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WORK PLAN FOR ENHANCED BIOREMEDIATION INTERIM REMEDIAL ACTION AT STUDY  
AREA 39 WITH TRANSMITTAL LETTER NTC ORLANDO FL

10/11/2000  
CH2M HILL



**CCI NAVY RAC**

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October 11, 2000

Ms. Barbara Nwokike  
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Southern Division  
Naval Facilities Engineering Command  
2155 Eagle Drive  
Charleston, SC 29406

Subject: Work Plan for Enhanced Bioremediation IRA at Study Area 39  
Naval Training Center, Orlando, Florida  
CTO 0017, Contract No. N62467-98-D-0995

Dear Ms. Nwokike:

Enclosed please find 2 copies of the Work Plan for the Enhanced Bioremediation IRA at Study Area 39, Naval Training Center, Orlando. Copies are also being distributed to members of the Orlando Partnering Team.

If you have any questions regarding this document, please call.

Sincerely,

CH2M HILL CONSTRUCTORS, Inc.

A handwritten signature in cursive script, appearing to read 'Steven N. Tsangaris'.

*for*  
Steven N. Tsangaris, P.E.  
Project Manager

xc: Wayne Hansel, Southern Division (2 copies)  
Nancy Rodriguez, USEPA Region IV (2 copies)  
David Grabka, FDEP (2 copies)  
Rick Allen, HLA  
Steve McCoy, Tetra Tech NUS  
Craig Haas, CH2M HILL



## WORK PLAN MEMORANDUM

# Work Plan for Enhanced Biodegradation IRA at Study Area 39, Naval Training Center, Orlando, Florida

PREPARED FOR: Barbara Nwokike – SoDiv

PREPARED BY: Steve Tsangaris - CH2M HILL

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CONTRACT: Navy Contract # N62467-98-D-0995

CTO: CTO 0017, Naval Training Center (NTC) Orlando

DATE: October 11, 2000

## 1. Introduction

This memorandum presents the Work Plan for activities related to the vegetable oil injection enhanced biodegradation Interim Remedial Action (IRA) at Study Area (SA) 39 at Orlando Naval Training Center (NTC). This work is being performed under the Remedial Action Contract No. N62467-98-D-0995, Contract Task Order (CTO) No. 0017 at Naval Training Center (NTC) Orlando in Orlando, Florida.

This document includes a description of the following:

- Project Background
- Project Objectives
- Project Organization
- Schedule
- Injector and Monitoring Well Installation Activities
- Vegetable Oil Injection Activities
- Hydraulic Testing and Groundwater Sampling Activities
- Waste Management Plan
- IRA Construction Documentation Report

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Chlorinated solvents may undergo biodegradation through three different pathways: as an electron acceptor, as an electron donor, or cometabolism. Under anaerobic conditions, biodegradation of chlorinated solvents usually proceeds through a process called reductive dehalogenation. In general, reductive dehalogenation occurs by sequential dechlorination. For the chlorinated ethenes, dechlorination progresses from PCE to TCE to DCE to VC and ethene. PCE and TCE are the most susceptible of these compounds to reductive dehalogenation because they are the most oxidized. Because these compounds are used as electron acceptors, there must be an appropriate source of carbon for microbial growth and reductive dehalogenation to occur.

The most common approach utilized to stimulate reductive dehalogenation has been the addition of a carbon source dissolved in groundwater. Food-grade vegetable oil is a potential carbon source for microbial growth and the reductive dehalogenation process. The separate phase nature of vegetable oil allows for slow dissolution into groundwater thus making it a slow release carbon source. Vegetable oil is an inexpensive, innocuous carbon source that is not regulated as a contaminant by the United States Environmental Protection Agency (USEPA).

The approach to enhance biodegradation at SA-39 will be to inject vegetable oil as a carbon source for microbial growth and stimulation of the reductive dehalogenation process. The following section presents the proposed field activities for this process at SA 39.

## 2. Project Background

Study Area 39 is located in the southwest corner of the Main Base at the Naval Training Center in Orlando, Florida, as shown on the site map, Figure 1. SA 39 encompasses approximately 10 acres of land bounded on the south and west by the Main Base's property line, on the east by Grace Hopper Avenue, and on the north by Nautilus Street. The site contains two parking lots, a grassy area and a retention pond. Surface runoff drains into the retention pond and then into Lake Gear, located south of the Base.

Data collected during the *Environmental Site Screening Report (ESSR)* (HLA 1999) indicated tetrachloroethene (PCE) is present at concentrations exceeding the Florida Groundwater Cleanup Target Level (GCTL). Tetra Tech NUS then performed an additional investigation to delineate the lateral and vertical extent of PCE in groundwater at the site. Their *Site Investigation for Study Area 39 Report (SI)* (Tetra Tech NUS 2000) also indicates PCE groundwater contamination in the shallow aquifer zone (A zone wells screened from 6 – 20 ft bls), the intermediate aquifer zone (B zone wells screened from 23 – 30 ft bls), and the deep aquifer zone (C zone wells screened from 34 – 45 ft bls). Specifically, PCE was detected in concentrations above the Florida GCTL in wells 03A, 08A, 09A, 04A and 11A (23 ug/l max. conc.) for the shallow zone, wells 07B, 15B, 33B, 35B, and 38B (94 ug/l max. conc.) for the intermediate zone, and wells 16C, 32C, and 37C (26 ug/l max. conc.) in the deep zone. The locations of these wells are shown on Figure 2. The Florida GCTL for PCE is 3 ug/l. According to the *SI for SA-39 Report* (Tetra Tech NUS 2000), the intermediate component of the plume (aquifer zone B) is located slightly downgradient of the shallow zone (aquifer zone A), and the deeper component (aquifer zone C) further downgradient. This suggests that the plume is migrating downward as it nears Lake Gear. There was no PCE detected in the two wells screened at the base of the surficial aquifer.

As a result of the PCE contamination detected at the site, the Orlando Partnering Team (OPT) requested that CCI implement an IRA at the site consisting of enhanced bioremediation using vegetable oil.

### 3. Project Objectives and Activities

The objective of the enhanced bioremediation IRA is to improve quality so that VOC concentrations in groundwater meet regulatory maximum contaminant levels (MCLs). Activities described in the Work Plan that will be completed to meet this objective include the following:

- 1) Installation of 16 vegetable oil injection points;
- 2) Installation of 7 downgradient monitoring wells;
- 3) Baseline groundwater sampling of new and select existing monitoring wells (pre-treatment);
- 4) Conduct hydraulic conductivity tests on newly installed wells to help characterize hydrogeologic conditions in the treatment areas;
- 5) Implement the vegetable oil injection activities;
- 6) Upon completion of the injection activities, begin a one year monitoring period to assess the effectiveness of the treatment.

### 4. Project Organization

The U.S. Naval Facilities Engineering Command, Southern Division is the lead agency for this project.

The Southern Division Project Manager (PM), Mrs. Barbara Nwokike, is responsible for providing contract oversight for the Navy. Wayne Hansel, with the Navy Southern Division is the BRAC Environmental Coordinator responsible for the overall environmental activities at NTC. Bill Jacobs is the site caretaker for the Navy, and is responsible for contractor site access.

A summary of key project personnel is presented in **Table 1**.

#### 4.1 Subcontractor Information

Monitoring wells and injection points will be installed using the hollow stem auger (HSA) drilling method. The drilling subcontractor will be Groundwater Protection Inc.

All groundwater samples, except for methane, ethane, and ethene (MEE) and metabolic acid analyses, collected during the baseline sampling activities will be sent to Accura Lab in Norcross, GA. Groundwater samples collected for MEE analyses will be sent to Microseeps Laboratories of Pittsburgh, Pennsylvania.

#### 4.2 CH2M HILL Project Team

Members of the CH2M HILL project team are presented below:

Project Manager – Steve Tsangaris, PE

Site Supervisor – Craig Haas  
 QC Manager – Jennifer Ottoson  
 Site Safety Coordinator – Fernando Ferreira  
 Field Team Members - Fernando Ferreira  
                                     Emiliano Cabale  
                                     Jennifer Ottoson  
                                     Kim-Lee Murphy  
                                     Isaac Lynch  
                                     Joshua Hayes

Contact information for key CH2M HILL project team members is included in Table 1.

## 5. Schedule

A tentative schedule for IRA field activities is presented below:

Proposed Milestone	Start Date
Installation of injection points and downgradient monitoring wells	September 18, 2000
Baseline groundwater sampling	October 2, 2000
Hydraulic conductivity testing	October 9, 2000
Vegetable Oil Injection	November 6, 2000
Proposed groundwater monitoring at 2, 6, 9, and 12 months after injection:	
Groundwater monitoring at 2 months after injection	January 20, 2001
Groundwater monitoring at 6 months after injection	May 19, 2001
Groundwater monitoring at 9 months after injection	August 18, 2001
Groundwater monitoring at 12 months after injection	November 17, 2001

## 6. Injector and Monitoring Well Installation Activities

Sixteen vegetable oil injection points and seven downgradient monitoring wells will be installed using HSA drilling methods. New wells and injection points will be placed around the two highest PCE concentration areas at the site, wells OLD-39-38B and OLD-39-08A. Data from the most recent sampling event at the facility (completed in March 2000) is shown on Figure 3.

For the source area near well OLD-39-38B and OLD-39-35B, the nine injection points will be located approximately 5 – 7 ft upgradient or northwest of well 38B. They will be approximately 8 – 10 ft apart with both rows of injection points in a staggered and juxtaposed position. The proposed five monitoring wells for this area will be installed downgradient of wells 38B and 35B.

For the second area near well OLD-39-08A, the seven injection points will be located approximately 5 – 7 ft upgradient or northwest of well 08A. They will be approximately 8 – 10 ft apart with both rows of injection points in a staggered and juxtaposed position. The two proposed monitoring wells for this area will be installed 10 and 20 ft downgradient or southeast of well 08A. All locations are shown on Figure 4.

All injection points will consist of 2-inch diameter stainless steel risers and 5 ft stainless steel screens. All new monitoring wells will be constructed of 2-inch diameter PVC risers with 5-ft PVC screens. The screens for both monitoring wells and injection points will be factory slotted with 0.010 inch openings. Also, a 20/30 sand pack will be used along with a bentonite seal and grout to surface. Screens will be placed at different depth intervals for the monitoring wells and injection points based on location. This information is presented in Table 2, which summarizes the injection point and monitoring well construction details.

## 6.1 Installation Procedures

Borehole diameters will be at least 4 inches larger than the outside diameter of the casing and well screen. In the case of a HSA, the augers will be 6 ¼-inch in diameter.

A completed monitor well will be straight and plumb. The monitor well will be sufficiently straight to allow passage of pumps or sampling devices. The documentation record and forms will document the following information for each boring:

- Boring or well identification – Begin with well # OLD-39-42B
- Purpose of the boring (e.g., soil sampling, monitor well)
- Location in relation to an easily identifiable landmark
- Names of drilling subcontractor and logger
- Start and finish dates and times
- Drilling method
- Types of drilling fluids and depths at which they were used
- Diameters of surface casing, casing type, and methods of installation
- Depth at which saturated conditions were first encountered
- Lithologic descriptions and depths of lithologic boundaries
- Sampling-interval depths
- Zones of caving or heaving
- Depth at which drilling fluid was lost and the amount lost
- Changes in drilling fluid properties
- Drilling rate
- Drilling rig reactions (e.g., chatter, rod drops, and bouncing)

Prior to drilling activities and between each monitoring and injection location, all drilling equipment and rig will be decontaminated using a high pressure steamcleaning wash.

### Logging of Boreholes

The lithology in all boreholes will be logged. The boring log form, included in the Attachment will be used for recording the lithologic logging information. Information on the boring log sheet includes the borehole location; drilling information; sampling information such as sample intervals, recovery, and blow counts; and sample description information.

Unconsolidated samples for lithologic description will be obtained at each change in lithology or every 5-foot interval. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include:

- Identification of the predominant particles size and range of particle sizes
- Percent of gravel, sand, fines, or all three
- Description of grading and sorting of coarse particles
- Particle angularity and shape
- Maximum particle size or dimension.

Plasticity of fines description include:

- Color using Munsell Color System
- Moisture (dry, wet, or moist)
- Consistency of fine grained soils
- Structure of consolidated materials
- Cementation (weak, moderate, or strong)

Identification of the Unified Soil Classification System (USCS) group symbol will be used. Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory samples, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

All samples will be monitored with an organic vapor monitor (e.g., PID, organic vapor analyzer [OVA]). Each headspace sample will be brought (if necessary) to a temperature of between 20°C (68°F) and 32°C (90°F), and the reading obtained five minutes thereafter. Since an FID will be used, each soil sample must be split into two jars, and one of the readings must be obtained with the use of an activated charcoal filter unless the unfiltered reading is 10 ppm or less. The total corrected hydrocarbon measurement must be determined by subtracting the filtered reading from the unfiltered reading. Analytical instruments must be calibrated in accordance with the manufacturer's instructions. The headspace samples will be collected and analyzed using the following procedure:

1. From the sample location, remove the top 1 to 2 inches of soil using a decontaminated stainless steel spoon.
2. Fill ½ of two decontaminated 16-ounce mason jars with soil from the resulting hole using the stainless steel spoon.

3. Cover the jars immediately with aluminum foil and fasten the jar lids.
4. Allow the sample vapors to equilibrate in the jars (approximately 5 minutes).
5. Punch a hole in the aluminum foil with the tip of a calibrated FID.
6. Record the highest reading.
7. Repeat Steps 5 and 6 with the methane filter tip of a calibrated FID with the second jar.

If a headspace sample from a perimeter boring has a total corrected hydrocarbon measurement greater than 50 ppm, the grid will be extended out 25 feet in that respective direction and the soil boring/headspace screening repeated. Soil boring/screening will be continued until headspace sample total corrected hydrocarbon measurements are less than 50 ppm.

The samples will be handled in such a way as to minimize the loss of volatiles. Cuttings will be examined for their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with the Resource Conservation and Recovery Act (RCRA) and the state and local requirements.

### **Casing Requirements**

The casing requirements that will be followed include:

- All casing will be new, unused, and decontaminated.
- Glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that will not interfere with the planned use of the well.
- All polyvinyl chloride (PVC) will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
- All metal casing will be seamless stainless steel casing, and the casing "mill" papers will be included in the appendix of the technical report.
- The casing will be straight and plumb within the tolerance stated for the borehole.
- The driller will cut a notch in the top of the casing to be used as a measuring point for water levels.

### **Well Screen Requirements**

Well screen requirements are as follows:

- All requirements that apply to casing will also apply to well screen, except for strength requirements.
- Monitor wells will not be screened across more than one water-bearing unit.
- Screens will be factory slotted or wrapped.
- Screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and for wells where no filter pack is used, the screen slot size will be selected to retain 60 to 70 percent of the formation materials opposite the screen.

- The bottom of the screen is to be capped and the cap will be joined to the screen by threads.

### **Annular Space Requirements**

The annular space requirements are as follows:

- The annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall.
- Any drilling fluids will be thinned with potable water of known acceptable quality to a density less than 1.2 grams per cubic centimeter ( $\text{g}/\text{cm}^3$ ) (10 lbs/gal) before the annular space is filled, and a mud balance or Marsh Funnel will be kept on site to allow measurement of drilling fluid density.
- As the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole.

### **Filter Pack Requirements**

The filter pack will consist of silica sand or gravel and will extend from the bottom of the hole to at least 2 feet above the top of the well screen. After the filter pack is emplaced, the well will be surged with a surge block for 10 minutes. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be placed as required to return the level of the pack to 2 feet above the screen. Surge the well for 5 minutes. Again, place additional filter packs as required to bring the level to 2 feet above the screen.

The filter pack material will be clean, inert, and well-rounded and will contain less than 2 percent flat particles. The sand or gravel will be certified free of contaminants by vendor or contractor.

The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen, as described in Chapter 12, *Ground Water and Wells*, 2nd Edition, 1986. The filter pack will not extend across more than one water-bearing unit. In all wells (deep or shallow), the filter pack will be emplaced with a bottom-discharge tremie pipe of at least 1-1/2 inches in diameter. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. The contractor will record the volume of the filter pack emplaced in the well. Potable water may be used, with the approval of the regulatory agency providing oversight, to emplace the filter pack so long as no contaminants are introduced. The contractor may use formation materials as a filter pack when they are compatible with the slot size of the screen, such as in glacial outwash gravel deposits.

### **Bentonite Seal Requirements**

The bentonite seal requirements are as follows:

- The bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout.
- The bentonite will be hydrated before placement and will be installed by pump tremie methods.
- Only 100 percent sodium bentonite will be used.

## Casing Grout Requirements

The casing grout requirements are as follows:

- The casing grout will extend from the top of the bentonite seal to ground surface.
- The grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water.
- All grout will be pump tremied using a side-discharge tremie pipe, and pumping will continue until 20 percent of the grout has been returned to the surface to ensure the grout job is done properly and surface contaminants will not enter the annulus.
- In wells where the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary so long as the tremie pipe is pulled back as the grout is emplaced.
- The excess grout (20 percent) will be removed and cleaned from the site prior to installing the pad.

## Surface Completion Requirements

For flush-mounted completions, cut the casing approximately 3 inches bls and provide a water-tight casing cap to prevent surface water from entering the well. To allow for escape of gas, a small diameter (e.g., 1/4-inch) vent hole will be placed in the upper portion of the casing, or a ventilated well cap will be used. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least 1 foot above the bottom of the box. The valve box lid will be centered in a 3-foot diameter, 4-inch thick concrete pad that slopes away from the box at 1/4-inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

When aboveground surface completion is used, extend the well casing 2 or 3 feet above land surface. Provide a casing cap for each well, and shield the extended casing with a steel sleeve that is placed over the casing and cap and seated in a 3-foot by 3-foot by 4-inch concrete surface pad. To allow for escape of gas, a small diameter (e.g., 1/4-inch) vent hole will be placed in the well casing, or a ventilated well cap will be used. The concrete surface pad will be reinforced with steel reinforcing bars at least 1/4-inch in diameter. The ground surface will be freed of grass and scoured to a depth of 2 inches before setting the concrete pad. The diameter of the sleeve will be at least 6 inches greater than the diameter of the casing. Slope the pad away from the well sleeve. Install a lockable cap or lid on the guard pipe. The identity of the well will be permanently marked on the casing cap and the protective sleeve. Install three 3-inch diameter concrete-filled steel guard posts. The guard posts will be 5 feet in total length and installed radially from each well head. Recess the guard posts approximately 2 feet into the ground and set in concrete. Do not install the guard posts in the concrete pad placed at the well base. The protective sleeve and guard posts will be painted with a color specified by the installation civil engineer.

All wells will be secured as soon as possible after drilling. Provide corrosion-resistant locks for both flush and aboveground surface completions. The locks must either have identical keys or be keyed for opening with one master key.

A completion diagram will be submitted for each monitor well or injection point installed. It will include the following information:

- Well identification (this will be identical to the boring identification described)
- Drilling method
- Installation date(s)
- Elevations of ground surface and the measuring point notch
- Total boring depth
- Lengths and descriptions of the screen and casing
- Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any back-filled material
- Elevation of water surface before and immediately after development
- Summary of the material penetrated by the boring

The locations and elevations of the injection points and monitoring wells will be surveyed by a licensed surveyor upon completion.

## 6.2 Monitoring Well Development

The monitor well development requirements are as follows:

- All newly installed monitor wells will be developed no sooner than 24 hours after installation to allow for grout curing.
- All drilling fluids used during well construction will be removed during development.
- Wells will be developed using surge blocks and bailers or pumps, and wells will be developed until:
  - The suspended sediment content of the water is less than 0.75 milliliters per liter (ml/L), as measured in an Imhoff cone according to method E160.5;
  - The turbidity remains within a 10 nephelometric turbidity unit range for at least 30 minutes; and
  - The stabilization criteria as stated in the *Florida Department of Environmental Protection Standard Operating Procedures for Laboratory Operations and Sample Collection Activities, DEP-QA-001/92*, are met.
- Discharge water color and volume will be documented.
- No sediment will remain in the bottom of the well.
- No detergents, soaps, acids, bleaches, or other additives will be used to develop a well.

- All development equipment will be decontaminated according to the *Florida Department of Environmental Protection Standard Operating Procedures for Laboratory Operations and Sample Collection Activities, DEP-QA-001/92*.

## 7. Summary of Hydraulic Conductivity Testing

Hydraulic conductivity will be measured at specified monitoring wells using slug-in (falling head) or slug-out (rising head) tests. The hydraulic conductivity or slug testing will be performed in accordance with the procedures outlined in the *POP (ABB-ES 1997)*.

To perform the slug tests, the water in the well will be displaced using either a PVC slug or compressed air.

The following steps will be taken before the start of a slug test:

1. The static depth to water and total depth of the well will be determined with an electronic water level indicator.
2. A 0- to 15-pound per square inch pressure transducer will be placed in the well. The transducer shall be positioned approximately 1 foot from the bottom of the well. The transducer cable will then be connected to a data logger.
3. The data logger will then be programmed to measure and record water levels during the slug test. Some of the items that may need to be adjusted are:
  - Alarm
  - Rate: frequency and time interval of data recording
  - Number of transducers connected
    - Station Identification
    - Reference: i.e. datum elevation or static depth to water
  - Other
    - Linearity (from transducer reel)
    - Scale (from transducer reel)
    - Offset (from transducer reel)
    - Delay (of start of data sampling)
    - Specific Gravity
    - Units
    - TOC or Surface readings

The data logger can be set to record water levels in linear or logarithmic time intervals, depending on how quickly the water in the well is assumed to equilibrate.

### 7.1 PVC slugs

Using this method, a 1-inch diameter PVC slug is lowered into the monitoring well quickly. The rise and decline of the water level is then observed until the approximate original water elevation is achieved. The slug is then rapidly removed from the well, causing the water level to drop quickly. The data logger will measure and record the recovery of the water level with time in the well until the approximate original water elevation is reached.

## 7.2 Compressed Air

Using this method, compressed air is applied to the water column in the well, pressurizing it. To compress air, a PVC manifold is attached to the well with a low range (0-20 psi) air pressure regulator. Another transducer is then hooked up to the manifold to monitor air pressures. To perform slug test, the pressure is instantaneously released. The data logger then measures and records the recovery of the water level with time in the well until the approximate original water elevation is reached. This can be performed several times, depending on the time it takes the water level to return to its original level.

Should field conditions render hydraulic conductivity test using slugs ineffective, the following alternative method will be used. A submersible pump will be used to remove water from the well. The discharge rate will be measured and recorded using an in-situ data logger and pressure transducer, as described above. Changes in water levels will be measured as a function of time during both pumping and recovery.

Slug or aquifer test data will be analyzed using the Bouwer and Rice (1976) method.

## 8. Vegetable Oil Injection Procedures

Upon completion of the hydraulic conductivity testing and baseline groundwater sampling and evaluation of analytical results, the vegetable oil injection will begin. Approximately 50 to 75 gallons of vegetable oil (specifically food-grade soybean oil) is proposed for injection into each of the sixteen new injection points. The actual volume of vegetable oil pumped into each injection point will depend on the surrounding lithology.

The vegetable oil injection will begin with the simplest method of delivering the vegetable oil into the injection points (simple gravity feed). If this method is not successful, then a 1-inch diaphragm pump will be used to inject the vegetable oil under pressure to no more than 10 psi. A schematic of the injection pump process is provided in Figure 5. Based upon observations and experience gained during the initial injection, a modification of the injection method to better accommodate the site specific conditions may be warranted.

In order to trace the oil and water leaving the injection points, a bromide tracer will be added to the groundwater in two injection points just prior to the oil injection. The tracer will be batched onsite from a concentrated sodium bromide solution. The proposed initial bromide concentration of 1,500 mg/l has a solution density near that of the native groundwater. Using analytical methods with a detection limit of 0.1 mg/l, the proposed tracer releases should provide conclusive evidence of oil-exposed groundwater at the monitoring point. Combining approximately 1.01 gallons of 38 percent sodium bromide solution (295,000 ppm bromide ion – see Material Safety Data Sheet and additional information in Attachment A) with 199 gallons of potable water with very low bromide levels will result in the 200 gallons of 1,500 mg/l bromide tracer. A technical memorandum describing the rationale for the batch mixing calculations is provided in Attachment B. The bromide tracer will be tracked in groundwater after injection to determine the advection rate of the groundwater.

It should be noted that the increase in biodegradation may stimulate bacteria growth therefore increasing the values of dissolved iron and sulfide in the groundwater. These parameters will be monitored during the subsequent groundwater sampling events

## 9. Groundwater Sampling Parameters and Procedures

Five different sampling events for laboratory analysis will be conducted as part of the IRA. The first sampling event will be performed prior to injection activities, and will be used for IRA baseline data. Four subsequent sampling events will be conducted 2, 6, 9, and 12 months after injection to monitor performance of the treatment activities.

All sampling will be in accordance with the Orlando POP and CH2M HILL's approved FDEP CompQAP. Field testing equipment will be calibrated according to the manufacturer instructions and recorded in the site logbook.

A description of each of the sampling events is presented below, along with sampling procedures.

### 9.1 Summary of Sampling Events

#### Baseline Groundwater Sampling

Groundwater samples will be collected from the following fifteen monitoring wells as part of a baseline sampling event:

- OLD-39-42B through 46B, OLD-39-38B, OLD-39-35B, OLD-39-37C, OLD-39-36A, and OLD-39-47A, OLD-39-48A, OLD-39-08A, OLD-39-09A, OLD-39-03A, OLD-39-07B.

The locations of these monitoring wells are illustrated on Figure 4. Groundwater samples from the monitoring wells will be laboratory analyzed for the following analyte suite (summary provided in Table 3):

- VOCs by EPA Method 8260B.
- Nitrate, Nitrite, Chloride, and Bromide by EPA Methods 352, 354, 325, 320.1, respectively 300.1.
- Alkalinity by EPA Method 310.1
- TOC by EPA Method 9060 Modified.
- TPH by DEP FLPRO
- Volatile Fatty Acids
- MEE by AM19GA

Further, the field team will measure natural attenuation parameters ferrous iron, manganese, hydrogen sulfide, and sulfate using Colorimetric Hach test kits. Oxidation-reduction potential (ORP), dissolved oxygen (DO), pH, specific conductivity, temperature, and turbidity will also be measured. This information is summarized in Table 4.

#### Treatment Performance Monitoring Sampling Events

Groundwater samples will be collected from up to 15 monitoring wells at the site as part of the treatment efficiency quarterly monitoring after completion of the injection-related activities. The list of monitoring wells to be sampled and sampling parameters will be determined upon completion of the injection activities, and will be provided to the OPT for approval prior to the initiation of sampling.

## 9.1 Monitoring Well Purging and Sampling Procedures

Because of concerns about turbidity in the wells and the effects on metals sampling results, the low-flow purge and sample method will be used. Monitoring well purging and sampling procedures are described below.

### Pre-Purging Activities

The following activities will be performed immediately prior to purging each well:

1. Check the well for proper identification and location.
2. Measure and record the height of protective casing.
3. Measure and record the distance between the top of the well casing and the top of the protective casing.
4. Using the electronic water-level meter, measure and record the static water level from the reference point to an accuracy of 0.01 foot. Upon removing the water-level wire, rinse it with analyte-free water from an approved water source.
5. Inspect the well head for any signs of forced entry, which could invalidate the sampling data.

### Purging

The low-flow purge and sample method consists of using a submersible or peristaltic pump to purge the well at a very low flow rate (less than 1 liter per minute [l/min]). The pump intake (dedicated Teflon<sup>®</sup> tubing) is set approximately in the middle of the well screen, with a stagnant water column over the top of the pump. The well is purged at the low-flow rate until the field parameters (temperature, pH, specific conductance, turbidity, DO, and redox potential) have stabilized. The sample is then collected using the peristaltic pump. The following steps outline the purging and sampling activities.

1. The intake for the peristaltic pump should be set at approximately the middle of the screen. Be careful not to place the pump intake less than 2 feet above the bottom of the well because this may cause mobilization of any sediment present in the bottom of the well. Start pumping the well at less than 1 l/min.
2. The water level in the well should be monitored during pumping and, ideally, the pump rate should equal the well recharge rate with little or no water-level drawdown in the well (the water level should stabilize for the pumping rate). There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken or entrainment of air in the sample. Record the pumping rate adjustments and depth(s) to water in the logbook. If the recharge rate of the well is very low and the well is purged dry, then wait until the well has recharged to a sufficient level and collect the appropriate volume of sample with the pump, or use standard purge-and-sample techniques.
3. The well should be purged at a low-flow rate (ideally, less than 1 l/min). During purging, monitor the field parameters (temperature, pH, turbidity, specific conductance, DO, and redox potential) using the flow through cell approximately every 3 to 5 minutes (or as often as practical) until the parameters have stabilized to within 10 percent (plus or minus 5 percent) over a minimum of three readings. Turbidity and DO are typically the last of the field parameters to stabilize. If turbidity readings are below 7 nephelometric turbidity units

(NTUs), then the stabilization range can be amended to 20 percent (plus or minus 10 percent) over a minimum of three readings. Wells should be purged a minimum of three well volumes and no more than five well volumes prior to sampling.

4. Record the *in situ* parameters (pH, temperature, specific conductance, turbidity, DO, and redox potential), along with the corresponding volume purged, on a Groundwater Sample Field Data Record or in a bound field logbook.

### **Field Measurements**

Once the field parameters have stabilized, perform Colorimetric Hach tests for natural attenuation parameters. Since these measurements are based on variations of color, sample water should be filtered. Perform tests according to instructions provided by the manufacturer, included with the test kits.

### **Sampling Procedures**

Once the field parameters have stabilized, collect the samples. Volatiles and analytes that degrade by aeration must be collected first. Volatile samples will be collected by shutting off the pump, disconnecting the tubing, holding a thumb over the end of the tubing, and withdrawing the tubing from the well. The sample containers will be filled by removing the thumb and allowing groundwater to flow, by gravity, into the containers containing preservatives. All other sample bottles should be filled, using the submersible pump, by allowing the water to flow gently down the inside of the bottle with minimal turbulence. Cap each bottle as it is filled.

Clean unused tubing should be used for each monitoring well. Used tubing will be disposed of as solid waste.

### **Shipping**

Samples will be preserved, labeled, and placed immediately into a cooler and maintained at 4 degrees Celsius (°C) throughout the sampling and transportation period. Samples should be labeled, recorded on the COC, and shipped/delivered to the appropriate laboratory.

### **Field Documentation**

A single responsible party will be designated for field documentation whenever feasible. For multi-person sampling teams, the party responsible for documentation will be focused on the field documentation effort such as the daily log and other related forms and will not be directly involved in the sample collection activities. The field documentation will include sufficient detailed information so that the history of each sample can be retained when necessary without the assistance of the sample collection personnel. Data will typically include a detailed description of equipment decontamination procedures, equipment calibration procedures, preparatory purging at each sample location, inventory of all generated wastes, and disposition of all generated wastes. Information can be recorded in the field log book, or on a Waste Inventory Tracking Form, Water Level Form, Monitoring Well Purging Form, and Field Sampling Report.

## Sample Identification

All samples and field quality control will be designated a unique sample identification. The sample identification procedure to be implemented for the monitoring well samples is described as follows:

CTO Number-Monitoring Well Location-Q #-Year-Number of Months of Treatment System Operation (if applicable)

- Q #: Represents the quarter number in the calendar year (e.g., fourth quarter is Q4)
- Number of Months of Treatment System Operation (if applicable): Represents the number of months the groundwater treatment system, soil treatment system, and/or product recovery system has been in operation since start-up.
- An example of the monitoring well sample identification protocol is a quarterly sampling event conducted at a site with an air sparge system that has been in operation since November 1997. The sample event, conducted under CTO No. 0002, included a sample collected from groundwater monitoring well MW-1 in May 1998. This example has the following identification number: 002-MW1-Q2-98-06.

The monitoring wells that will be installed for remedial action activities will begin with the number OLD-39-42B.

## Sample Custody

Because of the evidentiary nature of samples collected throughout the project, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. To maintain and document sample possession, chain-of-custody procedures are followed as described below:

A sample is under your custody if:

- It is in your actual possession, or
- It is in your view, after being in your physical possession, or
- It was in your physical possession and then you locked it up to prevent tampering, or
- It is in a designated secure area.

The custody of samples is recorded in the following field documents:

- Sample logs
- Sample labels
- Custody seals
- Chain-of-custody (COC) form

## Sample Log Book

It is necessary for the sampling crew to maintain daily field notes. Items that must be included are sampling protocol, any changes to the procedures, meetings, instructions, safety precautions, personnel protection, and activities pertaining to the samples. The person taking notes must be knowledgeable enough about these activities to know which details are important.

Repetition of information recorded in other permanent logs should be avoided, but enough should be recorded to present a clear and accurate picture of technical activities. At a later date,

should a question arise concerning a specific event or a procedure used, it will be answered from these notes. The following information should be logged into the log books and/or database:

- Date and time of sampling
- Sample number, locations, type, matrices, volumes, sample ID and descriptions, type and number of sample containers, names and signatures of individuals performing sampling tasks, COC and airbill numbers, preservatives, and date samples were sent
- Name of laboratories and contacts to which the samples were sent
- Termination of a sample point or parameter and reasons
- Unusual appearance or odor of a sample
- Measurements, volume of flow, temperature, and weather conditions
- Additional samples and reasons for obtaining them
- Levels of protection used (with justification)
- Meetings and telephone conversations held with the Southern Division, NTR, regulatory agencies, project manager, or supervisor
- Details concerning any samples split with another party
- Details of QC samples obtained
- Field testing equipment calibration results

These notes must be dated and signed (each page) for validity in a court of law. All log books will be bound and pre-numbered. All log book entries will be made with indelible ink and legibly written. The language will be factual and objective. No erasures will be permitted. If an incorrect entry is made, the error will be crossed out with a single strike mark, initialed, and dated.

When audits are performed, the auditor's remarks and decisions must also appear in these notes. These audits should be followed up by written report submitted by the auditor, including opinions and conclusions. A copy of this report should be placed in the project file and one copy kept in the sampling file for easy reference.

### **Sample Labels**

Any samples placed into a sample container will be identified by a sample label. The following information is included on the label:

- Project Number and Project Name
- Date – month, day, year
- Time – Military time
- Sample Identification
- Sample Description
- Sampler – Sampler's name(s)
- Preservatives

- Analyses Requested

This information should be printed neatly using an indelible marker. After the sample is taken and the label is securely attached, the sample is logged into the sample log book.

### **Custody Seals**

Custody seals are narrow strips of adhesive tape of glass fiber used to demonstrate that no tampering has occurred. They may be used on sampling equipment, sample transport containers, and individual sample jars. They should be signed and dated by the sampler and placed from one side, across the top, and to the other side of the sample bottle or across the openings of the sample transport containers.

### **Chain-of-Custody Form**

A COC form will be completed for each sampling event and will accompany the samples during shipment. The COC record documents the sample information and the transfer of custody from the sampler to the laboratory. The record will, at a minimum, contain the following:

- Project Name
- Project Location – City and State in which the project is located
- Project Number
- Project Contact – employee responsible for overseeing the sampling operation. This person should be the individual to whom questions are to be directed or verbal results given (Project Manager, Site Supervisor, Project QC Officer, or Project Chemist)
- Site Telephone Number – Telephone number of on-site office trailer or number where person responsible for samples can be contacted.
- Sample Date – month, day, year
- Sample Time – military time
- Sample Identification – unique sample number/identifier
- Sample Type – designation of sample as grab or composite
- Sample Description – sample matrix and a brief description of the sampling location
- Sample Preservation – preservatives used
- Analytical Parameters Requested – analytical parameter, method numbers, and specific compounds of interest, if applicable.
- Airbill or courier tracking number
- Laboratory – laboratory where samples are to be sent
- Laboratory Phone – telephone number of laboratory
- Laboratory Contact – contact for laboratory

- Relinquished by – signature of sender
- Date Relinquished – date samples were relinquished
- Accepted by – signature of acceptor
- Date Received – date samples were accepted
- Turnaround Time – turnaround times requested or date the results are required from the lab
- Sampler's Signature – signature of sampler
- Signature of person(s) involved in chain of possession
- Transfer date(s) and time(s) in chain of possession

Personnel preparing the COC form (i.e., sampler) will retain a copy of the form and attach it to the project's daily field logs.

If the samples are shipped by common carrier, the COC form will be placed in a sealed plastic bag inside the shipping container. Prior to shipment, the shipping container will be secured with strapping tape and a custody seal. Thus, in the case of using a common carrier for shipment, two signatures will be required on the final chain-of-custody: one signature by the sample technician who prepared the form and one signature of the sample custodian assigned by the laboratory. The sample technician will relinquish the samples to the carrier. The carrier's company name and tracking number will be placed in the box of "receiver" and in the box of "relinquisher" upon being received at the laboratory by the sample custodian. The sample custodian must ensure that the tracking number on the sample container matches that on the COC. The sample custodian assigned by the laboratory will open the shipping container and will document on the chain-of-custody form any shipping container custody seal breaks and/or shipping container or sample container(s) damage.

### **Equipment Decontamination**

Field equipment decontamination should follow the procedures described below. For equipment not listed below, refer to the *Performance Operations Plan* for proper decontamination procedures

**Well Sounders and Groundwater Measurement Tapes:** Decontamination procedures for Teflon™, PVC, stainless-steel, and glass tubing used for groundwater sampling are listed below.

- Wash with laboratory detergent and tap water.
- Rinse with tap water.
- Rinse with analyte-free (deionized) water.
- Wrap equipment in aluminum foil.

**Field Parameter Measurement Probes:** Field parameter measurement probes, (e.g., pH or specific ion electrodes, geophysical probes, or thermometers) that come in direct contact with the sample will be decontaminated using the procedures listed below, unless manufacturer's instructions indicate otherwise. Probes that make no direct contact (e.g., OVA equipment) will be wiped with clean paper towels.

- Rinse with tap water.
- Rinse with analyte-free (deionized) water.
- Solvent rinse if obvious contamination remains after rinsing and if solvent will not damage probe.
- Rinse with analyte-free (deionized) water.

**Sampling Equipment for Organic and Metal Analysis:** Teflon™, stainless-steel, glass, or metal sampling equipment used to collect samples for organic and metal analysis will be cleaned between sample locations as listed below.

- Wash and scrub equipment thoroughly with laboratory detergent and tap water.
- Rinse thoroughly with tap water.
- Rinse thoroughly with deionized, analyte-free water.
- Rinse with solvent (pesticide-grade isopropanol). Note: Do not rinse PVC or plastic materials with solvent.
- Rinse with organic-free water and allow to air dry as long as possible.
- Wrap with aluminum foil to prevent contamination.

### **Field Quality Control**

The following Field Quality Control Samples will be collected during the sampling activities

**Duplicate Sample** -- two or more samples collected from a common source. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contaminant associated with a population.

**Trip Blanks** -- a sample which is prepared at the laboratory using analyte-free water and shipped with the empty sampling containers and is stored with the samples throughout the sampling event. They are then packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If volatile organic samples are to be shipped, trip blanks are to be provided with each cooler.

**Pre-Cleaned Equipment Blanks** - a sample collected using analyte-free water, which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Pre-cleaned equipment blanks will be collected on equipment that is brought to the site pre-cleaned and ready for use. Pre-cleaned equipment will include disposable sampling equipment (i.e., disposable Teflon bailers, etc.). These blanks will be collected from the sampling equipment immediately prior to sampling by rinsing the sampling equipment with analyte-free water and collecting rinsate in the appropriate sample containers.

**Field-Cleaned Equipment Blanks** - a sample collected using organic-free water, which has been run over/through sample collection equipment. These samples are used to determine if

contaminants have been introduced by contact of the sample medium with sampling equipment. Field-cleaned equipment blanks are often associated with collecting rinse blanks of equipment that has been field-cleaned. These blanks will be collected after the equipment is decontaminated by rinsing the sampling equipment with analyte-free water and collecting rinsate in the appropriate sample containers.

**Field Water Blanks** Field water blanks include a complete set of samples collected from each water source used in the investigation. One set of samples will be collected from each water source used at the beginning of the project and one set at the completion of the project. These blanks should account for potential artifacts that could be introduced through decontamination procedures.

**MS and MSD Samples** An important element of the NTC, Orlando effort will be the collection and analysis of samples to evaluate matrix effects on target compound response. Extra sample volume will be provided to the laboratory for the preparation of MS/MSD samples. MS/MSD samples will be prepared in the laboratory by adding a known amount of pure compounds to an environmental sample to simulate background and interference found in actual samples. MS/MSDs will be performed for every 20 samples of similar matrix.

## 10. Waste Management Plan

As part of the field activities, a certain amount of waste material will be generated in association with personal protection, sample handling, injection and monitoring well installation, well purging and sampling, and decontamination. Every effort will be made to minimize the waste generated and to dispose of the material in the most appropriate, cost-effective manner. The majority of material generated by investigation activities will be uncontaminated or below applicable disposal limits; however, some material will come in contact with, or be composed of contaminated media, which may require pretreatment or off-site disposal.

The IDW will be segregated by medium (i.e., solids or liquids) and by location (i.e., boring, well, study area) into storage containers (generally, Department of Transportation [DOT]-approved 55-gallon drums). Analysis Pending labels will be attached to the storage containers that describe the content of the specific container, the POI or Study Area of origin, the specific exploration location, and the date of generation. The storage containers will be segregated on pallets by POI or Study Area of origin.

After receipt of analytical results, the IDW storage containers will be labeled as "Non-Hazardous" or "Hazardous Waste", using the criteria below.

- Analytical results are less than TCLP threshold values (40 CFR §261.24) - the corresponding IDW will be labeled as "Non-Hazardous"
- Analytical results exceed TCLP threshold values - the corresponding IDW will be labeled as "Hazardous Waste"

Labels will also include the initial date of accumulation (i.e., the date the waste is first placed in a tank or drum). Wastes will be disposed of from the site within 45 days of generation.

The storage container pallets will be arranged so as to allow access between them for inspection. A logbook will be maintained with the preceding information recorded in it, as well as a sketch

map of the storage areas. The IDW storage area will be designated within the fenced area of the site. Daily inspections of the IDW storage areas will be conducted to confirm that all requirements are being met and that the integrity of all storage containers remains uncompromised.

Approximately 2 weeks of drilling is anticipated at the site. A representative IDW soil sample will be collected upon completion of drilling activities to characterize the soil IDW generated. Laboratory analysis of composite soil samples from IDW drums will be compared to background soil screening criteria developed for NTC Orlando. If analytical results are below background screening criteria, the material can be spread on the ground surface within the contaminated area at the site. Analytical results above background screening criteria will be used to characterize the material for offsite disposal.

Laboratory analysis of groundwater samples from the representative monitoring wells will be used to determine if the liquid IDW is acceptable to the City of Orlando for disposal to the onsite sewer systems. If representative groundwater samples have been collected and submitted for laboratory analysis of site-specific compounds, those results will be submitted to determine disposal options.

Analytical results, either from the contract laboratory (Level III or IV data) will be submitted to the City of Orlando for approval, on a drum-by-drum basis, to dispose of the IDW in the onsite sewer system. Once approval for disposal via the sewers is received, the City and Public Works Center (PWC) Orlando are notified of the date, location, and approximate amount of liquid to be disposed of. A designated drain at each separate facility at NTC, Orlando has been designated for IDW disposal to minimize the handling and transportation of the containers. If the City of Orlando rejects a specific container or group of containers, a determination will be made whether some pretreatment (e.g., carbon stripping) will render the material suitable for on-site disposal or whether off-site disposal will be necessary.

## **11. IRA Construction Documentation Report**

Upon completion of the IRA implementation, a construction documentation report will be prepared to describe the details of the vegetable oil injection and groundwater monitoring activities. The construction documentation report will also include applicable record drawings sealed by a registered Florida Professional Engineer.

After each groundwater monitoring event, a progress report will be prepared to discuss the findings. At one year from injection, the data will be interpreted and a Report will be generated. Conclusions and recommendations will be made based on the data for SA-39. A discussion of the increased reductive dehalogenation process, extent and uniformity of vegetable oil distribution and radius of influence, observed changes in geochemistry, and changes in contaminant concentrations will be included in the Report. Based upon the results of the vegetable oil injection, continued monitoring and/or additional vegetable oil injection will be evaluated.

# TABLES

**NO.**

- 1 Project Personnel Directory for NTC Orlando
- 2 Proposed Injection Point and Monitoring Well Construction Summary SA-39, NTC, Orlando
- 3 Sampling and Laboratory Analytical Summary
- 4 Field Sampling and Analytical Summary

**TABLE 1**  
Project Personnel Directory for NTC Orlando

Contact	Role	Address	Phone No.	Fax No.	E-Mail
Barbara Nwokike	Navy Remedial Project Manager	U.S. Naval Facilities Engineering Command Southern Division, Code 1873 2155 Eagle Drive N. Charleston, SC 29406	(843) 820-5566	(843) 820-7465	<a href="mailto:nwokikebr@efdsouth.navfac.navy.mil">nwokikebr@efdsouth.navfac.navy.mil</a>
Wayne Hansel	BRAC Environmental Coordinator	U.S. Naval Facilities Engineering Command Southern Division, Code 18B7 2155 Eagle Drive N. Charleston, SC 29406	Charleston (843) 820-5572 Orlando (407) 895-6714	Charleston (843) 820-7465 Orlando (407) 894-4992	<a href="mailto:Hanselwj@efdsouth.navfac.navy.mil">Hanselwj@efdsouth.navfac.navy.mil</a>
Bill Jacobs	Site Caretaker	Caretaker Site Office 2850 Seabee Street Orlando, FL 32806	407) 895-9103	(407) 894-4992	
Scott Newman	Program Manager	CCI 115 Perimeter Center Place, N.E., Suite 700 Atlanta, GA 30346-1278	Atlanta (770) 604-9182 x 519 Charleston (843) 746-8882	(770) 604-9182	<a href="mailto:snewman@ch2m.com">snewman@ch2m.com</a>
Bob Nash	Health & Safety Manager	CH2M HILL 115 Perimeter Center Place, N.E., Suite 700 Atlanta, GA 30346-1278	(770) 604-9182 x 341	(770) 604-9182	<a href="mailto:rnash@ch2m.com">rnash@ch2m.com</a>
Mike Rossman	Contracts Administrator/ Project Controls	CCI 115 Perimeter Center Place, N.E., Suite 700 Atlanta, GA 30346-1278	(770) 604-9182 x 421	(770) 604-9182	<a href="mailto:mrossman@ch2m.com">mrossman@ch2m.com</a>
Theresa Rojas	Program Quality Control	CCI 115 Perimeter Center Place, N.E., Suite 700 Atlanta, GA 30346-1278	(770) 604-9182 x 568	(770) 604-9182	<a href="mailto:troyas@ch2m.com">trojas@ch2m.com</a>
Lisa Schwan	Project Chemist	CCI 115 Perimeter Center Place, N.E., Suite 700 Atlanta, GA 30346-1278	(770) 604-9182 x 561	(770) 604-9182	<a href="mailto:Lschwan@ch2m.com">Lschwan@ch2m.com</a>
Steve Tsangaris	Project Manager	4350 W. Cypress Street, Suite 600 Tampa, FL 33607	(813) 874-0777 x 4305 Cellular phone (727) 492-7467	(813) 874-3056	<a href="mailto:Stsangar@ch2m.com">Stsangar@ch2m.com</a>
Craig Haas	Site Supervisor	4350 W. Cypress Street, Suite 600 Tampa, FL 33607	(813) 874-0777 x 4305 Cellular phone (904) 237-3038	(813) 874-3056	<a href="mailto:Chaas@ch2m.com">Chaas@ch2m.com</a>
Jennifer Ottoson	Field Hydrogeologist/ QC Manager	205 Indian River Dr. Cocoa, FL 32922	321-636-7575	321-636-7522	<a href="mailto:jottoson@ch2m.com">jottoson@ch2m.com</a>
Fernando Ferreira	Field Hydrogeologist / Site Health & Safety Coordinator	1328 Richwood Circle Rockledge, FL 32955	(321) 693-0169		<a href="mailto:fferreir@ch2m.com">fferreir@ch2m.com</a>

**TABLE 2**  
Proposed Injection Point and Monitoring Well Construction Summary  
SA-39, NTC, Orlando

Identification	Diameter (inch)	Total Depth (ft bls)	Screened Interval (ft bls)	Screen Length (ft)	Aquifer Zone
<b>Area Near wells OLD-39-35B and OLD-39-38B</b>					
OLD-39-Inj-01	2	28	22 - 27	5	B
OLD-39-Inj-02	2	28	22 - 27	5	B
OLD-39-Inj-03	2	28	22 - 27	5	B
OLD-39-Inj-04	2	28	22 - 27	5	B
OLD-39-Inj-05	2	28	22 - 27	5	B
OLD-39-Inj-06	2	28	22 - 27	5	B
OLD-39-Inj-07	2	28	22 - 27	5	B
OLD-39-Inj-08	2	28	22 - 27	5	B
OLD-39-Inj-09	2	28	22 - 27	5	B
OLD-39-42B	2	30	24 - 29	5	B
OLD-39-43B	2	30	24 - 29	5	B
OLD-39-44B	2	30	24 - 29	5	B
OLD-39-45B	2	30	24 - 29	5	B
OLD-39-46B	2	30	24 - 29	5	B
<b>Area near well OLD-39-08A</b>					
OLD-39-Inj-10	2	18	12 - 17	5	A
OLD-39-Inj-11	2	18	12 - 17	5	A
OLD-39-Inj-12	2	18	12 - 17	5	A
OLD-39-Inj-13	2	18	12 - 17	5	A
OLD-39-Inj-14	2	18	12 - 17	5	A
OLD-39-Inj-15	2	18	12 - 17	5	A
OLD-39-Inj-16	2	18	12 - 17	5	A
OLD-39-47A	2	18	7 - 17	10	A
OLD-39-48A	2	18	7 - 17	10	A

TABLE 3  
Sampling and Laboratory Analytical Summary

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method (Note 1)	Sampling Equipment (Note 1)	TAT <sup>1</sup>	DQO Level/ Data Package Reqmnt	Required Analysis	Analytical Method	Holding Time	Sample Preservtn <sup>3</sup>	Containers
<b>SA-39 Baseline Groundwater Sampling</b>													
Groundwater Sampling	15 Groundwater Monitoring Wells at SA-39 OLD-39-42B thru OLD-39-46B, OLD-39-38B OLD-39-35B OLD-39-37C OLD-39-36A OLD-39-47A OLD-39-48A OLD-39-08A OLD-39-09A OLD-39-03A OLD-39-07B	Water	Quarterly	15 + 10% Dup + 5% MS/MSD total = 18	Grab	Teflon Bailor	14 days	DQO Level III, CCI Level C	Volatiles	8260B	14 days	HCl pH< 2, Cool to 4°C	(3) 40 ml vial
									Nitrate	300.1	48 hours	Cool to 4°C	(1) 250 mL HDPE
									Nitrite	300.1	48 hours	Cool to 4°C	(1) 250 mL HDPE
									Chloride	300.1	28 days	Cool to 4°C	(1) 250 mL HDPE
									Bromide	300.1	28 days	Cool to 4°C	(1) 250 mL HDPE
									TOC	9060	28 days	HCl or H2SO4 pH< 2, Cool to 4°C	(1) 500 mL HDPE
									Alkalinity	310.1	14 days	Cool to 4°C	(1) 250 mL HDPE
									MEE	AM19GA or ASTM 1945	14 days	Cool to 4°C	(3) 40mL vial
									Volatile Fatty Acids	AM21G	14 days	Cool to 4°C	(2) 40mL vial
									TPH	DEP FLPRO	7 days to extraction, 40 days to analysis	H2SO4 pH<2, Cool to 4°C	(2) 1L amber
	Pre-cleaned Equipment Rinsate Blank	Water	1 per quarter	2	Prepared in the Field	N/A	14 days	DQO Level III, CCI Level C	Volatiles	8260B	14 days	HCl pH< 2, Cool to 4°C	(3) 40 ml vial
									Nitrate	300.1	48 hours	Cool to 4°C	(1) 250 mL HDPE
									Nitrite	300.1	48 hours	Cool to 4°C	(1) 250 mL HDPE
									Chloride	300.1	28 days	Cool to 4°C	(1) 250 mL HDPE
Bromide									300.1	28 days	Cool to 4°C	(1) 250 mL HDPE	
TOC									9060	28 days	HCl or H2SO4 pH< 2, Cool to 4°C	(1) 500 mL HDPE	
Alkalinity									310.1	14 days	Cool to 4°C	(1) 500 mL HDPE	
MEE									AM19GA or ASTM 1945	14 days	Cool to 4°C	(3) 40mL vial	
Volatile Fatty Acids									AM21G	14 days	Cool to 4°C	(2) 40mL vial	
FL-PRO									DEP FLPRO	7 days to extraction, 40 days to analysis	H2SO4 pH<2, Cool to 4°C	(2) 1L amber	
Ambient Blank	Water	1 per quarter	2	Prepared in the Field	N/A	14 days	DQO Level III, CCI Level C	Volatiles	8260B	14 days	HCl pH< 2, Cool to 4°C	(2) 40 ml vial	
Trip Blank	Water	1 per VOC cooler	2	Prepared by Lab	N/A	14 days	DQO Level III, CCI Level C	Volatiles	8260B	14 days	HCl pH< 2, Cool to 4°C	(2) 40 ml vial	

Notes  
1) In accordance with NTC Orlando POP

**TABLE 3**

Sampling and Laboratory Analytical Summary

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method (Note 1)	Sampling Equipment (Note 1)	TAT <sup>1</sup>	DQO Level/ Data Package Reqmnt	Required Analysis	Analytical Method	Holding Time	Sample Preservtn <sup>1</sup>	Containers
<b>SA-39 Disposal Sampling</b>													
Disposal of Aqueous Waste Sampling, and Decon Activities	Drums	Water	Once	7	Grab	Drum thief or dip jar	7 days	DQO Level III, CCI Level A	TCL Volatiles	8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 ml vial
									TCL Semi-volatiles	8270C	14 days ext, 40 days analysis	Cool to 4°C	(3) 1L amber glass
									TCL Pesticides	8081A	14 days ext, 40 days analysis		
									Herbicides	8151A	7 day extr, 40 day analysis		
									TCL PCBs	8082	14 days ext, 40 days analysis		
									TAL Metals	6010B/7470A	180 days; Hg = 28 days	HNO3 pH< 2; Cool to 4°C	(1) 500ml HDPE
									Cyanide	335.3	14 days	Cool to 4°C NaOH pH>12	(1) 200ml glass
									Reactivity	9045B	ASAP	Cool to 4°C	(1) 500ml HDPE
									Ignitability	1010/1020A	ASAP		
Corrosivity	Chapter 7.3	ASAP											

Notes

1) In accordance with NTC Orlando POP

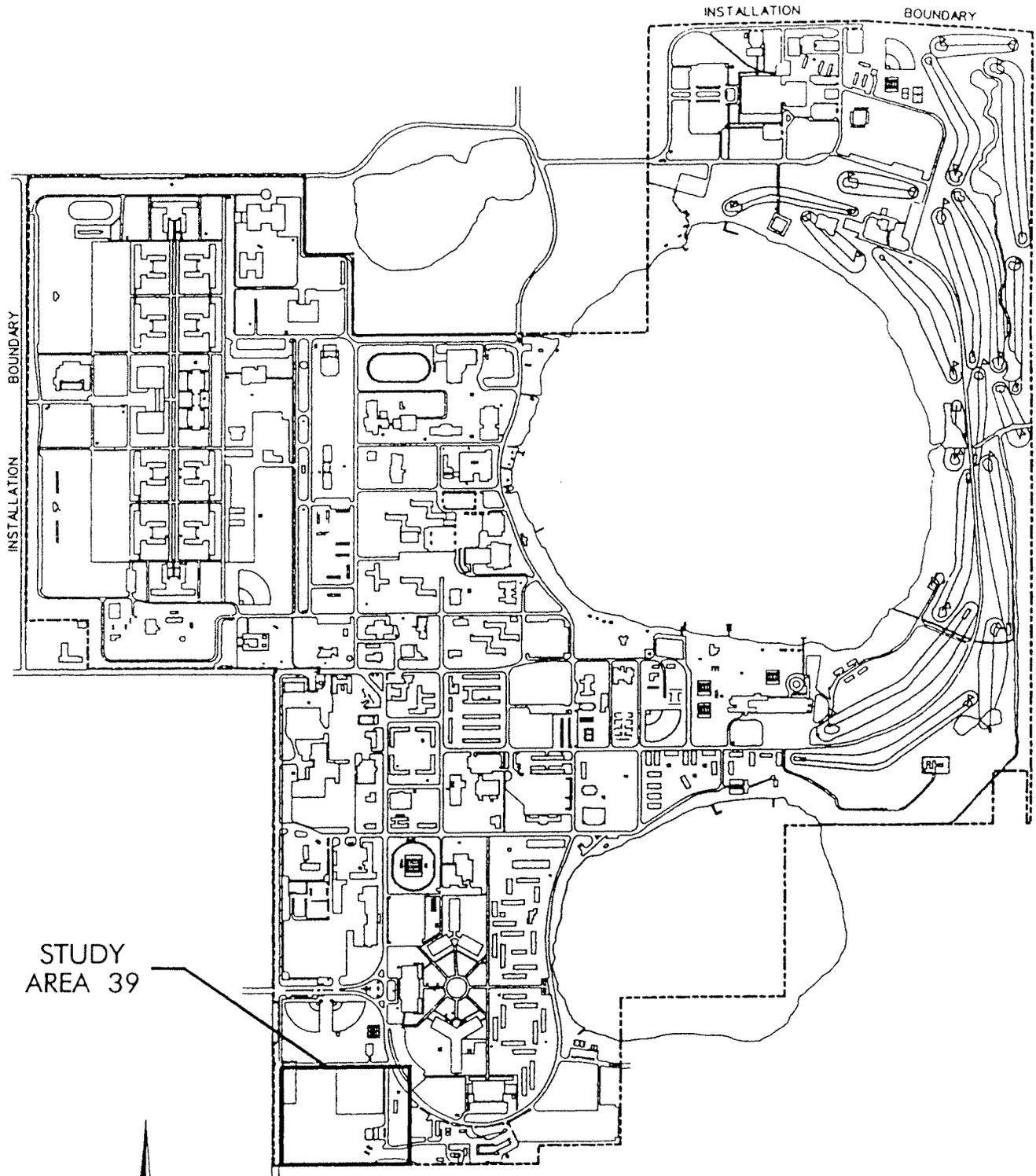
**TABLE 4**  
Field Sampling and Analytical Summary

Task	Location	Activity	Parameter	Method	QC Level	QC Requirements
Groundwater Sampling Field Analyses	Groundwater Monitoring Wells at SA-39	Measurement	Ferrous Iron	Hach Method 8146 (or similar)	None	Filter sample before taking measurement. Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Manganese	Hach Method 8034 (or similar)	None	Filter sample before taking measurement. Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Hydrogen Sulfide	Hach Method 8131 (or similar)	None	Filter sample before taking measurement. Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Sulfate	Hach Method 8051 (or similar)	None	Filter sample before taking measurement. Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Temperature	Direct reading thermometer	None	Calibrate as per NTC Orlando POP Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	pH	Direct reading meter	None	Calibrate as per NTC Orlando POP Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Specific Conductance	Direct reading meter	Screening	Calibrate as per NTC Orlando POP Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Dissolved Oxygen	Direct reading meter	Screening	Calibrate as per manufacturer's instructions
		Measurement	Oxidation Reduction Potential	Direct reading meter	Screening	Calibrate as per manufacturer's instructions
		Measurement	Turbidity	Direct reading meter	None	Calibrate as per NTC Orlando POP Collect sample when conditions meet conditions required in NTC Orlando POP
		Measurement	Water Level	Water Level Indicator	None	As specified in NTC Orlando POP

# FIGURES

## NO.

- 1 Site Location Map
- 2 Site Plan, Study Area 39
- 3 Monitoring Well Exceedances, August/September 1999 and March 2000
- 4 Proposed Injection Point and Monitoring Well Locations
- 5 Schematic for Injection Pump



STUDY  
AREA 39

MAIN BASE

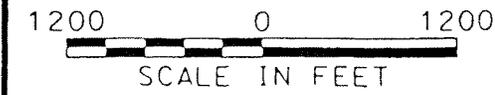
FIGURE 1

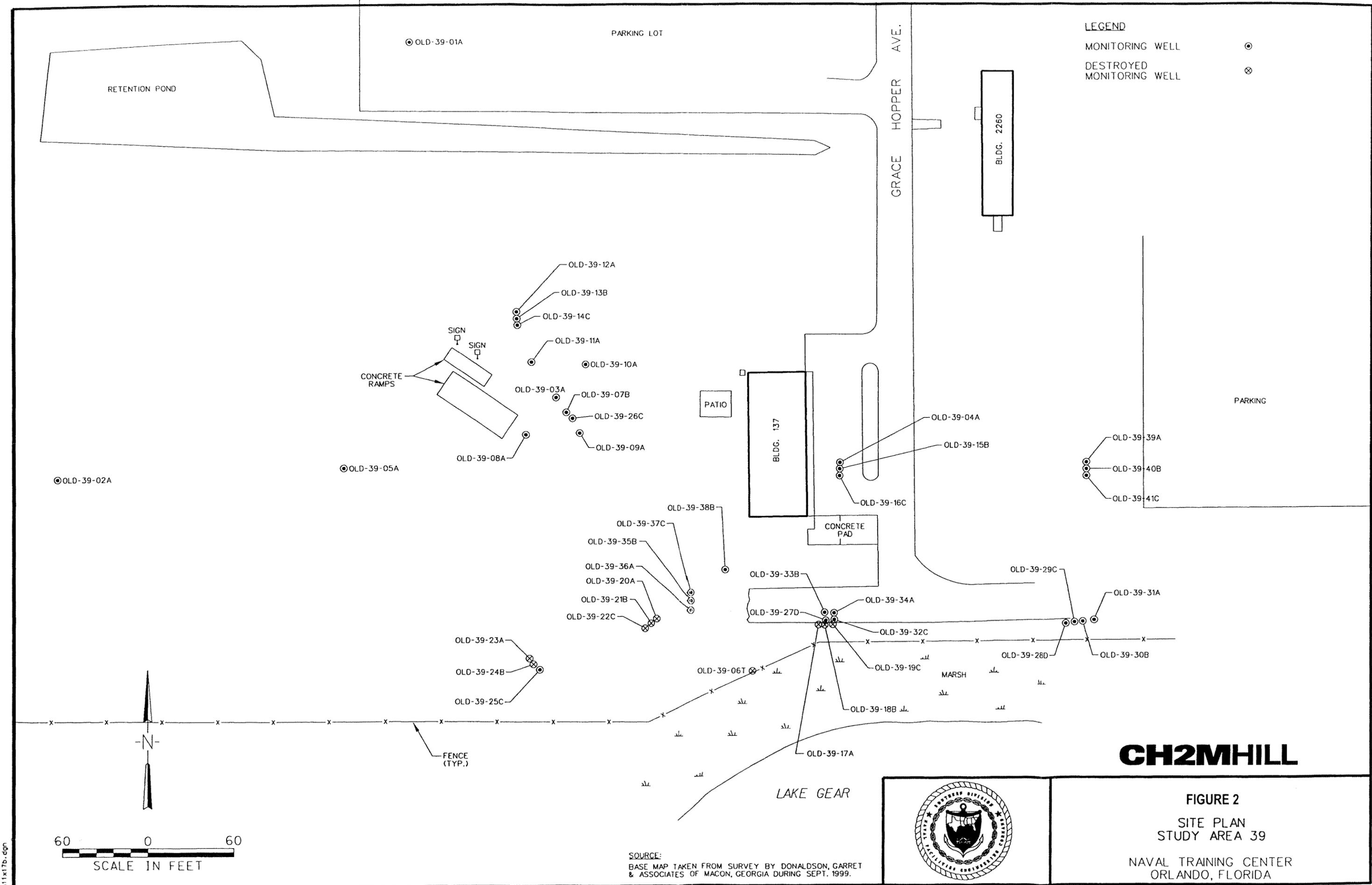


SITE LOCATION MAP  
STUDY AREA 39 - MAIN BASE

NAVAL TRAINING CENTER  
ORLANDO, FLORIDA

28-5x11v.000





LEGEND

- MONITORING WELL      ⊙
- DESTROYED MONITORING WELL      ⊗

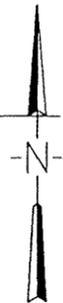
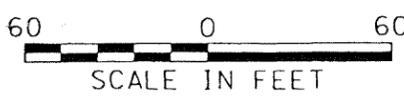
**CH2MHILL**

**FIGURE 2**  
SITE PLAN  
STUDY AREA 39

NAVAL TRAINING CENTER  
ORLANDO, FLORIDA



SOURCE:  
BASE MAP TAKEN FROM SURVEY BY DONALDSON, GARRET  
& ASSOCIATES OF MACON, GEORGIA DURING SEPT. 1999.



n11x17b.dgn

**LEGEND**

MONITORING WELL

DESTROYED MONITORING WELL

WELL ID

SCREEN INTERVAL TO NEAREST FOOT	OLD-39-04A	SAMPLE COLLECTION DATE		
	5 TO 15	4/3/96	5/22/97	9/9/99
ANALYTE	BDCM	<1	<0.5	1
	PCE	<1	15/14	5.7
				DUPLICATE SAMPLE
				ANALYTE CONCENTRATION 1-2

ESTIMATED CONCENTRATION

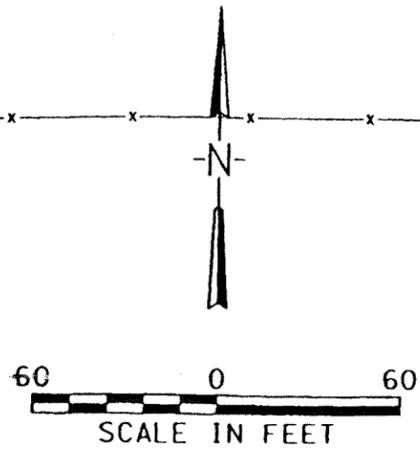
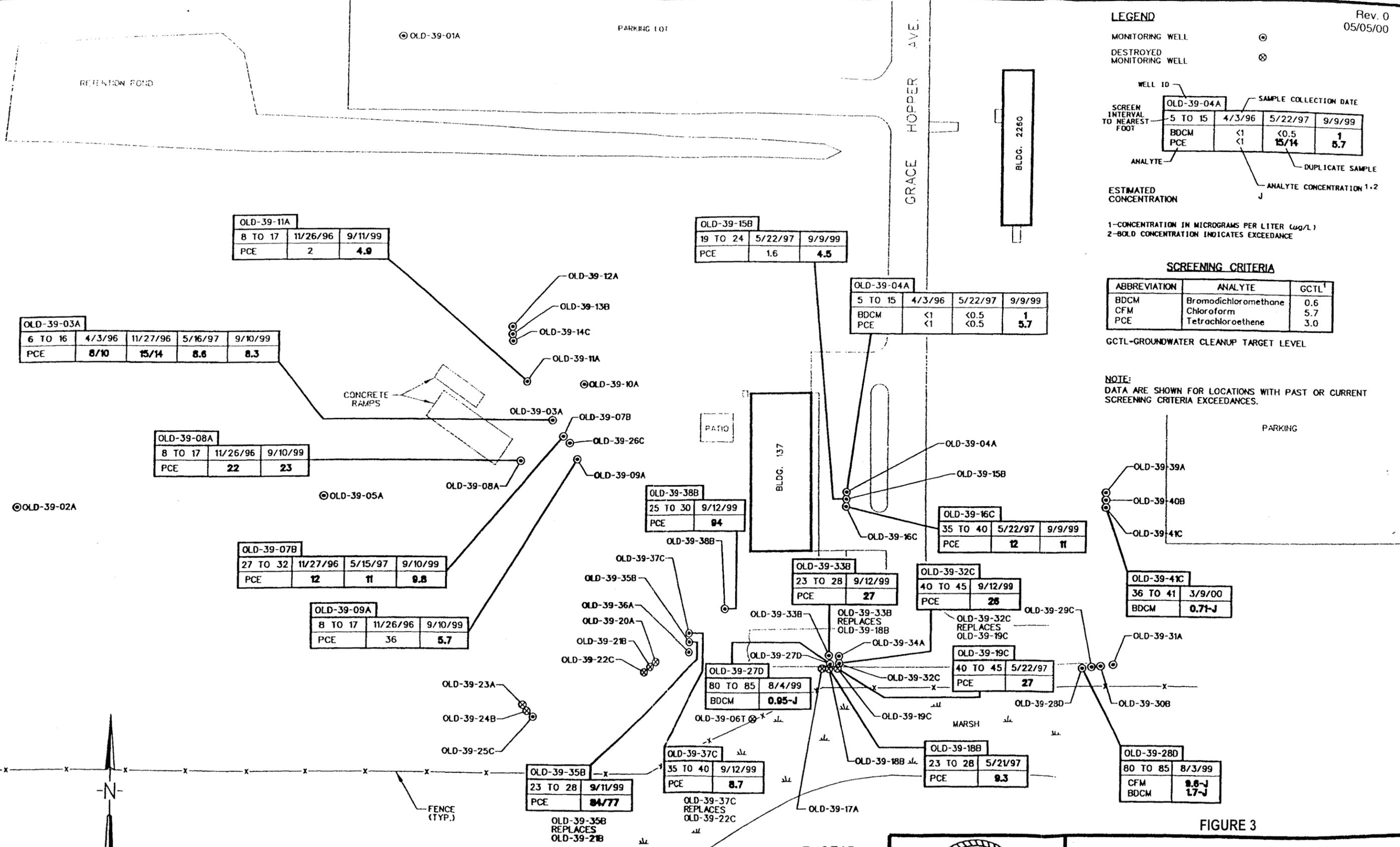
1-CONCENTRATION IN MICROGRAMS PER LITER (ug/L)  
2-BOLD CONCENTRATION INDICATES EXCEEDANCE

**SCREENING CRITERIA**

ABBREVIATION	ANALYTE	GCTL <sup>1</sup>
BDCM	Bromodichloromethane	0.6
CFM	Chloroform	5.7
PCE	Tetrachloroethene	3.0

GCTL-GROUNDWATER CLEANUP TARGET LEVEL

**NOTE:**  
DATA ARE SHOWN FOR LOCATIONS WITH PAST OR CURRENT SCREENING CRITERIA EXCEEDANCES.



SOURCE:  
BASE MAP TAKEN FROM SURVEY BY DONALDSON, GARRET & ASSOCIATES OF MACON, GEORGIA DURING SEPT. 1999.

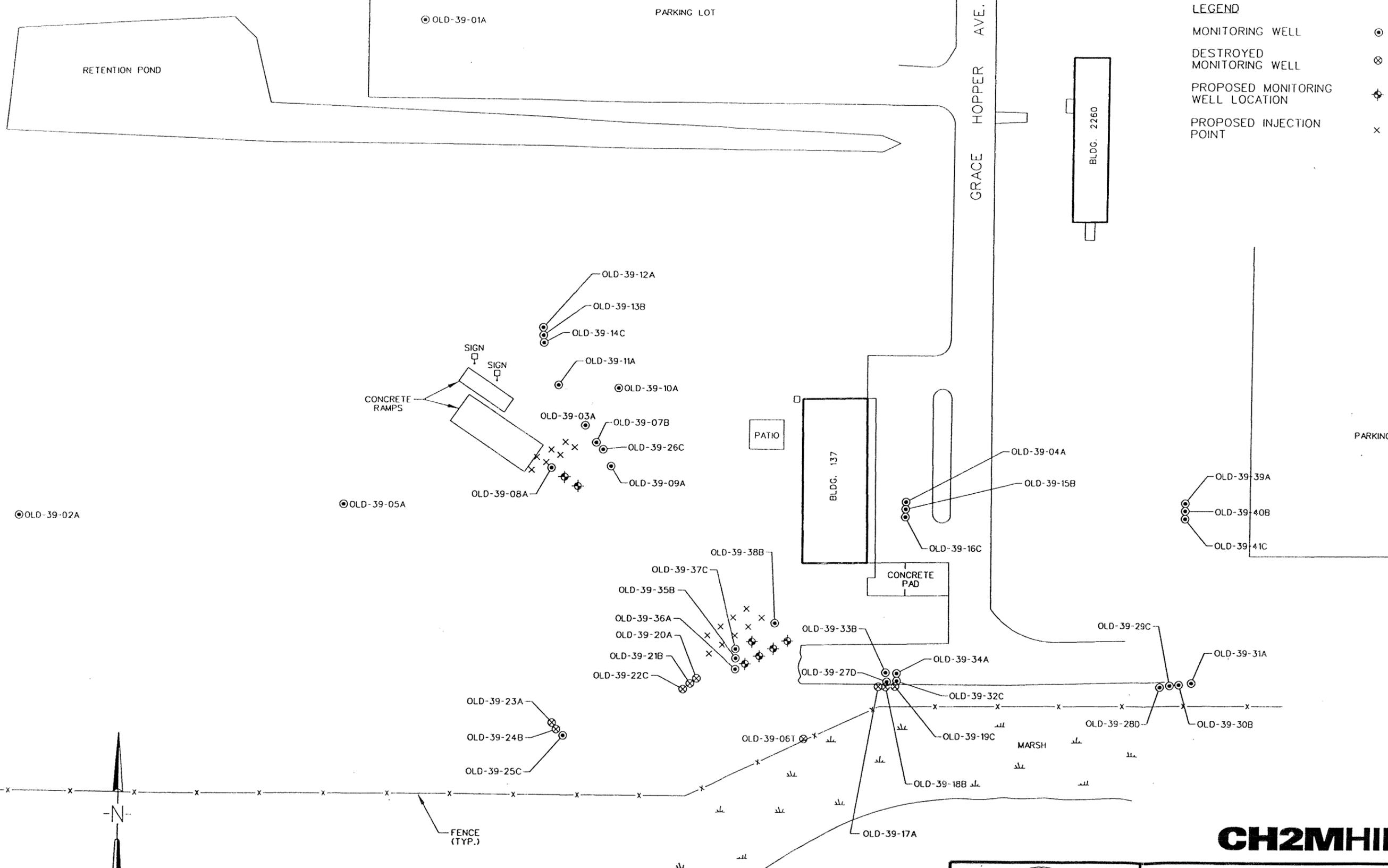


**FIGURE 3**

**MONITORING WELL EXCEEDANCES**  
**AUGUST/SEPTEMBER 1999 AND MARCH 2000**

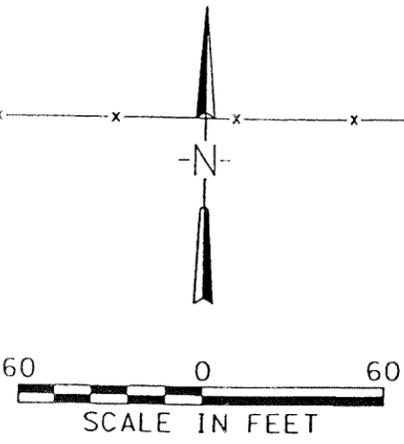
**STUDY AREA 39 - MAIN BASE**

**NAVAL TRAINING CENTER**  
**ORLANDO, FLORIDA**



**LEGEND**

MONITORING WELL	⊙
DESTROYED MONITORING WELL	⊗
PROPOSED MONITORING WELL LOCATION	⊕
PROPOSED INJECTION POINT	x



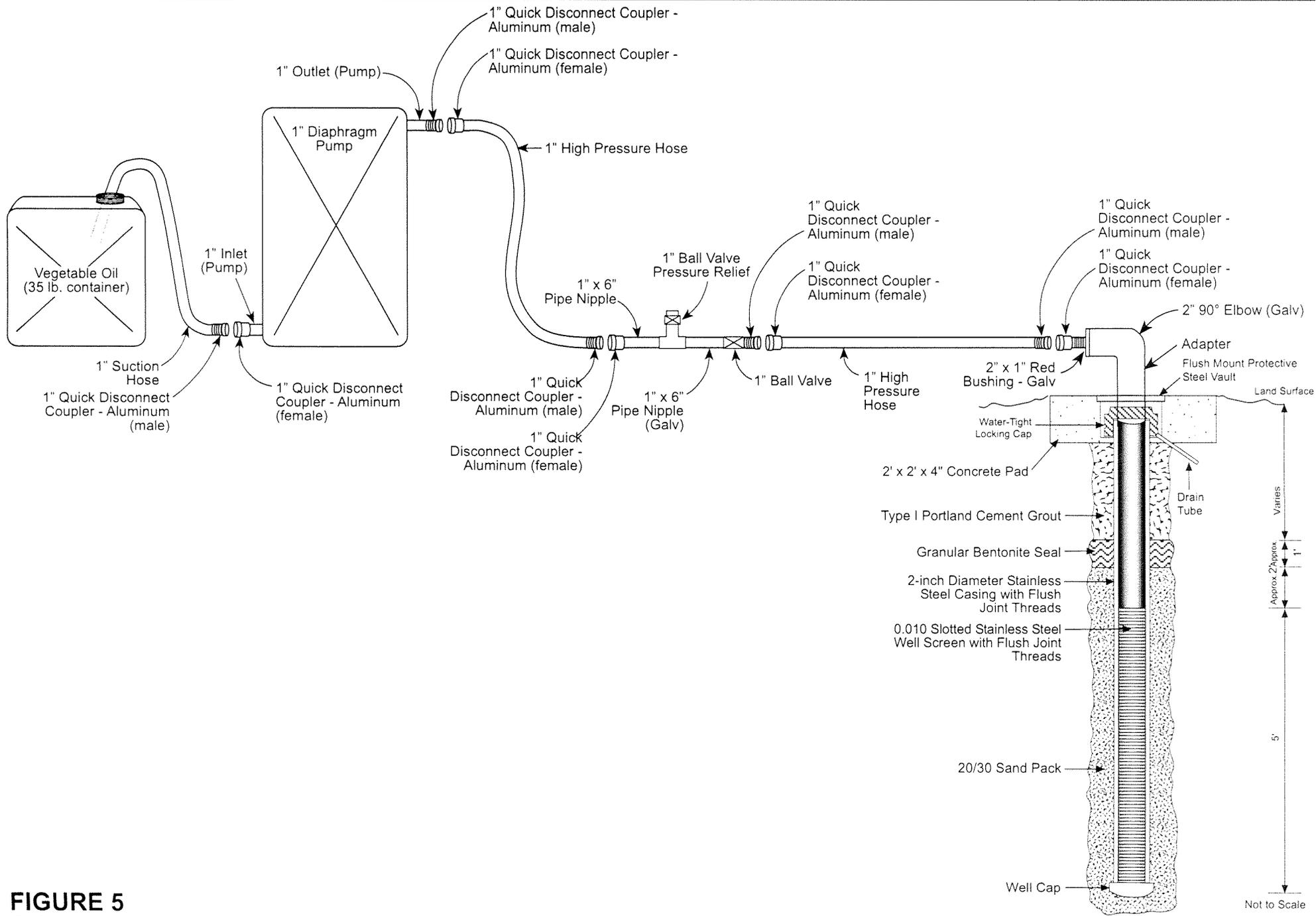
**SOURCE:**  
 BASE MAP TAKEN FROM SURVEY BY DONALDSON, GARRET & ASSOCIATES OF MACON, GEORGIA DURING SEPT. 1999.



**CH2MHILL**

**FIGURE 4**  
 PROPOSED INJECTION POINT AND MONITORING WELL LOCATIONS  
 STUDY AREA 39 - MAIN BASE  
 NAVAL TRAINING CENTER  
 ORLANDO, FLORIDA

n11x17b.dgn



**FIGURE 5**  
Schematic for Injection Pump

Appendix A

**SODIUM BROMIDE MATERIAL SAFETY  
DATA SHEETS**

---

**DREWBROM® Precursor****General**

DREWBROM precursor is an aqueous solution of bromide ion. When intimately mixed with a concentrated aqueous solution of sodium hypochlorite or chlorine, hypobromous acid (HOBr), a powerful broad spectrum oxidizing agent, is generated which effectively controls algal, bacterial and fungal slimes.

The biocide generated from DREWBROM precursor can be used as a disinfectant, sanitizer, bactericide, slimeicide, algicide and mollusk control agent in recirculating cooling water systems, brewery pasteurizing systems, air washers, once-through cooling water and wastewater treatment systems, and pulp and paper mills.

**Typical Properties**

Form:	Liquid
Total Bromide Ion:	295,000 ppm
Sodium Bromide:	38%
Specific Gravity:	1.3 to 1.5
pH:	5.5 to 8.5
Total Hardness (calcium and magnesium ions):	Less than 100 ppm
Freeze Point (First Crystal Formed):	-18°F
Weight per U.S. Gallon (at 70°F):	11.2 to 12.0 pounds
Flash Point:	None

EPA Reg. No. 5185-466-1757

**Application and Dosage**

To form the active disinfectant (HOBr), DREWBROM precursor must be intimately mixed with a concentrated aqueous solution of sodium hypochlorite or chlorine. A one to one molar ratio, sodium bromide to sodium hypochlorite or chlorine is generally recommended as a maximum. To achieve the recommended molar ratio, DREWBROM precursor should be dosed as follows:

ACTIVATOR	AMOUNT	LBS. DREWBROM
Cl <sub>2</sub>	1 lb	3.82
NaOCl	1 lb	0.46

By using this factor as a foundation and simply adding the specific multiplication factor for the system volume to be treated and the dosage level desired, the correct mole ratio for any system can be determined.

Generally speaking, the active disinfectant (HOBr) will replace chlorine in applications that favor its use, i.e., high pH and/or ammonia-contaminated systems.

Thorough mixing of DREWBROM precursor and the concentrated aqueous hypochlorous acid solution is critical to achieve maximum benefit. Once intimate mixing is achieved, the active disinfecting agent, hypobromous acid, is formed instantaneously. Distribution throughout the bulk water system is achieved through dilution after the mixer and then injection through a diffuser.

All materials of construction should be corrosion-resistant plastic. Schedule 80 PVC or PVDF plastic piping is normally preferred. The pump should be manufactured with corrosion resistant plastic heads. The static mixer can be obtained in either PVC or PVDF plastic. Storage vessels should be made of polyethylene, FRP, or epoxy-coated steel.

When feeding DREWBROM precursor and generating hypobromous acid, control the treatment using the DPD chlorine test at a dosage of 0.1-0.3 ppm free halogen.

**Packaging**

DREWBROM precursor is available in different package sizes including bulk, portable tanks and drums.

**Important Information**

*Ashland maintains Material Safety Data Sheets on all of its products. Material Safety Data Sheets contain health and safety information for your development of appropriate product handling procedures to protect your employees and customers.*

*Our Material Safety Data Sheets should be read and understood by all of your supervisory personnel and employees before using Ashland products in your facilities.*

® Registered trademark of Ashland Inc.

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MATERIAL SAFETY DATA SHEET

Ashland

Page 009

Date Prepared: 07/08/98

Date Printed: 03/20/00

MSDS No: 999.0249398-005-001

DREWHROM PRECURSOR

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CERCLA RQ - 40 CFR 302.4(a)  
None listed

SARA 302 Components - 40 CFR 355 Appendix A  
None

Section 311/312 Hazard Class - 40 CFR 370.2  
Immediate(X) Delayed(X) Fire( ) Reactive( ) Sudden  
Release of Pressure( )

SARA 313 Components - 40 CFR 372.65  
None

OSHA Process Safety Management 29 CFR 1910  
None listed

EPA Accidental Release Prevention 40 CFR 68  
None listed

International Regulations  
Inventory Status  
Not determined

State and Local Regulations  
California Proposition 65  
None

---

16. OTHER INFORMATION

The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.

Last page

SOURCE: ASHLAND INC WTR EASYWTR

MATERIAL SAFETY DATA SHEET

Ashland

Page 008  
Date Prepared: 07/08/98  
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MSDS No: 999.0249598-003.001

DREWBROM PRECURSOR

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13. DISPOSAL CONSIDERATION

Waste Management Information

Do not discharge effluent containing this product into lakes, streams, ponds or estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit, and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA. For assistance with your waste management needs including disposal, recycling and waste stream reduction, contact Ashland Distribution Company, IC&S Environmental Services Group at 800-637-7922.

---

14. TRANSPORT INFORMATION

DOT Information - 49 CFR 172.101  
DOT Description:  
NON-REGULATED BY D.O.T.

Container/Mode:  
55 GAL DRUM/TRUCK PACKAGE

Hazard Component:  
None

RQ (Reportable Quantity) - 49 CFR 172.101  
Not applicable

---

15. REGULATORY INFORMATION

US Federal Regulations

TSCA (Toxic Substances Control Act) Status  
TSCA (UNITED STATES) The intentional ingredients of this product are listed.

Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 007  
Date Prepared: 07/08/98  
Date Printed: 03/20/00  
MSDS No: 999.0249598-005.001

DREWBROM PRECURSOR

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Physical Form  
HOMOGENEOUS SOLUTION

Color  
CLEAR & COLORLESS

Odor  
No data

pH  
6.0 - 8.0

---

10. STABILITY AND REACTIVITY

Hazardous Polymerization  
Product will not undergo hazardous polymerization.

Hazardous Decomposition  
May form: carbon dioxide and carbon monoxide, undefined organics.

Chemical Stability  
Stable.

Incompatibility  
Avoid contact with: anionic materials, oxidizable substances.

---

11. TOXICOLOGICAL INFORMATION

LD 50 and LC 50 Data  
For DREWBROM Precursor:  
14 day Oral LD50 (rat) > 5000 mg/kg  
14 day Dermal LD50 (rabbit) > 2000 mg/kg

---

12. ECOLOGICAL INFORMATION

Ecotoxicological Information  
For hypobromous acid (as Br):  
96 hour LC50 rainbow trout (static conditions): 0.23 mg/l  
96 hour LC50 bluegill sunfish (static conditions): 0.52 mg/l  
48 hour LC50 Daphnia magna (static conditions): 0.71 mg/l  
Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 006  
Date Prepared: 07/08/98  
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MSDS No: 999-0249598-005.001

DREWEROM PRECURSOR

Exposure Guidelines  
Component

SODIUM BROMIDE (7647-15-6)  
OTHER LIMIT 10.000 mg/m3 - TWA (Recommended)

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point  
(for product) 217.0 - 219.0 F (102.7 - 103.8 C) @ 760 mmHg

Vapor Pressure  
(for product) < 17.500 mmHg @ 68.00 F

Specific Vapor Density  
.600 @ AIR=1

Specific Gravity  
1.360 - 1.510 @ 77.00 F

Liquid Density  
11.940 lbs/gal @ 77.00 F  
1.440 kg/l @ 25.00 C

Percent Volatiles  
62.0 %

Evaporation Rate  
SLOWER THAN ETHYL ETHER

Appearance  
No data

State  
LIQUID

Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 005  
Date Prepared: 07/08/98  
Date Printed: 03/20/00  
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DREWERON PRECURSOR

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clean, dry utensils and equipment. Do not add this product to any dispensing device containing remnants of any other product. Such use may cause a violent reaction leading to fire and explosion. Contamination with other chemicals may start a chemical reaction with generation of heat, hazardous gases and possible fire and explosion. In case of contamination or decomposition, do not reuse container. If possible, isolate container in open air or well-ventilated area. If necessary, flood with large volumes of water.

**Storage**

Do not store near high heat or open flames. Store in closed containers in a dry, well-ventilated area.

---

**B. EXPOSURE CONTROLS/PERSONAL PROTECTION**

**Eye Protection**

Wear safety glasses in compliance with OSHA regulations. (Consult your safety representative.)

**Skin Protection**

Wear resistant gloves such as: neoprene. To prevent repeated or prolonged skin contact, wear impervious clothing and boots..

**Respiratory Protection**

If overexposure has been determined or documented, a NIOSH/MSHA jointly approved air supplied respirator is advised in absence of proper environmental control. OSHA regulations also permit other NIOSH/MSHA respirators under specified conditions. (See your safety equipment supplier.) Engineering or administrative controls should be implemented to reduce exposure.

**Engineering Controls**

Provide sufficient mechanical (general and/or local exhaust) ventilation to maintain exposure below level of overexposure (from known, suspected or apparent adverse effects).

Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 004

Date Prepared: 07/08/98

Date Printed: 03/20/00

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DREWEROM PRECURSOR

---

**Hazardous Products of Combustion**

May form: bromine, hydrogen bromide.

**Fire and Explosion Hazards**

No special fire hazards are known to be associated with this product.

**Extinguishing Media**

regular foam, alcohol foam, water fog, carbon dioxide, dry chemical.

**Fire Fighting Instructions**

Wear a self-contained breathing apparatus with a full facepiece operated in the positive pressure demand mode with appropriate turn-out gear and chemical resistant personal protective equipment. Refer to the personal protective equipment section of this MSDS.

**NFPA Rating**

Health - 1, Flammability - 0, Reactivity - 0

---

**6. ACCIDENTAL RELEASE MEASURES**

**Small Spill**

Absorb liquid on vermiculite, floor absorbent or other absorbent material.

**Large Spill**

Persons not wearing protective equipment should be excluded from area of spill until clean-up has been completed. Stop spill at source, dike area of spill to prevent spreading, pump liquid to salvage tank. Remaining liquid may be taken up on sand, clay, earth, floor absorbent, or other absorbent material and shoveled into containers.

---

**7. HANDLING AND STORAGE**

**Handling**

Containers of this material may be hazardous when emptied. Since emptied containers retain product residues (vapor, liquid, and/or solid), all hazard precautions given in the data sheet must be observed. Strong oxidizing agent. Mix only with water. Use  
Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 003  
Date Prepared: 07/08/98  
Date Printed: 03/20/00  
MSDS No: 999-0249598-005.001

DREWBROM PRECURSOR

Skin

Remove contaminated clothing. Wash exposed area with soap and water. If symptoms persist, seek medical attention. Launder clothing before reuse.

Swallowing

Seek medical attention. If individual is drowsy or unconscious, do not give anything by mouth; place individual on the left side with the head down. Contact a physician, medical facility, or poison control center for advice about whether to induce vomiting. If possible, do not leave individual unattended.

Inhalation

If symptoms develop, move individual away from exposure and into fresh air. If symptoms persist, seek medical attention. If breathing is difficult, administer oxygen. Keep person warm and quiet; seek immediate medical attention.

Note to Physicians

Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsions may be needed. Preexisting disorders of the following organs (or organ systems) may be aggravated by exposure to this material: lung (for example, asthma-like conditions).

5. FIRE FIGHTING MEASURES

Flash Point

Not applicable

Explosive Limit

Not applicable

Autoignition Temperature

No data

Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 002

Date Prepared: 07/08/98

Date Printed: 03/20/00

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DREWBROM PRECURSOR

---

Inhalation

Breathing of vapor or mist is possible. Breathing small amounts of this material during normal handling is not likely to cause harmful effects. Breathing large amounts may be harmful. Excessive inhalation or ingestion may produce rashes, depression, emaciation, and in severe cases, psychoses and mental deterioration.

Symptoms of Exposure

Signs and symptoms of exposure to this material through breathing, swallowing, and/or passage of the material through the skin may include: irritation (nose, throat, airways).

Target Organ Effects

Overexposure to this material (or its components) has been suggested as a cause of the following effects in laboratory animals: male and female reproductive fertility effects.

Developmental Information

There are no data available for assessing risk to the fetus from maternal exposure to this material.

Cancer Information

This material is not listed as a carcinogen by the International Agency for Research on Cancer, the National Toxicology Program, or the Occupational Safety and Health Administration.

Other Health Effects

No data

Primary Route(s) of Entry

Skin contact, Eye contact, Ingestion.

---

4. FIRST AID MEASURES

Eyes

If symptoms develop, immediately move individual away from exposure and into fresh air. Flush eyes gently with water for at least 15 minutes while holding eyelids apart; seek immediate medical attention.

Continued on next page

MATERIAL SAFETY DATA SHEET

Ashland

Page 001  
Date Prepared: 07/08/98  
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MSDS No: 999.0249598-005.001

DREWEROM PRECURSOR

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Material Identity  
Product Name: DREWEROM PRECURSOR  
General or Generic ID: MICROBIOCID

Company  
Ashland  
Ashland Distribution Co. &  
Ashland Specialty Chemical Co.  
P. O. Box 2219  
Columbus, OH 43216  
614-790-3333

Emergency Telephone Number:  
1-800-ASHLAND (1-800-274-5263)  
24 hours everyday

Regulatory Information Number:  
1-800-325-3751

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient(s)	CAS Number	% (by weight)
SODIUM BROMIDE	7647-15-6	38.0

3. HAZARDS IDENTIFICATION

Potential Health Effects:

Eye

Can cause eye irritation. Symptoms include stinging, tearing, redness, and swelling of eyes.

skin

May cause mild skin irritation. Symptoms may include redness and burning of skin. This material is unlikely to pass into the body through the skin.

Swallowing

Swallowing this material may be harmful.

Continued on next page

Appendix B

**GROUNDWATER TRACER VOLUME  
AND CONCENTRATION TECHNICAL  
MEMORANDUM**

---

# Groundwater Tracer Volume and Concentration, SA-39, Naval Training Center, Orlando, Florida

PREPARED FOR: Steve Tsangaris/TPA  
Jennifer Ottoson/TPA

PREPARED BY: James Dwyer/AUS

DATE: September 22, 2000

## 1.0 Introduction and Background

In support of the ongoing assessment of bioremediation strategies for SA-39, Naval Training Center (NTC), Orlando, Florida, CH2M HILL has proposed a groundwater tracer survey. One remediation strategy involves introduction of food-grade vegetable oil into the shallow aquifer to enhance biodegradation of chlorinated solvents. The oil will be injected at two sites in SA-39. The tracer will be introduced immediately prior to the oil injection to tag groundwater at the injection sites.

## 2.0 Purpose

The purpose of this Technical Memorandum (TM) is to present the results of groundwater modeling and transport modeling performed in support of the bromide tracer study. The main purpose of the modeling was to determine the volume and concentration of tracer necessary to provide conclusive detection of tagged groundwater. For the recommended tracer release, a range of detection concentrations are presented to account for uncertainty in model inputs.

## 3.0 Groundwater Flow Modeling

The U. S. Geological Survey groundwater flow model MODFLOW<sup>1</sup> was used to construct a simplified model of the aquifer system. Two active aquifer units are specifically modeled; A zone and B zone<sup>2</sup>. The model construction, analyses, and results reflect the following assumptions and limitations:

- Each aquifer unit is simulated as a single, homogeneous and isotropic layer
- There is no confining layer between A zone and B zone
- The clay zone between B zone and C zone is assumed to be impermeable

<sup>1</sup> McDonald, M.G. and Harbaugh, A.W., 1984. *A Modular Three-Dimensional Finite-Difference Groundwater Flow Model*. U.S. Geological Survey.

<sup>2</sup> TETRA TECH NUS, Inc., August, 2000. *Site Investigation Report for Study Area 39, Naval Training Center, Orlando Florida*. Department of the Navy.

The measured March 2000 potentiometric surface in A and B zones<sup>3</sup> was used to establish a constant hydraulic gradient across the model area. A rectangular model grid composed of 63 rows and 78 columns was used to discretize the model domain. Cells at the release and monitoring sites were set at 2 feet on a side. The grid spacing gradually increases to a maximum of 20 feet near the model boundaries.

Table 1 summarizes aquifer parameter values included in the groundwater flow and transport models. The transient simulation included four stress periods, a one-day tracer release followed by three one-year monitoring periods.

**TABLE 1**  
Simulated Aquifer Parameters

Model Layer	Porous Media Zone	Parameter	Units	Value
1	A Zone	Horizontal Conductivity	ft/d	4
		Specific Yield	ft <sup>3</sup> /ft <sup>3</sup>	0.2
		Top El.	ft bls	water table
		Bottom El.	ft bls	95
		Porosity	%	20
		Longitudinal Dispersivity	ft	30
		Transverse Dispersivity	ft	6
		Leakance	ft/d/ft	4.0E-02
2	B Zone	Horizontal Conductivity	ft/d	4
		Storage Coefficient	ft <sup>3</sup> /ft <sup>3</sup>	3.0E-03
		Top El.	ft bls	94
		Bottom El.	ft bls	85
		Porosity	%	20
		Longitudinal Dispersivity	ft	30
		Transverse Dispersivity	ft	6

<sup>3</sup> TETRA TECH NUS, Inc., August, 2000. *Site Investigation Report for Study Area 39, Naval Training Center, Orlando Florida.* Department of the Navy.

## 4.0 Solute Transport Modeling

Interaction of the tracer with the native groundwater was simulated to estimate the tracer conc. at the installed monitoring points. The numerical transport code MT3D<sup>4</sup>, developed for the U.S. Environmental Protection Agency, was used to perform the transport simulation. The MT3D model incorporates inputs including hydraulic head and various flow and source/sink terms computed by MODFLOW to simulate the solute response to advection, dispersion, source/sink mixing, and chemical reaction. Advection, dispersion, and source/sink mixing were assumed to dominate the interaction between the tracer and native groundwater at SA-39. Chemical reaction processes, such as sorption or biodegradation, would have minimal effect on the movement and concentration of the tracer.

Aquifer parameters in Table 1 that are unique to solute transport are porosity and dispersivity (longitudinal and transverse). Site-specific data for these transport parameters were not determined during onsite testing so the modeling relied on experience at similar sites. As with aquifer parameters in the flow model, transport parameter values were assumed to be uniform within each aquifer unit.

The Table 2 presents the range of estimated tracer concentration at a theoretical monitoring point 20 feet down gradient of the release point. The estimates assume a single, 200 gallon tracer release at each of the two sites. The proposed initial bromide concentration of 1,500 mg/l has a solution density near that of the native groundwater. Using analytical methods with a detection limit of 0.1 mg/l, the proposed tracer releases should provide conclusive evidence of oil-exposed groundwater at the monitoring point. The plan will need to be modified if bromide levels in the native groundwater exceed 0.2 mg/l.

**TABLE 2**  
Simulated Aquifer Parameters

Site	30-day Concentration (mg/l)	180-day Concentration (mg/l)
Upgradient	0.7 – 1.5	0.6 – 0.8
Downgradient	0.5 – 1.2	0.6 – 0.7

The tracer will be batched onsite from a concentrated sodium bromide solution. Combining approximately 1.01 gallons of 38 percent sodium bromide solution (295,000 ppm bromide ion) with 199 gallons of potable water with very low bromide levels will result in the 200 gallons of 1,500 mg/l bromide tracer. After thorough mixing, a sample of the tracer will be collected and analyzed to document the release. Separate tracer samples will be collected from each separate batch.

<sup>4</sup> Zheng, C., 1990. *A Modular Three-Dimensional Transport Model for Simulation of Advection, Dispersion and Chemical Reaction of Contaminants in Groundwater Systems*. U.S. Environmental Protection Agency.