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TRANSMITTAL LETTER FOR DRAFT FINAL BIOX INJECTION LETTER REPORT SITE 1586  
NS MAYPORT FL  
02/17/2015  
TETRA TECH



Document Tracking Number 15JAX0009

February 17, 2015

Project Number 112G02801

Naval Facilities Engineering Command, Southeast  
ATTN: Mr. Dana Hayworth (OPDE3)  
Remedial Project Manager  
135 Ajax Street North  
Naval Air Station Jacksonville  
Jacksonville, FL 32212-0030

Reference: CLEAN Contract Number N62470-08-D-1001  
Contract Tack Order Number JM33

Subject: BIOX<sup>®</sup> Injection Letter Report, Site 1586, Naval Station Mayport, Jacksonville, Florida

Dear Mr. Hayworth:

Tetra Tech, Inc. is pleased to submit this BIOX<sup>®</sup> Injection Letter Report for Site 1586 at Naval Station (NAVSTA) Mayport in Jacksonville, Florida. This report was prepared for the United States Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) under Contract Task Order (CTO) JM33 for the Comprehensive Long-term Environmental Action Navy Contract Number N62470-08-D-1001.

## **SITE LOCATION**

NAVSTA Mayport is located within the corporate limits of the city of Jacksonville, Duval County, Florida, approximately 12 miles to the northeast of downtown Jacksonville and adjacent to the town of Mayport. A Facility Location Map is provided as Figure 1. The installation complex is located on the northern end of a peninsula bound by the Atlantic Ocean to the east and the St. Johns River to the north. NAVSTA Mayport occupies the entire northern part of the peninsula except for the town of Mayport, which is located to the west between the installation and the St. Johns River.

## **SITE DESCRIPTION AND HISTORY**

Building 1586 is located in the northeastern portion of NAVSTA Mayport. Building 1586 is used as the Bachelors' Quarters and is constructed with brick and cement block in the shape of a "Y". Site 1586 is an impacted area near the northeastern corner of Building 1586 where an underground storage tank (UST) containing fuel oil is located. The UST is located under a cement slab and has a flush mount manhole covering the fill port. A pump house is located at the northeastern end of Building 1586, and the piping for the UST runs along the southeastern corner of the building. The UST system currently has an active electronic leak detection system. The UST and piping are surrounded by gravel backfill that is covered with sod. This backfilled area extends from the area surrounding the UST approximately 40 feet along the southern wall of Building 1586 and extends out from the building 15 to 20 feet to the sidewalk (see Figure 2). Currently, a well network of 16 monitoring wells, 1 piezometer, and 1 recovery well has been installed on site.

**Tetra Tech, Inc.**

8640 Philips Highway, Suite 16, Jacksonville, FL 32256  
Tel: (904) 636.6125 Fax: (904) 636.6165 www.tetrattech.com



Site 1586 has been the focus of a petroleum investigation since 1991. On September 6, 1991, during a weekly fuel inventory inspection, a leak in the fuel line was reported. NAVSTA Mayport personnel estimated that approximately 3,000 gallons of diesel fuel were released from a 4,000-gallon UST.

The 4,000-gallon steel UST was replaced with a new 5,000-gallon double-walled fiberglass UST in the same tank pit area in the spring of 2000. Pea-sized gravel was used to backfill the new tank pit and surrounding area. Approximately 1,400 gallons of fuel was mistakenly pumped into a fill port previously connected to the removed 4,000-gallon UST in mid-2000.

Investigations at Site 1586 include the following:

- Initial Site Assessment – Enviropact, September 1991
- Preliminary Contamination Assessment – ABB Environmental Services, Inc., April 1993
- Contamination Assessment Report – ABB Environmental Services, Inc., June 1994
- Contamination Assessment Report Addendum – ABB Environmental Services, Inc., April 1997
- Site Assessment Report Addendum – Harding Lawson and Associates, February 1999
- Quarterly Groundwater Monitoring and Free Product Recovery – Tetra Tech, August 1999 through March 2000
- Site Assessment Report – Tetra Tech, August 2002
- Initial BIOX<sup>®</sup> Injection – Tetra Tech, March 30 through April 6, 2012; 72 (5,328 gallons) BIOX<sup>®</sup> injection points (see Attachment 1)
- Remedial Action Plan – Tetra Tech, June 2012
- Quarterly groundwater monitoring and free product recovery – Tetra Tech, August 2005 through October 2012
- Second BIOX<sup>®</sup> Injection – Tetra Tech, April 28 through May 2, 2014; 39 (2,184 gallons) BIOX<sup>®</sup> injection points (see Attachment 2)

## INJECTION SUMMARY

Tetra Tech conducted a second BIOX<sup>®</sup> injection at Site 1586 from April 28 to May 2, 2014. The plan of work was to re-treat the area previously treated during the initial injection and to treat the 144-square foot area in the vicinity of monitoring well MW04S. All injection points were cleared for utilities using a water wand.

On April 28, 2014, at approximately 3:15 PM, a direct push technology rig was advancing the fourth injection point of the day in the vicinity of monitoring well MW04s when an unmarked utility (3/4-inch copper water line) was struck. This utility was within the excavation area of the dig permit (see Attachment 3), and no markings were on the ground. Although the location was cleared to approximately 7 feet using the water wand, it is apparent the narrow wand had missed the water line that was approximately 4 feet below ground surface. The copper water line was repaired by the Public Works Department.

Injection Points 4 through 39 were completed between April 29 and May 1, 2014, as depicted in Attachment 2. On the evening of May 1, 2014, at approximately 6:20 PM, a resident of Building 1586 notified Tetra Tech personnel that foam material was seeping from an electrical panel in the building. It is believed that a preferential pathway (the electrical conduit) allowed the BIOX<sup>®</sup> to enter the building. The situation was discussed with NAVSTA Mayport personnel, and the decision was made that the injection activities would cease to prevent any potential for additional BIOX<sup>®</sup> intrusion. The Public Works electrician inspected the electrical box, and no harm was caused by the BIOX<sup>®</sup> material. The quantity of BIOX<sup>®</sup> injected totaled 2,184 gallons in 39 injection points.



When BIOX® comes in contact with contaminants, a chemical reaction can be observed (i.e., foaming). This reaction in combination with petroleum odor in the foam was used during the 2012 and 2014 injections to score each injection point and to identify areas with petroleum contamination (see Attachments 1 and 2). Injection points were focused in areas with the greatest reaction. During the 2014 injection, areas previously treated with BIOX® had decreased reaction strength compared to previously observed reactions in 2012, indicating that the 2012 injection had been successful at reducing petroleum contamination.

The greatest reaction strength observed during the 2014 injection was in the vicinity of monitoring well MW04S. Unfortunately due to the decision to cease injection activities, only three injection points were completed in this area.

### RECOMMENDATIONS

It is recommended that one year of quarterly monitoring for site contaminants and Florida Department of Environmental Protection (FDEP)-approved permit-required parameters be conducted at Site 1586 to determine the effectiveness of the 2014 BIOX® injections.

A copy of the FDEP-approved injection permit is provided as Attachment 4. It may be necessary to conduct additional remedial action in the vicinity of monitoring well MW04S if the injections did not successfully reduce the contamination in that area.

If you have any questions with regard to this submittal, please feel free to contact me at (904) 730-4669, extension 226, or via e-mail at [david.siefken@tetrattech.com](mailto:david.siefken@tetrattech.com).

Sincerely,

A handwritten signature in black ink, appearing to read 'D. Siefken'.

David R. Siefken  
Project Manager

DRS/ds

Attachments (6)

c: John Winters, FDEP (electronic only)  
Paul Malewicki, NAVSTA Mayport (1 copy, 1 CD)  
John King, Resolution Consultants (electronic only)  
RDM (unbound copy, 1 CD)  
CTO JM33 Project File

## FIGURES



**Legend**

Facility Boundary

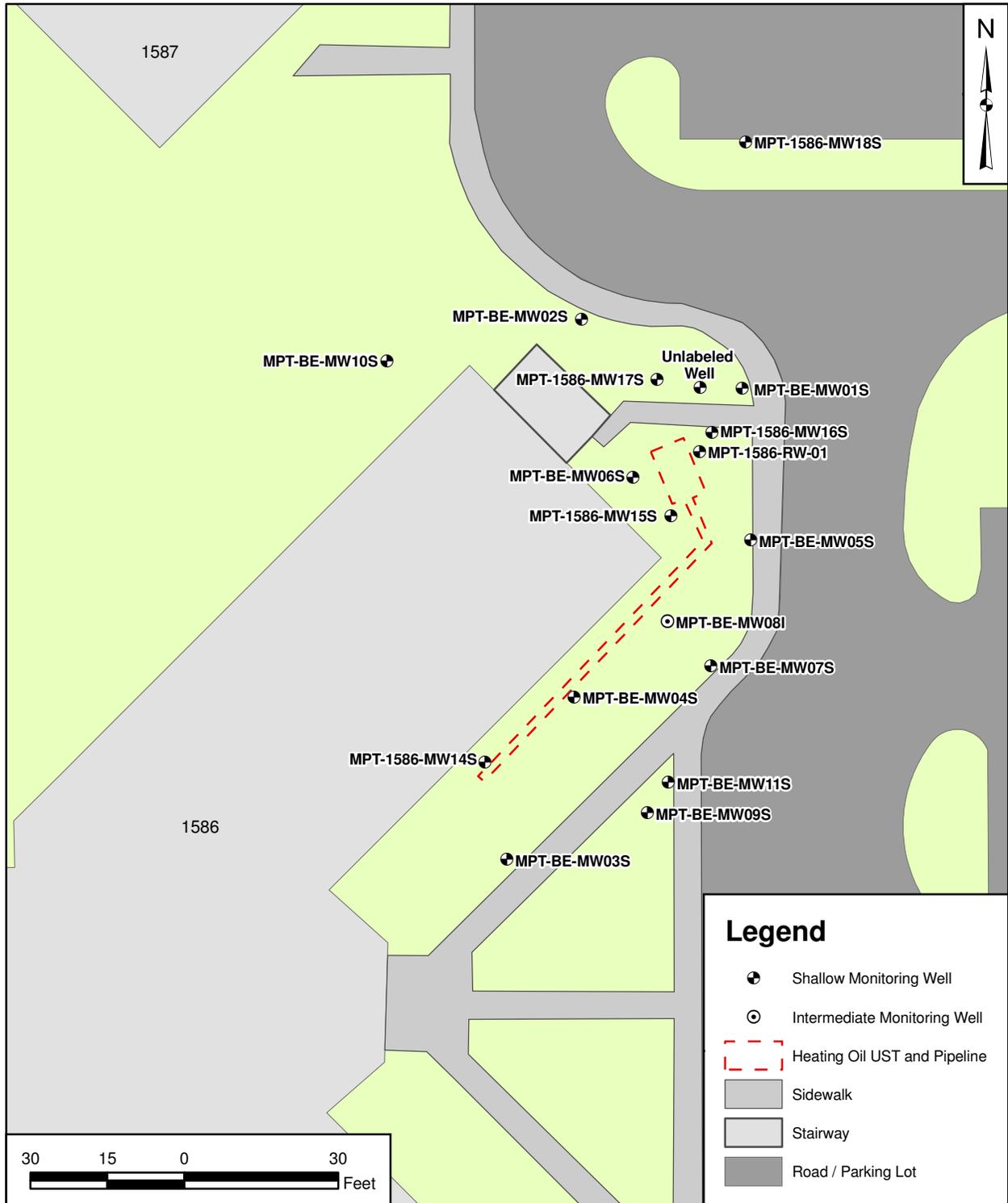


DRAWN BY J. ENGLISH	DATE 05/19/10
CHECKED BY B. MARSHALL	DATE 11/09/10
REVISED BY T. WHEATON	DATE 11/09/10
SCALE AS NOTED	



**FACILITY LOCATION MAP**  
**NAVAL STATION MAYPORT**  
**JACKSONVILLE, FLORIDA**

CONTRACT NUMBER	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 1	REV 0



**Legend**

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Heating Oil UST and Pipeline
- Sidewalk
- Stairway
- Road / Parking Lot



DRAWN BY	DATE
T. WHEATON	11/09/10
CHECKED BY	DATE
B. MARSHALL	11/09/10
REVISED BY	DATE
SCALE	AS NOTED

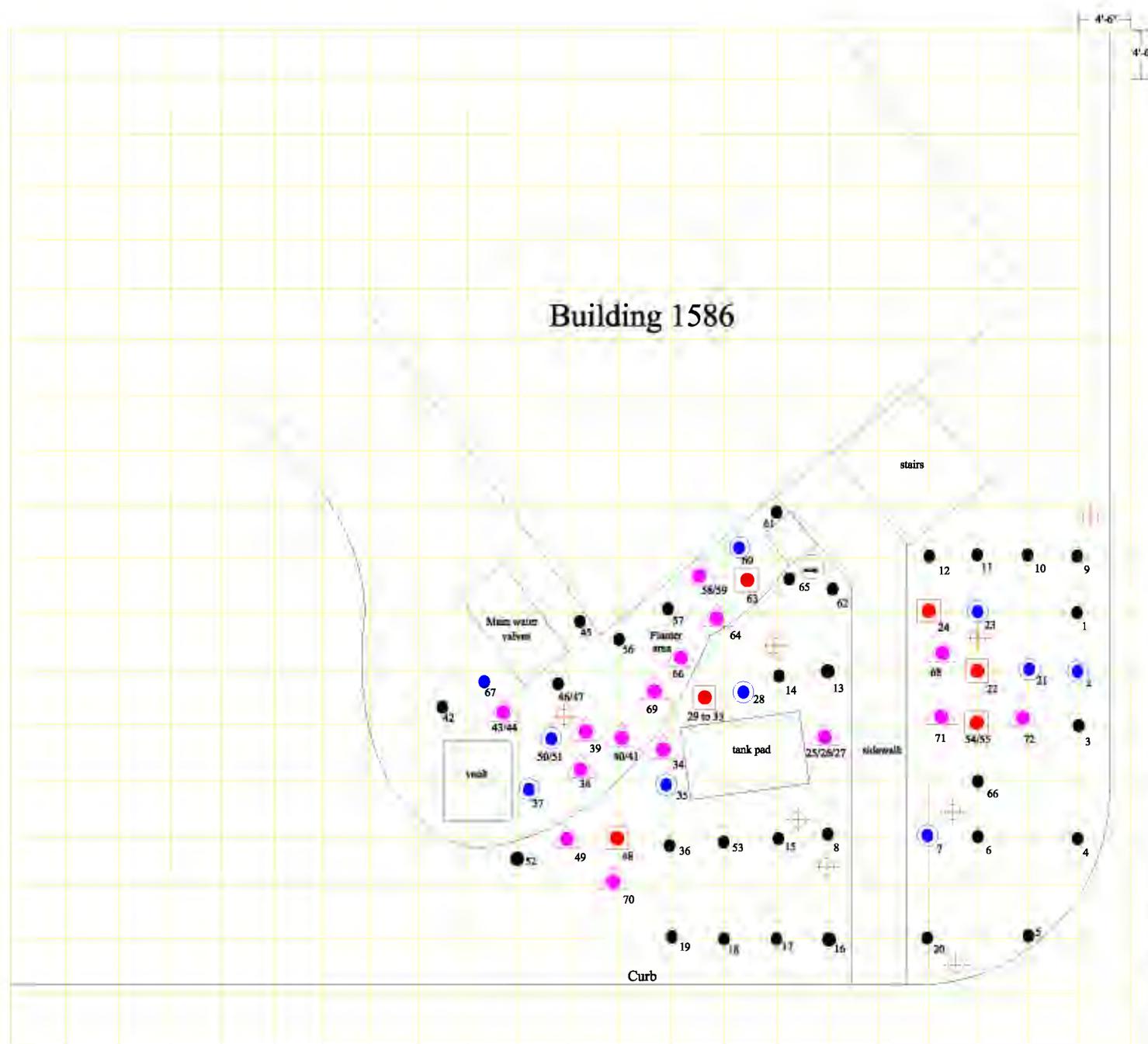


MONITORING WELL LOCATIONS  
SITE 1586  
NAVAL STATION MAYPORT  
JACKSONVILLE, FLORIDA

CONTRACT NUMBER CTO JM33	
OWNER NUMBER	
APPROVED BY	DATE
FIGURE NO. FIGURE 2	REV 0

**ATTACHMENT 1**

**BIOX® INJECTION AREA – 2012**



**Legend**

- Monitoring Well
- Injection Point
- Injection Point w/light odor
- Injection Point w/medium odor
- Injection Point w/strong odor

72 holes total  
5,328 total gals. Biox

Biomangement Services  
1692 Sunnyslope Dr.  
**BMS Inc.** Crownpoint, IN 46307  
Off. (888) 477-0550  
Fax (219) 988-5923

**BIOX Injection Area**  
Mayport Naval St. B #1586  
Mayport, FL

Scale: N.T.S.      File: 1136

Revised: 6-2-12      Drawn by: LH

**ATTACHMENT 2**

**BIOX<sup>®</sup> INJECTION AREA – 2014**



**Mayport Naval Base  
Building #1586  
Mayport, FL**

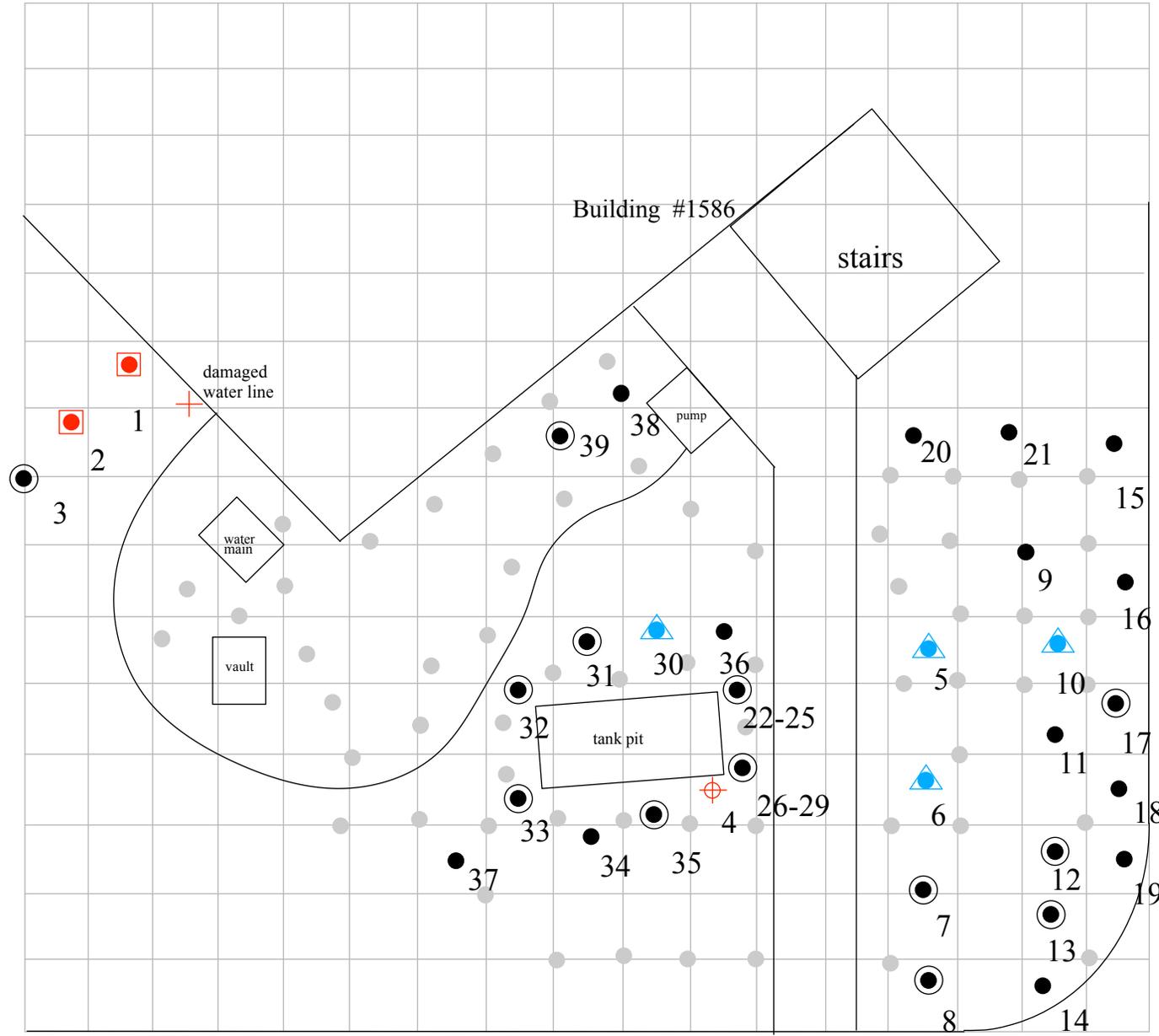
Scale:  
NOT TO SCALE

Drawn by:  
LaVelle Higley

Job No.:  
14-0090-301

Date:  
June 2014

Checked by:  
Mark Santangelo



- Legend:
- Monitoring Well
  - Injection Point
  - Injection Point w/light odor
  - Injection Point w/medium odor
  - Injection Point w/strong odor
  - 1st injection (2012)
  - 2nd injection (April/May 2014)



**ATTACHMENT 3**

**DIG PERMIT – 2014**

**NAVFAC SE PRMP 12**  
**Utility Locate Request Form**  
for  
**Excavation Permit**

NAVFAC SE Form 12001 (Rev A) 2009

Locate Request Number **MYPT 04-14-067**

1a. Requestor (Company Name) **Tetra Tech**      Date Requested **04-14-2014**      Date Required **04-22-2014**

1b. Requesting Individual **Jeff Krone**      Office Phone **(904) 636-6125**      Cell Phone **(904) 699-7473**      Fax **(904) 636-6165**  
E-Mail Address: **jeff.krone@tetrattech.com**

1c. Government Contracting Office:  
**NAVFAC SE PRMP 12 Naval Station Mayport, Fl**      POC **Patrick Evans (904) 270-5184**  
E-Mail Address: **patrick.m.evans@navy.mil**

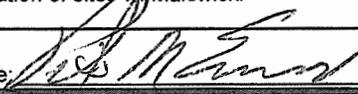
2a. Project Title: **Building 1586 BIOX injections.**      Sub-Contractor/Excavator: **Biomanagement Services**

2b. Scope of Excavation (Specify Purpose, Method, Length, Width and Depth of Excavation) Provide Location and Site Maps  
**Mechanically drill 75 each 4 inch diameter holes Approx. 20 Ft. deep for Biox injection.**

3. NAVFAC SE Locate Request Processor  
Processor: **Patrick M. Evans**      Processor Signature: **Patrick M. Evans**      Date Received: **04-14-2014**

Processor Comments:

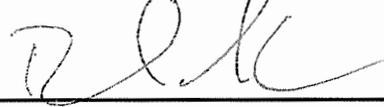
4. Utility	Organization	Telephone	Ticket No.	Date	comments & Initials
4a. Fluor Fed Solutions(RBOS) contractor	Secondary Utility(Water,Sewer) Electric by Fluor	270-6761	263408	4-14-14	Marked Secondary in Area
4b. Fluor-Fed (RBOS Contractor	Primary Utility ( Electric, Water , Sewer )	(904) 270-5397	263410	4-22-14 4-15-14	NO H.V. in Area water sewer located
4c. Sunshine State One Call Of Florida	1-800-432-4770 (Natural Gas / AT&T Telephone / CATV		086407521	3/28/2014	
4d. NMCI : Bldg 12 POC: Dean Jorgensen	Telephone (904) 270-6162 ext 13 (Government Fiber Optics)			4-16-14	Marked in Orange
4e. GEMD Bldg 2215 POC : Ronald Renta	(904) 270-6148 Government Communications Cable			4-14-14	OK
4f. NCTC/ GMSI NAS Jax POC :John Buettgen	(904) 542-4569 / Mayport 270-7451 Navy Owned- Copper Telephone Cables			4-16-14	Completed
4g. Navy Fuel Depot POC :Jacob Schmaltz	(904) 696-6556 ext 203 Under Ground Fuel Distribution System			4-14-14	NO known bulk U/G piping in Area
4h. SPAWARs/SASE POC :Craig Mauel	(904) 625-2393 SPAWARs Fiber Optic Cables		N/R	4-23-14	Free
4i. NAVFAC SE Environmental	POC : PAUL MALEWICKI / Linda Kruse Bldg 2021 Tele. (904) 270-3188 / 270-6730			4/14/2014	Environmental consultant performing environmental remediation of site. P. Malewicky

Processors Name: **Patrick M. Evans**      Date: **4-23-14**      Processors Signature: 

- Notes:
- Locators please initial and date Excavation Permit Request when locates are completed, Fax signed copy to NAVFAC SE PRMP 12, Attn :Patrick Evans FAX (904) 270-5115, or e-mail: patrick.m.evans@navy.mil
  - Naval Station Locators (Brady, Fluor-Fed, NCTC, NMCI, Environmental and GEMD) are provided five (5) working days to complete Locate and mark underground utilities in proposed excavation sites.
  - Requestor shall provide a copy of Sunshine State Reports to NAVFAC SE PRMP 12, Attn : patrick.m. evans@navy.mil.

NAVFAC SE Code PRMP-12  
Public Work Office Engineering Department  
Excavation Permit No.  
MYPT 04-14-067

*UTILITY LOCATES FOR TETRA TECH TO INJECT 75 SITES WITH BIOX FOR BLDG. 1586 HAVE  
BEEN COMPLETED*



*Signature MR. JEFF KRONE OR TOM DECK*

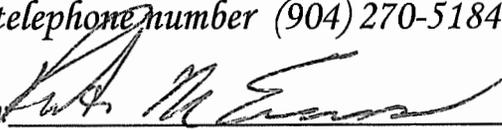
*Locating and Marking Underground Utilities in Excavation Site  
On Date 4-23-2014*

*Sunshine Locate number 086407521*

*NAVFAC SE (Code PRMP 12) Public Work Office  
at Naval Station Mayport*

*Patrick M. Evans at telephone number (904) 270-5184*

*Excavation Permit Issued by*



*Patrick M Evans*

**Facilities Engineering Command Southeast  
Planning and Project Development Code PRMP 12  
Building 1966  
Naval Station Mayport, Florida 32228  
Telephone (904) 270-5184  
Fax (904) 270-5115**

Date: April 14, 2014

From: Patrick M. Evans Code PRMP 12  
PWO Engineering  
Bldg 1966, Tel (904) 270-5184

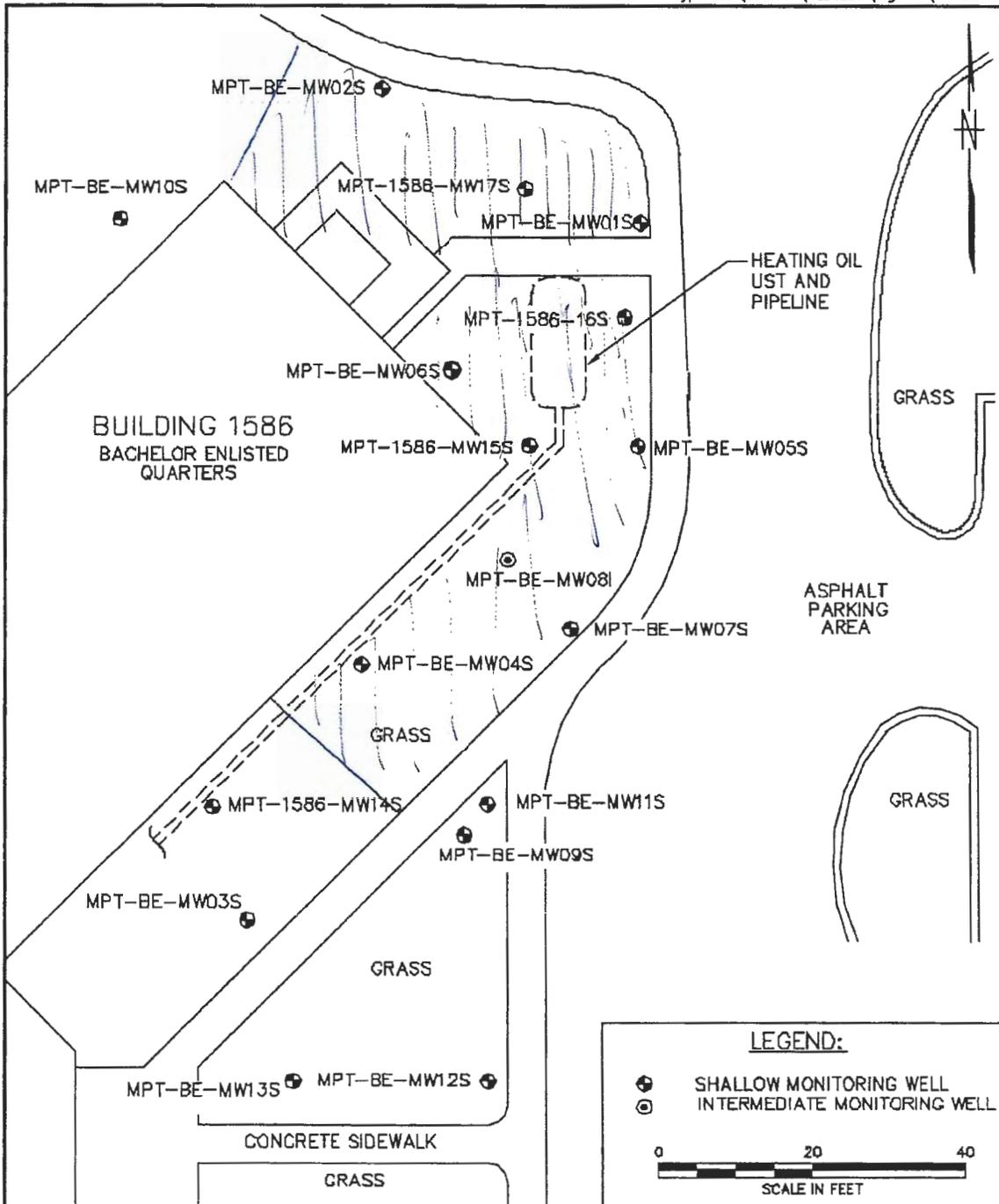
To: Fluor Federal Solutions LLC  
Building 12  
Fax Number (904) 249-9752

Subj: Naval Station Mayport Request for Utilities Locates  
Excavation Permit MYPT 04-14-067

Encl: (1) Location map  
(2) Site map

1. Tetra Tech requests utility locates for the area shown of Bldg. 1586 for the drilling of 75 each 4 inch diameter by 20 Ft. injection sites See Attached location and Site Maps.
2. Sunshine State Confirmation Number is 086407521 Dated 03-28-2014.
3. Contact Mr. Jeff Krone Cell phone (904) 699-7473 or Mr. Tom Deck Office Ph. (904) 730-4669 Ext 228 for more information on this job.
4. Brady, Fluor Fed Solutions, NMCI, NCTS and NS Mayport personnel performing locate and reviews shall **initial** and **date** form when locate (s) are complete.  
**Provide copy of signed and dated Locates Request form to PWD Engineering. FAX 270-5115. Attn: Patrick M. Evans or E-Mail to: patrick.m.evans@navy.mil**

Thank you for your assistance.  
V/R  
Patrick M. Evans



DRAWN BY DM	DATE 9/23/02	<b>MONITORING WELL LOCATIONS</b> SITE 1586 SITE ASSESSMENT REPORT NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 4240	
CHECKED BY	DATE		APPROVED BY	DATE
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-2	REV. 0

FORM CADD NO. SDIV\_AV.DWG - REV 0 - 1/20/98

*Handwritten:* Shamans  
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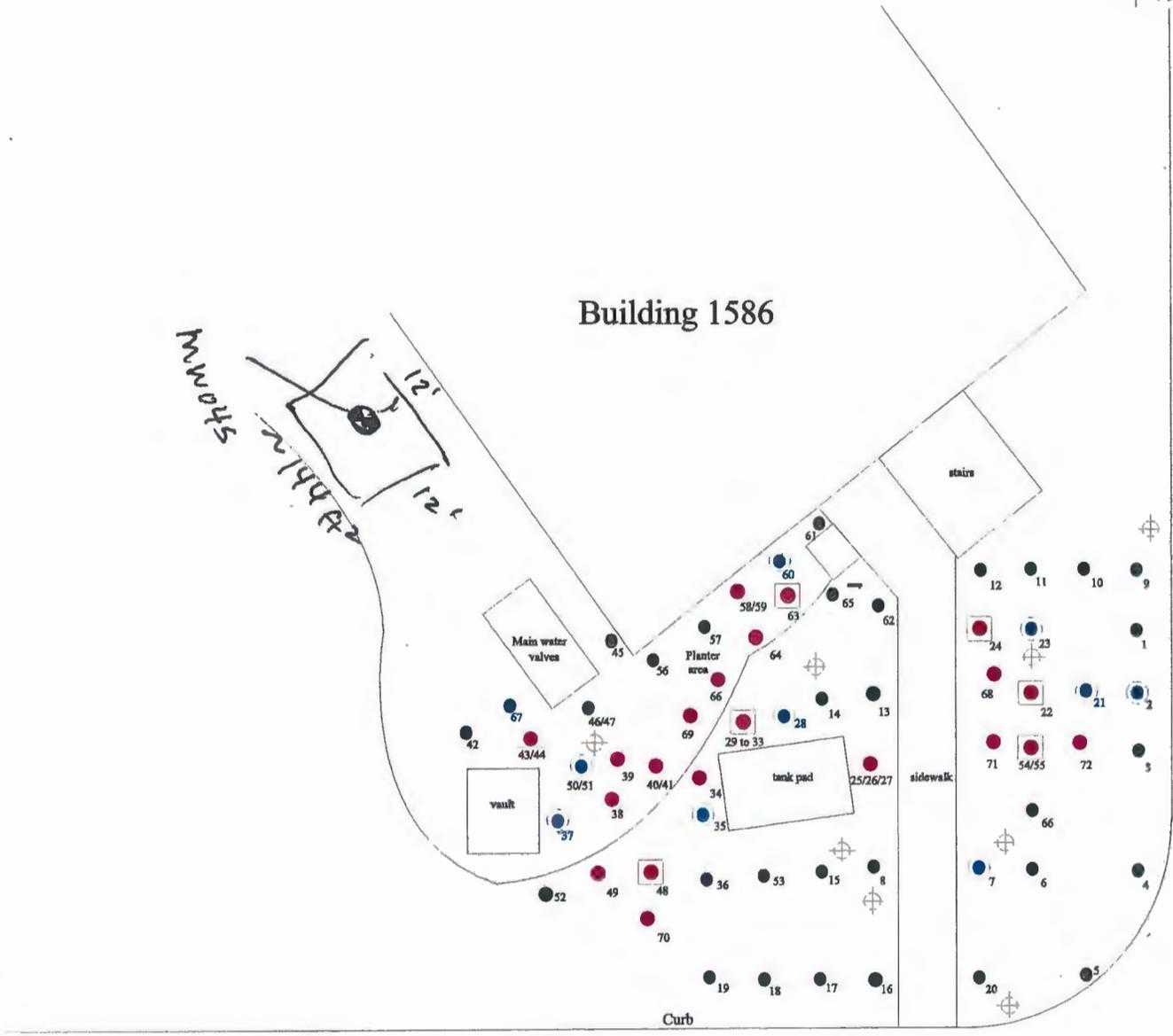
### Building 1586



**Legend**

- Monitoring Well
- Injection Point
- Injection Point w/light odor
- Injection Point w/medium odor
- Injection Point w/strong odor

72 holes total  
 5,328 total gals. Biox



Biomangement Services  
 1692 Sunnyslope Dr.  
**BMS Inc.** Crownpoint, IN 46307  
 Off. (888) 477-0550  
 Fax (219) 988-5923

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**BIOX Injection Area**

**Mayport Naval St. B #1586**  
**Mayport, FL**

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Scale: N.T.S.	File: 1136
Revised: 6-2-12	Drawn by: LH

MYPT 04-14-067  
Site Map

2159

4813

1586

257

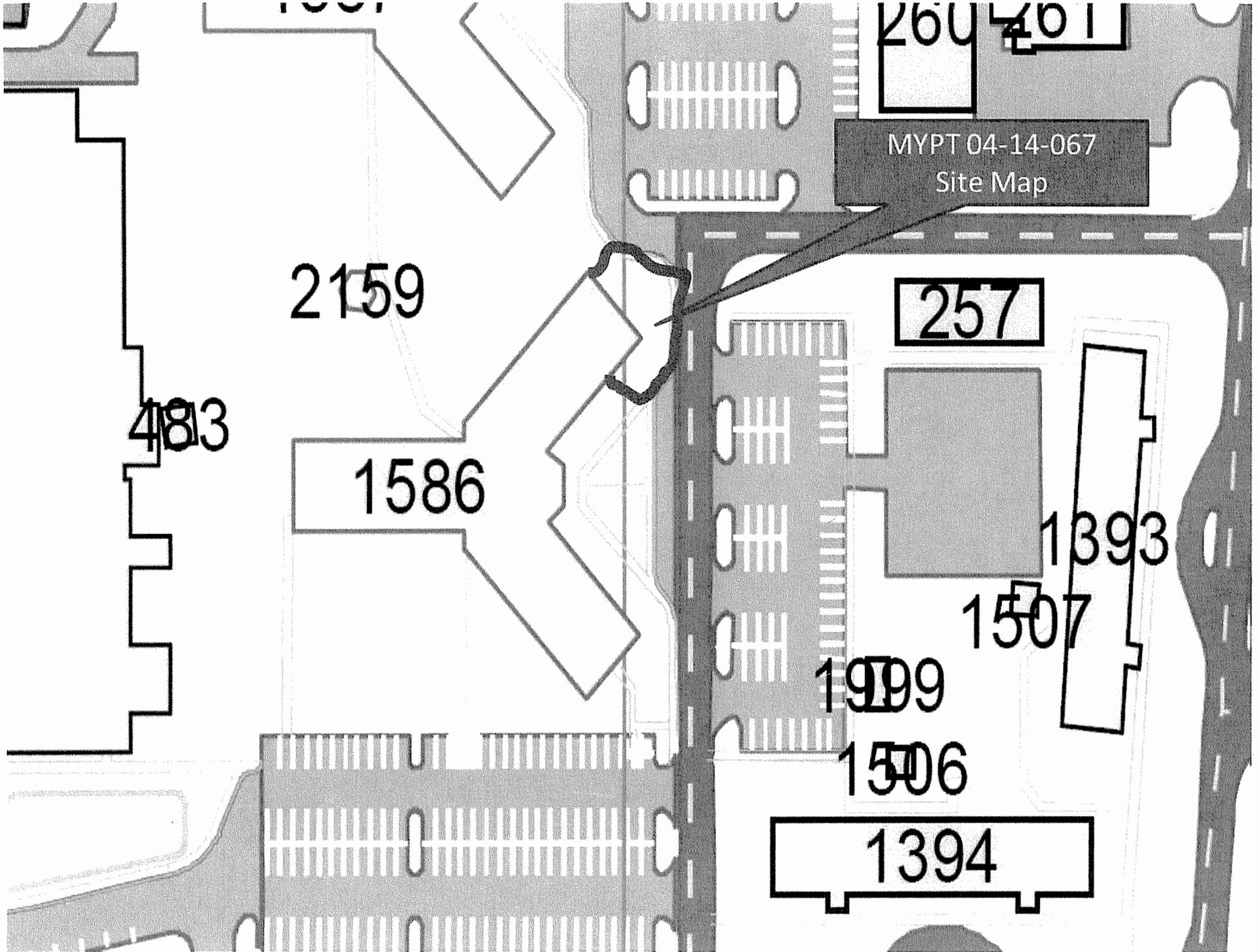
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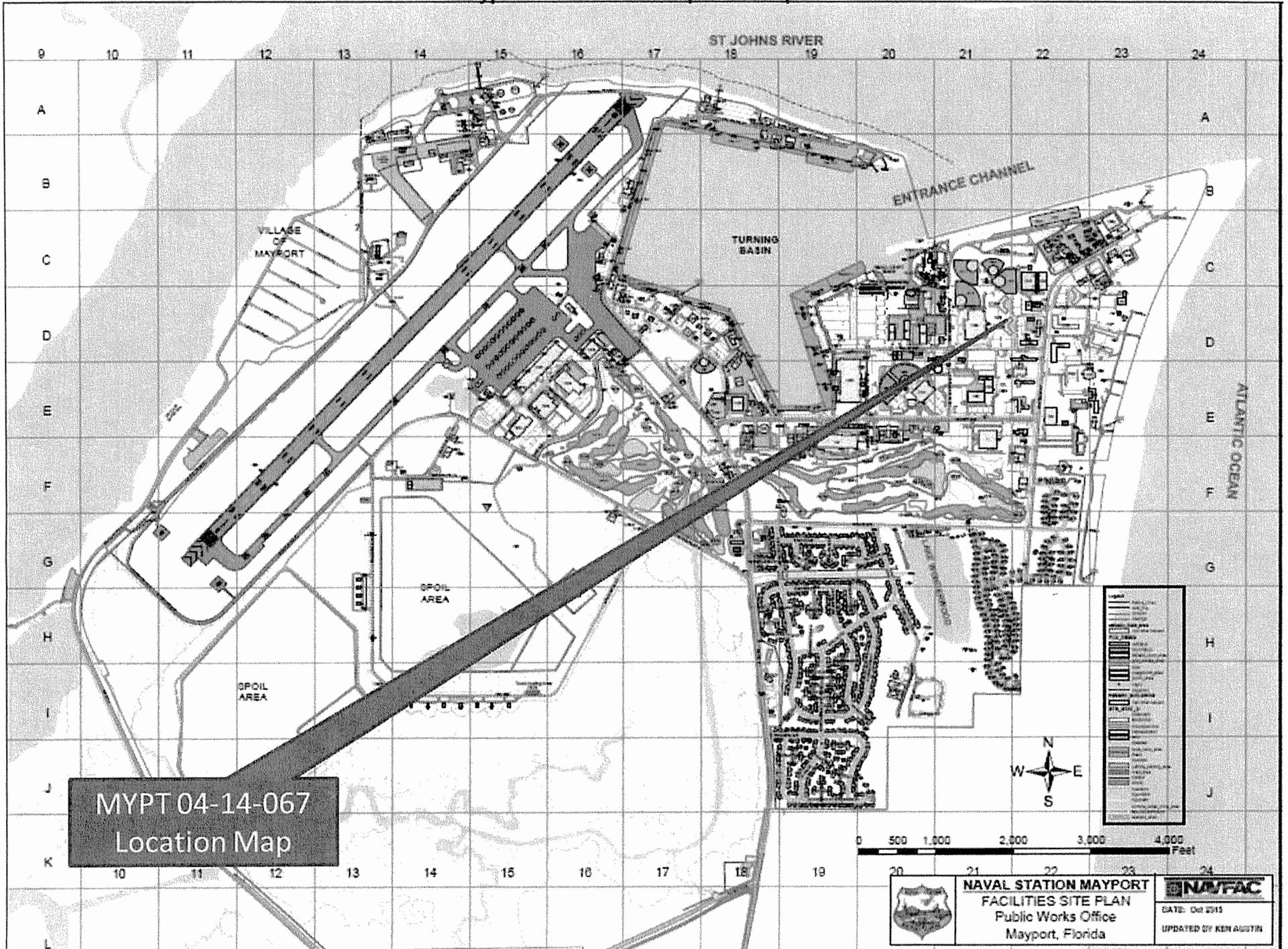
1999

1506

1394



# Mayport General Development Map



**ATTACHMENT 4**

**FDEP-APPROVED INJECTION PERMIT**



# Department of Environmental Protection

Jeb Bush  
Governor

Twin Towers Office Building  
2600 Blair Stone Road  
Tallahassee, Florida 32399-2400

Colleen M. Castille  
Secretary

February 14, 2005

Andreas D. Jazdanian, Ph.D.  
BioManagement Services, Inc.  
506 East Summit Street  
Crown Point, Indiana 46307

Re: **BIOX™ Process**

Dear Dr. Jazdanian:

The Bureau of Petroleum Storage Systems hereby accepts the BIOX™ Process for remediation of petroleum and other suitable contaminants in groundwater and soil, in situ and ex situ. BIOX™ acts first as a chemical oxidation process, in the relatively neutral pH range of 7.0 to 8.5, and with a minimal temperature rise of 5 °F or less, and then as a bioremediation process by providing nutrients and oxygen for the indigenous aerobic microorganisms at the remediation site.

The chemical oxidation aspect of the process is a Fenton-type reaction involving hydrogen peroxide and ferrous sulfate. The source of the hydrogen peroxide can be from any or a mixture of the following: liquid hydrogen peroxide, or solid compounds such as calcium peroxide, magnesium peroxide, and sodium percarbonate, which produce hydrogen peroxide when mixed with water. The hydroxyls produced by the Fenton reaction break down the contaminants at a remediation site to intermediate compounds that are more easily degraded by the site's indigenous microorganisms. The ultimate degradation products of petroleum hydrocarbon contaminants are carbon dioxide and water, and the ultimate degradation products of chlorinated hydrocarbon contaminants are carbon dioxide, water and chloride. The elemental chemical composition of BIOX™ is shown in Enclosure 1.

This acceptance applies only to the regulatory jurisdiction and the remediation needs of the Bureau of Petroleum Storage Systems, which is primarily the cleanup of subsurface petroleum contamination pursuant to Chapter 62-770, Florida Administrative Code (F.A.C.). Other state agencies and local governments may choose to recognize this acceptance if their needs and regulations are similar. This Bureau, however, is not responsible for applications beyond its jurisdiction.

For vadose remediation, where the underlying groundwater will not be affected by the leaching of BIOX™, there are no special concerns beyond those that would normally need to be addressed in preparing a Remedial Action Plan and conducting a cleanup in accordance with Chapters 62-770 and 62-777, F.A.C. However, for injection-type in situ groundwater

*"More Protection, Less Process"*

Visit Our Internet Site At: [www.dep.state.fl.us/waste/categories/pcp/default.htm](http://www.dep.state.fl.us/waste/categories/pcp/default.htm)

*Printed on recycled paper.*

remediation, via direct injection of BIOX™ into an aquifer, there are underground injection control regulations that must be observed. Since injection-type in situ aquifer remediation is likely to be the most common application of this product, the bulk of the regulatory requirements discussed herein will be directed to that topic.

The Bureau recognizes BIOX™ as a viable process for the remediation of petroleum contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a variance from Rule 62-522.300(3), F.A.C., allowing a temporary zone of discharge for ammonia nitrogen is granted by the Department's Division of Water Resource Management; (c) a site-specific Remedial Action Plan is submitted pursuant to Chapter 62-770, F.A.C., and approved by the Department for each site where the use of the BIOX™ Process is proposed; and (d) the Remedial Action Plan specifies the injection zone of discharge size and duration for iron, sodium, sulfate, and total dissolved solids, and proposes adequate groundwater monitoring for them, pursuant to Rule 62-522.300(2)(c), F.A.C. Some major regulatory considerations that apply to the BIOX™ Process are discussed in Enclosure 2.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health and safety. Vendors must then market the products and processes on their own merits regarding performance, cost, and safety in comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory acceptance letter be construed as Department certification of performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance" letters and an approval. Products and processes are accepted but they are not approved.

Also, it is not a requirement that a particular remediation product or process have an official acceptance letter in order for it to be proposed in a site-specific Remedial Action Plan. The plan, however, must contain sufficient information about the product or process to show that it meets all applicable and appropriate rules and regulations, especially those of the Florida Administrative Code pertaining to underground injection control.

Those who prepare Remedial Action Plans are advised to include a copy of this letter in the appendix, and call attention to it in the text of their document. In this way, technical reviewers will be informed that you have contacted the Department of Environmental Protection to inquire about the environmental acceptability of the BIOX™ Process. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as Enclosure 3.

The Department reserves the right to revoke its acceptance of a product or process if it has been falsely represented. Additionally, Department acceptance of any product or process does not imply it has been deemed applicable for all cleanup situations, or that it is preferred over other treatment or cleanup techniques in any particular case. A site-specific evaluation of applicability and cost-effectiveness must be considered for any product or process, whether conventional or

Andreas D. Jazdanian, Ph.D.  
February 14, 2005  
Page 3

innovative, and adequate site-specific design details must be provided in a Remedial Action Plan. You may contact me at (850) 877-1133, extension 29, if there are any questions.

Sincerely,

Rick Ruscito, P.E.  
Ecology and Environment, Inc.  
Bureau of Petroleum Storage Systems  
Petroleum Cleanup Section 6

Rebecca S. Lockenbach  
FDEP Section Leader  
Bureau of Petroleum Storage Systems  
Petroleum Cleanup Section 6

c: Tom Conrardy - FDEP/Tallahassee

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inn\_123.doc  
2/14/05

## BIOX™ ELEMENTAL CHEMICAL COMPOSITION †

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Iron, Fe	100 mg/L ▲
Sulfur, S	8,887 mg/L
Nitrogen, N	2,592 mg/L
Phosphorus, P	9,362 mg/L
Sodium, Na	6,417 mg/L
Calcium, Ca	35,297 mg/L
Magnesium, Mg	33,707 mg/L
Potassium, K	8,263 mg/L
Oxygen, O §	125,943 mg/L
Carbon, C	1,285 mg/L

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† Maximum concentrations expected in BIOX fluids to be injected.

▲ mg/L (milligrams per liter)

§ Elemental oxygen, not the diatomic molecule.

## REGULATORY CONSIDERATIONS

For BIOX™ Process applications, the major regulatory considerations are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of the BIOX™ Process to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for petroleum and other contaminants that may be present, any residuals associated with the ingredients of BIOX™ and any byproducts produced as a result of chemical or biochemical reactions involving those ingredients. The following chapters of the Florida Administrative Code (F.A.C.) are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards, and minimum criteria; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., also for cleanup and minimum groundwater criteria.

A noteworthy aspect of the minimum criteria set forth in Chapter 62-520, F.A.C., is that it requires groundwater to be free from substances that are harmful to plants, animals, and organisms, and free from substances that are carcinogenic, mutagenic, teratogenic or toxic to human beings. In effect, these "free from" requirements form a catchall. They close what would otherwise be a loophole in the regulations by preventing injection of a potentially harmful product in the event that any of its ingredients is not regulated as a specific primary or secondary drinking water contaminant.

- b. Injection well permit: The issuance of a site-specific Remedial Action Plan Approval Order by either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup, for remediation via injection of the BIOX™ Process into an aquifer, constitutes the granting of a Class V injection well permit. [62-528.630(2)(c) and 62-528.640(1)(c), F.A.C.]
- c. Groundwater injection standards: For in situ aquifer remediation, the composition of an injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C., pursuant to underground injection control Rule 62-528.600(2)(d), F.A.C. Aquifer remediation fluids that do not meet these requirements must obtain an injection zone of discharge. Depending on the ingredients of the fluid, it will be necessary to obtain an injection zone of discharge by either one or both of the following methods: by Rule 62-522.300(2)(c), F.A.C., or by variance from Rule 62-522.300(3), F.A.C. The nature of the reagents used in the BIOX™ process are such that both of these methods will be necessary.
- d. Variance: In order for BIOX™ reagents to be used for injection-type in situ aquifer remediation, BioManagement Services Incorporated must obtain a variance for a deviation from Rule 62-522.300(3), F.A.C., in order to allow a temporary injection zone of discharge for ammonia nitrogen. Once granted, a variance will allow a temporary zone of discharge of specified dimensions around each injection point (usually expressed as a radius of influence) for a specified period of time. The measurement of the time period usually begins after the final injection. By the end of the time period, the groundwater concentration of any residual

ammonia nitrogen in the zone of discharge must not exceed the 2.8-milligram per liter (mg/L) maximum allowed by Chapter 62-777, F.A.C. If the groundwater's natural-occurring background concentration of ammonia nitrogen at a specific remediation site is already in excess of the established minimum groundwater criterion, then its residual concentration at the completion of remediation shall be no greater than the pre-existing background concentration.

If the variance granted by the Department is not site-specific, then it may be considered as portable from one BIOX™ cleanup project to another in Florida, provided a site-specific Remedial Action Plan is submitted for each site. With a portable variance, BioManagement Services, Inc. and users of the BIOX™ Process do not have to petition for a new variance each time the BIOX™ Process is proposed for the remediation of a site, provided there is no deviation from the terms of the variance. Instructions on how to petition for a temporary injection zone of discharge variance are currently located at web page [www.dep.state.fl.us/waste/categories/pcp/pages/innovative.htm](http://www.dep.state.fl.us/waste/categories/pcp/pages/innovative.htm).

- e. Zone of discharge by rule: Rule 62-522.300(2)(c), F.A.C., applies to the iron, sodium, sulfate and total dissolved solids in BIOX™. Each site-specific Remedial Action Plan proposing its use must: (a) indicate that the concentrations of iron, sodium, sulfate, and total dissolved solids in the fluid to be injected will be in excess of their groundwater injection standards; (b) specify a temporary zone of discharge size; (c) specify the period of time for which the temporary zone of discharge will be needed; and (d) propose groundwater monitoring of these parameters. The current groundwater standards for the BIOX™ parameters that require a zone of discharge by rule are iron (0.3 mg/L), sodium (160 mg/L), sulfate (250 mg/L), and total dissolved solids (500 mg/L).
- f. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells for the application of the BIOX™ Process. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply BIOX™ reagents. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not also used for treatment, there will be more assurance that the treatment process has permeated the entire site and that it did not remain localized to the area immediately surrounding each injection well.
- g. Additional nutrients: If, in the future, either BioManagement Services Incorporated or a user of the BIOX™ Process decides to augment it with other nutrients and/or chemicals, then the injection of such nutrients and other chemicals into an aquifer must also be in accordance with the underground injection control requirements of Chapter 62-528, F.A.C., which requires that substances injected meet the drinking water standards set forth Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C.

h. Groundwater monitoring:

1. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored in accordance with the requirements set forth in Section 62-770.700, F.A.C., for the petroleum contaminants of concern. Two noteworthy rules within that section are 62-770.700(3)(i), F.A.C., for frequency of sampling, and 62-770.700(5)(f), F.A.C., which requires a sampling schedule for bioremediation.
  2. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring for the petroleum contaminants of concern shall be conducted at a minimum of two (2) wells, one located in the area of maximum petroleum contamination, the other downgradient of the area of maximum petroleum contamination, pursuant to Section 62-770.750, F.A.C.
  3. Underground injection control monitoring: A variance from Rule 62-522.300(3), F.A.C., when granted, allowing a temporary zone of discharge, will include groundwater monitoring requirements for underground injection control purposes, for the ammonia nitrogen in BIOX™. Such monitoring will occur before and after the injection of BIOX™. For the iron, sodium, sulfate and total dissolved solids, for which a temporary injection zone of discharge is permitted by rule for BIOX™, the groundwater shall be monitored in accordance with the Department-approved Remedial Action Plan that addresses the monitoring of these parameters.
- i. Underground injection control inventory: Remedial Action Plans prescribing injection-type in situ aquifer remediation shall include information pursuant to Rule 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of underground injection control. Per Rule 62-528.630(2)(c), F.A.C., aquifer remediation projects involving injection wells may be authorized under the provisions of a Remedial Action Plan, provided the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. A memorandum outlining the inventory information about injection-type aquifer remediation plans to be transmitted by Department reviewers to the Underground Injection Control Section is provided as Enclosure 4. Only reviewers within the Department, including its district offices, may approve in situ injection-type remediation plans in which the approval constitutes a Class V injection permit; local programs are not authorized to grant such approvals. See Enclosure 3.

j. Operation:

1. Avoidance of migration: For injection-type in situ aquifer remediation projects, injection of the BIOX™ reagents shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the reagents or the petroleum contaminants in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.
2. Underground injection control operating permit: Although an operating permit is not required for aquifer remediation wells pursuant to Rule 62-528.640(1)(b), and

62-528.640(1)(c), F.A.C., since no movement of the petroleum contamination plume is expected to accompany the treatment process, the Department requests that the information items listed in Rule 62-528.640(1)(b), F.A.C., be considered and included in Remedial Action Plan proposals as a matter of good and thorough design practice. Briefly summarized, they are: quality of water in the aquifer; quality of the injected fluid; existing and potential uses of the affected aquifer; and well construction details. Additionally, each Remedial Action Plan should clearly indicate the total volume of the BIOX™ reagents that will be injected.

3. Operating parameter measurements: Rule 62-770.700(9)(h), F.A.C., sets forth frequency requirements for the measurement of bioremediation operating parameters such as dissolved oxygen levels, rates of nutrient addition, temperature, etc. It also includes an option for reduction in the frequency or discontinuation of some measurements in situations when appropriate.
- k. Abandonment of wells: Upon issuance of a petroleum Site Rehabilitation Completion Order, or a declaration of "No Further Action", injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C. The Underground Injection Control Section of the Department shall be notified so that the injection wells can be removed from the inventory-tracking list.
- l. Phosphate: The Bureau has considered the orthophosphate present in BIOX™, which serves as a macronutrient for bioremediation purposes. Phosphate, which is an element essential for life, occurs naturally in Florida's groundwater and is not a regulated groundwater contaminant. At a Panama City, Florida site, total phosphorus in the groundwater was measured at 800 to 1,100 micrograms per liter (ug/L). At a Volusia County site in Florida, it was measured at 1,200 ug/L, as PO<sub>4</sub>. For comparison purposes, the European Community Guide level for phosphorus in drinking water is 400 ug/L, as P<sub>2</sub>O<sub>5</sub>. While phosphorus may not be a matter of great toxicological concern for in situ injection-type groundwater remediation projects, the Bureau would like to remind users of the BIOX™ Process that it could become an environmental concern if surface water is very close or present at a remediation site. In that case, if there could be any interaction between the groundwater being remediated and the nearby surface water body, then the state's surface water regulations should be reviewed first for information about phosphorus.
- m. Open-pit applications: While open-pit applications of BIOX™ reagents is not an injection-type application, and notification of the Underground Injection Control Section therefore not required, the user of BIOX™ must still be mindful of groundwater quality. For open-pit applications, the Bureau of Petroleum Storage Systems suggests that groundwater in the application area be monitored for the same parameters that would have required monitoring had the application been an injection: ammonia nitrogen, iron, sodium, sulfate, and total dissolved solids.

## SUPPLEMENTAL INFORMATION

The information below, compiled from several sources, may be helpful to reviewers of Remedial Action Plans prescribing bioremediation.

- a. Department of Environmental Protection reviewers of injection-type in situ aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the Enclosure 4 memorandum, whose subject is "Proposed Injection Well(s) for In situ Aquifer Remediation at a Petroleum Remedial Action Site". The completed form must be submitted to the Underground Injection Control Section at 2600 Blair Stone Road, Tallahassee, Florida 32399-2400 (Mail Station 3530).

Only reviewers within the Department and its district offices may approve injection-type in situ remediation plans in which the approval constitutes the issuance of a Class V injection permit; local programs are not authorized to grant such approvals. Reason: Although an arrangement between the Environmental Protection Agency and the Department delegates underground injection control authority to the Department, it does not allow the Department to delegate that authority any further. This includes delegation to the Department's contracted remediation review agencies such as those operated by the counties and other local governments.

- b. Pilot study: For bioremediation, per rule 62-770.700(2), Florida Administrative Code (F.A.C.), a pilot study proposal shall be submitted for review, and a pilot test shall be performed prior to designing a treatment system. If conditions or the situation at a site does not warrant a pilot study, then a proposal explaining the rationale for the decision not to perform a pilot study shall be submitted for review. For state funded projects, reviewers are encouraged to use judgment in balancing cost and the need for technical information to be obtained from a pilot study.
- c. Dosage and application rate: It is recommended that the dosage and application details of the BIOX™ Process be determined on a site-specific basis, but for information and planning purposes, the following may be helpful:
- Delivery methods: Injection, open-pit application, or overspraying
  - Injection delivery: 1.25-inch diameter direct-push at 2-foot depth intervals
  - Injection rate and pressure: 3 to 5 gallons per minute; 30 to 200 pounds per sq. in.
  - Injection spacing: 3 to 7 ft for free product or low contaminant concentrations,  
10 to 15 for low contaminant concentrations
  - Number of injections: One or more may be necessary, depending on conditions
- d. Oxidation reaction: In the first step of the BIOX™ treatment process, reagents partially oxidizing contaminants in order to produce intermediates that are more readily biodegradable in the second step. Unlike a conventional Fenton reaction, the BIOX™ Process is not highly exothermic -- it generates minimal heat -- and does not need to occur a low pH.

- e. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of petroleum hydrocarbons. The intermediate products may include simple acids, alcohols, and fatty acids. Aerobic processes use oxygen as an electron acceptor to produce the carbon dioxide and water.
- f. Sampling frequency and sample parameters: BioManagement Services Incorporated has provided information about indicator parameters and the frequency of sampling that it believes are important to the BIOX™ treatment process, and the Bureau of Petroleum Storage Systems would like to pass that information along to both potential users and technical reviewers of the process. Pre-treatment baseline sampling no earlier than 30 days prior to BIOX™ application is recommended, and post-treatment sampling is recommended at 30, 60 and 90 days as follows:

Soil Analytical Parameters

Groundwater Analytical Parameters

Contaminants of Concern (COC)

COC

Chemical Oxygen Demand (COD)

COD

Biological Oxygen Demand (BOD)

BOD

Total Organic Carbon (TOC)

TOC

Total Heterotrophic Plate Count

Total Heterotrophic Plate Count

Dissolved Oxygen (DO)

Oxidation-Reduction Potential (ORP)

BioManagement Services Incorporated indicates how these parameters are useful as follows:

- Declining trends in the TOC of soil and concomitant increasing trends in the groundwater can be indicative of the extent of desorption caused by the BIOX™ process.
- Comparison of pre- to post-treatment COD and BOD of soil allows for assessment of the transformation of the soil organic matter, including contaminants, to more biodegradable species.
- Increasing trends in COD and BOD of groundwater are also indicative of desorption processes.
- Comparison of pre- to post-treatment COD and BOD of groundwater allows for the assessment of the biodegradability of the dissolved organic fraction.
- Comparison of trends in post-treatment BOD/COD ratios for soil to trends in post-treatment BOD/COD ratios for the groundwater allows for assessment of the effectiveness of enhanced biodegradation and bioavailability of contaminants over time.
- Analysis of trends in dissolved oxygen concentration, heterotrophic plate counts and biodegradability indicators (BOD, COD, BOD/COD ratio) can be used to derive limiting factors for natural and enhanced biodegradation of a cleanup site.

**Florida Department of  
Environmental Protection**

**Memorandum**

TO: Richard Deuerling, Mail Station 3530  
Division of Water Facilities  
Underground Injection Control Section  
Florida Department of Environmental Protection  
2600 Blair Stone Road, Tallahassee, FL 32399-2400

FROM: \_\_\_\_\_ (Note 1.)  
\_\_\_\_\_  
\_\_\_\_\_

DATE: \_\_\_\_\_

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

Pursuant to Rule 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 petroleum-contaminated site.

Site name: \_\_\_\_\_  
Site address: \_\_\_\_\_  
City/County: \_\_\_\_\_  
Latitude/Longitude: \_\_\_\_\_  
FDEP Facility Number: \_\_\_\_\_

Site owner's name: \_\_\_\_\_  
Site owner's address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Well contractor's name: \_\_\_\_\_ (Note 2.)  
Well contractor's address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Brief description of the in situ injection-type aquifer remediation project:  
\_\_\_\_\_  
\_\_\_\_\_

Summary of major design considerations and features of the project:

Areal extent of contamination (square feet): \_\_\_\_\_  
Number of injection wells: \_\_\_\_\_  
Composition of injected fluid (Note 3)  
(ingredient, wt. %): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Injection volume per well (gallons): \_\_\_\_\_  
Single or multiple injection events: \_\_\_\_\_  
Injection volume total (all wells, all  
events): \_\_\_\_\_

Richard Deuerling  
Page Two  
Date: \_\_\_\_\_

Site name: \_\_\_\_\_  
FDEP facility no.: \_\_\_\_\_

A site map showing the areal extent of the groundwater contamination plume, and the location and spacing of injection wells and associated monitoring wells is attached.

The following is a summary description of the affected aquifer:

Name of aquifer: \_\_\_\_\_  
Depth to groundwater (feet): \_\_\_\_\_  
Aquifer thickness (feet): \_\_\_\_\_

The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or Conventional (circle the appropriate well type)  
Diameter of well(s) (i.e., riser pipe & screen)(inches): \_\_\_\_\_  
Total depth of well(s) (feet): \_\_\_\_\_  
Screened interval: \_\_\_\_\_ to \_\_\_\_\_ feet below surface  
Grouted interval: \_\_\_\_\_ to \_\_\_\_\_ feet below surface  
Casing diameter, if applicable (inches): \_\_\_\_\_  
Cased depth, if applic.: \_\_\_\_\_ to \_\_\_\_\_ feet below surface  
Casing material, if applic.: \_\_\_\_\_

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is intended to meet the groundwater petroleum cleanup criteria set forth in Chapter 62-770, F.A.C. 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 contaminating petroleum 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 Chapter 62-520, F.A.C.

The remediation plan estimates that site remediation will take \_\_\_\_\_ 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. 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 arrange for Department headquarters' execution of an approval order, and then complete this form. This form is primarily for use by state and local program technical reviewers, but petroleum remediation contractors may fill in all blanks except those labeled "FROM", "DATE", and "approval date", and "telephone number" blanks in the last paragraph. Those blanks should be completed only by a state or local program reviewer.
- 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 injected fluid is required by Chapter 62-528, Florida Administrative Code. Proprietary formulations shall make confidential disclosure. Injected fluids must meet drinking water standards of Chapter 62-550, F.A.C., unless an exemption or variance has been granted.