GW - 114

WORK PLANS

7-30-08

REVISED WORK PLAN FOR GROUND WATER CONTAINMENT
SCHLUMBERGER TECHNOLOGY CORPORATION
ARTESIA, NEW MEXICO

July 30, 2008

Prepared For:

Schlumberger Technology Corporation
300 Schlumberger Drive, Room 263
Sugar Land, Texas 77478

Prepared By:

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July 30, 2008

Mr. Edward Hansen
Environmental Bureau
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Revised Ground Water Containment Work Plan
Schlumberger Technology Corporation Facility – Artesia, New Mexico (GW-114)

Dear Mr. Hansen:

Enclosed is a revised Work Plan, submitted on behalf of Schlumberger Technology Corporation, for ground water containment at their (Dowell) facility in Artesia, New Mexico. This plan was prepared by Deuell Environmental, LLC and addresses the issues discussed during the April 17 meeting at your office in Santa Fe. Since the previous submittal, the City of Artesia has rejected sending the discharge water to the POTW. The work plan has been revised to now discharge the water to an infiltration/treatment trench on the site.

If you have any questions or comments, please call me at 307-760-3277 or Joe Ferguson at 281-285-3692.

Sincerely,

Rick Deuell

Rick Deuell, P.E.
Project Manager

Enclosures
cc: Du'Bois Ferguson, Schlumberger Technology Corporation
Carey Brannan, Dow
Scott Madill, LLEC

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1.0 INTRODUCTION

Schlumberger Technology Corporation has been conducting remedial activities and monitoring ground water at their Oilfield Services (formerly Dowell) facility in Artesia, New Mexico since 1988. Historic actions to remediate the source areas and ground water at the site have included:

- Removal of underground storage tanks and impacted soils at the fuel-island and wash bay,
- Installation and operation of soil vapor extraction systems (SVE) at the wash bay and maintenance shop,
- Purchase of adjacent properties that have been impacted,
- Demolition of the acid loading facility and warehouse along with excavation of impacted soils, and
- Injection of zero-valent iron in the ground water to stimulate the reductive dechlorination process to address residual chlorinated compounds in the ground water down gradient of the facility.

Schlumberger has demonstrated that ground water conditions are conducive to the biodegradation of chlorinated hydrocarbons under anaerobic conditions. A combination of source removal and natural attenuation processes have succeeded in reducing concentrations of both aromatic and chlorinated hydrocarbons in the ground water near the source areas. The most current results are presented in the report titled "Annual Report, Schlumberger Oilfield Services, Artesia, New Mexico" dated January 28, 2008 by Deuell Environmental, LLC.

With the source areas removed the ongoing natural attenuation processes are remediating ground water at the site. Notwithstanding, residual chlorinated hydrocarbons are present in the ground water down gradient of the source areas. These are low concentrations that were present down gradient of the source area prior to source area remediation. Though the concentrations are decreasing over time there is concern that they may migrate from the Schlumberger property. The New Mexico Oil Conservation Division has put a condition on the Ground Water Discharge Permit (GW-114) that ground water is to be intercepted at the property boundary to contain and prevent offsite migration of chlorinated hydrocarbons in the ground water. A preliminary concept for constructing a system to intercept and contain ground water at the property boundary is presented in this work plan.

2.0 EXISTING CONDITIONS

2.1 Geology

Several site investigations have been performed on behalf of Schlumberger since 1988. Drilling at the site has reached a maximum depth of 61 feet below ground surface. All sediments encountered are Quaternary alluvial valley fill included in a unit locally referred to as the carbonate gravel unit which comprises a portion of the "shallow aquifer". An underlying quartzose unit has not been encountered. The sediments beneath the facility consist of red clay, silty clay, and clay interbedded with thin (2-4 inch) white or pinkish cream carbonate or caliche layers. Zones where carbonate/caliches are common can be identified from drill cores, but individual carbonate/caliche layers are difficult to trace laterally between even closely spaced monitoring wells.

The water bearing zones in this interval are the carbonate/caliche layers in which the permeability has been enhanced by the dissolution of carbonate materials. Below the water table many, but not all, of the carbonate/caliche layers are saturated, whereas the clays and silts appear only damp to moist. Zones of unsaturated carbonate/caliche below the water table are present irregularly with saturated zones above and below these dry zones.

The ground water flow direction has been consistently to the northeast since monitoring has been conducted at the facility. A potentiometric map prepared from water level data collected in October 2007 indicates that ground water flow continues to the northeast (Figure 1). Tables of all historic water level data are found in the 2007 Annual Report.

Samples collected in 1995 and 1996 were analyzed for major cation and anions. The total dissolved solids concentrations were in the range of 3,000-4,000 mg/l.

2.2 Constituent Status

The concentration and extent of dissolved-phase BTEX in ground water has declined since 1990. In October 2007 total BTEX constituents were highest at MW-12 at 0.315 mg/l with most other wells being non-detect for BTEX.

The concentration and extent of dissolved phase chlorinated hydrocarbons in ground water has declined since 1990. Although the maximum concentrations have declined, the area with the highest concentration has migrated to the northeast. Well MW-25 now has the highest concentrations for total chlorinated compounds at 0.367 mg/l (Figure 2). Monitoring wells up-gradient of this location are all declining in total chlorinated hydrocarbon concentrations.

3.0 DESIGN

3.1 Purpose

It is the intent of this project to establish containment of ground water with chlorinated hydrocarbon impacts and intercept it before leaving the Schlumberger property. This work plan is conceptual in nature. Though the basic concept has been established, design details will vary as more data are collected and input is received from the local municipal treatment plant.

3.2 Capture Zone Analysis

Ground water containment and interception options require the removal of ground water from the shallow aquifer. To evaluate the effectiveness of different ground water pumping scenarios an analytical model was developed. The analytical model is solved using Environmental Simulations Incorporated "Aquifer, Win32 Version 3".

A pump test was performed on the site in 1991. The results of the test are presented in "Additional Assessment and Remediation Feasibility Testing, Dowell Schlumberger Incorporated, Artesia, New Mexico" dated November 20, 1991 by Western water Consultants, Inc. Pump test analysis showed that at a sufficiently large scale, the aquifer demonstrated homogeneous characteristics. There was some anisotropy in the southwest-northeast direction. Based on this pump test data the shallow aquifer has been assumed to be homogeneous, isotropic, and unconfined. Accordingly, the following assumptions are made for model development based on the geology and pump test:

-Aquifer thickness is 61 feet,

-Gradient is 0.0033 to the northeast,

-Aquifer Transmissivity is 540 ft^2/day (median value from pump tests),

-Hydraulic Conductivity is 9 ft/day (67 gpd/ft^2),

-Storage coefficient is $1x10^{-3}$ (not used in steady state model),

-No recharge or leakage is occurring,

-Reference head set to 86 feet at MW-11 in the eastern portion of the site, and

-Top of aquifer is 86 feet and bottom 25 feet.

Through several simulations it was determined that a single pump well located near MW-30 and pumping at 7 gpm with a 200Ft. infiltration trench up-gradient would provide a capture zone sufficient to encompass all impacted monitoring wells. The modeled potentiometric surface and flow lines are shown on Figure 2.

3.3 Containment Well Design

The containment well will be constructed using an air-rotary drill rig and a bit at least 8-inches in diameter. The boring will go to a depth of 60 feet and be completed with Schedule 40 slotted screen and solid casing. The annulus will be filled with silica sand sized to the screen slot size. The silica sand will be installed up to two feet above the screen. The remaining annulus with be sealed with a bentonite/cement slurry or as required by the New Mexico State engineer's Office. The well will be equipped with a Grundfos ¾ HP stainless steel submersible pump. HDPE drop pipe will be used for ease of pump removal by hand. Installation of two wells will be evaluated. Each could each be pumped at a lower rate. This would provide redundancy and the horizontal spacing would increase zone of capture.

3.4 Facility Design

A 10 x 12 Ft. portable building will be installed adjacent to the well. The building previously used for the maintenance shop SVE system will be moved to this location. This building will serve for electrical distribution, electronic controls, flow meter, and house a surge tank. The building is equipped with heat and lighting. The well and building will be surrounded by a 6 Ft. chain-link fence for security.

It is anticipated that the well discharge will be above ground and connect to the building. Continuous operation should eliminate freezing problems, if not the piping will be wrapped with heat tape. Once in building an accumulating flow meter will be installed. The flow will open air discharge to a 500 gallon polyethylene surge tank equipped with a high level shutdown and alarm. Outflow from the surge tank will be by gravity via a 4-inch PVC gravity discharge line.

3.5 Discharge Design

Outflow from the surge tank will be by gravity via a 4-inch PVC gravity sewer line. Originally four options were considered:

-Direct discharge to the sanitary sewer system. The sewer line will have cleanouts spaced every 300 feet and connect to the sanitary sewer line in Richey Avenue. This will depend on receiving permission from the POTW. A meeting with them is scheduled in the near future.

-If the POTW requires pretreatment an air-stripper or other suitable treatment technology will be installed in the building. To operate the air stripper with high TDS water it will be necessary to install a system for injection of anti-scale agents.

-If the water is not accepted at all by the POTW it will be disposed in an injection trench. This may require a UIC permit. The trench would be installed up-gradient of the highest concentrations found in the ground water.

-If required by UIC permit, water treatment will be installed.

Due to capacity limitations and water right issues, the City has denied discharge of the water to the POTW. It will be necessary to construct an infiltration trench to re-inject the discharge water

3.6 Discharge Treatment

Treatment of the discharge water for chlorinated hydrocarbons typically consists of aeration, activated carbon filtration, or a combination of both. At this site, the very low concentrations of chlorinated hydrocarbons and high levels of total dissolved solids present operational difficulties for both these technologies. Activated carbon has limited adsorption capacity at low levels requiring large amount of carbon that must be disposed. High TDS water is very susceptible to mineral deposits that clog aeration systems. To combat the mineralization problem it will be necessary to inject chemicals to prevent the mineral deposits, which increases the operational complexity of the system. It is proposed to provide some aeration of the water followed by treatment in an in-situ permeable reactive trench that will also function as the reinjection trench.

The aeration will consist of an open surge tank which the pumped water will be dropped into. From the surge tank the water will flow by gravity to an infiltration/treatment trench. The trench layout is shown on Figure 3. The trench will intersect the ground water, be backfilled with a permeable media, have a horizontal distribution line to distribute the water over the entire length of the trench, and have vertical access points to monitor the trench and provide for future maintenance injections as needed. An advantage of this design is that it will also treat any ground water that passes through the trench. At this time it is proposed to use zero-valent iron in the trench as a treatment medium mixed with the permeable backfill. The use of metallic iron for the remediation of halogenated is well documented as presented in "Work Plan, Zero-Valent Iron Treatment, Pilot Study, Artesia, New Mexico" dated July 27, 2001 which was submitted to NMOCD. Unfortunately the pilot study demonstrated the difficulty of distributing the iron within this aquifer, which is fractured in nature, and providing contact with much of the aquifer was not achieved. Treatment in a permeable trench solves this distribution problem.

As designed the trench provides a large amount of flexibility for the future. As the iron is used up it will be possible to re-inject the trench with emulsified, nano-scale zero-valent iron to rejuvenate the system. It will also be possible to inject organic compounds such as HRC, molasses, or emulsified soy oils to create an anaerobic treatment cell if the need arises.

Effectiveness of the system will be observed by the monitoring well network that is in place plus an additional well to be placed immediately down gradient of the trench. The discharge water and monitoring wells will be sampled quarterly and analyzed for volatile organic compounds by EPA Method 8260. The data will be reported quarterly to NMOCD. Any increases in concentrations will be reported immediately and the system corrected.

3.7 Permitting

It is anticipated that the following permits or approvals may be necessary prior to construction:

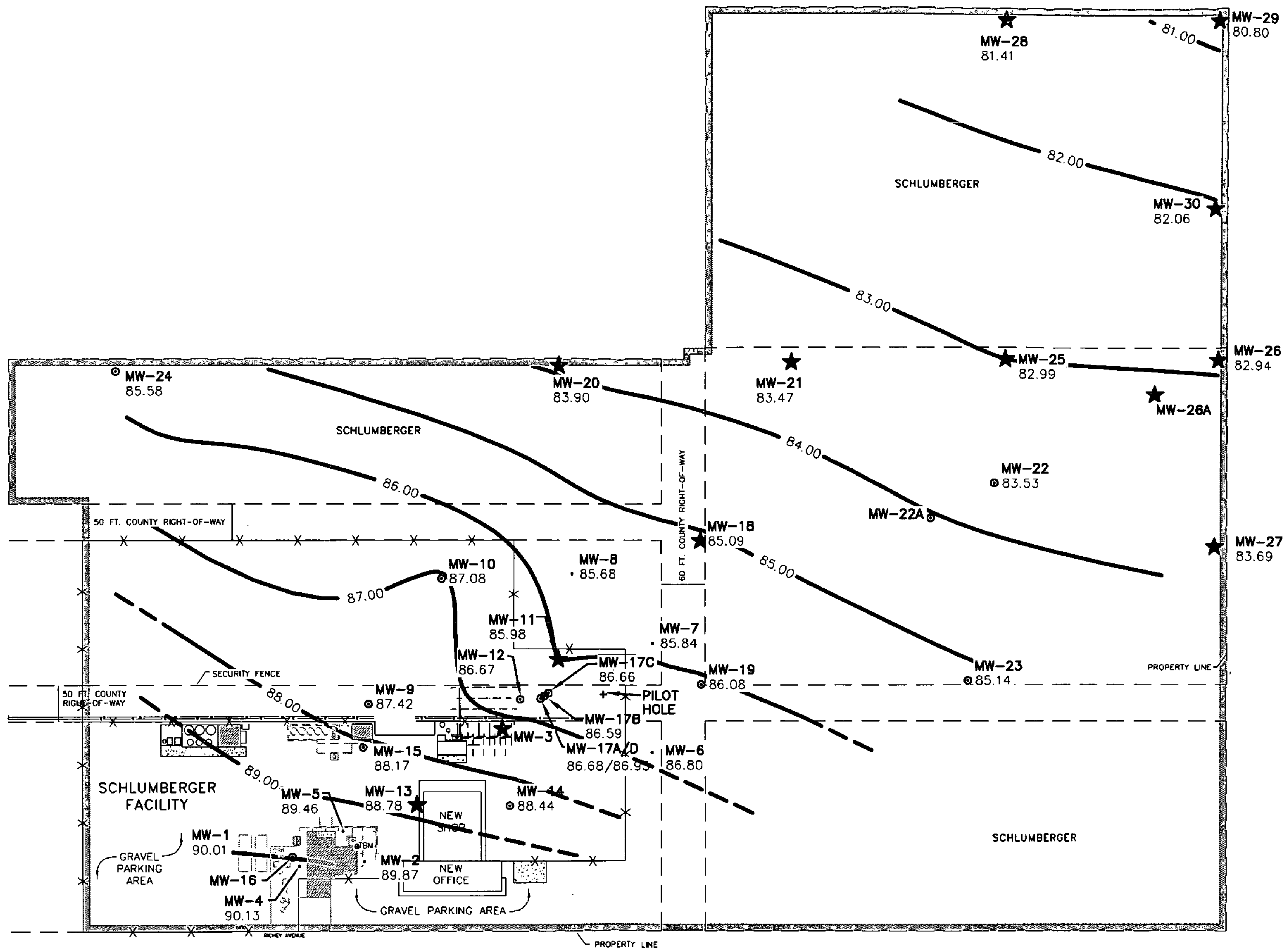
-NMOCD work plan approval which includes reinjection of discharge water,

-State Engineer's Office Permit, and

-Electric utility power drop (a property survey has been required).

4.0 OPERATION AND MAINTENANCE

The ground water interception system will operate continuously. An operator will inspect the system weekly and make any repairs that are necessary. Discharge water will be sampled quarterly and analyzed for volatile organics by EPA Method 8260.



EXPLANATION

MW-9 87.64	WWC MONITORING WELL LOCATION, IDENTIFICATION, AND POTENTIOMETRIC SURFACE
MW-6 87.08	REED AND ASSOCIATES MONITORING WELL LOCATION, IDENTIFICATION, AND POTENTIOMETRIC SURFACE
★	MONITORING WELLS TO BE SAMPLED QUARTERLY
86.00	POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED)
TBM	TEMPORARY BENCH MARK
----	AIR PIPING
·	SVE EXTRACTION WELL

0 200 FT.
SCALE

BASE MAP MODIFIED FROM REED & ASSOCIATES

FIGURE 1

SITE MAP WITH POTENTIOMETRIC SURFACE (10/17/07)

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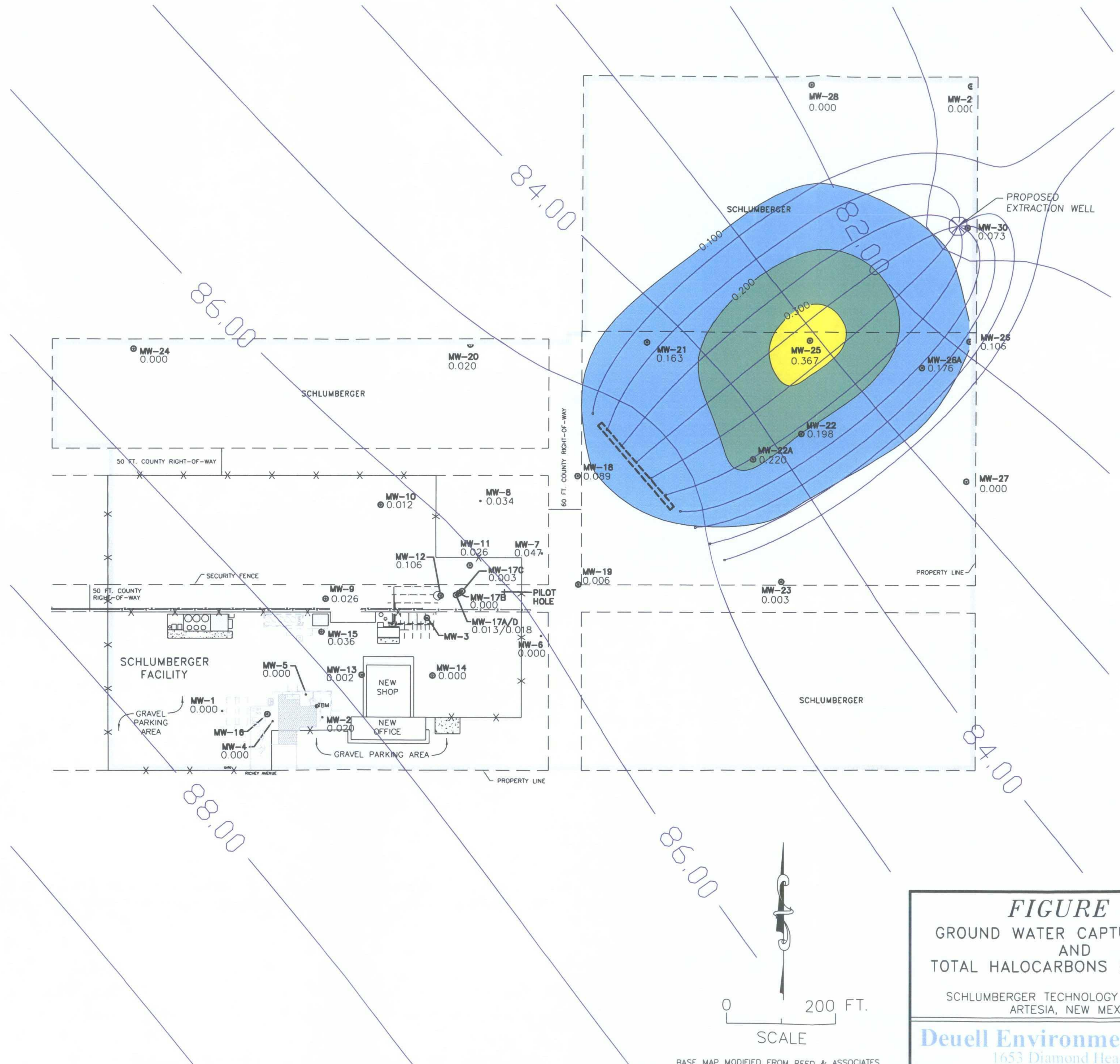

EXPLANATION

MW-12 0.128 — WWC MONITORING WELL LOCATION AND IDENTIFICATION ISOCONCENTRATION FOR TOTAL HALOCARBONS

MW-6 0.000 — REED AND ASSOCIATES MONITORING WELL LOCATION AND IDENTIFICATION ISOCONCENTRATION FOR TOTAL HALOCARBONS

TBM — TEMPORARY BENCH MARK

AIR PIPING

SVE EXTRACTION WELL

NM — NOT MEASURED

— 0.500
— 0.400
— 0.300
— 0.200
— 0.100

FIGURE 2

GROUND WATER CAPTURE ZONE
AND
TOTAL HALOCARBONS (10/17/07)

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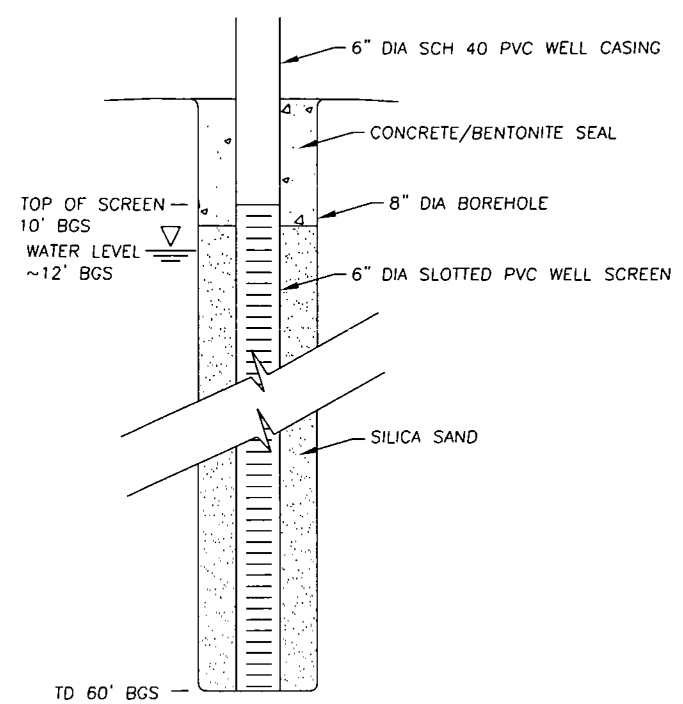
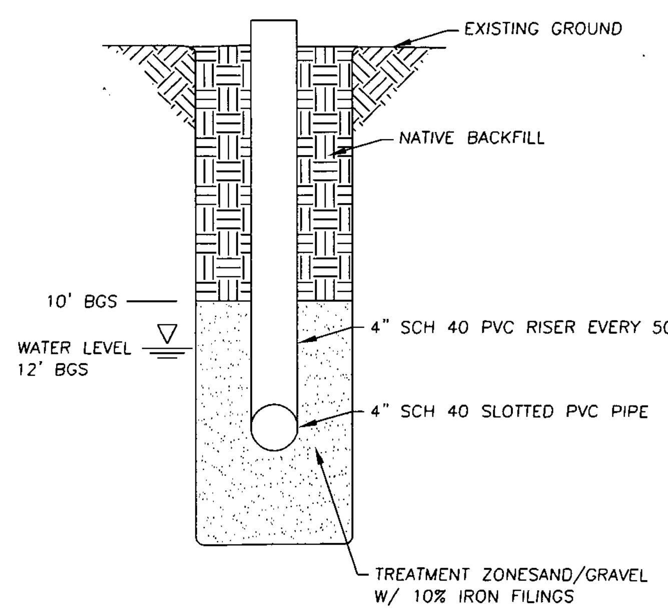
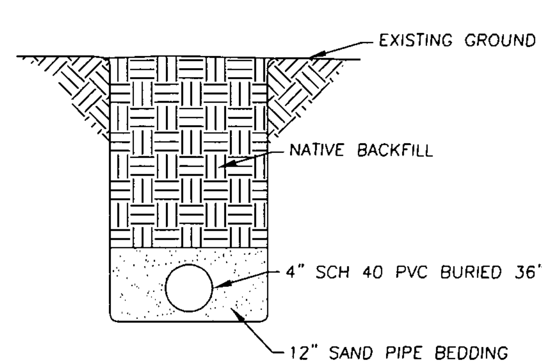
PROPOSED EXTRACTION WELL

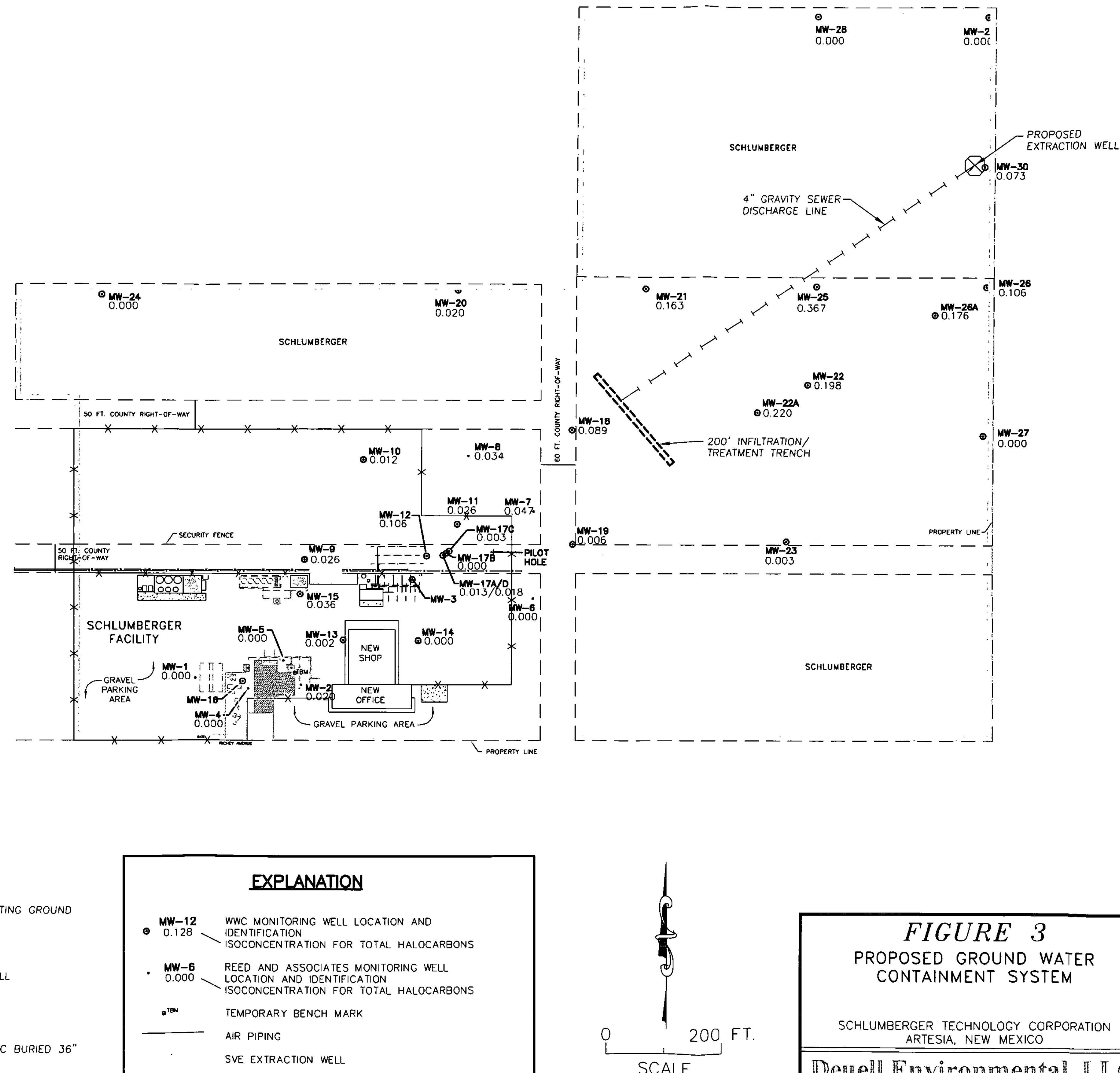


INFILTRATION/TREATMENT TRENCH



DISCHARGE LINE





BASE MAP MODIFIED FROM REED & ASSOCIATES

EXPLANATION

- MW-12 0.128 — WWC MONITORING WELL LOCATION AND IDENTIFICATION ISOCONCENTRATION FOR TOTAL HALOCARBONS
- MW-6 0.000 — REED AND ASSOCIATES MONITORING WELL LOCATION AND IDENTIFICATION ISOCONCENTRATION FOR TOTAL HALOCARBONS
- TBM — TEMPORARY BENCH MARK
- AIR PIPING
- SVE EXTRACTION WELL
- NM — NOT MEASURED

FIGURE 3

PROPOSED GROUND WATER CONTAINMENT SYSTEM

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