and the North Goethite Pile, were located at the western portion of the Facility. The piles were used for the disposal of goethite resulting from the leach and purification plant processes.

Hot Tower Precipitate

A materials pile known as the Hot Tower Precipitate (HTP) pile was located adjacent to and north of Landfill LF.8, at the western portion of the Facility. The pile was used for the placement of hot tower precipitate, a wastewater treatment plant filter cake, from 1976 until 1982.

Nickel-Cobalt (LF.8)

Landfill LF.8 was an above-grade, hazardous waste landfill located north of the North Goethite Pile at the western portion of the Facility. The landfill was used for the disposal of goethite and nickel-cobalt filter cake. ZCA began placing goethite and nickel-cobalt filter cake in separate areas within the landfill in 1991 and stopped placing material in the landfill in 1993.

Cherryvale Piles

Three distinct materials piles known as the Cherryvale Piles were located on the western boundary of the Facility. The piles were created during a one-time placement of zinc-rich residues from another site that were moved to the Facility for reprocessing during the period from January through March, 1980.

Construction and Demolition Debris (LF.5)

During the 1970's demolition debris from the Bartlesville Zinc Company plant was disposed on top of Landfill LF.4 at the center of the Facility. Landfill LF.5 was closed in 1980 and was covered with fill material and vegetated with grass.

Plant Landfill (LF.1)

Landfill LF.1 was a RCRA permitted landfill that is located on the northern border of the Facility. Landfill LF.1 has been used for the disposal of plant waste as follows:

- 1972 to 1985: Plant trash, concentrate cleanup debris, and construction and demolition debris were disposed in approximately the eastern one-third of Landfill LF.1.
- 1985 to mid-1991: Concentrate cleanup and construction and demolition debris were disposed in approximately the central one-third of Landfill LF.1.
- Mid-1991 to July 13, 1995: Lime-stabilized goethite, manganese residue, and construction and demolition debris have been placed in the central portion of the eastern two-thirds of Landfill LF.1, over the waste placed in the unit from 1972 to mid-1991. A clay layer was constructed in approximately the western one-third of Landfill LF.1 in accordance with a consent agreement and final order entered into with the ODEQ (previously OSDH) in July 1991.
- July 14, 1995 to Closure: Permitted disposal of construction and demolition material, impacted soils, and PWTF filter media.

Municipal Landfill LF.2 and LF.4

Municipal Landfill LF.2 and LF.4 were located in the east-central portion of the Facility. Landfill LF.2 was used as a public landfill and salvage area from 1951 until 1973. It is believed that the landfill was closed to public use in 1973. Specific wastes deposited in the landfill are unknown; however, it is assumed that municipal solid waste and scrap metal were disposed in the unit. The landfill was covered with fill material and vegetated with grass.

Landfill LF.4 was used as a public landfill from 1954 until 1973. During the 1970's, construction and demolition debris from the Bartlesville Zinc Company plant was disposed on top of much of the abandoned landfill, and that portion of the area was designated as Landfill LF.5. The thickness of the debris from the construction and demolition activities ranges up to 15 feet. The landfill was closed in 1980 and has been covered with fill material and vegetated with grass. Specific municipal solid wastes disposed in the landfill are unknown.

Acid Tank Sludge

From the late 1970's to 1985, rinsewater sludges from cleaning of acid storage tanks and acid tanker trucks were disposed in two areas. Acid Sludge Disposal Area Numbers .1 and 2 are located in the central portion of the Facility. Both areas were covered with fill material (primarily clay). Wastes disposed in the units included acid tank sludges created when tank sediments containing a relatively small volume of sulfuric acid were washed from the tanks by spraying with relatively large volumes of high pressure water.

Slag/Clinker

A Slag/Clinker disposal area was located in the south-central part of the Facility. The area was historically used for the disposal of Slag/Clinker produced from horizontal retorts. Slag/Clinker was disposed in this area, which is unlined, from 1907 until the late 1960s.

Used Oil Storage

A Used Oil Storage area was located in the central portion of the Facility. The Used Oil Storage area consisted of a partially paved and graveled area where a building was once located. The building was utilized to store used oil from Facility vehicles and process equipment in 55-gallon drums prior to transport off-site for reclamation. The building was demolished in 1993.

12.6.2 Characterization of the Contaminated Groundwater [40 CFR270.14(c)(7)(ii)]

A summary of groundwater analytical data for groundwater samples collected at the Facility from 1992 through June of 2001 is included on Table 12-1. Isopleth maps of the primary contaminants in groundwater at the Facility, zinc, cadmium, and lead are included on Figures 12-3, 12-4, and 12-5, as presented in the original Post-Closure Permit Application. The most recent Facility groundwater monitoring information is located in the 2015 Groundwater Monitoring Report, which is provided in Appendix C.

12.6.3 Monitoring Constituents [40 CFR 270.14(c)(7)(iii)]

The previously approved groundwater monitoring constituents are presented in Section 2.0 of the Post-Closure Plan (see Appendix B).

12.6.4 Proposed Concentration Limits [40 CFR 270.14(c)(7)(iv)]

A flexible closure plan was proposed for the Facility in accordance with 40 CFR 264.90(f) and subsequently approved by ODEQ. As part of the flexible closure plan, trend analyses are proposed in place of comparison to concentration limits and establishment of a point of compliance. The method for implementing trend analyses is presented in Section 2.0 of the Post-Closure Plan (see Appendix B).

12.6.5 Proposed Groundwater Monitoring System [40 CFR 270.14(c)(7)(v)]

The previously approved groundwater monitoring system for the Facility, presented in Section 2.0 of the Post-Closure Plan (see Appendix B), was subsequently approved by ODEQ and has been utilized as documented in the 2015 Groundwater Monitoring Report (Appendix C).

12.6.6 Proposed Data Evaluation Procedures [40 CFR 270.14(c)(7)(vi)]

The previously approved data evaluation procedures are presented in Section 2.0 of the Post-Closure Plan (see Appendix B).

12.7 Corrective Action Program [40 CFR 270.14(c)(8)]

12.7.1 Characterization of Contaminated Groundwater [40 CFR270.14(c)(8)(i)]

A groundwater contamination characterization discussion is presented in Section 12.6.2 of this Application.

12.7.2 Concentration Limits [40 CFR 270.14(c)(8)(ii)]

A groundwater contaminant concentration limit discussion is presented in Section 12.6.4 of this Application.

12.7.3 Corrective Action [40 CFR 270.14(c)(8)(iii)]

Corrective action is discussed in Section 2.0 of the Post-Closure Plan in Appendix B.

12.7.4 Demonstration of the Adequacy of the Corrective Action [40 CFR270.14(c)(8)(iv)]

The adequacy of the corrective action has been, and will continue to be, demonstrated by conducting trend analyses for constituents in groundwater during post-closure. The previously approved method for conducting trend analyses is presented in Section 2.0 of the Post-Closure Plan in Appendix B. A discussion of the most recent trend analysis is included in the 2015 Annual Groundwater Monitoring Report included in Appendix C.,

13.0 INFORMATION ON SWMUS [40 CFR 270.14(D)]

ZCA originally identified Solid Waste Management Units (SWMUs) in Section 11.0 of the July 17, 1992, Part B RCRA Operating Permit application. Based on this information, the EPA performed a RCRA Facility Assessment and expanded the list of SWMUs. The SWMUs were investigated during corrective action activities authorized initially in an Administrative Order on Consent entered into by ZCA and EPA on September 1, 1993. When ODEQ was given authorization to administer the HSWA program by EPA in December 1994, the SWMUs were included in the corrective action requirements of the Permit.

ZCA completed all of the corrective action requirements of the Permit including the investigation and, where required, the corrective action of the SWMUs. No additional SWMUs have been identified for purposes of this Application; therefore, the information requirements of 40 CFR 270.14 (d) are not applicable to this Application.

14.0 REFERENCES

Bouwer, H. and R.C. Rice, 1976. A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Res. 12, p. 423-428.

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Marcher, Melvin V. and Jacob, 1940 Roy H. Bingham, 1971. Reconnaissance of the Water Resources of the Tulsa Quadrangle, Northeastern Oklahoma, Hydrologic Atlas 2, U.S. Geological Survey, 4 maps.

Oklahoma Corporation Commission, 1983. Treatable Water Maps.

RSA, 1994b. RCRA Facility Investigation (RFI) Work Plan Phase I, Zinc Corporation of America, Bartlesville, Oklahoma, August 16, 1994.

RSA, 1997. Corrective Measures Study (CMS) Report and Summary, Zinc Corporation of America, Bartlesville, Oklahoma, March 7, 1997.

15.0 CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Responsible Corporate Officer, Horsehead Corporation

Signature

Thomas W. Johnston, Rockwood Plant Manager
Printed Name and Title

March 14, 2016
Date

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-1A	23-Jul-92	58	1820	<0.05	0.003	0.02	<0.005	1.20	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.16
	20-Oct-92	60	1840	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.012	<0.01	0.20
	22-Jan-93	54	1810	<0.05	<0.002	0.01	<0.005	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.19
	7-Apr-93	49	1760	<0.05	<0.002	<0.01	<0.005	0.003	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.51
	15-Jul-93	56	1690	<0.05	0.003	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	0.04	<0.005	<0.01	0.17
	6-Oct-93	57	1790	<0.05	<0.002	<0.01	<0.005	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.24
	6-Jan-94	54	2010	<0.05	0.003	<0.01	<0.005	0.005	<0.01	<0.01	0.007	<0.0005	<0.01	<0.005	<0.01	0.84
	6-Apr-94	48	1770	<0.05	<0.002	0.01	<0.01	0.003	<0.01	<0.01	0.003	<0.0005	<0.01	0.011	<0.01	0.20
	28-Jul-94	54	1680	<0.05	0.008	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	0.14
	5-Oct-94	61	1790	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.09
	25-Jan-95	46	1690	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.21
	6-Apr-95	49	1690	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.19
	13-Sep-95	45	1250	<0.05	<0.002	<0.01	<0.01	0.003	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	0.24
	16-Apr-96	36	1400	<0.0050	<0.0020	0.014	<0.0010	0.0028	<0.010	<0.010	0.0077	<0.0005	<0.010	<0.0050	<0.010	0.24
	24-Sep-96	48	1700	<0.0050	<0.0020	0.016	<0.0010	0.0073	<0.010	<0.010	0.0079	<0.0005	<0.010	<0.0050	<0.010	0.42
	7-May-97	41	2060	<0.005	<0.002	0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.14
	30-Oct-97	46	1720	<0.005	<0.002	<0.01	<0.001	0.006	<0.01	<0.01	<0.002	<0.0005	0.01	<0.005	<0.01	1.01
	25-Mar-98	35	2160	<0.005	<0.002	<0.01	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.29
	17-Nov-98	40	1870	<0.005	<0.002	0.01	<0.001	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.33
	16-Jun-99	46	1850	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.11
	21-Dec-99	39	1730	<0.005	<0.002	0.01	<0.001	0.001	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.11
	29-Jun-00	39	1810	<0.005	<0.005	<0.01	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.06
	15-Dec-00	276	1880	<0.005	<0.005	0.01	<0.005	0.002	<0.02	<0.02	0.008	<0.001	<0.05	<0.005	<0.01	0.21
	28-Jun-01	Cannot locate														
MW-4D	15-Jul-93	---		---	---	---	---	---	---	---	---	---	---	---	---	---
	6-Oct-93	460	3190	<0.05	<0.002	0.02	<0.005	0.14	<0.01	0.19	0.142	<0.0005	0.10	<0.005	<0.01	34.2
	6-Jan-94	500	3400	<0.05	<0.002	0.02	<0.005	0.12	<0.01	0.14	0.238	<0.0005	0.10	<0.005	<0.01	34.3
	6-Apr-94	574	3460	<0.05	<0.002	0.03	<0.01	0.11	<0.01	0.03	0.128	<0.0005	0.06	0.006	<0.01	29.7
	28-Jul-94	658	3450	<0.05	0.011	0.12	<0.01	0.15	0.01	0.13	0.471	<0.0005	0.07	0.010	<0.01	33.8
	5-Oct-94	607	3530	<0.05	0.004	0.02	<0.01	0.10	<0.01	0.10	0.085	<0.0005	0.07	<0.005	<0.01	90.3
	25-Jan-95	666	3540	<0.05	0.005	0.07	<0.01	0.20	<0.01	0.04	0.569	<0.0005	0.04	<0.005	<0.01	28.0
	6-Apr-95	709	3470	<0.05	0.008	0.09	<0.01	0.21	<0.01	0.05	0.438	<0.0005	0.05	<0.005	<0.01	28.9
(1)	13-Sep-95	648	3400	<0.05	0.004	0.04	<0.01	0.20	<0.01	0.04	0.154	<0.0005	0.02	<0.005	<0.01	18.5
(2)	13-Sep-95	661	3290	<0.05	0.004	0.03	<0.01	0.23	<0.01	0.04	0.192	<0.0005	<0.01	<0.005	<0.01	16.2
	16-Apr-96	550	3200	<0.0050	0.0054	0.038	<0.0010	0.077	<0.010	0.026	0.26	<0.0005	0.035	<0.0050	<0.010	20
	24-Sep-96	660	3500	<0.0050	0.0038	0.025	<0.0010	0.095	<0.010	0.072	0.19	<0.0005	0.025	<0.0050	<0.010	18
	7-May-97	657	4170	<0.005	0.004	0.04	<0.001	0.135	<0.01	0.02	0.209	<0.0005	0.02	0.008	<0.01	14.66
	30-Oct-97	757	3420	<0.005	<0.002	0.03	<0.001	0.345	<0.01	0.03	0.112	<0.0005	0.04	<0.005	<0.01	14.2
	25-Mar-98	573	3760	<0.005	<0.002	0.02	<0.001	0.245	<0.01	<0.01	0.057	<0.0005	0.02	<0.005	<0.01	14.2
	17-Nov-98	542	996	<0.005	<0.002	0.03	<0.001	0.143	<0.01	0.02	0.056	<0.0005	0.02	<0.005	<0.01	12.1
	16-Jun-99	552	3,000	0.005	0.012	0.09	<0.001	0.275	<0.01	0.02	0.638	<0.0005	0.03	<0.005	<0.01	13.4
	21-Dec-99	319	2,310	<0.005	0.008	0.06	<0.001	0.198	<0.01	0.02	0.339	<0.0005	0.02	0.014	<0.01	14.7
	29-Jun-00	351	2,360	<0.005	0.008	0.08	<0.005	0.242	<0.02	<0.02	<0.005	<0.001	<0.05	0.014	<0.01	13.3
	15-Dec-00	339	2,660	<0.005	<0.005	0.03	<0.005	0.095	<0.02	<0.02	0.076	<0.001	<0.05	0.023	<0.01	11.2
	28-Jun-01	373	2,440	<0.005	0.013	0.12	<0.001	0.231	0.02	<0.02	0.604	<0.0005	0.05	0.020	<0.01	14.6
MW-12A	23-Jul-92	353	2790	<0.05	0.004	0.31	<0.005	0.005	0.03	<0.01	0.039	<0.0005	0.02	<0.005	<0.01	0.66
(1)	20-Oct-92	371	2720	<0.05	0.009	0.22	<0.005	0.003	0.04	0.08	0.049	<0.0005	0.07	<0.005	<0.01	0.52
(2)	20-Oct-92	380	2820	<0.05	0.006	0.22	<0.005	0.003	0.05	0.08	0.054	<0.0005	0.05	0.008	<0.01	0.49
	22-Jan-93	348	3040	<0.05	<0.002	0.01	<0.005	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	2.36
	7-Apr-93	315	2720	<0.05	<0.002	0.02	<0.005	<0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	2.90
(1)	15-Jul-93	320	2660	<0.05	0.004	0.02	<0.01	0.003	<0.01	<0.01	<0.002	<0.0005	0.05	<0.005	<0.01	3.87
(2)	15-Jul-93	336	2830	<0.05	0.007	0.03	<0.01	0.003	0.02	<0.01	<0.002	<0.0005	0.06	<0.005	<0.01	3.76
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-12A (cont.)	6-Oct-93	357	2690	<0.05	<0.002	0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.92
	6-Jan-94	359	3060	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.20
	6-Apr-94	357	2840	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	0.003	<0.0005	<0.01	0.006	<0.01	1.22
	27-Jul-94	409	2830	<0.05	<0.002	0.01	<0.01	0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.24
	5-Oct-94	414	2910	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.19
	25-Jan-95	368	2970	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.21
	5-Apr-95	359	2880	<0.05	<0.002	0.04	<0.01	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	4.36
	13-Sep-95	397	2820	<0.05	0.004	0.05	<0.01	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.91
	16-Apr-96	310	2500	<0.0050	<0.0050	0.014	<0.0010	0.0018	<0.010	<0.010	<0.0050	<0.00050	<0.020	<0.0005	<0.010	0.14
	24-Sep-96	340	2900	<0.0050	<0.002	0.013	<0.0010	0.0026	<0.010	<0.010	<0.0050	<0.0005	<0.010	<0.005	<0.010	0.18
	7-May-97	357	3900	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.53
	30-Oct-97	409	3020	<0.005	<0.002	<0.01	<0.001	0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.44
	25-Mar-98	319	3290	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	4.25
	17-Nov-98	Plugged														
MW-14A	23-Jul-92	1340	6970	0.4	0.014	0.97	<0.005	1.29	0.20	<0.01	0.065	0.0005	0.34	<0.005	<0.01	342
	20-Oct-92	1640	8170	<0.05	0.008	0.17	<0.005	0.61	0.04	0.04	0.009	<0.0005	0.13	0.014	<0.01	114
	22-Jan-93	896	6320	<0.05	<0.002	0.01	<0.005	5.15	<0.01	0.28	0.016	<0.0005	0.26	<0.005	<0.01	1310
	7-Apr-93	1290	4720	<0.05	<0.002	0.01	<0.005	4.98	0.02	0.25	0.121	<0.0005	0.20	<0.005	<0.01	1070
	15-Jul-93	1400	4640	<0.05	0.008	0.08	<0.01	2.56	<0.01	0.16	0.185	<0.0005	0.21	<0.005	<0.01	488
(1)	6-Oct-93	1040	4740	<0.05	<0.002	0.03	<0.005	1.84	<0.01	0.08	0.042	<0.0005	0.13	<0.005	<0.01	315
(2)	6-Oct-93	1060	5070	<0.05	<0.002	0.03	<0.005	1.90	<0.01	0.08	0.040	<0.0005	0.14	<0.005	0.01	315
(1)	6-Jan-94	1220	6390	<0.05	<0.002	0.04	<0.005	4.72	0.02	0.23	0.049	<0.0005	0.25	<0.005	<0.01	1400
(2)	6-Jan-94	1260	6420	<0.05	<0.002	0.04	<0.005	4.64	<0.01	0.24	0.050	<0.0005	0.25	<0.005	<0.01	1350
	6-Apr-94	1650	4910	<0.05	<0.002	0.01	<0.01	4.22	<0.01	0.20	0.246	<0.0005	0.21	0.007	<0.01	979
	28-Jul-94	1110	4100	<0.05	<0.002	0.02	<0.01	2.77	<0.01	0.1	0.163	<0.0005	0.15	<0.005	<0.01	534
	5-Oct-94	1480	4980	<0.05	0.003	0.02	<0.01	2.52	<0.01	0.06	0.084	<0.0005	0.21	<0.005	<0.01	503
	25-Jan-95	1300	5120	<0.05	<0.002	0.02	<0.01	5.38	<0.01	0.21	0.270	<0.0005	0.25	<0.005	<0.01	1320
	5-Apr-95	1710	4410	<0.05	<0.002	0.01	<0.01	4.61	<0.01	0.16	0.086	<0.0005	0.20	<0.005	<0.01	907
	13-Sep-95	1380	4320	<0.05	<0.002	0.02	<0.01	2.46	<0.01	0.16	0.130	<0.0005	0.18	<0.005	<0.01	426
	16-Apr-96	1200	4600	<0.0050	<0.0020	0.014	<0.0010	1.3	<0.010	0.031	0.029	<0.0005	0.11	0.0098	<0.010	340
	24-Sep-96	1000	4900	<0.0050	<0.002	0.022	<0.0010	1.3	<0.010	0.036	0.032	<0.0005	0.11	0.0085	<0.010	280
	7-May-97	456	4570	<0.005	<0.002	0.01	<0.001	1.7	<0.01	0.1	0.072	<0.0005	0.1	<0.005	<0.01	412.05
	30-Oct-97	438	3470	<0.005	<0.002	0.01	<0.001	1.83	<0.01	0.12	0.095	<0.0005	0.13	<0.005	<0.01	663
	25-Mar-98	580	3130	<0.005	<0.002	0.01	<0.001	1.33	<0.01	0.04	0.058	<0.0005	0.09	<0.005	<0.01	284
	21-Dec-98	435	3560	<0.005	<0.002	0.02	<0.001	2.90	<0.01	0.09	0.035	<0.0005	0.11	<0.005	<0.01	750
	16-Jun-99	886	3,580	<0.005	<0.002	0.02	<0.001	1.84	<0.01	0.07	0.024	<0.005	0.11	<0.005	<0.01	503
	21-Dec-99	Destroyed														
MW-16A	23-Jul-92	994	1170	<0.05	0.004	0.08	<0.005	0.007	<0.01	<0.01	0.038	<0.0005	0.02	<0.005	<0.01	2.19
(1)	20-Oct-92	573	1050	<0.05	0.024	0.59	<0.005	0.10	0.06	0.04	0.430	0.0022	0.18	0.007	<0.01	11.5
(2)	20-Oct-92	552	1050	<0.05	0.017	0.57	<0.005	0.09	0.06	0.04	0.42	0.0016	0.16	0.012	<0.01	11.0
(1)	22-Jan-93	771	1030	<0.05	<0.002	0.01	<0.005	0.024	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	4.55
(2)	22-Jan-93	797	1040	<0.05	<0.002	0.01	<0.005	0.023	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	4.86
(1)	7-Apr-93	929	932	<0.05	<0.002	0.02	<0.005	0.012	<0.01	<0.01	0.006	<0.0005	0.02	<0.005	<0.01	2.98
(2)	7-Apr-93	968	886	<0.05	0.004	0.09	<0.005	0.021	0.02	<0.01	0.040	0.0006	0.04	<0.005	<0.01	4.27
	15-Jul-93	1520	912	<0.05	0.008	0.05	<0.01	0.016	<0.01	0.03	0.013	<0.0005	0.10	<0.005	<0.01	6.31
	6-Oct-93	1270	866	<0.05	<0.002	<0.01	<0.005	0.008	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	3.16
	6-Jan-94	987	736	0.07	<0.002	0.02	<0.005	0.009	<0.01	<0.01	0.009	<0.0005	0.03	<0.005	<0.01	2.58
(1)	6-Apr-94	1110	839	<0.05	<0.002	0.02	<0.01	0.013	<0.01	<0.01	0.006	<0.0005	0.04	0.008	<0.01	2.87
(2)	6-Apr-94	1110	809	<0.05	<0.002	0.02	<0.01	0.013	<0.01	<0.01	0.007	<0.0005	0.03	0.007	<0.01	2.86
	27-Jul-94	4710	749	<0.05	0.004	0.07	<0.01	0.09	<0.01	0.05	0.012	<0.0005	0.02	0.007	<0.01	7.92
(1)	5-Oct-94	4790	761	<0.05	<0.002	0.07	<0.01	0.11	<0.01	0.06	0.009	<0.0005	0.07	<0.005	<0.01	9.52
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-16A (cont.) (2)	5-Oct-94	4820	770	<0.05	0.003	0.07	<0.01	0.11	0.01	0.06	0.010	<0.0005	0.08	<0.005	<0.01	9.40
	25-Jan-95	2050	601	<0.05	<0.002	0.07	<0.01	0.011	<0.01	<0.01	0.013	<0.0005	0.05	<0.005	<0.01	5.41
	5-Apr-95	1540	718	<0.05	<0.002	0.02	<0.01	0.020	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	4.16
	13-Sep-95	1540	616	<0.05	<0.002	0.03	<0.01	0.015	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	3.33
(2)	13-Sep-95	1570	632	<0.05	<0.002	0.03	<0.01	0.012	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	3.45
	16-Apr-96	2300	600	<0.0050	<0.0020	0.071	<0.0010	0.040	<0.010	0.012	0.012	<0.0005	0.036	0.0079	<0.010	3.2
	24-Sep-96	1600	460	<0.0050	<0.0020	0.040	<0.0010	0.036	<0.010	<0.010	<0.0020	<0.0005	0.024	<0.0050	<0.010	3.0
	7-May-97	1390	892	<0.005	<0.002	0.03	<0.001	0.019	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	3.6
	30-Oct-97	1250	650	<0.005	<0.002	0.03	<0.001	0.029	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	3.78
	25-Mar-98	1200	641	<0.005	<0.002	0.02	<0.001	0.013	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	2.94
	17-Nov-98	1280	934	<0.005	<0.002	0.03	<0.001	0.100	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	4.64
	16-Jun-99	1,190	646	<0.005	<0.002	0.02	<0.001	0.050	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	4.00
	21-Dec-99	784	537	<0.005	<0.002	0.02	<0.001	0.012	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	1.94
	29-Jun-00	669	547	<0.005	<0.005	0.02	<0.005	0.020	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	2.48
	15-Dec-00	777	843	<0.005	<0.005	0.02	<0.005	0.010	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	1.63
	28-Jun-01	534	629	<0.005	<0.002	0.01	<0.001	0.018	<0.01	<0.02	<0.005	<0.0005	0.02	<0.005	<0.01	1.42
MW-17	23-Jul-92	574	1930	<0.05	<0.002	0.04	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	20-Oct-92	742	2080	<0.05	0.003	0.05	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.010	<0.01	0.04
	22-Jan-93	561	1710	<0.05	<0.002	0.03	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	7-Apr-93	391	1510	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.14
	15-Jul-93	509	1740	<0.05	0.006	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Oct-93	616	1810	<0.05	<0.002	0.03	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	<0.01
	6-Jan-94	550	1690	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	528	1660	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.008	<0.01	0.04
	27-Jul-94	535	1460	<0.05	0.004	0.03	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.07
	5-Oct-94	749	1860	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	191	804	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	5-Apr-95	503	1350	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	13-Sep-95	648	1860	<0.05	<0.002	0.07	<0.01	<0.002	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	<0.01
	16-Apr-96	560	1500	<0.0050	<0.0020	0.028	<0.0010	<0.0010	<0.010	<0.010	0.0056	<0.0005	<0.010	0.011	<0.010	0.054
	24-Sep-96	200	510	<0.0050	<0.002	0.054	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.032
	7-May-97	384	946	<0.005	<0.002	0.06	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	30-Oct-97	511	1020	<0.005	<0.002	0.04	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	25-Mar-98	223	775	<0.005	<0.002	0.06	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	17-Nov-98	DRY														
	16-Jun-99	396	1,330	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	21-Dec-99	DRY														
	29-Jun-00	DRY														
MW-23	23-Jul-92	310	9220	<0.05	0.015	<0.01	<0.005	1540	<0.01	11.8	1.90	<0.0005	33.7	0.011	<0.01	3820
	20-Oct-92	288	9880	<0.05	<0.002	0.03	<0.005	1270	<0.01	12.5	1.70	<0.0005	34.3	0.015	<0.01	3620
	22-Jan-93	154	3250	<0.05	<0.002	<0.01	<0.005	282	<0.01	2.75	0.700	<0.0005	6.08	0.007	<0.01	854
	7-Apr-93	129	2460	<0.05	<0.002	<0.01	<0.005	114	0.02	1.12	0.77	<0.0005	3.19	0.013	<0.01	455
	15-Jul-93	175	2930	<0.05	0.008	0.05	<0.01	164	0.02	1.73	1.68	<0.0005	4.67	0.006	<0.01	506
	6-Oct-93	153	2730	<0.05	<0.002	0.03	<0.005	114	0.01	1.13	1.12	<0.0005	2.75	0.007	<0.01	364
	6-Jan-94	154	4020	<0.05	0.003	<0.01	<0.005	113	<0.01	1.51	0.476	<0.0005	3.52	0.005	<0.01	6710
	6-Apr-94	150	2680	<0.05	<0.002	0.01	<0.01	120	<0.01	1.18	0.731	<0.0005	2.67	0.012	<0.01	546
	27-Jul-94	138	2590	<0.05	<0.002	0.02	<0.01	84.2	0.02	0.67	1.03	<0.0005	0.98	<0.005	<0.01	364
	5-Oct-94	212	2290	<0.05	<0.002	0.02	<0.01	69.2	0.02	0.67	0.646	<0.0005	1.80	0.006	<0.01	328
	25-Jan-95	123	2410	<0.05	<0.002	0.01	<0.01	68.3	0.01	0.68	0.297	<0.0005	2.00	0.016	<0.01	397
	6-Apr-95	127	2070	<0.05	<0.002	0.01	<0.01	50.6	<0.01	0.43	0.388	<0.0005	1.64	0.015	<0.01	290
	13-Sep-95	107	2300	<0.05	<0.002	0.02	<0.01	50.3	<0.01	0.45	0.608	<0.0005	0.71	0.008	<0.01	335
	16-Apr-96	71	1800	<0.010	<0.0020	0.013	0.0010	42	<0.010	0.48	0.34	<0.0005	1.5	0.019	<0.010	360
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-23 (cont.)	24-Sep-96	100	1700	<0.0050	<0.0020	0.020	<0.0010	28	<0.010	0.16	0.55	<0.0005	0.78	0.020	<0.010	170
	12-May-97	63	1630	<0.005	<0.005	0.020	<0.001	18.2	<0.01	0.08	0.286	<0.0005	0.55	0.029	<0.01	130
	30-Oct-97	76	1500	<0.005	<0.002	0.02	<0.001	13.1	<0.01	0.05	0.253	<0.0005	0.41	0.014	<0.01	155
	25-Mar-98	Plugged														
MW-25	23-Jul-92	1780	1710	<0.05	<0.002	0.09	<0.005	0.005	<0.01	<0.01	<0.002	<0.0005	<0.01	0.026	<0.01	0.10
	20-Oct-92	1490	2160	<0.05	0.021	0.02	<0.005	0.02	<0.01	<0.01	<0.002	<0.0005	<0.01	0.079	<0.01	0.09
	22-Jan-93	1730	2130	<0.05	<0.002	0.02	<0.005	0.013	<0.01	<0.01	<0.002	<0.0005	<0.01	0.027	<0.01	0.11
	7-Apr-93	1640	1910	<0.05	<0.002	0.02	<0.005	0.012	<0.01	<0.01	<0.002	<0.0005	<0.01	0.034	<0.01	0.17
	15-Jul-93	1030	2260	<0.05	0.007	0.02	<0.01	0.006	<0.01	<0.01	<0.002	<0.0005	0.06	0.022	<0.01	0.08
	6-Oct-93	1380	2220	<0.05	<0.002	0.01	<0.005	0.008	<0.01	<0.01	<0.002	<0.0005	<0.01	0.046	<0.01	0.01
	6-Jan-94	1210	2330	<0.05	<0.002	0.01	<0.005	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	0.028	<0.01	<0.01
	6-Apr-94	1310	2350	<0.05	<0.002	<0.01	<0.01	0.005	<0.01	<0.01	0.003	<0.0005	<0.01	0.062	<0.01	0.28
	27-Jul-94	1290	2340	<0.05	0.003	<0.01	<0.01	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	0.011	<0.01	0.11
	5-Oct-94	1010	2450	<0.05	0.002	0.01	<0.01	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	0.019	<0.01	<0.01
	25-Jan-95	1180	1670	<0.05	<0.002	0.02	<0.01	0.005	<0.01	<0.01	<0.002	<0.0005	<0.01	0.009	<0.01	0.01
	5-Apr-95	866	1210	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.009	<0.01	0.02
	13-Sep-95	701	1930	<0.05	<0.002	0.03	<0.01	0.005	<0.01	<0.01	<0.002	<0.0005	<0.01	0.007	<0.01	<0.01
(1)	16-Apr-96	800	1800	<0.0050	<0.0020	0.020	<0.0010	0.0039	<0.010	<0.010	<0.0010	<0.0005	<0.010	0.10	<0.010	0.040
(2)	16-Apr-96	840	1800	<0.0050	<0.0020	0.022	<0.0010	0.0039	<0.010	<0.010	0.0064	<0.0005	<0.010	0.10	<0.010	0.043
(1)	24-Sep-96	630	1200	<0.0050	<0.0020	0.044	<0.0010	0.0049	<0.010	<0.010	0.0050	<0.0002	<0.010	0.055	<0.010	0.14
(2)	24-Sep-96	630	1200	<0.0050	<0.0020	0.042	<0.0010	0.0050	<0.010	<0.010	0.0068	<0.0005	<0.010	0.051	<0.010	0.098
(1)	7-May-97	643	1090	<0.005	<0.002	0.07	<0.001	0.004	<0.01	<0.01	0.011	<0.0005	<0.01	0.029	<0.01	0.19
(2)	7-May-97	633	1080	<0.005	<0.002	0.07	<0.001	0.004	<0.01	<0.01	0.011	<0.0005	<0.01	0.028	<0.01	0.19
(1)	30-Oct-97	475	728	<0.005	<0.002	0.06	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.007	<0.01	0.03
(2)	30-Oct-97	479	732	<0.005	<0.002	0.06	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	0.02	0.008	<0.01	0.06
(1)	25-Mar-98	375	480	<0.005	<0.002	0.05	<0.001	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
(2)	25-Mar-98	374	470	<0.005	<0.002	0.05	<0.001	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
(1)	17-Nov-98	467	956	<0.005	<0.002	0.06	<0.001	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	0.009	<0.01	0.09
(2)	17-Nov-98	457	981	<0.005	<0.002	0.06	<0.001	0.004	<0.01	<0.01	<0.002	<0.0005	0.02	0.009	<0.01	0.11
	16-Jun-99	899	1,350	<0.005	<0.002	0.05	<0.001	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	0.016	<0.01	0.04
	21-Dec-99	834	1,340	<0.005	<0.002	0.04	<0.001	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	0.037	<0.01	0.03
	29-Jun-00	464	533	<0.005	<0.005	0.03	<0.005	0.006	<0.02	<0.02	<0.005	<0.001	<0.05	0.005	<0.01	0.04
	15-Dec-00	702	1,360	<0.005	<0.005	0.04	<0.005	0.003	<0.02	<0.02	<0.005	<0.001	<0.05	0.027	<0.01	0.03
	28-Jun-01	1010	1,630	<0.005	<0.002	0.04	<0.001	0.005	<0.01	<0.02	<0.005	<0.0005	<0.01	0.042	<0.01	0.02
MW-26	23-Jul-92	30	529	<0.05	0.003	0.05	<0.005	0.004	<0.01	<0.01	0.007	<0.0005	<0.01	<0.005	<0.01	0.44
	20-Oct-92	34	530	<0.05	<0.002	0.12	<0.005	0.002	<0.01	<0.01	0.018	<0.0005	0.04	<0.005	<0.01	0.48
	22-Jan-93	18	365	<0.05	<0.002	0.02	<0.005	0.007	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	1.03
	7-Apr-93	10	280	<0.05	0.005	0.09	<0.005	0.05	0.02	<0.01	0.019	0.0007	0.02	<0.005	<0.01	3.42
	15-Jul-93	5	149	<0.05	0.003	0.04	<0.01	0.008	0.02	0.03	0.004	<0.0005	<0.01	<0.005	<0.01	0.45
	6-Oct-93	18	400	<0.05	<0.002	0.02	<0.005	0.005	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.31
	6-Jan-94	22	428	<0.05	0.002	0.02	<0.005	0.004	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.28
	6-Apr-94	25	501	<0.05	<0.002	0.04	<0.01	0.012	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.80
	28-Jul-94	19	331	<0.05	<0.002	0.05	<0.01	0.004	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.47
	5-Oct-94	28	431	<0.05	<0.002	0.03	<0.01	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.14
	25-Jan-95	24	453	<0.05	<0.002	0.03	<0.01	0.005	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.31
	6-Apr-95	24	425	<0.05	<0.002	0.05	<0.01	0.011	<0.01	<0.01	0.008	<0.0005	<0.01	<0.005	<0.01	0.50
	13-Sep-95	22	393	<0.05	<0.002	0.06	<0.01	0.007	<0.01	<0.01	0.009	<0.0005	<0.01	<0.005	<0.01	0.46
	16-Apr-96	19	380	<0.0050	<0.0020	0.023	<0.0010	0.0012	<0.010	<0.010	0.0018	<0.0005	<0.010	<0.0050	<0.010	0.10
	24-Sep-96	26	420	<0.0050	<0.0020	0.028	<0.0010	0.0027	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.11
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-26 (cont.)	20-Jun-97	20	443	<0.005	<0.002	0.04	<0.001	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.19
	30-Oct-97	20	420	<0.005	<0.002	0.04	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	0.01	<0.005	<0.01	0.16
	25-Mar-98	15	355	<0.005	<0.002	0.03	<0.001	0.011	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.16
	17-Nov-98	19	382	<0.005	<0.002	0.05	<0.001	0.015	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.58
	16-Jun-99	5	139	<0.005	<0.002	0.08	<0.001	0.041	<0.01	<0.01	0.014	<0.0005	<0.01	<0.005	<0.01	2.01
	21-Dec-99	59	1030	<0.005	<0.002	0.05	<0.001	0.004	<0.01	<0.01	0.004	<0.0005	0.01	<0.005	<0.01	0.24
	29-Jun-00	22	429	<0.005	<0.005	0.04	<0.005	0.009	<0.02	<0.02	0.006	<0.001	<0.05	<0.005	<0.01	0.40
	15-Dec-00	Damaged														
MW-27	23-Jul-92	499	11700	<0.05	0.039	0.03	<0.005	91.7	0.09	5.93	0.560	<0.0005	5.40	<0.005	<0.01	3980
	20-Oct-92	531	12600	<0.05	0.010	<0.01	<0.005	88.7	0.10	7.31	0.400	<0.0005	5.51	<0.005	<0.01	4230
(1)	22-Jan-93	392	14400	<0.05	0.018	0.02	<0.005	294	<0.01	5.29	0.600	<0.0005	9.06	<0.005	<0.01	6050
(2)	22-Jan-93	408	14400	<0.05	0.007	0.01	<0.005	278	<0.01	5.2	0.600	<0.0005	8.69	<0.005	<0.01	5910
(1)	7-Apr-93	447	23600	<0.05	0.004	<0.01	<0.005	395	0.05	8.14	1.93	<0.0005	4.22	<0.005	<0.01	9540
(2)	7-Apr-93	448	23500	<0.05	0.046	0.05	<0.005	447	0.06	8.31	2.83	<0.0005	14.3	<0.005	<0.01	10200
	15-Jul-93	745	18500	<0.05	0.031	0.21	<0.01	281	0.02	5.87	0.946	<0.0005	11.0	0.013	0.04	5910
(1)	6-Oct-93	314	23600	<0.05	0.004	0.03	<0.005	386	0.02	3.36	0.609	<0.0005	12.6	<0.005	<0.01	7080
(2)	6-Oct-93	389	22800	<0.05	0.006	0.02	<0.005	387	0.02	3.38	0.607	<0.0005	12.6	<0.005	<0.01	7120
(1)	6-Jan-94	258	17800	<0.05	0.024	0.01	<0.005	223	<0.01	2.34	0.630	<0.0005	9.02	<0.005	<0.01	3590
(2)	6-Jan-94	251	16600	<0.05	0.025	0.01	<0.005	224	<0.01	2.37	0.657	<0.0005	9.11	<0.005	<0.01	3650
(1)	6-Apr-94	253	15400	<0.05	0.007	0.01	<0.01	274	0.02	3.07	0.201	<0.0005	8.40	0.006	<0.01	4360
(2)	6-Apr-94	246	14200	<0.05	0.007	0.01	<0.01	273	0.02	3.3	0.180	<0.0005	8.81	<0.005	<0.01	4900
	27-Jul-94	466	11900	<0.05	0.014	0.02	<0.01	204	0.04	2.86	0.492	<0.0005	0.20	<0.005	<0.01	3610
	5-Oct-94	666	11200	<0.05	0.008	0.01	<0.01	192	0.03	3.77	0.379	<0.0005	6.01	<0.005	<0.01	4040
	25-Jan-95	472	9930	<0.05	<0.002	0.02	<0.01	125	<0.01	4.04	0.274	<0.0005	4.81	<0.005	<0.01	3160
(1)	6-Apr-95	510	10600	<0.05	0.013	0.02	<0.01	108	0.02	5.03	0.776	<0.0005	5.82	<0.005	<0.01	3740
(2)	6-Apr-95	435	10700	<0.05	0.014	0.05	<0.01	106	0.03	5.03	0.803	<0.0005	5.83	<0.005	<0.01	3720
	13-Sep-95	180	9180	<0.05	0.010	<0.01	<0.01	91.0	<0.01	4.14	0.720	0.0029	4.62	<0.005	<0.01	2580
	16-Apr-96	180	7300	<0.010	0.010	0.014	<0.0010	96	<0.010	8.8	0.88	<0.0005	5.0	0.18	<0.020	4000
	24-Sep-96	140	6600	0.011	0.022	0.018	<0.0010	56	<0.010	4.0	0.96	<0.0005	3.3	<0.010	<0.010	860
	12-May-97	76	7530	0.01	0.028	<0.01	<0.001	42.5	<0.01	2.8	0.594	<0.0005	2.60	<0.005	0.02	2000
	30-Oct-97	99	4550	<0.005	0.006	0.01	<0.001	24.5	<0.01	1.85	0.627	<0.0005	1.97	<0.005	0.02	1560
	25-Mar-98	Plugged														
MW-30	23-Jul-92	125	1590	<0.05	0.018	0.03	<0.005	0.007	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.93
	20-Oct-92	98	1540	<0.05	<0.002	0.04	<0.005	0.01	<0.01	0.04	0.016	<0.0005	<0.01	<0.005	<0.01	1.39
	22-Jan-93	121	1620	<0.05	<0.002	0.02	<0.005	0.023	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	2.13
	7-Apr-93	110	1540	<0.05	<0.002	0.02	<0.005	0.011	0.02	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	1.38
	15-Jul-93	122	1700	<0.05	0.010	0.03	<0.01	0.018	<0.01	<0.01	0.005	<0.0005	0.02	<0.005	<0.01	2.49
	6-Oct-93	125	1580	<0.05	<0.002	0.02	<0.005	0.005	<0.01	0.02	0.003	<0.0005	<0.01	<0.005	<0.01	1.50
	6-Jan-94	120	1770	<0.05	<0.002	0.02	<0.005	0.016	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	1.60
	6-Apr-94	152	1790	<0.05	<0.002	0.02	<0.01	0.016	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	1.97
	28-Jul-94	128	1590	<0.05	0.006	0.03	<0.01	0.014	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	1.59
	5-Oct-94	122	1650	<0.05	<0.002	0.03	<0.01	0.01	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	1.38
	25-Jan-95	129	1690	<0.05	<0.002	0.02	<0.01	0.008	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	1.50
	5-Apr-95	153	1730	<0.05	<0.002	0.02	<0.01	0.012	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.36
	13-Sep-95	131	1610	<0.05	<0.002	0.03	<0.01	0.010	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.98
	16-Apr-96	110	1500	<0.0050	<0.0020	0.020	<0.0010	0.0099	<0.010	<0.010	0.0044	<0.0005	<0.010	<0.0050	<0.010	1.2
	24-Sep-96	150	1900	<0.0050	0.0031	0.032	<0.0010	0.0081	<0.010	<0.010	0.013	<0.0005	<0.010	<0.0050	<0.010	0.78
	7-May-97	159	2020	<0.005	<0.002	0.02	<0.001	0.011	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.6
	30-Oct-97	158	1780	<0.005	<0.002	0.02	<0.001	0.012	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	1.24
	25-Mar-98	147	2100	<0.005	<0.002	0.02	<0.001	0.010	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.30
	21-Dec-98	133	1900	<0.005	<0.002	0.03	<0.001	0.008	<0.01	<0.01	0.008	<0.0005	<0.01	<0.005	<0.01	0.90
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-30 (cont.)	16-Jun-99	151	1,750	<0.005	<0.002	0.02	<0.001	0.010	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	1.06
	21-Dec-99	155	1,820	<0.005	<0.002	0.02	<0.001	0.008	<0.01	<0.01	0.002	<0.0005	<0.01	0.037	<0.01	0.03
	29-Jun-00	296	2,050	<0.005	<0.005	0.02	<0.005	0.011	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	1.10
	15-Dec-00	276	2,120	<0.005	<0.005	0.02	<0.005	0.032	<0.02	0.03	<0.005	<0.001	<0.05	<0.005	<0.01	4.52
	28-Jun-01	373	2,250	<0.005	<0.002	0.02	<0.001	0.039	<0.01	<0.02	<0.005	<0.0005	0.03	<0.005	<0.01	5.56
MW-31	23-Jul-92	348	1840	<0.05	<0.002	0.04	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.012	<0.01	0.03
	20-Oct-92	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	22-Jan-93	195	1670	<0.05	<0.002	0.02	<0.005	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	7-Apr-93	160	1450	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.91
MW-31(A)	15-Jul-93	298	1790	<0.05	0.005	0.12	<0.01	0.016	<0.01	<0.01	0.025	<0.0005	0.05	<0.005	<0.01	0.62
	6-Oct-93	601	1720	<0.05	<0.002	0.05	<0.005	0.010	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	0.52
	6-Jan-94	490	2010	<0.05	<0.002	0.02	<0.005	0.034	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	0.27
	6-Apr-94	589	1990	<0.05	<0.002	0.02	<0.01	0.025	<0.01	<0.01	0.002	<0.0005	0.02	<0.005	<0.01	0.38
	28-Jul-94	829	1930	<0.05	0.011	0.05	<0.01	0.012	<0.01	<0.01	0.003	<0.0005	<0.01	0.012	<0.01	0.31
	5-Oct-94	694	1980	<0.05	<0.002	0.04	<0.01	0.019	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	0.17
	25-Jan-95	730	2020	<0.05	<0.002	0.01	<0.01	0.010	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.39
	6-Apr-95	777	1970	<0.05	<0.002	0.02	<0.01	0.026	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.37
	13-Sep-95	923	2240	<0.05	<0.002	0.02	<0.01	0.006	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.11
	16-Apr-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	24-Sep-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-97	1170	2570	<0.005	<0.002	0.03	<0.001	0.014	<0.01	<0.01	<0.002	<0.0005	0.04	<0.005	<0.01	0.55
	30-Oct-97	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@	@@
	25-Mar-98	1250	2370	<0.005	<0.002	0.03	<0.001	0.002	<0.01	0.02	<0.002	<0.0005	0.10	<0.005	<0.01	0.18
	17-Nov-98	597	2490	<0.005	<0.002	0.06	<0.001	0.006	<0.01	0.04	0.014	<0.0005	0.03	<0.005	<0.01	0.15
(1)	16-Jun-99	975	2,060	<0.005	<0.002	0.02	<0.001	0.003	<0.01	<0.01	0.007	<0.0005	0.02	<0.005	<0.01	0.34
(2)	16-Jun-99	979	2,060	<0.005	<0.002	0.02	<0.001	0.003	<0.01	<0.01	0.006	<0.0005	0.03	<0.005	<0.01	0.36
	21-Dec-99	725	1,970	<0.005	0.004	0.11	<0.001	0.014	<0.01	0.05	0.02	<0.0005	0.07	<0.005	<0.01	0.54
	29-Jun-00	644	1,820	<0.005	<0.005	0.02	<0.005	0.004	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.20
	15-Dec-00	586	1,930	<0.005	<0.005	0.05	<0.005	0.006	<0.02	0.04	<0.005	<0.001	0.06	<0.005	<0.01	0.24
	28-Jun-01	Cannot locate														
MW-32	23-Jul-92	834	1230	<0.05	<0.002	0.03	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	20-Oct-92	840	1220	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	0.0014	<0.01	<0.005	<0.01	0.05
	22-Jan-93	788	1140	<0.05	<0.002	0.02	<0.005	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	7-Apr-93	812	1150	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	15-Jul-93	797	1280	<0.05	0.004	0.03	<0.01	0.002	<0.01	<0.01	<0.002	<0.0005	0.02	0.006	<0.01	0.04
	6-Oct-93	790	1200	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	6-Jan-94	789	1230	<0.05	<0.002	0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	839	1330	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	28-Jul-94	865	1200	<0.05	0.003	0.02	<0.01	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	5-Oct-94	879	1280	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	799	1250	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	5-Apr-95	790	1210	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	13-Sep-95	768	1200	<0.05	<0.002	0.02	<0.01	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	16-Apr-96	680	1200	<0.0050	<0.0050	0.030	<0.0010	<0.0010	<0.010	<0.010	<0.0050	<0.00050	<0.020	<0.0050	<0.010	<0.020
	24-Sep-96	710	1300	<0.0050	<0.002	0.038	<0.0010	0.0027	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.036
	7-May-97	747	1720	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	30-Oct-97	760	1370	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	25-Mar-98	653	1480	<0.005	<0.002	0.03	<0.001	0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
	17-Nov-98	Plugged														
MW-33	23-Jul-92	540	3080	<0.05	<0.002	0.04	<0.005	<0.002	<0.01	<0.01	0.025	<0.0005	<0.01	<0.005	<0.01	0.62
	20-Oct-92	613	2970	<0.05	0.003	0.04	<0.005	<0.002	<0.01	0.07	0.045	<0.0005	0.02	<0.005	<0.01	0.44
	22-Jan-93	565	2760	<0.05	<0.002	0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.15
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-33 (cont.)	7-Apr-93	570	2810	<0.05	<0.002	0.01	<0.005	<0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.29
	15-Jul-93	579	3440	<0.05	0.005	0.01	<0.01	<0.002	<0.01	<0.01	0.024	<0.0005	0.02	<0.005	<0.01	0.21
	6-Oct-93	575	2780	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.14
	6-Jan-94	603	3260	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.30
	6-Apr-94	636	2940	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.16
	27-Jul-94	655	2930	<0.05	0.003	0.02	<0.01	0.004	<0.01	<0.01	0.002	<0.0005	<0.01	0.007	<0.01	0.22
	5-Oct-94	682	2930	<0.05	0.002	0.02	<0.01	<0.002	0.01	<0.01	0.007	<0.0005	<0.01	<0.005	<0.01	0.15
(1)	25-Jan-95	622	2870	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.12
(2)	25-Jan-95	616	2860	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.13
(1)	5-Apr-95	644	2880	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.13
(2)	5-Apr-95	620	2790	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	0.005	<0.0005	<0.01	<0.005	<0.01	0.18
	13-Sep-95	610	2940	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.19
	16-Apr-96	570	2600	<0.0050	<0.0020	0.014	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.18
	24-Sep-96	660	2800	<0.0050	<0.002	0.015	<0.0010	0.0015	<0.010	<0.010	0.0073	<0.0005	<0.010	<0.0050	<0.010	0.29
	7-May-97	641	3800	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.22
	30-Oct-97	733	3070	<0.005	<0.002	0.01	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.79
	25-Mar-98	579	3350	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.15
	17-Nov-98	Plugged														
MW-37	23-Jul-92	1160	1920	0.42	0.041	1.15	0.02	0.005	0.49	0.18	0.165	0.0006	0.73	<0.005	<0.01	342
	20-Oct-92	1130	1950	<0.05	0.006	0.11	<0.005	<0.002	<0.01	<0.01	0.016	<0.0005	0.08	<0.005	<0.01	0.24
	22-Jan-93	1120	1850	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	7-Apr-93	1070	1840	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	15-Jul-93	1090	2000	<0.05	0.006	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.007	<0.01	0.01
	6-Oct-93	1110	1970	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Jan-94	1150	1980	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	1140	1960	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	28-Jul-94	1160	1910	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	<0.01	0.002	<0.0005	0.01	<0.005	<0.01	0.26
	5-Oct-94	1210	1970	<0.05	0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	1130	1980	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	5-Apr-95	1160	1980	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	13-Sep-95	1080	1900	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	16-Apr-96	960	1500	<0.0050	<0.0020	0.017	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.032
	24-Sep-96	550	1000	<0.0050	<0.002	0.025	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	0.011	<0.0050	<0.010	0.044
	7-May-97	784	1990	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	30-Oct-97	1090	1840	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	25-Mar-98	870	2230	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	17-Nov-98	1650	2440	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	16-Jun-99	975	1990	<0.005	<0.002	0.02	<0.001	0.009	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	21-Dec-99	942	1940	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	29-Jun-00	724	1540	<0.005	<0.005	0.02	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.01
	15-Dec-00	868	169	<0.005	<0.005	0.02	<0.005	0.002	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.06
	28-Jun-01	367	570	<0.005	<0.002	0.02	<0.001	0.001	<0.01	<0.02	<0.005	<0.0005	<0.01	<0.005	<0.01	0.05
MW-38	23-Jul-92	31500	1390	<0.05	0.007	0.22	<0.005	0.135	0.03	<0.01	<0.002	<0.0005	0.04	0.026	0.06	0.28
	20-Oct-92	31300	1150	<0.05	0.003	0.14	0.01	0.07	<0.01	<0.01	<0.002	<0.0005	<0.01	0.019	0.07	0.13
	22-Jan-93	31000	1320	<0.05	<0.002	0.13	<0.005	0.07	<0.01	<0.01	<0.002	<0.0005	<0.01	0.011	0.05	0.02
	7-Apr-93	28200	1340	<0.05	<0.002	0.11	<0.005	0.019	<0.01	<0.01	<0.002	<0.0005	<0.01	0.017	0.08	<0.01
	15-Jul-93	27000	1540	<0.05	0.004	0.12	<0.01	1.36	<0.01	<0.01	<0.002	<0.0005	0.02	0.01	0.02	0.82
	6-Oct-93	29200	1420	<0.05	<0.002	0.11	<0.005	1.09	<0.01	<0.01	<0.002	<0.0005	<0.01	0.012	0.05	0.52
	6-Jan-94	30400	1400	<0.05	<0.002	0.14	<0.005	0.69	<0.01	<0.01	<0.002	<0.0005	0.05	0.038	0.06	0.38
	6-Apr-94	31100	1490	<0.05	<0.002	0.11	<0.01	0.58	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	0.05	0.31
	28-Jul-94	30500	1440	<0.05	0.018	0.16	<0.01	0.66	<0.01	<0.01	0.007	<0.0005	0.02	0.010	<0.01	0.57
	5-Oct-94	32500	1440	<0.05	0.015	0.12	<0.01	0.26	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	0.06	0.13
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-38 (cont.)	25-Jan-95	30500	1440	<0.05	<0.002	0.12	<0.01	0.73	<0.01	<0.01	<0.002	<0.0005	<0.01	0.028	<0.01	0.51
(1)	5-Apr-95	30800	1370	<0.05	<0.002	0.11	<0.01	0.49	<0.01	<0.01	<0.002	<0.0005	<0.01	0.034	0.04	0.46
(2)	5-Apr-95	30500	1370	<0.05	<0.002	0.11	<0.01	0.50	<0.01	<0.01	<0.002	<0.0005	<0.01	0.036	0.04	0.46
(1)	16-Apr-96	26000	1200	<0.0050	<0.0020	0.094	<0.0010	0.24	<0.010	<0.010	<0.0020	<0.0005	<0.010	0.11	0.059	0.48
(2)	16-Apr-96	27000	1200	<0.0050	<0.0020	0.091	<0.0010	0.22	<0.010	<0.010	<0.0020	<0.0005	<0.010	0.10	0.065	0.42
(1)	24-Sep-96	31000	1500	<0.0050	0.0022	0.12	<0.0010	0.56	<0.010	<0.010	<0.010	<0.0005	<0.010	0.087	0.048	0.38
(2)	24-Sep-96	30000	1400	<0.0050	<0.002	0.11	<0.0010	0.58	<0.010	<0.010	<0.010	<0.0005	<0.030	0.084	0.043	0.36
(1)	7-May-97	33500	1550	<0.005	<0.002	0.11	<0.001	0.360	<0.01	<0.01	0.004	<0.0005	<0.01	0.086	0.07	0.37
(2)	7-May-97	33700	1610	<0.005	<0.002	0.11	<0.001	0.360	<0.01	<0.01	0.004	<0.0005	<0.01	0.084	0.06	0.4
(1)	30-Oct-97	27100	1240	<0.005	<0.002	0.09	0.001	0.253	0.02	<0.01	<0.002	<0.0005	0.01	0.043	0.07	0.14
(2)	30-Oct-97	27000	1230	<0.005	<0.002	0.09	<0.001	0.253	0.01	<0.01	<0.002	<0.0005	0.02	0.043	0.06	0.23
(1)	25-Mar-98	26400	1580	<0.005	<0.002	0.09	<0.001	0.338	<0.01	<0.01	<0.002	<0.0005	<0.01	0.065	0.04	0.21
(2)	25-Mar-98	26400	1680	<0.005	<0.002	0.09	<0.001	0.334	<0.01	<0.01	<0.002	<0.0005	<0.01	0.058	0.05	0.20
	17-Nov-98	27700	1380	<0.005	<0.002	0.09	<0.001	0.243	<0.01	<0.01	<0.002	<0.0005	<0.01	0.050	0.06	0.47
(1)	16-Jun-99	24100	1050	<0.005	<0.002	0.07	<0.001	0.638	<0.01	<0.01	<0.002	<0.0005	<0.01	0.023	0.02	0.41
(2)	16-Jun-99	23900	1130	<0.005	<0.002	0.07	<0.001	0.627	<0.01	<0.01	<0.002	<0.0005	<0.01	0.024	0.02	0.40
(1)	21-Dec-99	27900	1290	<0.005	<0.002	0.08	<0.001	0.737	<0.01	<0.01	<0.002	<0.0005	<0.01	0.043	0.03	0.45
(2)	21-Dec-99	28100	1410	<0.005	<0.002	0.08	<0.001	0.814	<0.01	<0.01	<0.002	<0.0005	<0.01	0.039	0.03	0.53
(1)	29-Jun-00	27200	1020	<0.005	<0.005	0.08	<0.005	0.726	<0.02	<0.02	<0.005	<0.001	<0.05	0.030	0.03	0.47
(2)	29-Jun-00	27200	1070	<0.005	<0.005	0.08	<0.005	0.726	<0.02	<0.02	<0.005	<0.001	<0.05	0.031	0.03	0.48
(1)	15-Dec-00	23000	1220	<0.005	<0.005	0.10	<0.005	0.154	<0.02	<0.02	<0.005	<0.001	<0.05	0.041	0.04	0.06
(2)	15-Dec-00	23000	1260	<0.005	<0.005	0.09	<0.005	0.154	<0.02	<0.02	<0.005	<0.001	<0.05	0.041	0.04	0.06
(1)	28-Jun-01	18000	1480	<0.005	<0.002	0.09	<0.001	0.517	<0.01	<0.02	<0.005	<0.0005	0.01	0.045	0.03	0.37
(2)	28-Jun-01	17800	1530	<0.005	<0.002	0.09	<0.001	0.506	<0.01	<0.02	<0.005	<0.0005	0.01	0.046	0.03	0.39
MW-39	23-Jul-92	229	13	<0.05	<0.002	0.59	<0.005	0.002	<0.01	<0.01	0.055	<0.0005	<0.01	<0.005	<0.01	0.19
	20-Oct-92	250	3	<0.05	<0.002	0.76	<0.005	<0.002	<0.01	<0.01	0.014	<0.0005	<0.01	<0.005	<0.01	0.07
	22-Jan-93	185	71	<0.05	<0.002	0.59	<0.005	<0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.02
	7-Apr-93	149	32	<0.05	<0.002	0.57	<0.005	<0.002	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	<0.01
(1)	15-Jul-93	146	9	<0.05	0.007	0.68	<0.01	0.003	<0.01	<0.01	0.030	<0.0005	<0.01	<0.005	<0.01	0.21
(2)	15-Jul-93	145	10	<0.05	0.004	0.69	<0.01	0.004	<0.01	<0.01	0.030	<0.0005	0.03	<0.005	<0.01	0.21
	6-Oct-93	183	6	<0.05	0.004	0.66	<0.005	0.004	<0.01	<0.01	0.021	<0.0005	<0.01	<0.005	<0.01	0.18
	6-Jan-94	184	24	<0.05	0.005	0.65	<0.005	0.010	0.02	<0.01	0.105	<0.0005	0.03	<0.005	<0.01	0.54
	6-Apr-94	179	56	<0.05	<0.002	0.56	<0.01	<0.002	<0.01	<0.01	0.008	<0.0005	<0.01	<0.005	<0.01	0.06
(1)	27-Jul-94	167	14	<0.05	0.006	0.67	<0.01	0.006	<0.01	<0.01	0.033	<0.0005	<0.01	<0.005	<0.01	0.40
(2)	27-Jul-94	221	15	<0.05	0.006	0.68	<0.01	0.006	<0.01	<0.01	0.036	<0.0005	<0.01	<0.005	<0.01	0.43
(1)	5-Oct-94	265	1	<0.05	0.006	0.69	<0.01	<0.002	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	<0.01
(2)	5-Oct-94	113	1	<0.05	0.004	0.69	<0.01	<0.002	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.02
(1)	25-Jan-95	172	13	<0.05	<0.002	0.73	<0.01	<0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.05
(2)	25-Jan-95	169	13	<0.05	<0.002	0.71	<0.01	0.003	<0.01	<0.01	0.007	<0.0005	0.01	<0.005	<0.01	0.02
	5-Apr-95	166	5	<0.05	0.003	0.72	<0.01	0.005	0.02	0.02	0.057	<0.0005	<0.01	<0.005	<0.01	0.48
	13-Sep-95	206	1	<0.05	0.004	0.64	<0.01	<0.002	<0.01	<0.01	0.006	0.0010	<0.01	<0.005	<0.01	<0.01
	16-Apr-96	220	450	<0.0050	0.0028	0.17	<0.0010	<0.0030	<0.010	<0.010	0.020	<0.0005	<0.010	<0.0050	<0.010	0.10
	24-Sep-96	450	480	<0.0050	<0.002	0.22	<0.0010	0.0030	<0.010	<0.010	0.026	<0.0005	<0.010	<0.0050	<0.010	0.12
	7-May-97	263	8	<0.005	<0.002	0.97	<0.001	<0.001	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	30-Oct-97	320	17	<0.005	0.006	0.68	<0.001	0.002	<0.01	<0.01	0.019	<0.0005	0.01	<0.005	<0.01	0.16
	25-Mar-98	245	15	<0.005	0.005	0.69	<0.001	0.003	0.02	<0.01	0.030	<0.0005	0.01	<0.005	<0.01	0.23
	17-Nov-98	293	24	<0.005	<0.002	0.74	<0.001	0.010	0.01	<0.01	0.028	<0.0005	<0.01	<0.005	<0.01	497
	16-Jun-99	9	1	<0.005	0.004	0.09	<0.001	0.002	<0.01	<0.01	0.019	<0.0005	0.02	<0.005	<0.01	0.24
	21-Dec-99	266	2	<0.005	0.011	0.74	<0.001	0.009	0.03	<0.01	0.087	<0.0005	0.03	<0.005	<0.01	0.65
	29-Jun-00	98	10	<0.005	0.009	0.43	<0.005	0.004	<0.02	<0.02	0.024	<0.001	<0.05	<0.005	<0.01	0.31
	15-Dec-00	237	<1	<0.005	0.006	0.69	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.53
	28-Jun-01	167	12	<0.005	<0.002	0.29	<0.001	0.005	<0.01	<0.02	<0.005	<0.0005	0.08	<0.005	<0.01	0.61
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-40	23-Jul-92	299	147	<0.05	0.034	5.52	0.06	0.015	1.30	0.69	0.360	<0.0005	2.33	<0.005	<0.01	8.44
	20-Oct-92	562	261	<0.05	0.013	1.10	0.01	0.004	0.16	0.13	0.142	<0.0005	0.51	<0.005	<0.01	1.80
	22-Jan-93	506	170	<0.05	0.006	0.24	<0.005	<0.002	0.06	0.03	0.019	<0.0005	0.07	<0.005	<0.01	0.28
	7-Apr-93	617	377	<0.05	<0.002	0.06	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.31
	15-Jul-93	671	412	<0.05	0.004	0.07	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	6-Oct-93	435	341	<0.05	<0.002	0.05	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	<0.01
	6-Jan-94	523	215	<0.05	0.008	0.02	<0.005	<0.002	0.06	<0.01	0.026	<0.0005	0.05	<0.005	<0.01	0.14
	6-Apr-94	623	395	<0.05	<0.002	0.05	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	28-Jul-94	580	335	<0.05	0.018	0.07	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	5-Oct-94	---	---	<0.05	0.007	0.12	<0.01	<0.002	0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	0.06
	25-Jan-95	465	392	<0.05	<0.002	0.05	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.01
	5-Apr-95	525	356	<0.05	<0.002	0.06	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.01
	13-Sep-95	594	420	<0.05	<0.002	0.06	<0.01	<0.002	<0.01	---	<0.002	<0.0005	<0.01	<0.005	<0.01	0.11
	16-Apr-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	24-Sep-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-97	418	653	<0.005	<0.002	0.1	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.12
	30-Oct-97	450	392	<0.005	<0.002	0.06	<0.001	0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	25-Mar-98	308	375	<0.005	<0.002	0.04	<0.001	0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.13
	17-Nov-98	401	529	<0.005	<0.002	0.07	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	16-Jun-99	416	416	<0.005	<0.002	0.07	<0.001	0.002	<0.01	<0.01	0.006	<0.0005	<0.01	<0.005	<0.01	0.18
	21-Dec-99	425	419	<0.005	<0.002	0.06	<0.001	<0.001	<0.01	<0.01	0.007	<0.0005	<0.01	<0.005	<0.01	0.09
	29-Jun-00	218	234	<0.005	0.007	0.19	<0.005	0.002	0.06	0.02	0.034	<0.001	0.09	<0.005	<0.01	0.53
	15-Dec-00	445	335	<0.005	0.006	0.17	<0.005	0.002	0.05	<0.02	0.020	<0.001	0.06	<0.005	<0.01	0.34
	28-Jun-01	261	263	<0.005	<0.002	0.04	<0.001	<0.001	<0.01	<0.02	<0.005	<0.0005	<0.01	<0.005	<0.01	0.09
MW-41	23-Jul-92	617	2610	<0.05	0.054	2.50	0.03	0.006	0.89	0.38	0.223	0.0014	1.48	<0.005	<0.01	4.64
	20-Oct-92	1070	4280	<0.05	0.039	0.82	0.01	0.003	0.12	0.13	0.116	<0.0005	0.53	<0.005	<0.01	1.67
	22-Jan-93	1040	4240	<0.05	0.005	0.14	<0.005	0.003	0.05	0.02	0.012	<0.0005	0.06	<0.005	<0.01	0.23
	7-Apr-93	873	3750	<0.05	<0.002	<0.01	<0.005	<0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.50
	15-Jul-93	904	3620	<0.05	0.005	0.03	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	0.03	0.008	<0.01	0.04
	6-Oct-93	665	2560	<0.05	0.006	0.12	<0.005	<0.002	0.03	<0.01	<0.002	<0.0005	0.06	<0.005	<0.01	0.12
	6-Jan-94	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-Apr-94	999	3590	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	28-Jul-94	869	3000	<0.05	0.026	0.17	<0.01	0.003	0.06	0.03	0.013	<0.0005	0.09	0.005	<0.01	0.32
	5-Oct-94	639	1840	<0.05	0.003	0.04	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	0.005	<0.01	0.02
	25-Jan-95	830	3110	<0.05	<0.002	0.03	<0.01	<0.002	<0.01	<0.01	0.005	<0.0005	<0.01	<0.005	<0.01	0.03
	5-Apr-95	904	3310	<0.05	<0.002	0.03	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	13-Sep-95	1160	4120	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	---	0.005	0.0006	<0.01	<0.005	<0.01	0.25
	16-Apr-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	24-Sep-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-97	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	30-Oct-97	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	25-Mar-98	DRY														
	17-Nov-98	DRY														
	16-Jun-99	---	---	<0.005	0.005	0.03	<0.001	0.002	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	21-Dec-99	336	968	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	29-Jun-00	DRY														
	15-Dec-00	DRY														
MW-42	23-Jul-92	169	1760	<0.05	0.018	1.73	<0.005	0.026	0.36	0.12	0.264	<0.0005	0.40	<0.005	<0.01	3.77
	20-Oct-92	189	1880	<0.05	0.016	0.96	0.007	0.01	0.21	0.06	0.164	<0.0005	0.23	<0.005	<0.01	1.97
	22-Jan-93	186	1710	<0.05	<0.002	0.02	<0.005	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.15
	7-Apr-93	152	1720	<0.05	<0.002	0.04	<0.005	<0.002	0.02	<0.01	0.005	<0.0005	<0.01	<0.005	<0.01	0.31
	15-Jul-93	172	1890	<0.05	<0.002	0.02	<0.01	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-42 (cont.)	6-Oct-93	168	2020	<0.05	<0.002	0.03	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	0.03	<0.005	<0.01	0.06
	6-Jan-94	179	1910	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	174	1860	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	28-Jul-94	179	1800	<0.05	<0.002	0.03	<0.01	<0.002	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.11
	5-Oct-94	215	1960	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	169	1890	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	5-Apr-95	190	1810	<0.05	<0.002	0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	13-Sep-95	180	1820	<0.05	<0.002	0.03	<0.01	<0.002	<0.01	<0.01	0.009	<0.0005	<0.01	<0.005	<0.01	0.08
	16-Apr-96	170	1600	<0.0050	0.0024	0.020	<0.0010	0.0010	<0.010	<0.010	0.0049	<0.0005	<0.010	<0.0050	<0.010	0.12
	24-Sep-96	210	2200	<0.0050	<0.002	0.079	<0.0010	0.0036	0.011	<0.010	0.042	<0.0005	0.015	<0.0050	<0.010	0.35
	7-May-97	190	1910	<0.005	<0.002	0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.07
	30-Oct-97	200	1740	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	0.12
	25-Mar-98	160	1940	<0.005	<0.002	0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	17-Nov-98	396	1850	<0.005	<0.002	0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	16-Jun-99	182	1970	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	21-Dec-99	186	1750	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	29-Jun-00	159	1750	<0.005	<0.005	0.02	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.03
	15-Dec-00	---	---	<0.005	0.017	0.22	<0.005	0.008	0.05	<0.02	0.087	<0.001	<0.05	<0.005	<0.01	0.97
	28-Jun-01	223	1460	<0.005	<0.002	0.04	<0.001	<0.001	<0.01	<0.02	<0.005	<0.0005	<0.01	<0.005	<0.01	0.06
MW-43	23-Jul-92	27	241	<0.05	0.039	13.9	0.09	0.071	1.71	0.68	1.91	0.0012	2.39	<0.005	0.02	26.6
	20-Oct-92	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	22-Jan-93	43	530	<0.05	0.003	0.21	<0.005	0.004	0.04	0.01	0.053	<0.0005	0.04	<0.005	<0.01	0.53
	7-Apr-93	41	512	<0.05	0.004	0.16	<0.005	0.003	0.02	<0.01	0.043	<0.0005	0.01	<0.005	<0.01	0.42
	15-Jul-93	43	487	<0.05	0.004	0.04	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.04
	6-Oct-93	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-Jan-94	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-Apr-94	34	408	<0.05	<0.002	0.11	<0.01	<0.002	<0.01	<0.01	0.021	<0.0005	0.02	<0.005	<0.01	0.34
	28-Jul-94	---	---	<0.05	0.018	0.13	<0.01	0.006	0.02	<0.01	0.022	<0.0005	<0.01	<0.005	<0.01	0.50
	5-Oct-94	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	25-Jan-95	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	5-Apr-95	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	13-Sep-95	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	16-Apr-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	24-Sep-96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-97	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	30-Oct-97	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	25-Mar-98	29	561	<0.005	<0.002	0.05	<0.001	0.004	0.01	<0.01	0.009	<0.0005	<0.01	<0.005	<0.01	0.23
	17-Nov-98	DRY														
	16-Jun-99	---	---	<0.005	0.011	0.25	0.002	0.006	0.05	0.02	0.303	<0.0005	0.05	<0.005	<0.01	2.33
	21-Dec-99	DRY														
	29-Jun-00	DRY														
	15-Dec-00	DRY														
MW-44	23-Jul-92	509	1060	<0.05	<0.002	0.07	<0.005	<0.002	<0.01	<0.01	0.005	<0.0005	<0.01	<0.005	<0.01	0.16
	20-Oct-92	718	1270	<0.05	<0.002	0.05	<0.005	0.03	<0.01	0.04	0.006	<0.0005	<0.01	0.018	<0.01	0.32
	22-Jan-93	640	1290	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.06
	7-Apr-93	624	1330	<0.05	<0.002	0.02	<0.005	<0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	15-Jul-93	585	1330	<0.05	0.004	0.04	<0.01	0.008	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	0.24
	6-Oct-93	614	1250	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
	6-Jan-94	567	1310	<0.05	<0.002	0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	6-Apr-94	608	1440	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
	28-Jul-94	620	1260	<0.05	0.004	0.05	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.13
	5-Oct-94	658	1310	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.04
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-44 (cont.)	25-Jan-95	562	1300	<0.05	<0.002	0.04	<0.01	<0.002	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.39
	6-Apr-95	634	1400	<0.05	<0.002	0.05	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.14
	13-Sep-95	550	1280	<0.05	<0.002	0.03	<0.01	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.13
	16-Apr-96	480	1100	<0.0050	<0.0020	0.019	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.056
	24-Sep-96	600	1500	<0.0050	<0.0020	0.031	<0.0010	<0.0010	<0.010	<0.010	0.0055	<0.0005	<0.010	<0.0050	<0.010	0.062
	7-May-97	531	1770	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	30-Oct-97	577	1430	<0.005	<0.002	0.03	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	0.06
	25-Mar-98	452	1600	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	17-Nov-98	Plugged														
MW-46	23-Jul-92	399	1800	<0.05	0.029	0.69	<0.005	0.023	0.06	0.02	0.360	<0.0005	0.10	<0.005	<0.01	8.42
	20-Oct-92	436	1730	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	0.05	<0.002	<0.0005	0.02	<0.005	<0.01	3.27
	22-Jan-93	363	1630	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	0.06	<0.002	<0.0005	0.02	<0.005	<0.01	2.72
	7-Apr-93	323	1580	<0.05	<0.002	0.02	<0.005	<0.002	<0.01	0.06	0.003	<0.0005	0.01	<0.005	<0.01	2.92
	15-Jul-93	329	1690	<0.05	0.005	0.04	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	2.89
	6-Oct-93	368	1680	<0.05	<0.002	0.03	<0.005	<0.002	<0.01	0.07	<0.002	<0.0005	0.02	<0.005	<0.01	3.16
	6-Jan-94	369	1840	<0.05	0.004	0.03	<0.005	<0.002	<0.01	0.05	0.005	<0.0005	<0.01	<0.005	<0.01	3.14
	6-Apr-94	358	1620	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	0.02	<0.005	<0.01	4.59
	28-Jul-94	440	1630	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	3.21
	5-Oct-94	423	1680	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	3.60
	25-Jan-95	321	1460	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	3.70
	6-Apr-95	402	1550	<0.05	<0.002	0.02	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	4.38
	13-Sep-95	320	1560	<0.05	<0.002	0.03	<0.01	<0.002	<0.01	0.06	<0.002	<0.0005	<0.01	<0.005	<0.01	2.66
	16-Apr-96	270	1400	<0.0050	<0.0020	0.023	<0.0010	<0.0010	<0.010	0.065	0.0026	<0.0005	0.018	0.0064	<0.010	3.5
	24-Sep-96	310	1700	<0.0050	0.0022	0.028	<0.0010	<0.0010	<0.010	0.068	0.0070	<0.0005	0.028	<0.0050	0.011	2.9
	7-May-97	308	2060	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	0.08 / 0.07 ##	<0.002	<0.0005	<0.01	<0.005	<0.01	3.6
	30-Oct-97	282	1580	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	0.06	<0.002	<0.0005	0.02	<0.005	<0.01	2.81
	25-Mar-98	105	1240	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	0.04	<0.002	<0.0005	0.02	<0.005	<0.01	1.71
	17-Nov-98	43	442	<0.005	<0.002	0.04	<0.001	0.012	<0.01	<0.01	0.004	<0.0005	0.03	<0.005	<0.01	496
	16-Jun-99	2	23	<0.005	<0.002	0.04	<0.001	0.002	<0.01	<0.01	0.025	<0.0005	<0.01	<0.005	<0.01	0.34
	21-Dec-99	16	161	<0.005	<0.002	0.19	<0.001	0.006	<0.01	<0.01	0.008	<0.0005	<0.01	<0.005	<0.01	0.87
	29-Jun-00	6	96	<0.005	<0.005	0.15	<0.005	0.009	<0.02	<0.02	<0.005	<0.001	<0.05	0.035	<0.01	0.65
	15-Dec-00	26	218	<0.005	<0.005	0.12	<0.005	0.012	<0.02	<0.02	0.007	<0.001	<0.05	<0.005	<0.01	1.23
	28-Jun-01	207	99	<0.005	<0.002	0.12	<0.001	0.024	<0.01	<0.02	0.006	<0.0005	<0.01	0.010	<0.01	2.07
MW-47	23-Jul-92	6280	1840	<0.05	0.019	0.57	<0.005	<0.002	0.08	0.03	0.017	<0.0005	0.11	<0.005	<0.01	2.10
	20-Oct-92	6680	2080	<0.05	<0.002	0.04	<0.005	0.01	<0.01	<0.01	<0.002	<0.0005	<0.01	0.006	<0.01	0.93
	22-Jan-93	6440	1940	<0.05	<0.002	0.02	<0.005	0.007	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.08
	7-Apr-93	5080	2230	<0.05	0.004	0.03	<0.005	0.005	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.08
	15-Jul-93	5360	2440	<0.05	0.005	0.03	<0.01	0.018	<0.01	<0.01	<0.002	<0.0005	0.04	<0.005	<0.01	1.80
	6-Oct-93	7960	2120	<0.05	<0.002	0.02	<0.005	0.004	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.86
	6-Jan-94	5620	2370	<0.05	<0.002	0.01	<0.005	0.017	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	1.29
	6-Apr-94	6950	1980	<0.05	<0.002	<0.01	<0.01	0.011	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.82
(1)	28-Jul-94	5680	2270	<0.05	0.007	0.03	<0.01	0.011	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.54
(2)	28-Jul-94	5610	2310	<0.05	0.005	0.03	<0.01	0.012	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.54
	5-Oct-94	6270	2190	<0.05	<0.002	0.02	<0.01	0.013	<0.01	<0.01	0.003	<0.0005	<0.01	<0.005	<0.01	0.53
	25-Jan-95	5360	2370	<0.05	<0.002	0.02	<0.01	0.012	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.63
	6-Apr-95	6110	2290	<0.05	<0.002	0.02	<0.01	0.008	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	0.43
	13-Sep-95	5340	2300	<0.05	<0.002	0.02	<0.01	0.012	<0.01	<0.01	0.004	<0.0005	<0.01	<0.005	<0.01	0.53
	16-Apr-96	5400	2000	<0.0050	0.0026	0.029	<0.0010	0.013	<0.010	<0.010	<0.0020	<0.0005	0.012	<0.0050	<0.010	0.65
	24-Sep-96	5500	2600	<0.0050	0.0022	0.023	<0.0010	0.0071	<0.010	<0.010	<0.010	<0.0005	<0.010	0.0063	<0.010	0.34
	7-May-97	7910	2670	<0.005	<0.002	0.02	<0.001	0.011	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.66
	30-Oct-97	2660	1620	<0.005	<0.002	0.07	0.006	0.021	<0.01	<0.01	<0.002	<0.0005	0.01	<0.005	<0.01	1.63
	25-Mar-98	399	558	<0.005	<0.002	0.04	<0.001	0.013	<0.01	<0.01	<0.002	<0.0005	0.01	<0.005	<0.01	2.30
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
MW-47 (cont.) (1)	17-Nov-98	834	777	<0.005	<0.002	0.02	<0.001	0.003	<0.01	<0.01	<0.002	<0.0005	0.01	<0.005	<0.01	0.26
(2)	17-Nov-98	773	949	<0.005	<0.002	0.02	<0.001	0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.24
	16-Jun-99	2000	1130	<0.005	<0.002	0.02	<0.001	0.003	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.37
	21-Dec-99	796	435	<0.005	<0.002	0.02	<0.001	<0.001	<0.01	<0.01	0.002	<0.0005	<0.01	<0.005	<0.01	0.12
	29-Jun-00	238	238	<0.005	<0.005	0.05	<0.005	0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.20
	15-Dec-00	1890	808	<0.005	<0.005	0.03	<0.005	0.002	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	0.28
	28-Jun-01	770	760	<0.005	<0.002	0.03	<0.001	0.001	<0.01	<0.02	0.005	<0.0005	<0.01	<0.005	<0.01	0.26
MW-48	23-Jul-92	626	1420	<0.05	<0.002	0.06	<0.005	0.064	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	3.67
	20-Oct-92	681	1420	<0.05	0.003	0.09	<0.005	0.01	<0.01	<0.01	0.004	<0.0005	0.06	0.008	<0.01	0.78
	22-Jan-93	614	1400	<0.05	<0.002	0.04	<0.005	0.038	<0.01	<0.01	<0.002	<0.0005	0.02	<0.005	<0.01	1.99
	7-Apr-93	591	1380	<0.05	<0.002	0.05	<0.005	0.045	0.02	0.02	<0.002	<0.0005	<0.01	0.004*	<0.01	2.82
	15-Jul-93	514	1580	<0.05	0.013	0.05	<0.01	0.06	<0.01	0.04	<0.002	<0.0005	0.07	<0.005	<0.01	4.06
	6-Oct-93	584	1410	<0.05	<0.002	0.04	<0.005	0.020	<0.01	0.02	<0.002	<0.0005	0.01	<0.005	<0.01	2.29
	6-Jan-94	537	1620	<0.05	<0.002	0.04	<0.005	0.06	<0.01	0.04	<0.002	<0.0005	0.05	<0.005	0.01	4.47
	6-Apr-94	545	1540	<0.05	<0.002	0.03	<0.01	0.25	<0.01	0.12	<0.002	<0.0005	0.07	<0.005	<0.01	20.6
	28-Jul-94	530	1410	<0.05	0.013	0.05	<0.01	0.23	<0.01	0.11	<0.002	<0.0005	0.08	0.014	<0.01	19.1
	5-Oct-94	712	1480	<0.05	<0.002	0.04	<0.01	0.033	<0.01	0.02	<0.002	<0.0005	<0.01	<0.005	<0.01	2.66
	25-Jan-95	566	1530	<0.05	<0.002	0.03	<0.01	0.12	<0.01	0.04	<0.002	<0.0005	0.04	<0.005	<0.01	8.97
	5-Apr-95	632	1410	<0.05	<0.002	0.04	<0.01	1.50	<0.01	0.18	<0.002	<0.0005	<0.01	<0.005	<0.01	31.7
	13-Sep-95	564	1450	<0.05	<0.002	0.04	<0.01	0.14	<0.01	<0.01	<0.002	<0.0005	<0.01	0.009	<0.01	15.4
(1)	16-Apr-96	530	1200	<0.0050	<0.0020	0.032	<0.0010	0.0087	<0.010	<0.010	<0.0010	<0.0005	<0.010	0.011	<0.010	0.37
(2)	16-Apr-96	530	1200	<0.0050	<0.0020	0.033	<0.0010	0.0092	<0.010	<0.010	<0.0010	<0.0005	<0.010	0.012	<0.010	0.38
(1)	24-Sep-96	660	1500	<0.0050	<0.0020	0.045	<0.0010	0.038	<0.010	<0.10	<0.0020	<0.0005	<0.010	0.014	<0.010	3.1
(2)	24-Sep-96	650	1500	<0.0050	<0.0020	0.037	<0.0010	0.040	<0.010	<0.10	<0.0020	<0.0005	0.031	0.018	<0.100	3.2
(1)	7-May-97	643	1830	<0.005	<0.002	0.04	<0.001	0.073	<0.01	0.04	<0.002	<0.0005	0.02	0.017	<0.01	7.00
(2)	7-May-97	572	1760	<0.005	<0.002	0.03	<0.001	0.058	<0.01	0.03	<0.002	<0.0005	0.02	0.017	<0.01	6.30
(1)	30-Oct-97	485	1370	<0.005	<0.002	0.04	<0.001	0.028	<0.01	0.02	<0.002	<0.0005	0.03	0.007	<0.01	1.67
(2)	30-Oct-97	462	1480	<0.005	<0.002	0.04	<0.001	0.024	<0.01	0.01	<0.002	<0.0005	0.04	0.007	<0.01	1.85
(1)	25-Mar-98	327	1650	<0.005	<0.002	0.03	<0.001	0.200	<0.01	0.10	<0.002	<0.0005	0.12	0.011	<0.01	18.4
(2)	25-Mar-98	328	1710	<0.005	<0.002	0.03	<0.001	0.198	<0.01	0.09	<0.002	<0.0005	0.12	0.012	<0.01	18.3
	21-Dec-98	193	1450	<0.005	<0.002	0.02	0.002	0.420	<0.01	0.17	<0.002	<0.0005	0.21	<0.005	<0.01	41.6
(1)	16-Jun-99	54	1310	<0.005	<0.002	0.02	0.002	0.385	<0.01	0.17	<0.002	<0.0005	0.23	<0.005	<0.01	32.9
(2)	16-Jun-99	51	1300	<0.005	<0.002	0.02	0.002	0.396	<0.01	0.17	<0.002	<0.0005	0.24	<0.005	<0.01	33.4
(1)	21-Dec-99	175	1420	<0.005	<0.002	0.02	<0.001	0.297	<0.01	0.10	<0.002	<0.0005	0.15	0.006	<0.01	17.7
(2)	21-Dec-99	180	1430	<0.005	<0.002	0.02	<0.001	0.308	<0.01	0.10	<0.002	<0.0005	0.15	0.006	<0.01	17.9
(1)	29-Jun-00	42	1650	<0.005	<0.005	0.02	0.012	1.07	<0.02	0.42	0.055	<0.001	0.59	<0.005	<0.01	113
(2)	29-Jun-00	49	1660	<0.005	<0.005	0.02	0.012	1.06	<0.02	0.42	0.054	<0.001	0.58	<0.005	<0.01	116
	14-Dec-00	Damaged														
	28-Jun-01	178	1990	<0.005	<0.002	0.02	0.008	1.08	<0.01	0.41	0.042	<0.0005	0.66	<0.005	<0.01	116
EQUIPMENT BLANK #1	20-Oct-92	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	22-Jan-93	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.36
	7-Apr-93	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.12
	15-Jul-93	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Oct-93	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Jan-94	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.01
	27-Jul-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	5-Oct-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	13-Sep-95	---	---	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
(Water Level Indicator)	15-Apr-96	<0.25	<0.25	<0.0050	<0.002	<0.010	<0.0010	<0.0010	<0.010	<0.010	<0.0010	<0.0005	0.014	<0.0050	<0.010	0.025
	24-Sep-96	0.30	0.28	<0.0050	<0.0020	<0.010	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	0.025
GROUNDWATER PROTECTION STANDARD (MG/L)		**NONE**	**NONE**	**0.01**	**0.05**	**1.00**	**0.001**	**0.01**	**0.05**	**2.2**	**0.05**	**0.002**	**0.1**	**0.01**	**0.05**	**0.11**

TABLE 12-1 : SUMMARY OF GROUNDWATER ANALYTICAL DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

MONITOR WELL	SAMPLING DATE	CHLORIDE MG/L	SULFATE MG/L	TOTAL ANTIMONY MG/L	TOTAL ARSENIC MG/L	TOTAL BARIUM MG/L	TOTAL BERYLLIUM MG/L	TOTAL CADMIUM MG/L	TOTAL CHROMIUM MG/L	TOTAL COBALT MG/L	TOTAL LEAD MG/L	TOTAL MERCURY MG/L	TOTAL NICKEL MG/L	TOTAL SELENIUM MG/L	TOTAL SILVER MG/L	TOTAL ZINC MG/L
EQUIPMENT BLANK #1 (cont.) (Water Level Indicator)	6-May-97	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
(Water Level Indicator)	29-Oct-97	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	25-Mar-98	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	17-Nov-98	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	21-Dec-98	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.03
	15-Jun-99	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.01
	20-Dec-99	5	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	28-Jun-00	<1	<1	<0.005	<0.005	<0.01	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	<0.01
	15-Dec-00	<1	<1	<0.005	<0.005	<0.01	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	<0.01
EQUIPMENT BLANK #2	23-Jul-92	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	20-Oct-92	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	22-Jan-93	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.08
	7-Apr-93	<1	<1	<0.05	<0.002	<0.01	<0.005	0.01	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.05
	15-Jul-93	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	6-Oct-93	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Jan-94	<1	<1	<0.05	<0.002	<0.01	<0.005	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	6-Apr-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	28-Jul-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	5-Oct-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
(T.D. Tape)	15-Apr-96	<0.25	<0.25	<0.0050	<0.0020	<0.010	<0.0010	<0.0010	<0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	<0.020
	24-Sep-96	0.30	<0.25	<0.0050	<0.0020	<0.010	<0.0010	<0.0010	0.010	<0.010	<0.0020	<0.0005	<0.010	<0.0050	<0.010	<0.020
(Water Level Indicator)	6-May-97	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
(T.D. Tape)	29-Oct-97	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	25-Mar-98	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.02
	17-Nov-98	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	15-Jun-99	<1	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	0.02
	20-Dec-99	5	<1	<0.005	<0.002	<0.01	<0.001	<0.001	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	29-Jun-00	3	<1	<0.005	<0.005	<0.01	<0.005	<0.001	<0.02	<0.02	<0.005	<0.001	<0.05	<0.005	<0.01	<0.01
FIELD BLANK #1	6-Apr-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	27-Jul-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	28-Jul-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	5-Oct-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	5-Apr-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	14-Sep-95	<1	<1	<0.05	<0.0020	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
FIELD BLANK #2	5-Oct-94	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	25-Jan-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01
	14-Sep-95	<1	<1	<0.05	<0.002	<0.01	<0.01	<0.002	<0.01	<0.010	<0.002	<0.0005	<0.01	<0.005	<0.01	<0.01

NOTES:

1. < : DENOTES A SAMPLE VALUE OF LESS THAN THE LABORATORY REPORTING LIMIT.
2. --- : MONITOR WELL DRY, NO SAMPLES COLLECTED.
3. * : ESTIMATED VALUE - SAMPLE VALUE IS LESS THAN LABORATORY REPORTING LIMIT.
4. ** : DUE TO EXCESSIVE SEDIMENT IN THE SAMPLE FOR THIS WELL THAT WAS COLLECTED ON MAY 7, 1997, THE WELL WAS RESAMPLED ON JUNE 20, 1997.
5. ## : MW-46 WAS RESAMPLED ON JUNE 20, 1997 FOR ONLY TOTAL COBALT IN ORDER TO CONFIRM THE TOTAL COBALT CONCENTRATION OF 0.08 MG/L FOR THE SAMPLE COLLECTED ON MAY 7, 1997.
6. @@ : WELL CAN NOT BE SAMPLED DUE TO DAMAGE.

TABLE 12-2 : SUMMARY OF GROUNDWATER APPENDIX IX DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

PARAMETER	ID:	MW-12A		MW-14A		MW-17		MW-23		MW-25		MW-27		MW-33		PARAMETER
	DATE:	27-Jul-94	05-Oct-94	28-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	
General	**Units**															**General**
Chloride	mg/L	409	414	1110	1,480	535	749	138	212	1,290	1,010	466	666	655	682	Chloride
Sulfate	mg/L	2,830	2,910	4,100	4,980	1,460	1,860	2,590	2,290	2,340	2,450	11,900	11,200	2,930	2,930	Sulfate
Total Metals																**Total Metals**
Arsenic	mg/L	---	---	---	0.003	0.004	---	---	---	0.003	0.002	0.014	0.008	0.003	0.002	Arsenic
Barium	mg/L	0.01	---	0.02	0.02	0.03	0.02	0.02	0.02	---	0.01	0.02	0.01	0.02	0.02	Barium
Cadmium	mg/L	0.002	---	2.77	2.52	---	---	84.2	69.2	0.006	0.004	204	192	0.004	---	Cadmium
Chromium	mg/L	0.01	---	---	---	---	---	0.02	0.02	---	---	0.04	0.03	---	0.01	Chromium
Cobalt	mg/L	---	---	0.10	0.06	---	---	0.67	0.67	---	---	2.86	3.77	---	---	Cobalt
Copper	mg/L	---	---	0.19	0.12	---	---	0.95	0.81	---	---	0.14	0.24	---	---	Copper
Lead	mg/L	---	---	0.163	0.084	---	---	1.03	0.646	---	---	0.492	0.379	0.002	0.007	Lead
Nickel	mg/L	---	---	0.15	0.21	---	---	0.98	1.80	---	---	0.20	6.01	---	---	Nickel
Selenium	mg/L	---	---	---	---	---	---	---	0.006	0.011	0.019	---	---	0.007	---	Selenium
Vanadium	mg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Vanadium
Zinc	mg/L	0.24	0.19	534	503	0.07	---	364	328	0.11	---	3610	4040	0.22	0.15	Zinc
Volatiles																**Volatiles**
Benzene	µg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Benzene
Chlorobenzene	µg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Chlorobenzene
1,4-Dichlorobenzene	µg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1,4-Dichlorobenzene
Semi-Volatiles																**Semi-Volatiles**
bis(2-Ethylhexyl)Phthalate	µg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	bis(2-Ethylhexyl)Phthalate
Naphthalene	µg/L	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Naphthalene

NOTES:

--- = Not measured above laboratory detection limits

+ = Estimated value - below laboratory detection limit

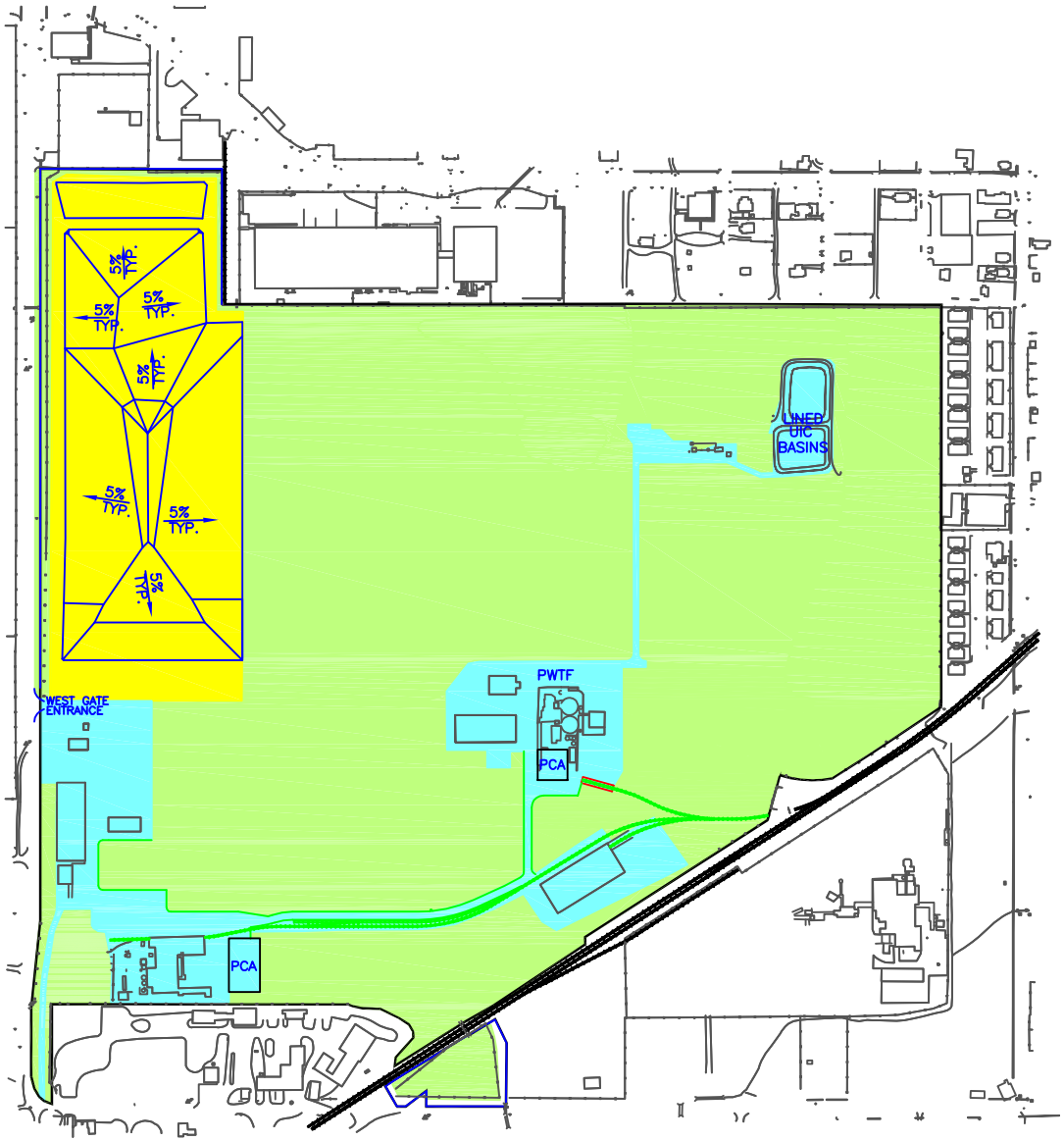
NOTES:

--- = Not measured above laboratory

+ = Estimated value - below laborator

TABLE 12-2 : SUMMARY OF GROUNDWATER APPENDIX IX DATA
HORSEHEAD CORP., BARTLESVILLE, OKLAHOMA

ID:	MW-37		MW-39		MW-39 (DUP)		MW-41		MW-42	
DATE:	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94	27-Jul-94	05-Oct-94
Units										
mg/L	1,160	1,210	167	265	221	113	869	639	179	215
mg/L	1,910	1,970	14	1	15	1	3,000	1,840	1,800	1,960
mg/L	---	0.002	0.006	0.006	0.006	0.004	0.026	0.003	---	---
mg/L	0.04	0.01	0.67	0.69	0.68	0.69	0.17	0.04	0.03	0.02
mg/L	---	---	0.006	---	0.006	---	0.003	---	---	---
mg/L	---	---	---	---	---	---	0.06	---	---	---
mg/L	---	---	---	---	---	---	0.03	---	---	---
mg/L	---	---	0.02	---	0.04	---	0.03	---	---	---
mg/L	0.002	---	0.033	0.004	0.036	0.003	0.013	---	0.003	---
mg/L	0.01	---	---	---	---	---	0.09	---	---	---
mg/L	---	---	---	---	---	---	0.005	---	---	---
mg/L	---	---	---	---	---	---	0.06	---	---	---
mg/L	0.26	---	0.40	---	0.43	0.02	0.32	0.02	0.11	---
µg/L	---	---	4.4[+]	8.4	4.5[+]	9.4	---	---	---	---
µg/L	---	---	21.0	41.8	21.0	42.1	---	---	---	---
µg/L	---	---	12.5	19.1	11.6	17.4	---	---	---	---
µg/L	---	---	15.91	---	15.6	10.8	---	---	---	---
µg/L	---	---	8.22	7.99	8.15[+]	8.15	---	---	---	---



N

LEGEND

- FACILITY BOUNDARY AND CHAIN-LINK FENCE
- AREA CONTAINING WASTE PILE AND SURFACE IMPOUNDMENT SEDIMENTS, SOLIDIFIED AS NEEDED, AND COVERED WITH A MULTIMEDIA CAP.
- AREA COVERED WITH SOIL AND VEGETATION.
- ACTIVE AREAS: BUILDINGS, PWTF, PCAS, UIC BASINS, AND ASPHALT/CONCRETE SURFACING

400' 0 400' 800'
SCALE FEET
1" = 400'

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FIGURE TITLE	CLOSED FACILITY
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701

FIGURE NUMBER
2-1

C:\Users\Colby.Codner\Desktop\1-2 (003).dwg on Mar 11, 2016-3:45pm

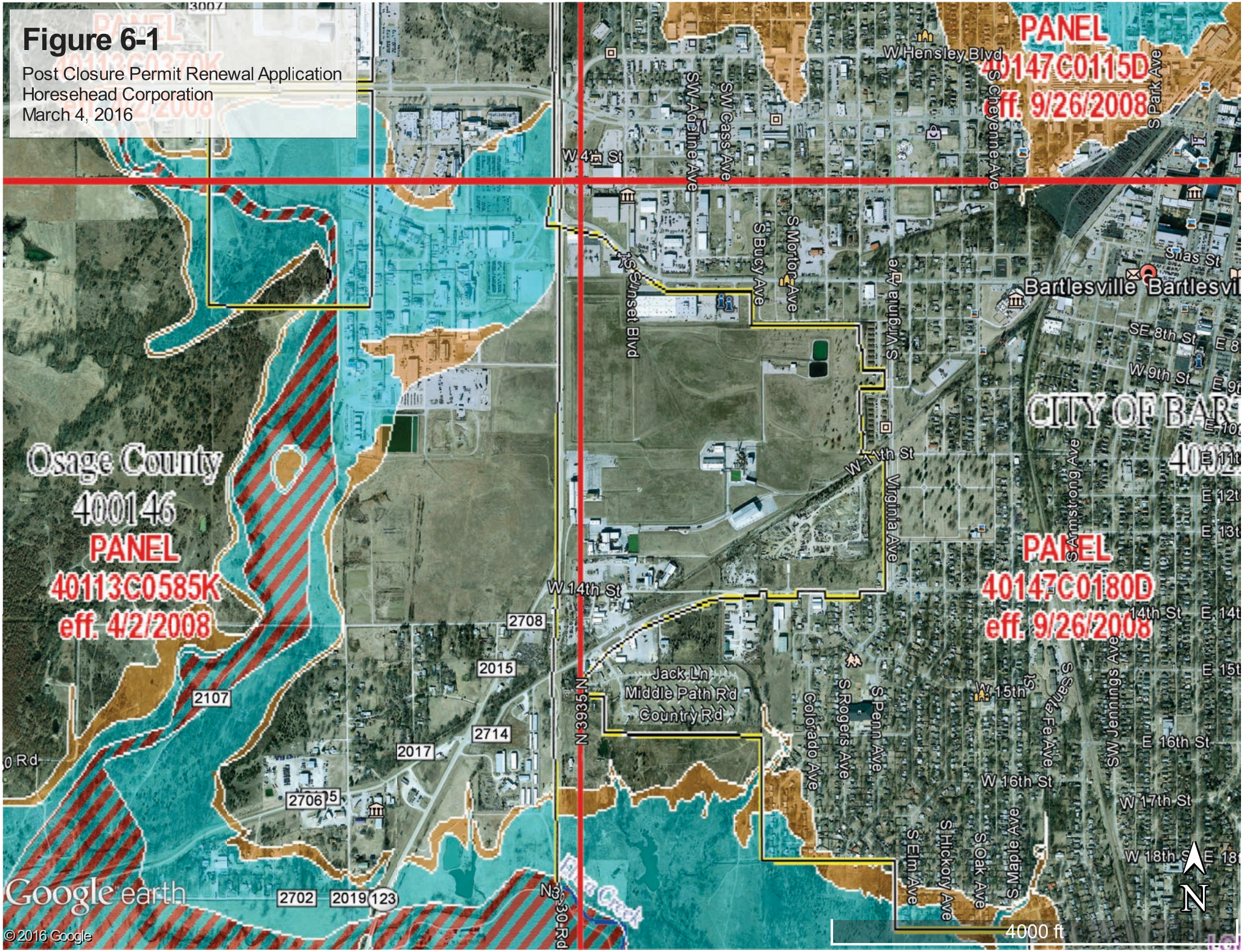
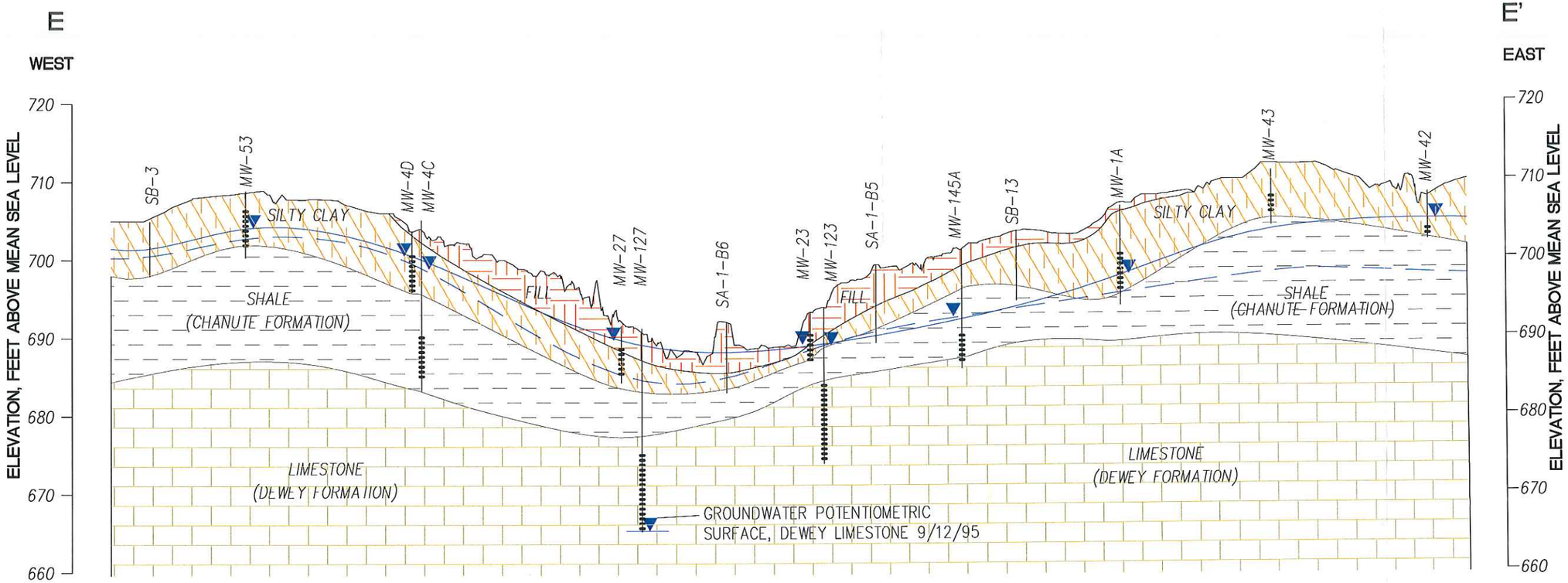


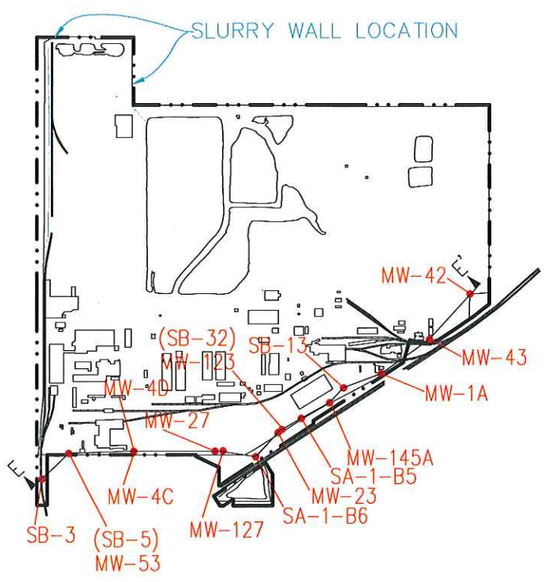
Figure 6-1
Post Closure Permit Renewal Application
Horesehead Corporation
March 4, 2016
PANEL
40147C0115D
eff. 9/26/2008
Osage County
400146
PANEL
40113C0585K
eff. 4/2/2008
PANEL
40147C0180D
eff. 9/26/2008
W Hensley Blvd
S Park Ave
S Cheyenne Ave
SW Cass Ave
SW Adeline Ave
W 4th St
S Bucy Ave
S Morton Ave
S Sunset Blvd
S Virginia Ave
Silas St
Bartlesville
SE 8th St
W 9th St
W 11th St
Virginia Ave
S Armstrong Ave
W 14th St
14th St
2708
2015
2107
2714
2017
2706
2702
2019
123
N 3935 Rd
N 3930 Rd
Jack Ln
Middle Path Rd
Country Rd
Colorado Ave
S Rogers Ave
S Penn Ave
W 15th St
S Santa Fe Ave
SW Jennings Ave
E 16th St
W 16th St
W 17th St
W 18th St
S Elm Ave
S Hickory Ave
S Oak Ave
S Maple Ave
Elm Creek
Google earth
© 2016 Google
4000 ft
N



SECTION E-E'

SCALES: VERTICAL: 1"=15'
HORIZONTAL: 1"=300'

VERTICAL EXAGGERATION: x 20



SOIL BORING

MONITOR WELL SCREEN INTERVAL

BEDROCK (CHANUTE FORMATION) GROUNDWATER POTENTIOMETRIC SURFACE, 9/12/95

UNCONSOLIDATED MATERIAL GROUNDWATER TABLE, 9/12/95

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FIGURE TITLE	CROSS SECTION E-E' (WEST TO EAST)
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 300'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
12-1

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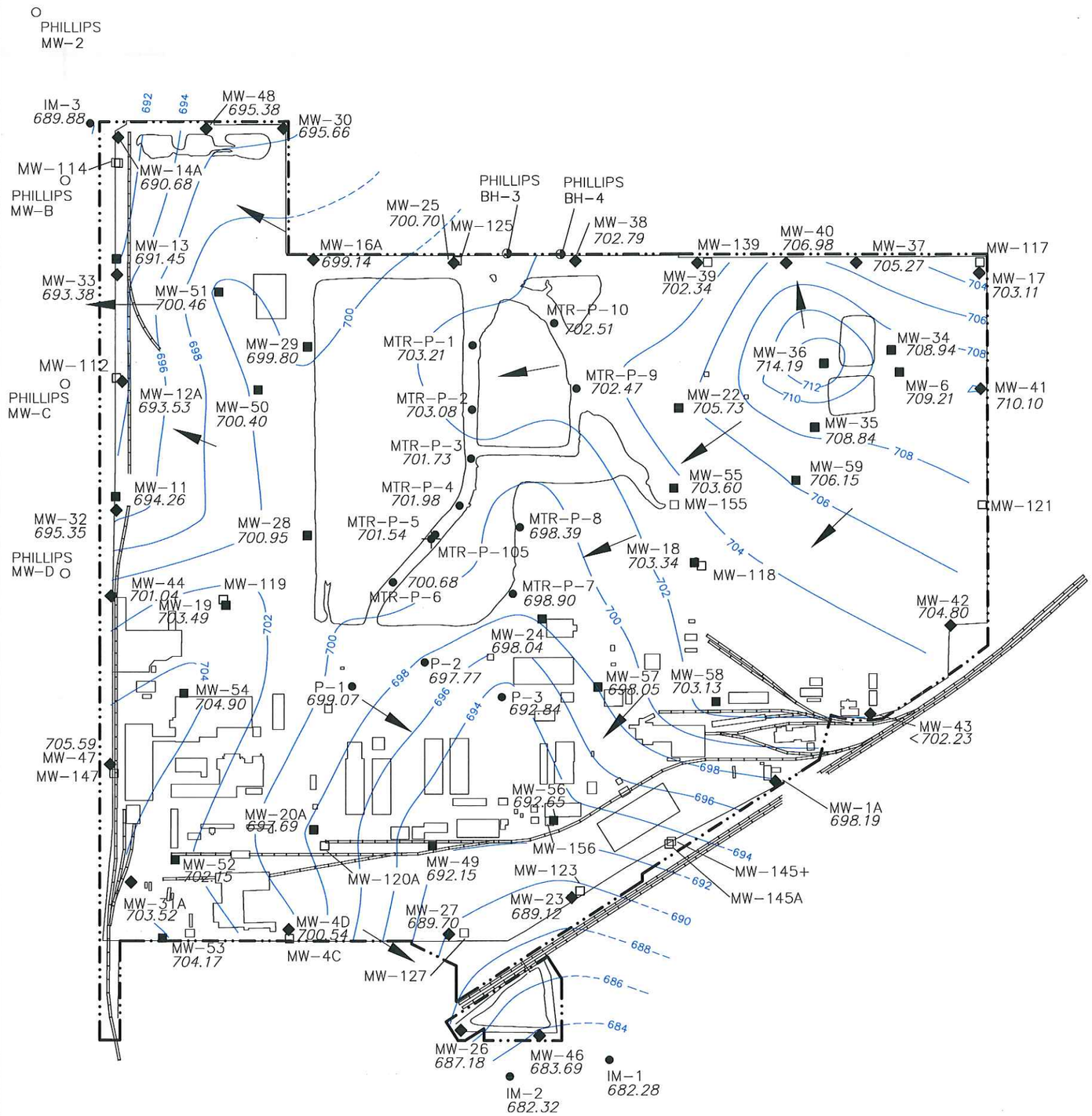

LEGEND

MW-22 ■ 705.73	MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 9/12/95
MW-121 □	MONITOR WELL LOCATION (BEDROCK)
MW-43 ◆ <702.23	RCRA MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 9/12/95
IM-1 ● 682.28	INTERIM MEASURES MONITOR WELL (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 9/12/95
P-3 ● 692.84	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 9/12/95
MTR-P-9 ● 702.47	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 9/12/95
MTR-P-105 ✦	PIEZOMETER LOCATION (BEDROCK)
PHILLIPS BH-4 ◑	PHILLIPS PETROLEUM COMPANY MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL)
PHILLIPS MW-2 ○	PHILLIPS PETROLEUM COMPANY APPROXIMATE MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL)
MW-145+ □	MONITOR WELL REMOVED ON 2/9/96
708	CONTOUR OF GROUNDWATER TABLE ELEVATION IN UNCONSOLIDATED MATERIAL, FEET AMSL, 9/12/95
686	CONTOUR OF GROUNDWATER TABLE ELEVATION IN UNCONSOLIDATED MATERIAL, FEET AMSL, 9/12/95 (OUTSIDE PROPERTY BOUNDARIES) CONTOUR INTERVAL: 2 FEET
←	DIRECTION OF GROUNDWATER FLOW

NOTE: MONITOR WELL NUMBER MW-4C OR NUMBERS GREATER THAN 100 ARE BEDROCK WELLS. "A" AND "D" DESIGNATION DENOTES A REPLACEMENT WELL.

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FIGURE TITLE: **GROUNDWATER TABLE ELEVATION (UNCONSOLIDATED MATERIAL), 9/12/95**

DOCUMENT TITLE: POST-CLOSURE PERMIT APPLICATION

CLIENT: HORSEHEAD CORP.

LOCATION: BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
12-2

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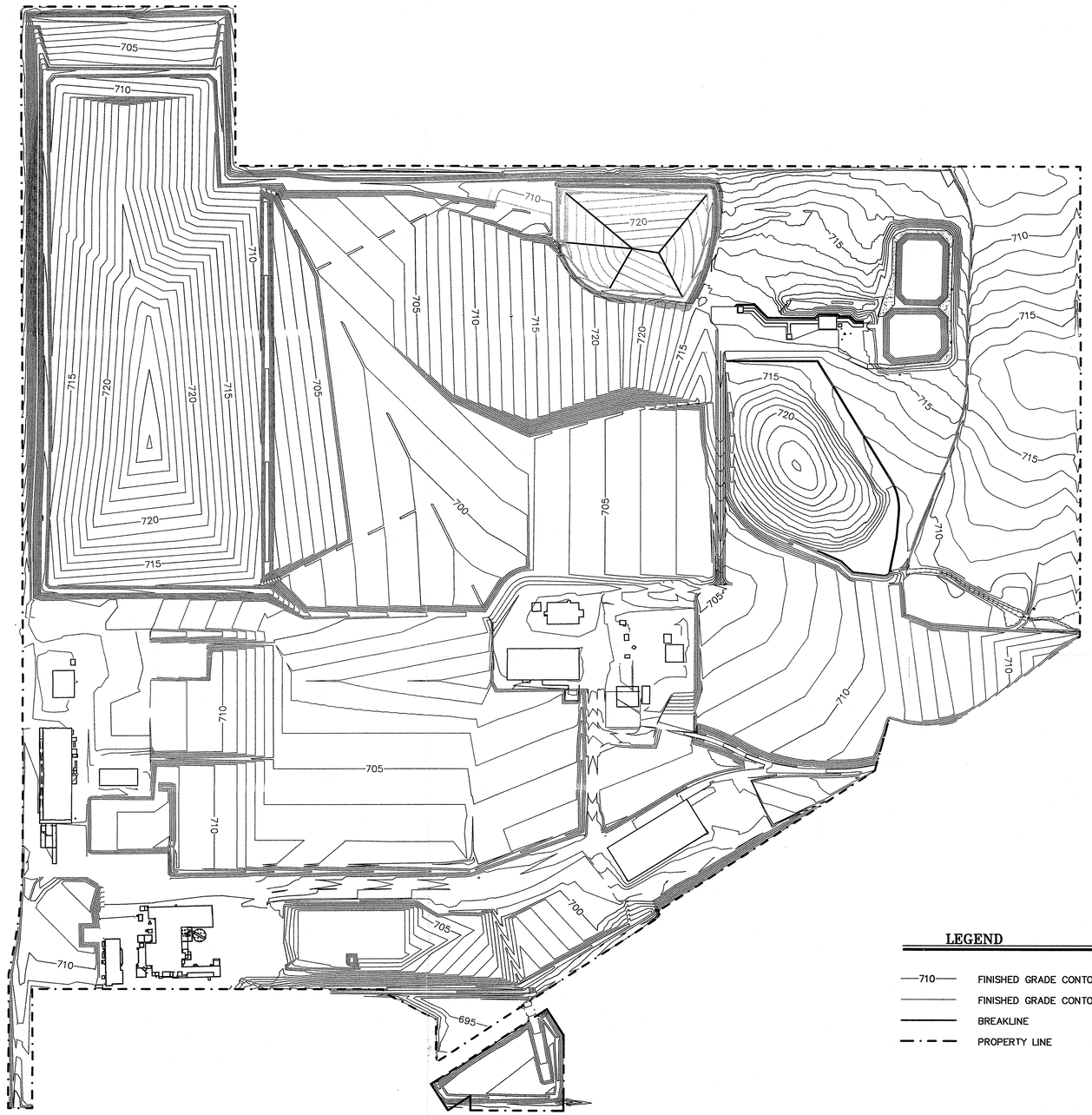

LEGEND

—710—	FINISHED GRADE CONTOUR (5' INTERVAL)
———	FINISHED GRADE CONTOUR (1' INTERVAL)
———	BREAKLINE
—·—·—	PROPERTY LINE

175 0 175 350
SCALE FEET
1" = 175

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NO.	DATE	DESCRIPTION OF REVISION OR ISSUE	BY	APP'D

OKLAHOMA CERTIFICATE OF AUTHORIZATION NO. 3722

FIGURE TITLE	*AS-DESIGNED TOPOGRAPHICAL MAP*
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OKLAHOMA

DESIGNED BY	JRC
APPROVED BY	BT
DRAWN BY	JRC

DATE	10/29/2004
SCALE	AS SHOWN
PROJECT NUMBER	9750701
DRAWING	11-1
REV	
1 OF 1	

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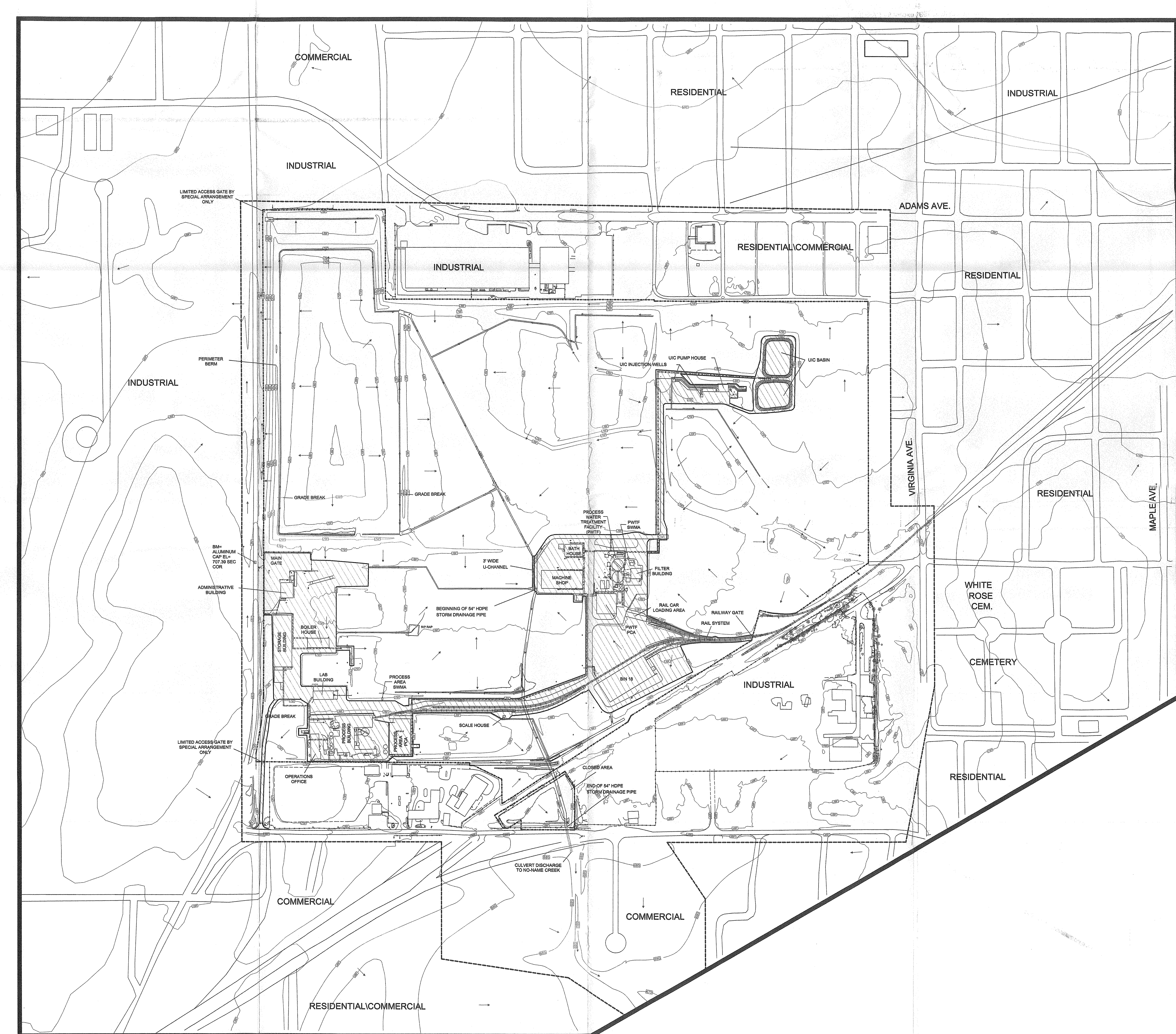


Horsehead Corp.

Legal Description

NOTE: The legal description was referenced from SHEET SP-02, PERIMETER BOUNDARY DESCRIPTION FOR THE ZINC CORPORATION OF AMERICA by G&A Associates dated JUNE 2, 1997, except for PARCEL 2, which is as described in the General Warranty Deed of record.

PARCEL 1

A part of the SE/4 SE/4, all of the SW/4 SE/4, all of government Lot 4 and a part of government Lot 3 of Section 11, T26N, R12E, Indian Base Line and Meridian, Washington County, Oklahoma and also part of government Lot 1, Part of the NW/4 NE/4 and part of the NE/4 NE/4 of Section 14, T26N, R12E, Indian Base Line and Meridian, Washington County, Oklahoma more particularly described as follows: Commencing at an iron pin and aluminum cap marking the NW corner of said Section 14, T26N, R12E, said pin being on the centerline of State Highway #123; Thence along the North line of said Section 14 S89°55'59"E a distance of 40.00 feet to another iron pin and aluminum cap on the Easterly Right-of-Way line of State Highway #123 and the true point of beginning: (1) Thence along the Easterly Right-of-Way line of State Highway #123 running parallel with and 40.00 feet East of the West line of said Section 14 SO°00'17"W a distance of 607.90 feet; (2) Thence SW along the curved Easterly Right-of-Way line of State Highway #123 an arc distance of 344.00 feet, said curve being concave to the NW having a radius of 1472.40 feet and a chord bearing S6°42'59"W 343.11 feet to intersect the West line of said Section 14 at a point which is SO°00'17"Wa distance of 948.70 feet from the NW corner of said Section 14; (3) Thence leaving the Easterly Right-of-Way of State Highway #123 and continuing along the West line of said Section 14 SO°00'17"W a distance of 41.65 feet to an iron pin and aluminum cap; (4) Thence continuing along the West line of said Section 14 SO°00'17"W a distance of 334.00 feet to an iron pin and aluminum cap marking the SW corner of government Lot 1; (5) Thence along the South line of government Lot 1 S89°50'42"E a distance of 67.30 feet to an iron pin marking the SW corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (6) Thence NO°00'17"E a distance of 334.00 feet to an iron pin marking the NW corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (7) Thence S89°50'42"E a distance of 570.90 feet to an iron pin marking the NE corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (8) Thence running parallel to and 334.00 feet North of the South line of the NW/4 NE/4 of said Section 14 S89°50'42"E a distance of 742.76 feet to a point on the Westerly Right-of-way line of the M.K.&T. Railroad, said Right-of-Way line being 100.00 feet from the centerline of the railroad; (9) Thence along the Westerly Right-of-Way line of the railroad S56°59'08"W a distance of 214.65 feet; (10) Thence following the Westerly line of a tract formerly within said railroad Right-of-Way SO°21'38"E a distance of 87.30 feet; (11) Thence following the Easterly line of said tract N56°45'10"E a distance of 746.08 feet; (12) Thence following the Northerly line of said tract NO°28'31"W a distance of 23.70 feet to a point on the Westerly Right-of-Way of the railroad, said Right-of-Way line being now 50.00 feet from the centerline of the railroad and also located N56°59'08"E along the Westerly Right-of-Way of the railroad a distance of 4.38 feet from the North end of the widening of the railroad Right-of-Way to 100.00 feet from the centerline of the railroad; (13) Thence continuing along the Westerly Right-of-Way line of the railroad N56°59'08"E a distance of 158.87 feet to a point on the East line of the NW/4 NE/4 of said Section 14 which is NO°02'22"E a distance of 650.66 feet from the SE corner of the NW/4 NE/4 of said Section 14; (14) Thence continuing along the Westerly Right-of-Way line of the Railroad N56°59'08"E a distance of 560.70 feet; (15) Thence continuing along the Westerly Right-of-Way line of the railroad N15°25'07"E a distance of 151.60 feet; (16) Thence continuing along the Westerly Right-of-Way line of the railroad S83°27'57"E a distance of 4.18 feet; (17) Thence SE along the curved Westerly Right-of-Way line of the railroad an arc distance of 175.00 feet, said curve being concave to the NW having a radius of 358.09 feet and a chord bearing S83°27'48"E 173.26 feet; (18)Thence continuing along the Westerly Right-of-Way line of the railroad N56°59'08"E a distance of 157.40 feet; (19) Thence NE along the curved Westerly Right-of-Way line of the railroad an arc distance of 271.40 feet, said curve being concave to the NW having a radius of 2864.79 feet and a chord bearing N54° 16' 18"E 271.30 feet to an iron pin marking a point on the North line of said Section 14 which is N89°55'59W along the North section line a distance of 280.65 feet from the iron pin marking the NE corner of said Section 14; (20) Thence continuing along the Westerly Right-of-Way line of the railroad N54°11'28"E a distance of 6.23 feet; (21) Thence leaving the railroad and running parallel with and 275.60 feet West of the East line of said Section 11, T26N, R12E, NO°04'28"E a distance of 1315.65 feet to an iron pin marking a point on the North line of the SE/4 SE/4 of said Section 11 which is N89°59'04"W along the North line of the SE/4 SE/4 from the NE corner of the SE/4 SE/4 of said Section 11; (22) Thence along the North line of the SE/4 SE/4 of said Section 11 N89°59'04"W a distance of 1044.57 feet to an iron pin marking the NW corner of the SE/4 SE/4; (23) Thence along the North line of the SW/4 SE/4 of said Section 11 N89°59'04"W a distance of 1320.17 feet to an iron pin marking the SE corner of government Lot 3; (24) Thence along the East line of government Lot 3 NO°02'52"W a distance of 446.90 feet to an iron pin marking the SE corner of the North 870.29 feet of government Lot 3; (25) Thence S89°57'52"W a distance of 599.54 feet to an iron pin marking a point on the South line of the North 870.29 feet of government Lot 3 which is N89°57'52"E a distance of 40.00 feet from an iron pin marking the West line of said Section 11, said point also being on the Easterly Right-of-Way line of State Highway #123 (26) Thence along the Easterly Right-of-Way line of State Highway #123 running parallel with and 40.00 feet East of the West line of said Section 11 SO°00'17"W a distance of 446.33 feet to a point on the South line of government Lot 3; (27) Thence continuing along the Easterly Right-of-Way line of State Highway #123, running parallel with and 40.00 feet East of the West line of said Section 11 SO°00'17"W a distance of 1316.77 feet to the beginning point, containing 6,402,991 sq. ft (146.992 acres) more or less.

PARCEL 2

A tract of land in Washington County, Oklahoma, in the NW/4 NE/4 of Section 14, T26N, R12E, described as follows: Commencing at the NW corner of Section 14, thence S00°00'17"W 990.35 feet, thence S89°57'13"E 1053.32 feet, to the true point of beginning, thence S89°57'13"E 333.37 feet, thence S57°23'37"W 214.65 feet, thence North 33.45 feet, thence N64°16'47"W 169.33 feet, thence North 9.00 feet to the point of beginning, containing 0.40 acres, more or less.

PARCEL 3

All that portion of the SE1/4 of the NW1/4 of the NEI/4 of Section 14, T26N, R12E, more particularly described as follows: beginning at a point on the South line of the NW1/4 NEI/4 that is 398 feet west of the Southeast corner thereof; thence West along the South line of said NW1/4 NEI/4 for a distance of 262 feet to the southwest corner of the SE1/4 NW1/4 NEI/4; thence North along the West line of said SE1/4 NW1/4 NEI/4 to the point of intersection with the South line of the M. K. & T. Railroad Right-of-Way; thence in a Northeasterly direction along the said South Right-of-Way line to a point due North of the point of beginning; thence South to the point of beginning.

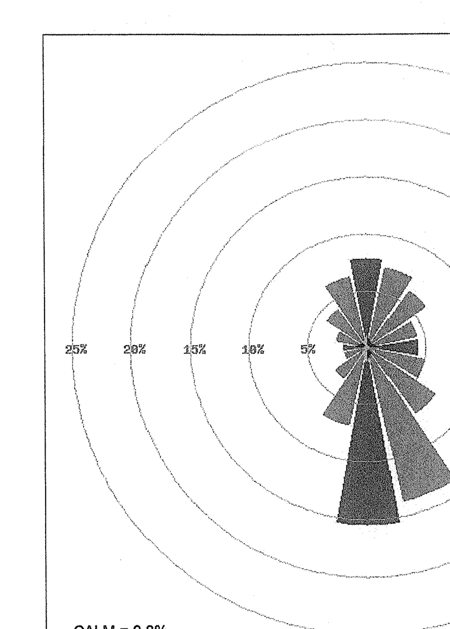
PARCEL 4

A tract of land situated in the NW/4 NE/4 of Section 14, Township 26 North, Range 12 East in Washington County, Oklahoma more particularly described as follows: Commencing the Southeast corner of said NW/4 NE/4, thence N89°55'08"W along the South line of said NW/4 NE/4, a distance of 398.00 feet, thence North along a straight line a distance of 207.91 feet to a point on the Southeasterly Right-of-Way line of the Missouri Pacific Railroad Company and the true point of beginning. Thence S57°27'25"W along said Southeasterly Right-of-Way line, a distance of 386.00 feet to a point on the said South line of the NW/4 NE/4 , thence N89°55'08"W along said South line, a distance of 23.76 feet, thence N32°36'23"W along a straight line, a distance of 75.19 feet, thence N57°27'25"E along a straight line, a distance of 406.00 feet, thence S32°36'23"E along a straight line, a distance of 88.00 feet to the point of beginning containing an area of .82 of an acre, more or less.

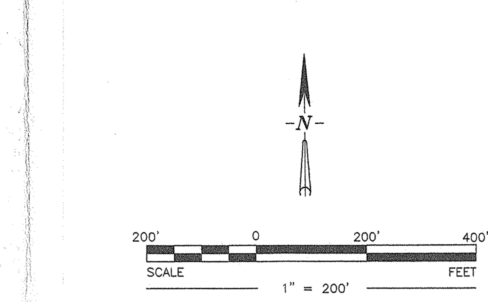
LEGEND

(heavy solid line)	1,000 FOOT BOUNDARY AROUND FACILITY
(dash-dot line)	FACILITY PROPERTY BOUNDARY
(dashed line)	MATCH LINE. MAP DETAILS OUTSIDE MATCH LINE BASED ON U.S.G.S. TOPOGRAPHIC QUADRANGLE BARTLESVILLE SOUTH, OKLAHOMA, PHOTOINSPECTED 1980, 5 ft. CONTOURS INTERPOLATED FROM 10 FT. CONTOURS SHOWN ON QUADRANGLE. MAP DETAILS INSIDE MATCH LINE BASED ON AS-BUILT DRAWINGS FROM MICHEAL J. HUDDLESTON, 2004 AND SUPPLEMENTAL SURVEY PERFORMED JULY 14, 2004.
(hatched box)	OPERATING AREAS ALL OTHER AREAS INSIDE FENCE ARE CLOSED AREAS
(contour symbol)	EXISTING GROUND CONTOUR (5' INTERVAL)
RESIDENTIAL	LAND USE DESIGNATION
SWMA	STORM WATER MANAGEMENT AREA
PWTF	PROCESS WATER TREATMENT FACILITY
PCA	PROCESS CONTAINMENT AREA
(arrow)	SURFACE DRAINAGE DIRECTION

NOTE: THIS AREA IS NOT IN THE 100 YEAR FLOOD PLAIN. FLOOD PLAIN INFORMATION IS TAKEN FROM THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE RATE MAP (FIRM) COMMUNITY. PANEL NUMBER 400220 0012 C. (MAP REVISED NOVEMBER 18TH, 1988).



REGIONAL WIND ROSE
COPAN, WASHINGTON COUNTY, OK, 1994-2003



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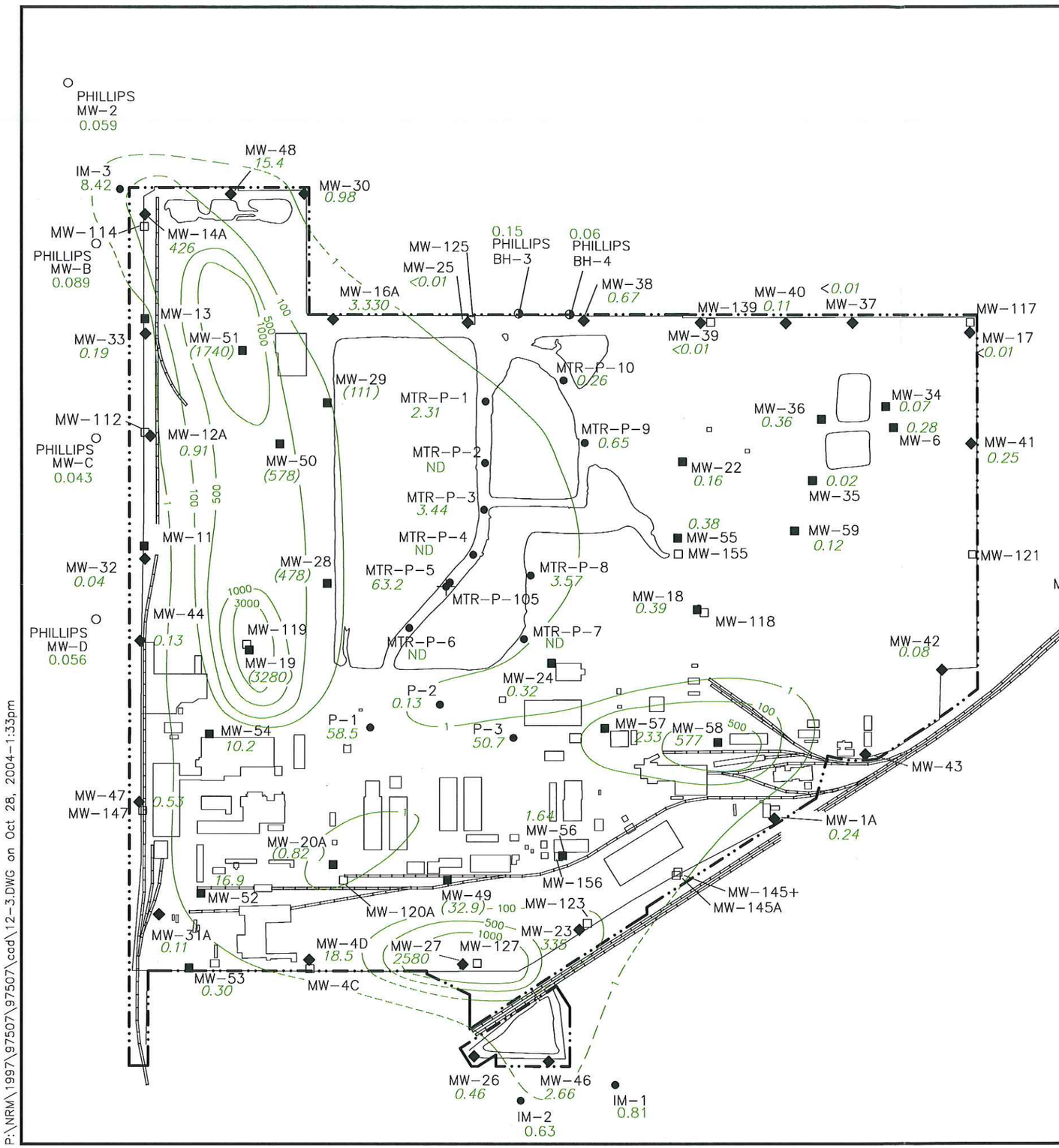
NO.	DATE	DESCRIPTION OF REVISION OR ISSUE	BY	APP'D

FIGURE TITLE	TOPOGRAPHIC MAP
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OKLAHOMA

DESIGNED BY	LL
APPROVED BY	JL
DRAWN BY	LJ
DATE	10/29/2004
SCALE	AS SHOWN

PROJECT NUMBER
9750701 M14
DRAWING NUMBER
11-2



LEGEND

MW-59 ■ 0.12	MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
MW-121 □	MONITOR WELL LOCATION (BEDROCK)
MW-32 ◆ 0.04	RCRA MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
(1740)	ZINC CONCENTRATION IN GROUNDWATER, MG/L, 4/5-7/95
IM-1 ● 0.81	INTERIM MEASURES MONITOR WELL LOCATION (UNCONSOLIDATED MATERIALS) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 5/17/94 (IM-3) AND 1/25/95 (IM-1 AND IM-2)
P-3 ● 50.7	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-1 ● 2.31	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-105 ✦	PIEZOMETER LOCATION (BEDROCK)
PHILLIPS ◑ BH-4 0.06	PHILLIPS PETROLEUM COMPANY MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 2/13/96
PHILLIPS ○ MW-2 0.059	PHILLIPS PETROLEUM COMPANY MONITOR WELL APPROXIMATE LOCATION (UNCONSOLIDATED MATERIAL) AND ZINC CONCENTRATION IN GROUNDWATER, MG/L, 2/92
MW-145+□	MONITOR WELL REMOVED ON 2/9/96
—100—	ISOPLETH OF ZINC CONCENTRATION IN GROUNDWATER MG/L
---1---	ISOPLETH OF ZINC CONCENTRATION IN GROUNDWATER MG/L (OUTSIDE PROPERTY BOUNDARIES)
ND	NO DATA AVAILABLE

ISOPLETHS SHOWN: 1, 100, 500, 1000 AND 3000 MG/L

NOTE:
MONITOR WELL NUMBER MW-4C OR NUMBERS GREATER THAN 100 ARE BEDROCK WELLS. AN "A" AND "D" DESIGNATION DENOTES A REPLACEMENT WELL.

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FIGURE TITLE	ISOPLETH MAP OF TOTAL ZINC CONCENTRATIONS IN GROUNDWATER (UNCONSOLIDATED MATERIAL)
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701

FIGURE NUMBER
12-3

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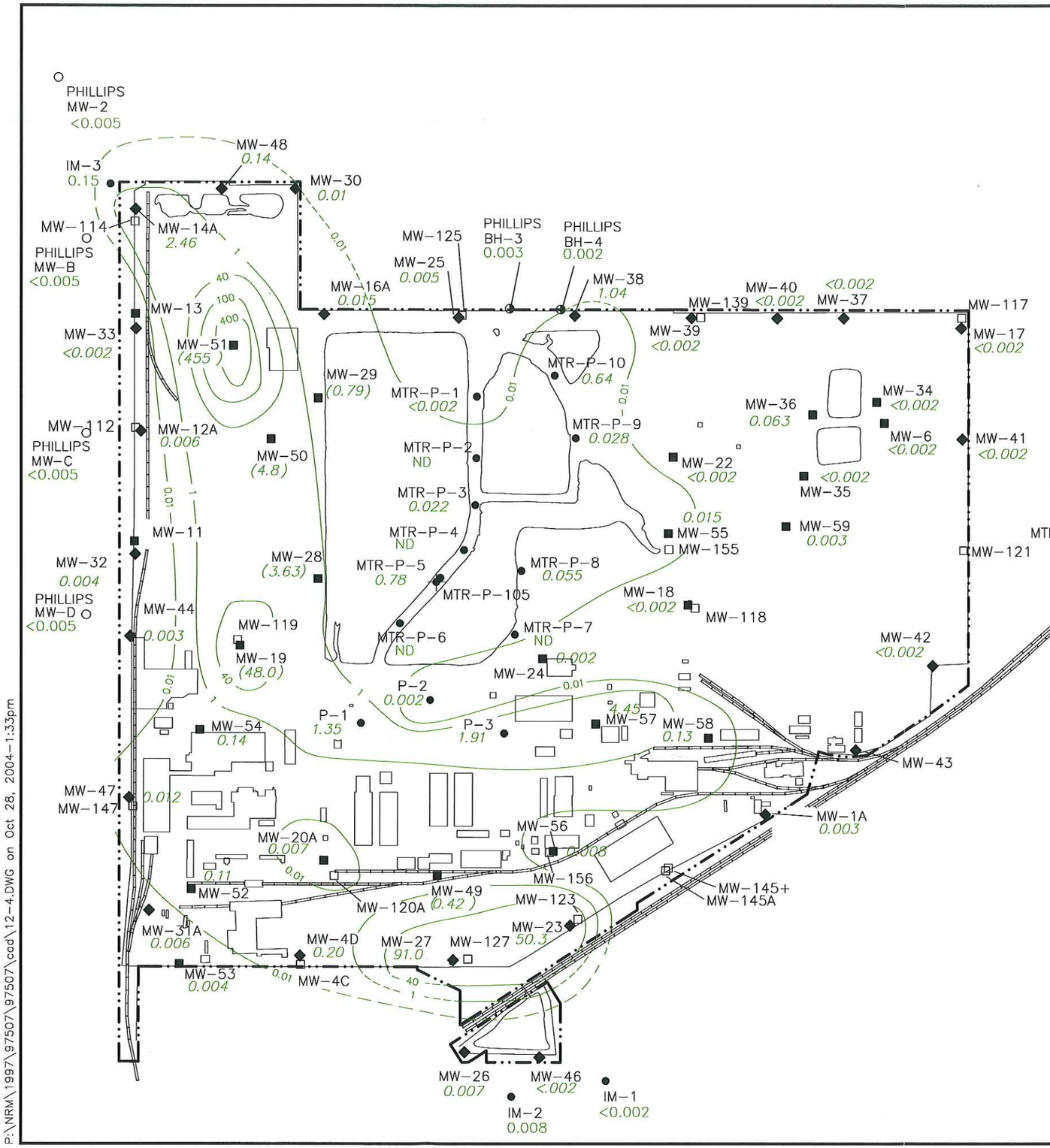

LEGEND

MW-59 ■ 0.003	MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
MW-121 □	MONITOR WELL LOCATION (BEDROCK)
MW-32 ◆ 0.004	RCRA MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
(4.8)	CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 4/5-7/95
IM-1 ● <0.002	INTERIM MEASURES MONITOR WELL LOCATION (UNCONSOLIDATED MATERIALS) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 5/17/94 (IM-3) AND 1/25/95 (IM-1 AND IM-2)
P-3 ● 1.91	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-1 ● <0.002	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-105 ✦	PIEZOMETER LOCATION (BEDROCK)
PHILLIPS BH-4 ◑ 0.002	PHILLIPS PETROLEUM COMPANY MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 2/13/96
PHILLIPS MW-2 ○ <0.005	PHILLIPS PETROLEUM COMPANY MONITOR WELL APPROXIMATE LOCATION (UNCONSOLIDATED MATERIAL) AND CADMIUM CONCENTRATION IN GROUNDWATER, MG/L, 2/92
MW-145+ □	MONITOR WELL REMOVED ON 2/9/96
—100—	ISOPLETH OF CADMIUM CONCENTRATION IN GROUNDWATER MG/L
-- 40 --	ISOPLETH OF CADMIUM CONCENTRATION IN GROUNDWATER MG/L (OUTSIDE PROPERTY BOUNDARIES)
ND	NO DATA AVAILABLE

ISOPLETHS SHOWN: 0.01, 1, 40, 100, AND 400 MG/L

NOTE:
MONITOR WELL NUMBER MW-4C OR NUMBERS GREATER THAN 100 ARE BEDROCK WELLS. AN "A" AND "D" DESIGNATION DENOTES A REPLACEMENT WELL.

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FIGURE TITLE	ISOPLETH MAP OF TOTAL CADMIUM CONCENTRATIONS IN GROUNDWATER (UNCONSOLIDATED MATERIAL)
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
12-4

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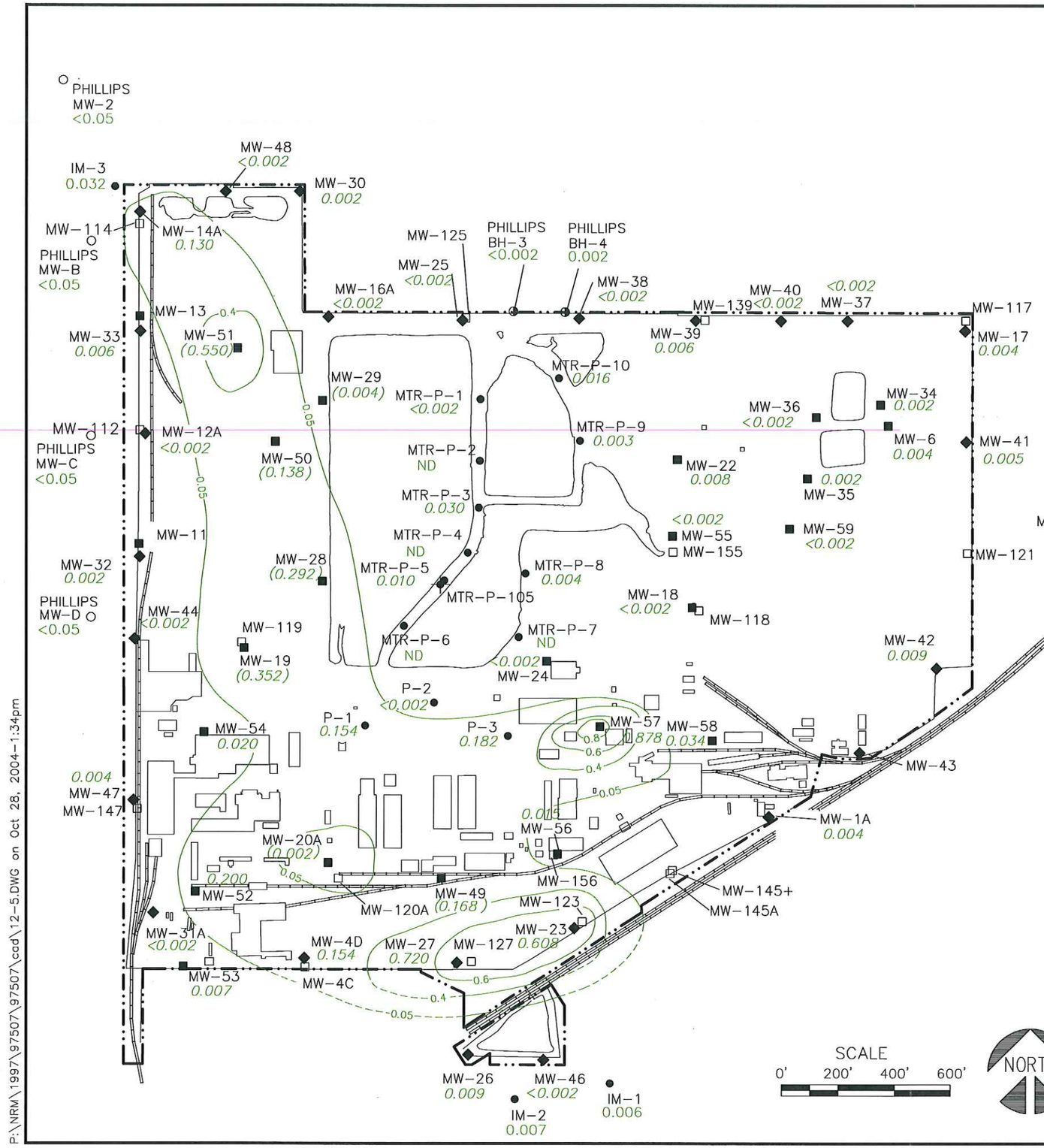

LEGEND

MW-59 ■ <0.002	MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
MW-121 □	MONITOR WELL LOCATION (BEDROCK)
MW-32 ◆ 0.002	RCRA MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 9/13-14/95
(0.168)	LEAD CONCENTRATION IN GROUNDWATER, MG/L, 4/5-7/95
IM-1 ● 0.006	INTERIM MEASURES MONITOR WELL LOCATION (UNCONSOLIDATED MATERIALS) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 5/17/94 (IM-3) AND 1/25/95 (IM-1 AND IM-2)
P-3 ● 0.182	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-1 ● <0.002	PIEZOMETER LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 9/14/95
MTR-P-105 ✦	PIEZOMETER LOCATION (BEDROCK)
PHILLIPS BH-4 ◑ 0.002	PHILLIPS PETROLEUM COMPANY MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 2/13/96
PHILLIPS MW-2 ○ <0.05	PHILLIPS PETROLEUM COMPANY MONITOR WELL APPROXIMATE LOCATION (UNCONSOLIDATED MATERIAL) AND LEAD CONCENTRATION IN GROUNDWATER, MG/L, 2/92
MW-145+ □	MONITOR WELL REMOVED ON 2/9/96
— 0.6 —	ISOPLETH OF LEAD CONCENTRATION IN GROUNDWATER MG/L
- - - 0.4 - - -	ISOPLETH OF LEAD CONCENTRATION IN GROUNDWATER MG/L (OUTSIDE PROPERTY BOUNDARIES)
ND	NO DATA AVAILABLE

ISOPLETHS SHOWN: 0.05, 0.4, 0.6, AND 0.8 MG/L

NOTE:
MONITOR WELL NUMBER MW-4C OR NUMBERS GREATER THAN 100 ARE BEDROCK WELLS. AN "A" AND "D" DESIGNATION DENOTES A REPLACEMENT WELL.

BENHAM infrastructure & environment

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FIGURE TITLE	ISOPLETH MAP OF TOTAL LEAD CONCENTRATIONS IN GROUNDWATER (UNCONSOLIDATED MATERIAL)
DOCUMENT TITLE	POST-CLOSURE PERMIT APPLICATION
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
12-5

P:\NRM\1997\97507\97507\cad\12-5.DWG on Oct 28, 2004-1:34pm

Horsehead Corp.
Legal Description

NOTE: The legal description for Parcels 1, 3, and 4 is a certified land surveyor description and was referenced from SHEET SP-02, PERIMETER BOUNDARY DESCRIPTION FOR THE ZINC CORPORATION OF AMERICA by G&A Associates dated JUNE 2, 1997. PARCEL 2 is as described in the General Warranty Deed of record.

PARCEL 1

A part of the SE/4 SE/4, all of the SW/4 SE/4, all of government Lot 4 and a part of government Lot 3 of Section 11, T26N, R12E, Indian Base Line and Meridian, Washington County, Oklahoma and also part of government Lot 1, Part of the NW/4 NE/4 and part of the NE/4 NE/4 of Section 14, T26N, R12E, Indian Base Line and Meridian, Washington County, Oklahoma more particularly described as follows: Commencing at an iron pin and aluminum cap marking the NW corner of said Section 14, T26N, R12E, said pin being on the centerline of State Highway #123; Thence along the North line of said Section 14 S89°55'59"E a distance of 40.00 feet to another iron pin and aluminum cap on the Easterly Right-of-Way line of State Highway #123 and the true point of beginning: (1) Thence along the Easterly Right-of-Way line of State Highway #123 running parallel with and 40.00 feet East of the West line of said Section 14 S0°00'17"W a distance of 607.90 feet; (2) Thence SW along the curved Easterly Right-of-Way line of State Highway #123 an arc distance of 344.00 feet, said curve being concave to the NW having a radius of 1472.40 feet and a chord bearing S6°42'59"W 343.11 feet to intersect the West line of said Section 14 at a point which is S0°00'17"W a distance of 948.70 feet from the NW corner of said Section 14; (3) Thence leaving the Easterly Right-of-Way of State Highway #123 and continuing along the West line of said Section 14 S0°00'17"W a distance of 41.65 feet to an iron pin and aluminum cap; (4) Thence continuing along the West line of said Section 14 S0°00'17"W a distance of 334.00 feet to an iron pin and aluminum cap marking the SW corner of government Lot 1; (5) Thence along the South line of government Lot 1 S89°50'42"E a distance of 67.30 feet to an iron pin marking the SW corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (6) Thence N0°00'17"E a distance of 334.00 feet to an iron pin marking the NW corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (7) Thence S89°50'42"E a distance of 570.90 feet to an iron pin marking the NE corner of the South 334.00 feet of the East 570.90 feet of government Lot 1; (8) Thence running parallel to and 334.00 feet North of the South line of the NW/4 NE/4 of said Section 14 S89°50'42"E a distance of 742.76 feet to a point on the Westerly Right-of-way line of the M.K.&T. Railroad, said Right-of-Way line being 100.00 feet from the centerline of the railroad; (9) Thence along the Westerly Right-of-Way line of the railroad S56°59'08"W a distance of 214.65 feet; (10) Thence following the Westerly line of a tract formerly within said railroad Right-of-Way S0°21'38"E a distance of 87.30 feet; (11) Thence following the Easterly line of said tract N56°45'10"E a distance of 746.08 feet; (12) Thence following the Northerly line of said tract N0°28'31"W a distance of 23.70 feet to a point on the Westerly Right-of-Way of the railroad, said Right-of-Way line being now 50.00 feet from the centerline of the railroad and also located N56°59'08"E along the Westerly Right-of-Way of the railroad a distance of 4.38 feet from the North end of the widening of the railroad Right-of-Way to 100.00 feet from the centerline of the railroad; (13) Thence continuing along the Westerly Right-of-Way line of the railroad N56°59'08"E a distance of 158.87 feet to a point on the East line of the NW/4 NE/4 of said Section 14 which is N0°02'22"E a distance of 650.66 feet from the SE corner of the NW/4 NE/4 of said Section 14; (14) Thence continuing along the Westerly Right-of-Way line of the Railroad N56°59'08"E a distance of 560.70 feet; (15) Thence continuing along the Westerly Right-of-Way line of the railroad N15°25'07"E a distance of 151.60 feet; (16) Thence continuing along the Westerly Right-of-Way line of the railroad S83°27'57"E a distance of 4.18 feet; (17) Thence SE along the curved Westerly Right-of-Way line of the railroad an arc distance of 175.00 feet, said curve being concave to the NW having a radius of 358.09 feet and a chord bearing S83°27'48"E 173.26 feet; (18)Thence continuing along the Westerly Right-of-Way line of the railroad N56°59'08"E a distance of 157.40 feet; (19) Thence NE along the curved Westerly Right-of-Way line of the railroad an arc distance of 271.40 feet, said curve being concave to the NW having a radius of 2864.79 feet and a chord bearing N54° 16' 18"E 271.30 feet to an iron pin marking a point on the North line of said Section 14 which is N89°55'59W along the North section line a distance of 280.65

feet from the iron pin marking the NE corner of said Section 14; (20) Thence continuing along the Westerly Right-of-Way line of the railroad N54°11'28"E a distance of 6.23 feet; (21) Thence leaving the railroad and running parallel with and 275.60 feet West of the East line of said Section 11, T26N, R12E, N0°04'28"E a distance of 1315.65 feet to an iron pin marking a point on the North line of the SE/4 SE/4 of said Section 11 which is N89°59'04"W along the North line of the SE/4 SE/4 from the NE corner of the SE/4 SE/4 of said Section 11; (22) Thence along the North line of the SE/4 SE/4 of said Section 11 N89°59'04"W a distance of 1044.57 feet to an iron pin marking the NW corner of the SE/4 SE/4; (23) Thence along the North line of the SW/4 SE/4 of said Section 11 N89°59'04"W a distance of 1320.17 feet to an iron pin marking the SE corner of government Lot 3; (24) Thence along the East line of government Lot 3 N0°02'52"W a distance of 446.90 feet to an iron pin marking the SE corner of the North 870.29 feet of government Lot 3; (25) Thence S89°57'52"W a distance of 599.54 feet to an iron pin marking a point on the South line of the North 870.29 feet of government Lot 3 which is N89°57'52"E a distance of 40.00 feet from an iron pin marking the West line of said Section 11, said point also being on the Easterly Right-of-Way line of State Highway #123; (26) Thence along the Easterly Right-of-Way line of State Highway #123 running parallel with and 40.00 feet East of the West line of said Section 11 S0°00'17"W a distance of 446.33 feet to a point on the South line of government Lot 3; (27) Thence continuing along the Easterly Right-of-Way line of State Highway #123, running parallel with and 40.00 feet East of the West line of said Section 11 S0°00'17"W a distance of 1316.77 feet to the beginning point, containing 6,402,991 sq. ft (146.992 acres) more or less.

PARCEL 2

A tract of land in Washington County, Oklahoma, in the NW/4 NE/4 of Section 14, T26N, R12E, described as follows: Commencing at the NW corner of Section 14, thence S00°00'17"W 990.35 feet, thence S89°57'13"E 1053.32 feet, to the true point of beginning, thence S89°57'13"E 333.37 feet, thence S57°23'37"W 214.65 feet, thence North 33.45 feet, thence N64°16'47"W 169.33 feet, thence North 9.00 feet to the point of beginning, containing 0.40 acres, more or less.

PARCEL 3

All that portion of the SE/4 of the NW/4 of the NE/4 of Section 14, T26N, R12E, more particularly described as follows: beginning at a point on the South line of the NW/4 NE/4 that is 398 feet west of the Southeast corner thereof; thence West along the South line of said NW/4 NE/4 for a distance of 262 feet to the southwest corner of the SE/4 NW/4 NE/4; thence North along the West line of said SE/4 NW/4 NE/4 to the point of intersection with the South line of the M. K. & T. Railroad Right-of-Way; thence in a Northeasterly direction along the said South Right-of-Way line to a point due North of the point of beginning; thence South to the point of beginning.

PARCEL 4

A tract of land situated in the NW/4 NE/4 of Section 14, Township 26 North, Range 12 East in Washington County, Oklahoma, more particularly described as follows: Commencing the Southeast corner of said NW/4 NE/4, thence N89°55'08"W along the South line of said NW/4 NE/4, a distance of 398.0 feet, thence North along a straight line a distance of 207.91 feet to a point on the Southeasterly Right-of-Way line of the Missouri Pacific Railroad Company and the true point of beginning, thence S57°27'25"W along said Southeasterly Right-of-Way line, a distance of 386.0 feet to a point on the said South line of the NW/4 NE/4 , thence N89°55'08"W along said South line, a distance of 23.76 feet, thence N32°36'23"W along a straight line, a distance of 75.19 feet, thence N57°27'25"E along a straight line, a distance of 406.0 feet, thence S32°36'23"E along a straight line, a distance of 88.0 feet to the point of beginning, containing an area of 0.82 of an acre, more or less.

APPENDIX B

POST-CLOSURE PLAN

POST - CLOSURE PLAN
HORSEHEAD CORP.
BARTLESVILLE, OKLAHOMA FACILITY

Prepared for:

Horsehead Corp.
Bartlesville, Oklahoma

RECEIVED
JUN 28 2005
Land Protection Division
Department of Environmental Quality

Prepared by:

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July 2, 2001

Revised September 10, 2003

Revised October 29, 2004

Revised June 27, 2005

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POST - CLOSURE PLAN
HORSEHEAD CORP.
BARTLESVILLE, OKLAHOMA
July 2, 2001
Revised September 10, 2003
Revised October 29, 2004
Revised June 27, 2005

1.0 INTRODUCTION

1.1 Regulatory Basis for Post-Closure Monitoring

The Oklahoma Department of Environmental Quality (ODEQ) has adopted the Flexible Closure Plan Rule that was promulgated by the Environmental Protection Agency (EPA) on October 22, 1998 (63 FR 57609).

The Flexible Closure Plan Rule allows the EPA or the state administering agency (i.e., ODEQ) a degree of flexibility in administering sites for closure and post-closure. Specifically, 40 CFR 264.90(f) states "The Regional Administrator may replace all or part of the requirements of §§264.91 through 264.100 applying to a regulated unit with alternative requirements for groundwater monitoring and corrective action for releases to groundwater set out in the permit (or in an enforceable document) as defined in 40 CFR 270.1(c)(7) where the Regional Administrator determines that:

> The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and
>
> It is not necessary to apply the groundwater monitoring and corrective action requirements of §§264.91 through 264.100 because alternative requirements will protect human health and the environment. [40 CFR 264.90(f)(1-2)]

As determined during the Resource Conservation and Recovery Act (RCRA) Facility Investigation, Landfill LF.1, the Facility regulated unit is situated among solid waste management units (SWMUs), a release has occurred, and both the regulated unit and one or more of the SWMUs are likely to have contributed to the release (RSA, 1996b). Additionally, as part of the Corrective Measures Study (CMS), a Focused Risk Analysis was performed which determined that impacted groundwater beneath the Facility does not present a significant human health or ecological risk (RSA, 1997). The CMS Report stated that the shallow groundwater system beneath the Facility was not a potential source of drinking water based on the EPA groundwater classification system (EPA, 1988). This finding is consistent with the National Zinc Site Operable Unit 1 Record of Decision that stated the groundwater at the National Zinc Site is not used for drinking water because it yields only small amounts of poor quality water due to natural geological conditions and historical oil production activities. Therefore, the conditions specified in 40 CFR 264.90(f)(1) have been satisfied for use of the Flexible Closure Rule. Accordingly, an alternative post-closure groundwater monitoring program is proposed for the Facility as discussed in Section 2.0.

1.2 Facility Location and Description

The Horsehead Corp. (HC) (formerly Zinc Corporation of America (ZCA)) Facility (Facility) is located at Highway 123 and West 11th in Bartlesville, Oklahoma, and includes parts of Sections 11 and 14 of Township 26N, Range 12E, in western Washington County. During its operation, the Facility produced various metals from the smelting and refining of zinc concentrates, secondary materials, and other zinc rich materials. The Facility has undergone closure and corrective action as required by the RCRA permit number OKD000829440.

The goals that were achieved with the closure of the Facility included the elimination of the following:

- possible human exposures to soils and waste with lead, cadmium, and arsenic levels above industrial use soil standards; and
- storm water impacts occurring from such Facility soils, waste, and continuing operations

The Facility was prohibited from discharging impacted storm water or process water beginning in 1980, and ZCA maintained several on-site surface impoundments, a process water treatment facility (PWTF) and two permitted deep injection wells for storm water and process water control. The corrective measures implemented during closure eliminated the need for collection of impacted surface water on-site with the exception of the operating portions of the Facility.

The HC Process Area (Process Area) and the PWTF are the current active areas on-site. Controls will direct, for collection, any surface water runoff from these active areas into process containment areas (PCAs). The water collected in the PCAs is reused or treated and then injected in the permitted on-site deep wells. During severe storm events, the PCAs are designed to bypass, after filling, to the Central Drainage System (CDS) which discharges to No-Name Creek. However, the Storm Water Pollution Prevention Plan (SWPPP) required under the ODEQ General Permit for Storm Water Discharge contains best management practices, including the possibility for shutdown of the HC Process, in the event that a bypass discharge is necessary.

A portion of the remaining Facility surface water is discharged directly off-site either from vegetated or paved areas. However, the majority of the storm water is routed through the CDS to No-Name Creek. The as-designed drainage map, Drawing 1-1, shows the flow of surface water at the facility.

For the purposes of corrective action, the Facility was divided into five distinct areas (shown on Figure 1-1) as follows:

- Northeast Area
- Class I Area
- Class II Area
- Class III Area
- Class IV Area

The corrective action design and construction activities were performed in phases by Class Area. The permitted RCRA unit, Landfill LF.1, has been closed. The remaining areas, including all interim status units and all SWMUs encompassed by the five areas described above, which include the Corrective Action Management Unit (CAMU), are also closed, as depicted on Figure 1-2. This Post-Closure Plan addresses the post-closure activities that will be implemented for Landfill LF.1, Class Areas I, II, III, and IV, and the Northeast Area. The areas not addressed in this plan include the following:

- Active areas of the Facility
- Underground Injection Control System – separately permitted by the ODEQ
- No-Name Creek Off Site Flow Improvements (described below)

As part of the overall corrective action, the off-site upper reaches of No-Name Creek, located south of the Facility, were improved. Channel improvements were necessary in No-Name Creek in order for the drainage area to handle the increased surface water runoff that was generated from the corrective measures throughout the Facility. However, No-Name Creek is not within the boundary of the RCRA-permitted area and it does not contain any regulated units (including CAMU) that will require post-closure care; therefore, it is not included as part of this Plan. The Facility has a separate Operation and Maintenance Plan for the off-site upper reaches of No-Name Creek and an agreement with the City of Bartlesville to ensure that the improved portions of the creek are maintained.

1.3 Regulatory History of Facility

When ZCA acquired the operating zinc refinery in 1987, solid wastes generated from the refining and processing activities conducted at the Facility were exempt from regulation as hazardous wastes under RCRA Section 3001(b)(A)(ii) (commonly known as the Bevill exclusion). On September 1, 1989, the Environmental Protection Agency (EPA) issued a final rule regarding Bevill-excluded wastes. Under this rule, all mineral processing wastes not specifically listed in the rule for permanent or conditional retention were removed from the Bevill exclusion effective March 1, 1990. The solid

wastes, which were being generated at the Facility's zinc refinery, were not listed for permanent or conditional retention under the Bevill exclusion.

The ODEQ is authorized to operate its hazardous waste management program in lieu of the federal program; therefore, the loss of the Bevill exclusion did not become effective in Oklahoma until July 18, 1991.

Due to the loss of the Bevill exclusion, the ODEQ notified ZCA that certain solid wastes generated at the Facility were newly regulated as hazardous wastes, effective July 18, 1991, by virtue of the solid wastes exhibiting one or more characteristics of hazardous waste as identified in 40 CFR 261.24 (*i.e.*, characteristically hazardous by the Toxicity Characteristic Leaching Procedure (TCLP)). Therefore, in accordance with RCRA requirements for facilities that treat, store, or dispose of hazardous waste, ZCA submitted a Notification of Regulated Waste Activity on October 15, 1991, a Part A application for a RCRA hazardous waste permit on January 14, 1992, and a Part B application for a RCRA hazardous waste permit on July 17, 1992. Submission of these documents to the Oklahoma State Department of Health (OSDH - now ODEQ) and EPA allowed ZCA to operate until a RCRA permit could be issued. However, before the Facility became permitted, ZCA ceased zinc refining operations.

Shortly after the RCRA regulatory program became applicable to the Facility, ODEQ conducted a 2-day compliance inspection. Based on this inspection, ZCA and ODEQ entered into a Consent Agreement and Final Order (CAFO) on July 15, 1992. The CAFO required various actions, including increased security and storm water controls. All requirements of the CAFO have been satisfied.

As part of the RCRA permitting process, a 1992 RCRA Facility Assessment (RFA) was conducted by EPA contractors. The RFA identified certain operating and historical units with the potential to contain hazardous constituents. EPA recommended that a total of 37 units identified in the RFA be investigated by performing a RCRA Facility Investigation (RFI).

Based on the findings in the RFA and other studies performed by ZCA, the EPA and ZCA entered into a RCRA Administrative Order on Consent (AOC) on September 1, 1993, to implement a Corrective Action Plan with three mutual objectives. These objectives were as follows:

1. Perform Interim Measures at the Facility to mitigate potential threats to human health and the environment.

2. Perform an RFI to determine the nature and extent of any release(s).

3. Perform a CMS to identify and evaluate alternatives for corrective action to prevent or mitigate any migration of release(s) of hazardous wastes or hazardous constituents from the Facility.

The AOC included provisions that allowed EPA to direct ZCA to implement Subsequent Interim Measures, if deemed necessary. On July 14, 1995, as a Subsequent Interim Measure, the EPA modified the AOC by designating a portion of the Facility as a Corrective Action Management Unit (CAMU). The CAMU regulation (40 CFR 264.552) allowed more efficient management of remediation waste during the corrective measures process.

A RCRA Operations Permit (Permit) was issued to ZCA by the ODEQ, effective July 14, 1995. Issuance of the Permit resulted in the AOC being terminated by the EPA as documented in a letter from EPA to ZCA dated September 8, 1995.

The Permit allowed operation of one landfill (Landfill LF.1) to dispose of wastes generated at the Facility. In issuing the Permit, ODEQ incorporated most of the technical provisions of the AOC, including the use of a CAMU.

A permit modification to realign the CAMU boundary was granted in a letter dated August 29, 1996, from the ODEQ to ZCA. The purpose of the realignment was to ensure that an adequate area would be available for corrective action. The boundary was realigned a second time upon issuance of the modified permit incorporating the CAMU.

1.4 Discussion of Corrective Measures Implemented at the Facility

1.4.1 Northeast Area

The Northeast Area covers approximately 11.32 acres. The construction activities that were performed in this area include the following:

- Removal of roadways and surface improvements
- Abandonment of underground utilities
- Placement of soil cover
- Establishment of vegetative cover and visual screening
- Plugging and abandonment of two oil and gas production wells

The removal activities performed during the Northeast Area construction did not leave any items requiring post-closure care. The soil cover was placed as part of beautification and does not require post-closure care. Therefore, the Northeast Area is not addressed further in this plan, except with respect to Facility-wide maintenance of vegetative cover.

1.4.2 Class I Area

The Class I Area covers approximately 0.75 acres. The Class I Area, located on the south side of 11th Street was covered with a 6-inch topsoil cap that was vegetated.

As with the Northeast Area, the Class I Area does not require post-closure care and is not addressed further in this plan, except with respect to Facility-wide maintenance of vegetative cover.

1.4.3 Class II Area

The Class II Area covers approximately 55 acres. The Class II Area consisted of impacted soils, old smelter structures, refinery structures, interim status waste piles and surface impoundments, SWMUs, structure foundations, refinery utilities, pavements, roads, and an active railroad spur. Construction activities for the Class II Area included the following:

- Demolition of certain plant structures

- Placement of a soil cover system and a vegetative cover to prevent storm water contact with impacted soils and wastes
- Utilities abandonment and replacement above the caps
- Plugging, abandonment, and modification of groundwater monitoring wells
- Storm water management and construction of drainage structures
- Construction of storm water process containment areas (PCAs) at the Process Area and the PWTF
- Construction of roadways
- New and relocated rail construction
- Construction of a central drainage system (CDS)
- Management of materials
- Construction of a soil cover system
- Establishment of vegetative cover
- Tree and shrub planting
- Poles supporting overhead utility service
- Fencing
- Plugging and abandonment of oil and gas wells
- Air monitoring and dust control

1.4.4 Class III Area

The Class III Area covers approximately 20 acres. Corrective action for the Class III Area consisted of placement of a soil cover system and a vegetative cover to enhance the existing cover and prevent storm water runoff from contacting impacted soils and waste. Construction activities for this area included the following:

- Underground utilities abandonment and replacement above the cap
- Plugging, abandonment, and modification of groundwater monitoring wells
- Installation of new Underground Injection Control (UIC) system monitoring well and system upgrades
- Storm water management and construction of drainage structures
- Construction of roadways and hard surface access areas for the UIC system
- Construction of a soil cover system
- Establishment of vegetative cover
- Tree and shrub planting

- Air monitoring and dust control
- Plugging and abandonment of oil and gas wells

The UIC system is located within the Class III Area. This system includes two lined holding basins, two deep injection wells, a pumping system, and the associated piping and equipment. The UIC basins relining and injection system upgrades were completed prior to placement of the soil cover system, and were not part of the corrective measures activities but are covered under the ODEQ UIC Permit (Number IW-NH 74006-R1). Therefore, this Plan does not address the UIC wells and ancillary equipment, or the UIC basins except for vegetative cover on the outside slopes in conjunction with vegetative cover maintenance throughout the Facility.

1.4.5 Class IV Area

The Class IV Area covers approximately 58.3 acres, excluding the area covered by Landfill LF.1, and is located in the northwest portion of the Facility. The Class IV Area contained interim status units (surface impoundments and Landfill LF.8), SWMUs, and impacted soils. RCRA Landfill LF.1 is located adjacent to the Class IV Area.

Construction activities for this area included the following:

- Demolition of a fertilizer plant
- Grading, contouring, and solidification of waste pile materials
- Placement of rubble and demolition materials
- Solidification and relocation of surface impoundment sediments
- Construction of a multimedia cover system over solidified materials in the west part of the Class IV Area
- Construction of a soil cover system, including vegetative cover
- Removal and/or demolition of remnant pipes or septic tanks associated with the demolished fertilizer plant, where necessary
- Storm water management, during construction and post construction
- Management of waste materials

- Plugging and abandonment of groundwater monitoring wells
- Plugging and abandonment of oil and gas wells
- Modification of groundwater monitoring wells
- Air monitoring and dust control
- Tree and shrub planting

1.5 Purpose and Objectives of the Post-Closure Plan

A Post-Closure Plan was included in ZCA's RCRA operations permit (#OKD000829440). However, the Plan included in the Permit was written prior to the completion of the corrective measures and prior to the adoption of the Flexible Closure Rule. This Plan revises and expands the information that was included previously and will be the basis for the Post-Closure Permit. Landfill LF.8 was included in the subsequently adopted CAMU as part of the Class IV Area.

A description of the cover systems constructed for the multimedia cap portion of the Class IV Area and Landfill LF.1 follows.

Class IV Area Multi-Media Cap Description

A geotextile serves as a marker layer and is placed between the waste surface and the clay layer. A low hydraulic conductivity layer, consisting of a 40-mil thick HDPE liner placed on 6 inches of compacted clay bedding material, is constructed on the geotextile marker layer. A drainage layer is constructed above the low hydraulic conductivity layer and consists of a geonet/geotextile composite with sufficient hydraulic transmissivity to intercept and rapidly convey infiltrating water laterally to a perimeter collection system. A geosynthetic filter fabric (a component of the geonet/geotextile composite) reduces the potential for the drainage layer clogging with topsoil layer fines. A final layer is composed of a minimum of 24 inches of topsoil with vegetative cover. The multimedia cover system extends over the entire waste/sediment surface and is terminated in the perimeter berm.

Landfill LF-1 Soil and Vegetation Cap Description:

A 24-inch low permeability clay layer is placed on top of the waste surface. A drainage layer is constructed above the clay layer and consists of a geonet/geotextile composite with sufficient hydraulic transmissivity to intercept and rapidly convey infiltrating water laterally to a perimeter collection system. A geosynthetic filter fabric (a component of the geonet/geotextile composite) reduces the potential for the drainage layer clogging with topsoil layer fines. A final layer is composed of a minimum of 24 inches of topsoil with vegetative cover. The soil cover system extends over the entire waste/sediment surface and is terminated in the perimeter berm.

Details of the cover systems are shown on Drawing 1-2.

2.0 GROUNDWATER MONITORING PLAN

2.1 Background

Groundwater monitoring has been conducted at the Facility since 1992. Groundwater monitoring tasks have been conducted semi-annually in accordance with the RCRA Permit since 1995. During groundwater monitoring events, groundwater levels were measured in order to calculate groundwater elevations, flow directions, and flow rates. In addition, groundwater samples were tested for the following Indicator Parameters and Water Quality Parameters specified in the Permit:

- Indicator Parameters: antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, mercury, nickel, selenium, silver, and zinc
- Water Quality Parameters: barium, chloride, sulfate, specific conductivity, pH, and temperature.

Monitoring data collected since 1992 have consistently shown that groundwater beneath the northern portion of Class IV flows primarily towards the northwest property boundary. Groundwater beneath the southern portions of the Facility flows towards the south-central property boundary. Analytical data generated as part of the groundwater sampling events were utilized in conjunction with prior sampling data to conduct annual trend analyses. Trend analyses have indicated either decreasing, or insignificant trends for all of the monitored constituents in the wells at the Facility, other than in those wells believed to have been temporarily impacted by ongoing Facility closure operations in the immediate vicinity of such wells. Completion of the corrective action caps and covers are expected to attenuate the trends seen in these wells.

2.2 Regulatory Basis For Post-Closure Monitoring

In accordance with EPA's Flexible Closure Rule (see Section 1.1 of this Plan), an alternative post-closure groundwater monitoring program is proposed for the Facility. As presented in the report entitled: *Corrective Measures Study Report and Summary, Zinc Corporation of America* (CMS Report) dated March 7, 1997, the Facility regulated units (Landfill LF.1 and CAMU) are situated among solid waste management units, a release has occurred, and both the regulated units and one or more of the solid waste

management units are likely to have contributed to the release. Therefore, the first condition specified in 40 CFR 264.90(f)(1) has been satisfied. The CMS Report also established that impacted groundwater beneath the Facility did not present a significant human health or ecological risk. Therefore, the second condition specified in 40 CFR 264.90(f)(1) has been satisfied.

Solute transport modeling presented in the CMS Report indicated that movement of zinc, cadmium, and lead were highly retarded in groundwater at the Facility due to soil sorption interactions. In addition, the CMS Report stated that the shallow groundwater system beneath the Facility was not a potential source of drinking water based on the EPA groundwater classification system (EPA, 1988). This finding is consistent with the National Zinc Site Operable Unit 1 Record of Decision which stated that the groundwater at the National Zinc Site is not used for drinking water because it yields only small amounts of poor quality water due to natural geological conditions and historical oil production activities.

Given the lack of pathways for human receptors for Facility groundwater, a focused risk analysis (FRA) was conducted and included as part of the CMS Report to evaluate the potential for ecological impact posed by Facility groundwater. In addition, groundwater transport modeling was conducted for the northern, northwestern and southern portions of the Facility (RSA, 1997). Based on the modeling results, no significant movement of cadmium, lead, or zinc in groundwater was predicted over a period exceeding 100 years.

The FRA focused on the most sensitive ecological receptor in the vicinity of the Facility; benthic species residing in sediments within No-Name Creek located approximately 200 feet south of the Facility. The constituents-of-potential-concern (COPC) identified in Facility groundwater and evaluated in the FRA included zinc, cadmium, and lead. Levels of the COPCs detected in groundwater in September 1995 were utilized for evaluation in the FRA. Based on the results of the FRA, it was concluded that COPC

levels in groundwater beneath the Facility did not pose a significant risk to benthic species within sediments in No-Name Creek.

Groundwater primarily moves towards the northwest and southern-central boundaries of the Facility, as shown on Figure 2-1. Accordingly, the focus of post-closure monitoring will be on trend analysis for COPC levels in the groundwater moving toward the northwest and south-central boundaries of the Facility, resulting in the placement of monitoring wells as shown on Figure 2-2.

2.3 Post-Closure Sampling and Analysis Plan

2.3.1 Introduction

This section presents the procedures to be followed for well sampling, sample management, sample custody control, and sample analysis control, as well as analytical methods and data evaluation procedures that will be conducted during post-closure groundwater monitoring. A project Quality Assurance Project Plan (QAPP) has been prepared for post-closure groundwater monitoring and is included in Attachment 1. Standard Operation Procedures (SOPs) which are applicable to post-closure groundwater monitoring are included in Attachment 2.

2.3.2 Groundwater Monitoring Well Network

The post-closure groundwater monitoring well network consists of six wells supplemented by fifteen temporary piezometers. Construction of the post-closure monitoring well network was performed between June 17-20, 2003. Six new wells were installed for groundwater level and water quality monitoring. Ten existing monitoring wells at the Facility were left for use as temporary piezometers for water level measurements. Five additional piezometers were installed for a total of 15 temporary piezometers. The temporary piezometers, shown on Figure 2-2, will be used for the purpose of water level monitoring in order to substantiate groundwater flow direction in accordance with the plan set out in a February 28, 2003 letter (see Attachment 3 to this Plan).

The post-closure monitoring wells, the locations of which are shown on Figure 2-2, are designated as follows:

- Northwest Boundary of the Facility (Downgradient):

  Monitoring wells MW-33A, MW-14B, and MW-48A.

- Southern Boundary of the Facility (Downgradient):

  Monitoring wells MW-23A, MW-26A, and MW-46A.

The groundwater monitoring wells and piezometers were installed using protocols for well drilling and installation specified in the RCRA Facility Investigation Work Plan Phase I, Zinc Corporation of America, Bartlesville Oklahoma, August 16, 1994, with the exception of monitoring wells MW-14B, MW-26A, MW-46A, and MW-48A. These wells required hand-augering since their locations were inaccessible by a drill rig. Only the drilling method was modified, and all other completion protocols were followed.

Given that COPC level trends will be monitored in each individual well, background wells are not proposed to be included as part of the post-closure groundwater monitoring program.

2.3.3 Sampling Frequency and Procedures

Groundwater levels will be measured in all wells and temporary piezometers and samples will be collected from the monitoring wells on a quarterly basis during the first year of post-closure monitoring. During subsequent years, monitoring will be conducted on a semi-annual basis. All measurements and sampling activities will be conducted in accordance with the SOPs that are included in Attachment 2.

2.3.4 Analytical Methods

Groundwater samples will be analyzed for the COPCs (cadmium, lead, and zinc). Using the appropriate EPA-approved methods that are presented in the QAPP (Attachment 1). The water quality parameters, temperature, pH and specific conductance, will be measured in the field, and recorded in the field book for reporting with the analytical parameter

2.3.5 Data Evaluation and Reporting Procedures

The execution of the groundwater monitoring program will require the review and assessment of groundwater monitoring results and trends. Review and assessment activities will be conducted to identify anomalous data and to initiate proper actions. Initially, all data will be validated by reviewing the data and accepting or rejecting it based on sound criteria. Records of all data will be maintained, even those judged to be suspect. The data will be validated by reviewing the following activities:

- Field notebooks and checklists;
- Chain-of-custody records;
- Replicate sample results;
- Trip blank and field blank results;
- Laboratory QA/QC samples; and
- Previously collected analytical data (historical review).

The data will then be formatted into tabular displays, to include water level measurements, measured field parameters, and analytical results. A groundwater potentiometric surface map will also be prepared for each monitoring event. Analytical data from each groundwater monitoring well will be evaluated by conducting a trend analysis using the Mann-Kendal Statistical Test. A trend analysis will be performed annually and included in the annual groundwater monitoring report, beginning with the annual report for 2005 (a minimum of eight (8) sampling events are required to conduct the trend analysis).

Using this test, the null hypotheses of no trend present is accepted if S is a positive, negative, or zero value and the tabular probability value P is greater than the assigned α of 0.01. If the tabular probability value is less than the assigned α of 0.01 and S is a positive value, then the alternate hypothesis of an upward trend is accepted. The alternate hypothesis of a downward trend is accepted when S is negative and the tabular probability value is less than the assigned α of 0.01. The tabular probability value is from a table of values developed by Kendall that gives probability values for the

calculated Mann-Kendall statistic, *S*, for different values of n where n is equal to the number of data points used in the test.

The term "statistical significance" for trend is utilized in the output for the Mann-Kendall test. Statistical decisions about a population can be made on the basis of sample information. In attempting to reach a decision, assumptions about the populations involved, called statistical hypotheses, are made. In general these assumptions are statements about the probability distributions of the populations. A procedure which allows the determination of whether to accept or to reject a hypothesis is called test of significance. The maximum probability (α) of a hypothesis being rejected when it should have been accepted (referred to as a Type 1 error) is called the level of significance. A level of significance of 0.05 or 0.01 is typically utilized for statistical evaluations. A 0.01 or 1% level of significance indicates that there is approximately one chance in 100 that a type 1 error has occurred. In other words, there is a 99% probability that the correct decision has been made.

If statistically significant increasing trends are indicated for any of the parameters in any of the monitoring wells, then one or more of the following remedial actions will be taken:

- The data validity will be checked,
- The increasing trend will be verified by additional sampling and analysis,
- The contaminant transport model prepared or conducted for the CMS will be recalibrated and rerun to confirm model results, or
- Other appropriate actions will be conducted.

Any proposed action will be discussed with the ODEQ prior to implementation.

An annual report will be prepared and submitted to the ODEQ by March 1 of each year. The report will include a summary of all of the post-closure monitoring data collected for the prior year.

3.0 MAINTENANCE INSPECTIONS

This section discusses the inspections that will be performed during post-closure activities along with the inspection frequencies. Attachment 4 is a training plan for HC personnel that may be performing inspections and maintenance. The items that will require inspection during the post-closure period include:

- Monitoring wells
- Storm water drainage structures
- Utility structures
- Fencing
- Paved areas
- Portland cement concrete structures
- Railroads
- Soil cover system
- Landscaped areas

All inspection items are included in the maintenance inspection forms provided in Attachment 5 and are discussed below.

Certain inspections will be performed after each heavy storm event for a period of one year. For the purposes of this Plan, a heavy storm event is defined as one in which 1.0 inch or greater of rainfall occurs over a 24-hour period or less.

If, during the first year there is no evidence of erosion, washouts or subsidence, the frequency of inspections may be reduced at the discretion of HC, but to no less frequently than annually.

3.1 Monitoring Well Inspections

Active monitoring wells are clearly marked and accessible. For post-closure monitoring, the Facility will maintain six wells as shown on Figure 2-2. These wells are protected from surface water intrusion. The components of the surface protection system include surface protective well pad and an outer protective casing with a locking cap.

Inspection of the active monitoring wells will be performed during sampling events and during the annual Facility-wide inspection.

3.2 Storm Water Drainage Structures

All storm water runoff from capped surfaces is eventually routed off-site. Conveyance structures include gravity flow using vegetated swales, concrete gutters and channels, and a central subsurface 54-inch diameter HDPE drainage pipe. All drainage structures will be visually inspected during a site walk for sediment and debris after heavy storm events as defined in Section 3.0.

All subgrade drain inlets and outlets shall be visually inspected at least semi-annually. The inspections will consist of viewing the inlets and outlets to determine that they are free from debris or other impediments that could block the flow of drainage.

3.3 Utility Structures

Poles and sleepers supporting the overhead utility service and concrete foundations associated with the UIC system penetrate the soil cover system. Soil shrinkage around utility poles, sleepers, and adjacent to foundations will generally be self-healing but should be inspected annually to ensure that a large space between the structures and soil cover system does not develop.

3.4 Fencing

Fencing will be inspected on a semi-annual basis to identify any damage which could occur as a result of vandalism, mowing equipment, or other causes.

3.5 Paved Areas

Paved areas (including roads) located within the Facility are constructed of an asphaltic concrete paving and will be inspected annually for aging, cracking, rutting, corrugating, and shoving.

3.6 Portland Cement Concrete Structures

Headwalls, retaining walls, v-gutters and u-channels located within the Facility are constructed of Portland cement concrete and will be inspected annually for joint and concrete distress.

3.7 Railroads

The railroad tracks and ballast at the Facility are constructed on an asphaltic concrete underlayment. The railroad bed shall be inspected annually for track distress, deflection and misalignment, and for ballast displacement. Switch and frog systems will also be inspected for proper operational condition and wear.

3.8 Soil and Vegetative Cover System

The soil cover system has a permanent vegetative cover. The function of the vegetative cover is to provide protection against wind and water erosion of the soil cover. Inspection practices will be used to maintain the soil cover system in year one and thereafter as follows:

- Vegetated areas will be inspected for bare spots, washouts, and healthy growth after heavy storm events for the first year and annually thereafter.
- All drainage berms and earthen channels will be inspected after heavy storm events for the first year and annually thereafter.

3.9 Landscaped Areas (trees/shrubs)

The landscaped areas contain several varieties of trees and shrubs. Trees and shrubs should be inspected monthly during the first growing season to maintain healthy growth, proper moisture level, and to prevent damage from intrusive plants and insects. Thereafter, an annual inspection in the spring will be performed.

4.0 MAINTENANCE ACTIVITIES

This section discusses the maintenance that will be performed in conjunction with the inspections discussed in the previous section to ensure that the corrective measures remain intact. Routine maintenance activities will include the following items.

4.1 Post-Storm Maintenance for Caps and Covers

If there is evidence of erosion, washouts or subsidence of the caps or covers, steps will be taken to repair the damage caused by the storm event.

4.2 Monitoring Well Maintenance

Monitoring wells that are found to be damaged during inspection will be repaired prior to the next scheduled sampling event.

4.3 Storm Water Drainage Structure Maintenance

Sediment and debris removal is the primary maintenance item for the storm water drainage structures. Any significant sediment or debris accumulations noted during the inspection of the structures will be removed and appropriately disposed. All subgrade drains will be cleaned as required to maintain proper operating conditions. Drain openings shall be adequately screened and protected to prevent entry of varmints. Cracking or displacement of concrete structures will be repaired since such damage compromises performance.

Riprap has been placed at the outlet of the earthen channel that drains the Class II Area. The function of the riprap is to protect the channel against erosion. Riprap that has washed or slid out of place will be recovered and the affected area reconstructed with specified rip-rap materials. The filter fabric underlying the rip-rap will also be replaced as needed.

4.4 Maintenance Around Structures

Spacing gaps of 2 inches or greater around poles and sleepers supporting the overhead utility service or the concrete foundations associated with the UIC system, will be filled in with clean soil to limit erosion and infiltration.

4.5 Fencing Maintenance

Any fence or security gate damage will be repaired immediately upon detection to maintain security.

4.6 Paved Area Maintenance

Paved areas (including roads) located within the Facility are constructed of an asphaltic concrete paving and will be maintained for aging, cracking, rutting, corrugating, and shoving. Distressed areas will be repaired as soon as possible to reduce further deterioration and maintain pavement serviceability. Maintenance will be completed within 90 days of discovery, weather permitting.

Joint and crack treatment will be performed to prevent potential subgrade damage and progressive pavement failure. All pavement openings will be sealed or filled with a high quality crack treatment material specifically designed for the intended application, and in accordance with the manufacturer's recommendation. Crack opening sizes, potential movements, edge deterioration and frequency of occurrence will determine the method of repair.

Additionally, surface treatments, to reduce the effects of asphalt aging will be performed at least every five years to maintain the life expectancy of the pavement. Surface treatments may also be required in areas where frequent cracking is present. Numerous crack sealing, surface sealing, and distress patching materials and procedures are available, and a competent paving contractor will be consulted for the appropriate materials and methods for repair. All sealing, filling and surface treatment activities shall be performed using a high quality material suitable for the application and installed in accordance with the manufacturer's recommendation.

Pavement distress resulting from excessive deflection shall be repaired by deep patching the affected area to the depth required for adequate subgrade support. All distressed areas will be repaired as soon as practicable after discovery to reduce progressive failures. Replacement, overlaying and patching of paving will be performed

in accordance with Specification Section 02513 - Asphaltic Concrete Paving, of the Construction Document and The Asphalt Institute's publication, MS-16-Asphalt in Pavement Maintenance.

4.7 Portland Cement Concrete Structure Maintenance

Headwalls, retaining walls, v-gutters and u-channels located within the Facility are constructed of Portland cement concrete. Distressed areas will be repaired as soon as possible to reduce further deterioration. Maintenance will be completed within 90 days of discovery.

Joint and crack sealing will be performed to prevent potential subgrade damage and progressive failure of the surfacing. Cracks will be sealed as soon as practicable after they have developed. Joints shall be resealed as necessary. All sealing activities shall be performed using a high quality joint sealing material suitable for the application and installed in accordance with the manufacturer's recommendation.

4.8 Railroad Maintenance

The railroad tracks and ballast at the Facility are constructed on an asphaltic concrete underlayment. All deficiencies noted during inspection will be repaired as soon as possible to reduce further deterioration. Maintenance will be completed within 90 days of discovery.

4.9 Soil and Vegetative Cover System Maintenance

The soil cover system has a permanent vegetative cover. The function of the vegetative cover is to provide protection against wind and water erosion of the soil cover. The following maintenance and inspection practices will be used to maintain the soil cover system in year one and thereafter:

- Vegetated areas found to have bare spots greater than approximately two feet across will be replanted.
- Sediment will be removed from v-gutters and swales as required to maintain proper drainage and appropriately disposed.

Maintenance will be completed within 90 days of discovery.

4.9.1 Mowing

Mowing will be performed on the following schedule: First mowing between May 1 and June 1, second mowing between July 1 and August 1, and third mowing between September 1 and October 1; however, no mowing will be allowed during wet conditions or when surface conditions are sufficiently wet to damage cover. A minimum cutting height of 2.5 inches is recommended during the summer months. At least three cuttings per year is recommended to prevent buildup of dry matter. Mowing will not be performed when the soil is wet, to avoid rutting of the cover soils.

4.9.2 Re-establishment of Vegetative Cover

Soil replacement and re-vegetation will be required in areas where erosion has occurred. Areas where the vegetative cover has been damaged or destroyed, such as by vehicular traffic, drought, mowing equipment, etc., will also require revegetation. Areas with erosion at depths of 2 inches or greater for distances of 3 feet or greater and bare spots that are 25 ft^2 or larger in surface area will require soil replacement and/or re-vegetation. Maintenance will be completed within 90 days of discovery.

Revegetation will be established by hydroseeding with Bermuda grass seed, sprigging, or sodding, as appropriate to the area being revegetated. Specifications for revegetation are covered in Specification Section 02931 – Revegetation, of the Construction Documents. If used, herbicides should be applied in a manner consistent with the manufacturer's instructions.

4.9.3 Intrusive Plants

Excessive intrusive plant growth in the Bermuda grass is undesirable and should be controlled until a vigorous stand of grass is established. Once a vigorous stand of grass is established, no weed control measures are anticipated to be necessary.

Control measures will be implemented during the first two growing seasons as needed depending on the degree and variety of plant intrusion.

4.9.4 Erosion

Erosion of the soil cover system may occur by wind or rain. Inspections will determine if wind or rain has eroded the cover system significantly. Areas with erosion at depths of 2 inches or greater for distances of 3 feet or greater and bare spots that are 25 ft^2 or larger in surface area will require soil replacement and/or re-vegetation.

In the event that erosion occurs, the severity of the erosion will be assessed and steps taken to fill in eroded areas and re-establish vegetation. Maintenance will be completed within 90 days of discovery.

4.9.5 Burrowing Animals

If extensive damage to the vegetative cover from burrowing animals is observed, it may be necessary to implement an eradication or control program. Grub control is the most effective means of preventing mole intrusions. Pesticide granules or liquids applied in late August per the manufacturer's recommendations should be effective in controlling grubs.

4.9.6 Subsidence

There is minor tolerance for subsidence due to the slight grades of the drainage structures. The cover system will be inspected for ponding or evidence of subsidence and areas where water is ponded for depths of 2 inches or greater as the result of subsidence will require maintenance. Fill material will be placed in areas where subsidence interferes with proper drainage of the cover system. Revegetation of fill areas will also be required. Maintenance will be completed within 90 days of discovery.

4.10 Landscaped Areas (trees/shrubs) Maintenance

Decaying root systems from dying or dead trees and shrubs can affect the performance of the cover and slopes. Therefore, early detection and proper treatment of potentially dying or distressed plants is required for long-term performance of the cover system. . Dead shrubs and trees will be replaced according to a schedule recommended by the local OSU County Extension Service.

5.0 POST-CLOSURE NOTICES

No later than 60 days after certification of closure of each hazardous waste disposal unit, the owner or operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the ODEQ a record of the type, location, and quantity of hazardous wastes disposed of within each cell or other disposal unit of the facility. The owner or operator must identify the type, location, and quantity of the hazardous wastes to the best of his knowledge and in accordance with any records he has kept.

Within 60 days of certification of closure of the first hazardous waste disposal unit and within 60 days of certification of closure of the last hazardous waste disposal unit, the owner or operator must:

(1) Record, in accordance with State law, a notation on the deed to the facility property—or on some other instrument which is normally examined during title search—that will in perpetuity notify any potential purchaser of the property that:
   (i) The land has been used to manage hazardous wastes; and
   (ii) Its use is restricted under 40 CFR 264 subpart G regulations; specifically that post-closure use of the property must never be allowed to disturb the integrity of the final cover or any other component of the containment system, or the function of the facility's monitoring systems, unless the ODEQ finds (1) that it is necessary to the proposed use of the property, and will not increase the potential hazard to human health and the environment; or (2) is necessary to reduce a threat to human health or the environment; and
   (iii) The survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each cell or other hazardous waste disposal unit of the facility required by §§264.116 and 264.119(a) have been filed with the local zoning authority or the authority with jurisdiction over local land use and with the Regional Administrator (Oklahoma regulations allow filing with the ODEQ Director); and

(2) Submit a certification, signed by the owner or operator, that he has recorded the notation on the deed, including a copy of the document in which the notation has been placed, to the ODEQ.

The post-closure notices will be prepared and submitted as stated above. Upon submittal, copies of the notices will be inserted herein as Attachment 6, and thereby incorporated into this Post-Closure Plan. Portions of the Class II Area may be

industrially developed at a future date, subject to the limitations and requirements of 40 CFR 264, Subpart G. All information or plans to this effect will be submitted to ODEQ in advance, discussed with the ODEQ, and the approval of ODEQ obtained. Such information or plans may also be placed in the post-closure notice.

6.0 POST-CLOSURE CERTIFICATION

No later than 60 days after completion of the established post-closure care period for each hazardous waste disposal unit, the owner or operator must submit to the ODEQ, by registered mail, a certification that the post-closure care period for the hazardous waste disposal unit was performed in accordance with the specifications in the approved post-closure plan. The certification must be signed by the owner or operator and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the ODEQ upon request until it releases the owner or operator from the financial assurance requirements for post-closure care under §264.145(i).

The post-closure certification will be prepared and submitted as stated above.

7.0 POST-CLOSURE COST ESTIMATE

According to 40 CFR 264.117(a), post-closure care begins after completion of each unit and must continue for 30 years unless a shorter period is approved by ODEQ. The post-closure cost estimate must include the annual costs multiplied by the number of years of post-closure costs and the sum of the periodic costs. (40 CFR 264.144 and OSWER Policy Directive #9476.00-6)

The total post-closure cost estimate is $2,045,739. This cost includes 5 years of groundwater monitoring and 30 years of inspection and maintenance of all other structures discussed in this Plan. A breakdown of the post-closure costs is included in Attachment 7.

8.0 REFERENCES

EPA, 1988. Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy, PB95-169603, June 1988.

RSA 1996b. RCRA Facility Investigation (RFI) Phase I Report, Zinc Corporation of America, Bartlesville, Oklahoma, February 28, 1996.

RSA, 1997. Corrective Measures Study (CMS) Report and Summary, Zinc Corporation of America, Bartlesville, Oklahoma, March 7, 1997.

TABLES

Table 1: Post-Closure Inspection and Maintenance Schedule
Horsehead Corp.
Bartlesville, Oklahoma Facility

Inspection Areas[1]	Annual	Semi-Annual	Monthly	After Heavy Storm Events	Maintenance Completion Timeframe[3]
3.1 Groundwater Monitoring Well System	X[2]				90 days
3.2 Stormwater Drainage Structures					
Vegetated Swales				X	90 days
Concrete Gutters				X	90 days
Concrete Channels				X	90 days
Central Drainage Pipe				X	90 days
Subsurface Drains - Inlets and Outlets		X			90 days
3.3 Utility Structures	X				90 days
3.4 Fencing and Security Gate		X			Immediately
3.5 Paved Areas (asphaltic concrete; includes roads)	X				90 days
3.6 Portland Cement Concrete Structures					
Headwalls	X				90 days
Retaining Walls	X				90 days
V-Gutters	X				90 days
U-Channels	X				90 days
3.7 Railroads	X				90 days
3.8 Soil and Vegetative Cover System	X (Spring)			X (1st yr)	90 days
3.9 Landscaped Areas	X (Spring)		X (1st yr)		Per OSU County Extension Schedule

Notes:

1. Item numbers correspond to Post-Closure Plan Section 3.0
2. Inspections will also be performed during groundwater sampling.
3. The following contact will be in charge of all inspection and maintenance activities at the Facility:

   Horsehead Corp. Post-Closure Inspector
   P.O. Box 579
   Bartlesville, OK 74005-0579
   (918) 336-7100

FIGURES

CORRECTIVE MEASURES STUDY
SOIL AND WASTE CLASS LOCATIONS

CLASS DESCRIPTIONS:

NORTHEAST AREA: BUFFER ZONE BETWEEN RESIDENTIAL AND INDUSTRIAL AREAS (PREVIOUSLY INCLUDED IN CLASS I AREA)

CLASS I: AREAS BELOW CORRECTIVE ACTION LEVELS

CLASS II: ACTIVE INDUSTRIAL AREAS EXCEEDING CORRECTIVE ACTION LEVELS.

CLASS III: NON-ACTIVE AREAS EXCEEDING CORRECTIVE ACTION LEVELS - WITH EXISTING VEGETATIVE COVER

CLASS IV: NON-ACTIVE AREAS EXCEEDING CORRECTIVE ACTION LEVELS - WITH EXPOSED MATERIALS

HILL STEEL

RAILROAD RIGHT OF WAY

BENHAM
infrastructure & environment

The Benham Companies, LLC
infrastructure & environment
3700 W. Robinson, Suite 200
Norman, Oklahoma 73072
(405) 321-3895
www.benham.com

FIGURE TITLE	MAP OF SOILS AND WASTE, FACILITY-WIDE CLASS LOCATIONS
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
1-1

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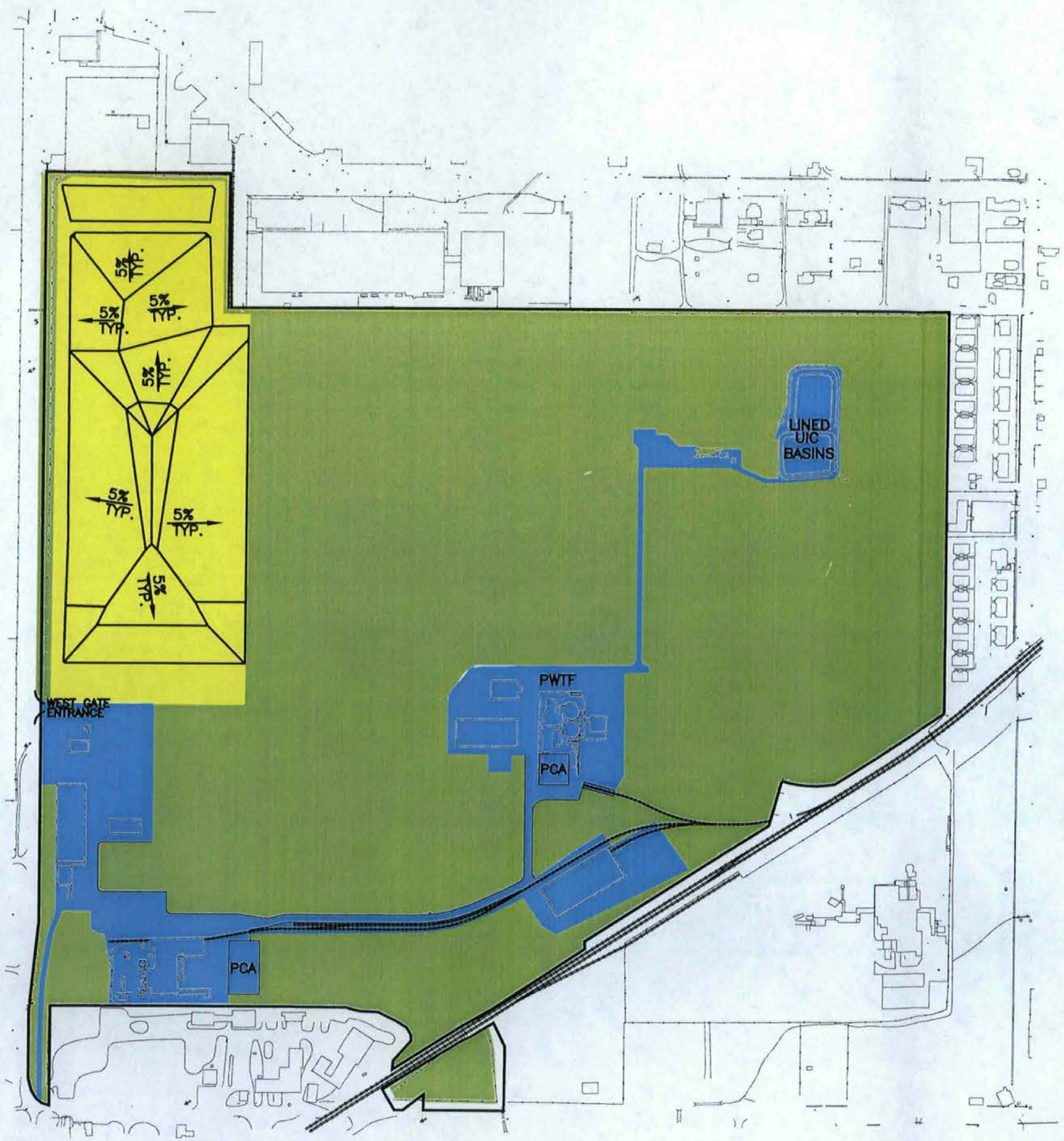


N

LEGEND

- FACILITY BOUNDARY AND CHAIN-LINK FENCE
- AREA CONTAINING WASTE PILE AND SURFACE IMPOUNDMENT SEDIMENTS, SOLIDIFIED AS NEEDED, AND COVERED WITH A MULTIMEDIA CAP.
- AREA COVERED WITH SOIL AND VEGETATION.
- ACTIVE AREAS: BUILDINGS, PWTF, PCAS, UIC BASINS, AND ASPHALT/CONCRETE SURFACING

400' 0 400' 800'
SCALE FEET
1" = 400'

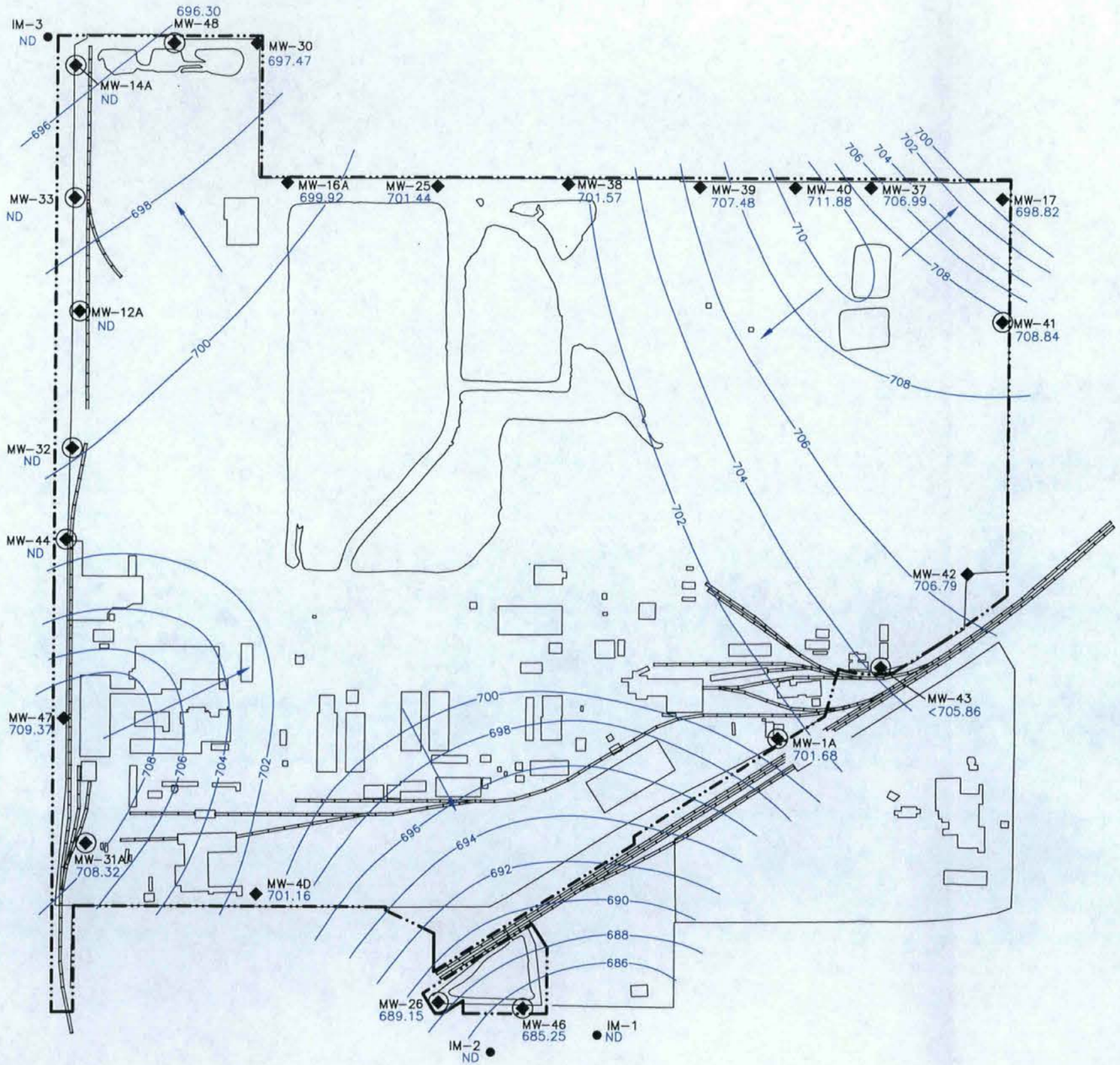
BENHAM
The Benham Companies, LLC
infrastructure & environment
3700 W. Robinson, Suite 200
Norman, Oklahoma 73072
(405) 321-3895
www.benham.com

FIGURE TITLE	*CLOSED FACILITY*
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER
9750701
FIGURE NUMBER
1-2

P:\NRM\1997\97507\97507\cad\1-2.dwg on Jun 27, 2005-3:54pm



LEGEND

MW-17 ◆ 698.82 — RCRA MONITOR WELL LOCATION (UNCONSOLIDATED MATERIAL) AND GROUNDWATER TABLE ELEVATION, FEET AMSL, 6/28/00

IM-1 ● — INTERIM MEASURES MONITOR WELL (UNCONSOLIDATED MATERIAL)

708 — CONTOUR OF GROUNDWATER TABLE ELEVATION IN UNCONSOLIDATED MATERIAL, FEET AMSL, 6/28/00

CONTOUR INTERVAL: 2 FEET

DIRECTION OF GROUNDWATER FLOW

ND — NO DATA COLLECTED

WELL DAMAGED OR ABANDONED DURING CORRECTIVE ACTION

N

400' 0 400' 800'

SCALE FEET

1" = 400'

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Norman, Oklahoma 73072
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FIGURE TITLE	GROUNDWATER TABLE ELEVATION (UNCONSOLIDATED MATERIAL), 6/28/00
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OK

DATE	10/29/2004
SCALE	1" = 400'
DESIGNED BY	
APPROVED BY	
DRAWN BY	

PROJECT NUMBER

9750701

FIGURE NUMBER

2-1

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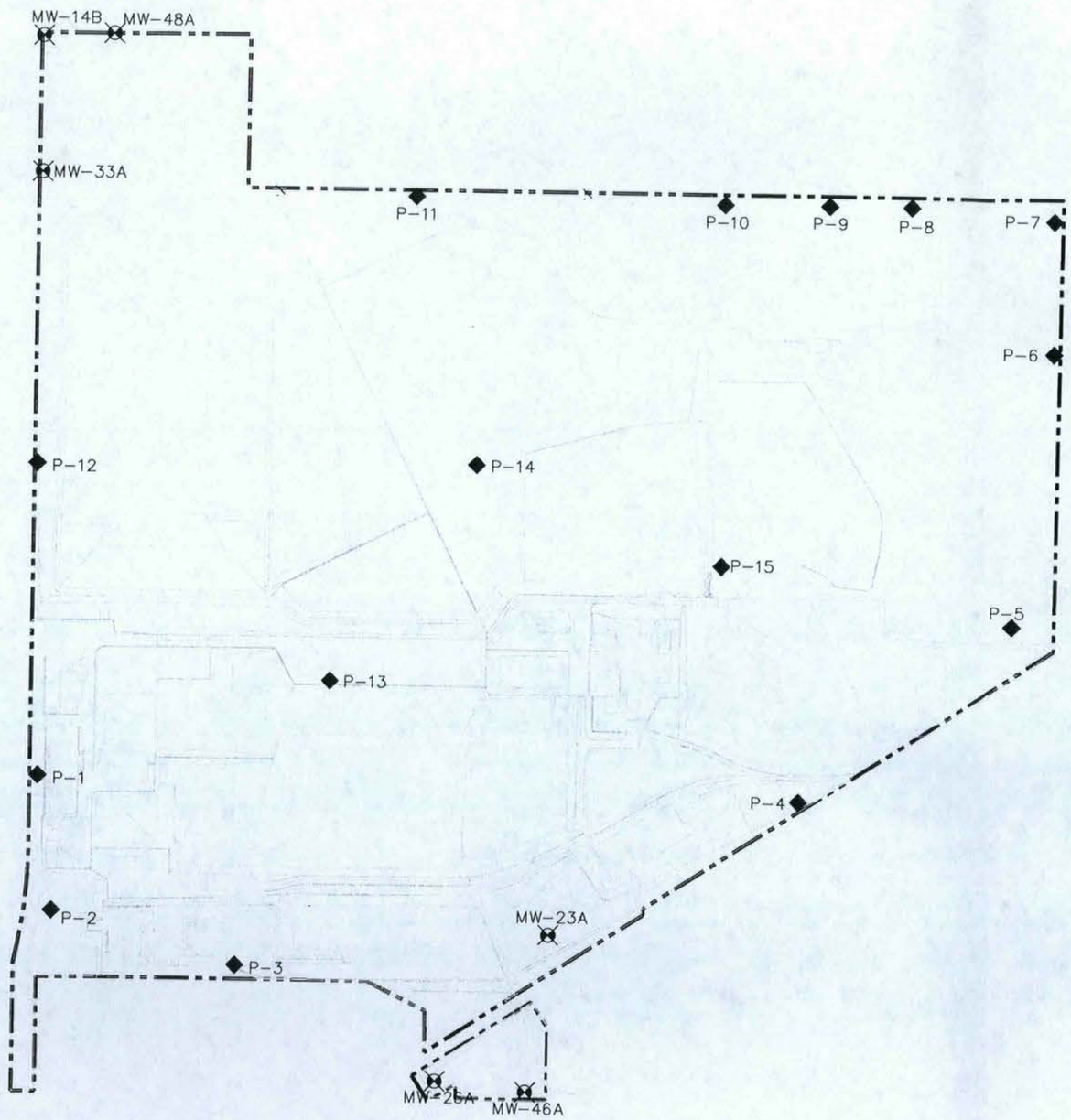

LEGEND

MW-32A	POST CLOSURE GROUNDWATER MONITORING WELL
P-1	POST CLOSURE TEMPORARY PIEZOMETER
	GRADE BREAKLINE
	PROPERTY LINE

-N-

400' 0 400' 800'
SCALE FEET

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FIGURE TITLE	RCRA POST CLOSURE PERMIT GROUNDWATER MONITORING WELL NETWORK AND TEMPORARY PIEZOMETERS
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OKLAHOMA

DATE	10/29/2004
SCALE	AS SHOWN
DESIGNED BY	JL
APPROVED BY	JL
DRAWN BY	LJ

PROJECT NUMBER
9750701 M15

FIGURE NUMBER
2-2

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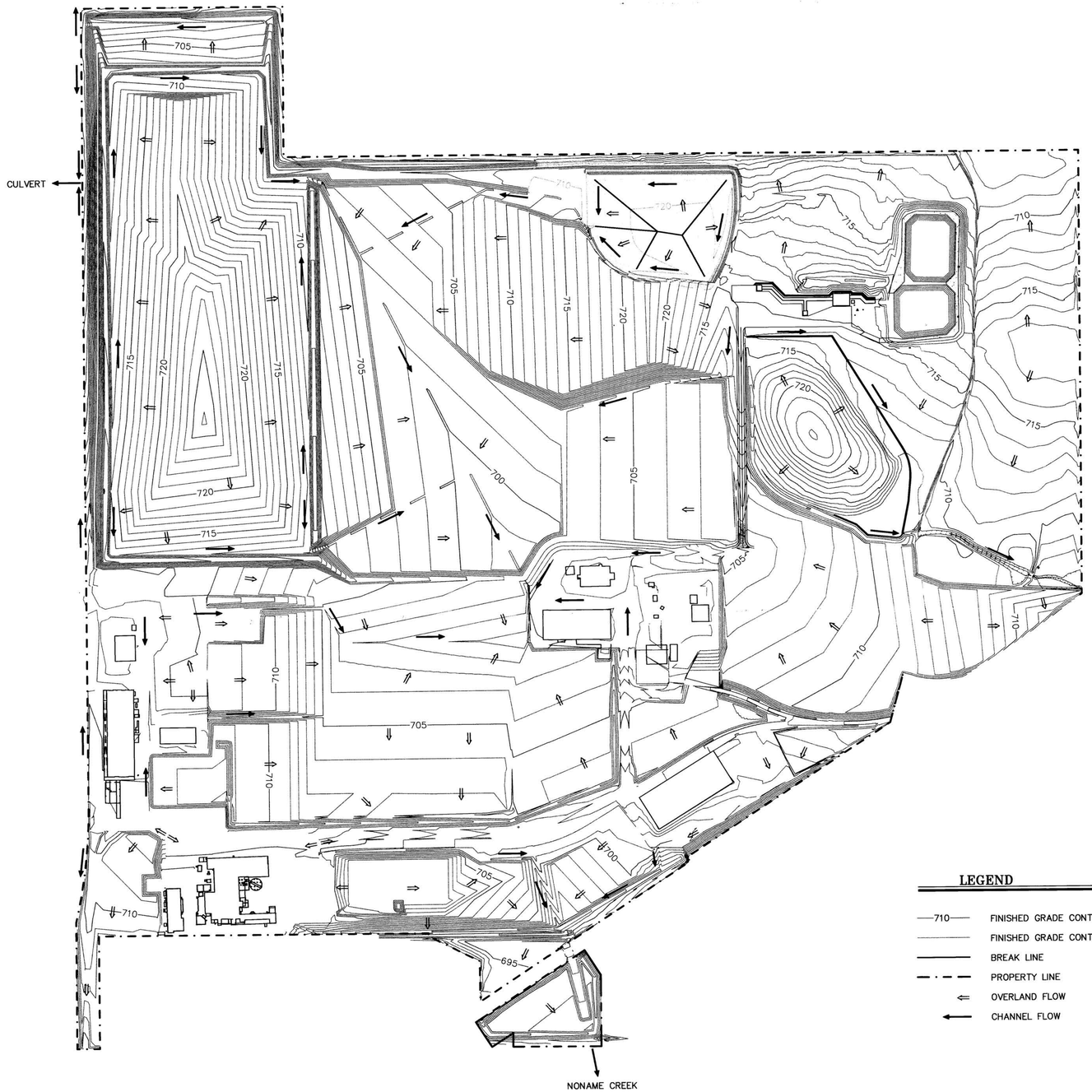
DRAWINGS



LEGEND

—710—	FINISHED GRADE CONTOUR (5' INTERVAL)
———	FINISHED GRADE CONTOUR (1' INTERVAL)
———	BREAK LINE
—·—·—	PROPERTY LINE
⇐	OVERLAND FLOW
←	CHANNEL FLOW

175 0 175 350
SCALE FEET
1" = 175

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NO.	DATE	DESCRIPTION OF REVISION OR ISSUE	BY	APP'D

OKLAHOMA CERTIFICATE OF AUTHORIZATION NO. 3722

FIGURE TITLE	*AS-DESIGNED DRAINAGE MAP*
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OKLAHOMA

DESIGNED BY	JRC
APPROVED BY	BT
DRAWN BY	JRC

DATE	10/29/2004
SCALE	AS SHOWN
PROJECT NUMBER	9750701
DRAWING	1-1
REV	
1 OF 1	

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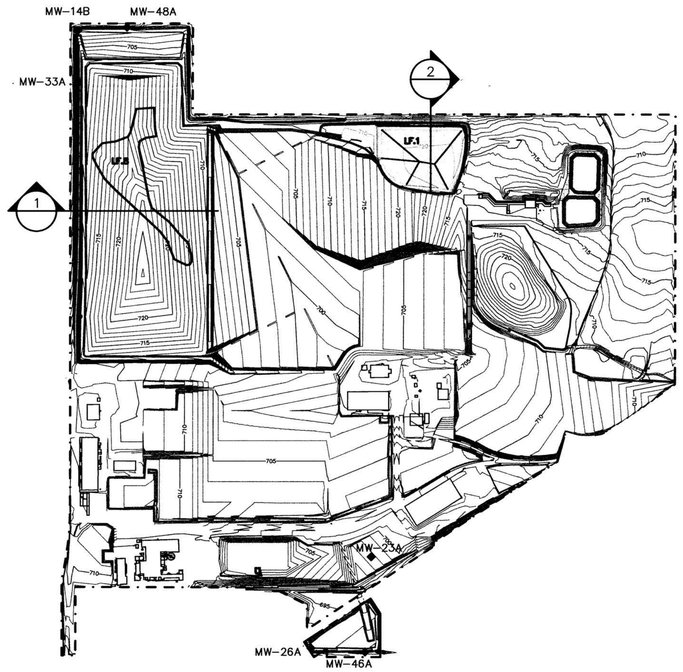
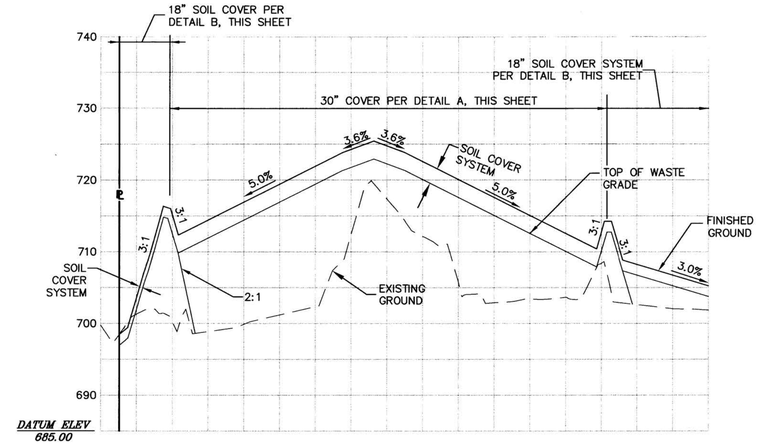


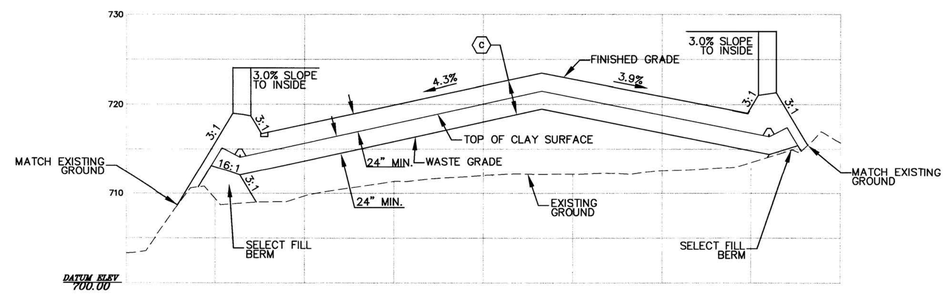
ZCA PLAN VIEW

SCALE: 1"=350'



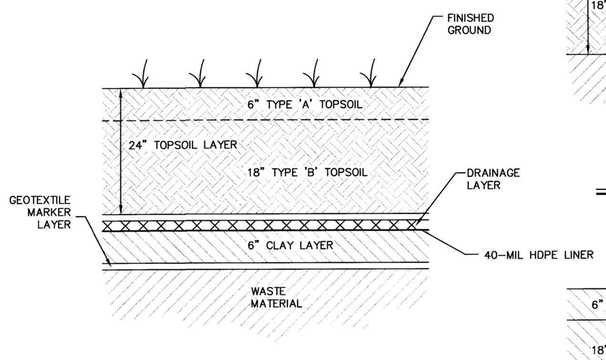
1 SECTION

SCALE: HORIZONTAL 1"=100'
VERTICAL: 1"=10'

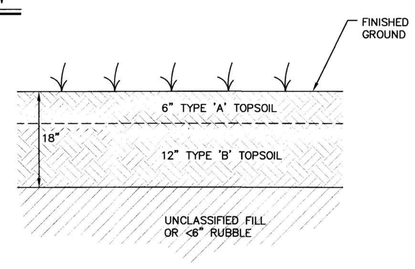


2 TYPICAL SECTION

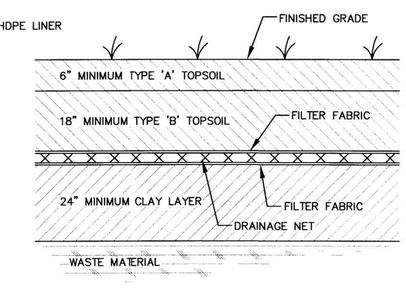
SCALE: HORIZONTAL 1"=40'
VERTICAL 1"=8'



MULTIMEDIA COVER SYSTEM (A)



18" SOIL COVER SYSTEM (B)



SOIL COVER SYSTEM (C)

LEGEND

- FINISHED GRADE CONTOUR (5' INTERVAL)
- FINISHED GRADE CONTOUR (1' INTERVAL)
- BREAKLINE
- PROPERTY LINE
- LANDFILL BOUNDARY

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OKLAHOMA CERTIFICATE OF AUTHORIZATION NO. 3722

FIGURE TITLE	LANDFILL DETAIL SHEET
DOCUMENT TITLE	POST-CLOSURE PLAN
CLIENT	HORSEHEAD CORP.
LOCATION	BARTLESVILLE, OKLAHOMA

DESIGNED BY	JRC
APPROVED BY	BT
DRAWN BY	JRC
DATE	04/10/2003
SCALE	AS SHOWN
PROJECT NUMBER	9750701
DRAWING	1-2
REV	
1 OF 1	

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ATTACHMENT 1

QUALITY ASSURANCE PROJECT PLAN

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ATTACHMENT 1
QUALITY ASSURANCE PROJECT PLAN
HORSEHEAD CORP.
BARTLESVILLE, OKLAHOMA FACILITY
Revised, October 29, 2004

1.0 INTRODUCTION

This quality assurance project plan (QAPP) presents the necessary activities, organization, and quality assurance/quality control (QA/QC) to ensure that the quality and quantity of the field and analytical data are sufficient for this project. This plan pertains to environmental sampling, testing, and data review activities.

2.0 KEY PERSONNEL

The key personnel that are necessary for implementing each activity during the Post Closure Monitoring, along with their responsibilities, are defined in this section.

HC Project Manager - The HC contact and project manager for this project is Mr. Tom Johnston. Mr. Johnston will be responsible for ensuring that the work adheres to the approved Post-Closure Plan. He will also represent HC in meetings with Oklahoma Department of Environmental Quality (ODEQ) and The Benham Companies, LLC, (Benham) and provide overall management for the work to be performed. The primary mode of communication will be through telephone conversations, U.S. mail, fax, personal communication, and progress meetings.

Benham Senior Project Manager - The Benham Senior Project Manager for this project is Mr. Jack Lawmaster. Mr. Lawmaster will be responsible for the overall management of all work performed under contract with HC. Mr. Lawmaster will be available to the project throughout the duration of this contract. He will be responsible for negotiating and communicating contractual obligations, including program objectives, technical requirements, schedules, budgets, and deliverables. He will coordinate all administrative, progress, and financial reporting, and will review all deliverables.

Benham Site Manager - The Benham Site Manager for this project is Mr. Bert Smith. Mr. Smith will be responsible for the day-to-day management and coordination of the sample program and will supervise all field activities. Mr. Smith will be responsible for ensuring that all applicable field procedures are implemented properly.

Benham Health and Safety Officer - The Health and Safety Officer (HSO) for this project will be Mr. Steve Lowery. Mr. Lowery is a Certified Industrial Hygienist and will oversee the development and implementation of the Health and Safety Plan (HSP). He will also oversee implementation of the Health and Safety Plan in compliance with OSHA Standard 29 CFR 1910.120, 29 CFR 1926, and applicable sections of 49 CFR Transportation requirements.

Benham Quality Assurance/Quality Control (QA/QC) Coordinator - Ms. Debby McElreath will be the Quality Assurance/Quality Control Coordinator for this project and will assist the Benham Senior Project Manager and Benham Site Manager in ensuring that quality work is accomplished on schedule. Ms. McElreath will be responsible for the following:

- Directing the overall QA/QC program,
- Maintaining QA oversight,
- Reviewing QA sections in reports,
- Reviewing applicable procedures,
- Conducting audits or surveillances of selected activities,
- Initiating, reviewing, and implementing corrective actions as necessary,
- Overseeing quality control of sampling, sample handling, sample custody, and field testing,
- Coordinating the QA/QC of the analytical laboratory,
- Assuring the required submittals are on time and of acceptable quality.

Benham Field Technician/Sample Custodian - Mr. Stan Marshall and/or Mr. Jack WieSel will be the field technicians/sample custodians for this project. They will be responsible for the collection of samples as overseen by the Benham Site Manager. Specific responsibilities include:

- Ensuring that project personnel have and use the appropriate sample identification and custody records.
- Overseeing sample preparation, handling, and storage requirements.
- Arranging for prompt shipment of samples to the analytical laboratory.
- Notifying the laboratory QA/QC Coordinator of sample shipment.
- Maintaining all appropriate documentation of sampling activities.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 Approach

The goal of the environmental data collection is to produce data capable of withstanding scientific scrutiny and of a quality appropriate for a specific task. This will allow HC to fully assess the impact of past activities and identify, quantify and delineate the extent of impact at each site.

Data quality objectives (DQOs) are qualitative and quantitative criteria used to guide sample collection and analysis activities. The DQOs help ensure that data of appropriate quality are generated to support the anticipated end use of the data.

Practical quantitation limits (PQLs) will be used by the laboratory in reporting the data. The PQLs for each constituent are provided on Table QAPP-1.

3.2 DQO Development Process

Data quality generally refers to the level of uncertainty associated with a data set. DQOs for each task will reflect the amount of uncertainty in the data that will be acceptable to meet the goals of the project and the objectives of the task. The DQOs for the project will be Level III.

Level III analysis performed at a permanent laboratory remote to the site sampling will be utilized during the site investigations. Data will consist of laboratory analyses of water and soil samples. The analyses to be performed are presented in the Work Plan and will be used to determine the presence of specific compounds and parameters at specific sites.

Precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters are the indicators of data quality. Each of these parameters is defined as follows:

Precision: Precision is a measurement of the reproducibility of a measurement under a given set of conditions. The closer the numerical values of the measurements, the more precise is the overall measurement. Precision will be stated in terms of the standard deviation for three or more measurements of the percent differences for two measurements, depending on the necessary precision of a particular study. Laboratory precision will be within established control limits for a particular analytical method, if known. For chemical analyses, laboratory precision will be assessed using laboratory-spiked samples.

Accuracy: Accuracy is defined as the degree of agreement between the measurement and average of measurements for a parameter and the accepted reference or true value. It will be expressed as the difference between the measured value (X) and the reference or true value (T), the difference in percent between two values, 100(X-T)/T, or a ratio of the two values, X/T. Laboratory accuracy will be within established control limits for a particular method when known. For chemical analyses, laboratory accuracy will be assessed using laboratory-spiked samples.

Representativeness: Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter

variations at a sampling point, a process condition or an environmental condition. Accurate sample collection requires that samples be undisturbed and representative of the native substance being sampled. All measurements will be made so that the results are accurately representative of the media (soil, water) and specific time, place and conditions being measured. Representativeness will be ensured by systematic, documented, and (when possible) random sampling designs.

Completeness: Completeness is defined as a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected under correct normal conditions. Field sampling conditions are unpredictable and non-uniform. Other problems affecting field completeness will be equipment/instrument malfunctions and problems with sample recovery. These problems will be reduced by having trained field personnel who can perform basic equipment repairs on-site. The overall completeness goal for all sampling efforts for each site is 80%. This means that at least 80% of all samples requested and documented in the Work Plan must be collected.

Analytical completeness is affected if a sample is not analyzed before its holding time is expired; if it is damaged during handling, shipping, unpacking, or storage; or if the laboratory data cannot be validated and the sample cannot be reanalyzed. The overall completeness goal for the analytical portion of the investigation is 85%. This means that at least 85% of all requested analytes must be completed and compliant with the method requirements.

Comparability: Data comparability expresses the confidence factor by which one data set can be compared to another. All data will be calculated and reported in units consistent with all the sites involved and the regulatory standards allowing for comparability of databases within the project.

Numerical precision, accuracy and completeness goals have been established for the data associated with Level III sampling as follows:

Precision =	20%
Accuracy =	SW-846 specified control limits for the particular analysis
Completeness =	Sampling Efforts: 80%
	Laboratory Analyses: 85%
Representativeness and comparability =	evaluated as part of the data validation process

All data will be validated using the PARCC parameters. Data that are rejected during this process will not be used.

3.3 QA/QC Sample Requirements

During the sampling, QA/QC samples will be taken in accordance with SOP-1030. These samples include trip blanks, field blanks (i.e., rinsate blanks), equipment blanks, and replicates (i.e., duplicates). A list of the number and frequency of each type of QA/QC sample is included in Table QAPP-2.

The total number of QC samples will represent approximately 10 percent of the total samples collected. Analytical data from these samples will help to identify and diagnose problems related to sampling, shipment, and analysis.

One duplicate for every ten samples will be sent to the laboratory as a blind duplicate sample (i.e., not identified as duplicate sample). This sample will allow assessment of laboratory analytical data precision and sampling variability and representativeness.

An equipment blank sample will be collected once a day during groundwater sampling. It will be collected from final rinse water following decontamination of sampling equipment in the field. Results of the rinsate blank sample will be used to evaluate the effectiveness of decontamination procedures.

4.0 SAMPLE CUSTODY

4.1 Chain-Of-Custody Requirements

The purpose of chain-of-custody (COC) procedures is to document the identity and integrity of a sample, and its handling, from its first existence as a sample. Custody records trace a sample from its collection through all transfers of custody until it is transferred to an analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition. A sample or a group of samples is considered to be in the custody of sampling, field, and laboratory personnel if it is: 1) in direct view; or 2) in direct possession; or 3) locked in a secure, restricted area.

A Sample Custodian has been designated for this project (see Section 2.0). The Sample Custodian has overall responsibility for sample custody and field document control. The Custodian will ensure the use of appropriate sample identification and custody records, and will resolve custody issues in the field, and handle the shipment of samples to the analytical laboratories.

Sample Labels - Each sample collected, including duplicates, trip blanks, and field blanks, will have a completely filled-in sample label securely attached to the sample container. Sample collection labels will be pre-printed to ensure that space for the required information is provided on each tag. Figure QAPP-1 is an example of a preprinted label. The person who physically collects the sample will initial the sample label.

Chain-of-Custody Record Sheets - Chain-of-Custody records will be used to record sample custody for this project in general accordance with SOP-1040 and the requirements discussed in this QAPP. The Chain-of-Custody forms will be filled out completely. In addition, the unique Chain-of-Custody and sample label numbers will be cross-referenced on each of these documents. Figure QAPP-2 is an example of a Chain-of-Custody record sheet. The Sampler will initiate the four-part Chain-of-Custody record to accompany each sample shipment sent from the field to the laboratory.

The Chain-of-Custody records will be used for a packaged lot of samples since more than one sample will usually be recorded on one form. The original Chain-of-Custody record travels with the samples, and the initiator of the record keeps a copy. The original Chain-of-Custody record shows each person who has been in custody of a sample or group of samples and has properly relinquished custody by signing the form.

Using a Four-Part Custody Record Sheet

- The initiator fills in all requested information from the sample labels and records the corresponding air bill number on the Chain-of-Custody form.

- The initiator signs in the top left "Relinquished by" box and keeps the copy.

- The original record sheet and first copy travels with the samples. The third and fourth copies are returned to the Benham project manager.

- The person receiving the samples checks the sample label information against the custody record. The individual also checks sample condition and notes anything unusual in the "Remarks" section on the custody form.

- The person accepting custody signs in the adjacent "Received by" box.

- The Date/Time will be the same for both signatures because custody must be transferred to another person. (When samples are shipped via common carrier {e.g., Federal Express}, the date/time may not be the same for both signatures because the common carrier will not sign the custody form.)

- When samples are shipped via common carrier, the original and first copy travel with the samples and the shipper (e.g., Field Sample Custodian) keeps the second and third copies. The shipper also keeps all shipping papers, bills of lading or other transport documentation.

- In all cases, it must be documented that the same person receiving custody has subsequently relinquished it to the next custodian.

- If samples are left unattended or a person refuses to sign, this occurrence must be documented and explained on the custody record.

Questions/Problems Concerning Custody Records - If a discrepancy between sample tag numbers and custody records listings is found, the person receiving custody should document this fact and then properly store the samples. The samples should not be analyzed until the problem is resolved by contacting Benham QA/QC Coordinator.

The responsible person receiving custody should attempt to resolve the problem by checking all available information (other markings on sample container, type of sample, etc.). The responsible party should then document the situation on the custody record, and in their project logbook, and then notify the Benham QA/QC Coordinator by the fastest available means, followed by written notification.

Changes may be written in the "Remarks" section of the Custody record and should be initialed and dated. A copy of this record should accompany the written notification to the Sample Custodian.

Custody Seals - Custody seals are narrow strips of adhesive paper used to demonstrate that no tampering has occurred as shown on Figure QAPP-1. They will be used on sample transport containers. The sample transport container will be sealed in such a manner that opening the container will break the custody seals.

Laboratory Custody Procedures - Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipping container and the individual samples. Shipping containers, custody seals, and samples will be inspected and their condition noted. Overall condition of the sample containers will be noted on the laboratory shipment documentation form. The enclosed Chain-of-Custody records will be cross-referenced with all samples in the shipment; these records will be signed by the Laboratory Sample Custodian and placed in the laboratory project file. The Laboratory Sample Custodian will continue the chain-of-custody by assigning a unique laboratory number to each sample on receipt; this number identifies the sample through all further handling.

4.2 Sample Handling and Shipment

Each sample will be identified with a sample identification tag and will be listed on the Chain-of-Custody record completed for each sample shipping container.
Sample storage and handling in the laboratory will be in accordance with laboratory requirements and will be adequate to ensure that the custody of the sample is maintained.

Specific procedures for handling, storing and shipping samples are detailed in the SAP.

4.3 Use And Maintenance Of Field Notebooks

Field notebooks and field forms will provide the means for recording all data collecting activities performed at the site. Entries will be descriptive and detailed. The procedures for use of field notebooks are included in SOP-T2.

5.0 ANALYTICAL PROCEDURES

The specific laboratory analytical methods that will be used for sample analyses are included in Tables QAPP-1. All laboratory methods for chemical analyses to be employed have been approved by the U.S. EPA or the ODEQ. Analyses will be performed by a subcontract laboratory.

6.0 LABORATORY QA/QC

QC samples are analyzed for the purpose of assessing the quality of the sampling effort and analytical data. These internal quality control checks performed by the laboratory at a minimum, will follow standard QC procedures commensurate with the level of analysis specified in the appropriate SW-846 method. Analytical data from the QC samples provided as part of the laboratory standard batch QC will be used in the data validation process.

7.0 DATA VALIDATION AND REPORTING

7.1 Data Recording And Reduction

All field measurements and observations made by field personnel will be recorded in controlled field notebooks as described in SOP-T2. Field data will be reduced to a table format, where applicable, including references to dates recorded, locations, and other pertinent information.

All laboratory analytical data will be cross-referenced to the appropriate field QC samples (i.e., trip and field blanks), background samples, and laboratory QC samples (e.g., method blanks, standards, matrix spikes) that were associated with that data.

Data and sample identification will be cross-referenced in spreadsheet fashion. In addition, all pertinent dates (i.e., dates samples were collected, received by the laboratory, extracted, and analyzed) for each sample will be referenced against the applicable holding times for each analytical method.

The field data and laboratory analytical results will be collated into a technical document that will serve to provide a record of the sampling program.

7.2 Data Validation

Validation of field data will be conducted through a qualitative evaluation of the representativeness and comparability of the data. Validity of laboratory analytical data will be determined by calculation of values for precision, accuracy, and completeness. Representativeness and comparability will also be evaluated. QC criteria listed in the analytical methods will be used to evaluate the analytical data. In addition, a guidance presented in U.S. EPA Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, (7/88) will be utilized where possible.

The analytical laboratory will be required to flag data that do not meet established QC requirements of the U.S. EPA methods used. A minimum of twenty percent of all data and associated flags will be reviewed to assess the usability of the data. The validation percentage may be increased due to poor validation results, or at the discretion of QA staff. Data rejected during the validation process will not be used; data with assigned qualifiers may be used at the discretion of the Project Manager, and valid data is usable for its intended purposes. Other items which will be considered during data validation include the following:

- Compliance with holding times.
- Field QC samples (including split, field duplicate samples, and blanks).
- Spike recoveries.

Data found to be rejected during the validation process will not be used and will be documented as to why they were found to be unacceptable.

7.2.1 Precision

Precision will be evaluated by the analysis of replicate samples and will be expressed as the relative percent difference. This attribute will be calculated as follows:

$$RPD = 100 \frac{(D_1 - D_2)}{(D_1 + D_2)/2}$$

Where, RPD = relative percent difference

D_1 = the larger of the two observed values

D_2 = the smaller of the two observed values

7.2.2 Accuracy

Accuracy will be estimated from the analysis of QC samples whose true values are known, or from surrogate or matrix spike recoveries. Accuracy will be expressed as percent recovery. The formulas to calculate these values are:

For QC Samples:

$$\text{Percent Recovery} = 100 \frac{\text{(Measured Value)}}{\text{(True Value)}}$$

For Surrogate Spikes:

$$\text{Percent Recovery} = 100 \frac{\text{(Measured Value)}}{\text{(True Value)}}$$

For Matrix Spikes:

$$\text{Percent Recovery} = 100 \frac{C_i - C_o}{C_t}$$

Where C_o = value of unspiked aliquot
C_i = value of spiked aliquot
C_t = value for spike added

7.2.3 Completeness

Completeness will be reported as the percentage of all measurements made whose results are judged to be valid. Data will be validated in general accordance with U.S. EPA requirements found in the "Laboratory Data Validation Functional Guidelines for Evaluation of Organic Analyses", and in the "Laboratory Data Validation Functional Guidelines for the Evaluation of Inorganic Analyses". The following formula will be used to estimate completeness:

$$C = 100 \frac{(V)}{(T)}$$

where C = percent completeness
V = number of measurements judged valid
T = total number of measurements

7.2.4 Representativeness

Representativeness and comparability are qualitative attributes of a data set. Representativeness is the degree to which data accurately and precisely represent the true value of a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness of data will be assessed through evaluation of sampling techniques, documents and QC samples described.

Comparability refers to the confidence with which one data set can be compared to another. Comparability is assessed by using approved sampling plans based on standardized consensus procedures, and by presenting data in standard formats. Both representativeness and comparability will be evaluated as part of data validation.

TABLES

QUALITY ASSURANCE PROJECT PLAN

Table QAPP-1: Summary of Analytical Parameters, Methods, and Sampling Specifications for Water Samples
Horsehead Corp.

Parameter	Method	Required PQL mg/l	Minimum Sample Volume	Recommended Holding Time	Sample Container	Preservation
Metals						
Cadmium	SW-846 6010B or 7131A, 7421, 7951	0.01	200 ml	180 Days	500 ml polyethylene	HNO^3 to PH <2
Lead		0.05				
Zinc		0.11				

TABLE QAPP-2
QC SAMPLES TO BE USED IN THE FIELD INVESTIGATION

QC Sample Type	Frequency of QC Samples	Purpose
Replicate (i.e., Duplicate)	One in ten	To assess laboratory analytical data, and sampling variability and representativeness.
Equipment Blank	One for every day of groundwater sampling	To evaluate the effectiveness of decontamination procedures.

FIGURES

QUALITY ASSURANCE PROJECT PLAN

FIGURE QAPP-1

CONTAINER LABELS AND CUSTODY SEALS

FIGURE QAPP-1
CONTAINER LABELS AND CUSTODY SEALS

BENHAM
The Benham Companies, Inc.
3700 West Robinson, Suite 200
Norman, OK 73072
(405) 321-3895

Company Name

Sample Description

Parameter Preservative

Date Time

Sampler's Signature

BENHAM
The Benham Companies, Inc.
3700 West Robinson, Suite 200
Norman, OK 73072
(405) 321-3895

Signature _____

Date _____

FIGURE QAPP-2
CHAIN-OF-CUSTODY FORM

FIGURE QAPP-2
CHAIN-OF-CUSTODY FORM

6926

CLIENT NAME: | SITE MANAGER:

PROJECT NO.: | PROJECT NAME:

PAGE: PAGE | LAB. POV:

DATE	TIME	MATRIX	SAMPLE IDENTIFICATION	NUMBER OF CONTAINERS	PARAMETER/METHOD NUMBER							LAB I.D. NUMBER (LAB USE ONLY)	REMARKS (FIELD FILTERED, UNFILTERED, PRESERVED, UNPRESERVED, GRAB DISPOSITE)

CHAIN-OF-CUSTODY RECORD

BENHAM

- Norman, OK 405-321-3655
- Tulsa, OK 918/872-4600
- Arlington, TX 817/640-6007
- Houston, TX 281/493-1010

SAMPLED BY: (Signature) DATE: TIME:

RELINQUISHED BY: (Signature) DATE: TIME:

RECEIVED BY: (Signature) DATE: TIME:

RELINQUISHED BY: (Signature) DATE: TIME:

RECEIVED BY: (Signature) DATE: TIME:

SAMPLE SHIPPED BY: (Circle) AIRBILL #:

FEDEX PONY XPS VEL XPS

HAND DELIVERED UPS OTHER

CONCENTE: | TURN AROUND TIME NEEDED

RECEIVING LACORATORY:

ADDRESS:

CITY: STATE: ZIP:

CONTACT:

PHONE:

RECEIVED BY LABORATORY:

DATE: TIME:

SAMPLE CONDITION UPON RECEIPT: (Lab Use Only)

Temperature: Ice Present: Y N

VOAs Free of Headspace: Y N

Comments:

AAI CONTACT PERSON(S): SUSAN MEYERS

PHONE #: 405-321-3655/405-841-5643

POINT OF ORIGIN: O NORMAN O TULSA O ARLINGTON O OTHER:

PAGE #1 - RECEIVING LAB PAGE #2 - RETURN TO BENHAM PAGE #3 - PROJECT MANAGER PAGE #4 - QA/QC COORDINATOR

ATTACHMENT 2

STANDARD OPERATING PROCEDURES

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Standard Operating Procedure – 1040	Sample Control and Custody Procedures
Standard Operating Procedure – 1060	Calibration and Maintenance of Field Instruments

STANDARD OPERATING PROCEDURE (SOP) FOR FIELD ACTIVITY DOCUMENTATION--FIELD BOOKS (SOP-T2)

Prepared by:_____ Date:_____

Reviewed by:_____ Date:_____

Approved by:_____ Date:_____

ATKINS BENHAM, INC. ENVIRONMENTAL DIVISION
ROBERTS/SCHORNICK & ASSOCIATES, INC.

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STANDARD OPERATING PROCEDURE FOR FIELD ACTIVITY DOCUMENTATION—FIELD BOOKS (SOP-T2)

1.0 SCOPE AND APPLICABILITY

The purpose of Standard Operating Procedure-T2 (SOP-T2) is to describe the procedures for acquiring and using a Field Book (FB) for recording data and observations during field activities as described in work plans or task summary sheets, Sampling and Analysis Plans, or other specifications to provide documentation of field work (i.e. Work Plan).

1.1 Scope of SOP-T2

This Standard Operating Procedure (SOP) describes the procedures for obtaining a project FB, lists the essential elements that shall be recorded in the FB, and describes the RSA document control system for FBs.

1.2 Related Documents and Procedures

- Field Activity Forms
- 48-Hour Notification of Field Activity
- Field Measurements
- Sample Control and Custody Procedures
- Equipment Calibration and Maintenance
- Site Health and Safety Plan

1.3 Applicability

Documentation shall be recorded and maintained for all field activities conducted at a site. All documentation should be recorded in original form in a bound FB. Documentation that should be recorded shall include:

- All sampling activities (planned and revised)
- Field testing and analysis results
- Labeling and chain-of-custody information
- Decontamination of personnel and equipment information
- Packaging and shipping of samples information

- Instrumentation calibration and maintenance information
- Health and Safety Plan documentation requirements

The types of field activities which require the above record keeping include:

- Drilling, well installation, grouting and well development activities
- Hydrogeologic testing and sampling
- Air monitoring
- Field audits
- Environmental investigation (general)
- Remediation/construction oversight
- Other sampling as required

Field documentation as described herein shall be conducted for all activities as specified in the Work Plan (WP). In the event there is a conflict in specifications presented herein with those presented in the WP referencing this SOP, then the specifications in the WP will be followed to the extent they are different. FB documentation is not required for site visits where field activities as described above are not conducted.

1.4 Standard Terms

Attachment T2-1 to SOP-T2 contains definitions for standard terms that are acceptable for use for FB entries and for forms or other methods of documentation. Use of standardized terms insures that all RSA personnel have the same understanding when using these defined terms.

2.0 PERSONNEL QUALIFICATIONS

All RSA personnel that perform field activities shall be familiar with the requirements of SOP-2 prior to beginning the field activities requiring documentation. Additionally, training on the use of equipment and materials is required.

3.0 EQUIPMENT AND MATERIALS

3.1 Field Book

Each FB shall consist of a bound book, preferably with waterproof paper and pre-numbered pages; except for field activities that do not require extensive documentation, a small bound book without waterproof paper is acceptable. The individual recording observations or field data in the small book shall number the pages of the book with sequential numbers.

RSA personnel shall utilize an assigned project FB for documenting field activities for a specific project. All field personnel should have at least one (1) spare FB with them at any time they are required to go to a project site.

3.2 Writing Utensils

All entries recorded in a project FB will be made using either blue or black waterproof ink or marker. Use of a pencil is not acceptable. Black waterproof pens and markers can be obtained from the QA/QC Department (QA/QCD). Field personnel should carry an ample supply of spare writing utensils.

4.0 RSA DOCUMENT CONTROL SYSTEM FOR FIELD BOOKS

4.1 Field Book Initiation

Each FB shall be initiated by the RSA QA/QCD when the Field Activity Form (SOP-T4) for a new project is processed. The following information, at a minimum, shall be recorded on the front of each FB:

- Client and/or project name and/or location
- Project number
- FB number

The FB number consists of a three-digit number that will be sequentially assigned to a FB. Typically, the sequence number will begin with the number 001, then 002, 003, etc. Whenever the larger size FB is initiated, the client and/or project name and project number shall also be recorded on the spine of the FB.

4.1.1 Initiation of a Spare Field Book

Under some circumstances RSA personnel may find it necessary to initiate a FB while at a project field site. For example, this could occur due to damage or loss of the essential information or because the assigned project FB has become full. The steps below shall be followed whenever a FB is initiated at a field site.

- Contact the QA/QCD (within 3 days) with the pertinent information regarding the initiation of the new FB. (Project name and number, 3-digit number assigned to the new FB, date initiated, and individual retaining custody of the FB) The QA/QCD will record the information in the FB Tracking Log. (Attachment T2-2)

- Use a black Sharpie marker to record the information discussed in Section 4.1 on the front, and if appropriate, the spine of the FB.

- The first entry in the new FB shall be a notation that the book has been initiated and is checked out by the individual initiating the book. Record the date the entry is made. Make a notation in the FB that the QA/QCD has been notified as to the initiation of the FB.

4.2 Field Book Organization

The first two (2) pages in each field book are reserved for specific information described in Section 4.2.1 and Section 4.2.2 below. The remaining pages in the FB are for field activity documentation.

4.2.1 Ownership

A self-inking stamp shall be used to stamp the name, address, and phone number of RSA on the first page of the FB. The QA/QCD is responsible for making sure this information in placed in each FB in the appropriate manner.

All FBs are the property of RSA and/or the RSA client for which the project is being performed. Only pertinent project information shall be recorded in the project FB.

4.2.2 Signatures

The next page of the FB shall be used to record the printed name, written name, and initials of each person that makes entries into the FB. This will help to determine which entries were made by various personnel using the FB.

4.2.3 FB Initiation Documentation

A notation of the date the FB is initiated will follow the signature page. The individual initiating the FB shall include their name in the initiation notation. For example:

Book initiated on April 8, 1997 by Jane Smith.

4.3 Returning a FB to Central Files

All FBs shall be returned to the QA/QCD immediately after the field activity so that the FB can be properly checked in and processed. The QA/QCD is responsible for recording the appropriate entry into the FB Tracking Log to reflect that the FB has been returned. A copy of the field notes shall be maintained in an appropriate file in the Central File Area.

4.4 Obtaining an Established FB

Once a FB has been initiated it will be available for use. Each FB shall be retained in the Central File Area in an appropriately marked file until the FB is checked out for use. The QA/QCD shall obtain the appropriate FB when processing the Field Activity Request Form for upcoming project field work. In addition, RSA personnel may obtain the FB from the Central File Area by completing a file check out card and by notifying the QA/QCD that the FB has been removed from the Central File Area.

5.0 DOCUMENTATION GUIDELINES

The purpose of the FB is to fully document a field activity. Individuals making entries into the FB should ask themselves whether the field activity that is being documented can be re-created by another individual who is unfamiliar with the site by using only a site map and the FB notes. If not, then the level of detail of the field notes is deficient and more details

are necessary. In the case of a legal proceeding, notes, if referred to, can be subjected to cross-examination and are admissible as evidence. Both FBs and RSA personnel (including other personnel in addition to the original note taker) are subject to subpoena. All FB entries should be factual, detailed, objective, and unbiased. At no time should a personal opinion be recorded in a FB.

The type of information that shall be recorded in the field notes is listed in Section 5.1 below. In addition, an example of typical FB entries is included in Attachment T2-3. Even though specific information is required for FB entries, the format of information entry is left to the discretion of the individual making the entry. Individuals should use a tabular format where possible for conciseness and ease of use. This type of information may be duplicated on a form or may be transcribed to a form; however, the bound logbook record will take official precedence over transcribed or duplicated form records when the same data (whether conflicting or agreeing) is contained in both.

In some cases it may become necessary to augment existing FB entries. Any such entry shall be noted as such, making it clear that the new information was not made at the time the original work was performed.

5.1 Required Information

The following list includes information that shall be included in FB documentation:

- Date and signature of person who checked out the FB
- Date and time of arrival at the field site
- Purpose of the site visit
- Documentation of site safety meeting to review Site Safety & Health Plan
- Signatures of all persons making current entries into the FB
- Weather conditions (daily, or as weather conditions change)
- Names of all personnel present at the site (daily)
- Field equipment unit numbers or other identification number (i.e., serial number)
- Calibration readings of all field instruments including initial calibration, continuing calibration, and any appropriate notes
- Method of sample collection and any factors that may affect sample quality
- Equipment decontamination procedures utilized

- Actual field measurements, including, at a minimum, actual measurement results and units of measurement
- Any health and safety monitoring measurements as indicated by the Health and Safety Plan
- Documentation of any relevant conversations (such as discussion with a client representative)
- Documentation of any problems encountered (i.e., well lock broken, well pad cracked, etc.) (daily)
- Photograph details
  - ◊ Approval to take photographs
  - ◊ Time, date, description of photograph
  - ◊ Name of photographer
- Initials of each person making entries at the bottom of each page
- A diagonal line on blank space of any incompletely filled page (see Attachment T2-3 for examples)
- Date, signature, and notation by person who returns the FB to the QA/QCD

5.2 Correction of Errors

All errors in the FB shall be corrected by drawing one (1) line through the entry. The initials of the person making the correction, along with the date of the correction, shall be entered near the error. Appropriate error correction can also be found in the example of typical FB entries in Attachment T2-3.

Wherever possible, error codes shall be utilized to explain why it was necessary to change a FB entry. The error code should be written near the correction and should be circled to make it clear that the entry is an error code. Proper error codes are listed in Table T2-1.

6.0 REFERENCES

EPA SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC (June 1997).

EPA 330/9-78-001-R, NEIC Policies and Procedures, U.S. Environmental Protection Agency, Office of Enforcement, Denver, Colorado (August 1991).

OSWER-9950.1, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. Environmental Protection Agency, Washington, DC (September 1986).

PBS-181557, *A Compendium of Superfund Field Operations Methods*, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC (December 1987).

TABLE T2-1

ERROR CODES

Error Code	Description
CE	Calculation error correction
CL	Changed for better clarity
DC	Original sample description changed after further evaluation
NI	Not initialed and dated at the time of entry
OB	Not recorded at the time of initial observation
RE	Recording error
TE	Transcription error
SE	Spelling error
WO	Write over

ATTACHMENT T2-1

STANDARD TERMS AND ABBREVIATIONS

Soil

SB	Soil Boring (SB-1)
BH	Bore Hole (BH-2)
HA	Hand Auger Boring (HA-1)
BGL	Below Ground Level
SS	Surface Soil Sample, usually from 0.0 - 0.5 feet (SS-2 0.0 - 0.5 feet)
GS	Ground Surface
S	Sediment Sample (S-3)
SP	Soil Probe sample (SP-6)

When collecting soil samples, always record the depth interval that was sampled. (BH-1 2.0 - 3.0 feet BGL)

Water

WL	Water Level
SW	Surface Water sample (SW-4)
TD	Total Well Depth
TOC	Top of Casing
DTGW	Depth to Groundwater
MW	Monitor Well (MW-3)

General

VOA/VOC	Volatile Organic Analysis/Volatile Organic Compounds
SVOA/SVOC	Semi-Volatile Organic Analysis/Semi-Volatile Organic Compounds

STANDARD OPERATING PROCEDURE-210
FIELD REPORTING AND DOCUMENTATION

STANDARD OPERATING PROCEDURE
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STANDARD OPERATING PROCEDURE-210
FIELD REPORTING AND DOCUMENTATION

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-210 (SOP-210) describes the requirements for reporting of procedures, acquired data, and observations during field operations as described in the Work Plan, Sampling and Analysis Plan, or other specifications to provide documentation of the work. Date collected using the SOPs will be used in conjunction with previously collected site data. Therefore, to the extent practical, the procedures presented herein shall be comparable to those used previously, especially with respect to sample collection, handling, and laboratory analyses.

1.2 Scope Covered by SOP-210

- General Documentation Requirements and Considerations
- Standard Field Documents and Their Use
- Field Document Control System

1.3 Related Procedures and Documents

- Geologic Logging and Material Classification Procedures (SOP-320)
- Borehole Grouting Procedures (SOP-330)
- Groundwater Monitoring Well Installation (SOP-410)
- Site Media Sampling Procedures (SOP-520, 620, and 710)
- Field Measurements (SOP-640)
- Sample Classification, Storage, Packaging, and Shipment (SOP-930)
- Equipment Decontamination (SOP-1020)
- Sample Control and Custody Procedures (SOP-1040)

- Equipment Calibration and Maintenance (SOP-1060)
- Handling of Investigation - Generated Materials (SOP-1100)
- Work Plan, Sampling and Analysis Plan (SAP), and Quality Assurance Project Plan

1.4 Work Specifications

Field reporting and documentation as described herein shall be conducted for all activities as so specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used or implied in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP.

2.0 EXECUTION

2.1 General Requirements and Considerations

Documentation should be recorded and maintained for all planned activities and other significant occurrences at the site during field operations.

Where possible, organized documentation should be completed on appropriate forms designed to prompt the user for all standard information for planned activities. Significant data collected and observances made that may be required as legal evidence should be recorded in original form in a bound field logbook, and may be transcribed to a form or duplicated on a form. In any case, the bound logbook record will take official precedence over transcribed or duplicate form records, if the same data (whether conflicting or agreeing) is contained in both. All written entries made in the field log book will be made using indelible ink. Documentation should be kept for the following planned field activities and occurrences:

- All planned and revised sampling activities and sample data
- Field testing and analysis results
- Labeling and chain-of-custody procedures
- Drilling, well installation, grouting and well development activities
- Hydrogeologic testing
- Air monitoring
- Decontamination of personnel and equipment
- Packaging and shipping of samples
- Calibration and maintenance procedures
- Exposure incidents and accidents (see Health and Safety Plan for requirements)
- Field audits and corrective action

All methods of documentation should be consistent with the requirements of SOPs for obtaining samples, calibration of equipment, preparing samples for analysis, and tracking of samples and documents. In the event this or other SOPs differ, the requirements of the QAPP will take precedence.

All recordings of field procedures, observations, and data should be signed, dated, and legible, and the field documents should be protected against contamination (soiling and smudging) to the extent possible.

Photocopies should be made periodically of all field forms and log books and maintained in a duplicate file. Copies should be stamped, clearly marking the copy as a copy.

2.2 Standard Field Documents and Their Use

2.2.1 Field Logbook

Logbooks will provide the documentary evidence for procedures as performed by field personnel. Each entry should be legible and contain accurate and complete field documentation of specific activities. The logbook should contain only facts and observations. Each logbook page should be numbered, dated, and signed by all personnel making entries on that page. Under no circumstances will pages be removed from the logbook. General information that should be documented in the field logbook(s) includes, but is not limited to the following:

- The objective(s) of the days' activities.
- Identification of drilling/sampling teams, major equipment used, procedures followed, and weather conditions.
- Notation of time and chronological summary of field activities and events.
- Signatures of individuals making entries.

Specific information that should be documented in the field logbook includes, but is not limited to:

- Sampling data, descriptions, references, and labeling described for specific activities presented in the SOPs for sampling and chain-of-custody procedures.
- Sample identification, analyses ordered, number of containers shipped, laboratory destination, and chain-of-custody records sent.
- Results of measurements and calibration of field instruments used.
- Documentation of proper borehole grouting and equipment decontamination.
- Photography information and descriptions.
- Detailed description of health and safety related activities at the site, including use of personal protective equipment and air monitoring data.

Project field logbooks should generally not contain personnel records or data which is not relevant to the work being performed at the site.

2.2.2 Field Drilling/Sampling/Installation Forms

Documentation of drilling, sampling, and well installation, along with other types of field activities, may be kept on activity-specific forms as a more comprehensive means of recording data from those activities.

Forms used should reflect the specific data required in the Work Plan, SAP, or SOP addressing that specific activity. The information collected on forms should generally duplicate data recorded in the field logbook, but should allow for more detail to be entered. Such activity-specific forms should be suitable as back-up to the Daily Activity Report (see Section 2.2.8).

2.2.3 Calibration/Maintenance Records

Documentation of calibration and maintenance of individual field instruments should be kept in the field book for each time the calibration or maintenance is performed. Calibration and maintenance records may be documented on special forms but should be referenced in the field book. A calibration log should be maintained in a hard-bound log book as long-term record of calibrations for that project. Data and information to be recorded in the calibration and maintenance record and calibration logbook are specified in SOP-1060, Calibration and Maintenance of Field Instruments.

2.2.4 Sample Labels

Self-adhesive sample labels shall be affixed to each sample container, providing the information required as specified in SOP-1040, Sample Control and Custody Procedures. In cases where field samples will be packaged in shipping containers to satisfy DOT requirements as outlined in SOP-930, a duplicate label will also be placed on the outer container along with any other DOT required information as specified in SOP-930.

2.2.5 Chain-of-Custody Forms and Custody Seals

A chain-of-custody form shall accompany each batch of samples transported from the site. Forms will contain the minimum information specified in SOP-1040. If samples within a given shipment are to be separated at some point before their final disposition, then separate chain-of-custody forms will be provided for each separate group of samples. A custody seal shall be placed over the lid and body of the sample container, including one over any other package or container required to ship the sample. The custody seal shall be used in accordance with SOP-1040.

2.2.6 Decontamination Records

Decontamination records shall be kept on forms, or within the field log book to document observations that verify proper personnel and equipment decontamination procedures are followed. Personnel decontamination procedures are presented in the Health and Safety Plan. Equipment decontamination procedures are presented in SOP-1020.

2.2.7 Visitor's Log

A log will be maintained at the site to record names of people visiting the site. Dates and times of arrivals and departures of visitors and the nature of their activities will be recorded. It should be noted by the site manager whether the visitor remained in the clean zone of the site or not. Unauthorized persons will not be permitted onsite during any field activities. Unauthorized visitors should be reported to the project manager for proper action.

2.2.8 Daily Activity Report

A summary of daily field activities should be kept to report the progress of field operations for that day. Information that should be summarized includes, but is not limited to, the following:

- Sampling locations worked
- Drilling footage planned/completed
- Drilling rig or major equipment work hours
- Number of samples planned/taken at each location
- Location and status of monitoring well installations
- Summary of other field activities
- Summary of supplies and water used
- Identification of problems, downtime and corrective action taken
- Summary of weather and weather impacts
- Personnel and visitors recorded on-site that day
- Change in the work scope or methodology initiated in the field

Copies of field forms and logbooks may be attached to the Daily Activity Report for submittal to the Project Manager.

2.2.9 Photographs

During sampling activities, photographs should be taken of the location of a sample and its relation to site facilities. Photographs may be used during site investigation to identify topographic features and to document site structures.

Information concerning each photograph must be entered into the logbook immediately after the photograph has been taken, including a photograph identification, a description of the object being photographed, the time taken, and the geographic direction in which the photograph was taken. If photographs of samples are taken, then the photographs should be in color with the samples placed on a back board on which the following is indicated:

- Project name and number
- Sample location and depth
- Date and time of sample
- Length and orientation (top/bottom) of sample

2.2.10 Other Field Documentation

Other field documentation may be generated at the site for purposes of quality assurance. Such documentation includes audit reports and corrective action notices.

2.3 Document Control System

2.3.1 Project Files

Project files including all non-draft records, documents, and information relating to the performance of the work at the site and the removal of waste materials from the site may be maintained at the site. These files can include sampling analyses, chain-of-custody records, manifests, contracts, trucking logs, bill of lading, receipts, records pertaining to traffic routing, destination of waste materials, and volume and chemical nature of such materials, correspondence, and other final documents produced. A filing system should be used for maintaining project documents in a complete, organized manner so the status of these records can be easily attainable.

Each file entry should be given a unique sequential reference number with these kept on an official file docket or inventory form. Sign-out sheets should be utilized to have access to these files. An authorized access list should be posted near the document files and used to ensure that unauthorized personnel will not be able to check files without the consent of the project manager or project coordinator.

2.3.2 Serialization

Logbooks, chain-of-custody forms, and other data records will be serialized before being used in the field. Serialization can assist in controlling and tracing documents until they are placed into the project file.

STANDARD OPERATING PROCEDURE-423
GROUNDWATER LEVEL MEASUREMENTS

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423-3 Continuous Water Level Measurements Using Pressure Transducers and Electronic Data Storage

STANDARD OPERATING PROCEDURE-423
GROUNDWATER LEVEL MEASUREMENTS

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-423 (SOP-423) describes the minimum acceptable requirements for obtaining groundwater levels in monitoring wells and piezometers as required in the Work Plan, Sampling and Analysis Plan, or as otherwise specified.

1.2 Scope Covered by SOP-423

- Field Measurements of Groundwater
- Discrete Water Level Measurements
- Continuous Water Level Measurements

1.3 Related Procedures and Documents

- Groundwater Sampling (SOP-620)
- Work Plan or Sampling and Analysis Plan (SAP)

1.4 Work Specifications

Water level measurements as described herein shall be conducted as specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with Attachment 423-1 to this SOP. Otherwise, it is intended that they be consistent with those used or implied in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements

Water level measurements shall be obtained at wells and piezometers designated in the Work Plan or Sampling and Analysis Plan. Water levels should be referenced to a common elevation datum for the entire site, preferably to a USGS benchmark. Water depths within wells and piezometers shall be referenced to the top of the casing, which is, in turn, referenced to a permanent benchmark.

Water level measurement devices shall be decontaminated as per SOP-1020 or as specified in the Work Plan or Sampling and Analysis Plan, or other parent document referencing this SOP.

Personnel obtaining water level measurements could be subject to exposure from impacted groundwater and should follow the Health and Safety Plan regarding this activity. Care shall be exercised to avoid direct skin contact with the water or well contaminants on equipment during and after measuring.

2.2 Discrete Water Level Measurements

2.2.1 Wells/Piezometers with Screens, Fully Open to Water Table

Discrete water levels shall typically be required from a series of wells when data for preparing groundwater contour maps are needed. Discrete water levels may also be required when monitoring the changes in water level during aquifer testing if aquifer response is sufficiently slow.

Discrete water level measurements shall be made by determining the depth to the water surface below the reference point. The fixed reference point is

established by scribing the point on the northern, outer edge (lip) of the well casing. A line should be scribed or notched so that filings do not fall into the wall.

Attachment 423-2 describes the method to be used making discrete water level measurements with electronic water level indicators. Electronic water level indicators are conduction probes which activate an alarm and light when they intersect the water. The depth to water level is determined by reading the measured and marked increments on the lowering cord.

2.3 Continuous Water Level Measurements

2.3.1 Pressure Transducer Method

Continuous water level measurements are made by determining the height of the water column above a pressure transducer and electronically recording fluctuations in this height with a data logger. The continuous record is used for aquifer testing where rapid changes in water level are anticipated. Procedures for using the pressure transducer method are described in Attachment 423-3 to this SOP.

2.4 Interface Probes

If light non-aqueous phase liquids (LNAPS) are suspected to be present or if dense non-aqueous phase liquids (DNAPLS) are suspected, then an electronic interface probe should be utilized that is capable of distinguishing between water and LNAPLS/DNAPLS. If LNAPLS or DNAPLS are suspected, then an electronic interface probe should be used to check the surface of the fluid column and also the base of the fluid column. All reading will be recorded in the field log book.

3.0 REFERENCES

Driscoll, Fletcher, G., Groundwater and Wells, Second Edition, Minnesota, 1986.

Practical Guide for Ground-Water Sampling, U. S. EPA, EPA/600/2-85/104, September 1985.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, U. S. EPA, September 1986.

ATTACHMENT 423-1

DEFINITIONS

Water Table Elevation: The water level in an unconfined aquifer with no vertical flow.

Hydraulic Head: The elevation in the well above some datum (usually mean sea level) is called the hydraulic head or simply head.

Discrete Water Level: Noncontinuous measurements of the distance from a fixed reference point to the water surface in a given well.

Continuous Water Level: An unbroken record of measurements from a fixed measurement point to the water surface over a specified period of time in a given well.

ATTACHMENT 423-2

WATER LEVEL MEASUREMENT WITH ELECTRICAL SOUNDERS

Description

Electrical sounders use the water in the well to close an electrical circuit. Contact with water is indicated by a small lamp or amp meter. Power is supplied by small flashlight batteries. Typical electrical sounders use either a single wire or a two-wire configuration. Single wire (electrode) sounders are grounded to the steel well casing. The wire is then lowered to contact the water, and the circuit is closed. The wire is then lowered to contact the water, and the circuit is closed. Both the positive and negative electrodes are lowered into contact with the water in two-wire configuration. In both sounder types, the wire is marked in 0.01-foot intervals to indicate depth. Depth is referenced to the surveyor's mark. All sounders are equipped with weights to maintain line tension for accurate readings.

Application

Electrical sounders are useful for all water level measurement needs. Electrical sounders can also be used to obtain accurate readings in pumping wells where water turbulence makes steel tape readings difficult. Electrical sounders may be left in a well for long periods of time, if required.

Limitations

The most serious drawback to the use of electrical sounders in monitoring is the insulating effect of oil contaminants (if present), particularly where there is a significant amount of floating oil. In such cases, an electrical sounder made to detect floating oil and water should be used.

Procedure

Check the interval markers with a surveyor's tape to verify length of sounder tape. Inspect the surveyor's reference mark inside the casing to be sure of legibility.

Lower the sounder until it just makes contact with the water in the well. Record the position of the sounder relative to the reference point. Record the actual water level reading to the nearest 0.01-foot. Repeat to confirm depth.

Withdraw the sounder from the well. Decontaminate the sounder wire and electrode in accordance with SOP-1020.

ATTACHMENT 423-3

CONTINUOUS WATER LEVEL MEASUREMENTS USING PRESSURE TRANSDUCERS AND ELECTRONIC DATA STORAGE

Description and Application

This procedure describes the measurement of water levels in completed wells using pressure-sensitive transducers with data recorded electronically by a data logger. The transducer is lowered into a well; it measures pressure exerted by a column of water above the transducer. This can be converted to feet of water when the density of the water is known. Care must be taken to place the transducer below the seasonal low water level to ensure continuous measurement capability. The data logger is programmed for each application; it records the electronic signals from the transducer in a format specified by the selected software program. All data is recorded by calendar day to facilitate data reduction. Collected data is periodically transferred from the data logger to a personal computer for storage and subsequent data manipulation.

> **NOTE: Some data loggers may use lithium batteries which the Department of Transportation considers a hazardous material. These batteries must never be transported on passenger aircraft.**

Procedure

Enter the program into a data logger which has fully charged batteries. Alkaline batteries are preferred. During use, the battery voltage should not drop below the minimum voltage specified by the manufacturer; damage to the data logger and loss of recorded data could result.

Select a pressure transducer for use in a given well that is compatible with both water quality and anticipated pressure sensitivity range (i.e., 5 psi, 30 psi, etc.).

The pressure range selected is dictated by the anticipated range in the water column above the transducer and by the desired precision in measurement.

Hook up the transducers to the data logger in the field following manufacturer's instructions.

Typically, four to eight input channels are available on the system; other factors affecting the sampling configuration include cable length, distance between monitored wells, terrain, local human activities (traffic, plant operations), and the ability to secure the system from weather and vandals.

Attach the transducer to the data logger and calibrate in air according to manufacturer's instructions. If multiple data loggers are used, internal clock synchronization should also be performed.

Measure water level and depth to the bottom of the well prior to lowering the transducer into the well. Water levels are measured with an electrical water level indicator; total depth of the well is measured with a device compatible with well depth.

Lower transducer into the well through the surface of the well to a depth between the water level and the bottom of the well. The transducer must be kept submerged during the period of measurement. Take care to keep the tip of the transducer out of any fine sediment that has accumulated in the bottom of the well. Measure water level again; record the time indicated on the data logger digital display and water level. From these readings (and other periodic manual water level measurements), the water levels can then be converted to elevations.

Transfer data stored in the data logger periodically to a portable computer. The frequency of data transfer depends on available memory and conditions encountered in the field. Data may be transferred as frequently as daily. The data logger has wrap-around memory; it is important to transfer data so that records are not recorded over.

References

"In-Situ, Inc., Hermit Environmental Data Logger, Model SE1000C, Operator's Manual", Version 1.0, April 1991, In-Situ, Inc., Laramie, Wyoming.

STANDARD OPERATING PROCEDURE-620
GROUNDWATER SAMPLING

STANDARD OPERATING PROCEDURE-620
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STANDARD OPERATING PROCEDURE-620
GROUNDWATER SAMPLING

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-620 (SOP-620) describes the minimum acceptable requirements for obtaining samples of groundwater from monitoring wells, production wells, or piezometers as described in the Work Plan, Sampling and Analysis Plan or as otherwise specified for the purpose of measuring groundwater constituent chemistry and physical properties.

1.2 Scope Covered by SOP-620

- Sample Collection Requirements
- Identification of Appropriate Sampling Equipment
- Field Measurements of Groundwater Samples
- Well Purging and Evacuation Procedures
- Sampling Methodology
- Sample Documentation

1.3 Related Procedures and Documents

- Monitor Well Installation (SOP-410)
- Air Quality Monitoring (SOP-520)
- Sample Containers, Preservation and Holding Times (SOP-910)
- Equipment Decontamination (SOP-1020)
- Quality Assurance Samples (SOP-1030)
- Labeling and Chain-of-Custody (SOP-1040)
- Calibration and Maintenance of Field Equipment (SOP-1060)
- Handling of Investigation - Generated Materials (SOP-1100)
- Work Plan or Sampling and Analysis Plan (SAP)

1.4 Work Specifications

Groundwater sampling as described herein shall be conducted at the locations specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used or implied in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP.

1.6 Health & Safety Considerations

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precaution procedures and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements

Activities which will occur during groundwater sampling are summarized as follows:

- Pre-arrangement of Sample Analytical Requests with analytical Testing Laboratory.
- Assembly and Preparation of Sampling Equipment and Supplies as shown on Table 620-1.
- Determine Statistically Significant Number of Groundwater Samples for Specific Tasks, if statistical analysis is required. Statistical methodology, if required, can be found in the Work Plan or SAP incorporating this SOP.
- Groundwater Sampling
  - Determine sample type (i.e. composite or grab), frequency and number of samples, and proper sampling containers.
  - Inspection of well
  - Water-level measurements
  - Well depth measurement
  - Measurement of any floating product in well
  - Visual inspection of borehole water
  - Calculation of purge volume
  - Well bore evacuation
  - Sampling
- Sample Preservation and Shipment
  - Sample preparation
  - On-site measurement of parameters
  - Sample labeling including date, time, location, sampler's initials, analyses, and tracking number
- Completion of Sample Records (Field Log Book)
- Completion of Chain-of-Custody Records
- Sample Shipment

Detailed sampling procedures are presented in the following sections.

2.1.1 Equipment Assembly and Preparation

Prior to the sampling event, all equipment to be used (listed in Table 620-1) will be assembled, and the operating condition verified, calibrated (if required), and properly cleaned (if required). In addition, all recordkeeping materials will be prepared.

2.1.2 Equipment Check

This activity includes the verification that all equipment is in proper operating condition. Also, arrangements for repair or replacement of any equipment which is inoperative are made.

2.1.3 Equipment Calibration

Where appropriate, equipment will be calibrated according to the manufacturer's specifications prior to field use. Equipment for making on-site measurements of pH, Eh, dissolved oxygen, specific conductance, and temperature of water will be available.

2.1.4 Equipment Cleaning (Decontamination)

All portions of sampling and test equipment which will contact the interior well casing will be thoroughly cleaned before use. This includes water-level tapes or probes, pumps, tubing, bailers, lifting line, test equipment for on-site use, and other equipment or portions thereof which are to be immersed. The procedure for equipment cleaning will be in accordance with SOP-1020.

Non-dedicated equipment (such as water level or interface probes) which contacts the interior well casing before evacuation of the casing water should be rinsed thoroughly with distilled water (or appropriate organic rinse (such as hexane, methanol, or acetone) if significant levels of organics are noted)

between wells. Every effort should be made to minimize the use of organic solvents, and non-dedicated equipment should be first cleaned using a high pressure steam cleaner, if available. If organic solvents are required as cleaning agents, their use will be documented in the Work Plan or SAP referencing this SOP. Dedicated bailers should be rinsed thoroughly with distilled water between sampling events. If used, dedicated bailers will be left in the well between sampling events. However, prior to use all dedicated equipment will be cleaned in accordance with SOP-1020 before each sampling event. All other equipment which contacts the interior well casing during or after evacuation of the well casing water should be cleaned between well sampling use in accordance with the above detailed procedures. Disposable bailers will be utilized whenever possible to avoid the cleaning process and to minimize potential cross-contamination issues.

Any necessary deviation from these procedures will be documented in the permanent record of the sampling episode.

Laboratory-supplied sample containers will be cleaned and sealed by the laboratory before shipping.

2.2 Groundwater Sampling Procedures

Special care will be exercised to prevent contamination of the groundwater and extracted samples during the sampling activities. The two primary ways in which such contamination can occur are:

- Contamination of a sample through contact with improperly cleaned equipment; or

- Cross-contamination of the groundwater through insufficient cleaning of equipment between wells. This could occur if non-dedicated sampling equipment is used.

To prevent such contamination, all sampling equipment will be thoroughly cleaned before and between uses at different sampling locations in accordance with SOP-1020. In addition to the use of properly cleaned equipment, two further precautions will be followed:

- A clean pair of new, disposable latex (or similar) gloves will be worn each time a different well is sampled; and
- Sample collection activities will proceed progressively from background area to the down gradient area or from wells which are least affected by contaminants progressively to wells most affected by contaminants.

The following paragraphs present procedures for the several activities which comprise groundwater sample acquisitions. These activities will be performed in the same order as presented below. Exceptions to this procedure will be noted in the permanent sampling record.

2.2.1 Groundwater Level and Well Depth Measurement

Prior to the water-level and well depth measurements, each well will be inspected thoroughly for signs of damage. Any damage to or repairs needed on the well must be noted on the attached Groundwater Sampling Record form, Figure 620-1 or in the field log book.

Using a pre-cleaned water level meter, the groundwater surface will be measured in accordance with SOP-423. These measurements will be

recorded on the Groundwater Sampling Record form or in the field log book. The date and time of the water-level measurements must also be recorded.

2.2.1.1 Immiscible Phase and Dense Phase Organic Measurement

If an immiscible floating layer or a heavier-than-water organic phase is thought to be present on the groundwater surface or near the base of the groundwater in the well, then its thickness must be measured and recorded. The presence of an immiscible layer precludes the exclusive use of electric (conductivity) sounders to establish an accurate static water level measurement. The electric sounders will not work properly in immiscible liquids.

The measurement of an immiscible layer and the static groundwater directly below it requires specialized measuring equipment and/or methodology. One method used to measure the immiscible phase thickness is to use a clean interface probe which distinguishes between organic liquids and water. When taking measurements in wells where organic immiscible liquids are present, it is important to record: 1) the depth to the top of the immiscible liquid from the reference datum; 2) the thickness of the immiscible layer; and 3) the depth to the top of the groundwater beneath the immiscible layer. Another method of measuring an immiscible layer is through the use of a transparent or semi-transparent sampling device such as a bailer. The bailer is carefully lowered into the well to minimize agitation of the immiscible/water interface. The bailer is then raised to the surface and the thickness of the immiscible layer is measured and recorded. If a clean interface probe is used, then the probe should be dropped to the bottom of the well to determine the thickness of

dense phase organics. Similarly, if a bottom discharge bailer is used, it should be dropped to the bottom of the well to determine the thickness of dense phase organics.

2.2.2 Visual Inspection of Well Water

Prior to well evacuation, but after water level and well depth measurements, a small quantity of water will be removed with a bailer in a manner which will not totally immerse the bailer. The recovered sample is representative of the top of the water column in the well casing. If immiscible contaminants accumulate at the top of the water column, this technique can allow their detection. The water will be inspected for the presence of a floating film or other indications of contamination. Also, a sample of the groundwater will be removed from the bottom of the well (sump) and inspected for dense phase or heavier-than-water organics. Any distinct sample color or odors will be noted. All observations regarding odor or visual indications of impact will be recorded on the Groundwater Sampling Record form or in the field log book.

2.2.3 Immiscible Phase Sampling

If an immiscible floating layer is present on the groundwater surface in the well, it should be sampled prior to well evacuation.

Also, if it is determined that heavier-than-water or dense phase organics are suspected to be present, then the bottom discharge bailer will be lowered to the bottom of the well and a sample will be collected for analyses prior to well evacuation.

The dedicated bailer must be cleaned if immiscible or heavier-than-water organics are detected prior to further sampling of the well.

2.2.4 Well Casing Evacuation

The water standing in a well prior to sampling may not be representative of in-situ groundwater quality. Therefore, the standing water in the well and

sand filter pack must be removed so that formation water can replace the stagnant water. Using the depth-to-water, well depth, and filter pack interval (assume a porosity of 30%) calculate the volume of groundwater to remove from each well. Applicable formulas are listed in SOP-420. Three casing volumes, at a minimum, (including filter pack pore water) must be removed before sampling. Sampling will only occur after removal of 3 casing sand pack volumes and after stabilization (+/- 10%) of the parameters pH, specific conductance, and temperature. These parameters should be made after each casing volume is evacuated, and more frequently if possible.

If a well is incapable of yielding 3 casing volumes, then the well will be evacuated to dryness and allowed to recover to near static levels prior to sampling. The purged water will be tested for pH and conductivity and compared to the groundwater sample to insure that the water quality in the well has stabilized. Stabilization is indicated when the above parameters vary less than "10 percent. In the event stabilization has not occurred, then additional purging of the well will be conducted until stabilization of the parameters occurs.

The wells can be purged using clean stainless steel or teflon bottom discharge bailers. A clean monofilament nylon line will be used to lower the bailer into the well. Special care will be taken to insure that the bailer or bailer line does not contact the ground. Alternatively, a properly cleaned non-aerating pump system can be used for purging, such as a bladder and/or peristaltic pump.

During groundwater collection, no equipment or lifting lines will be allowed to contact the ground. If equipment or lifting lines contact the ground, they will be replaced or recleaned prior to use.

2.2.5 Sample Extraction

A bailer, if dedicated, constructed of stainless steel or teflon will be used to extract water samples from the well. Alternately, a manufactured, pre-cleaned disposable PVC bailer may be used. Disposable bailers will normally be utilized unless dedicated equipment is in use at a site. If dedicated equipment is used, it is preferable that the bailers be dedicated to specific wells. A bailer must be recleaned in accordance with Section 2.1.3, if it was previously used to collect an immiscible phase sample or used to sample more than one (1) well. Also, each dedicated bailer must be cleaned in accordance with SOP-1020. A new and clean monofilament nylon line will be used during each sampling event. Care must be taken to prevent either the bailer or lifting line from contacting the ground surface and becoming potentially contaminated during sampling. Care will be taken during insertion of sampling equipment to prevent undue disturbance of water in the well. The bailer will be lowered into the water gently to prevent splashing and extracted gently to prevent creation of excessive turbulence in the well. The sample will be poured directly into appropriate containers. While pouring water from bailer, the water will be carefully poured down the inside of the sample bottle to prevent significant aeration of the sample. For volatile organic analyses, bottom discharge bailers will be utilized in order to minimize volatilization.

If a significant immiscible layer remains in the well following purging, care must be taken to avoid sample bias by sampling directly from the top of the water column. A sample of the immiscible layer should have previously been taken. Proceed to first measure field parameters in accordance with SOP-640 and then fill all required sample containers.

Excess water taken during sampling will be placed in a container for proper disposal as described in SOP-1100.

During sample collection, the order in which samples are collected should be noted in the field log book. Normally, wells containing free product will not be sampled. However, in the event sampling is required, procedures will be outlined in the Work Plan or SAP incorporating this SOP.

3.0 REFERENCES

Field Sampling Procedures Manual, Prepared by the New Jersey Department of Environmental Protection; Bureau of Environmental Measurements and Quality Assurance; Final, July, 1986.

Morrison, R. D., Groundwater Monitoring Technology, Procedures, Equipment and Applications, Prairie Du Sac, Wisconsin: TIMCO Mfg., Inc., 1983.

Scalf, M. R., et al, "Manual of Groundwater Sampling Procedures," National Water Well Association and the U.S. EPA Robert S. Kerr Environmental Research Laboratory, 1980.

Sisk, S. W., "NEIC Manual for Groundwater/Subsurface Investigations at Hazardous Waste Sites," Publication EPA-330/9-81-002, July, 1981.

U.S. EPA, "Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities," Publication EPA/530/SW-611, August, 1977

U.S. EPA, "Test Methods for Evaluating Solid Waste," Publication SW-846, 1980, Appendix A; also available as "Samples and Sampling Procedures for Hazardous Waste Streams," Publication EPA-600/2-80-018, January, 1980

TABLE 620-1

LIST OF EQUIPMENT AND SUPPLIES FOR MONITORING WELL SAMPLING

1. Health and Safety Equipment Required by Site Safety Plan
2. Access Keys
3. Logbook
4. Site Map
5. Sample Location Map
6. Chain-of-Custody Forms
7. Cooler with Ice and Bubble Wrap
8. Disposable Vinyl and Rubber Gloves
9. Distilled or Deionized Water
10. Alconox Detergent
11. Brushes
12. Decon Trays
13. 5-Gallon Buckets
14. Visqueen Plastic
15. Glass Pint Jars
16. Trash Bags
17. Ziplock Bags
18. Paper Towels
19. Appropriate Organic Rinse (for heavy organic impacts)
20. Black Ink Pens
21. Roll Clear Tape
22. Garden Sprayers
23. Tape Measure
24. pH Meter
25. Specific Conductivity Meter
26. Water Level Meter
27. Organic Interface Probe
28. PID Organic Vapor Meter
29. 0.1 Normal Nitric Acid
30. Potable Water (for decon)

31. Teflon, Stainless Steel, or Disposable Bailers
32. Monofilament Bailing Line
33. Eh Meter
34. Pump Lines
35. Dissolved Oxygen Meter
36. Containers for Purge Water

STANDARD OPERATING PROCEDURE-640
FIELD MEASUREMENTS

STANDARD OPERATING PROCEDURE-640
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STANDARD OPERATING PROCEDURE-640
FIELD MEASUREMENTS

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-640 (SOP-640) describes the minimum acceptable requirements for procedures to obtain measurement of specific field parameters as described in the Work Plan, Sampling and Analysis Plan, or as otherwise specified.

1.2 Scope Covered by SOP-640

- General Sampling Requirements
- Measurement Procedures

1.3 Related Procedures and Documents

- Field Reporting and Documentation (SOP-210)
- Air Monitoring (SOP-520)
- Equipment Decontamination (SOP-1020)
- Calibration and Maintenance of Field Instruments (SOP-1060)
- Handling of Investigation - Generated Materials
- Work Plan or Sampling and Analysis Plan (SAP)

1.4 Work Specifications

Field measurements as described herein shall be conducted for all sampling activities as specified in the Work Plan, SAP, or other document referencing this SOP. In the event there is a conflict in specs presented herein with those presented in the parent document referencing this SOP, then specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used or implied in the Work Plan, SAP, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, personnel should follow the precaution procedures and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements and Considerations

Field methods to be utilized may include measurements of the following:

- Temperature, pH, and oxidation - reduction potential (ORP)
- Specific conductance
- Dissolved oxygen

The site geologist or engineer is responsible for implementing the techniques correctly, for obtaining samples required and for recording the field data and observations.

Field measurement devices shall be calibrated in accordance with the manufacturer's procedures or as specified in SOP-1060, as appropriate.

All equipment covered by this method shall be decontaminated after use in the field in a manner such that contamination of the equipment is minimized. Specific decontamination procedures are described in SOP-1020.

2.2 Procedure

2.2.1 Temperature/pH/ORP

Temperature, pH, and oxidation/reduction potential (ORP) can be measured using one instrument with different probes, although separate instruments could be used as well. The instrument shall be calibrated in accordance with the manufacturer's instructions and SOP-1060. Measurements shall be reported to the nearest 0.1°C for temperature, to the nearest 0.01 unit for pH and to the nearest millivolt for ORP. All calibration and measurements shall be recorded in the field logbook.

2.2.2 Specific Conductance

The specific conductance of the sample shall be measured using a self-contained conductivity meter. The instrument shall be calibrated in accordance with the manufacturer's instructions and SOP-1060. Conductance shall be reported to the nearest ten units for readings under 1000 umho/cm and to the nearest 100 units for readings over 1000 umho/cm. Also temperature shall be measured for correction of the conductance value to 25°C. All calibrations and measurements shall be recorded in the field logbook.

2.2.3 Dissolved Oxygen

Dissolved oxygen (DO) content of water samples shall be measured using a membrane electrode DO meter. The meter shall be calibrated in accordance with the manufacturer's instructions and SOP-1060. DO content shall be reported to the nearest 0.1 mg/L. All calibrations and measurements shall be recorded in the field logbook.

3.0 REFERENCES

American Water Works Association, "Standard Methods of Examination of Water and Wastewater", sixteenth edition, 1985.

U.S. Environmental Protection Agency, "Compendium of Superfund Field Operations Methods," EPA/540/P-87/001, December, 1987.

U.S. Environmental Protection Agency, "RCRA Groundwater Monitoring Technical Enforcement Guidance Document," September, 1986.

STANDARD OPERATING PROCEDURE-910
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

STANDARD OPERATING PROCEDURE-910
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STANDARD OPERATING PROCEDURE-910
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-910 (SOP-910) describes the requirements for preparation of sample containers, preservation of samples, and sample holding times as specified in the Work Plan, Sampling and Analysis Plan, or as otherwise specified to ensure that accurate and valid chemical analyses may be performed.

1.2 Scope Covered by SOP-910

- General Requirements
- Types of Containers
- Cleaning Procedures for Sample Containers
- Preservation Procedures for Samples
- Holding Times for Samples

1.3 Related Procedures and Documents

- Sampling and Analysis Plan (SAP)
- Quality Assurance Project Plan (QAPP)
- Field Reporting and Documentation (SOP-210)
- Field Quality Assurance Samples (SOP-1030)
- Sample Classification, Storage, Package, and Shipment (SOP-930)

1.4 Work Specifications

Procedures for sample containers, preservation of samples, and sample holding times as described herein shall be conducted as specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications

2.0 EXECUTION

2.1 General Requirements and Considerations

Sample containers and preservation methods should be selected and used such that accurate and valid chemical and physical analyses may be performed, and materials or procedures that might cause overt disturbance, contamination, oxidation or other chemical decomposition or reaction of the sample should be avoided. This SOP only addresses containers and preservation of chemical analytical samples. Sample preservation methods should adequately meet the requirement of the chain-of-custody and sample security presented in SOP-1040 or as otherwise established in the Work Plan, Sampling and Analysis Plan, or Quality Assurance Project Plan (QAPP). Use of containers and preservation procedures should be consistent with the analytical procedures to be used by the analytical laboratory. Preservation is generally limited to pH control, addition of chemicals, and refrigeration. These techniques are intended to retard biological action, retard hydrolysis of chemical compounds, keep metals in solution, and reduce volatility of constituents.

Refrigeration to maintain the sample temperature near 4°C is the minimum amount of preservation that should be performed for environmental samples. Samples should not be frozen and dry ice should not be used as the cooling agent (due to shipping restrictions). Chemical preservatives may be added to sample bottles in advance, generally by the testing laboratory or by field personnel.

The sample volumes required for analysis vary widely depending on laboratory capabilities. The volumes prescribed herein are conservative

presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different. Further, if an analytical method change occurs (e.g., EPA SW 846 or equivalent), the new procedures will supercede the protocols presented herein.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used of implied in the Work Plan, SAP, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

This procedures may involve exposure to impacted sample waters or soils via routes of dermal contact and inhalation. Accordingly, personnel should follow the precautions procedures, and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

numbers; however, the laboratory should be consulted as to the quantity required.

2.2 Container Types

Containers in which samples of soil or water are collected should be constructed of materials that remain inert with respect to the suspected contaminants. They should have screw-type lids to assure adequate sealing of the bottles. Teflon inserts should be placed inside the lids of glass containers to prevent sample reaction with the lid and improve the quality of the seal. Sample containers should generally be supplied by the laboratory which is contracted to perform the analyses. In these cases, sample bottles should be cleaned by the laboratory prior to shipment to the field. If this procedure has been followed, each bottle should be clearly labeled as to the type of parameter for analysis. If laboratory prepared bottles are unavailable, the cleaning procedures described in Section 2.3 may be used to decontaminate sample containers.

2.2.1 Documentation of Containers and Preservatives Used

A list of containers and preservatives used to collect aqueous or solid samples shall be recorded in the field log book.

2.3 Cleaning Procedures for Sample Containers

All sample containers used for laboratory analysis will be supplied by the analytical laboratory and accompanied by a certification of cleaning procedure. These procedures will be equivalent to, or more stringent than the following:

"Protocol A" is used for general chemistry analysis, metals, and analysis of extractable organics. Protocol A consists of the following steps:

- Wash containers, closures and teflon liner in hot tap water with laboratory ade non-phosphate detergent.
- Rinse three times with tap water
- Rinse with 1:1 nitric acid
- Rinse three times with deionized water
- Rinse with pesticide grade methylene chloride
- Oven dry at 125°C. Allow to cool.
- Remove containers, closures, and teflon liners from oven
- Place teflon liners in closures and place closures on container.

Attendant to wear gloves and containers are not to be removed from preparation room until sealed.

"Protocol B" is used for organic analysis and analysis of purgeable (volatile) organics. The cleaning procedures are:

- Wash containers, septa, and closures in hot water with laboratory grade non-phosphate detergent.
- Rinse three times with tap water.
- Rinse three times with deionized water.
- Oven dry containers, septa, and closures at 125°C
- Remove containers, septa, and closures at 125°C
- Place liners in closures, teflon side down, and place on containers.

Attendant to wear gloves and containers are not to be removed from preparation room until sealed.

"Protocol C" is used for the same analysis as Protocol A excluding phenols, oil and grease, and total organic carbon. These cleaning procedures are:

- Wash containers, closures, teflon liners in hot tap water with laboratory grade non-phosphate detergent.
- Rinse three times with tap water.
- Rinse with 1:1 nitric acid.
- Rinse three times with deionized water
- Air dry in contaminant-free environment.
- Place liners in closures and place closures on containers. Attendant to wear gloves and containers are not to be removed from preparation room until sealed.

2.4 Container and Preservation Requirements for Environmental Samples

Containers, preservatives, and holding times specific to an individual project should be provided in the site-specific Work Plan or SAP.

2.4.1 Water Samples

Organics

Water samples for organics should be collected in glass bottles equipped with Teflon-lined screw caps. Water supply and other samples suspected of also containing residual chlorine should have 0.008 percent $NA_2S_2O_3$ (sodium thiosulfate) added. These water samples should be preserved by cooling with ice below 4°C.

Regulatory or other considerations may require that duplicate samples be collected for purgeable (volatile organics). Samples for purgeables should be collected in 40 ml glass vials (purge vials) equipped with Teflon-backed

silicon septum screw caps and filled to the top. Samples for extractables should be collected in one-gallon or four one-liter glass bottles with Teflon-lined caps.

Metals

Water samples for organics analyses should be collected in one-liter high-density polyethylene bottles with solid polyethylene or polyethylene-lines caps. Bakelite caps should be avoided. The bottles are cleaned with dilute nitric acid and washed well with distilled or deionized water. The samples should be preserved with nitric acid to below pH 2. Nitric acid concentration should not exceed 0.15 percent if the sample is to be shipped via air cargo.

Sulfide

Water samples for sulfide analysis should be collected in 500 ml polyethylene bottles, with a 0.04 percent zinc acetate added.

2.4.2 Soil or Sediment Samples

Soil or sediment samples should be collected in wide-mouth glass jars equipped with Teflon-lined screw caps. Samples should be preserved by cooling with ice or refrigeration at 4°C.

3.0 HOLDING TIMES

The USEPA has established holding times for various analyses related to environmental samples. For analytical data to be correct and/or accurate, all analyses should be performed within the maximum holding times outlined in Table 910-1. Table 910-1 provides a list of required holding times as found in USEPA SW-846 for aqueous samples and for solid samples such as soils. All environmental samples shall be analyzed within the holding times specified in this table.

4.0 REFERENCES

Heritage Environmental Services, Inc., Comprehensive Quality Assurance Plan, May, 1994.

U.S. EPA, "Methods for Evaluation of Water and Wastes," EPA-600/4-79-020.

U.S. EPA, "RCRA Groundwater Monitoring Technical Enforcement Guidance Document," September, 1986.

U.S. EPA, "Test Methods for Evaluating Solid Waste, "publication SW-846, 1986 (Third Edition).

U.S. EPA, "User's Guide to the Contact Laboratory Program," December 1988, 9240.01.

STANDARD OPERATING PROCEDURE-930

SAMPLE CLASSIFICATION, STORAGE, PACKAGING, AND SHIPMENT

STANDARD OPERATING PROCEDURE-930
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STANDARD OPERATING PROCEDURE-930
SAMPLE CLASSIFICATION, STORAGE, PACKING AND SHIPMENT

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-930 (SOP-930) describes the requirements for sample classification, storage, packaging, and shipment as described in the Work Plan, Sampling and Analysis Plan or as otherwise specified for the purpose of ensuring proper handling of samples.

1.2 Scope Covered by SOP-930

- General Requirements
- Sample Classification Categories
- Sample Storage Requirements
- Sample Packaging Procedures
- Sample Shipping Requirements

1.3 Related Procedures and Documents

- Field Reporting and Documentation (SOP-210)
- Sample Containers, Preservation, and Holding Times (SOP-910)
- Sampling and Analysis Plan (SAP)
- Quality Assurance Project Plan (QAPP)

1.4 Work Specifications

Procedures for classification, storage, packaging, and shipment of samples as described herein shall be conducted as specified in the Work Plan, SAP, or other document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used of implied in the Work Plan, Field Sampling Plan, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

These procedures may involve exposure to impacted sample waters or soils via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures and use the appropriate personal protective equipment described in the approved Site Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements and Considerations

Classification of samples shall be made on the basis of the suspected level of contaminant concentration which determines subsequent packaging and labeling requirements, shipping procedures and laboratory handling of samples.

Contamination concentrations must be assessed early in the planning stage of an investigation because of their effect upon field operations. Sample classification must be considered in the development of the Health and Safety Plan and Field Sampling Plan. The procedures and materials used for sample packaging must adequately protect the sample container from accidental breakage and should be sufficient to prevent any leaks or spills.

Sample labels for proper sample identification are discussed in the SOP for the appropriate sampling technique and in SOP-1040. The correct labels which must be applied to sample containers and shipping containers to conform with U. S. Department of Transportation (DOT) shipping regulations are included in this SOP.

Samples classified as hazardous can be shipped only by means specified in the DOT regulations as discussed herein.

2.2 Sample Classification

2.2.1 Environmental Samples

Environmental samples are those which contain less than 10 ppm of any one contaminant. Samples collected off-site are considered "environmental" unless information to the contrary exists. On-site samples may be classed as

"environmental" by the Project Manager based on knowledge of the site and the nature of the sample.

Initially, concentrations of constituents are estimated based on knowledge of contaminant sources and the contaminant transport mechanisms and their effects on contaminant concentrations. It is, therefore, necessary to be conservative in the estimate of contaminant concentration. Sample classification can be downgraded for subsequent samples if data exists to support that decision.

2.2.2 Hazardous Samples

Two categories of hazardous samples are defined as follows:

1. Medium concentration - samples expected to contain greater than 10 ppm and up to 15 percent (150,000 ppm) concentration of any <u>one</u> contaminant.

2. High concentration - samples expected to contain greater than 15 percent of any <u>one</u> contaminant.

"Hazardous Samples" include soil or water samples that may be highly contaminated, sludge or waste pile samples of concentrated wastes, and any sample from a closed drum or container.

2.3 <u>Sample Storage</u>

Samples should be stored in a manner consistent with the requirement for sample preservation so as to maintain the quality of the sample. Samples preserved by cooling should be stored in such a way as to maintain the acceptable range of temperature for the duration of the holding time.

Samples should not be stored on-site for extended periods of time and should be protected from environmental extremes. Shipment to the laboratory should be completed as soon as possible and well within any holding time limits specified for particular analyses (Refer to QAPP) to allow initiation of analyses within the holding time limits. If temporary storage is necessary, samples should remain in an area that has been designated as the "sample storage area" which must be locked and secured to maintain sample integrity and chain-of-custody requirements. Separate containers must be used to store low, medium, and high concentration samples.

Samples shall not be stored in refrigerators or other areas where food or drink may also be stored and vice versa.

2.4 Environmental Sample Packaging

2.4.1 Regulatory Considerations

DOT regulations do not consider environmental samples hazardous. In addition, DOT has stated that dilute solutions of chemical preservatives are not subject to Hazardous Materials Regulations as long as the concentrations do not exceed specified values.

In accordance with 49 CFR 173.24(a), the following is required for all packages:

> "Each package used for shipping hazardous materials... shall be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation:

(1) there will be no significant release of the hazardous materials to the environment;

(2) the effectiveness of the packaging will not be substantially reduced; and

(3) there will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging."

In accordance with 49 CFR 173.6(a), the following is required for all shipment by air:

"Each package...shall be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation:

(1) there will be no significant release of ... materials to the environment.

(2) Inner containers that are breakable (such as earthenware, glass, or brittle plastic) must be packaged to prevent breakage and leakage under conditions normally incident to transportation. These completed packages must be capable of withstanding a 4-foot drop on solid concrete in the position most likely to cause damage. Cushioning and absorbent materials must not react dangerously with the contents...

(3) For any packaging with a capacity of 110 gallons or less containing liquids, sufficient outage (ullage)

must be provided to prevent liquid contents from completely filling the packaging at 130E F. The primary packaging (which may include composite packaging), for which retention of the liquid is the basic function, must be capable of withstanding, without leakage, an internal absolute pressure of not less than 26 pounds per square inch or no less than the sum of the absolute vapor pressure of the contents at 130E F (55E C) and the atmospheric pressure at sea level, whichever is greater.

(4) Stoppers, corks, or other such friction-type closures must be held securely, tightly and effectively in place with wire, tape, or other positive means. Each screw-type closure on any inside plastic packaging must be secured to prevent the closure from loosening due to vibration or substantial changes in temperature...."

2.4.2 Shipping Containers

All sample containers should be placed inside a strong shipping container capable of withstanding a 4-foot drop on solid concrete in the position most likely to cause damage. A metal or plastic picnic cooler (ice chest) with a hard plastic liner withstands this test. The drainage hole at the bottom of the cooler must be taped shut so that the contents from broken containers or water from ice bags will not escape. The shipping container should be taped shut to form an adequate seal around the lid to prevent any leakage in the event that the cooler is turned over.

The shipping container should be marked "THIS END UP" with arrows indicating the proper upward position of the container affixed to all four sides. To prevent cross-contamination, the shipping container must be adequately cleaned between shipments.

2.4.3 Ice

Ice should be placed into a plastic bag (minimum 2-mil thick) and that bag sealed tightly. The amount of ice used will depend on the available space in the cooler but 10 pounds per 20 quarts of cooler volume should be the minimum to assure sufficient cooling. Dry ice (CO_2) generally should not be used.

2.4.4 Glass Containers

The lid of the container should be tightened to assure an adequate seal and taped to prevent loosening during transit. The container may be placed into a clear plastic bag which has a minimum thickness of 2-mil (many sandwich and freezer bags are suitable) and this bag taped tightly shut. They should be wrapped and cushioned in an inert packing material such as styrofoam, closed-cell foam packing material, or an absorbent material such as vermiculite.

2.4.5 Plastic Containers

Plastic containers do not require individual cushioning material, but should be packed to prevent movement during transport. Caps should be tightly screwed on an taped to prevent loosening during transit. These bottles may also be placed into a 2-mil-thick, plastic bag and the bag sealed.

2.5 Hazardous Sample Packaging

2.5.1 Regulatory Considerations

Hazardous samples are classified as ORM-E (Other Regulated Material - Series E) substances by the DOT. They are treated as a flammable liquid or solid and must be packaged accordingly to conform with DOT requirements.

If a sample is known to contain a material identified in the DOT Hazardous Materials Table (49 CFR 172.101), packaging and shipment should conform to the specific requirements for that substance.

If the nature of the sample is unknown, the materials should be prepared for shipment in accordance with DOT regulations for packaging and labeling the ORM-E hazard class.

2.5.2 Shipping Containers for Unanalyzed Waste Excluding Closed Container Samples

The procedures in this section should be applied to unanalyzed waste samples except those which come from closed containers whose contents are presumed to warrant a more careful packaging as described in Section 2.5.3.

Each sample container, properly labeled with sample information, should be placed into a 4-mil minimum thickness polyethylene bag, one sample per bag, and the bag sealed tightly with tape. This sealed container is placed into a metal can or overpack (such as a 1-gallon paint can) with incombustible, absorbent cushioning material, such as vermiculite or earth. Only one bag should be placed inside each can. The can lid should be

closed tightly and sealed using tape or other positive means. Each metal can must bear the following labels and markings:

1. Testing laboratory name and address and a return address.
2. "Flammable Liquid, N.O.S." or "Flammable Solid, N.O.S."

The abbreviation, "N.O.S." means "Not Otherwise Specified."

The following labels must be placed next to one another and near the "Flammable Liquid, N.O.S." marking:

1. "Cargo Aircraft Only" and
2. "Flammable Liquid" or "Flammable Solid" and "Dangerous When Wet".

More than one can may be placed in a shipping container surrounded with incombustible packaging material for stability. The outside of the shipping container must bear the following markings and labels:

1. All of the labels described above for the sample cans; and
2. "Laboratory Samples," and
3. "This End Up" on the container top with upward pointing arrows on all four sides.

Using the word "flammable" does not convey the certain knowledge that a sample is, in fact, flammable or how flammable, but is intended to prescribe the class of packaging in order to comply with DOT regulations.

2.5.3 Shipping Containers for Unanalyzed Waste from Closed Containers

The Project Manager should make a judgment as to the hazard class of all samples from closed containers based upon available data. The following procedures provide typical worst-case methods for packaging of materials classed by the DOT as "Poison A"; this type of "reasonable doubt" practice is provided for in the regulation (49 CFR 172.402 h). Unless reliable data exclude the possibility of the presence of "Poison A" substances (as defined in 49 CFR 173.326), sample containers of unanalyzed waste from tanks or drums (solid, liquid or gas) must be packaged in a DOT Spec. 3A1800 or 3AA1800 metal compressed gas cylinder. The sample container is first labeled with required sample information. Then, using a string of flexible wire attached to the neck of the sample container, it is lowered into a metal cylinder which has been partially filled with incombustible, absorbent, packaging material. Allow enough cushioning material between the bottom and sides of the sample container and metal cylinder to prevent breakage. After the sample container is completely covered with cushioning material, the string or wire is dropped into the cylinder. The cylinder valve assembly and protector are replaced. The following markings must be placed on the tag wired to the cylinder valve protector or a label affixed to the cylinder itself:

1. "Poisonous Liquid, N.O.S." and
2. Laboratory name and address and return address

The following label must be placed on the cylinder, regardless of the location of all other markings:

1. "Poisonous Gas," (the "Poisonous Liquid" label is not acceptable here, even if the sample is a liquid).

One or more cylinders may be placed into the same shipping container. The shipping container must bear the following markings:

1. All of the labels described above for the metal cylinders, and
2. "Laboratory Sample" and "Inside Packages Comply with Prescribed Specifications" should be marked on top of the container.
3. "This Side Up" marking should be placed on the top of the container with upward pointing arrows on all four sides.

2.6 Shipping of Samples

2.6.1 Environmental Samples

Environmental samples may be shipped by commercial common-carrier, bus, by rental vehicle or air-cargo service to the testing laboratory. Samples should be received by the laboratory within twenty-four (24) hours after sampling or sooner, if necessary, to allow initiation of analyses within prescribed holding times.

2.6.2 Hazardous Samples

Hazardous samples, excluding those from closed containers, may be shipped by common carrier, air-cargo, or other more protective means suitable for closed container shipments as described below.

Carrier-provided bills of lading and certification for restricted articles will be completed and signed. Standard industry forms will be used if carrier does not provide them. One form may be used for multiple shipping containers. The following information should be entered on the shipping papers:

1. "Flammable Liquid (or Solid), N.O.S."
2. "Net Weight" by item or "Net Volume" by item
3. "Cargo Aircraft Only"
4. "Limited Quantity"
5. "Laboratory Samples"

Shipping containers with unanalyzed wastes from drums or tanks should be entered as "Poisonous Liquid, N.O.S." on the first line above.

Unanalyzed samples taken from closed containers may not be transported by commercial air cargo or common carrier aircraft or by rental, non-government aircraft. Federal regulations require shipment by common, public or commercial "ground" carrier, or governmental aircraft.

3.0 REFERENCES

Code of Federal Regulations, Title 49 (Transportation), Hazardous Materials Tables and Hazardous Materials Communications Regulations: 49 CFR, Part 172, Office of the Federal Register, Material Archives and Records Service, General Services Administration, 1989.

Code of Federal Regulations, Title 49 (Transportation), Shippers - General Requirements for Shipments and Packages: 49 CFR, Part 173, Office of the Federal Register, National Archives and Records Service, General Services Administration, 1989.

U.S. EPA National Enforcement Investigations Center, "Enforcement Considerations for Evaluation of Uncontrolled Hazardous Waste Disposal Sites by Contractors," Draft, dated April, 1980.

U.S. EPA, "EPA Technical Methods for Investigating Sites Containing Hazardous Substances," Technical Monograph No. 22, Draft, dated June, 1981.

U.S. EPA, "RCRA Ground-water Technical Enforcement Guidance Document," September 1986.

U.S. EPA, "User's Guide to the Contract Laboratory Program,: December 1988, 9240.01

TABLE 930-1

STANDARD PRESERVATIVE SOLUTIONS EXEMPTED* FROM DOT HAZARDOUS WASTE REGULATION

Preservative	Quantity of Preservative Per Liter of Sample	Maximum Weight of Preservative (%)
HCl	2 ml of 1:1**	0.04
$HgCl_2$	40 mg	0.004
HNO_3	3 ml of 1:1	0.15
H_2SO_4	2 ml of 36 N	0.35
NaOH	2 ml of 10 N	0.08
H_3PO_4	Sufficient to yield pH range between 2 and 4	

Notes:

* U.S. EPA, NEIC, "Enforcement Considerations for Evaluations of Uncontrolled Hazardous Waste Disposal Sites by Contractors", Draft, dated April, 1980; Appendix D: Letter of Understanding Provided EPA by DOT for Environmental Samples.

** Ratios are volume of acid to distilled water.

STANDARD OPERATING PROCEDURE-1020
EQUIPMENT DECONTAMINATION

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STANDARD OPERATING PROCEDURE-1020
EQUIPMENT DECONTAMINATION

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-1020 (SOP-1020) describes the requirements for decontamination of personnel and equipment during hazardous waste investigation field activities as specified in the Work Plan, Sampling and Analysis Plan or as otherwise specified.

1.2 Scope Covered by SOP-1020

- General decontamination requirements
- Required site facilities and supplies
- Decontamination procedures for vehicles, drilling and sampling equipment, and well materials
- Disposal procedures
- Typical decontamination solutions

1.3 Related Procedures and Documents

- Health and Safety Plan (HSP)
- Field reporting and documentation (SOP-210)
- Field quality assurance samples (SOP-1030)
- Calibration and maintenance of field instruments (SOP-1060)
- Sampling and Analysis Plan (SAP)
- Handling of Investigation - Generated Materials (SOP-1100)

1.4 Work Specifications

Equipment decontamination procedures as described herein shall be conducted as specified in the Work Plan, Sampling and Analysis Plan, or

other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an Attachment 1 to this SOP. Otherwise, it is intended that they be consistent with those used of implied in the Work Plan, SAP, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

This procedures may involve exposure to impacted surface waters or soils via routes of dermal contact and inhalation. Accordingly, field personnel should follow the precautions, procedures and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements and Considerations

A decontamination plan should be developed and sufficiently scoped to address all the expected types and levels of contaminants at the site and the methods used to investigate them. Until proven otherwise, the decontamination plan should assume that all personnel and equipment exiting the area of potential contamination are contaminated and, therefore, comprehensive decontamination procedures must be implemented. Procedures for decontamination of equipment as well as personal protective clothing and safety equipment must be included in the Health and Safety Plan, or the Work Plan and/or Sampling and Analysis Plan (SAP).

Decontamination requires constant monitoring of supplies (such as chemicals, water, etc.). A large-scale operation requires close supervision and coordination of decontamination efforts; consequently, consideration should be given to assigning personnel specifically to decontamination duties. The exact level of effort needed for decontamination should be determined prior to starting the field work and be commensurate with the level of contamination anticipated. Procedures for personal decontamination of field personnel should be specifically addressed in the site-specific Health and Safety Plan. These procedures should be followed and incorporated with the equipment decontamination procedures contained in this SOP to mitigate exposure and cross-contamination potential. Decontamination activities should be documented to verify that proper procedures are followed. Quality assurance samples such as rinsate samples and equipment blanks shall be taken as required by the quality assurance plan. Documentation shall be in accordance with the requirements specified in the Work Plan, SAP, and/or QAPP.

Decontamination procedures may be subject to federal, state, or local regulations and/or the client's requirements. All such requirements must be satisfied but the procedures adopted should be no less rigorous than those presented in this SOP.

Climatic conditions anticipated during the decontamination activities may play a significant factor in the procedures selected. Special facilities may be needed to compensate for weather conditions such as temporary heated structures for winter work and wind screens for dust prevention. It may be necessary to establish special work conditions during periods of high heat stress.

2.2 Site Facilities and Supplies

2.2.1 Site Selection

The equipment decontamination site should be in an area where contaminants can be controlled and at the boundary of a "clean" zone. The location should also be selected to prevent equipment from being exposed to additional or other contamination. On large projects a formal "Contamination Reduction Zone" should be established in which all decontamination efforts will be conducted. This area should be conspicuously marked as 'off-limits' to all personnel not involved with the decontamination process.

The decontamination area should have adequate storage area for storing unused drums, used drums containing spent decontamination fluids and waste, and trash containers, until such time that they can be relocated or disposed offsite in accordance with SOP-1100.

2.2.2 Decontamination Pad

One type of decontamination area is a reinforced, curbed concrete pad sloping to a corner where a collection area is located. The pad should be large enough to hold the largest piece of equipment used on the project that must be cleaned. An access ramp for the pad must be constructed. The collection area should be of sufficient size to contain enough fluid and by-products to clean the largest single piece of equipment completely (200 to 400+ gallons). A mechanism for removal of fluids and other materials from the collection area must be supplied so that they can be routinely collected, containerized and disposed of at other locations at some later time in accordance with SOP-1100.

Other methods of pad construction include using railroad ties or planking to form a curb and covering the entire area with plastic sheeting. Numerous other methods can be utilized; key elements are flexibility and the capability of improvising to meet specific site conditions. On small projects, a decontamination pad may not be necessary. Where only hand samplings or other small equipment work is being conducted, several small wash tubs (filled with soap and potable water) may be sufficient for decontamination.

2.2.3 Water Supply

Large volumes of water may be required for cleaning, especially for drill rigs and other large equipment. The water used for equipment decontamination must be clean, potable water; municipal water supplies are generally adequate.

To ensure the water supply is clean, chemical analysis of the water at its source and analysis of the water after it has been stored in the tank should be obtained prior to use at the site.

2.2.4 Cleaning Equipment and Supplies

A portable steam cleaner or high-pressure hot water washer is normally required to clean drilling equipment as well as materials and associated equipment. Most washers and steam cleaners are commercially available for both portable generators or supplied AC power. Site logistical considerations may control the type of equipment required. Typical steam cleaners/washers operate on relatively low water consumption rates (2 to 6 gpm) and can be used in conjunction with other cleaning fluids mixed with the water.

On some small projects, garden sprayers may be utilized for final rinsing or cleaning. Typically, these sprayers are for use with small hand tools or sampling equipment.

Decontamination solutions, other than potable water, may be required to adequately clean the equipment or neutralize some contaminants. These solutions vary from "normal", low sudsing detergent and water to various organic solvents and acids. These materials must be stored either in a protected (dry chemicals) or outside (flammable liquids) environment. Storage areas must be secure and flammable chemicals should be located away from buildings and high traffic areas. Federal, state or local laws may dictate the storage methods. A list of general purpose compounds/solutions used for decontamination, their mixing ratios and typical uses are provided on Table 1020-1; other materials and solutions are available.

Miscellaneous items typically required for decontamination efforts include some of the following:

- Brushes - to remove heavy muds, dust, etc.;
- Racks - normally metal (not wood) to hold miscellaneous equipment such as drill rods, sampling tools, etc.;
- Utility pump - to collect spent fluids for containerizing;
- Paper Towels - to dry off equipment;
- Drums - to store contaminated materials;
- Tables - (not wood) to hold small items after/during cleaning;
- Plastic sheeting - to wrap decontaminated equipment, tools, etc., after cleaning.

Attachment 1020-1 to this SOP presents a checklist of decontamination equipment typically used for hazardous waste investigations. Supplies may also be needed other than shown on this checklist.

2.2.5 Personnel Protection

Personnel involved in the decontamination process can be exposed to significant concentrations of various contaminants. The level of protection for decontamination personnel must be addressed in the health and safety plan. Typically, those personnel are equipped with the same protective equipment as those conducting the on-site investigation until a lower level of risk can be confirmed.

2.3 Drilling Equipment and Vehicle Decontamination Procedures

The following procedures are presented as a function of the level of contaminant concentration and are intended as general guidelines.

Appropriate site procedures should be established based on the individual site characteristics and type of investigation prescribed.

1. Low to Moderate Contaminant Concentration:
   a. Steam or water rinse with potable water to remove mud or dirt,
   b. Steam or hot water wash with a mixture of detergent and potable water or other type of decontamination solution,
   c. Steam or hot water rinse with clean, potable water, and
   d. Air dry.

2. High Contaminant Concentration:
   a. Steam rinse with potable water to remove mud or dirt,
   b. Rinse critical pieces of sampling or drilling equipment with organic solvent and or acid solution,
   c. Steam wash with a mixture of detergent and potable water or other type of decontamination solution,
   d. Steam rinse with clean, potable water, and
   e. Air dry.

During decontamination of drilling equipment and accessories, clean the inside of hollow-stem auger flights, drill rods and drill bits (particularly roller bits), as well as all couplings and threads. Generally, decontamination can be limited to the back portion of the drill rig and those parts which come in direct contact with samples or casing, or drilling equipment that is placed into or over the borehole. Some items of drilling equipment cannot typically be decontaminated; these include wood materials (planks, etc.), porous hoses, engine air filters, etc. These items should not be removed from the site until they are ready for disposal in an appropriate manner.

Other drilling equipment (especially rotary drill rigs) that require extensive decontamination are water or grout pumps. Flushing may suffice to clean them. However, if high concentration of constituents or visible product is

known to exist, then disassembly and thorough cleaning of internal parts is required prior to removal of the equipment from the site.

The mud pumps, kelly, swivel, kelly and suction hoses on rotary drill rigs should be cleaned by circulating a sufficient volume of clean water and cleaning solution through the system followed by a clean water rinse through the system.

2.4 Sampling Equipment Decontamination Procedures

All sampling equipment which may contribute to the potential contamination of a sample must be thoroughly decontaminated prior to its initial use, unless specific documentation exists that the sampling equipment has been decontaminated.

Generally, sampling equipment can be cleaned by hand. The following procedure is given as a typical sequence which should be modified to be consistent with on-site conditions:

- Scrub with potable water to remove mud and residue,
- Scrub with a non-phosphate detergent-potable water solution or other decontamination solutions using a hard bristle brush,
- Rinse with clean potable water,
- Rinse with an approved organic or metal solvent,
- Air dry, and
- Package and seal equipment in plastic bags or other appropriate containers to prevent recontamination.

Use of high pressure seam or hot water washing may be substituted for hand scrubbing if it effectively removes contaminants and soil and can be done

safely without burning or contaminating the personnel. Special racks should be used to hold equipment while high pressure washing.

Split-spoon, split-barrel, and Shelby tube samplers are commonly used to obtain soil samples at hazardous waste studies. Most samplers contain a ball-check valve above the sample barrel which should be thoroughly decontaminated prior to reuse.

Steel tapes, water probes, transducers, thermometers and water quality meters shall be rinsed in deionized water (demonstrated analyte-free) or cleaned in a non-phosphate detergent solution and rinsed once in deionized water after each use.

Bailers, sample containers and laboratory equipment shall be decontaminated as follows:

- Wash and scrub with a non-phosphate detergent
- Tap water rinse
- Optional organic rinse
- Optional metals rinse
- Deionized water rinse
- Air dry
- Wrap in protective packaging for transport

Liquids except methanol, acetone, and hexane shall be handled in accordance with site-specific SAPs developed for a particular project. Methanol, acetone, and hexane waste shall be minimized and disposed in a controlled manner as required by local authorities. If organic solvents such

as methanol, acetone, or hexane are used, then their use, and criteria for their use, will be described in the SAP.

2.5 Well Materials Decontaminated Procedures

Well-casing, whether constructed of PVC, stainless steel, or other materials, must be cleaned thoroughly before it is installed. The well casing supplier should supply documentation of cleanliness. In lieu of supplier documentation, the following decontamination procedure will generally be used or adapted as appropriate for site conditions.

- High pressure hot water steam wash with a non-phosphate detergent and potable water solution, organic or acid rinses (if appropriate) or other types of decontamination solution;
- High pressure hot water or steam rinse with clean potable water;
- Air dry or wipe dry; and
- Wrap with plastic to prevent contamination.

A typical decontamination procedures checklist is provided as Attachment 1020-2. Significant variations may be required due to site-specific conditions.

3.0 REFERENCES

Felter, C.W., Jr., "Potential Sources of Contamination in Groundwater Monitoring," Groundwater Monitoring Review, Spring, 1983.

Morely, R.L., "Monitoring Well Basics - Equipment Decontamination, Groundwater Age," April, 1985.

U.S. EPA, "Technical Methods for Investigating Sites Containing Hazardous Substances," Technical Monograph No. 23, draft, June, 1981.

U.S. EPA, (Region VII) and Union Pacific Railroad, "Hazardous Materials First Responder Course."

SOP-1020 - ATTACHMENT 1
CHECKLIST OF DECONTAMINATION EQUIPMENT

_____ Potable Water Supply

_____ Decontamination Solution(s)
- _____ detergent:
- _____ solvent:
- _____ other:

_____ Cleaning Accessories
- _____ water supply hoses with proper couplings
- _____ wire-bristle brushes
- _____ buckets
- _____ soft cloths, sponges

_____ Steam or hot water high pressure cleaning unit

_____ Decontamination/Storage Facilities
- _____ drilling rigs, vehicles
- _____ sampling equipment
- _____ well casing

_____ Waste water holding facility or discharge permit (if required)

TABLE 1020-1
GENERAL PURPOSE DECONTAMINATION SOLUTIONS

Chemical	Solution	Uses/Remarks
Clean, Potable Water	None	Used under steam or high pressure hot water to remove mud, dirt, or residues or rinse other solutions.
Low-Sudsing Detergent	Follow the mixing instructions written on the particular product label.	Generally has the widest range of use. Best choice on sites where contaminant is unknown or a wide range of contaminants exists.
2% Trisodium Phosphate (Na_2PO_4)TSP	To 10 gallons of water, add 4 pounds of trisodium phosphate	Useful for solvents and organic compounds (such as toluene, chloroform, trichloroethylene) and PCB's
Ethylenediaminetetra-acetic acid (EDTA, versene, sequestrene)	Commercial product, follow product label	EDTA is a chelating agent and is the decontaminant of choice for heavy metal contaminants.
3% to 5% citric, tartaric, oxalic acids or their respective sodium salts	To 10 gallons of water, add 4 pounds citric, tartaric or oxalic acid	These compounds are chelating agents and are a decontaminant of choice for heavy metal contaminants
Organic solvents, such as acetone, methanol, methylene chloride	Used concentrated.	Organic solvents are used to clean drilling equipment, if contaminated with organics, well casing to remove surface oils, etc. The use of an organic solvent for decontamination should be approved by the project manager to assure that the solvent is not one of the potential site contaminants.

Notes:
Some information in this table has been adapted from the U.S. EPA "Technical Methods for Investigation Sites Containing Hazardous Substances," Technical Monograph No. 23, June, 1981, Table 23-1.

SOP-1020 - ATTACHMENT 2
CHECKLIST OF DECONTAMINATION PROCEDURES

Sampling Equipment

_____ Wash (scrub) with potable water
_____ Wash (scrub) with detergent and potable water (or decontamination solution)
_____ Potable water rinse
_____ Organic solvent rinse
_____ Air or wipe dry
_____ Package to prevent contamination

Drilling Equipment - Low to Moderate Contamination

_____ Steam rinse with potable water to remove mud
_____ Steam wash with detergent and potable water (or decontamination solution)
_____ Steam rinse with potable water
_____ Air Dry

Drilling Equipment - High Contamination

_____ Steam rinse with potable water to remove mud
_____ Organic solvent rinse (critical pieces)
_____ Steam wash with detergent and potable water (or decontamination solution)
_____ Steam rinse with potable water
_____ Air dry

Well Materials

_____ Swab surfaces with organic solvent
_____ Steam wash with detergent and potable water (or decontamination solution)
_____ Steam rinse with potable water
_____ Air or wipe dry
_____ Cover to prevent contamination

STANDARD OPERATING PROCEDURE-1030
FIELD QUALITY ASSURANCE SAMPLES

STANDARD OPERATING PROCEDURE-1030
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STANDARD OPERATING PROCEDURE-1030
FIELD QUALITY ASSURANCE SAMPLES

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-1030 (SOP-1030) describes requirements and typical frequencies for preparing and submitting quality assurance (QA) samples for chemical analyses along with site media to support the validity of chemical data generated for the sampling event.

1.2 Scope Covered by SOP-1030

- General requirements
- Types and purposes of QA samples
- Preparation of QA samples
- Suggested frequency of submitting QA samples

1.3 Related Procedures and Documents

- Groundwater sampling procedures (SOP-620)
- Surface water sampling procedures (SOP-630)
- Soil and sediment sampling procedures (SOP-710)
- Sample containers, preservation, and holding times (SOP-910)
- Equipment decontamination (SOP-1020)
- Sample labeling and custody procedures (SOP-1040)
- Calibration and maintenance methods (SOP-1060)
- Sampling and Analysis Plan (SAP)
- Quality Assurance Project Plan (QAPP)

1.4 Work Specifications

Preparation and submittal of field QA samples shall be conducted in conformance with the procedures described in this SOP, including the prescribed type and frequency for site media, unless otherwise prescribed in the Work Plan, SAP, or QAPP. In the event there is a substantive conflict in the specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 Definitions of Standards

Definitions of terms and adopted standards shall be in accordance with an attachment to this SOP, if so provided. Otherwise, it is intended that they be consistent with those used or implied in the Work Plan, SAP, QAPP, or other parent document referencing this SOP.

1.6 Health and Safety Considerations

This procedure may involved exposure to impacted waters or soils via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 EXECUTION

2.1 General Requirements

Quality Assurance (QA) samples should be included within each separate sampling event as a means of evaluating the validity of chemical data. The use of QA samples should provide sufficient evidence to conclude that media samples are representative of the insitu state of the media, and that chemicals found within them are not overtly affected by chemicals from outside sources or cross-contamination.

Field QA samples may include one or more of the following types:

- Replicates (Duplicates)
- Equipment Blanks
- Field Blanks
- Trip Blanks

Media for QA sampling should be of similar physical conditions as the site media being sampled (i.e., soil, liquid, vapor), so that the QA sample is likely to be contaminated the same way and by the same degree as would the site media being sampled.

All QA samples may be submitted to the laboratory "blind". Accordingly, a sample identification should be used that does not designate the QA samples as being different from the actual site media samples collected. This method is to be specifically stated in the WP and SAP.

2.2 Replicate Samples

2.2.1 Replicate Purpose Types

Replicate samples provide duplicate or additional specimen or aliquots from the same sample by dividing the original sample at some point in the measurement process. Field replicates are split in the field for potential repeat testing of essentially the same sample at a given laboratory, or they may be split and tested at different laboratories. Replicates may be discrete or composite; however, each replicate must be prepared the same.

Replicates from discrete samples must come from the same sample; that is, they must be divided from a portion of the sample taken from the same interval at the same time. For example, discrete replicates would be:

- For solid sample media, the replicates could be divided from the same sampler device at a particular depth taken at the same location and time.
- For groundwater (non-volatile organics), the replicates would be divided from the contents of the same bailer full of water after the contents were emptied into a collection container and mixed. Replicates from composites should only be taken after the composited materials have been thoroughly blended to insure uniformity.
- For volatile organic samples, replicate groundwater samples will be collected from the contents of the same bailer full of water, and this replicate sample is to be collected directly from the bailer after collection of the initial sample.

2.2.2 Replicate Preparation and Sampling

Replicate (duplicate) soil samples or other solid matrices obtained with discrete samplers should be prepared as follows:

- Select the vertical interval of the cylindrical soil core to be replicated.
- Split the section in half along the length of the core, then split each half in half along its length into quarters.
- Combine diametrically opposite quarters from the core sections to create two duplicate samples.

A composite replicate from each coring or sampling interval may be required to obtain the necessary volume of soil material to fill each sample aliquot for required analysis. In this case, select additional vertical core sections along the entire length of the core as is both available and representative, then repeat the process described above. For instance, if the available total core length from a particular sampling interval is 18 inches long, the top and bottom 6-inch long sections could be selected for additional chemical analysis, discrete replication, or geotechnical testing. In this example, equivalent proportions from both the top and bottom sections would be included in each sample aliquot.

For aqueous matrices (non-volatile organics), the replicates may be prepared as follows:

- Obtain aqueous sample from well, surface body, or container and pour contents of the sampler into a single collection container.
- If one sampler volume is not adequate for all required specimens and replicates, then a composite of more than one sampler volume should be made.
- The collection container should have only limited air space available to limit volatilization during blending. The agitation while decanting the sample into the collection container should be adequate to mix the sample from one or more samplers.

- Decant equivalent amounts from the collection container into appropriate jars or vials to create replicates.

For aqueous matrices for volatile organics analysis, incrementally fill all sample containers directly from the sampler.

Replicates may be spiked into the laboratory to determine the extent of matrix bias or interference on analyte recovery and sample to sample precision. The frequency required for obtaining replicates of site media samples is provided as specified in the SAP or QAPP.

2.3 Equipment Blanks

2.3.1 Equipment Blank Purpose

Equipment blanks are artificially prepared matrix-similar samples used to evaluate whether field equipment has been adequately cleaned so as not to yield a false-positive concentration of contaminants. Positive results from blanks should not be used to correct results from site media samples, but rather should be used to identify a problem and warrant action to correct the source of cross-contamination.

2.3.2 Solid Matrix Equipment Blank Preparation and Sampling

For solid, non-aqueous matrices, equipment blanks (if necessary) may be composed of one of the following soil materials:

- Clean Ottawa Sand,
- Diatomaceous earth,
- Sterilized inorganic soil, or
- Deionized water

The soil-like equipment blank, if used, should be prepared (using deionized water) to a moisture content approximately that of the media to be collected. Dry material should be avoided, as it may be overly absorptive of airborne contaminates (particularly true for diatomaceous earth). The soil-like equipment blank should be prepared each day on-site in a clean area subject to normal ambient conditions but away from sources by hydrocarbons, solvents, fuels, or engine exhausts. Place the prepared material into cleaned containers to be used for environmental soil samples.

Transport equipment blank to field in sample shuttle (cooler). Between selected sample intervals or locations, open the equipment blank container and place in intimate contact with sampling equipment as follows:

- For previously cleaned soil samplers, place cleaned cap on or cover with the hand (with clean glove) one end of the sampler and pour or place soil-like equipment blank or deionized water into sampler. Cover or cap other end and stir around in sampler by repeatedly inverting and rotating. Extrude if necessary and replace into original equipment blank container and treat as any other soil sample.
- For small sampling tools, simply stir the equipment blank material in the jar with the tools, recap, and handle blanks as any other soil sample.

2.3.3 Aqueous Equipment Blank Preparation and Sampling

For aqueous equipment blanks, two methods are available as follows:

- Prepared container
- Rinsate sample

For the prepared container equipment blank, a pint jar is filled to near full with deionized water. For the rinsate sample, deionized water is rinsed over equipment components that came into contact with the sample, then collected in a sample jar.

Transport prepared container of aqueous equipment blank to field in sample shuttle. Stir small sampling tools and probes of field instruments that come into direct contact with site media in the water in the container. Handle and preserve blank as for the media being sampled.

For rinsate samples, hold samplers and tools over a cleaned sample container. Using a squirt bottle, rinse the equipment with deionized water sufficiently to collect sample quantity for analysis. For larger specimen quantity requirements, pour additional deionized water from a supply container over the equipment into a collection container then decant into the appropriate sample containers. Handle and preserve as for the site media being sampled.

2.4 Field Blanks

2.4.1 Field Blank Purpose and Preparation

Field blanks are matrix-similar samples, artificially prepared, used to evaluate background or ambient conditions and handling procedures that may affect the results of site media samples. Positive results from field blanks should not be used to correct results from site media samples, but rather should be used to identify potential sources of false positives due to ambient conditions or handling procedures in the field.

Field blanks should be prepared identically as for equipment blanks previously described, except that no rinsate samples would be prepared.

2.4.2 Field Blank Sampling

Field blanks should be sampled by opening the sample container of material during the entire time that a site media sample is exposed to ambient conditions. The field blank should remain open in the general area of the sample handling activity, but in such a place that is not subject to airborne or other undesirable contamination to which a site-media sample would not also be subject.

Close the field blank container at the completion of the sampling intervals activity and handle and preserve as for any other site media.

2.5 Trip Blanks

2.5.1 Trip Blanks Purpose and Preparation

Trip blanks are media-similar samples, prepared in the analytical laboratory, shipped with the cleaned sample containers (usually provided by the laboratory), carried through the field sampling activity, and returned to the laboratory, having never been opened.

Trip blanks should be used by the laboratory to evaluate whether 1) the laboratory is contributing cross-contamination to tested samples either via the sample containers it provides or via laboratory contaminants during the test; or 2) contaminants are falsely introduced into site-media during handling at the laboratory or during shipping due to contaminants being on the outside of the sample container. Positive results should not be used to correct results of analysis on site media samples, but rather should be used to identify sources of false positives due to inadequate procedures an to enact correction of the problem.

Trip blanks should ideally be prepared using materials similar to the site media; however, typically deionized or water identified as Type II reagent grade will be used.

2.5.2 Trip Blank Sampling

Place trip blank into field sample shuttle (cooler) along with sample containers for site media. Sample shuttle should remain shut except to take out or place in a sample container from that time until it is returned to the site sample dispensing area.

At a selected sampling interval or location, take out the trip blank along with sample containers for that sampling interval or location. Do not open the trip blank container.

Sample site media as per the SAP. Label and handle the trip blank as for any other sample at that location.

STANDARD OPERATING PROCEDURE-1040
SAMPLE CONTROL AND CUSTODY PROCEDURES

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STANDARD OPERATING PROCEDURE-1040
SAMPLE CONTROL AND CUSTODY PROCEDURES

1.0 SCOPE OF PROCEDURE

1.1 Purpose of Procedure

Standard Operating Procedure-1040 (SOP-1040) describes the procedures for controlling sample identification and custody in order to maintain the quality of samples during collection, transportation, and storage for analysis.

1.2 Scope Covered by SOP-1040

- Sample Identification Labels or Tags
- Transfer of Sample Custody and Shipment
- Chain-of-Custody Forms
- Custody Seals
- Calibration/Maintenance Documentation

1.3 Related Procedures and Documents

- Field Reporting and Documentation (SOP-210)
- Sample Containers, Preservation, and Holding Times (SOP-910)
- Sample Classification, Storage, Packaging, and Shipment (SOP-930)
- Sampling and Analysis Plan (SAP)

1.4 Work Specifications

Sample control and custody procedures shall be conducted as described herein for all sampling activities associated with the site as specified in the Work Plan or SAP referencing this SOP. In the event there is a conflict in the specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.