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TECHNICAL MEMORANDUM PILOT STUDY WORK PLAN PHASE II UPDATE OPERABLE
UNIT 4 (OU 4) HAWTHORN ZONE EOS PRO INJECTIONS NTC ORLANDO FL
05/18/2015
RESOLUTION CONSULTANTS

Subject: **Pilot Study Work Plan Phase II Update
OU 4 Hawthorn Zone EOS[®] Pro Injections
Former Naval Training Center, Orlando, Florida**

Prepared For: Art Sanford, NAVFAC SE BRAC PMO East, RPM

Prepared By: Marianne Sweeney, P.E., Resolution Consultants (RC)

Copied To: David Barney, NAVFAC SE BRAC PMO East, Deputy BCM
David Grabka, FDEP
Jessica Keener, Solutions-IES

Date: May 18, 2015

On behalf of the Navy, Resolution Consultants (RC) has prepared this Pilot Study Work Plan Update for Phase II of the Hawthorn Zone Emulsified Oil Substrate (EOS[®] Pro) injections at Operable Unit (OU) 4 located at the former Naval Training Center (NTC) Orlando, Florida. This work plan update was prepared under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract N62470-11-D-8013, Contract Task Order (CTO) No. JM89.

Introduction

OU 4 is located within Area C of the former NTC Orlando and is the site of the former Navy laundry and dry cleaning facility. Chlorinated solvent contamination in the Hawthorn Water Bearing Zone (WBZ) at this site is being evaluated through a focused Remedial Investigation/Feasibility Study (RI/FS). A pilot study is being performed to evaluate EOS[®] Pro injections as a potential remedy. Phase I of the pilot study was completed in February 2015; Phase II is tentatively scheduled for June 2015.

The purpose of this Tech Memo is to request a modification to the Underground Injection Control permit to include a sodium sulfite additive. This additive will be used during Phase II to reduce oxygen concentrations in the injection fluids. Additionally, based on current site conditions, eight of the Phase II injection locations will be installed at angles due to surface development activities. The groundwater monitoring plan has also been adjusted based on well availability.

Background

A Draft Tier II Sampling and Analysis Plan for RI Addendum Sampling Activities (RC, September 2014) was prepared for groundwater sampling and drilling activities to assess the conditions in the Hawthorn WBZ. Groundwater samples were collected from existing monitoring wells in October 2014. Drilling activities were completed in November 2014 and included collection of continuous soil cores for lithological description and soil screening at four locations (SB09 to SB12), collection of groundwater samples at several discrete intervals, and installation of two temporary injection wells

at the locations of soil borings SB09 and SB12 (zone of discharge [ZOD] D3). Phase I Pilot Study activities were completed in accordance with the *Pilot Study Work Plan, OU 4 Hawthorn Zone EOS[®] Injections* (RC, February 2015), which was approved by FDEP on February 12, 2015. Specified volumes of EOS[®] Pro along with dilution water and chase water was injected into each of the two injection wells February 17-23, 2015. The two injection wells were abandoned by the developer following injection activities.

Phase I Results

During Phase I monitoring well OLD-13-62D, located approximately 10 feet from the nearest injection well, did not immediately indicate detection of EOS[®] Pro. However, one week following injections the bromide tracer was detected in this monitoring well. This tracer, along with increased turbidity, indicates that the injected mixture was distributed in a radius of influence (ROI) of at least 10 feet. Analysis of groundwater samples collected from OLD-13-62D one month after Phase I injections indicated reduced concentrations of tetrachloroethylene (PCE) and trichloroethylene (TCE) and increased concentrations of cis-1,2-dichloroethene and vinyl chloride; indicating reductive dechlorination is occurring. A comprehensive evaluation of the results will be discussed in the focused RI/FS (pending).

Current Conditions

The existing Hawthorn wells within the footprint of the Hawthorn WBZ contaminant plume, excluding three wells at the northern border (OLD-13-68D, OLD-13-69D and OLD-13-70D), have been abandoned in conjunction with site development activities. Replacement wells will be installed following the completion of major construction activities.

The lined stormwater pond in the area of ZOD 3 is currently under construction, and soils have been excavated to the water table in this location. Temporary lined holding ponds have been constructed for stormwater management, including a temporary pond in the future location of Building 4 (reference **Figure 1**).

Implementation – Phase II

EOS[®] Pro will be injected into the Hawthorn aquifer via thirteen temporary injection wells to be installed in three treatment zones identified as ZOD D3, D4, and D5 as illustrated in **Figure 1**. The injections will be performed between 100 to 130 feet below land surface (bls) as indicated in **Table 1**. Phase I demonstrated that a ROI of 10 feet was achievable; therefore the ROI goal of 12.5 feet was not adjusted for the Phase II injections. However, due to development of the property and the excavation that has already occurred for the on-site stormwater pond, ZODs D3 and D4 injection wells will be installed at angles up to 20 degrees from the vertical, as depicted in **Figure 1**.

Prior to injections, groundwater samples collected from the newly installed injection wells and northern boundary wells will be analyzed for select cVOCs, natural attenuation parameters, microbial analysis using quantitative polymerase chain reaction (qPCR), compound specific isotope analysis (CSIA), tracer (bromide) and ZOD parameters (sodium and sulfite). Phase II performance data will be collected from designated wells as shown in the sampling plan provided in **Table 2**.

The volume of EOS[®] Pro was determined using the manufacturer's design tool and has not changed from the original Work Plan design. The volume calculations are based on a ROI of 12.5 feet and 25% of the pore volume being replaced by the EOS[®] Pro mixture. Following injection of the EOS[®] Pro mixture, an equal volume of chase water will be injected into each well location, for a design replacement of 50% of the available pore volume. A summary of the proposed injection volumes is provided in **Table 1**.

A sodium bromide tracer will be added to the EOS[®] Pro mixture at a concentration of 1,000 parts per million (ppm) to enable a bromide ion detector to detect the mixture in adjacent injection wells.

A revision to the original Work Plan is the planned addition of sodium sulfite during Phase II injections to reduce the oxygen in the EOS[®] Pro mixture and chase water prior to injection. This will assist in keeping the environment in a reducing state by decreasing the dissolved oxygen concentration. Sodium sulfite will be added to the batch water at a concentration of approximately 66 ppm to deoxygenate the EOS[®] Pro mixture as well as the chase water. Sodium sulfite volume calculations are provided as **Attachment A**. The concentration of sodium sulfite may be adjusted as necessary based on field measurements.

Treated discharge water from the site pump and treat system will be used for the injections. A totalizing flow meter and pressure gage will be mounted onto the injection piping in order to record injection flow rates and corresponding pressures. The proposed volume of EOS[®] Pro mixture and associated chase water to be injected is expected to take several weeks; therefore concurrent injections are planned.

Adjacent injection wells, prior to their use, will be monitored for changes in water level and water quality parameters, and a bromide ion detector will be used to evaluate ROI during injection events.

All temporary injection points will be abandoned by grouting following completion of the injection activities.

Underground Injection Control (UIC)

See **Attachment B** for a draft Underground Injection Control (UIC) notification letter; modified to include the sodium sulfite additive. The EOS[®] Pro application will be conducted using Class V,

Group 4 aquifer remediation wells. Downgradient well OLD-13-69D will be monitored following injection activities to insure UIC parameters are not exceeded, or if so, that they return to their groundwater standards or background level, whichever is less stringent. The estimated time to achieve cleanup of the site is 50 months.

Investigative Derived Waste

Temporary injection well installation for Phase II is expected to generate Investigative Derived Waste (IDW) in the form of drill cuttings, decontamination fluids, development water and decontamination trash (plastic sheeting, gloves). Purge water from the pilot study will be containerized and transferred to the pump and treat system for processing and disposal. IDW will be managed in accordance with Section 8.4.5 of the *Draft Tier II Sampling and Analysis Plan for RI Addendum Sampling Activities* (RC, September 2014).

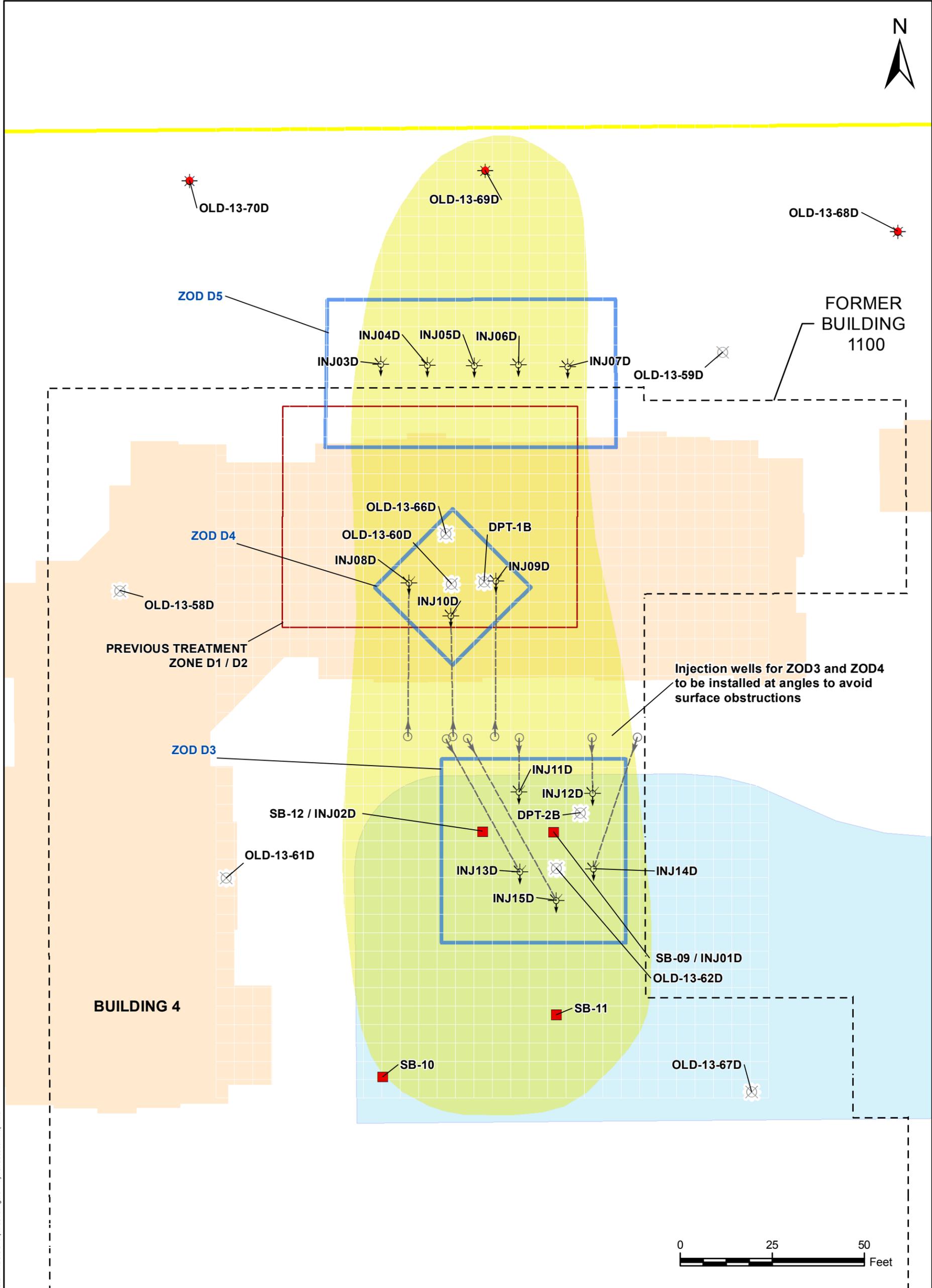
Closure

Resolution Consultants appreciates the opportunity to be of service on this project. If you have any questions or require additional information, please contact me at (407) 513-8251.



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FIGURE



\\usor12p02\data\projects\Navy CLEAN\NTC Orlando\9_0_Geospacial\MXDs\OU4\April 2015\Figure 1 InjWellLocation Map.mxd

Legend

-  Injection Well Location
-  CMT Monitoring Well Location
-  Abandoned Well Location
-  Rotosonic Boring Location
-  Treatment Zones (ZOD) D3, D4 and D5
-  Previous Treatment Zones D1 / D2
-  Approximate Extent of VOCs (Hawthorne)
-  Operable Unit 4 Boundary
-  Future Building
-  Pond A
-  Angled Injection Well

Notes:
ZOD - Zone of Discharge



<p>FIGURE 1 PILOT STUDY LAYOUT Operable Unit 4 NAVAL TRAINING CENTER ORLANDO ORLANDO, FLORIDA</p>	
	
<p>REQUESTED BY: J. Ceather</p>	<p>DATE: 5/6/2015</p>
<p>DRAWN BY: M. Barron</p>	<p>TASK ORDER NUMBER: JM89</p>

TABLES

TABLE 1
EOS PRO VOLUME SUMMARY
Operable Unit 4
Former Naval Training Center Orlando

Location	Injection Interval Feet BLS	EOS Pro Volume gallons	Water Volume gallons	Total Mixture Volume gallons	Injection Volume Including Chase Water gallons	Estimated Injection Time hours	Estimated Injection Time days
PHASE 1							
Treatment Zone D3							
SB09-INJ01	110 - 120	70	2684	2754	5508	18	2
SB12-INJ02	110 - 120	70	2684	2754	5508	18	2
Phase 1 total		140	5368	5508	11016	37	5
PHASE 2							
Treatment Zone D3							
INJ PT (5 total)	115 - 130	104	4027	4131	8262	28	3
Phase 2 subtotal		520	20135	20655	41310	138	17
Treatment Zone D4							
INJ PT (3 total)	115 - 130	92	4039	4131	8262	28	3
Phase 2 subtotal		276	12117	12393	24786	83	10
Treatment Zone D5							
INJ PT (5 total)	100 - 120	55	5453	5508	11016	37	5
Phase 2 subtotal		275	27265	27540	55080	184	23
Phase 2 Totals		1071	59517	60588	121176	404	50
TOTALS		1211	64885	66096	132192	441	55

BLS - below land surface

Injection time estimates injecting at 5 gpm

Chase water is twice the volume of the total mixture

ATTACHMENT A

Sodium Sulfite Volume Calculations

Attachment A
Additive Volume Calculations
Operable Unit 4
Former Naval Training Center Orlando

Location	Injection Interval Feet BLS	EOS Pro Volume gallons	Water Volume gallons	Total EOS Mixture Volume gallons	Bromide Volume to be added to EOS Mixture lbs	Sodium sulfite Volume to be added to EOS Mixture lbs	Chase Water Volume gallons	sulfite Volume to be added to Chase Water lbs
PHASE 2								
Treatment Zone D3								
INJ PT (5 total)	115 - 130	104	4027	4131			4131	
Phase 2 subtotal		520	20135	20655	172	11	20655	11
Treatment Zone D4								
INJ PT (3 total)	115 - 130	92	4039	4131			4131	
Phase 2 subtotal		276	12117	12393	103	7	12393	7
Treatment Zone D5								
INJ PT (5 total)	100 - 120	55	5453	5508			5508	
Phase 2 subtotal		275	27265	27540	229	15	27540	15
Phase 2 Totals		1071	59517	60588	505	33	60588	33

Notes:

1 liter (L) water = 1,000 grams(g); 1 g = 1,000 mg; 1 parts per million (ppm) = 1 mg/L.

Bromide will be added at a concentration of 1,000 ppm.

EOS Mixture (gallons) * 3.785 L/gal * 1,000 mg/L * 1 gram/ 1,000 mg * 1 kg/1,000 grams * 2.2 lbs/kg = bromide (lbs)

Sodium sulfite will be added at a concentration of 66 ppm.

EOS Mixture (gals) * 3.785 L/gal * 66 mg/L * 1 gram/ 1,000 mg * 1 kg/1,000 grams * 2.2 lbs/kg = sodium sulfite (lbs)

ATTACHMENT B

Updated UIC Permit Information

Memorandum

**Florida Department of
Environmental Protection**

TO: Cathy McCarty, P.G.
Florida Department of Environmental Protection
Bureau of Water Facilities Regulation
Underground Injection Control Section - MS 3530
2600 Blair Stone Road, Tallahassee, FL 32399-2400

FROM: _____ (Note 1.)

DATE: _____

SUBJ: **Proposed Injection Well(s) for In Situ Aquifer
Remediation at a Remedial Action Site**

Pursuant to paragraph 62-528.630(2)(c), F.A.C., inventory information is hereby provided regarding the proposed construction of temporary injection well(s) for the purpose of in situ aquifer remediation at a contaminated site.

Facility name: Operable Unit 4 (OU 4)
Facility address: 1060 Warehouse Rd.
City/County: Orlando/Orange
Latitude/Longitude: 28°33'39.0" N/ 81°20'46.4" W
FDEP Facility Number: DOD 14 1997

Facility owner's name: Art Sanford, Restoration Program Manager
Facility owner's address: Naval Facilities Engineering Command
BRAC Program Management Office East
203 S. Davis Drive, Bldg 247
Joint Base Charleston, SC 29404

Well contractor's name: Groundwater Protection dba DrillPro. (Note 2.)
Well contractor's address: 2300 Silver Star Rd.
Orlando, FL 32804Orlando, FL 32804

AFFECTED AQUIFER

Name of aquifer: Hawthorn water bearing zone
Depth to groundwater (feet): 5
Aquifer thickness (feet): 40
Areal extent of contamination (square feet): 12,500

INJECTION WELLS

A site map showing the location and spacing of injection wells, the areal extent of the groundwater contamination plume, and associated monitoring wells is attached. The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or HSA/Mud rotary Rotosonic (circle the appropriate well type)
Diameter of well(s) (i.e., riser pipe & screen) (inches): 2
Total depth of well(s) (feet): 130
Screened interval: 100 to 130 feet below land surface
Grouted interval: 0 to 100-115 feet below land surface
Casing diameter, if applicable (inches): NA (rotosonic install)
Cased depth, if applicable: _____ to _____ feet below land surface
Casing material, if applicable: _____

PROJECT DESCRIPTION

The in situ, injection-type aquifer remediation product/process remediates contaminants by:
(check those that apply)

- bioremediation,
 chemical oxidation, or
 other (describe) _____

Brief description of the project:

EOS[®] Pro with sodium bromide tracer & sodium sulfite

Summary of major design considerations and features of the project:

Number of injection wells: 15
Injection volume per well (gallons): ~5,500 - ~ 11,000
Single or multiple injection events: single, two phases
Injection volume total (all wells, all events): ~132,000 gallons

FLUID TO BE INJECTED

Composition of injected fluid:
(ingredient, wt. %) (Note 3.): EOS® Pro 5%, sodium bromide 1000 ppm,
sodium sulfite 66 ppm

TEMPORARY INJECTION ZONE OF DISCHARGE (ZOD)

(check those that apply)

- No ZOD needed. The fluid to be injected meets the primary and secondary groundwater standards of Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapters 62-520 and 62-777, F.A.C.
- ZOD permission by rule 62-520.310(8)(c), F.A.C., for reagent chemical species and/or parameter(s) in the fluid to be injected (or re-injected) that exceed secondary groundwater standards. ZOD permission by this rule also applies to chemical species in the fluid to be injected that exceed primary groundwater standards or minimum groundwater criteria, provided those species are prime constituents of the reagents used to remediate site contaminants. The list of chemical species and parameters for which the approved Remedial Action Plan identifies zone size, duration and groundwater monitoring are as follows:
__TRPH, sodium, chloride, sulfite

- ZOD permission by rule 62-520.310(8)(c), F.A.C., for the following contaminants of concern that exceed their groundwater standards in the fluid to be re-injected as part of a closed-loop re-injection system for which the approved Remedial Action Plan identifies zone size, duration and groundwater monitoring:

- ZOD permission by variance because fluid to be injected contains the following impurities that are not prime constituents of the reagents used to remediate the site's contaminants, and the concentration of those impurities in the fluid to be injected are in excess of their primary groundwater standards:

- A variance needs to be granted before the remediation can be conducted.
- A variance has already been granted for the impurities listed above:

Date variance granted: _____ Zone size (feet): _____ Duration (time): _____

..... ◆◆ ◆◆

- If ZOD permission by rule 62-520.310(8)(c), F.A.C., or by variance is checked above, then a figure that delineates the ZOD is attached, or the ZOD is described as follows:

CLEANUP CRITERIA AND ENFORCEABLE APPROVAL ORDER

In situ injection-type aquifer remediation of the contaminants of concern at this site is intended to meet the groundwater cleanup target levels established for them in accordance with applicable and appropriate chapters of the Florida Administrative Code and cited in the approved Remedial Action Plan. Additionally, all other groundwater standards will be met at the time of project completion for any residuals associated with the ingredients of the injected remediation products, and any by-products or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminants of concern during their use. Applicable primary and secondary drinking water standards are set forth in Chapter 62-550, F.A.C., and additional groundwater quality criteria are set forth in Chapters 62-520 and 62-777, F.A.C.

The remediation plan estimates that site remediation will take 50 months. We will notify you if there are any modifications to the remediation strategy which will affect the injection well design or the chemical composition and volume of the injected remediation product(s).

The proposed remediation plan was approved on _____ by an enforceable approval order. A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.

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- Note 1. This notification memorandum is primarily for use by state technical reviewers, but remediation contractors may fill in all blanks except those labeled "FROM" and "DATE" on page 1, and the "approval date", and "telephone number" blanks in the last paragraph on page 4. Those blanks are filled only by the regulator. In the case that the memorandum form is partially completed by the remediation contractor, the FDEP technical reviewer must verify that the information provided by the contractor is accurate and complete. Local programs are not authorized to approve underground injections into aquifers. Reason: Per agreement with EPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should follow the instructions in the March 16, 2000, memorandum to arrange for Department headquarters' execution of an approval order, and then complete this memorandum.
- Note 2. If an injection well installation contractor has not yet been selected, then indicate the name and address of the project's general remediation contractor/consultant.
- Note 3. Complete chemical analysis of the fluid to be injected is required by Chapter 62-528, F.A.C. Some remediation products and processes may have already submitted this information at the time of application for acceptance by the Innovative Technology Acceptance Program. For those situations, when completing the Fluid To Be Injected section of this memorandum, it will suffice to indicate: (1) an Innovative Technology Acceptance letter has been issued; (2) the date of the acceptance letter; (3) the acceptance letter contains the chemical analysis, or a voucher for the confidential disclosure of the injected fluid's chemical composition if it is a proprietary formulation; and (4) the fluid will be injected at concentrations that are less than or equal to those cited in the acceptance letter. For products and processes that do not hold an Innovative Technology Acceptance letter, but for which the site-specific Remedial Action Plan provides a complete description of the chemical composition of the fluid to be injected, it will be necessary to enter this information into the Fluid To Be Injected section of this memorandum.