51778

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August 11, 2004

South Carolina Department of Health
and Environmental Control
Groundwater Quality Section
Bureau of Water
2600 Bull Street
Columbia, South Carolina 29201

Attn: Ms. Jennifer Boynton

Re: Work Plan for Remedial Activities
Delavan Spray Technologies Site
Bamberg, South Carolina
Site ID #02211
H&H Job No. GDR-06

Dear Jennifer:

On behalf of Delavan Spray Technologies, Hart & Hickman, PC (H&H) is submitting this Work Plan for Remedial Activities in accordance with your request.

Should you have any questions or require any additional information, please feel free to contact me at (704) 586-0007.

Very truly yours,

Hart & Hickman, PC

Michael S. Crouch, PG
Project Manager

RECEIVED
AUG 13 2004
Water Monitoring, Assessment &
Protection Division

Attachments
cc: Mr. Richard Kearse
Ms. Mary Foley

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A3

Work Plan for Remedial Activities
Delavan Spray Technologies Facility
Bamberg, South Carolina
DHEC Site ID #02211

August 11, 2004

H&H Job No. GDR-006

Hart & Hickman

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Appendix

Work Plan for Remedial Activities
Delavan Spray Technologies Facility
Bamberg, South Carolina
H&H Job GDR-006

1.0 Introduction and Background

On behalf of Delavan Spray Technologies (Delavan), Hart & Hickman, PC (H&H) is submitting this work plan for remedial activities at the Delavan facility located on Highway 301 South in Bamberg, Bamberg County, South Carolina (Figure 1). A site layout is presented as Figure 2. Delavan manufactures fuel metering equipment and various nozzles at the facility. The Delavan property comprises approximately 20 acres of which approximately five are fenced (Figure 2). The remaining 15 acres are wooded to the north and west and grass-covered to the east.

Previous assessment activities indicate that chlorinated compounds are present in ground water at the Delavan facility. The results of previous ground water assessment activities are summarized in a Ground Water Assessment Report dated March 15, 2004 and various earlier reports. A brief summary of the assessment activities is provided below.

Ground water sampling indicates that tetrachloroethene (PCE) is the primary chlorinated compound present in ground water at the site. The only other analytes detected in ground water samples above the South Carolina Maximum Contaminant Level (MCL) are trichloroethene (TCE) and 1,1-dichloroethene (1,1-DCE). TCE is a degradation product of PCE via a process known as reductive dechlorination and was detected in DPT samples GP-1, GP-4, GP-6, and GP-7. 1,1-DCE was detected in samples from MW-10 and GP-4, both located in the wooded area north of the building outside of the facility fence.

The PCE concentrations in ground water from December 2003 and February 2004 ground water sampling events are presented on Figure 3. The highest concentration of PCE

(11,000 µg/l) was detected in MW-1. Two other areas of PCE are present; one near MW-9 (located near the northern property line) and one near MW-10 (located in the northwestern portion of the property within a powerline easement). The concentrations of PCE in ground water samples from MW-9 and MW-10 were 7,500 µg/l and 5,800 µg/l, respectively.

Based on the results of the ground water assessment, the South Carolina Department of Health and Environmental Control (DHEC) requested that Delavan prepare a remedial plan to address PCE in ground water at the three locations in the vicinity of monitor wells MW-1, MW-9, and MW-10. Based on the results of the ground water assessment activities and DHEC's request, Delavan proposes to conduct remedial activities in the three PCE areas to enhance site ground water remediation. The additional activities will include implementation of enhanced biodegradation using Hydrogen Release Compound (HRC), a commercially available carbon source which has proven effective in enhancing degradation of chlorinated ethenes such as PCE. Delavan will then conduct a monitoring program to determine the effectiveness of HRC and monitor site biodegradation processes. Details concerning the proposed HRC injection and follow-up monitoring are provided in the following sections.

2.0 Biodegradation Enhancement

Biodegradation of chlorinated ethenes such as PCE occurs by a process known as reductive dechlorination. In this process, organic carbon (which serves as a source of hydrogen) serves as an electron donor and the chlorinated ethene serves as the electron acceptor. Because oxygen is a more favored electron acceptor than chlorinated ethenes, reductive dechlorination occurs most favorably under anaerobic conditions. Reductive dechlorination is generally an electron donor limited reaction. That is, if there is an insufficient supply of organic carbon, the reaction will not be efficient.

Because reductive dechlorination is electron donor limited, enhancement of chlorinated ethene biodegradation can be accomplished by augmenting the supply of organic carbon. There are several compounds that have been used at sites to augment the organic carbon supply. These include materials such as sugar and molasses. The main disadvantage of these materials is that they dissolve readily in ground water and must be reapplied frequently.

HRC is a propriety organic carbon supply manufactured by Regenesis that has been designed for applications such as those at the Delavan site. HRC is a food-grade substance (polylactate ester known as glycerol tripolylactate) which produces lactic acid and a low level supply of hydrogen upon contact with water. Lactic acid occurs naturally in milk and foods. The main advantage of HRC over other electron donors is that HRC releases hydrogen over a longer time period than other compounds. Most HRC applications last for a minimum of one year. Because of the relative insolubility of HRC compared with other electron donors, HRC remains where placed for continued treatment of passing ground water rather than ready dissolution into ground water leading to rapid advection out of the target area.

The HRC enhancement to natural attenuation is two fold. HRC provides a substrate for microbes to assimilate other compounds such as oxygen to drive the aquifer anaerobic or to assimilate nitrate and sulfate which compete with chlorinated VOCs such as PCE in anaerobic biological reactions. Secondly, HRC provides a source of hydrogen (electron donor) that can be used by microbes which participate in reductive dechlorination of chlorinated VOCs (electron acceptor).

A common method of HRC injection is in direct injection through borings (Appendix A). The thick HRC is delivered with a special pump into the saturated interval targeted for treatment. Once HRC is placed in the desired interval, the boring is backfilled and capped.

3.0 Injection Program

Delavan proposes to implement an HRC (or equivalent) application program in the three areas in the vicinity of MW-1, MW-9, and MW-10. The effects of the HRC on ground water will then be evaluated via periodic ground water monitoring. Prior to program implementation, an injection permit will be obtained from the DHEC Underground Injection Control (UIC) group. H&H will prepare the UIC application upon DHEC's approval of this work plan.

HRC will be injected into a grid of proposed borings in each of the three areas installed to a depth of approximately 20 ft below grade. Ground water in proposed injection areas occurs at depths of approximately 8 to 10 feet below ground level based on water level measurements collected between June 2003 and January 2004. The borings will be advanced using direct push technology (DPT) techniques.

Borings will be placed in three rows on approximate 15-ft spacing in each of the areas of concern. A total of 36 borings, 12 at each of the PCE areas, will be injected with HRC (or equivalent). The approximate locations of the proposed borings are indicated on Figure 4.

Based upon HRC guidelines and H&H's past experience, HRC will be injected at a rate of approximately 3 to 4 lbs of HRC per foot of boring. The borings will be advanced to the design terminal depth and the HRC will be injected under pressure through the DPT rods. During the injection at each location, the rods will be raised and injection continued throughout the saturated zone and approximately 2-ft above the water table to account for water level fluctuations. This injection technique will allow the HRC to be evenly distributed across the boring interval within the saturated zone. The borings will then be backfilled and the top of the boring will be grouted with bentonite. A diagram showing a typical HRC injection point is provided as Figure 5. HRC application procedures are further described in Appendix A.

4.0 Ground Water Monitoring Program

A ground water monitoring program will be implemented to evaluate the effect of the HRC injection program. The ground water sampling program will consist of pre-injection baseline and post-injection periodic monitoring. These sampling components are discussed below and summarized on Table 1.

Baseline Sampling

Prior to the implementation of the HRC injection program a baseline ground water sampling event will be conducted. Each of the existing 11 on-site monitoring wells will be sampled and the samples analyzed for volatile organic compounds (VOCs) by EPA Method 601 (see Table 1).

The ground water samples from select wells in the general vicinity of the remedial action areas (MW-1, MW-9, MW-10) will be analyzed for natural attenuation parameters in addition to the VOCs mentioned above. Field parameters collected from these wells will include dissolved oxygen, oxidation reduction potential (ORP), ferrous iron, specific conductivity, pH, and temperature. Laboratory analysis of the samples will include nitrate, sulfate, chlorides, total organic carbon (TOC), and methane.

Quarterly Sampling

Approximately three, six, and nine months after injection, the three wells in the remedial action areas will be analyzed for VOCs and natural attenuation parameters. Field parameters collected from these wells will include dissolved oxygen, ORP, ferrous iron, specific conductivity, pH, and temperature. Laboratory analysis of the samples will include VOCs by EPA Method 601, nitrate, sulfate, chlorides, TOC, methane, and metabolic acids (by-product of HRC injection).

Annual Sampling

Approximately twelve months after injection, samples collected from each of the 11 monitor wells will be analyzed for VOCs by EPA Method 601. The ground water samples from the three wells in the remedial action areas (MW-1, MW-9, and MW-10) will also be analyzed for natural attenuation parameters in addition to the VOCs mentioned above. Field parameters collected from these wells will include dissolved oxygen, ORP, ferrous iron, specific conductivity, pH, and temperature. Laboratory analysis of the samples will include nitrate, sulfate, chlorides, TOC, methane, and metabolic acids.

Reporting

H&H will prepare semi-annual reports documenting the ground water sampling results. The initial report will be prepared after completion of the six-month event and will document the HRC injection, the baseline sampling data, and the results of the first two quarterly events. The second semi-annual report will include data from the 9 and 12-month sampling events. The second semi-annual report will include recommendations for future activities and monitoring. The reports will be submitted approximately 60 days after completion of the six-month and annual sampling events.

5.0 Schedule

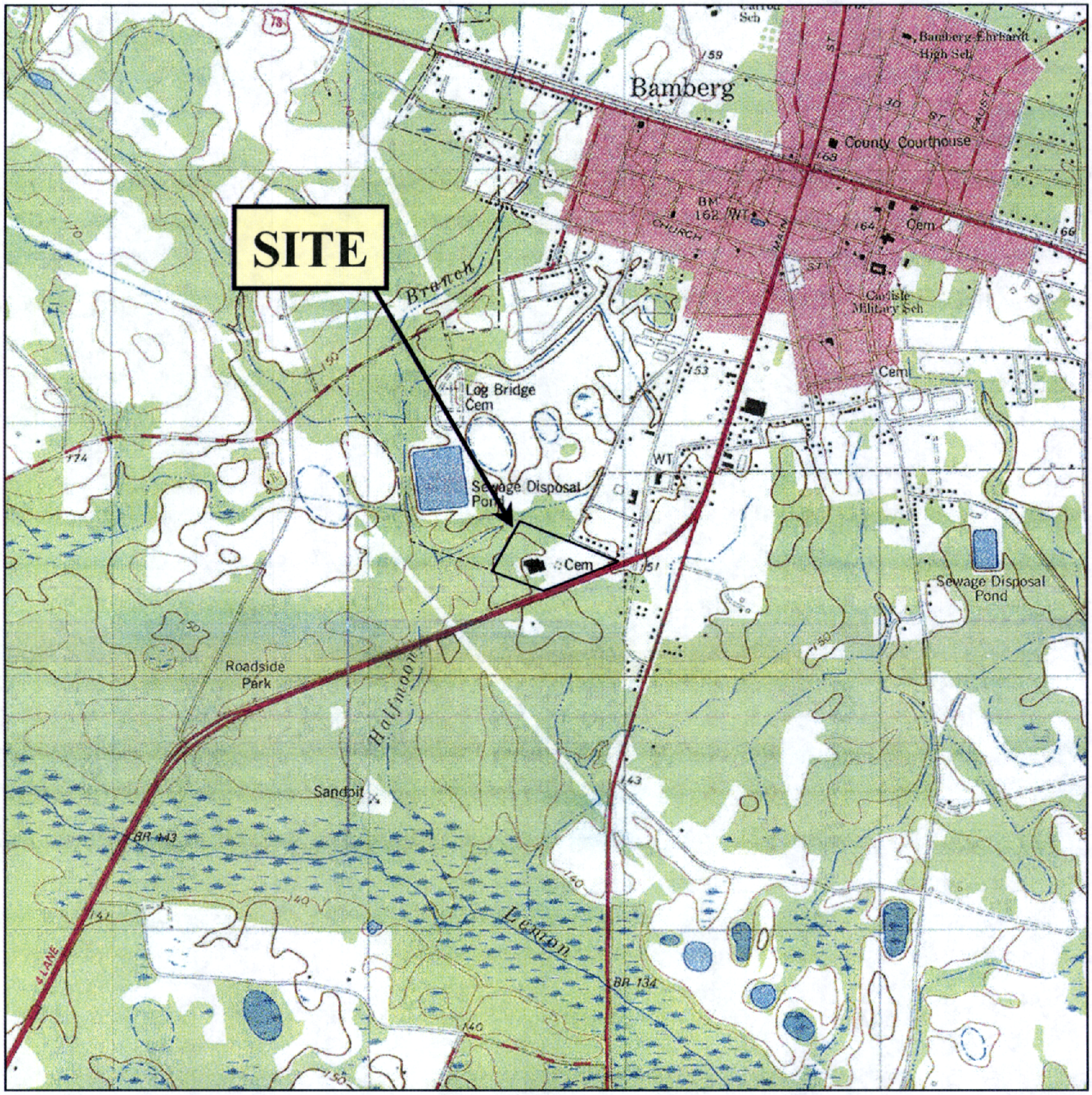
The following schedule of activities is proposed:

Activity	Date
Submit UIC Application	60 Days Following DHEC Work Plan Approval
Conduct Baseline Monitoring and Perform HRC Injection	120 Days Following Receipt of UIC Permit
Conduct Initial Quarterly Sampling Event	90 Days Following Injection
Subsequent Sampling Events and Reporting	As Noted in Section 4.0

Table 1
Sampling Matrix
Delavan Spray Technologies
Bamberg, South Carolina
H&H Project GDR-006

Sampling Location	Sampling Event		
	Baseline	Quarterly	Annual
MW-1	VOC, NA	VOC, NA, Acid	VOC, NA, Acid
MW-2	VOC	--	VOC
MW-3	VOC	--	VOC
MW-4	VOC	--	VOC
MW-5	VOC	--	VOC
MW-6	VOC	--	VOC
MW-7	VOC	--	VOC
MW-8	VOC	--	VOC
MW-9	VOC, NA	VOC, NA, Acid	VOC, NA, Acid
MW-10	VOC, NA	VOC, NA, Acid	VOC, NA, Acid
MW-11	VOC	--	VOC

VOC = Volatile Organic Compounds by EPA Method 601
NA = Natural Attenuation Parameters (see text)
Acid = Metabolic Acids
-- = No sample
SW = surface water samples
Quarterly = 3,6,and 9 month events



APPROXIMATE

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SCALE IN FEET

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U.S.G.S. QUADRANGLE MAP

BAMBERG, SC 1979 (PHOTO REVISED 1987)

QUADRANGLE
7.5 MINUTE SERIES (TOPOGRAPHIC)

TITLE	SITE LOCATION MAP
PROJECT	DELAVAN SPRAY TECHNOLOGIES BAMBERG, SOUTH CAROLINA

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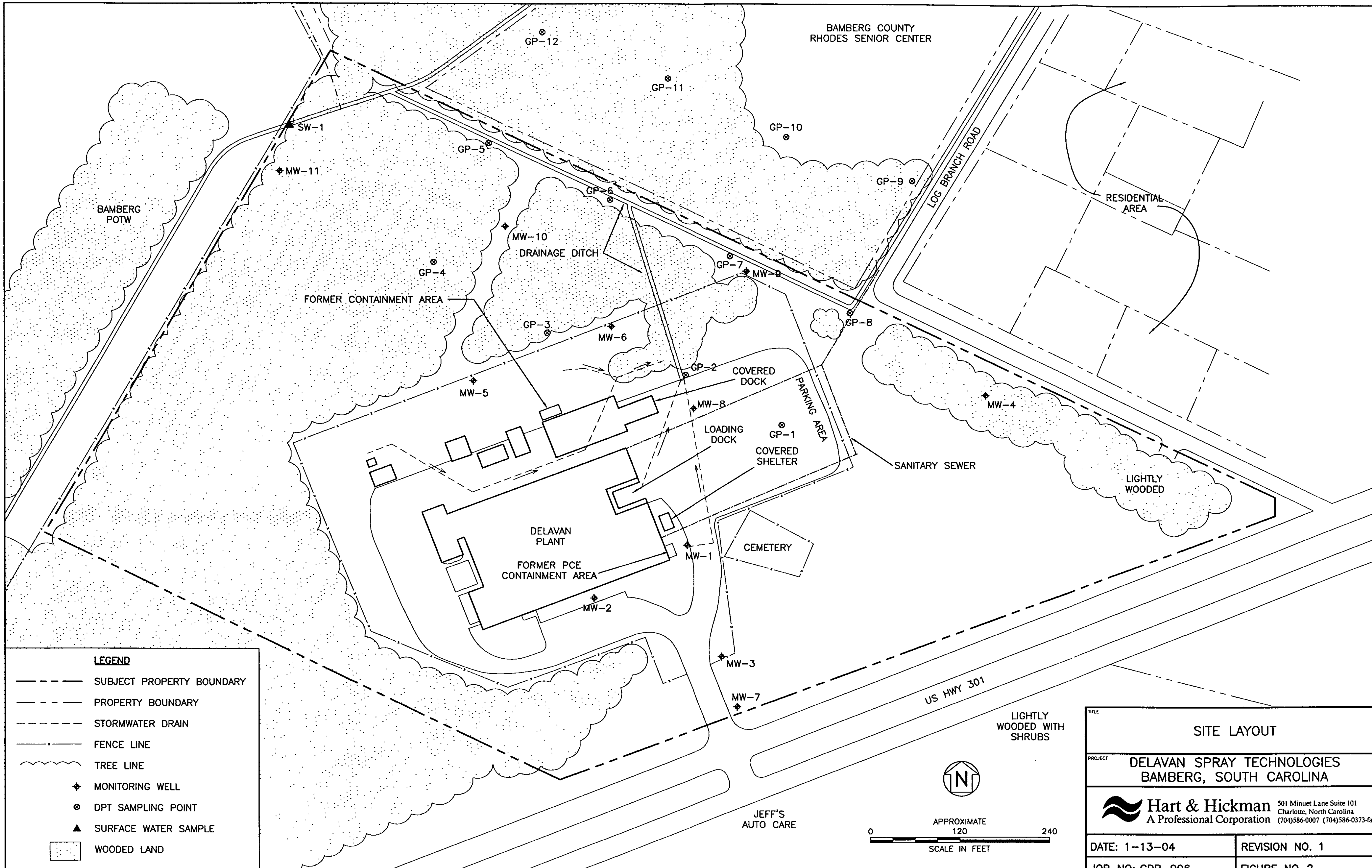
DATE:	04-09-04	REVISION NO:	0
JOB NO:	GDR-06	FIGURE NO:	1



TITLE

SITE LAYOUT

PROJECT

DELAVAN SPRAY TECHNOLOGIES
BAMBERG, SOUTH CAROLINA

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Charlotte, North Carolina
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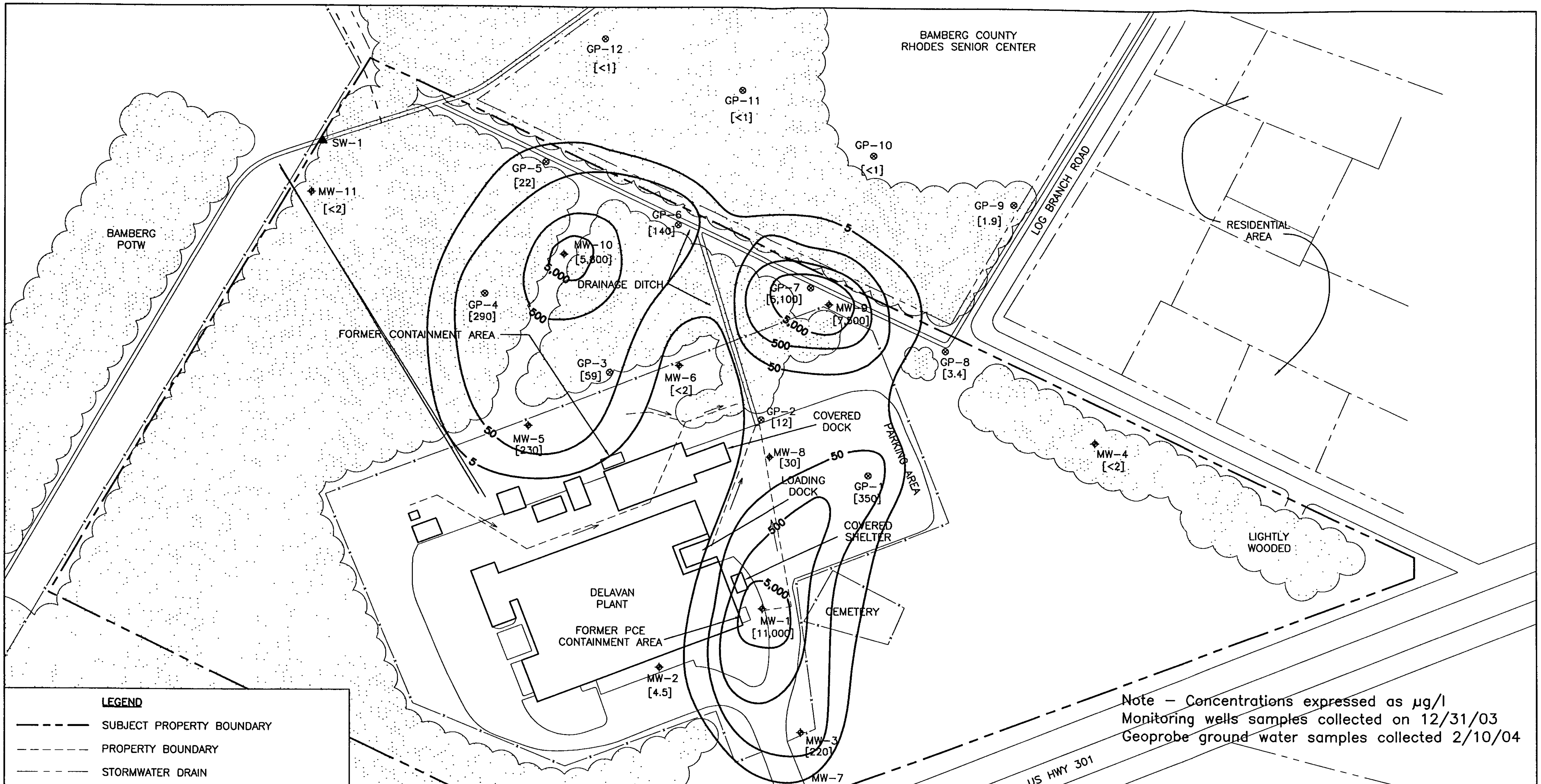
DATE: 1-13-04	REVISION NO. 1
JOB NO: GDR-006	FIGURE NO. 2



TITLE: PCE DETECTIONS IN GROUND WATER

PROJECT: DELAVAN SPRAY TECHNOLOGIES
BAMBERG, SOUTH CAROLINA

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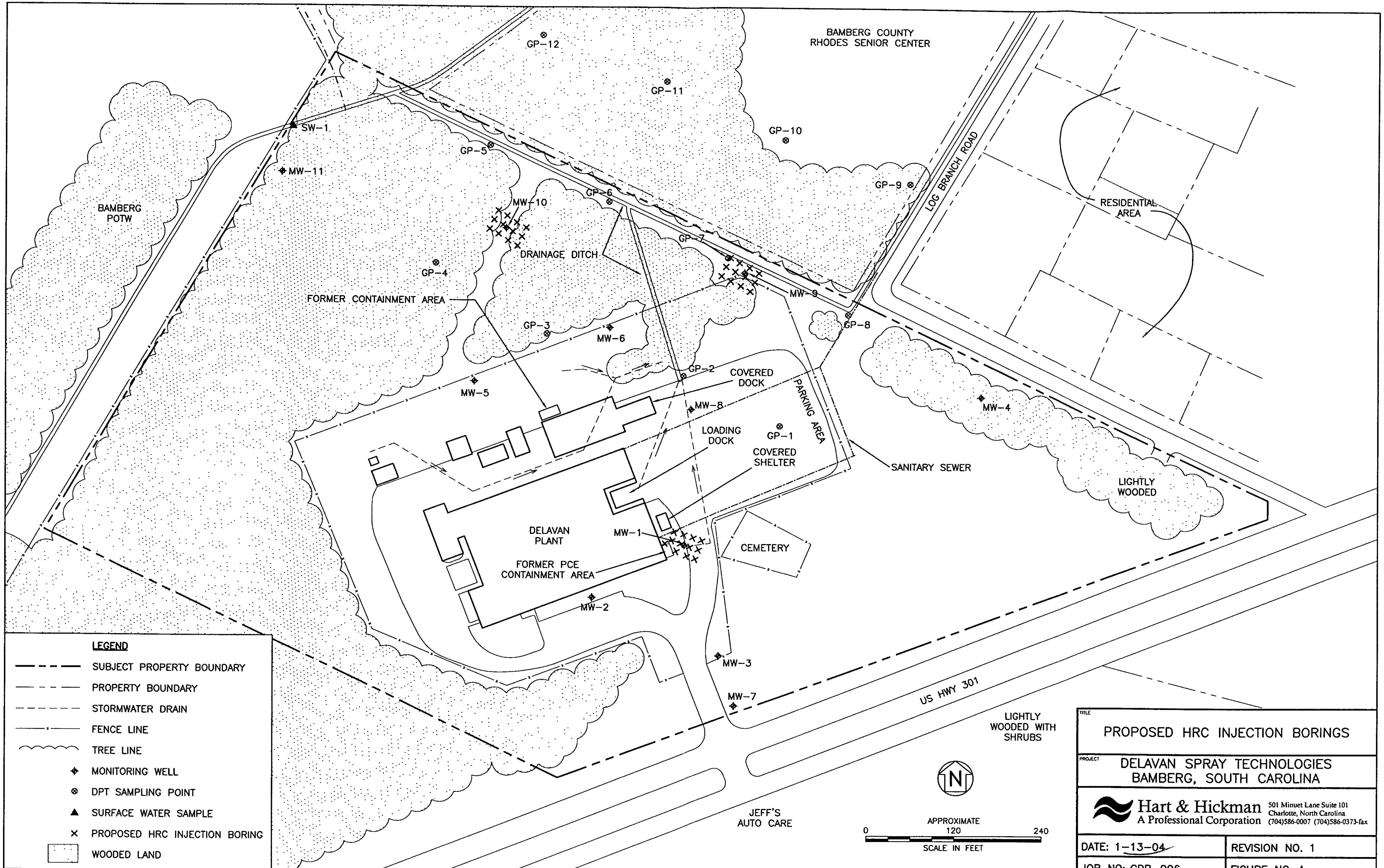
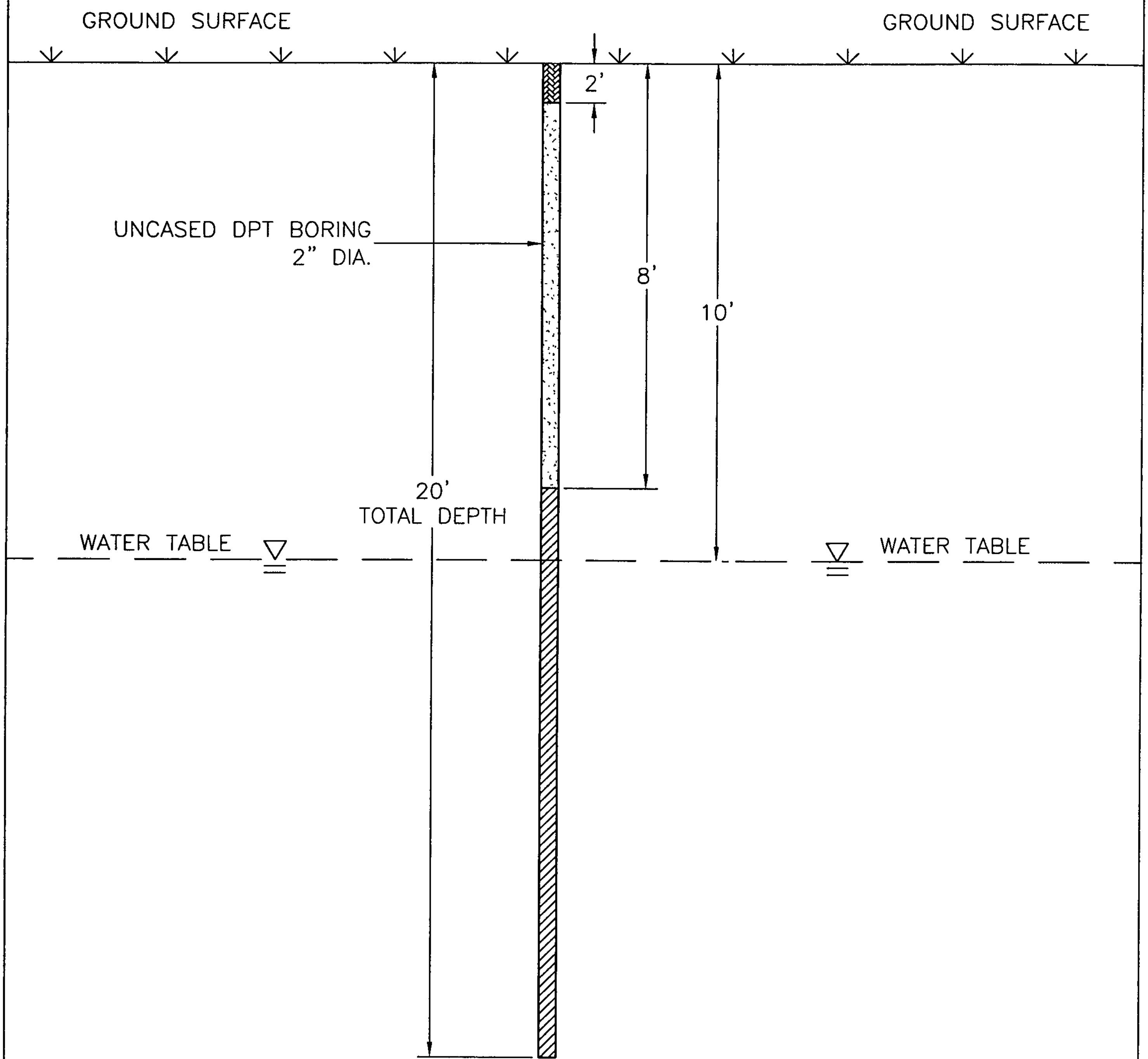
DATE: 1-13-04	REVISION NO. 1
JOB NO: GDR-006	FIGURE NO. 3



LEGEND

- SUBJECT PROPERTY BOUNDARY
- PROPERTY BOUNDARY
- STORMWATER DRAIN
- FENCE LINE
- TREE LINE
- MONITORING WELL
- DPT SAMPLING POINT
- SURFACE WATER SAMPLE
- × PROPOSED HRC INJECTION BORING
- WOODED LAND

TITLE: PROPOSED HRC INJECTION BORINGS	
PROJECT: DELAVAN SPRAY TECHNOLOGIES BAMBERG, SOUTH CAROLINA	
Hart & Hickman A Professional Corporation 501 Minuet Lane Suite 101 Charlotte, North Carolina (704)586-0007 (704)586-0373-fax	
DATE: 1-13-04	REVISION NO. 1
JOB NO: GDR-006	FIGURE NO. 4



NOTE: DPT=DIRECT PUSH TECHNOLOGY

LEGEND

- WATER TABLE
- HRC INJECTION INTERVAL
- BACKFILL
- BENTONITE

TITLE

TYPICAL INJECTION POINT

PROJECT

DELAVAN SPRAY TECHNOLOGIES
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DATE: 7-14-04	REVISION NO. 0
JOB NO: GDR-006	FIGURE NO. 5

Appendix A

HRC Installation Procedures

REGENESIS

Hydrogen Release Compound (HRC®) Installation Instructions

(DETAILED INSTALLATION PROCEDURES)

1. Prior to the installation of HRC, any surface or overhead impediments should be identified as well as the location of all underground structures. Underground structures include but are not limited to: utility lines, tanks, distribution piping, sewers, drains, and landscape irrigation systems.

2. The planned installation locations should be adjusted to account for all impediments and obstacles.

3. Regenesis recommends pre-heating HRC in a hot water bath. Place unopened buckets of HRC into an empty water tank. A Rubbermaid fiberglass Farm Trough Stock Tank (Model 4242-00-GRAY) is typically used for this application and can hold up to 16 buckets of HRC. Hot water (approximately = 130-170°F or 54-77°C) should be added to the tank after the buckets of HRC have been placed inside. When the HRC reaches a minimum temperature of 95°F or 35°C (approximately 20-30 minutes) it is ready to be poured into the pump hopper.

4. Pre-mark the installation locations, noting any points that may have different vertical application requirements or total depth.

5. Set up the direct push unit over each specific point and follow the manufacturer standard operating procedures (SOP) for the direct push equipment. Care should be taken to assure that probe holes remain in the vertical.

6. For most applications, Regenesis suggests using 1.25-inch O.D./0.625-inch I.D Geoprobe brand drive rods. However, some applications may require the use of 2.125-inch O.D./1.5-inch I.D. drive rods.

7. The HRC delivery sub-assemblies that Regenesis currently uses are designed for 1.25-inch Geoprobe rods. Other brands of drive rods can also be used but require the fabrication of a sub-assembly (see Regenesis Website).

8. Advance drive rods through the surface pavement, as necessary, following SOP.

9. Push the drive rod assembly with an expendable tip to the desired maximum depth. Regenesis suggests pre-counting the number of drive rods needed to reach depth prior to starting injection activities.

10. Drop the expendable tip from the drive rods, following SOP.

Note: In some cases, introduction of a large column of air may be problematic. This is particularly the case in deep injections (>50 ft) with large diameter rods (>1.5-inch O.D.)

11. To prevent the injection of air into the aquifer during HRC application, fill the drive rods with water. If water does not remain in the rods due to seepage, glycerine may be substituted.

12. Pour the pre-heated HRC into the pump hopper (up to 40 gallons). Remove the separated HRC from the bucket bottom by tipping the bucket into the hopper and scraping out the smooth residual material. Use the pumps mixing and recirculation features to create a uniform consistency. This typically requires recirculation of approximately one hopper volume. **NOTE**: Do not attempt to mix HRC with water or other liquids to thin or decrease the viscosity of the material. This may adversely affect HRC longevity.

13. A volume check should be performed prior to injecting HRC. Determining the volume displaced per pump stroke can be accomplished in two easy steps.

    Determine the number of pump strokes needed to deliver 3 gallons of HRC (use a graduated bucket for this)

    Divide 3 gallons by the results from the first step to determine the number of gallons of HRC delivered by each pump stroke

    Level indicators present in the hopper are in 3 gallon increments

    The volume of HRC displaced should be confirmed using the HRC level indicators located inside the pump hopper.

14. Connect the 1.25-inch O.D., 1-inch I.D. delivery hose to the pump outlet and the provided HRC delivery sub-assembly. Circulate HRC though the hose and the delivery sub-assembly to displace air in the hose.

15. Connect the HRC sub-assembly to the drive rod. After confirming that all of the connections are secure, pump the HRC through the delivery system to displace the water/fluid in the rods. **NOTE:** Prior to pumping HRC into the aquifer, close the pump recirculation valve; failure to do so will allow material to short-circuit into the hopper and change in the volume of HRC delivered per pump stroke.

16. The pump engine RPM and hydraulic settings should remain constant throughout the day. However, if the hydraulic system starts to "squeal" the pump speed should be decreased until the noise is mitigated.

17. Use the pump's stroke counter and the provided volume/weight conversions to apply the appropriate HRC volume per injection location (and per vertical foot of contaminated saturated zone). Table 1 shows typical HRC delivery information followed by an example calculation.

Table 1. Pump Volume Calculation

Pump Stroke Volume (gallons)	Number of Pump Strokes	HRC Per Stroke (pounds/stroke)
3.0	14	2.4
0.2	1	2.4

Example: For each injection location, install 60 pounds of HRC across 10 vertical feet of aquifer (6 pounds per vertical foot HRC dosing rate).

Solution:

60 pounds/10.8 pounds per gallon ≈ 5.6 gallons for the injection location
5.6 gallons/0.2 gallons per stroke ≈ 28 pump strokes for the injection location
28 pump strokes/10 vertical feet = 2.8 strokes per vertical foot
2.8 strokes per vertical foot = 8.4 strokes per 3 foot drive rod
2.8 strokes per vertical foot = 11.2 strokes per 4 foot drive rod

18. Slowly withdraw the drive rods using Geoprobe Rod Grip or Pull Plate Assembly (Part AT1222-For 1.25-inch drive rods). While slowly withdrawing single lengths of drive rod (3 or 4 feet), pump the pre-determined volume of HRC into the aquifer across the desired treatment interval (Step 13). Use the stroke counter and pump on/off switch to control volume of injection. See Helpful Hints at the end of this section.

19. Remove one section of the drive rod. The drive rod may contain some residual HRC. Place the HRC-filled rod in a clean, empty bucket and allow the HRC to drain. Eventually, the HRC should be returned to the HRC pump hopper for reuse.

20. Observe any indications of aquifer refusal. This is typically indicated by a high-pitched squeal in the pump's hydraulic system or (in the case of shallow applications) HRC "surfacing" around the injection rods or previously installed injection points. If aquifer acceptance appears to be low, allow enough time for the aquifer to equilibrate prior to removing the drive rod.

21. Repeat steps 15 through 20 until treatment of the entire contaminated vertical zone has been achieved.

22. Install an appropriate seal, such as bentonite, above the HRC material through the entire vadose zone. Depending on soil conditions and local regulations, use a bentonite seal via chips or pellets after the probe rods have been removed. This assures that the HRC remains properly placed and prevents contaminant migration from the surface. If HRC continues to "surface" up the direct push borehole, an appropriately sized (oversized) disposable drive tip or wood

plug/stake can be used to plug the hole until the aquifer equilibrates and the HRC stops surfacing.

23. Remove and clean the drive rods as necessary.

24. Finish the borehole at the surface as appropriate (concrete or asphalt cap, if necessary).

25. Periodically compare the pre- and post-injection volumes of HRC in the pump hopper using the pre-marked volume levels. Volume level indicators are not on all pump hoppers. In this case, volume level markings can be temporarily added using known amounts of water and a carpenter's grease pencil (Kiel crayon). We suggest marking the water levels in 3-gallon increments.

26. Move to the next probe point, repeating steps 8 through 20.

For direct assistance or answers to any questions you may have regarding these instructions, contact Regenesis Technical Services at 949-366-8000.