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# Chromate Remediation Pilot Study Work Plan

ChevronTexaco
Eunice, New Mexico

**PREPARED FOR**

ChevronTexaco Exploration and Production

ARCADIS

*Infrastructure, buildings, environment, communications*

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# Chromate Remediation Pilot Study Work Plan

ChevronTexaco
Eunice, New Mexico

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## Table of Contents

## Tables

## Figures

## Appendices

## Introduction

ChevronTexaco Exploration and Production Inc. (ChevronTexaco) has retained ARCADIS G&M (ARCADIS) to conduct remedial activities at the Eunice #2 (North) Gas Plant (Site). The purpose of this work plan is to define the implementation of a series of field scale pilot tests for chromate remediation. This includes the initial structure of the test with regard to layout, injection program, and monitoring.

The use of injectable soluble carbon substrates for the remediation of chromate impacted groundwater at the Eunice facility must take into account the effects of the following site-specific factors:

- Hydrogeology at the macro and micro scale. Geochemistry of the groundwater and mineral matrix.
- Microbial consortia present in the subsurface and the dynamic processes that can be stimulated in them.

The most efficient design and implementation of a remediation program requires accommodation for the above conditions. When the size of the impacted area is large the most economic and accurate method to gather data concerning the three key characteristics is to perform field scale pilot tests. This work plan describes how the pilot tests will be conducted.

## Background and Site Location

The gas plant was constructed in the 1940's, subsequently modified and currently operates as a compressor station. The site is located approximately 0.25 miles north of Eunice, New Mexico, in the southeast quarter (SE/4), of the northeast quarter (NE/4), and the NE/4 of the SE/4, Section 21, Township 21 South, and Range 37 East. Figure 1 presents a site location map and Figure 2 presents a site plan map, with structures, water wells and groundwater monitoring wells.

## Geologic Setting

The plant site lies within the Eunice Plain, which extends north and south from the Texas-New Mexico state line to midway between Hobbs and Eunice. It extends east and west from the Texas-New Mexico state line to the San Simon Ridge, west of Eunice about 20 miles. The geologic formations of interest at the site include from oldest to youngest, the Triassic Chinle, Cretaceous undifferentiated, Tertiary Ogallala and Quaternary alluvium, designated the Blackwater Draw formation. Of particular interest with regard to the impact of a chromate release to groundwater are the Tertiary Ogallala and Quaternary alluvium.

Resting directly upon an erosional surface carved into the Triassic Chinle formation under the site, the Tertiary Ogallala formation is composed of a heterogeneous combination of clay, silt, sand and gravel. The fluvial sediments were deposited on a sloping plain in the form of coalescing alluvial fans, by streams that originated in the Rocky Mountains to the west and northwest. The Ogallala was deposited in laterally restricted lenses of material, predominantly medium to yellowish-gray conglomeratic sandstone and fine to medium-grained well sorted sandstone. The primary fresh water bearing formation under and in the vicinity of the plant site is the Ogallala formation.

In contrast to the fluvial deposition of the lower Ogallala sediments, the upper part of the Ogallala (and all of the Blackwater Draw formation overlying the Ogallala) are windblown deposits.

The Blackwater Draw formation occurs near the surface at the plant site. It contains reddish sediments composed of up to six well-developed buried soils with similar features of lithology and morphology. It has been determined that the Blackwater Draw formation was deposited during the Quaternary time period. Throughout the depositional time of the Blackwater Draw Formation, laterally restricted lenticular patterns of eolian and playa or lacustrine facies were formed. The soil development occurred during periods of landscape stability, separated by intermittent periods of deposition, or by deflation that stripped surface horizons from newly developed soils.

## Site Specific Hydrology

The lowest geologic unit described in site investigations is a firm red silty clay. Overlying this is a 5-10 foot interval of gravel/sand/clay, which is the deep water-bearing zone in the Ogallala aquifer at the site. The gravel unit is in turn overlain by a red to yellow sand that exhibits vertical heterogeneity with alternating layers of loose and well-lithified sand. This is the unit that contains the shallow water-bearing zone. Wells screened in the gravel unit have 40 to 50 feet of hydraulic head. Wells screened in the shallow water-bearing zone of the aquifer have screens that intersect the groundwater table and typically have 10 to 15 feet of saturation. Overall depth to groundwater varies roughly with local topography and ranges from 38 to 72 feet below the surface. Groundwater gradients in the shallow water-bearing zone are relatively flat. The groundwater gradient in the vicinity of the site is shown on Figure 3.

The primary aquifer containing fresh water at the site is contained in the Ogallala formation. (The groundwater in the area may extend close enough to the land surface to reside in the eolian portion of the upper Ogallala, but lies below the Blackwater Draw Formation.) The water contained in the Ogallala is technically under unconfined conditions. However, if a well is screened in the lower portion of the aquifer and is subjected to a short (generally less than 72 hour) pump test, the test data indicates confined storage coefficients. This is due to the poor vertical to horizontal permeabilities, and the lenticular nature of the deposition of the sediments.

Within the Ogallala, it has been found that the poor vertical and horizontal permeability from releases at the plant site has resulted in a wide difference in the occurrence of the chromium in the groundwater from releases at the plant site. The shallow and deep groundwater isoconcentrations for hexavalent chromium are shown on Figures 4 and 5, respectively. The shallow zone of the water-bearing unit is comprised of the shallow and a middle zone. For purposes of this remediation, the shallow and middle zones are treated as a single unit. The chromium plume is of much smaller areal extent in the deep portion of the aquifer than in the shallowest portion of the aquifer. This is the result of the poor vertical permeability, as well as the poor horizontal permeability that appears to occur in the lower portion of the aquifer. Based on pumping tests conducted in the shallow and the deep zones of the aquifer, the groundwater velocity is almost 100 times greater in the shallow zone than in the deep zone, 23 to 33 ft/yr and 0.4 to 0.5 ft/yr respectively.

The hydraulic gradient (and the elevation of the water levels) in the shallow and deep zones are quite similar, indicating that there is hydraulic conductivity between the zones (Figure 3). In fact, when the pumping tests were conducted on both the shallow and deep zones, even though there were not any observed responses in the other zone during testing, the middle zone between the shallow and deep zones reflected the pumping of the separate individual shallow and deep zones.

As discussed above, the shallow and deep zones reflect similar water level elevations and hydraulic gradients, exhibiting a hydraulic high in the potentiometric surface southeast of the plant. The hydraulic gradient from this hydraulic high is to the southwest, west, northwest, north and northeast. The high is very likely due to the importation of water from outside the area of Eunice (from the Hobbs area), and the infiltration of return flow from park and residential lawn irrigation. Many cities in the arid southwest such as Midland and Lubbock demonstrate this mounding water table in the shallow aquifers beneath the parks and residential areas. This mounding alters the regional southeast hydraulic gradient that has been documented in the Eunice area in the past. This phenomenon will have to be considered in any remediation efforts conducted at the site that will be dependant on the local hydraulic gradient.

## In Situ Chromate Remediation

Remediation at the site is currently taking place via natural attenuation processes that remove both petroleum hydrocarbons and chromate. In areas were chromate and petroleum hydrocarbon impacts intermix, chromate has been removed by biochemical reduction driven by reactions with the petroleum hydrocarbon constituents. Chromate is also removed to a lesser degree by reaction with limited concentrations of native organic carbon, and limited concentrations of reducing inorganic constituents such as ferrous iron.

In the case of the chromate, in situ biological stimulation will be utilized to convert $Cr^{+6}$ to insoluble and innocuous $Cr^{+3}$, exploiting some processes that are unique to the biological systems as well as processes more akin to those utilized for the treatment of chromate laden industrial waste water.

Remediation of groundwater impacted with chromate will be implemented by the use of injection wells through which reagents will be introduced to stimulate biological activity that will cause the reduction of $Cr^{+6}$ to insoluble $Cr^{+3}$ by primary and secondary processes. The primary reagents will be soluble carbon substrates that will serve to stimulate biological activity, that will in turn produce low redox conditions. A variety of carbon substrates are available for use. Molasses and other soluble sugars are quick reacting, rapidly establishing the desired reducing conditions. Other carbon substrates, such as whey, offer similar reaction chemistry, but in a slow release form. Other materials have even slower reaction chemistry allowing increased active life in the aquifer and increased transport distances from individual injection points.

Chromate reduction will also take place by reaction with reduced inorganic species produced as a by-product of the stimulated primary bacterial activity. The dominant inorganic species produced by this process will be ferrous iron, with lesser concentrations of sulfides. Both can be produced by microbial action on iron and sulfate containing minerals in the native mineral matrix. Additional sources of reducing iron and sulfur species will naturally reside in the carbon substrates utilized, particularly in molasses. In the areas of the chromate plume that are the most distal from the injection points, the stimulated chromate reducing reactions are likely to be dominated by the presence of these reduced inorganic species. In some cases the economics offered by an enhanced radius of influence may justify the use of intentional supplementation of the injected carbon substrate with soluble iron or sulfate salts. The efficacy of iron as an inorganic reducing agent is particularly high for this type of application. When the ferrous iron reacts with chromate to form the $Cr^{+3}$ species it is oxidized to ferric iron. The ferric iron in the presence of a soluble carbon substrate is in turn biologically reduced to ferrous iron, beginning the chromate remediation cycle anew. This process works with great efficiency and significantly minimizes the requirement for supplemental inorganic reagents.

## Configuration of the Field Pilot Study

The physical key to the injection program is the design and location of the injection well arrays. It is possible that four distinct vertical zones of injection will be required. One is likely to be sufficient for the upper and middle zones of the Ogallala Sand.

The implementation of the injection system for the underlying clayey gravel unit is likely to be more complex. This unit is relatively thin, with a typical thickness of ten to fifteen feet. At its bottom it is in unconformable contact with Triassic clays and silts and at its top, it is in contact with the Ogallala Sand. It is not uncommon in units of this type, with high permeability contrasts, for there to be zones of preferential transport at the contact. The pumping tests performed to date indicate that the hydraulic conductivity of the clayey gravel is approximately three orders of magnitude less than that of the overlying Ogallala Sand. While no direct testing has been done, it is likely that the hydraulic conductivity of the Triassic clays and silts is at least another three orders of magnitude less than that of the clayey gravel. With such contrasts in hydraulic conductivity, it may be necessary to have injection wells that are discretely screened at either the upper or lower contacts of the clayey gravel, discreetly across the core of the clayey gravel, or (the simplest option if possible) with a continuous screen across the lower contact, the vertical extent of the clayey gravel layer, and its upper contact.

The site assessment has shown a distribution of chromate within the lower clayey gravel unit that is not possible (given the time frames of the release and groundwater velocities that are in the range of 0.1 foot per year) assuming that transport has simply been horizontally through the interior of the unit. It is most likely that transport has taken place through secondary porosity that vertically transects the clayey gravel unit. The ideal injection program will be designed to naturally exploit these features, if present. This would consist of a focus for the injection of the reactive solutions along the lower and upper contact. With sufficient volumes and reagent concentrations, secondary porosity could be exploited. In addition, high chemical concentration gradients will stimulate high rates of diffusion and osmotic flow (possible because of the clay constituents) into the interior.

The pilot evaluation of the injection of soluble carbon substrates for in-situ remediation of soluble chromate must include determination of key design parameters that fall into general categories, as well as, specific issues within each. These include:

- The hydrodynamics of the water bearing zones to be treated.
    - The magnitude of lateral dispersion as injection solutions are carried away from an injection point.
    - The impact of vertical and horizontal heterogeneity under pressure injection conditions.
    - The possible impact of hydraulic gradients induced by proximal extraction wells or water flood injection wells.
- The impact of the injected carbon substrates on the biogeochemical state of the treatment zones and ultimate efficacy of chromate remediation.
    - How long will it take to create oxidation reduction potential (ORP) conditions that are at a minimum iron reducing?
    - Will the rate of chromate reduction vary with continued decreases of ORP, the use of supplemental iron, or type of carbon substrate?
        - What is the most cost effective approach (taking into account reagent costs versus duration of effort)?
- The transport properties of the carbon substrate.
    - The rate of carbon substrate consumption under relatively static flow conditions.
        - This is driven by the rate at which the indigenous bacterial populations can grow given stimulation.
    - The rate of carbon substrate consumption under flowing conditions.
        - This is driven by the above, as well as the effective porosity of the treatment zone, and the existing bacterial population numbers.
- The effect of the chemistry of the carbon substrate on the rate of biological utilization.

- It must be sufficiently bioactive to stimulate the required ORP conditions given the local groundwater velocity.
- It should not be so bioactive that it is consumed within a short distance from the injection point.
- The attenuation rates of chromate under treatment conditions and the geochemical parameters which will govern the reduction of soluble hexavalent chromium to the insoluble trivalent form.

The answers to the above issues are in many cases interrelated. A pilot study is by definition a largely empirical process that is designed to cost effectively yield the design parameters required given the complexity of the inter-related processes described above. The injection arrays are located and screened to exploit these physical chemical processes using an iterative process that evaluates the effect of injection wells as they are installed and operated.

## Injection and Monitor Well Layout

The complex water-bearing zone will be evaluated with three separate injection locations. Detailed maps of the three injection sites (MW011, MW012 and MW008A) with total and hexavalent chromium concentrations are presented in Figures 6 through 8, respectively.

The configuration of the three pilot systems can be outlined as follows:

MW011 Area

- Injection Well 1 (IW001) – Screened between 40 to 95 feet.
    - Terminates at surface of clayey gravel.
  - Monitor Well 11 (MW011) – Screened between 47 and 62 feet.
    - Terminates in sand unit.
    - Located 38 feet from the injection well.
  - Monitor Well 11M (MW011M) – Screened between 80 to 90 feet.
    - Terminates in sand unit.
    - Located 36 feet from the injection well.
  - Monitor Well 11A (MW011A) – Screened between 107.5 and 115.0 feet.
    - Terminates in Triassic redbed.
    - Located 40 feet from the injection well.
  - Recovery Well 2 (RW002) – Screened between 48 and 68 feet.
    - Terminates in sand unit.
    - Located 15 feet from the injection well.

MW012 Area

- Injection Well 2 (IW002) – Screened between 40 to 90 feet.
    - Terminates two feet above lower clayey gravel.
    - Monitor Well 12 (MW012) – Screened between 45 and 65 feet.
        - Terminates in sand unit.
        - Located 36 feet from the injection well.
    - Monitor Well 12M (MW012M) – Screened between 80 and 90 feet.
        - Terminates in sand unit.
        - Located 38 feet from the injection well.
    - Monitor Well 12A (MW012A) – Screened between 106.1 and 113.6 feet.
        - Terminates in Triassic redbed.
        - Located 28 feet from the injection well.
    - Recovery Well 3 (RW003) – Screened between 45 and 65 feet.
        - Terminates in sand unit.
        - Located 15 feet from the injection well.

MW008A Area

- Injection Well is Recovery Well 004A (RW004A) – Screened between 95 and 115 feet.
    - Terminates in Triassic redbed.
    - Monitor Well 8 (MW008) – Screened between 46.6 and 66.1 feet
        - Terminates in sand unit.
        - Located 28 feet from the injection well.
    - Monitor Well 8M (MW008A) – Screened between 75 to 85 feet
        - Terminates in sand unit.
        - Located 24 feet from the injection well.
    - Monitor Well 8A (MW008A) – Screened between 105.5 and 113.4 feet
        - Terminates in Triassic redbed.
        - Located 16 feet from the injection well.

This configuration is designed to evaluate the hydraulic character of the upper and mid levels of the sand unit (Shallow Zone) as well as the intrinsic character of the gravelly clay (Deep Zone) and its relationship with the overlying sand unit. The primary difference between the three systems is the screened interval of the injection well. Injection Well 1 contacts the upper surface of clayey gravel. Injection Well 2 is screened only in the sand unit. Injection Well 3 terminates in the Triassic redbed and completely transects the clayey gravel.

## Injection Program

A Gant chart has been prepared as Figure 9 to illustrate the initially anticipated injection and monitoring program. The injection program will start with the injection of 200 gallons of 10% molasses into each of the three injection wells.

Based on the size of the chromate plume, and given the relatively flat hydraulic gradients at the site, it is possible that there is heterogeneity expressed as preferential pathways either in the sand unit, the clayey gravel unit, or where the sand unit contacts the clayey sand unit.

This complex hydrogeologic system has been previously evaluated with the performance of a series of pumping tests. The hydraulic performance of the system under injection conditions could be distinctly different than that seen under pumping conditions. This difference is due to the effect of an injection head versus localized head reduction under pumping conditions. Under pumping conditions an extreme hydraulic gradient may be on the order of 0.5 foot of vertical gradient to one foot of horizontal distance (0.5 foot per foot). This is two orders of magnitude greater than gradient commonly seen under natural flow conditions (i.e., 0.01 foot per foot).

Under injection conditions the maximum pressure of injection will be approximately 0.5 pound per square inch (PSI) per foot of depth to prevent the stimulation of hydrofracturing. For purposes of calculating the injection pressures, the top of the gravel pack in the well was used. This is the point at which hydrofracturing would most likely occur if pressure was applied to the well. The maximum injection pressure to be applied at the ground surface to IW001, IW002 and RW004A is 10 PSI, 10 PSI and 20 PSI respectively.

Aside from hydraulic gradient, two additional factors affecting the groundwater velocity are porosity and hydraulic conductivity. The porosity is typically 20 to 30%. However, the hydraulic conductivity can vary over seven orders of magnitude. Providing a source of hydraulic head that may be up to four orders of magnitude above the natural gradient can possibly result in significant preferential transport within the aquifer over significant distances. This in turn can have significant impact on the ultimate spacing of injection wells and injection well arrays.

The initial monitoring interval is designed to detect this type of preferential transport in the system. As the pilot program matures, the initial effects of any preferential transport will be overwhelmed by the general stimulation between the preferential pathways in the geologic matrix. Sampling intervals will be appropriately lengthened.

As an additional aid to this hydrogeologic evaluation, a bromide tracer will be used during the initial injection event and possibly during selected subsequent injection events. The concentration of the bromide tracer will begin at 300 mg/L. In the event that the bromide signal is masked by the natural bromide concentration of the water-bearing zone, the bromide tracer concentrations may be increased to, but will not exceed, 1,000 mg/L. The use of a conservative tracer may offer an enhanced transport signal between the injection wells and the various screened intervals in the monitor well networks.

If it appears that there is significant preferential transport, there may be some effort in the latter stages of the test to evaluate the potential of rapid injection transport between the individual injection set-ups. During the course of the pilot study, wells used for pumping tests can be used to create enhanced flow conditions by pumping, if required.

## Monitoring Program

The pilot test will be designed to yield the desired information in a 24-week test interval.

In addition to monitoring water levels it will be critical to monitor the biogeochemistry of the groundwater in the pilot test treatment zone. This will allow for the quantitative evaluation of the type of carbon substrate that will be required, the concentration of carbon substrate injection solutions, and the interval between injection events. The monitoring program will fall into two broad categories. The first are field parameters and the second are parameters that require laboratory analysis. Table 1 summarizes both types of parameters, as they are likely to be applied during the pilot test.

The need and use for each of the analytical parameters can be outlined as follows:

- The field parameters will provide instant data on conditions that in many cases are so sensitive to ambient ORP conditions that they would not remain stable during shipment to the laboratory. In particular this includes the ORP, dissolved oxygen, ferrous iron, and sulfides. Low flow sampling procedures and a multiprobe sampling head will be used to further facilitate the evaluation of these sensitive parameters.

- Analyses of total and dissolved chromium will evaluate the effectiveness of the chromium removal process. These analyses will speciate the chromium (differentiate between $Cr^{+6}$ and $Cr^{+3}$).

- Total alkalinity, TDS, Chlorides, calcium, sodium, magnesium, and potassium will provide information concerning general groundwater quality as well as aid in identifying groundwaters that may be of different origins.

- Bromide will be part of the tracer program.

- Analysis for arsenic will evaluate the potential impact of the program on other oxy-anionic species present in the mineral matrix.

- Nitrate, nitrite, ammonia, and phosphate analysis will provide information on trace nutrient levels in the treatment zone as well as the Redox impact of nitrate.

- Iron, manganese, sulfate, and sulfides analyses will be important indicators of the redox state of the water bearing zones before and after treatment.

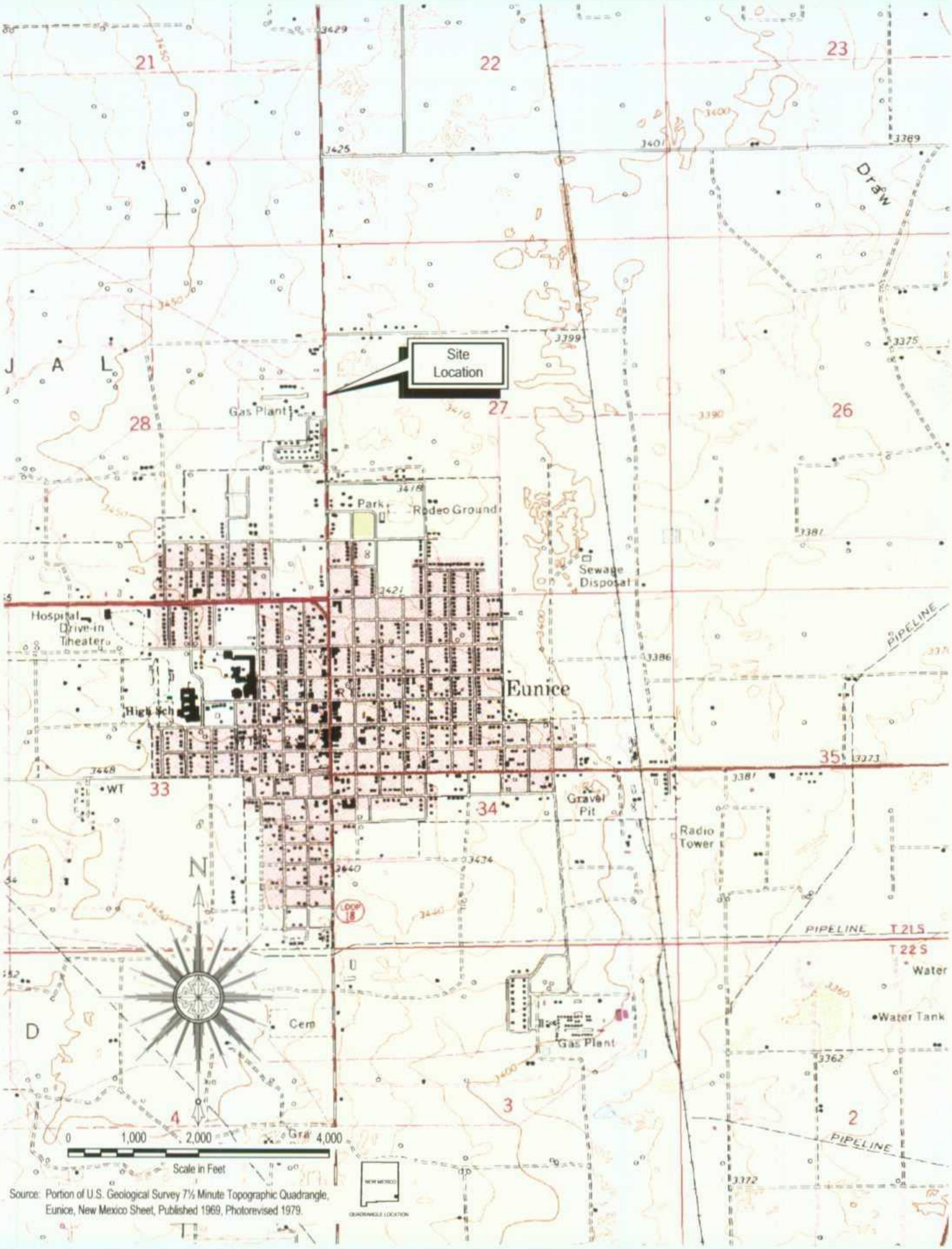
- Total organic carbon will provide information on the condition and concentration of the soluble carbon substrate.

- The permanent gases will provide information on the level of biologic activity, as well as the type of activity.

As the pilot-testing program is implemented and dynamic biogeochemical feedback becomes available, the monitoring and injection program may be modified appropriately.

## Conclusion

This pilot test program for in situ chromate remediation has been designed to evaluate a potentially complex multi-layer groundwater system. The exploitation of the site hydrodynamics and biogeochemistry will be optimized in order to design and implement a full-scale system in the most cost effective and rapid manner possible. During the course of the pilot study, brief quarterly reports will be produced to provide an outline of the progress of the study. A pilot status report will be submitted at the six-month point, and operation of the pilot for a period of six months will provide a majority of the occurred information. However, the pilot may be operational for a total of one year to gain all required information. At the end of one year of operation, a full report on the results will be prepared. A design for the full-scale remediation system will also be prepared at that time.



Source: Portion of U.S. Geological Survey 7½ Minute Topographic Quadrangle, Eunice, New Mexico Sheet, Published 1969, Photorevised 1979.

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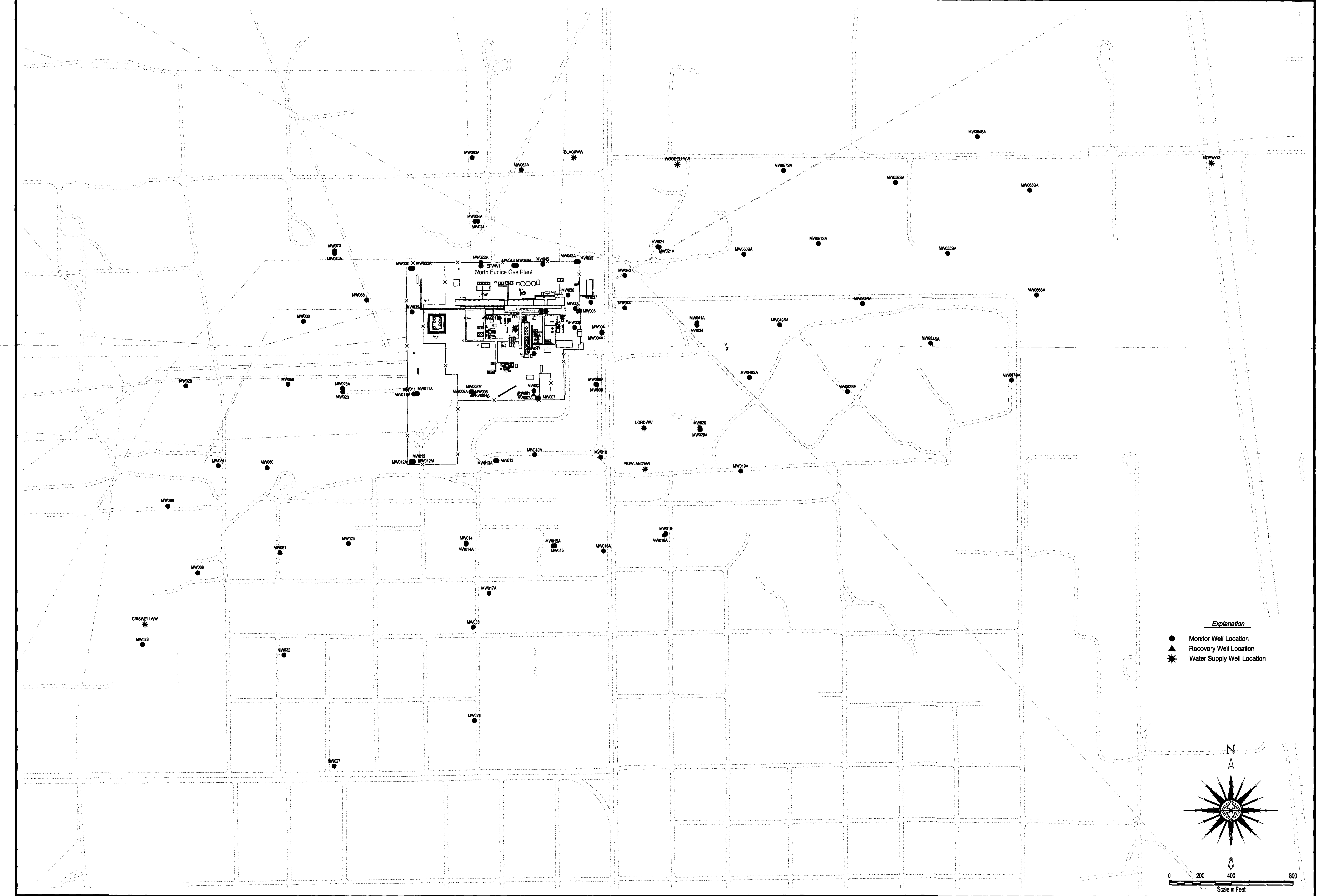
Chromate Remediation Pilot Study Work Plan

## SITE LOCATION MAP

Eunice #2 (North) Gas Plant, Lea County, New Mexico

Technical Review: S. Tischer
Unique Number: 31-014-00506
Project Number: MT000700.0005
Figure: 1



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## Site Plan

Eunice #2 (North) Gas Plant, Lea County, New Mexico

| | |
|---|---|
| Project Director<br>A.J. Reed | Area Manager<br>A. Schmidt |
| Task Manager<br>H. McConnell | Technical Review<br>S. Tischer |
| Project Number<br>MT000700.0005 | Figure<br>2 |

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## Hydraulic Gradient Map (March, 2003)

Eunice #2 (North) Gas Plant, Lea County, New Mexico

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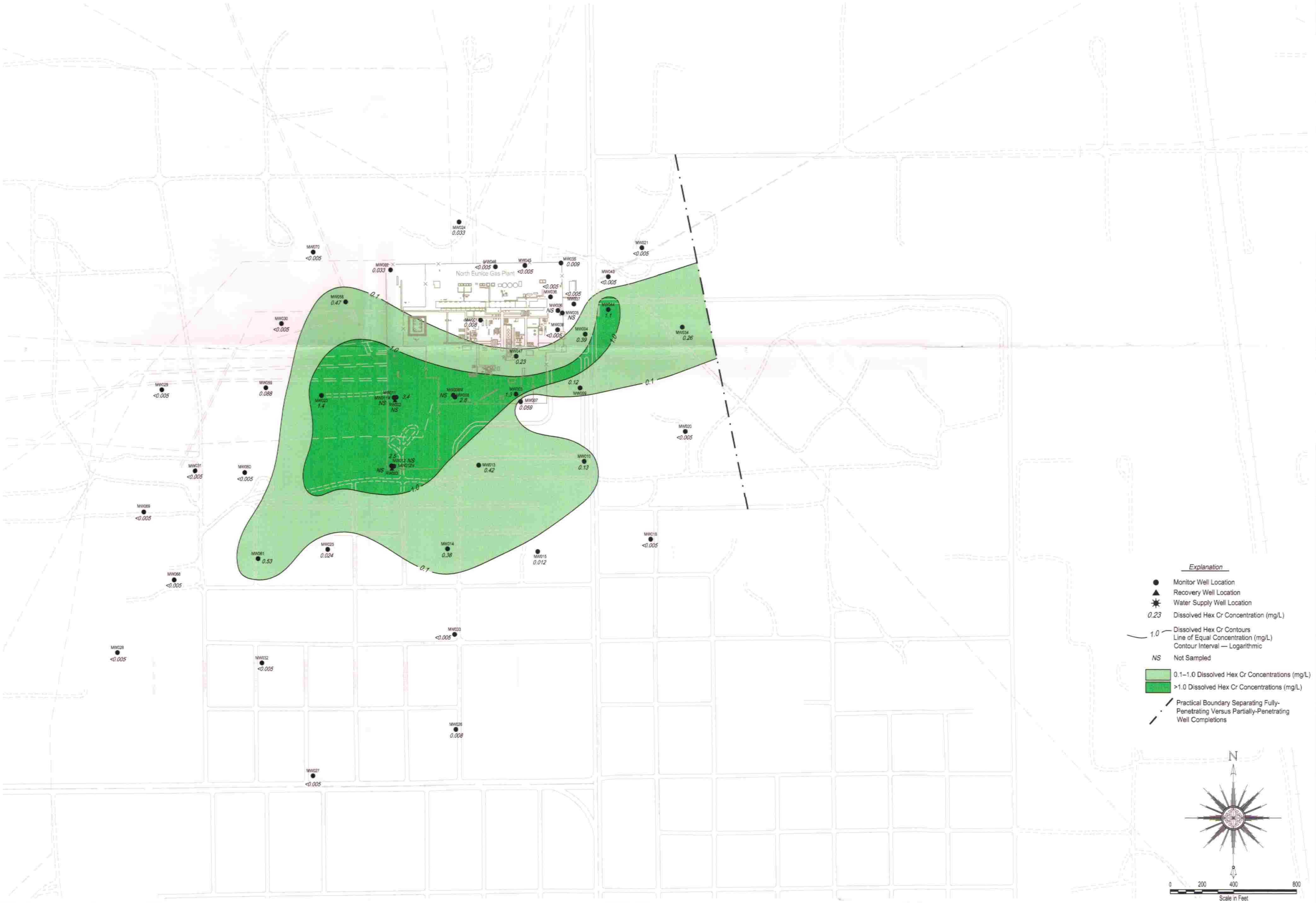
| Task Manager<br>H. McConnell | Technical Review<br>S. Tischer |
| Project Number<br>MT000700.0005 | Figure<br>3 |



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| | | | | | Task Manager<br>H. McConnell | Technical Review<br>S. Tischer |
| | | | | | Project Number<br>MT000700.0005 | Figure<br>4 |

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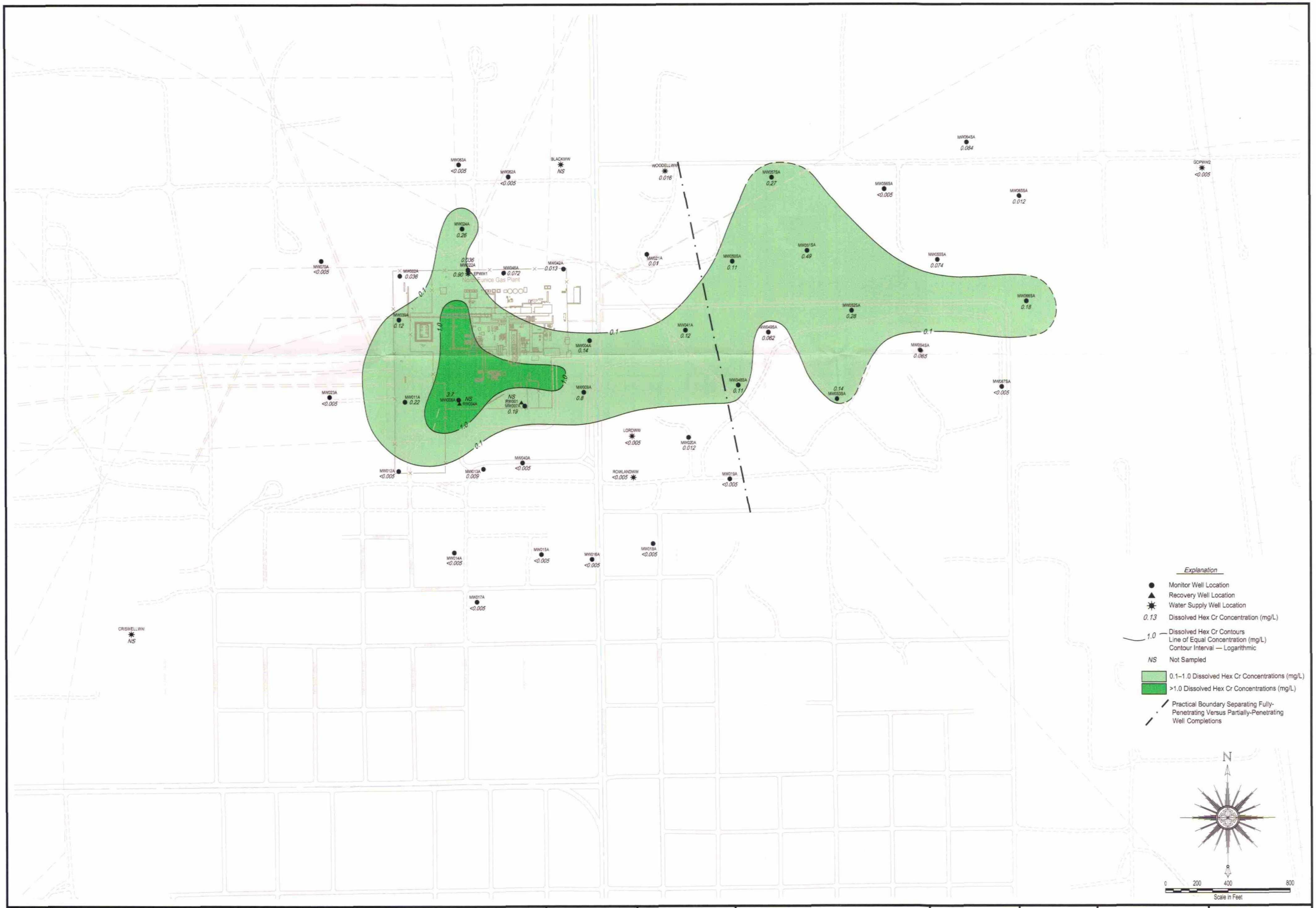
# Shallow Groundwater Isoconcentration Map (March, 2003)
# Dissolved Hexavalent Chromium (mg/L)

Eunice #2 (North) Gas Plant, Lea County, New Mexico



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Deep Groundwater Isoconcentration Map (March, 2003)
Dissolved Hexavalent Chromium (mg/L)

Eunice #2 (North) Gas Plant, Lea County, New Mexico

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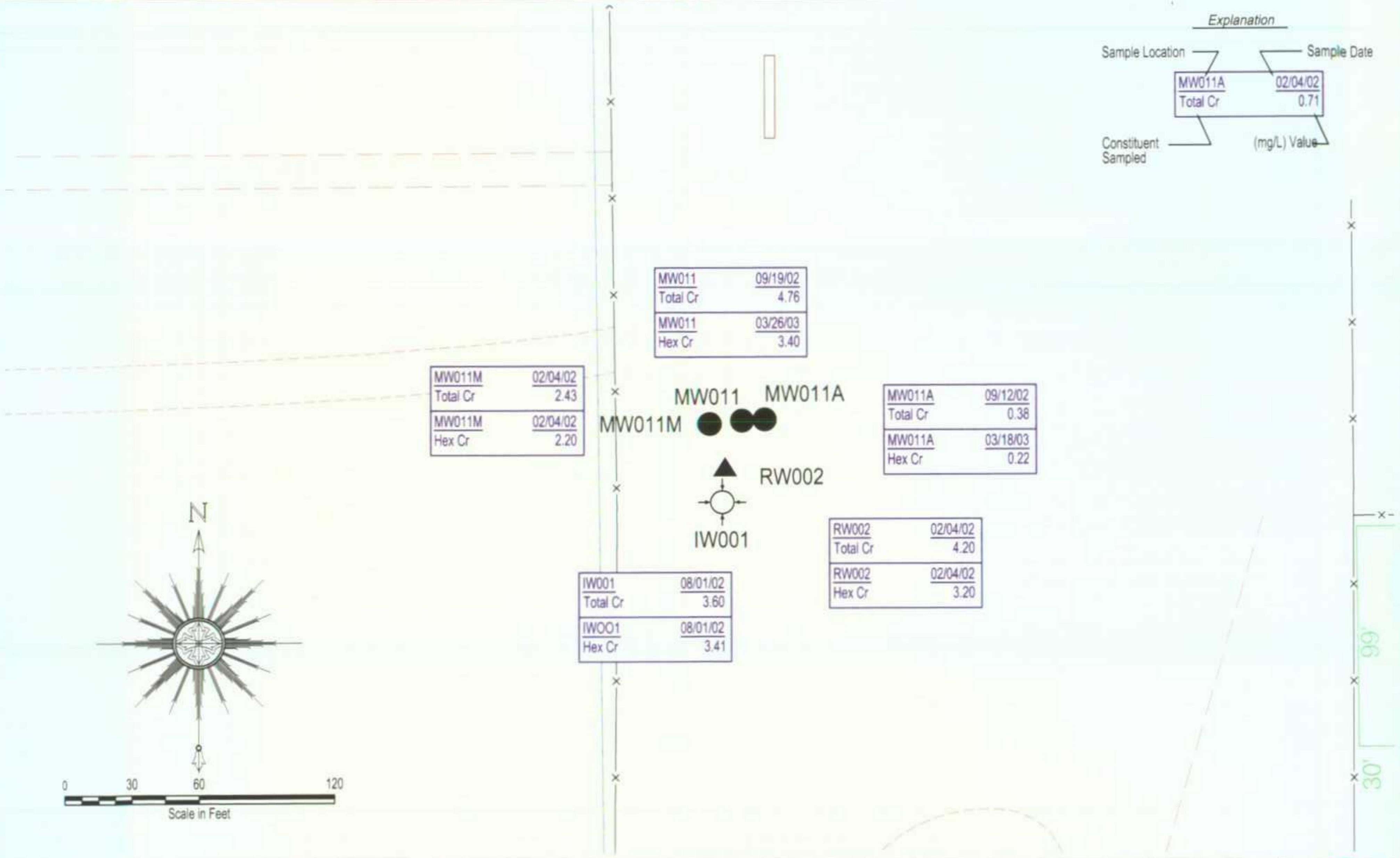

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ChevronTexaco Exploration and Production Company
Chromate Remediation Pilot Study Work Plan
MW011 Area
Well Locations and Dissolved Total Cr and Dissolved Hex Cr Concentrations (mg/L)
Eunice #2 (North) Gas Plant, Lea County, New Mexico

| | |
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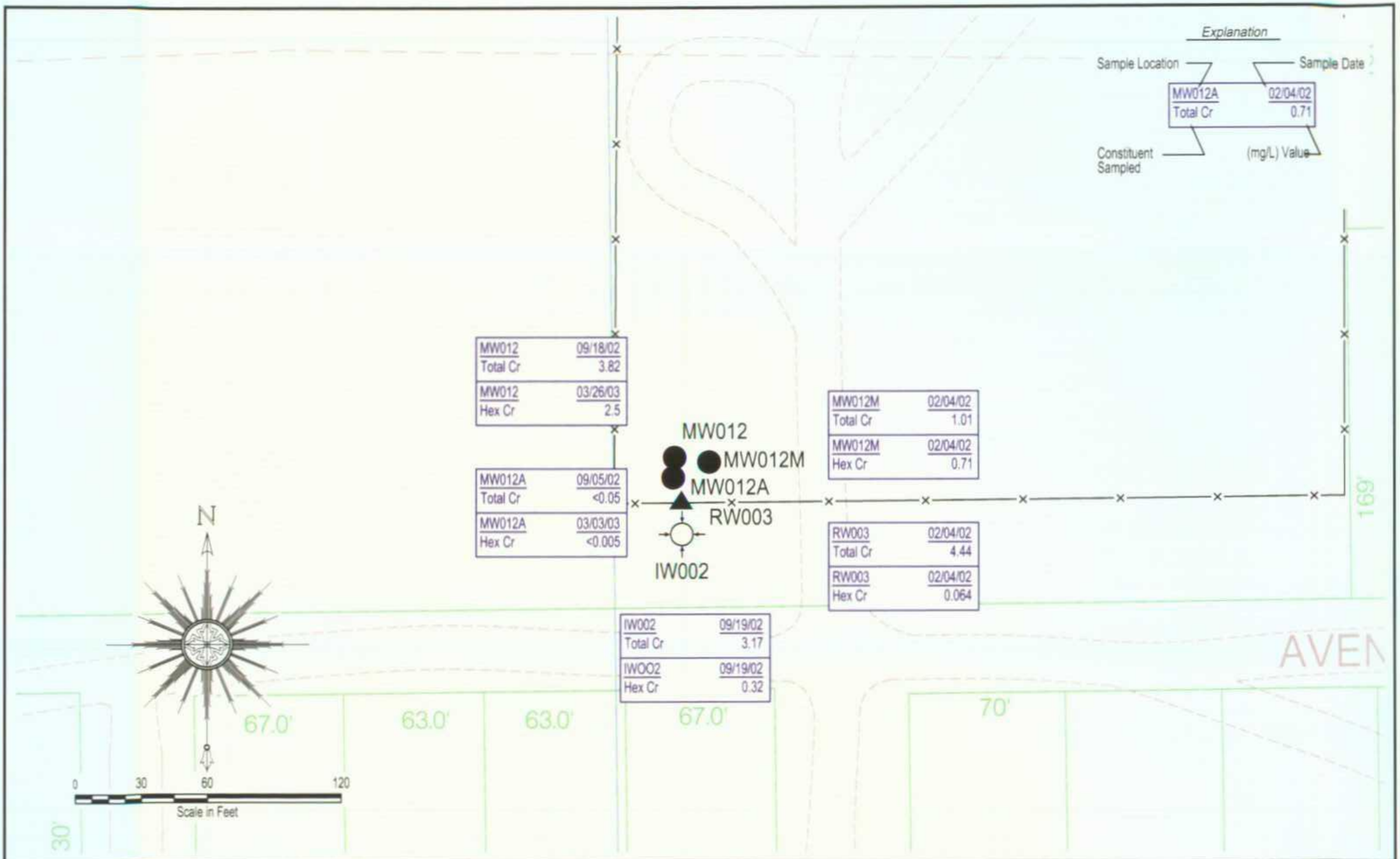
| Technical Review<br>S. Tischer | Unique Number<br>31-014-00500 |
| Project Number<br>MT000700.0005 | Figure<br>6 |



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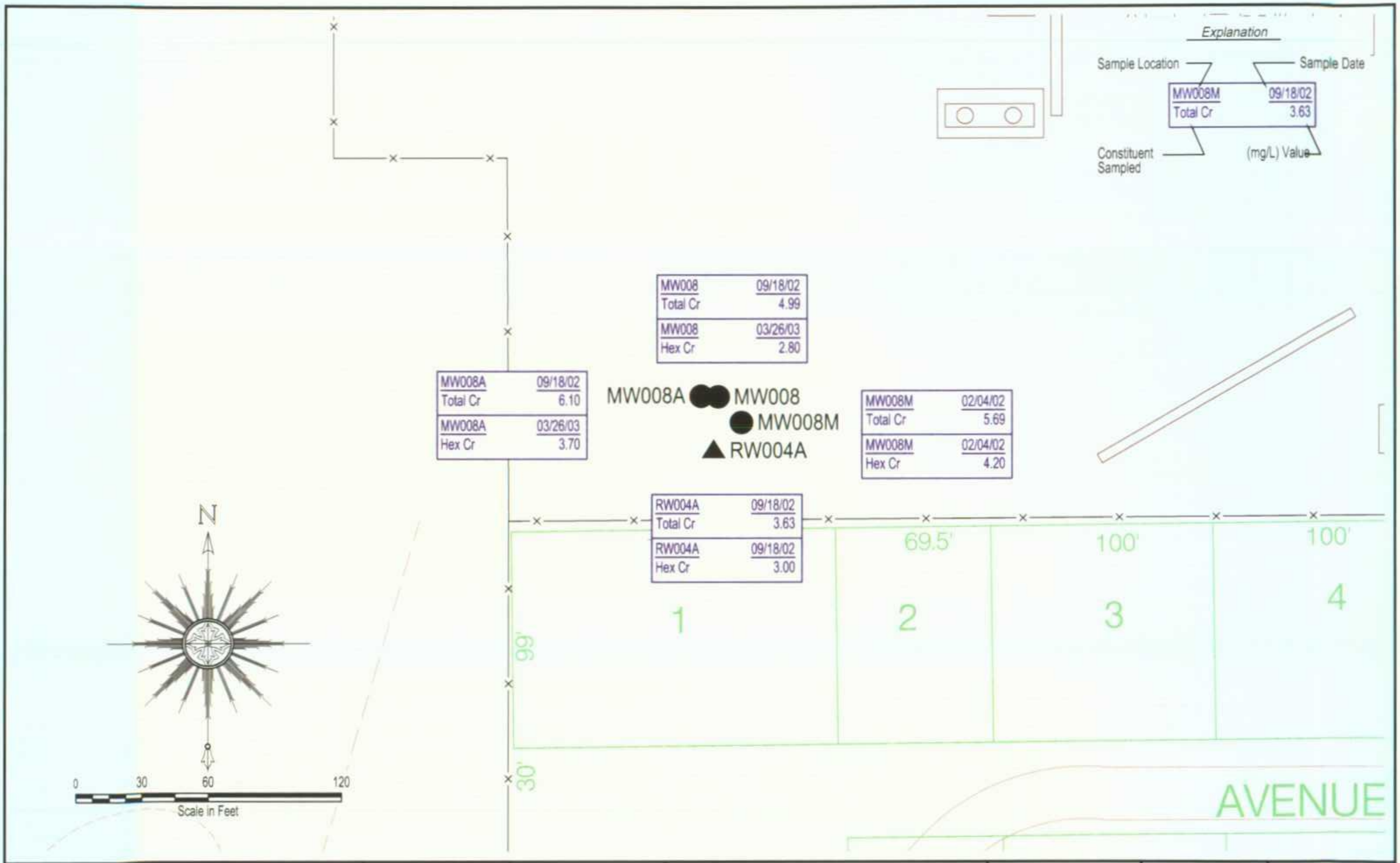
Tel 432 687 5400 Fax 432 687 5401

| | | | | | |
|---|---|---|---|---|---|
| Drawing Date<br>21 May 2003 | File Name<br>MT700500.dwg | File Location<br>G:\AutoCAD\DWG\ChevronTexaco\North Eunice\MT000700.005 | Task Manager<br>L. Markham | Project Director<br>H. McConnell | Area Manager<br>A. Schmidt |
| | | | | Technical Review<br>S. Tischer | Unique Number<br>31-014-00499 |
| | | | | Project Number<br>MT000700.0005 | Figure<br>7 |

ChevronTexaco Exploration and Production Company
Chromate Remediation Pilot Study Work Plan

MW012 Area
Well Locations and Dissolved Total Cr and Dissolved Hex Cr Concentrations (mg/L)
Eunice #2 (North) Gas Plant, Lea County, New Mexico



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| Drawing Date | File Name | File Location | Task Manager | Project Director | Area Manager |
|---|---|---|---|---|---|
| 21 May 2003 | MT700502.dwg | G:\AutoCAD\DWG\ChevronTexaco\North Eunice\MT000700.005 | L. Markham | H. McConnell | A. Schmidt |

ChevronTexaco Exploration and Production Company
Chromate Remediation Pilot Study Work Plan

## MW008A Area
## Well Locations and Dissolved Total Cr and Dissolved Hex Cr Concentrations (mg/L)

Eunice #2 (North) Gas Plant, Lea County, New Mexico

Technical Review
S. Tischer

Unique Number
31-014-00501

Project Number
MT000700.0005

Figure
8

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## Figure 9
## Project Schedule
## Chromate Remediation Pilot Study Work Plan
## ChevronTexaco N. Eunice Plant
## Eunice, Lea County, New Mexico

| Tasks | Week | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 91 | 20 | 21 | 22 | 23 | 24 |
| Site Inspection | ▨ | | | | | | | | | | | | | | | | | | | | | | | |
| Field Preparation | | ▨ | | | | | | | | | | | | | | | | | | | | | | |
| System Installation | | | ▨ | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **AREA MW008A** | | | | | | | | | | | | | | | | | | | | | | | | |
| Field Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | | | ▨ | | | | ▨ |
| Analytical Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| Carbon Substrate Injecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **AREA MW011** | | | | | | | | | | | | | | | | | | | | | | | | |
| Field Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | | | ▨ | | | | ▨ |
| Analytical Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| Carbon Substrate Injecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **AREA MW012** | | | | | | | | | | | | | | | | | | | | | | | | |
| Field Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | ▨ | | | | ▨ | | | | ▨ |
| Analytical Parameter Collecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| Carbon Substrate Injecting | | | | ▨ | ▨ | ▨ | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ | | | | ▨ |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Analytical Data Reduction | | | | | | | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ |
| Analytical Data Anlaysis | | | | | | | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ |
| Graphics Generation | | | | | | | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ |
| | | | | | | | | | | | | | | | | | | | | | | | | |

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# Appendix A

CORNELL

**Material Safety Data Sheets**

**Division of Facilities Services**

# DOD Hazardous Material Information (ANSI Format) For Cornell University Convenience Only

## SODIUM BROMIDE, PRODUCT NO C4627R

The information in this document is compiled from information maintained by the United States Department of Defense (DOD). Anyone using this information is solely reponsible for the accuracy and applicability of this information to a particular use or situation.
Cornell University does not in any way warrant or imply the applicability, viability or use of this information to any person or for use in any situation.

## Section 1 - Product and Company Identification
## SODIUM BROMIDE, PRODUCT NO C4627R

**Product Identification:** SODIUM BROMIDE, PRODUCT NO C4627R
**Date of MSDS:** 12/27/1994 **Technical Review Date:** 02/08/2000
**FSC: NIIN:** EMPTY
**Submitter:** D DG
**Status Code:** A
**MFN:** 01
**Article:** N
**Kit Part:** N

## Manufacturer's Information

**Manufacturer's Name:** SARGENT WELCH VWR SCIENTIFIC
**Manufacturer's Address1:** 911 COMMERCE COURT
**Manufacturer's Address2:** BUFFALO GROVE, IL 60089-2375
**Manufacturer's Country:** US
**General Information Telephone:** 800-727-4368
**Emergency Telephone:** 800-727-4368
**Other Number for MSDS Information:** WLC4627R
**Emergency Telephone:** 800-727-4368
**MSDS Preparer's Name:** STEVEN C. QUANDT
**Chemtec Telephone:** (800)424-9300
**Proprietary:** N
**Reviewed:** Y
**Published:** Y
**CAGE:** TO505

## Contractor Information

**Contractor's Name:** SARGENT WELCH VWR SCIENTIFIC
**Contractor's Address1:** 911 COMMERCE COURT
**Contractor's Address2:** BUFFALO GROVE, IL 60089-2375
**Contractor's Telephone:** 800-727-4368
**Contractor's CAGE:** TO505

## Contractor Information

**Contractor's Name:** WARDS NATURAL SCIENCE ESTABLISHMENT INC
**Post Office Box:** 92912
**Contractor's Address1:** 5100 W HENRIETTA RD
**Contractor's Address2:** ROCHESTER, NY 14692-9012
**Contractor's Telephone:** (716) 359-2502
**Contract Number:** MDA414-99A-0024-0023
**Contractor's CAGE:** 63759

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## Section 2 - Compositon/Information on Ingredients
## SODIUM BROMIDE, PRODUCT NO C4627R

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**Ingredient Name:** SODIUM BROMIDE (NABR)
**Ingredient CAS Number:** 7647-15-6 **Ingredient CAS Code:** T
**RTECS Number:** VZ3150000 **RTECS Code:** T
**=WT:** 99.9 **=WT Code:** M
**=Volume: =Volume Code:**
**>WT: >WT Code:**
**>Volume: >Volume Code:**
**<WT: <WT Code:**
**<Volume: <Volume Code:**
**% Low WT: % Low WT Code:**
**% High WT: % High WT Code:**
**% Low Volume: % Low Volume Code:**
**% High Volume: % High Volume Code:**

**% Text:**
**% Enviromental Weight:**
**Other REC Limits:** N/P
**OSHA PEL:** N/P **OSHA PEL Code:**
**OSHA STEL:** N/P **OSHA STEL Code:**
**ACGIH TLV:** N/P **ACGIH TLV Code:**
**ACGIH STEL:** N/P **ACGIH STEL Code:**
**EPA Reporting Quantity:**
**DOT Reporting Quantity:**
**Ozone Depleting Chemical:** N

---

## Section 3 - Hazards Identification, Including Emergency Overview
## SODIUM BROMIDE, PRODUCT NO C4627R

---

**Health Hazards Acute & Chronic:** MAY CAUSE MILD IRRITATION TO SKIN, EYES AND RESPIRATORY SYSTEM. INGESTION OF LARGE DOSES OF BROMIDE CAUSE NAUSEA, VOMITING, ABDOMINAL PAIN, COMA AND PARALYSIS. PROLONGED EXPOSURE TO DUST MAY CAUSE BRO NCHITIS

**Signs & Symptoms of Overexposure:**
SEE HEALTH EFFECTS SECTION

**Medical Conditions Aggravated by Exposure:**
NOT PROVIDED

**LD50 LC50 Mixture:** N/P

**Route of Entry Indicators:**
- **Inhalation:** N/P
- **Skin:** N/P
- **Ingestion:** N/P

**Carcenogenicity Indicators**
- **NTP:** N/P
- **IARC:** N/P
- **OSHA:** N/P

**Carcinogenicity Explanation:** NOT PROVIDED

---

## Section 4 - First Aid Measures
## SODIUM BROMIDE, PRODUCT NO C4627R

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**First Aid:**
CALL A PHYSICIAN. EYES AND SKIN: IMMEDIATELY FLUSH WITH PLANTY OF WATER FOR AT LEAST 15 MINUTES. INHALATION: REMOVE TO FRESH AIR. INGESTION: GIVE TWO GLASSES OF WATER AND INDUCE VOMITING IF CONSCIOUS

---

## Section 5 - Fire Fighting Measures
## SODIUM BROMIDE, PRODUCT NO C4627R

---

**Fire Fighting Procedures:**
WEAR SELF-CONTAINED BREATING APPARATUS
**Unusual Fire or Explosion Hazard:**
NONE
**Extinguishing Media:**
USE MEANS SUITABLE TO EXTINGUISH THE SUPPORTING FLAME
**Flash Point: Flash Point Text:** NONE

**Autoignition Temperature:**
  **Autoignition Temperature Text:** N/P
  **Lower Limit(s):** N/A
  **Upper Limit(s):** N/A

---

## Section 6 - Accidental Release Measures
## SODIUM BROMIDE, PRODUCT NO C4627R

**Spill Release Procedures:**
WEAR APPROPRIATE SAFETY EQUIPMENT. SWEEP UP AND CONTAINERIZE FOR DISPOSAL. FLUSH RESIDUE WITH LARGE AMOUNTS OF WATER.

---

## Section 7 - Handling and Storage
## SODIUM BROMIDE, PRODUCT NO C4627R

**Handling and Storage Precautions:**

**Other Precautions:**

---

## Section 8 - Exposure Controls & Personal Protection
## SODIUM BROMIDE, PRODUCT NO C4627R

**Repiratory Protection:**
NIOSH APPROVED DUST RESPIRATOR IF NEEDED
**Ventilation:**
LOCAL EXHAUSE RECOMMENDED
**Protective Gloves:**
RUBBER GLOVES
**Eye Protection:** SAFETY GOGGLES
**Other Protective Equipment:** LAB COAT OR APRON
**Work Hygenic Practices:** NOT PROVIDED
**Supplemental Health & Safety Information:** NOT RELEVANT

---

## Section 9 - Physical & Chemical Properties
## SODIUM BROMIDE, PRODUCT NO C4627R

**HCC:** N1
**NRC/State License Number:**
**Net Property Weight for Ammo:**
**Boiling Point:** =1390.C, 2534.F **Boiling Point Text:**
**Melting/Freezing Point:** =747.C, ######F **Melting/Freezing Text:**
**Decomposition Point: Decomposition Text:** N/P

**Vapor Pressure:** N/A **Vapor Density:** N/A
**Percent Volatile Organic Content:**
**Specific Gravity:** 3.21
**Volatile Organic Content Pounds per Gallon:**
**pH:** N/P
**Volatile Organic Content Grams per Liter:**
**Viscosity:** N/P
**Evaporation Weight and Reference:** N/A
**Solubility in Water:** 116% BY WEIGHT @ 50C
**Appearance and Odor:** WHITE CRYSTALLINE SOLID, ODORLESS
**Percent Volatiles by Volume:** 0
**Corrosion Rate:** N/P

---

## Section 10 - Stability & Reactivity Data
## SODIUM BROMIDE, PRODUCT NO C4627R

**Stability Indicator:** YES
**Materials to Avoid:**
STRONG OXIDIZING AGENTS; ACIDS CAN PRODUCE HYDROGEN BROMIDE, ALKALOIDIAL AND HEAVY METAL SALTS
**Stability Condition to Avoid:**
NOT APPLICABLE
**Hazardous Decomposition Products:**
NONE
**Hazardous Polymerization Indicator:** NO
**Conditions to Avoid Polymerization:**
NOT APPLICABLE

---

## Section 11 - Toxicological Information
## SODIUM BROMIDE, PRODUCT NO C4627R

**Toxicological Information:**
NOT PROVIDED

---

## Section 12 - Ecological Information
## SODIUM BROMIDE, PRODUCT NO C4627R

**Ecological Information:**
NOT PROVIDED

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## Section 13 - Disposal Considerations
## SODIUM BROMIDE, PRODUCT NO C4627R

**Waste Disposal Methods:**
DISCHARGE, TREATMENT OR DISPOSAL MAY BE SUBJECT TO FEDERAL, STATE OR LOCAL LAWS. THESE DISPOSAL GUIDELINES ARE INTENDED FOR THE DISPOSAL OF CATALOG-SIZE QUANTITIES ONLY.

---

## Section 14 - MSDS Transport Information
## SODIUM BROMIDE, PRODUCT NO C4627R

**Transport Information:**

SEE TRANSPORTATION DATA.

## Section 15 - Regulatory Information
## SODIUM BROMIDE, PRODUCT NO C4627R

**SARA Title III Information:**
NOT PROVIDED
**Federal Regulatory Information:**
NOT PROVIDED
**State Regulatory Information:**
NOT PROVIDED

## Section 16 - Other Information
## SODIUM BROMIDE, PRODUCT NO C4627R

**Other Information:**
NOT RELEVANT

### HMIS Transportation Information

**Product Identification:** SODIUM BROMIDE, PRODUCT NO C4627R
**Transporation ID Number:** 151391
**Responsible Party CAGE:** TO505
**Date MSDS Prepared:** 12/27/1994
**Date MSDS Reviewed:** 02/08/2000
**MFN:** 02/08/2000
**Submitter:** D DG
**Status Code:** A

**Container Information**
- **Unit of Issue:** NK
- **Container Quantity:** NK
- **Type of Container:**
- **Net Unit Weight:**

**Article without MSDS:** N
**Technical Entry NOS Shipping Number:**
**Radioactivity:**
**Form:**
**Net Explosive Weight:**
**Coast Guard Ammunition Code:**
**Magnetism:**
**AF MMAC Code:**
**DOD Exemption Number:** N/A
**Limited Quantity Indicator:** N
**Multiple Kit Number:** 0
**Kit Indicator:** N
**Kit Part Indicator:** N
**Review Indicator:** N
**Additional Data:**

### Department of Transportation Information

**DOT Proper Shipping Name:** NOT REGULATED BY THIS MODE OF TRANSPORTATION
**DOT PSN Code:** ZZZ
**Symbols:** N/R
**DOT PSN Modifier:**
**Hazard Class:** N/R
**UN ID Number:** N/R
**DOT Packaging Group:** N/R
**Label:** N/R
**Special Provision(s):** N/R
**Packaging Exception:** N/R
**Non Bulk Packaging:** N/R
**Bulk Packaging:** N/R
**Maximimum Quanity in Passenger Area:** N/R
**Maximimum Quanity in Cargo Area:** N/R
**Stow in Vessel Requirements:** N/R
**Requirements Water/Sp/Other:** N/R

## IMO Detail Information

**IMO Proper Shipping Name:** NOT REGULATED FOR THIS MODE OF TRANSPORTATION
**IMO PSN Code:** ZZZ
**IMO PSN Modifier:**
**IMDG Page Number:** N/R
**UN Number:** N/R
**UN Hazard Class:** N/R
**IMO Packaging Group:** N/R
**Subsidiary Risk Label:** N/R
**EMS Number:** N/R
**Medical First Aid Guide Number:** N/R

## IATA Detail Information

**IATA Proper Shipping Name:** NOT REGULATED BY THIS MODE OF TRANSPORTATION
**IATA PSN Code:** ZZZ
**IATA PSN Modifier:**
**IATA UN Id Number:** N/R
**IATA UN Class:** N/R
**Subsidiary Risk Class:** N/R
**UN Packaging Group:** N/R
**IATA Label:** N/R
**Packaging Note for Passengers:** N/R
**Maximum Quantity for Passengers:** N/R
**Packaging Note for Cargo:** N/R
**Maximum Quantity for Cargo:** N/R
**Exceptions:** N/R

## AFI Detail Information

**AFI Proper Shipping Name:** NOT REGULATED BY THIS MODE OF TRANSPORTATION
**AFI Symbols:**
**AFI PSN Code:** ZZZ
**AFI PSN Modifier:**
**AFI UN Id Number:** N/R
**AFI Hazard Class:** N/R
**AFI Packing Group:** N/R
**AFI Label:** N/R
**Special Provisions:** N/A

**Back Pack Reference:** N/A

## HAZCOM Label Information

**Product Identification:** SODIUM BROMIDE, PRODUCT NO C4627R
**CAGE:** TO505
**Assigned Individual:** Y
**Company Name:** SARGENT WELCH VWR SCIENTIFIC
**Company PO Box:**
**Company Street Address1:** 911 COMMERCE COURT
**Company Street Address2:** BUFFALO GROVE, IL 60089-2375 US
**Health Emergency Telephone:** 800-727-4368
**Label Required Indicator:** Y
**Date Label Reviewed:** 02/08/2000
**Status Code:** A
**Manufacturer's Label Number:**
**Date of Label:**
**Year Procured:** N/K
**Organization Code:** F
**Chronic Hazard Indicator:** N/P
**Eye Protection Indicator:** YES
**Skin Protection Indicator:** YES
**Respiratory Protection Indicator:** YES
**Signal Word:** CAUTION
**Health Hazard:** Slight
**Contact Hazard:** Slight
**Fire Hazard:** None
**Reactivity Hazard:** None

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