TETRA TECH

March 22, 2016

Mr. Mr. Rusty Kestle
Remedial Project Manager
U.S. Environmental Protection Agency
Region IV, Superfund North Florida Section
61 Forsyth Street, SW
Atlanta, GA 30303-3104

RE: **Transmittal of the Report "*Former South Lagoon Preliminary Design and Design Investigation Workplan, Former Cabot Carbon / Koppers Inc. Site, Gainesville, Florida*"**

Dear Mr. Kestle:

On behalf of Beazer East, Inc., attached is a revised final copy of the workplan entitled "*Former South Lagoon Preliminary Design and Design Investigation Workplan, Former Cabot Carbon / Koppers Inc. Site, Gainesville, Florida*". This workplan describes the activities to be performed for implementing ISGS remediation in the Upper Hawthorn beneath the former South Lagoon. Beazer East, Inc. will implement this workplan upon approval from the U. S. Environmental Protection Agency (EPA). Also, included with this workplan are responses to Stakeholder comments on the April 29, 2015 draft workplan.

Should you require additional information, please feel free to contact me at (303) 665-4390.

Sincerely,

James R. Erickson,
Vice President
Principal Hydrogeologist

Miguel Garcia, P.G.
Project Hydrogeologist
Professional Geologist FL #2355

Enclosure

cc: S. Miller, EPA
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Former South Lagoon Preliminary Design and Design Investigation Workplan, Former Cabot Carbon/Koppers Inc. Site Gainesville, Florida

Version 2
Operable Units Two and Three (Koppers)
Gainesville, Florida
EPA ID: FLD980709356

Version 2
March 22, 2016

Prepared on behalf of Beazer East, Inc.

TETRA TECH

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APPROVAL

Date: 03/22/2016

Gregory W. Council, P.E.
Supervising Contractor for Beazer East, Inc.
Tetra Tech, Inc.

Date: 03/22/2016

James R. Erickson
Project Manager for Beazer East, Inc.
Tetra Tech, Inc.

CERTIFICATION

This report has been reviewed and approved by the undersigned Florida Registered Professional Geologist. Tetra Tech prepared this report in a manner consistent with sound geology practices. Furthermore, either I or engineering staff working under my supervision completed all work described herein (except as otherwise noted) and I have expertise in the discipline used in the production of this document.

MIGUEL ANDRES GARCIA
LICENSE
No. PG2355
STATE OF
FLORIDA
PROFESSIONAL GEOLOGIST

Miguel A. Garcia, P.G.
Professional Geologist FL 2355

Date: 03/22/2016

REVISION HISTORY

Version	Date	Description
1	April 29, 2015	Initial Release
2	March 22, 2016	Revision

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APPENDICES

ABBREVIATIONS AND ACRONYMS

ASTM	American Society of Testing and Materials
Beazer	Beazer East, Inc.
bgs	Below Ground Surface
CGMSAP	Comprehensive Groundwater Monitoring Sampling Analysis Plan
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	Environmental Protection Agency
EVS©	Environmental Visualization System
FDEP	Florida Department of Environmental Protection
GCTL	Groundwater Cleanup Target Level
gpm	Gallons per Minute
GPS	Global Positioning System
HG	Hawthorn Group
HPT	Hydraulic-Profile Tool
ID	Inner Diameter
IDW	Investigation-Derived Waste
IRM	Interim Remedial Measures
ISGS	*In-Situ* Geochemical Stabilization
LH	Lower Hawthorn
MCL	Maximum Contaminant Level
msl	Mean Sea Level
OD	Outer Diameter
PID	Photoionization Detector
pSOD	Permanganate Soil Oxidant Demand
PVC	Polyvinyl Chloride
SCM	Site Conceptual Model
Site	Koppers portion of the Cabot Carbon/Koppers Superfund Site
SOP	Standard Operating Procedure
SVOCs	Semi-Volatile Organic Compounds
TIP	Temporary Investigation Point
TOC	Top of Casing
UH	Upper Hawthorn
VOCs	Volatile Organic Compounds
ZOD	Zone of Discharge
Ø	Diameter

1.0 INTRODUCTION

This workplan describes the detailed subsurface characterization of the former South Lagoon in order to support full-scale implementation for *in-situ* geochemical stabilization (ISGS). The ISGS remedy will be implemented in both the Surficial Aquifer and Upper Hawthorn (UH) unit of the former South Lagoon area of the Koppers portion of the Cabot Carbon/Koppers Superfund Site (the Site[1]) in Gainesville, Florida. ISGS entails the injection of an enhanced permanganate reagent to oxidize, contain and isolate subsurface dense non-aqueous phase liquids (DNAPLs). ISGS treatment for the former South Lagoon is part of the remedial plan for the Site, as described in the February 2011 Record of Decision (ROD) published by the United States Environmental Protection Agency (USEPA). The ISGS technology has been shown to be effective at reducing the mobility of DNAPL. A Consent Decree between Beazer and the United States government was entered in the United States District Court for the Northern District of Florida on July 9, 2013. The Consent Decree requires Beazer to conduct certain Remedial Design and Remedial Action activities at the Site, including the ISGS technology discussed in this report.

The ISGS remediation technology consists of a permanganate-based reagent (RemOx® EC) that is injected into DNAPL impacted zones for the purposes of DNAPL treatment, containment/stabilization and solute flux reduction. The reaction process has been described previously in "Former Process Area In-Situ Geochemical Stabilization Remediation Demonstration Project Workplan for Hawthorn Group Deposits" (Tetra Tech, 2012).

1.1 OBJECTIVES

The ultimate objective of the work described in this workplan is the full-scale ISGS implementation in the Surficial Aquifer and the UH beneath the former South Lagoon to reduce the mobility of subsurface NAPLs that may be present.

A primary concern of the USEPA and other groups and persons interested in Site remediation is the potential for vertical migration of free-phase DNAPL into the Upper Floridan Aquifer. Consequently, a primary short-term objective of the proposed ISGS program is to contain and stabilize free-phase DNAPLs in the Surficial Aquifer and UH beneath the Site's former South Lagoon. This objective will be achieved through the injection of an ISGS reagent at select depths between land surface and the top of the middle clay unit underlying the UH.

[1] In this document "Site" refers to the Koppers portion of the Cabot-Carbon/Koppers Superfund Site, unless otherwise noted. The Site property is now owned by Beazer East, Inc.

2.0 SITE HISTORY, HYDROGEOLOGY AND DNAPL DISTRIBUTION

2.1 SITE BACKGROUND

The Site is located within the City of Gainesville, in Alachua County, Florida (**Figure 1**). The Site encompasses approximately 90 acres and was used continuously as an active wood-treating facility from 1916 to 2009. The Site is located in an area of the City that is zoned industrial, with surrounding commercial and residential zoned properties. The adjacent property to the east of the Site is the former Cabot Carbon Superfund Site. This property was redeveloped for commercial use in the 1990s. The adjacent property to the north is the City of Gainesville vehicle/equipment maintenance facility. The properties to the west are private residences, and the properties to the south are a mixture of commercial and residential properties.

The Site is located on a gently sloping plain at an elevation of approximately 180 feet above mean sea level (msl). The ground surface immediately around the Site has low relief and slopes gently to the northeast. In general, the ground surface at the Site slopes gently to the north. From the southern property boundary to the northern property boundary (approximately 3,000 ft), the land-surface elevation decreases from approximately 190 feet to 170 feet above msl. A stormwater drainage ditch bisects the Site and flows in a north to northeasterly direction.

Creosote DNAPLs were released to the subsurface during the historical operation of the former wood-treating Site. Creosote-treatment operations at the Site ceased in the early 1990s. The majority of DNAPL releases are believed to have occurred before 1980 when creosote usage was greater. In the later years of operation (1990 to 2009), other wood preservatives were used in place of creosote at this facility.

Creosote DNAPL impacts have been found within and beneath four former operational areas: 1) Process Area; 2) Drip Track; 3) North Lagoon; and 4) South Lagoon. Creosote DNAPL impacts have been detected in the Surficial Aquifer and underlying Hawthorn Group (HG) deposits beneath these former operational areas (**Figure 2)**. DNAPL impacts have not been detected in the deeper Upper Floridan Aquifer and appear to be vertically contained by a clay unit (30-35 feet thick) at the base of the HG deposits. Field investigations in the former Process Area reveal that DNAPL impacts increase with depth with the more significant impacts present in the UH at a depth of approximately 45 to 55 feet. The majority of the HG deposits beneath the former source areas do not contain free-phase or residual DNAPL impacts. DNAPL impacts within the HG deposits are restricted to thin higher permeability deposits, 1-to 12-inches thick, with thick sequences (2 to 10 feet) of non-impacted deposits separating them. The majority of these HG impacts are within the UH; a low-permeability clay unit limits vertical migration of DNAPL impacts to the underlying Lower Hawthorn where only relatively thin zones of residual DNAPL impacts have been historically observed.

The former South Lagoon is located in the southwest corner of the Site. Although there is no history of buildings or other structures in the immediate vicinity, a possibility exists that underground structures may be present in this area.

Detailed descriptions of the Site historical source areas are provided in a 2004 report on subsurface investigations in these areas (GeoTrans, 2004a). The Site hydrogeologic conceptual model is provided in a groundwater flow and transport modeling report (GeoTrans, 2004b) and a conceptual depiction of the Site conceptual model is provided in **Figure 2**.

Much of the work described in this workplan involves intrusive subsurface investigation and injections. To effectively and safely perform this work, confirmatory investigation into the status of possible subsurface features in the former South Lagoon is needed. Numerous changes to the wood-treating operations over the 93 operational years have resulted in subsurface structures at the nearby former Process Area. The incomplete documentation of the history of the use of the Site at the former South Lagoon leaves a possibility of the existence of abandoned subsurface structures that may slightly impact injection locations. DNAPL investigations have been performed in the former South Lagoon; however, the level of detail resulting from these investigations alone is not sufficient to implement ISGS without additional data. A summary of the current understanding and potential challenges associated with ISGS implementation are provided below.

2.2 SUBSURFACE STRUCTURES

There is no documentation to indicate the existence of buildings, footers or slabs in for the former South Lagoon. However, one of the first tasks associated with implementation of the ISGS technology will be to verify that subsurface structures are not present in this area.

Wood-treating operations at the Site ceased in 2009 and the property was sold to Beazer East, Inc. (Beazer) in March 2010. Beazer conducted demolition activities of Site structures and buildings from December 2010 through February 2011. Subsurface structures and utilities may remain in place at the South Lagoon area including concrete slabs/footings and underground piping resulting in potential obstructions; however, one of the first tasks will be to verify the presence or absence of subsurface structures by performing a review of historical documents/photos. The use of geophysics to identify subsurface structures was not successful in the former Process Area and therefore, will not be used at the former South Lagoon.

2.3 HYDROGEOLOGY

The hydrogeology of the Site has been thoroughly investigated and analyzed over the past several decades by numerous investigations with more recent, detailed investigations of the Hawthorn Group beginning in 2002 (TRC, 2003; GeoTrans, 2004a, 2004b, 2005 and 2009; Tetra Tech, 2014, Adventus, 2009). Over 200 wells have been installed at this Site where geologic cores have been collected to characterize deposits. Immediately adjacent to the South Lagoon on the east, a set of approximately 100 investigative borings were advanced in 2012, and were described and characterized with respect to lithology and NAPL impacts. A simplified hydrostratigraphic model of the local geology consists of approximately 20 feet of unconsolidated surficial deposits, which overlie approximately 120 feet of unconsolidated HG deposits, which overlie greater than 300 feet of the Ocala Limestone and Avon Park Formations (**Figure 3**).

Surficial Aquifer

The Surficial Aquifer consists of approximately 16 to 22 feet of marine terrace deposits, primarily consisting of unconsolidated, fine- to medium-grained sand with thin layers of interbedded silt and clay deposits. Groundwater flow in the Surficial Aquifer is primarily controlled by surface topography and localized discharge points such as wetlands, creeks and drainage ditches. The Surficial Aquifer is not a source of potable groundwater on or around the Site; however, in other parts of the State, wells have been installed in this aquifer for residential irrigation purposes.

The local groundwater flow direction for the Surficial Aquifer at the Site is from southwest to northeast. A hydraulic-containment system was installed in the Surficial Aquifer system at the Site in 1995 to capture impacted groundwater prior to it flowing off Site. Groundwater extraction is occurring from a series of shallow downgradient extraction wells along the eastern and northern property boundary. In addition, four approximately 250 to 300-foot long horizontal drains (wells) were installed in 2009 adjacent to each of the former source area to recover impacted groundwater in proximity to the sources. Total groundwater extraction from the wells and horizontal drains average approximately 60 gallons per minute (gpm).

Hawthorn Group Deposits

The HG deposits underlie the Surficial Aquifer and consist of a thick sequence of low permeability, unconsolidated sedimentary deposits. The HG deposits are approximately 115 to 125 feet thick at the Site consisting of low-permeability clay, clayey sand and silt deposits interbedded with moderate-permeability sand, silty sand and carbonate deposits. Three major clay units are present in the HG deposits termed the upper clay, middle clay and lower clay units. The upper clay unit is approximately 3 to 5 feet thick, the middle clay unit is approximately 10 to 15 feet thick and the lower clay unit is approximately 30 to 35 feet thick at the Site. Moderately permeable sedimentary deposits that lie between the HG upper and lower clay units have been termed the UH and moderately permeable sedimentary and carbonate deposits that lie between the HG middle and lower clay units have been termed the Lower Hawthorn (**Figure3**).

The HG deposits effectively separate the overlying Surficial Aquifer from the underlying Floridan Aquifer as indicated by the approximately 120 feet of hydraulic-head difference between these two aquifers. The majority of the hydraulic-head loss is across the lower clay unit, with a hydraulic-head difference of approximately 90 feet. Hydraulic-head difference across the upper clay unit is about 2 feet and the head difference across the middle clay unit is about 30 feet. Hence, each of the clay units provides some level of protection, with the upper clay unit acting as the first of three hydraulic traps mitigating vertical DNAPL migration.

Lateral groundwater flow within the UH is generally to the northeast at the Site mirroring the groundwater flow direction in the Surficial Aquifer. Lateral groundwater flow in the Lower Hawthorn changes from east to west across the Site. A groundwater divide is present in the Lower Hawthorn, which is oriented southeast to northwest. Groundwater flow in the Lower Hawthorn on the eastern half of the Site is to the north-northeast and groundwater flow on the western half of the Site is to the north-northwest.

The HG deposits are not locally used for potable water due to the low permeability of the formation in this area; however, this unit has reportedly been used as a limited source of potable water in other parts of Florida.

Upper Floridan Aquifer

The Floridan Aquifer underlies the HG deposits and is subdivided into two aquifers, the Upper Floridan and the Lower Floridan Aquifers. The Upper Floridan Aquifer is the most widely used aquifer in this area and locally consists of the Ocala Limestone and Avon Park Formations. The Lower Floridan Aquifer is typically not utilized in this area due to its greater depth.

The Upper Floridan Aquifer is at a depth of approximately 140 to 150 feet at the Site. Regional groundwater flow within this aquifer is to the northeast towards the Murphree wellfield. The cone of depression resulting from the Murphree wellfield encompasses the Site resulting in the northeastern flow direction. The groundwater flow direction at the Site generally mimics the regional flow direction toward the wellfield; however, secondary permeability features in this aquifer result in some localized variations from the northeastern flow direction.

2.4 DNAPL DISTRIBUTION

Presently, the only accumulation of free-phase (i.e. mobile) DNAPL detected in wells at the Site is within monitoring wells installed in the UH. No significant free-phase/mobile DNAPL has been detected in any of the monitoring wells installed in the overlying Surficial Aquifer, or the underlying Lower Hawthorn. However, residual DNAPL impacts (*i.e.*, non-mobile) have been previously noted in cores collected from the Surficial, and to a lesser degree, Lower Hawthorn deposits. Once DNAPL reaches residual saturation it is immobile. Mobile and/or residual DNAPL impacts have never been observed in the Floridan Aquifer at this Site, indicating that the vertical extent of DNAPL migration is limited to HG deposits. The majority of the free-phase DNAPL impacts detected at the Site are restricted to deposits in the UH above the HG middle clay unit.

In 2004, a comprehensive effort was undertaken by Beazer to characterize the lateral and vertical extent of DNAPL-impacts in the surficial and HG deposits at the Site, including delineation of dissolved-phase impacts in the former South Lagoon. As a result of this study, the approximate lateral and vertical extent of DNAPL impacts at the source areas were defined. The results of this study are documented in a 2004 report on subsurface investigations in these areas (GeoTrans, 2004a). Site features and the approximate extent of DNAPL occurrence in the former South Lagoon resulting from this study are depicted in **Figure 4**. Based on the 2004 investigation, the areal extent of potential DNAPL impacts to be targeted in the former South Lagoon area occurs in an irregularly shaped footprint covering approximately 1.4 acres.

One UH monitoring well (HG-9S) was installed to monitor the former South Lagoon area. The location of HG-9S is located in the anticipated centroid of mass of the free-phase DNAPL. No DNAPL has been recovered from HG-9S since it was installed.

An investigation of DNAPL impacts in the former North Lagoon and Drip Track areas was performed by Beazer in February 2013. Fifteen DNAPL characterization borings were installed in the former North Lagoon and 10 borings were installed in the former Drip Track area. In addition, two of the borings were converted to temporary investigation points (TIPs) in each of these source areas to monitor for free-phase DNAPL. The results of this investigation demonstrated that free-phase DNAPL impacts were not wide-spread within these source areas. Only one of the four TIPs installed to monitor for free-phase DNAPL recently (June 2014) started recovering low volumes (less than 0.5 gal per 2 week event) of product. The remaining three TIPs have never contained recoverable DNAPL.

Although DNAPL has never been recovered in the former South Lagoon Area, DNAPL recovery has been on-going since 2004 at three other UH source areas. These areas include the former Process Area, the former Drip Track Area and the former North Lagoon. One conclusion that can be established from these investigations and historical DNAPL recovery is that free-phase DNAPL impacts within the UH appear to be restricted to thin, discrete and potentially discontinuous sand lenses. Recovered volumes tend to be relatively low in the former Drip Track Area and North Lagoon. The reason for these low recovery rates is DNAPL saturations are close to residual levels and the impacts are restricted to thin zones. These observations of DNAPL occurrence and recovery in the source areas are likely to be indicative of the nature and distribution of DNAPL in the South Lagoon Area, and can be used to guide the process of remediation in the South Lagoon.

Based on these data, one of the first tasks associated with implementing ISGS within the former South Lagoon is to more accurately identify zones of free-phase DNAPL impacts so they can be targeted for treatment. New DNAPL recovery wells will be installed to document recovery both pre- and post-ISGS treatment for some of the more highly-impacted zones. Details of these pre-implementation tasks are described in Section 3.1.

3.0 PROJECT IMPLEMENTATION

The project has been divided into four phases consisting of the following: 1) Phase I – South Lagoon Characterization; 2) Phase II - ISGS Reagent Injection; 3) Phase III - Spot Treatment; and 4) Phase IV - Performance Evaluation. Each of these phases is discussed below. The implementation will be similar to the former Process Area, incorporating lessons learned into this document.

3.1 PHASE I – SOUTH LAGOON CHARACTERIZATION

The Phase I South Lagoon Characterization will include a detailed evaluation of free-phase DNAPL distribution followed by installation of additional DNAPL recovery wells. During characterization activities, an emphasis will be placed on defining zones of free-phase (potentially mobile) DNAPL that will be targeted during the remediation phase. Investigation data will be gathered to better design the remediation program, including physical core analysis, injection methods and equipment testing. Specific tasks to be performed in the South Lagoon under Phase I are the following:

- Identification of subsurface structures in the treatment area;
- Subsurface characterization of free-phase/residual DNAPL;
- Installation of TIPs;
- Modelling DNAPL impacts using Environmental Visualization System (EVS©); and,
- Installation of DNAPL recovery wells and Zone-of-Discharge (ZOD) wells.

A discussion of each of these tasks is provided below.

3.1.1 LOCATING SUBSURFACE STRUCTURES

The former South Lagoon may contain historical subsurface structures. Attempts will be made to identify subsurface structures by utilizing historical basemaps, aerial photos and conducting field reconnaissance. If possible, the injection-point locations will be adjusted slightly in order to avoid structures. The locations of subsurface structures will be surveyed and plotted on a Site basemap for future reference.

3.1.2 DNAPL DISTRIBUTION CHARACTERIZATION

The current understanding of DNAPL impacts beneath the former South Lagoon is limited to a few wells and borings advanced in this area over the past 20 years (**Figure 4**). In order to strategically target free-phase and residual DNAPL impacts during remediation, a detailed characterization of subsurface impacts in the South Lagoon will be performed during this phase of the investigation.

Core samples will be collected in surficial and HG deposits using a rotasonic rig to provide detailed characterization of DNAPL impacts. The rotasonic-drilling method is efficient at drilling through unconsolidated deposits at this Site and has previously demonstrated success at collecting intact, continuous geologic cores for visual identification of DNAPL impacts.

Boring characterization will be conducted in a phased approach to reduce the number of unnecessary borings. Initially, 25 boring locations will be installed to delineate DNAPL impacts horizontally and vertically from land surface to the top of the HG middle clay unit. The 25 borings will be placed on an approximate 80- by 40-foot rectangular grid (**Figure5**). After these boring are completed, additional borings will be installed as necessary, to augment the characterization in DNAPL impacted areas. The augmentation borings will be located based on field data from the initial borings, as visualized using EVS (Section 3.1.4). As additional data become available from the borings, the EVS visual model will be updated and used to determine whether more borings are needed and, if so, where.

The description of the cores will include the following: 1) Measure volatile organic vapors (VOCs) using a photo-ionization detector (PID); 2) Describe lithologies based on the United Soil Classification System (USCS); 3) Classify relative permeabilities and DNAPL saturations. The data obtained from the cores will be analyzed for the 3-dimensional spatial extent of DNAPL in using visualization software (see Section 3.1.4). Real-time results of the spatial analysis will be used to locate additional boreholes, if needed, to further delineate the vertical and horizontal extent of DNAPL in the former South Lagoon area.

Preliminary boring locations will be established by first surveying the corner points of the grid lines shown in **Figure 5** and setting temporary metal and wooden stakes at the corners and every 160 feet along the perimeter of the grid, using the southwesterern corner as the starting point. In addition, a north-south transect will be run across the approximate high point within the grid. The end points of this transect line will be surveyed, and temporary metal and wooden stakes installed as along the perimeter. These stakes will be used to determine the locations of the characterization borings, with a target accuracy of +/- 2.5 feet. Individual boring locations will be established by measuring distances from the survey lines with a tape measure. Any significant changes to these locations will be resurveyed at the completion of the investigation.

Core samples will be collected continuously from land surface to the top of the HG middle clay unit at an approximate depth of 65 to 70 feet bgs. Relative DNAPL impacts will be evaluated using the following numerical rating from 1 to 5 used in the former Process Area characterization:

> 1 -- "DNAPL not observed" – no evidence, such as staining or liquid DNAPL, is observed in the core. Low PID readings possible;

2 -- “Elevated PID measurements observed” – PID measurements taken from the core are elevated above baseline values; often accompanied by creosote-like odors;

3 -- “Limited residual DNAPL Staining observed” – the sediments are discolored consistent with contact with DNAPL; staining is often accompanied by creosote-like odors;

4 -- “Heavy residual DNAPL Staining observed” – minimal or no staining on core sleeve; and

5 -- “DNAPL present above residual saturation” – DNAPL flows freely from the core material.

After all geologic descriptions, field measurements and photographs are completed on the cores, they will be disposed as Investigative Derived Waste (IDW).

3.1.3 Temporary Investigation Point Installation

Similarly to the former Process Area, TIPs will be installed in the former South Lagoon at locations where core samples with DNAPL characterization ratings of 4 or 5 are present over vertical distances of several feet, or as otherwise determined by the field geologist/engineer as likely to yield recoverable DNAPL in a TIP. During the former Process Area investigation TIPs were installed at the base of the borings; however, for this investigation the depth for completing the TIPs will be based on depth of observed DNAPL impacts. The previous characterization of the former Process Area (Tt, 2013), established that the majority of the DNAPL impacts were restricted to approximately 10 feet above the HG middle clay unit. Based on this observation, it is anticipated that the TIP screen interval will be installed at an approximate depth of 52-60 feet bgs in the former South Lagoon area. The actual TIP completion depths and screened intervals will be based on observed DNAPL in the core, but will not exceed the depth to the top of the HG middle clay.

It is anticipated that only one TIP will be installed at a location. However, if mobile DNAPL is believed to be present over an interval longer than 10 feet, the field geologist/engineer may determine that more than one TIP (at different depths) should be installed or that the upper limit of the pea gravel (as discussed below) should be raised a few feet to cover the affected interval.

TIPs will be installed by advancing a 6-inch diameter borehole to total depth of the selected interval. Prior to installation of the TIP, the borehole will be backfilled with bentonite chips to the base of the desired screened-depth interval, if needed. TIPs will be constructed inside the override casing using 2-inch flush-joint schedule-40 stainless steel pipe. The TIPs will have a 10 to 15 foot long 20-slot screen, with a cap at the bottom.

After the TIP casing is placed in the borehole, annular backfill material will be poured between the TIP casing and override casing, as the override casing is slowly withdrawn from the borehole. A tremie pipe will not be used for the placement of the backfill material because the override casing will prevent formation material from infiltrating the borehole. The filter pack will consist of an appropriate sized filter sand (6/20 silica sand); the filter pack will extend approximately 2 to 4 feet above the top of the screen. Approximately 2 feet of bentonite seal will be placed above the filter pack to prevent grout from migrating into the pea gravel. The remainder of the borehole annulus from the top of the fine sand to ground surface will be backfilled with cement-bentonite grout pumped through a tremie pipe placed immediately above the fine-sand backfill. Grouting will continue to ground surface, incrementally removing sections of the override casing as the borehole is grouted to land surface.

The 2-inch diameter TIP casings will extend approximately 1 foot above grade. The top of the casing will be fitted with a threaded cap. After installation, the TIP locations will be surveyed and the elevation of the TIP casings will be surveyed to within 0.01-foot vertical accuracy.

Borings not completed with a TIP will be abandoned by backfilling with a cement-bentonite grout mixture (6.5 gallons per 94 lb sack of cement with 3 to 5 percent bentonite). The grout mixture will be placed starting at the bottom of the boring using a tremie pipe or equivalent.

3.1.4 EVS© Model Development

Utilizing data and observations collected from the DNAPL investigation, the 3-dimensional distribution of DNAPL in both the Surficial Aquifer and the UH will be evaluated using the Environmental Visualization System (EVS©) software by C Tech Development Corporation. The DNAPL relative saturations will be entered into the EVS© model based on the numerical ratings described in Section 3.1.2.

The model will be used to display relative DNAPL impacts in 3-dimensions. An example of the data collected during the 2004 Source Area delineation at the South Lagoon, and a 3-dimensional schematic of the proposed investigation boreholes is presented in **Figure 6**. Borehole major lithologies and relative permeability data will be entered into the EVS© model to help in the identification of potential “geologic traps” for DNAPL accumulation. These data will assist in the selection of depth intervals to be targeted for ISGS reagent treatment. The targeted zones selected for treatment will coincide with free-phase DNAPL impacts.

At the completion of the initial Phase I characterization, Beazer will meet with the U.S. EPA and Stakeholders to discuss the results of the investigation. The investigation will be used to identify locations for new DNAPL recovery and monitoring wells.

3.1.6 DNAPL RECOVERY AND MONITORING WELL INSTALLATIONS

Part of Phase I will include the installation of up to four DNAPL recovery wells in the former South Lagoon area approximately 2 months after the characterization borings are completed. Initially, two DNAPL recovery well locations will be selected for the Surficial Aquifer and two for the UH. However, the final number and location of DNAPL recovery wells will be determined based on the results of DNAPL characterization. In addition, the need for the installation of additional DNAPL recovery wells will be evaluated after 12 months of performance monitoring. The primary objective of the new/existing DNAPL recovery wells is to provide baseline and post-injection DNAPL recovery data as a metric for DNAPL mobility reduction assessment. The wells will also help reduce easily recoverable DNAPL mass prior to the ISGS treatment. DNAPL recovery well installation details and procedures are described in **Appendix A** of this workplan.

DNAPL will be removed from the recovery wells on a bi-weekly basis using the DNAPL recovery procedures detailed in the Comprehensive Groundwater Management and Sampling Analysis Plan (CGMSAP) (FTS and GeoTrans, 2014). All pre- and post-removal depths to water and DNAPL will be recorded. In addition, total volumes of DNAPL and water removed from the wells will be monitored over the duration of this project. Similar to the two existing DNAPL recovery wells, it is anticipated that DNAPL will be removed via a peristaltic pump to minimize disturbance of the DNAPL/water column. If the depth to water/DNAPL in the new recovery wells is too great for the use of a peristaltic pump, disposable bailers will be used to remove DNAPL from the wells. DNAPL recovery activities will commence immediately after well completion and will continue through the project performance assessment phase. In the event that some of these wells do not contain recoverable DNAPL, the wells may be used to monitor dissolved-phase concentrations pre- and post-ISGS project implementation.

Zone-of-discharge (ZOD) wells are required by the Florida Department of Environmental Protection (FDEP) Permit Variance for the use of the *in-situ* chemical oxidation using RemOx® EC. The permit specifies a ZOD to be within 150 feet of the ISGS reagent injection point. Existing Surficial Aquifer monitoring well M-32B is located downgradient and within the 150-ft ZOD distance from the injection zone. There are no existing UH monitoring wells located within the 150 foot ZOD. Therefore, a well screened over a depth interval based on the predominant depths of DNAPL impacts in the UH will need to be installed to meet this Variance requirement. The preliminary UH ZOD monitoring well location for HG-ZOD1 is shown in **Figure 7**, along with the location of Surficial Aquifer monitoring well M-32B. The details and procedures to be used during well installation are provided in **Appendix B**.

The screen slot-size specifications for wells installed during this project vary depending on the intended use of the well: 1) A ZOD monitoring well; 2) A DNAPL recovery well; or 3) A temporary ISGS injection point. Although the screen slot size and sand pack is dependent on the formation grain size, it is also dependent on the intended use of the well. DNAPL recovery wells and temporary investigation points require larger screen and filter pack sizes than a monitoring well. The main concern is that the screen slot size is adequate to limit fine-grained material from entering the well through the screen. The 10-slot screen is the typical slot size used for most monitoring wells at the Site. The 10-slot screen prevents fine-grained material from entering the well over the long period of time that these wells are in use. The 20-slot screen is specified for DNAPL recovery wells to ensure that both the slot size and filter pack are large enough to enhance DNAPL migration into the well. It is important that the filter pack and screen slot size are larger than the formation grain size to encourage DNAPL flow into the well; however, the slot size needs to remain small enough to limit fine-grained formation material from entering the well. Similarly, TIPs will have 20-slot stainless-steel screens to provide sufficient openings for both DNAPL recovery (**Appendix C**). There is a potential for precipitate to form during reagent injection; hence, TIPs will not be used for reagent injections.

Following installation of the Phase I TIPs/wells (TIPs, ZOD monitoring wells, and DNAPL recovery wells), the horizontal and vertical coordinates will be determined by survey.

3.2 Phase II ISGS Reagent Injection

The Phase II ISGS implementation will be performed based on data obtained during the Phase I characterization. Although a number of the specific details for the implementation of the ISGS will be established during Phase I characterization, assumptions concerning implementation have been made for the purposes of this workplan. In addition, it is anticipated that groundwater extraction via the horizontal groundwater collection drain in the former South Lagoon area will be discontinued during- and post-ISGS reagent injection to eliminate the potential of ISGS reagent being captured by the drain.

An addendum to this Work Plan will be prepared based on the Phase I characterization results to provide greater detail for the Phase II reagent injections. The Phase II Addendum will specify the locations and depths of reagent injection using the Geoprobe tools.

3.2.1 Process Area Lessons Learned

In 2014, a pilot test of ISGS reagent injection was performed in the former Process Area. A full-scale ISGS reagent injections was implemented for impacted areas of the former Process Area in 2015. The pilot test and full-scale injections provided a number of lessons-learned for implementation of full-scale injections at the former South Lagoon. The direct-push injection tool was confirmed to be effective for targeting 2-foot intervals for injection. During reagent injections, increased formation pressure caused impacted groundwater to travel up the inside casing of adjacent TIPs, with the potential of groundwater discharging at land surface. Because of the pressure pulse, tight fitting caps must be installed on all TIPs and monitoring wells in the vicinity of the injections.

Reagent daylighting occurred in select locations during injection of reagent in the Surficial Aquifer. Preferential pathways caused by historical use of the Site allowed small volumes of reagent to daylight. To address reagent daylighting, injections will be stopped, and the boring advanced to the next shallowest interval until the daylighting stops. In addition, containment and reagent neutralization procedures will be readily available to mitigate impacts from reagent daylighting.

Low-permeability deposits within the Surficial Aquifer and UH caused reagent-injection refusal at select targeted intervals. When reagent injection refusal is encountered at a target interval, the reagent volume not injected will be added to the injected volumes at the next shallower targeted intervals.

3.2.2 Reagent Injection Approach

The method for injection of the ISGS reagent will be via Geoprobe tools to inject the reagent into 2-foot targeted DNAPL-impacted zones. It is anticipated that these targeted injections will require approximately 110 gallons of reagent over each 2-foot interval. Experience from the former Process Area ISGS indicates that injections will require about 15 to 40 minutes at a rate of about 5 to 15 gpm. The Geoprobe targeted approach allows for a more controlled injection, but requires high injection rates and pressures.

<u>Injection-Point Locations, Spacing and Sequencing</u>
Based on the pilot test performed in the former Process Area, the estimated conservative radius of influence that can be attained through careful injection pressure and volume control may be approximately 15 feet. It was confirmed during the former Process Area pilot test that while the injected reagent will tend to follow the path of least resistance, sometimes exceeding a 15-foot radius in certain directions, a 15-foot radius is appropriate for treating the formation. For this workplan it is assumed that the radius of influence will be 15 feet and that the injection points will be located on a 20-foot triangular grid. Preliminary injection-point locations are shown in **Figure 9**.
ISGS reagent injections will begin on the outer limits of the targeted treatment area in order to contain DNAPL displacement. At the completion of the Phase I investigations, specific injection sequencing and locations will be developed.

<u>Chemical-Mixing Systems</u>
The final reagent mixing will be performed at the Site immediately preceding injection. Specific details of the proprietary formulation will not be provided in this document; however, the generic formulation and procedure will be discussed below and were confirmed to be effective during the pilot test in the former Process Area. Description of ISGS reagents including MSDS and related materials were previously submitted, reviewed and approved by FDEP for use at the Site.

Chemicals required to prepare the ISGS solution include sodium permanganate (40% solution), carbonates, iron, silicates and other constituents. To ensure the highest quality, ISGS is generally mixed in the field using high-speed mixing equipment and appropriate means of safe chemical measuring and transfer. The permanganate mixed with other compounds are used along with a local supply of water to produce a 4.5 wt% ISGS solution. The ISGS reagents components may be shipped in drums, totes, or tankers, in accordance with specific product quantity and storage requirements.

A lithium chloride (LiCl) tracer will be added to the ISGS reagent during mixing. Approximately 6 grams (about 1 teaspoon) of LiCl will be added to 250 gallons of ISGS reagent, yielding a lithium concentration of approximately 1 mg/L in the ISGS reagent. The lithium tracer will provide a quantitative measure of the dilution of groundwater constituent-of-interest (COI) concentrations due to ISGS reagent injections. The detection limit for lithium is approximately 0.01 mg/L, approximately 2 orders of magnitude less than the injected concentration.

Prior to beginning the mixing process, it is important to verify that all injection equipment is operational. Most of these checks can be made using potable water. Location of the mixing tanks will be as close as practical to the injection points to minimize the length of the injection hose from the pump to the injection point.

Geoprobe-Injection Procedure

Geoprobe manufactures various sizes of downhole tooling and specially-designed injection equipment for *in-situ* applications. Typically, 1.0- to 1.5-inch diameter rods are used with Geoprobe GS-series grout pumps.

It is anticipated that the ISGS reagent injections will be performed from the bottom of the boring upward, similar to the former Process Area full-scale injections. The following general procedures are to be used during each injection (Note that the procedures described below are for one injection point):

1) Drive the injection rods to the deepest targeted injection interval at the location.

2) Open the injection tool to the zone to be treated using a retractable screen, a pressure-activated probe or other device at the lead end of the Geoprobe drill string.

3) Blend the reagents in a mixing and transfer tank.

4) Pump the pre-determined quantity of ISGS reagent into the formation while monitoring and recording pump pressures, flow rates and volumes to ensure the formation is accepting the reagent. In the event of refusal, stop injections and move to the next shallower interval.

5) In some tool designs a high-pressure hose, connected to the injection point, is used to inject the reagent. The high-pressure hose runs down the inside of the injection rods and isolates the rods from the reagent fluid. Other systems do not utilize a separate hose and the reagent is delivered inside of the injection rods. In cases where reagent is in contact with the rods, allow system pressures to dissipate before removing tooling to minimize reagent backsplash when rod joints are disconnected.

6) Move to next injection depth interval and repeat steps 2 through 5.

7) After completing the injection, remove the injection rods and seal the borehole with a bentonite-aggregate grout or a cement/bentonite grout to prevent blow-by/daylighting during injection in adjacent locations.

3.3 PHASE III – ISGS SPOT TREATMENTS

Additional ISGS treatment may be proposed after completion of the initial ISGS implementation and performance evaluation. Given the inherent difficulty in injecting ISGS reagent into low-permeability material, it may be necessary to address hot-spot zones that were not fully treated during the initial injection. Depending on the performance-monitoring data and post-ISGS DNAPL thickness/recovery rate at individual wells, it may be necessary to re-evaluate the initial ISGS reagent subsurface distributions. The need to perform a second spot treatment of DNAPL zones will be decided after 4 to 5 months of performance monitoring.

3.4 PHASE IV – PERFORMANCE EVALUATION

The performance goals of the remedy will be based on the RAOs developed in the Record of Decision (U.S. EPA, February 2011):

- *Eliminate potential risks to receptors exposed to Site-related contaminants in:*
  - *Surface soils*
  - *Groundwater in the Surficial Aquifer, Upper HG, Lower HG, and UFA*
  - *Subsurface soils*
  - *Sediment*
  - *Surface water*
- *Control and eliminate further migration of impacted groundwater*
- *Restore quality of groundwater outside of principal contaminant source areas to beneficial use having COC concentrations no greater than Federal MCLs or Florida GCTLs*
- *Reduce the mobility, volume, and toxicity of DNAPL to the maximum extent practicable.*

For the ISGS component of the remedy, the most important remediation mechanism to help meet RAOs is the stabilization of free-phase and residual DNAPLs (short-term goal). Groundwater monitoring will continue to be performed in both the Surficial Aquifer and UH at locations downgradient from the South Lagoon along the eastern and northern edges of the former Koppers Site boundary as part of the regularly scheduled monitoring activities. In addition groundwater monitoring will be performed at monitoring wells designated as ZOD wells as required for the UIC compliance.

The short-term evaluation of this project will concentrate on the reduction in DNAPL mobility. The long–term evaluation will concentrate on both the longevity of the stabilized DNAPL and the reduction in mass flux of constituents. A discussion of the short-term and long-term performance evaluation is provided in Table 1. A discussion of the performance goals is provided below.

3.4.1 IMMEDIATE-TERM PERFORMANCE EVALUATION (0 TO 6 MONTHS)

The immediate-term objective of the project is to contain and reduce the mobility of DNAPLs in the Surficial Aquifer and UH in the former South Lagoon area. The primary method for evaluating the effectiveness of the ISGS remedy toward meeting this goal will be through monitoring the rate of DNAPL recovery in the new DNAPL recovery wells and TIPs installed as part of the Phase I investigation. (During the pre-injection and post-injection periods, CGMSAP SOP #116 Depth to Groundwater and NAPL Measurements (FTS and GeoTrans, 2014) will be followed to ensure consistency between the two sets of measurements). It is expected that DNAPL recovery rates will steadily decline over the first 6 months following ISGS reagent injections; however, a continual decline in DNAPL recovery rates may persist up to 12 months following injection.

Approximately 15 geologic cores will be collected from land surface to the top of the HG middle clay unit to qualitatively evaluate reagent distribution and contact with DNAPL zones. The cores will be collected approximately 3 to 6 months following the completion of reagent injection and will be visually inspected for ISGS reagent and DNAPL distributions. The lithology of the cores will be logged and any evidence of ISGS reagent and/or DNAPL occurrence will be noted. Any visual evidence of ISGS precipitate encrustation will be noted where present. Careful attention will be paid to visually describing locations within the core where ISGS reagent did not contact DNAPL-impacted zones. The observations of DNAPL, ISGS reagent and precipitate encrustation will be entered into the EVS model for 3-dimensional visualization of the post-ISGS reagent distributions in relation to pre-characterization data.

Groundwater samples will be collected from monitoring wells designated as ZOD wells as required for UIC compliance. These groundwater samples will be analyzed for ISGS constituents identified in the UIC variance for the ISGS reagent. The ZOD wells will also be analyzed for the standard suite of Site constituents analyzed for during semi-annual events.

3.4.3 Short-Term Performance Evaluation (6 to 18 Months)

The short-term objective of the project is to contain and reduce mobility of DNAPLs in the former South Lagoon area. The primary method for evaluating the effectiveness of the ISGS remedy toward meeting this goal will be through continued monitoring of DNAPL recovery in the wells monitored during the pre-characterization and immediate-term monitoring.

The short-term determination of the effectiveness will be based on temporal plots of DNAPL thickness and recovery. Shortly after the injection phase, perturbations in the plots may occur, as water, and perhaps DNAPL saturations are redistributed. However, after a relatively short period (months), a dramatic decrease in the DNAPL recovery rate is expected, based on experience in the former Process Area. While immobilization of all free-phase DNAPL should not be expected, the majority of the DNAPL mass within the South Lagoon should have reduced mobility and be contained, with a corresponding decrease in the recovery rate in wells.

Groundwater samples will also be collected from monitoring wells designated as ZOD wells as required for UIC compliance. Groundwater samples will be analyzed for ISGS constituents identified in the UIC variance for the ISGS reagent. In addition, all wells sampled under this program will be analyzed for the lithium tracer added to the ISGS reagent to evaluate potential dilution of groundwater sample resulting from displacement of groundwater during the reagent injections.

3.4.4 Mid-Term Performance Evaluation (18 to 36 Months)

The mid-term objective of the project is to show reduced mobility of DNAPLs in the former South Lagoon area. The primary method for evaluating the effectiveness of the ISGS remedy toward meeting this goal will be through continued monitoring of DNAPL recovery in the same wells monitored during the immediate- and short-term monitoring. DNAPL monitoring and recovery will be performed on a monthly basis to ensure that DNAPLs continue to have reduced mobility.

Water quality samples will be collected from select wells within the former South Lagoon as part of the mid-term evaluation. In the event that continued UIC sampling is required, groundwater samples will be collected from monitoring wells designated as ZOD wells as required by UIC compliance. This sampling is in addition to the routine monitoring of wells at the Site.

Groundwater samples will be analyzed for ISGS constituents identified in the UIC variance for the ISGS reagent. ZOD wells will be analyzed for the standard suite of Site constituents specified in Table 2-3 in the CGMSAP (FTS and GeoTrans, 2014) for Floridan Aquifer wells. In addition, all wells sampled under this program will be analyzed for the lithium tracer that was added to the ISGS reagent to evaluate potential dilution of groundwater sample resulting from displacement of groundwater during the reagent injections.

To further improve the characterization of the effectiveness of distribution of the ISGS reagent, additional information in the form of post-injection coring may be performed. In the event that the DNAPL recovery rate is not significantly decreased, a rotasonic drill rig may be mobilized to the Site to conduct a limited set of confirmatory coring to map distributions of DNAPL, reacted ISGS reagent, and non-reacted ISGS reagent around the injection points. This additional information would be useful in developing better approaches for injection of reagents in the UH and similar lithologies, and to develop a program for additional treatment of the former South Lagoon.

Although these additional post-injection characterizations are not currently proposed as part of this project; one or more of these investigations may be proposed after preliminary performance monitoring data are evaluated. These data may be used to support the spot ISGS treatments discussed in Section 3.3.

3.4.5 Long-Term Performance Evaluation (36 to 60 Months)

The long-term objective of the project is to show continued reduced mobility of DNAPLs in the former South Lagoon area. The primary method for evaluating the effectiveness of the ISGS remedy toward meeting this goal will be through monitoring of DNAPL recovery in the same wells as monitored during the immediate-, short-, and mid-term monitoring. DNAPL monitoring and recovery will continue to be performed on a monthly basis to ensure that DNAPLs continue to have reduced mobility.

3.5 ISGS MIGRATION CONTINGENCY PLAN

Wide-spread off-Site migration of ISGS reagent is not expected to occur post-implementation of reagent injection. ISGS reagent will react with both DNAPLs and natural organic and inorganic materials in the HG deposits, in addition to dissolved organics in groundwater. ISGS reagent will be neutralized as it contacts these naturally occurring organic and inorganic constituents; it is not expected to migrate significant distances downgradient of the primary treatment areas. In addition, it should be recognized that the UH is comprised of relatively low-permeability material, such that uncontrolled migration of ISGS reagent is expected to be minimal. High permeability pathways are not present in the unconsolidated deposits to provide avenues for significant and rapid migration. The relatively low-permeability materials will naturally contain migration of the reagent until it is neutralized by organic materials within the formation.

The ISGS reagent will be injected above the HG middle clay unit, which is approximately 5 to 15 feet thick beneath the former South Lagoon. The middle clay unit consists of interbedded low-permeability clays and silts. These clays and silts will naturally contain any potential vertical migration of reagent. In the unlikely event that the reagent finds a vertical pathway through the middle clay unit, it will be neutralized by naturally occurring organic and inorganic constituents in the Lower Hawthorn deposits.

The closest Site boundary is hydraulically upgradient of the former South Lagoon. As a result, injection of ISGS reagent only has the potential to migrate off Site if the mass of DNAPL is located farther south than currently projected. The contingency plan to mitigate ISGS reagent migration beyond the Site property boundary during injection is to cease ISGS reagent injection as soon as off-Site migration is detected. The cessation of injection will remove the primary driving force for reagent migration and minimize future off-site migration. ISGS reagent injections will be discontinued in the area of off-Site migration and geologic cores will be collected in the area of concern to characterize the extent of the impacted area.

The comprehensive remedy for the four former source areas includes the installation of a low-permeability groundwater barrier wall surrounding the former source areas. The groundwater barrier wall will consist of a bentonite-slurry wall extending from land surface to HG middle clay unit. This barrier wall will provide the primary long-term contingency plan for controlling potential off-site migration of ISGS reagents.

3.6 Equipment Decontamination and IDW

3.6.1 Equipment Decontamination

A thorough decontamination of downhole equipment between each Geoprobe investigative borehole is not critical given that the investigation will be performed in the former source area. Concern with cross-contamination between boreholes is not a major issue because these areas with mobile DNAPL will be treated. All downhole drilling equipment will be thoroughly decontaminated prior to the equipment arriving on Site and following the investigative boring program. Decontamination between investigative boreholes will be on an as needed basis at the discretion of the on-Site geologist. Gross DNAPL contamination on downhole equipment will be removed; however, a thorough decontamination is not planned or needed during this investigation.

Decontamination will be performed prior to installing each of the new DNAPL recovery wells. Decontamination will be performed by steam/pressure washing all downhole equipment. An isolation casing will be set in the HG upper clay unit, prior to drilling into the UH. All drilling equipment and tools will be decontaminated prior to drilling the open hole beneath the lowermost casing and prior to starting a new DNAPL recovery well.

3.6.3 INVESTIGATIVE DERIVED WASTE

All wastewater and soil generated during the activities described in this workplan will be containerized in drums or bulk tanks. The aqueous fractions from drums or bulk tank(s) will be mixed with influent water from the on-going groundwater extraction system and treated on-Site, prior to discharging to the permitted POTW. Soils and rock cuttings will be staged in sealed roll-off containers or drums for characterization and off-Site disposal.

4.0 PERMIT REQUIREMENTS

All necessary permits will be obtained prior to the implementation of this project. State permits required for this work include: 1) DNAPL recovery well construction permits; and 2) TIP permits. It is Beazer' understanding that an Underground Injection Control (UIC) permit may be required for reagent injections at the former South Lagoon. Further, Beazer assumes that the Carus Corporation, Inc. March 28, 2008 State-wide Petition for Variance for RemOx® EC Stabilizing Reagent usage, approved by FDEP on July 24, 2008, is still in effect and that modifications to this variance are not required for this project.

Well and TIP Permits

St. Johns River Water Management District (SJRWMD) is responsible for the issuance of permits for well construction at the Site. All forms and associated fees associated with obtaining well permits from SJRWMD will be completed prior to well-installation activities.

The use of TIPs will be evaluated as part of the Phase I investigations and testing. Beazer will work with the SJRWMD to obtain all permits.

UIC Permit

A Class V UIC permit application may be required by the FDEP. Beazer will work with the FDEP to obtain an UIC permit, if needed.

Petition for Variance

On July 24, 2008, the State of Florida Department of Environmental Protection granted Carus Corporation a Final Order Granting Petition for Variance from Rule 62-522.300(3) of the Florida Administrative Code. The petition was for a variance under section 120.542 of the Florida Statutes, from Rule 62-522.300(3), which prohibits a zone of discharge through wells as part of an *in-situ* remediation process. The process described in the variance involves the use of temporary Class V underground injection control wells or borings at the site of contamination. The variance applies specifically to Carus' RemOx® EC Stabilizing Reagent. The variance is subject to the following conditions:

1) Use of this product must be through a Department approved remedial action plan, or other Department-enforceable document, for an aquifer remediation project and such approval shall not be solely by a delegated local program.

2) The discharge to the groundwater must be through a Class V, Group 4 underground injection control well which meets all of the applicable construction, operating, and monitoring requirements of chapter 62-528 of the Florida Administrative Code.

3) The extent of the zone of discharge for antimony, arsenic, chromium, mercury, beryllium, cadmium, lead, thallium, selenium, and molybdenum shall be within a 150 foot radius from the point of injection and the duration of the zone of discharge shall be 1 year. This will allow ample time for the temporarily exceeded parameters to return to the drinking water standards or applicable levels set forth in chapters 62-550 and 62-777 of the Florida 5 Administrative Code, or their naturally occurring background levels at the site, whichever is less stringent.

4) The injection of the product shall be at such a rate and volume (no greater than 4.5-percent sodium permanganate solution {the concentration of sodium permanganate in RemOx® EC}) that no undesirable migration occurs of the product, it's by-products, or the contaminants already present in the aquifer.

5) The Department-approved remedial action plan shall address appropriate groundwater monitoring requirements associated with the use of the ***in-situ*** chemical oxidation using RemOx® EC for remediation based on site-specific hydrogeology and conditions. These shall include the sampling of groundwater at monitoring wells located outside the contamination plume, before use of RemOx® EC Stabilization Reagent, to determine the naturally occurring background levels of antimony, arsenic, chromium, mercury, beryllium, cadmium, lead, thallium, selenium, molybdenum, sodium, chloride, aluminum, manganese, TDS, pH, iron, and color which are the parameters pertinent to this variance. Monitoring of these parameters in groundwater should also be included downgradient from the injection points for at least 1 year after active remediation. (Sodium, chloride, aluminum, manganese, TDS, pH, iron, and color are included herein solely because of the recent rules amendments discussed in paragraph 3 above, which require any parameter that will not meet its standard, and for which a variance is no longer needed, to be included in the remedial action plan for monitoring and zone of discharge purposes).

6) The sodium permanganate which is used in the RemOx® EC Stabilization Reagent shall be derived from manganese ore as specified in the petition.

The Variance specifies a zone of discharge to be within 150 feet of the ISGS reagent injection. As required by the 2008 Variance discussed above, baseline groundwater samples will be collected from both Surficial Aquifer and Upper Hawthorn ZOD monitoring wells to evaluate metals, inorganic constituents and field parameters associated with RemOx® EC. Preliminary ZOD monitoring well locations are shown in **Figure 7**.

One round of groundwater samples will be collected using conventional methods from each of the ZOD monitoring wells to establish baseline constituent concentrations prior to ISGS reagent injection. Quarterly samples will collected from these monitoring wells for 1 year following the ISGS reagent treatment.

5.0 PROJECT MANAGEMENT PLANS

The project management plans that will be utilized to guide the work outlined in this section will include the following documents:

1) Health and Safety Plan (HASP);
2) Quality Assurance Project Plan (QAPP); and
3) Comprehensive Groundwater Management and Sampling Analysis Plan (CGMSAP).

A HASP and QAPP were previously prepared (TRC, 2002b; TRC, 2002c) and were incorporated into the items listed below:

Health and Safety Plan

A project-specific HASP was prepared by Tetra Tech (2014) for ISGS injections in the former Process Area and will used as well for this project. This HASP establishes the procedures and requirements used to minimize health and safety risks to persons working on the project. The HASP meets the requirements of the Occupational Safety and Health Administration (OSHA) Standard, 29 CFR 1910.120 and 29 CFR 1926.65, "Hazardous Waste Operations and Emergency Response". The 2014 HASP will be modified and updated to incorporate specific health and safety risks associated with the ISGS reagent injection at the former South Lagoon.

In addition to the plan prepared or amended under this workplan, subcontractors will be required to prepare HASPs that are specifically focused on their specialized activities. These plans will include Job Hazard Analyses and MSD forms for any materials that may be required to complete the specified task.

Quality Assurance Project Plan

Quality assurance/quality control activities and requirements, including project quality objectives, field data reduction, data validation, and quality assurance objectives for measurements for all groundwater samples collected under this workplan, will be performed as specified in the QAPP (Environmental Standards, 2016).

Comprehensive Groundwater Management and Sampling Analysis Plan

The CGMSAP will be used for monitoring data collection and handling. This plan will be amended, if necessary, to accommodate new monitoring locations and any new sampling procedures required for this fieldwork (FTS and GeoTrans, 2014).

6.0 REPORTING, SCHEDULE AND COMMUNITY RELATIONS

6.1 REPORTING

Two reports will be developed for the former South Lagoon ISGS injections. The Phase I Characterization report will detail the Phase I investigations and EVS model results. This report will be submitted after the DNAPL recovery and ZOD monitoring wells are installed. This report will be submitted prior to a meeting with the EPA and Stakeholders to discuss results and proposed modifications to the ISGS injections.

The final report will detail the ISGS injection implementation and the Immediate-Term Performance monitoring. The report will include a description of all field activities, boring logs, as-built drawings for well installations, and documentation of ISGS reagent injection (description of the solution, solution strength, injection locations, volumes, pressures and duration). The final report will include documentation of the performance evaluation criteria, DNAPL collection, and analytical results from ZOD monitoring wells.

6.2 SCHEDULE

The schedule for completion of this project is subdivided into four phases: Phase I: South Lagoon Characterization; Phase II: ISGS Reagent Injection; Phase III: Spot Treatment; and Phase IV: Performance Evaluation. The total time required to implement the first three phases of this project is approximately 1.5 years. The approximately 1.5 years required to complete this project is due to the extended time required to collect pre-injection- DNAPL recovery data. It is estimated that a minimum of a 6-month time period is required to establish the pre-injection DNAPL recovery rates in new wells. Therefore, the overall project schedule is dependent on initiating Phase I of this project as soon as possible to allow sufficient time to establish DNAPL recovery baseline conditions.

Phase IV is the performance monitoring that is broken into four performance monitoring periods: 1) Immediate-term; 2) Short-term; 3) Mid-term; and 4) Long-term. The total performance monitoring is scheduled for 5 years, with the immediate-term lasting 6 months, the short-term lasting 1 year, the mid-term lasting 1.5 years and the long-term lasting a minimum of 2 years.

The schedule for ISGS project Phases I through III is provided in **Figure 10** and the schedule for Phase IV is provided in **Figure 11**. The schedule is based on the assumption that Phase I fieldwork will begin in May 2016. Phase I will require approximately 12 months to complete. Phase II will require approximately 10 months to complete. Phase III Spot Treatment may not be required; however, if needed, these injections are anticipated to take approximately 2 weeks to complete and Phase IV will require approximately 5 years. A detailed description of time required to complete subtasks under each of these four phases is provided in **Figures 10 and 11**.

The schedule for implementation of this work plan will be dependent on regulatory approval and subcontractor availability.

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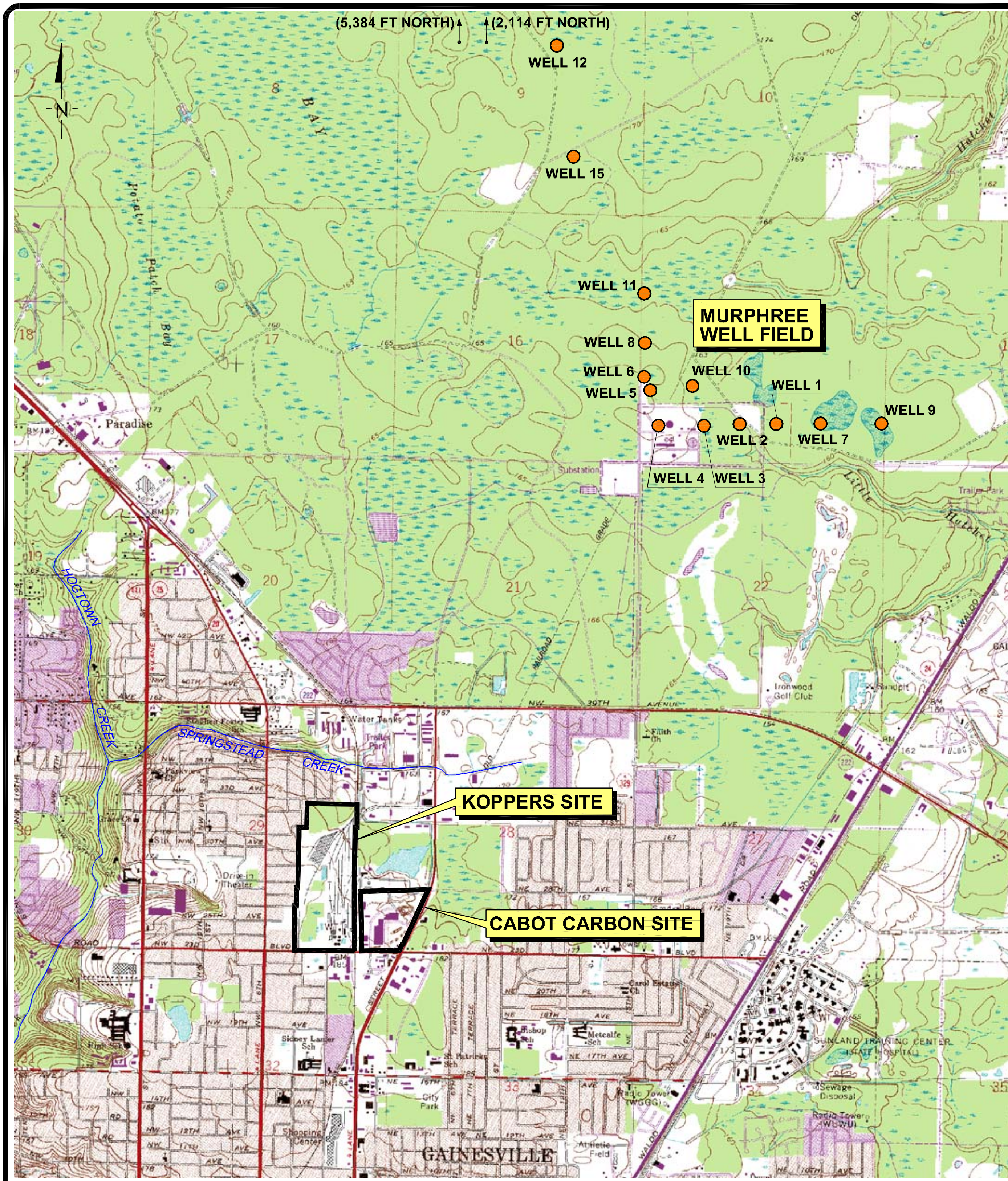
FIGURES



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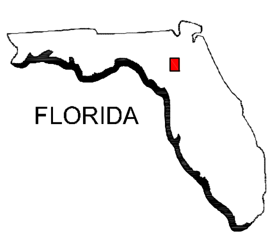

TITLE:	SITE LOCATION MAP
LOCATION:	Cabot Carbon/Koppers Superfund Site Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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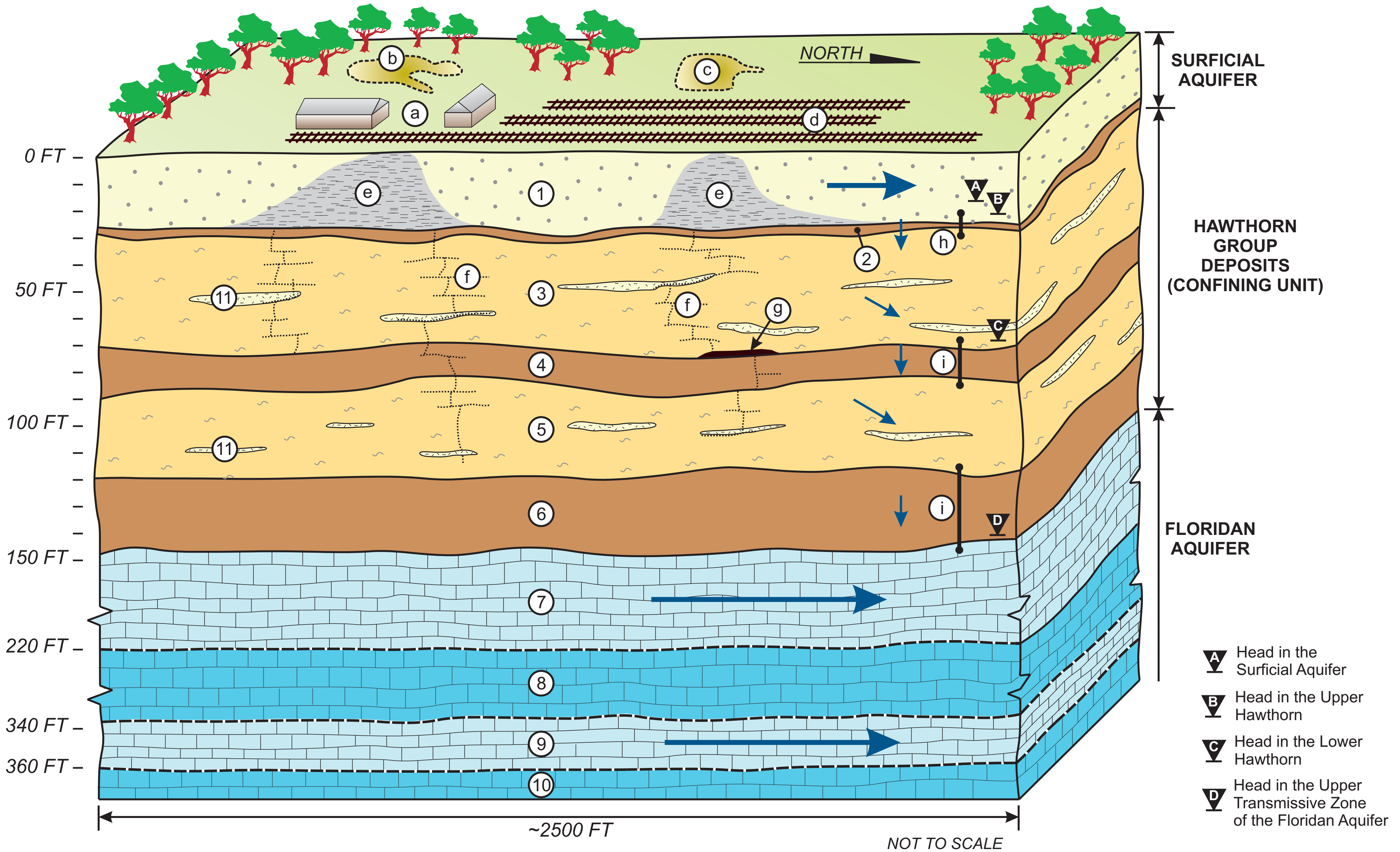


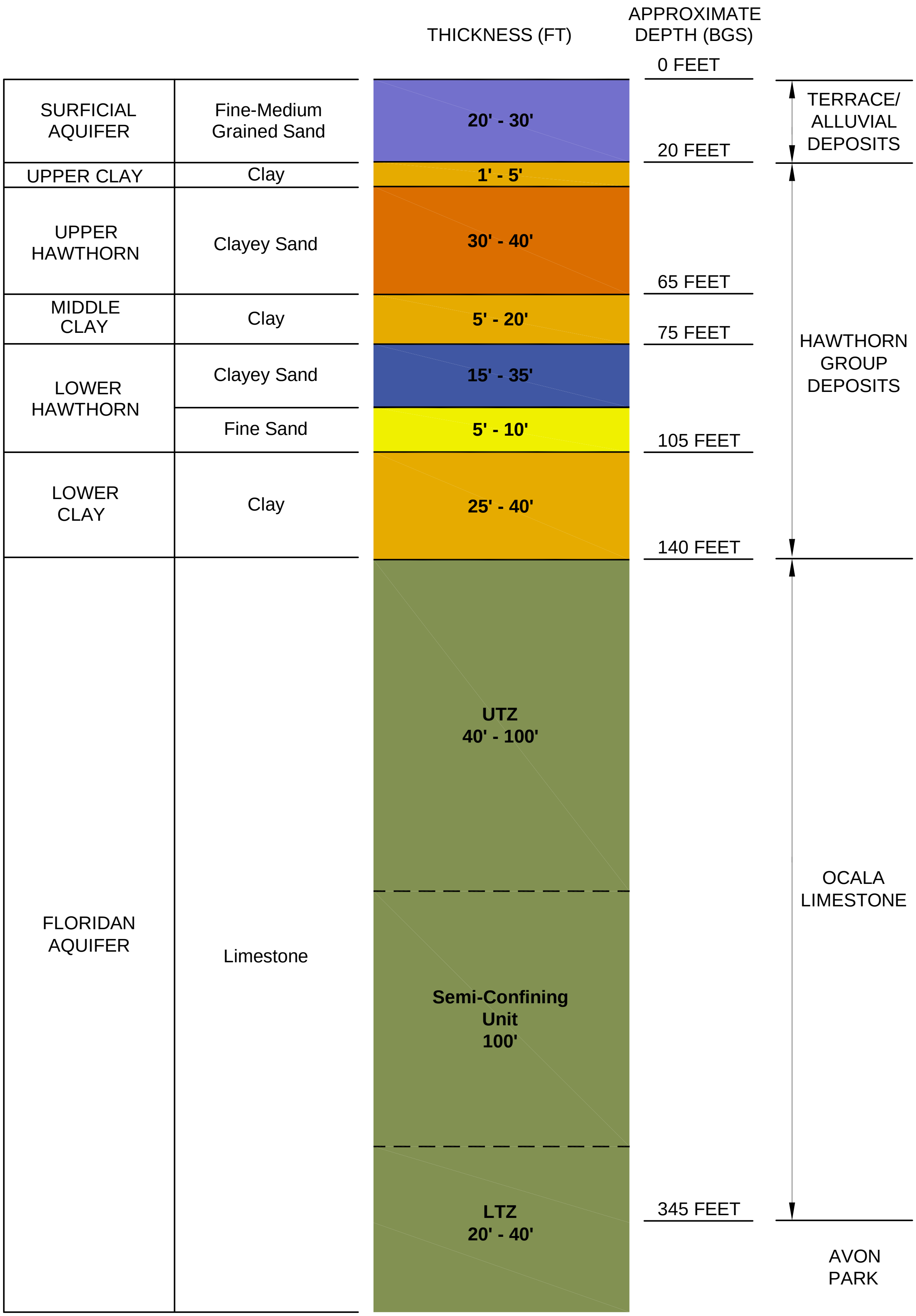
1) Surficial Aquifer
2) Hawthorn Group - Upper Clay
3) Hawthorn Group - Upper Hawthorn
4) Hawthorn Group - Middle Clay
5) Hawthorn Group - Lower Hawthorn
6) Hawthorn Group - Lower Clay
7) Floridan Aquifer - Upper Transmissive Zone
8) Floridan Aquifer - Semi-Confining Zone
9) Floridan Aquifer - Lower Transmissive Zone
10) Floridan Aquifer - Semi-Confining Zone
11) Discontinuous Sandy Interbeds

a) Former Process Area
b) Former South Lagoon
c) Former North Lagoon
d) Former Drip Track
e) Soils with Residual DNAPL
f) Sparse Seams of Residual DNAPL
g) Sparse Seams of Locally Continuous DNAPL
h) Moderate Vertical Hydraulic Gradient (~1 ft/ft)
i) Large Vertcial Hydraulic Gradient (~3 ft/ft)

Note:
There are uncertainties associated with the conceptual understanding presented in this figure.

GROUNDWATER FLOW
(SIZE INDICATIVE OF APPROXIMATE RELATIVE MAGNITUDE)

Figure 2.
Conceptual Block Diagram
Cabot Carbon/Koppers Superfund Site, Gainesville, Florida



TITLE: HYDROSTRATIGRAPHY OF DEPOSITS BENEATH SITE

LOCATION: Cabot Carbon/Koppers Superfund Site
Gainesville, Florida

TETRA TECH

APPROVED	GC	FIGURE
DRAFTED	CP	3
PROJECT#	117-2201303	
DATE	12/9/13	

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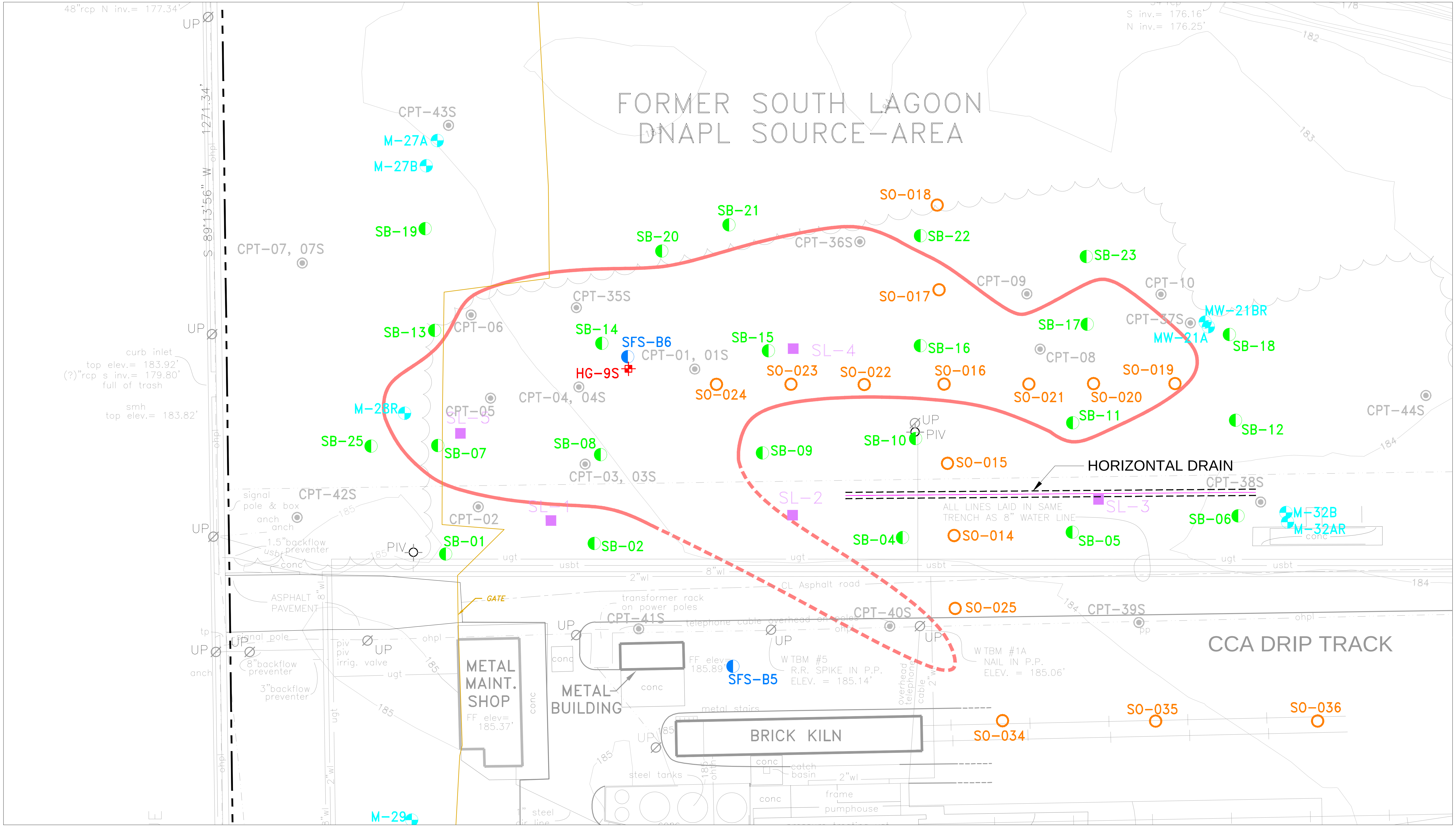

EXPLANATION

- SURFICIAL AQUIFER MONITORING WELL
- HAWTHORN GROUP MONITORING WELL
- CPT BORING
- SOIL BORING (McLAREN/HART, 1994)
- SFS SOIL BORING (TRC, 1999)
- SOIL BORING (HUNTER/ESE, 1989)
- SFS SURFACE COMPOSITE SAMPLE (TRC, 1999)
- LATERAL EXTENT OF DNAPL SOURCE-AREAS WITHIN THE SURFICIAL AQUIFER PROJECTED VERTICALLY TO THE SURFACE
- KOPPERS PROPERTY BOUNDARY
- ACCESS-RESTRICTING FENCELINE

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TITLE:	FORMER SOUTH LAGOON FEATURES
LOCATION:	Cabot Carbon/Koppers Superfund Site Gainesville, Florida

TETRA TECH

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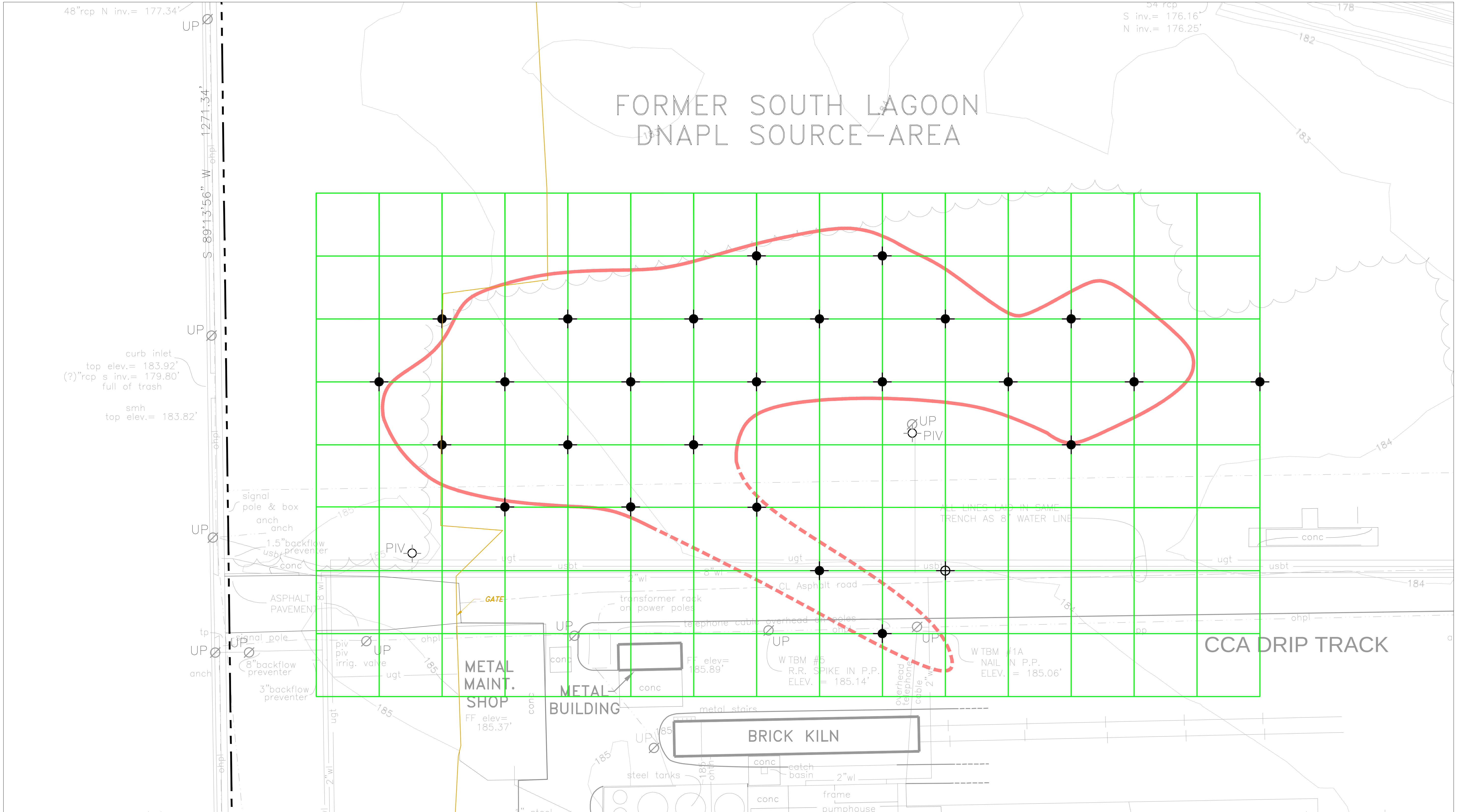
DRAFTED	HF	
FILE	117-2201338	
DATE	09/10/2014	



EXPLANATION

- PRIMARY DNAPL INVESTIGATION BORING
- ACCESS-RESTRICTING FENCELINE
- PRELIMINARY GRID FOR DNAPL CHARACTERIZATION BORINGS
- LATERAL EXTENT OF DNAPL SOURCE-AREAS WITHIN THE SURFICIAL AQUIFER PROJECTED VERTICALLY TO THE SURFACE
- KOPPERS PROPERTY BOUNDARY

0 60 120
SCALE IN FEET

TITLE: PRELIMINARY GRID LAYOUT FOR FORMER SOUTH LAGOON CHARACTERIZATION BORINGS

LOCATION: Cabot Carbon/Koppers Superfund Site
Gainesville, Florida

TETRA TECH

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DATE	03/17/2016

FIGURE: 5

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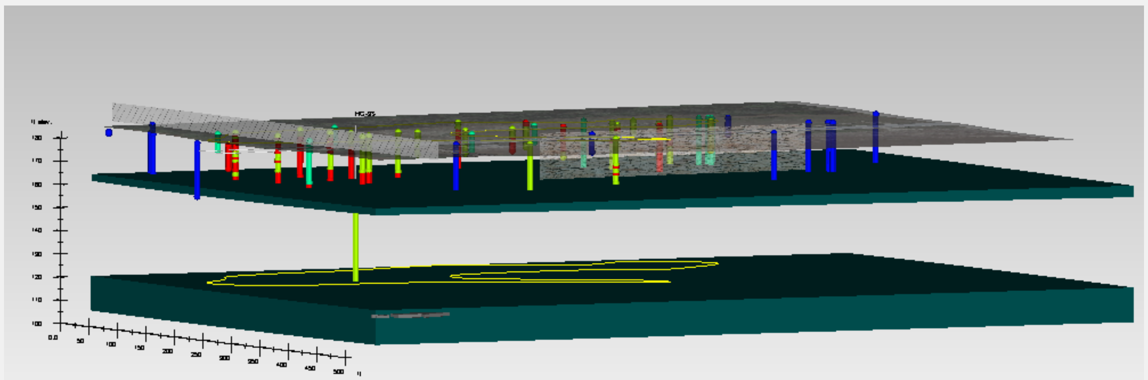
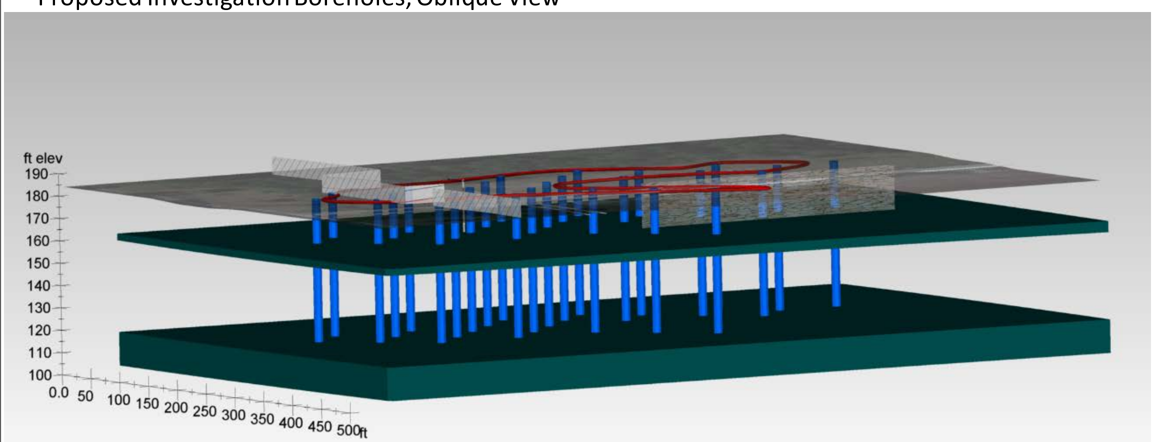


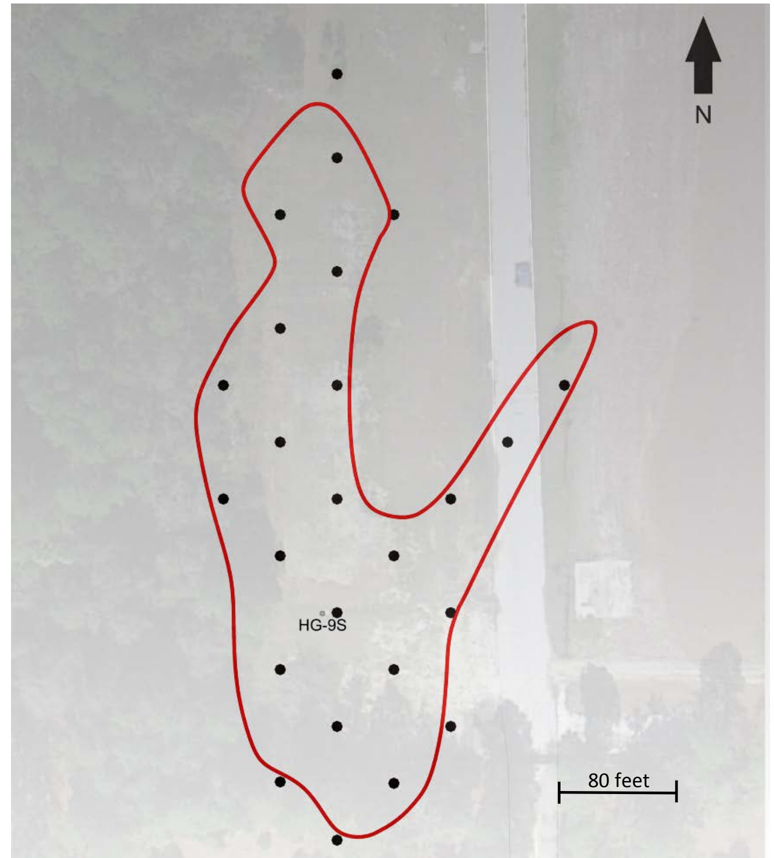
2004 DNAPL Source Areas Delineation

- Unimpacted boring outside Source Area
- Unimpacted boring inside Source Area
- Minor impact or unimpacted at boring within Source Area
- Prominent impact at boring within Source Area

Proposed Investigation Boreholes, Oblique View



Proposed Investigation Boreholes, Overhead View



● Proposed Primary Borehole

TITLE:	EVS 3D VISUALIZATION OF DNAPL INVESTIGATION BORINGS
LOCATION:	Cabot Carbon/Koppers Superfund Site Gainesville, Florida

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PROJECT#	117-2201338	
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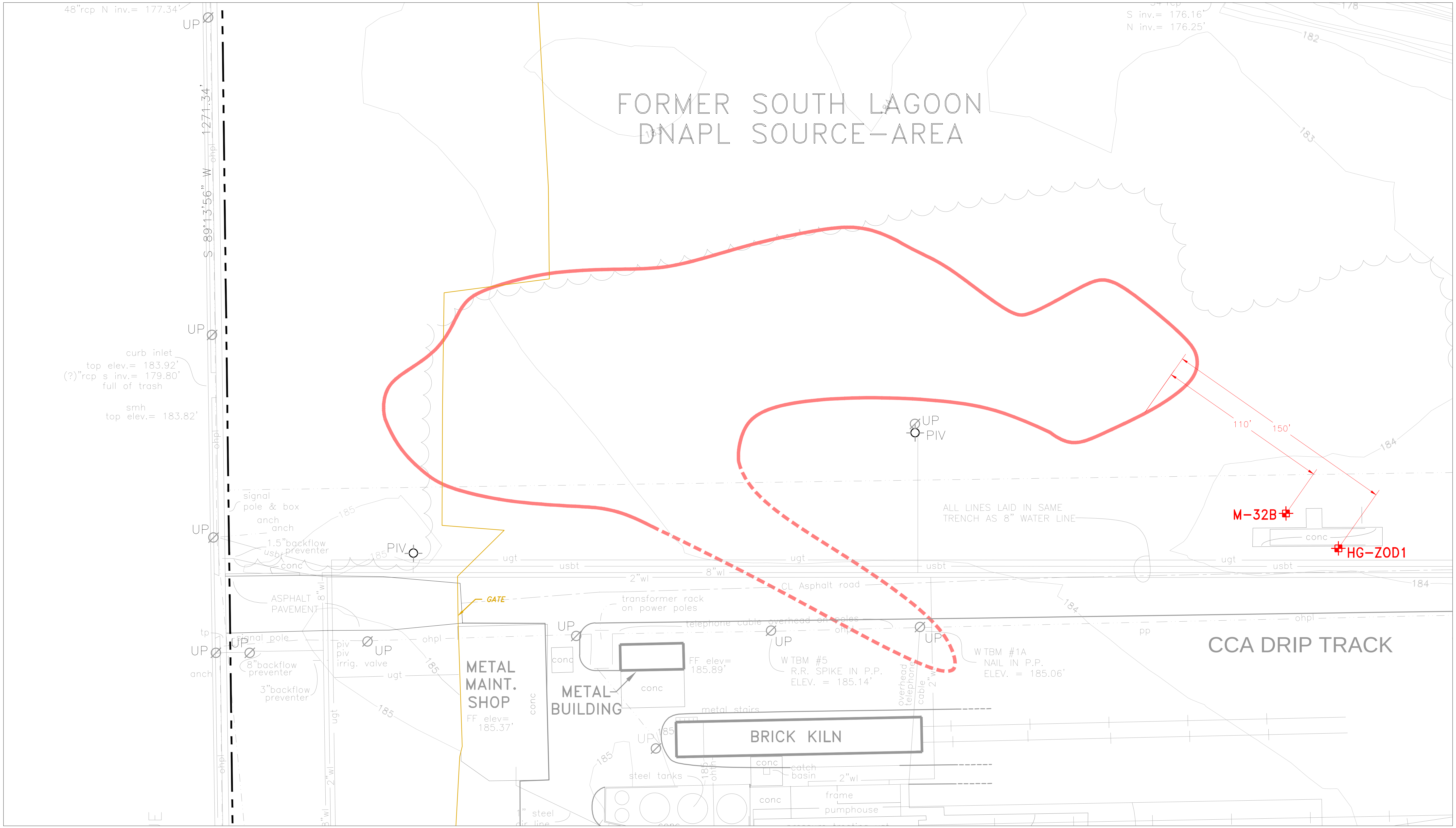

EXPLANATION

- PROPOSED ZONE OF DISCHARGE (ZOD) WELL
- LATERAL EXTENT OF DNAPL SOURCE-AREAS WITHIN THE SURFICIAL AQUIFER PROJECTED VERTICALLY TO THE SURFACE
- KOPPERS PROPERTY BOUNDARY
- ACCESS-RESTRICTING FENCELINE

N

0 60 120

SCALE IN FEET

TITLE:
PRELIMINARY LOCATION OF ZONE OF DISCHARGE (ZOD) MONITORING WELLS

LOCATION:
Cabot Carbon/Koppers Superfund Site
Gainesville, Florida

TETRA TECH

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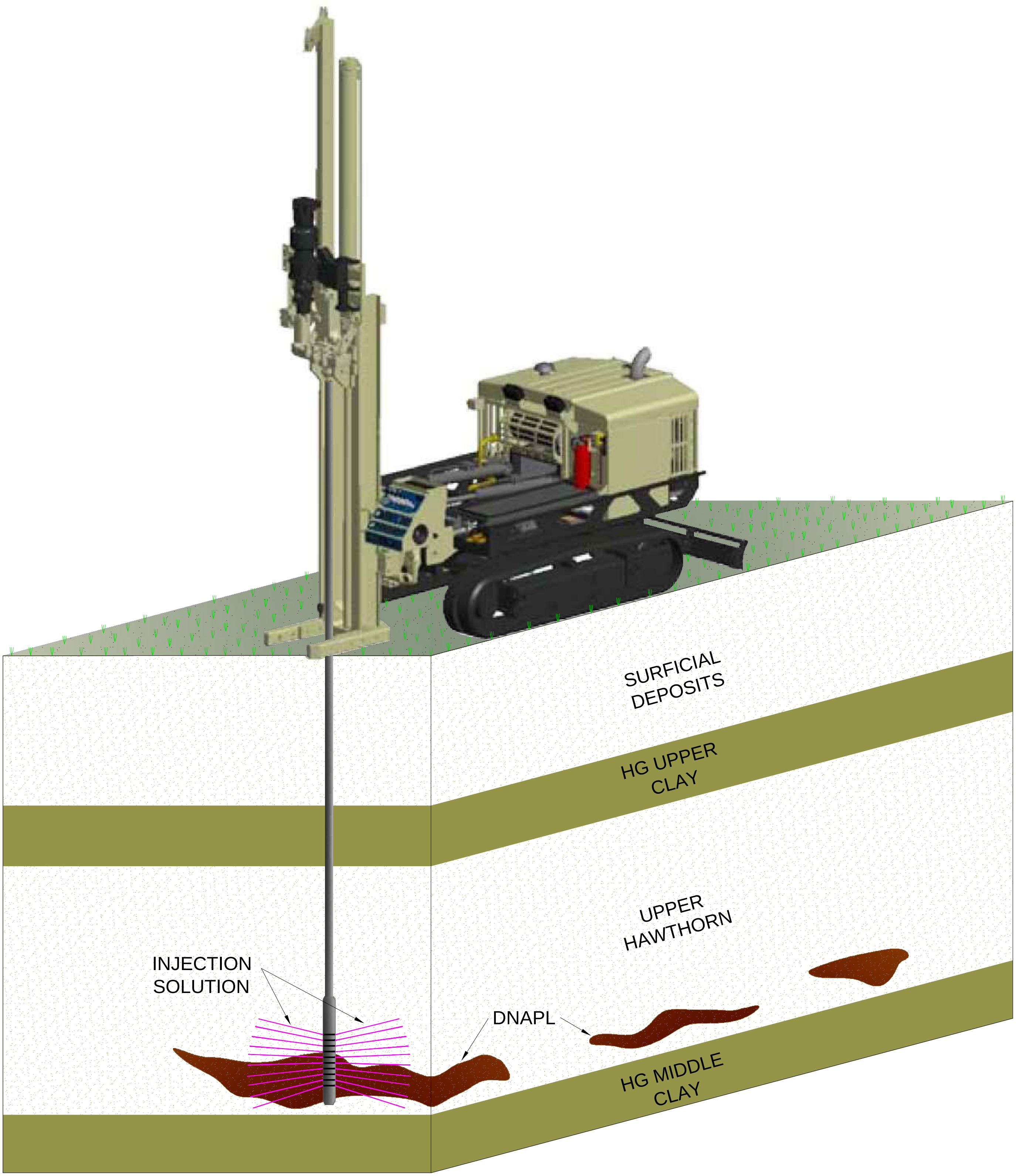
FILE	117-2201338	
DATE	09/10/2014	



TITLE: SCHEMATIC INJECTION POINT DESIGN WITH CONCEPTUAL HORIZONTAL INJECTION PATTERN

LOCATION: Cabot Carbon/Koppers Superfund Site
Gainesville, Florida

TETRA TECH

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EXPLANATION

⊗ ISGS INJECTION POINT

LATERAL EXTENT OF DNAPL SOURCE-AREAS WITHIN THE SURFICIAL AQUIFER PROJECTED VERTICALLY TO THE SURFACE

PRELIMINARY GRID FOR DNAPL CHARACTERIZATION BORINGS

KOPPERS PROPERTY BOUNDARY

0 60 120
SCALE IN FEET

TITLE: PRELIMINARY ISGS INJECTION POINT LOCATIONS

LOCATION: Cabot Carbon/Koppers Superfund Site
Gainesville, Florida

TETRA TECH

CHECKED	JE	FIGURE:
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FILE	117-2201338	
DATE	09/10/2014	

Figure 10. Schedule ISGS project for the Upper Hawthorn in the Former South Lagoon.

ID	Task Name	Start	Finish	Duration
1	**South Lagoon ISGS Implementation**	**Wed 4/29/15**	**Wed 2/15/17**	**471 days?**
2	Workplan Submitted for EPA Review	Wed 4/29/15	Wed 4/29/15	0 days
3	Revised Workplan Submitted	Fri 3/18/16	Fri 3/18/16	0 days
4	Revised Workplan Review/Approved	Fri 3/18/16	Thu 4/28/16	30 days
5	**Phase I -- South Lagoon Characterization**	**Fri 5/6/16**	**Wed 12/21/16**	**164 days**
6	Permit Preparation	Fri 5/6/16	Wed 5/25/16	14 days
7	Identify Subsurface Obstructions	Fri 5/20/16	Fri 5/20/16	1 day
8	Stake and Clear Grid Locations	Mon 5/23/16	Wed 5/25/16	3 days
9	**Core Collection Program**	**Thu 6/2/16**	**Wed 8/10/16**	**50 days**
10	Core Samples/Install Temporary Injection Points	Thu 6/2/16	Mon 7/4/16	23 days
11	EVS Model Development	Thu 6/16/16	Wed 7/27/16	30 days
12	EPA/Stakeholder Meeting	Wed 8/10/16	Wed 8/10/16	0 days
13	**DNAPL Recovery and ZOD Well Installation**	**Thu 8/18/16**	**Wed 12/21/16**	**90 days**
14	DNAPL Recovery & ZOD Well Installation	Thu 8/18/16	Wed 8/24/16	5 days
15	Pre-ISGS DNAPL Recovery	Thu 8/25/16	Wed 12/21/16	85 days
16	**Documentation and WP Adendum**	**Thu 8/25/16**	**Tue 11/1/16**	**49 days?**
17	Characterization Report	Thu 8/25/16	Wed 9/21/16	20 days
18	ISGS Workplan Addendum	Thu 9/15/16	Tue 10/4/16	14 days?
19	Approval ISGS WP	Tue 11/1/16	Tue 11/1/16	0 days
20	**Phase II -- ISGS Reagent Injection**	**Wed 10/12/16**	**Wed 2/15/17**	**91 days**
21	Contract and Planning	Wed 10/12/16	Tue 11/15/16	25 days
22	ISGS Injections	Mon 12/12/16	Wed 2/15/17	48 days

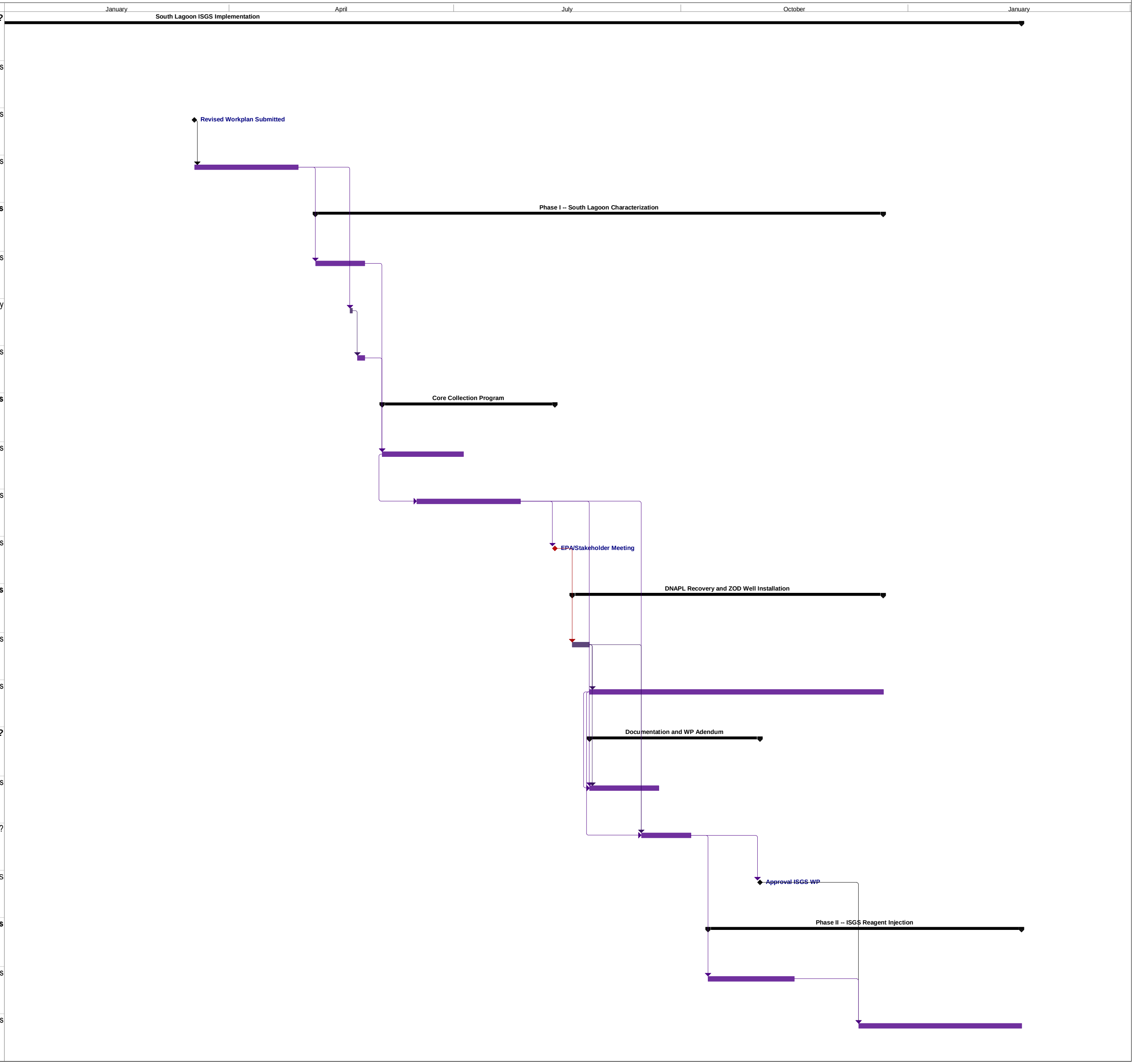
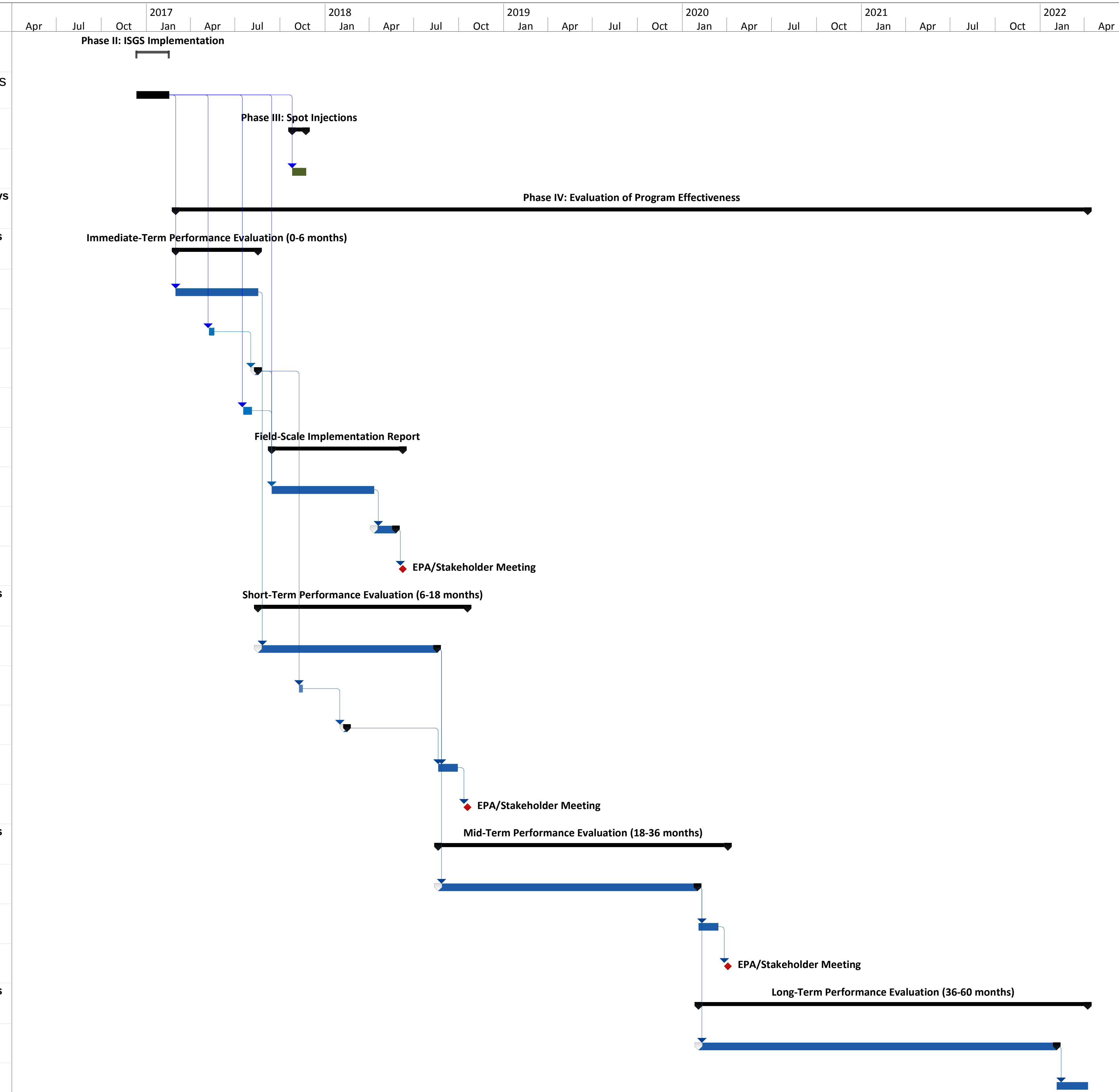


Figure 11. Schedule Phase IV: Performance monitoring for ISGS project in Former South Lagoon.

ID	Task Name	Start	Finish	Duration
1	**Phase II: ISGS Implementation**	**Mon 12/12/16**	**Wed 2/15/17**	**48 days**
2	Full-Scale ISGS Injection	Mon 12/12/16	Wed 2/15/17	48 days
3	**Phase III: Spot Injections**	**Thu 10/26/17**	**Wed 11/22/17**	**20 days**
4	Perform Spot Injections	Thu 10/26/17	Wed 11/22/17	20 days
5	**Phase IV: Evaluation of Program Effectiveness**	**Thu 3/2/17**	**Thu 4/7/22**	**1331 days**
6	**Immediate-Term Performance Evaluation (0-6 months)**	**Thu 3/2/17**	**Wed 8/16/17**	**120 days**
7	DNAPL Recovery (semi-monthly)	Thu 3/2/17	Wed 8/16/17	120 days
8	Groundwater Monitoring UIC, 1st quarterly sampling	Thu 5/11/17	Wed 5/17/17	5 days
9	Groundwater Monitoring UIC, 2nd quarterly sampling	Thu 8/10/17	Wed 8/16/17	5 days
10	Collect Geologic Cores Treated Area	Thu 7/20/17	Wed 8/2/17	10 days
11	Field-Scale Implementation Report	Thu 9/14/17	Fri 6/8/18	192 days
12	Draft Report	Thu 9/14/17	Tue 4/10/18	149 days
13	Final Report	Wed 4/11/18	Fri 5/25/18	33 days
14	EPA/Stakeholder Meeting	Fri 6/8/18	Fri 6/8/18	0 days
15	**Short-Term Performance Evaluation (6-18 months)**	**Thu 8/17/17**	**Thu 10/18/18**	**306 days**
16	DNAPL Recovery (semi-monthly)	Thu 8/17/17	Fri 8/17/18	262 days
17	UIC Groundwater Monitoring, 3rd quarterly sampling	Thu 11/9/17	Wed 11/15/17	5 days
18	UIC Groundwater Monitoring, 4th quarterly sampling	Thu 2/8/18	Wed 2/14/18	5 days
19	Performance Letter Report	Mon 8/20/18	Fri 9/28/18	30 days
20	EPA/Stakeholder Meeting	Thu 10/18/18	Thu 10/18/18	0 days
21	**Mid-Term Performance Evaluation (18-36 months)**	**Mon 8/20/18**	**Thu 4/2/20**	**424 days**
22	DNAPL Recovery (semi-monthly)	Mon 8/20/18	Fri 1/31/20	380 days
23	Performance Letter Report	Mon 2/3/20	Fri 3/13/20	30 days
24	EPA/Stakeholder Meeting	Thu 4/2/20	Thu 4/2/20	0 days
25	**Long-Term Performance Evaluation (36-60 months)**	**Mon 2/3/20**	**Thu 4/7/22**	**569 days**
26	DNAPL Recovery (Monthly)	Mon 2/3/20	Thu 2/3/22	524 days
27	Final Performance Report	Fri 2/4/22	Thu 4/7/22	45 days



TABLES

Table 1. ISGS project performance milestones and goals.

Milestone	Performance Goal	Demonstration Method	Positive Indicators	Negative Indicators	Notes/Comments
Source Area Characterization	**Baseline** - Determine aquifer baseline pre-treatment conditions in Surficial and Upper Hawthorn units.	1) SA & UHG cores; 2) DNAPL recovery monitoring.	NA	NA	Baseline data to which post-treatment data will be compared. Requires UHG cores, and installation of DNAPL recovery wells in UHG. See notes[1, 2, 3, 4].
	DNAPL Distribution - Determine DNAPL distribution and architecture vertically and horizontally in Surficial and Upper Hawthorn.	Same	NA	NA	Same
	UIC Sampling (Baseline)	UHG dissolved-phase UIC analytical data.	NA	NA	Baseline data to which post-treatment data will be compared.
ISGS Injection	**ISGS Delivery** - Consistent, controlled delivery and distribution of ISGS injectate throughout designated treatment area.	1) Field observations demonstrating control; 2) Cores show ISGS injectate contacted the majority of DNAPL zones with good sweep and no significant by-passing of DNAPL zones. 3) Conservative tracer added to ISGS injectate; 4) UIC GW monitoring (see Notes[1,2,3]).	1) No liquefaction, maintain control of injection pressures; 2) Injectate contacts majority of DNAPL zones identified in cores. Cores show precipitate encrustation in the DNAPL zones; 3) Conservative tracer and purple ISGS show good sweep; 4) Compliance with UIC ZOD laterally and vertically.	1) Liquefaction of soil; loss of injection pressure control or insufficient injection rate; 2) Injectate failed to contact majority of DNAPL zones identified in cores and/or limited encrustation of DNAPL; 3) UIC exceedances.	Use post-treatment cores to assess distribution and treatment success. Without adequate DNAPL/ injectate contact the remedial alternative may not succeed.
Immediate-Term Performance Monitoring: *(6 months post-injection)*	**ISGS Delivery** - Consistent, controlled delivery and distribution of ISGS injectate throughout designated treatment area; i.e. good "sweep" of ISGS injectate.	1) Field observations demonstrating control; 2) Cores: Minimum of 15 cores through entire treated interval 6 months after injection; 3) Conservative tracer added to ISGS injectate; 4) GW monitoring.	1) Cores show precipitate encrustations where DNAPL is present; 2) Contact of MnO2 injectate with majority of DNAPL in Immediate Post-Treatment cores; 3) Compliance with UIC ZOD laterally and vertically.	Insufficient contact between injectate and DNAPL in Immediate Post-Treatment cores.	This evaluation will be largely based on how well the injectate was delivered to the DNAPL. Installation of appropriate cores is required to assess distribution and treatment success (see notes[1,2]).
	DNAPL Recovery (Semi-monthly) - Decline in rate of DNAPL recovery; encapsulation of DNAPL to minimize DNAPL mobility.	Continue DNAPL recovery/ monitoring in UHG wells & compare with pre-test data.	Decline in rate of DNAPL flow to wells.	Increase in flow of DNAPL to wells or little change in DNAPL flow rate.	Early decline in rate of DNAPL flow to wells is expected.

Table 1. ISGS demonstration project performance milestones and goals. (Continued)

Short-Term Performance Monitoring *(6-18 months post-injection)*	**DNAPL Recovery (Semi-monthly)** - Significant Decline in rate of DNAPL recovery; encapsulation of DNAPL to minimize DNAPL mobility.	Continue DNAPL recovery/ monitoring in UHG wells & compare with pre-test data.	Little to no DNAPL flow to wells.	1) No material reduction in DNAPL recovery; 2) Appearance of recoverable volumes of DNAPL in previously unaffected MWs.	Significant decline in DNAPL flow is expected[5].
	Compliance with UIC	Pre-test and post treatment groundwater monitoring.	1) No unpermitted migration of ISGS components beyond ZOD laterally or vertically; 2) No ISGS solution observed beyond ZOD, laterally or vertically.		Contingency plans are implemented to address uncontrolled ISGS or contaminant plume migration.
Mid-Term Performance Monitoring *(18-36 Months Post-Injection)*	**DNAPL Recovery (Monthly)** - Continued limited to no DNAPL recovery in MW.	Continue monthly DNAPL recovery/ monitoring in UHG wells & compare with pre-test data.	Maintain decline in rate of DNAPL flow to wells.	1) Rebound in DNAPL recovery rates; 2) Appearance of recoverable volumes of DNAPL in previously unaffected MWs.	
	Compliance with UIC	Post treatment groundwater monitoring.	1) No unpermitted migration of ISGS components beyond ZOD laterally or vertically; 2) No ISGS solution observed beyond ZOD, laterally or vertically.		Contingency plans are implemented to address uncontrolled ISGS or contaminant plume migration.
Long-Term Performance Monitoring *(36-60 Months Post-Injection)*	**DNAPL Recovery (Monthly)** - Cessation of lateral/vertical DNAPL migration is maintained.	Continue monthly DNAPL recovery/ monitoring in UHG wells & compare with pre-test data.	Little to no DNAPL flow to wells.	1) Rebound in DNAPL recovery rates; 2) Appearance of DNAPL in previously unaffected MWs.	

[1] Adequate characterization of DNAPL in surficial & UHG including installation of new UIC monitoring wells in South Lagoon Area will be conducted prior to reagent injection.

[2] Purpose of the MWs is to evaluate effectiveness of ISGS and demonstrate compliance with UIC. Monitoring wells will be installed downgradient of source areas.

[3] Groundwater Monitoring - Parameters monitored to evaluate ISGS performance include the following: field parameters (dissolved oxygen, oxidation reduction potential [ORP], pH, specific conductance, temperature, turbidity), total and dissolved metals (Fe and Mn in particular), nitrate/nitrite, sulfate, sulfide, TOC, carbon dioxide, and alkalinity. It is particularly important to establish the natural background concentration of manganese in all aquifer zones prior to initiating RemOx EC injections. The full list of organic COCs and arsenic should also be analyzed.

[4] Installation of additional Lower Hawthorn (LH) wells is not part of the ISGS demonstration project. The need for new LH wells will be reevaluate after the Phase 1 characterization is completed.

[5] The need to install additional DNAPL recovery wells will be evaluated after 12 to 18 months of performance monitoring.

APPENDIX A

DNAPL RECOVERY WELL INSTALLATION PROCEDURES

APPENDIX A

DNAPL RECOVERY WELL INSTALLATION PROCEDUES

FORMER KOPPERS INC. SITE GAINESVILLE, FLORIDA

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

This document provides procedures for the installation of Surficial Aquifer and Upper Hawthorn Dense Non-aqueous Phase Liquid (DNAPL) recovery wells for the former Koppers Inc. portion of the Cabot Carbon/Koppers Superfund Site in Gainesville, Florida (the Site).

The objective of the DNAPL recovery wells is to: 1) Provide pre- and post-ISGS injection product recovery rate information to be used as a basis for evaluation of system effectiveness; and 2) Facilitate recovery DNAPL to reduce contaminant mass in the former South Lagoon.

2.0 RECOVERY WELL CONTRUCTION

Because the DNAPL recovery wells will be completed at locations that contain free-phase DNAPLs, they will be constructed using stainless-steel casing and screen. The recovery wells will use 4-inch diameter casing and will have 20-slot screen openings to maximize DNAPL recovery and to minimize the production of fine-grained sediments, as shown in Figure A-1 and Figure A-2. The screened intervals for the wells will be installed across DNAPL-impacted lithologic deposits most likely to contain free-phase DNAPLs. For the Upper Hawthorn recovery wells, a permanent isolation casing will not be installed into the HG upper clay unit to isolate the Surficial Aquifer impacts from the Upper Hawthorn, since drag down during well installation is not a concern. Rather, a temporary isolation casing will be installed into the Hawthorn Group (HG) upper clay unit and removed during the final installation of the recovery wells.

2.1 DRILLING AND WELL COMPLETION

Prior to drilling, the proposed well sites will be staked and the necessary permits will be obtained from the Saint Johns River Water Management District (SJRWMD). Sunshine State One Call (SSOC) will be contacted (as required by law) for utility clearance of the site. Because historic subsurface structures are known to exist in the former South Lagoon (these subsurface structures will not be located by the SSOC service), the well locations will be cleared as described in the workplan, to which this document is appended. Additionally, the borings will be advanced by hand auger or vacuum drilling to a depth of 4 feet.

Continuous 4-inch diameter soil core will be collected from rotasonic borings and logged by the oversight geologist/engineer to characterize lithology and observable DNAPL impacts in the Surficial Aquifer and in the HG Deposits. Core will be described, photographed, scanned with a photo ionization detector (PID) and carefully evaluated for the presence of DNAPLs. The core samples will be disaggregated to facilitate the identification of residual DNAPLs, if present. In addition, potable water will be sprayed on the disaggregated core to facilitate the identification and logging of residual DNAPL that may be present. DNAPL will occur in the disaggregated cores as small “blebs” or droplets on the surface of the wet core. These observations will be recorded in the lithologic log. Core samples will be preserved in labeled, wooden core boxes for potential subsequent analysis. The well completion depth and screened intervals will be based on the depths to these geologic contacts and on the presence and apparent mobility of DNAPL in the core samples. The core also will be used to identify and describe major lithologic unit tops and bottoms.

For the Upper Hawthorn DNAPL recovery wells, temporary 10-inch isolation casing will be advanced approximately 2 feet into the HG upper clay unit, prior to drilling into the Upper Hawthorn. The temporary isolation casing will be sealed with approximately 1 foot of bentonite at the base of the casing. The boring will be reamed to 8 inches inside of the 10-inch temporary casing to accommodate permanent 4-inch wells.

The recovery wells will be completed in accordance with the State of Florida requirements and will be constructed with 4-inch 304 stainless steel well casing to be constructed inside of the rotasonic override casing (Figure A-1). The well screen depth will be determined based on conditions observed during coring, but are anticipated to be 10- to 20-feet in length. Grain-size analysis of the upper HG deposits indicate the use of 20/30 mesh silica sand filter pack with 0.020-inch opening (20-slot) screen. The filter pack material (sand) will be poured into the borehole through the override casing and will extend to approximately 2 feet above the top of the well screen. A 2-foot thick bentonite seal will be placed above the filter pack. The bentonite will be allowed to hydrate for approximately 2 hours prior to grouting the remainder of the borehole to land surface. All grout will be tremied into the borehole. If subsurface conditions indicate that it is necessary to separate the well screens with blank casing to improve placement of the screens adjacent to DNAPL-bearing strata, the filter pack will be continuous and only one bentonite seal will be place in the well.

2.2 CASING GROUT

The grout slurry to be used in extraction well construction will be in accordance with SJRWMD requirements and with ASTM D-5092. The mixture will consist of ASTM Type I Portland cement, powdered bentonite, and potable city water. The cement will first be mixed into a smooth slurry using 6 to 7 gallons of fresh water for each 94-pound bag of cement; 5 pounds of powdered bentonite will be added to the cement mixture to minimize cement shrinkage during the curing process. The annular space outside of the well casings will be filled from the bottom up via a tremmie pipe or equivalent, positive displacement method. Where required, casing centralizers will be installed at appropriate distances on the outside of all casings to help minimize grout channeling and to help ensure a complete grout seal. The grout will be allowed to cure a minimum of 12 hours prior to additional work being performed inside of the casing.

2.3 EQUIPMENT DECONTAMINATION

All drilling equipment, rods, bits, tools, and rotasonic casing that enter the borehole during the drilling will be decontaminated by thorough pressure washing prior to advancing the borehole. Because of the presence of product at the well locations, all downhole equipment will be thoroughly inspected before use and after each decontamination process for visual indications of residual product. If necessary, additional decontamination will be performed using steam and/or trisodium phosphate detergent (such as Alconox) to ensure that all product has been removed.

2.4 WELL SURFACE COMPLETION AND DEVELOPMENT

Each 4-inch diameter well casing will be completed within a locking, steel, stickup protective casing. Each protective casing will be painted safety yellow with the well ID stenciled with black paint with locks to be keyed alike and match existing Site locks. The protective casings will be encased in a 3-foot by 3-foot by 6-inch thick concrete pad. Each pad will be completed 3 inches above existing grade with the apron tapered 2 inches lower such that precipitation runoff will flow away from the well. Bollard poles will be located around all casings with stickup for surface protection, as needed. All locks for the wells will be keyed alike and match existing Site locks.

The wells will be developed no sooner than 24 hours after installation to remove fine-grained material from the sand packs of each well. Wells will be developed by bailing and/or by pumping, as determined by the field geologist, in consultation with the drilling firm. Well development shall consist of over-pumping or bailing the well until the discharge water appears to be visibly clear and free of sediment. Care will be taken to minimize excessive development to help ensure that DNAPL impacted zones are not adversely impacted. With the potential risk of damage to field instruments from DNAPL immersion, field parameters will not be measured, rather, purge water will be monitored for visual clarity and the lack of visible sediments. Wells will be developed up to a maximum of 4 hours or until the purge water is visibly free of sediments, as documented by the field geologist. An attempt will be made to contain all DNAPL removed during the development phase to document recovered DNAPL volumes.

After installation, the ground surface and the top of each inner well casing will be surveyed to within 0.01-foot vertical accuracy. As-built well diagrams will be constructed for each of the wells.

2.5 INVESTIGATIVE DERIVED WASTE

All wastewater and soil generated during the activities described in this workplan, including wastewater generated from drilling, DNAPL logging, and development will be containerized in drums or bulk tanks. The aqueous fractions from drums or bulk tank(s) will be mixed with influent water to the on-Site system, prior to discharging to the permitted POTW. Soils and rock cuttings will be staged in sealed drums for characterization and off-Site disposal.

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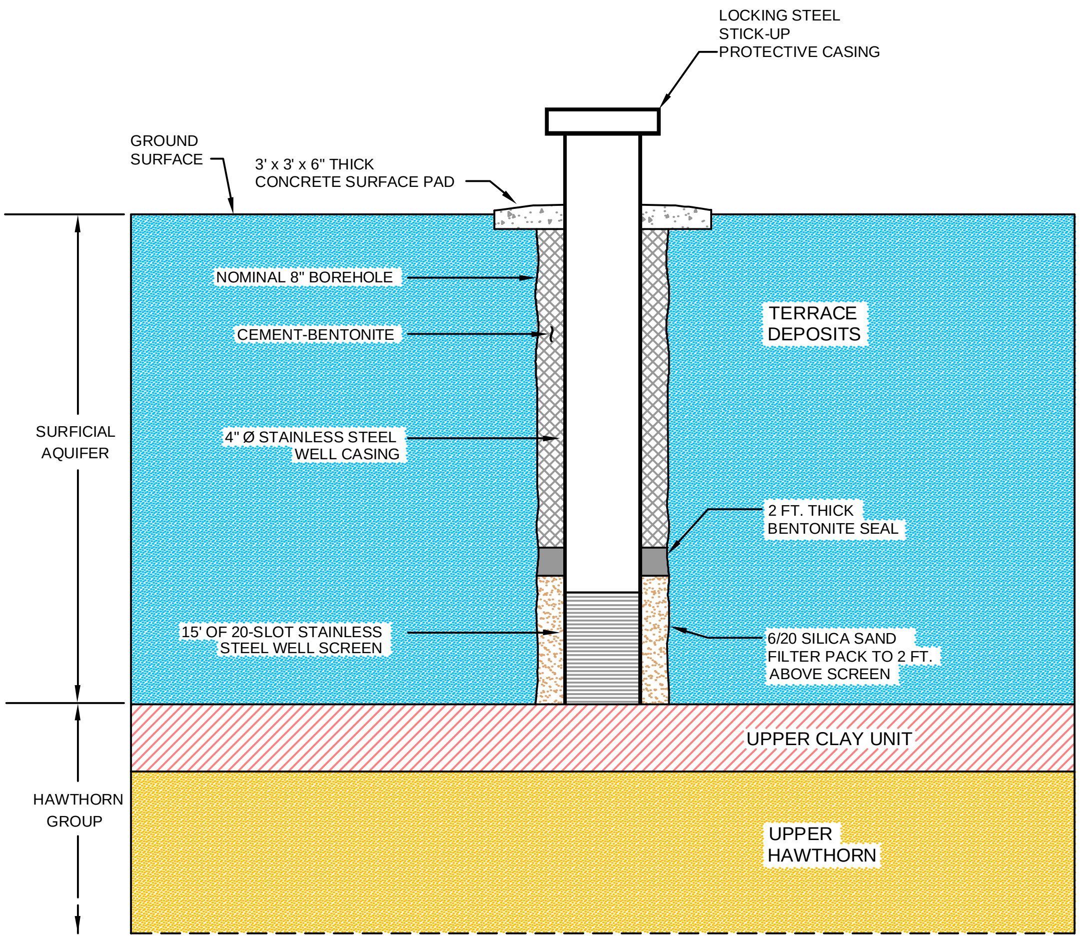

NOT TO SCALE

TITLE:
CONCEPTUAL DESIGN FOR THE FORMER SOUTH LAGOON SURFICIAL AQUIFER DNAPL RECOVERY WELLS

LOCATION:
Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

TETRA TECH

CHECKED	JE	FIGURE:
DRAFTED	CP, DB, HF, ES	A-1
PROJ. #	117-2201303	
DATE	11/13/13	

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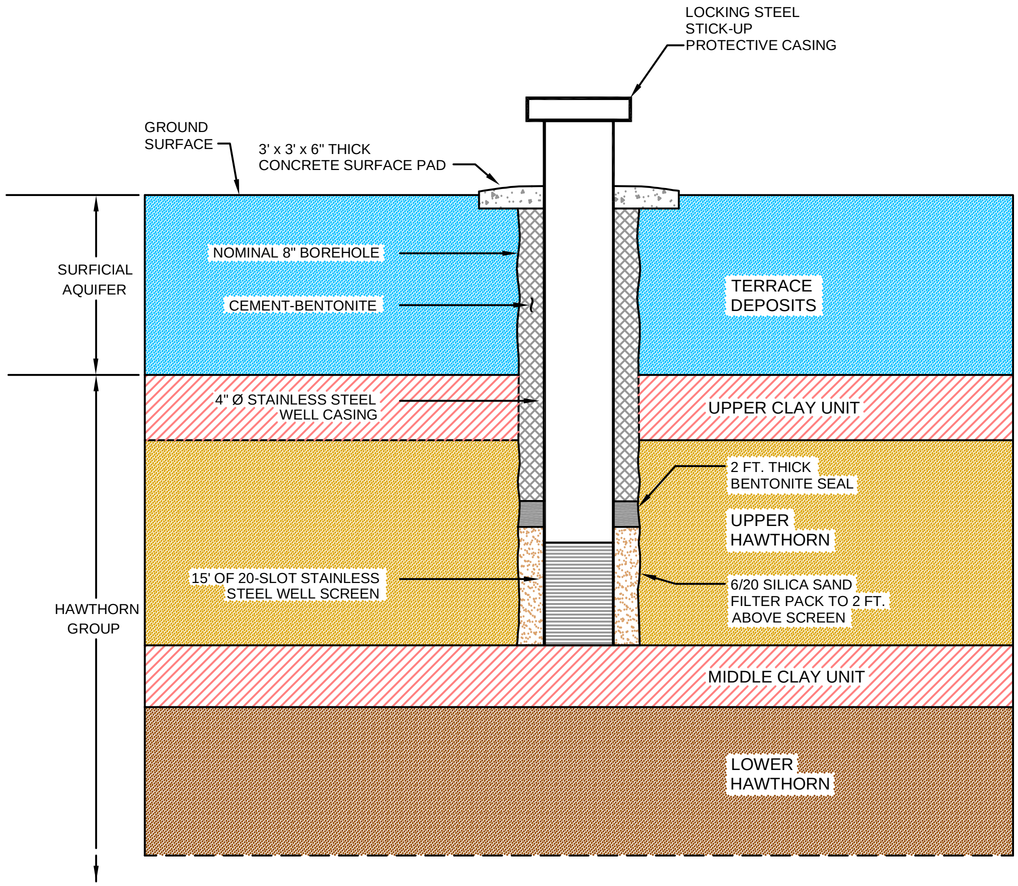

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TITLE:

CONCEPTUAL DESIGN FOR THE FORMER SOUTH LAGOON UPPER HAWTHORN DNAPL RECOVERY WELLS

LOCATION:

Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

TETRA TECH

CHECKED	JE	FIGURE:
DRAFTED	CP, DB, HF, ES	A-2
PROJ. #	117-2201303	
DATE	11/11/13	

APPENDIX B

UPPER HAWTHORN MONITORING WELL INSTALLATION PROCEDURES

APPENDIX B

UPPER HAWTHORN MONITORING WELL INSTALLATION PROCEDURES

FORMER KOPPERS INC. SITE GAINESVILLE, FLORIDA

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LIST OF FIGURES

1.0 INTRODUCTION

This document provides procedures for the installation of Upper Hawthorn monitoring wells for the former Koppers Inc. portion of the Cabot Carbon/Koppers Superfund Site in Gainesville, Florida (the Site).

The objective of the Upper Hawthorn monitoring wells is to provide post-ISGS injection water quality information to monitor the effects of the ISGS reagent on water quality.

2.0 WELL CONTRUCTION

The Upper Hawthorn well will be completed as 2-inch diameter schedule 40 polyvinyl chloride (PVC) monitoring wells. PVC well casing and screens will be utilized for the construction of the monitoring wells, since the wells are located outside of residual creosote DNAPL impacts; as such, degradation of PVC materials would not be anticipated. The screen interval for the well will be approximately 10-feet in length and will have a 10-slot screen opening.

2.1 DRILLING AND WELL COMPLETION

Prior to drilling, the proposed well sites will be staked and the necessary permits will be obtained from the Saint Johns River Water Management District (SJRWMD). Sunshine State One Call (SSOC) will be contacted (as required by law) for utility clearance of the site. Because historic subsurface structures are known to exist in the former South Lagoon (these subsurface structures will not be located by the SSOC service), the well locations will be cleared as described in the workplan, to which this document is appended. Additionally, the borings will be advanced by hand auger or vacuum drilling to a depth of four feet.

Continuous 4-inch diameter soil/rock core will be collected from all rotasonic borings and logged by the oversight geologist/engineer to characterize lithology. Core will be described and photographed before disposing of the core with the drill cuttings. Core samples will not be saved and stored, since sufficient on-Site core currently exists for the HG deposits. The well completion depth and screened intervals will be based on ISGS injection depths, but will not exceed the depth to the top of the Middle HG clay.

Because the Upper Hawthorn monitoring wells will be installed immediately downgradient of an impacted area, they will be constructed with a single telescopic isolation casing by drilling a nominal 10-inch diameter hole from land surface to approximately 1-2 feet into the HG upper clay unit with a rotasonic override casing. A 6-inch ID mild-steel (or equivalent) isolation casing will be set in the upper clay unit and grouted to land surface. After an appropriate grout set-up period of at least 12 hours, a nominal 6-inch hole will be advanced through the center of the 6-inch ID casing into the Upper Hawthorn using a nominal 6-inch OD rotasonic override casing. A permanent 2-inch ID PVC well casing and screen will be constructed at the selected depth inside of the override casing (Figure B-1).

2.2 BOREHOLE AND CASING GROUT

The grout slurry to be used in monitoring well and telescoping casing installation will consist of ASTM Type I Portland cement, powdered bentonite, and potable city water. The cement will first be mixed into a smooth slurry using 6 to 7 (per ASTM) gallons of water for each 94-pound bag of cement; 5 pounds of powdered bentonite will be added to the cement mixture to minimize cement shrinkage during the curing process. The annular spacing outside of all telescoping casings will be filled from the bottom up via a tremmie pipe. Where required, casing centralizers will be installed at appropriate distances on the outside of all casings to help minimize grout channeling and to help ensure a complete grout seal. The grout will be allowed to cure a minimum of 12 hours prior to additional work being performed inside of the casing.

2.3 EQUIPMENT DECONTAMINATION

All drilling equipment, rods, bits, tools, and rotasonic casing that enter the borehole during the drilling and installation of each of the telescoping casings will be decontaminated by steam/pressure washing prior to advancing the borehole to the next surface/well casing completion depth. Similarly, all drilling equipment and tools will be decontaminated prior to drilling the open hole beneath the lowermost casing and prior to starting a new borehole. The same procedure will be used for the investigative borings.

2.4 WELL SURFACE COMPLETION AND DEVELOPMENT

The 2-inch diameter PVC well casing will use a stick-up protective casing. The stickup will be spray painted safety yellow with the well ID stenciled with black paint. A 3-foot by 3-foot by 6-inch thick concrete pad will be constructed around each stickup, where appropriate. Each pad will be completed 3 inches above existing grade with the apron tapered 2 inches lower such that precipitation runoff will flow away from the well. Bollard poles will be located around all casings with stickup for surface protection, as needed. All locks for the wells will be keyed alike and match existing Site locks. After installation, the ground surface and the top of each inner well casing will be surveyed to within 0.01-foot vertical accuracy. As-built well diagrams will be constructed for each of the wells.

The wells will be developed no sooner than 24 hours after installation to remove fine material from around the monitored interval of each well. Wells will be developed by bailing or by pumping, as determined by the field geologist, in consultation with the drilling firm. Well development shall consist of over-pumping of the well until the discharge water appears to be visibly clear. The purge water will be monitored for pH, temperature, specific-conductance and turbidity. Wells will be developed up to a maximum of 4 hours or until the water-quality field measurements become stable and the purge water is visibly free of sand, as documented by the field geologist. Data collection and recording will follow procedures used in previous fieldwork at the Site.

2.5 GROUNDWATER SAMPLING

Following the development of the wells, a groundwater sample will be collected from the well and analyzed for potential Site constituents and associated ISGS reagent constituents. Sample collection procedure and collection criteria will be similar to the existing monitoring program at the Site described in the Comprehensive Groundwater Monitoring and Sampling Analysis Plan (CGMSAP) for the Site.

2.6 INVESTIGATIVE DERIVED WASTE

All wastewater and soil generated during the activities described in this workplan, including wastewater generated from drilling, development, and sampling will be containerized in drums or bulk tanks. The aqueous fractions from drums or bulk tank(s) will be mixed with influent water to the on-Site treatment system, prior to discharging to the permitted POTW. Soils and rock cuttings will be staged in sealed drums for characterization and off-Site disposal.

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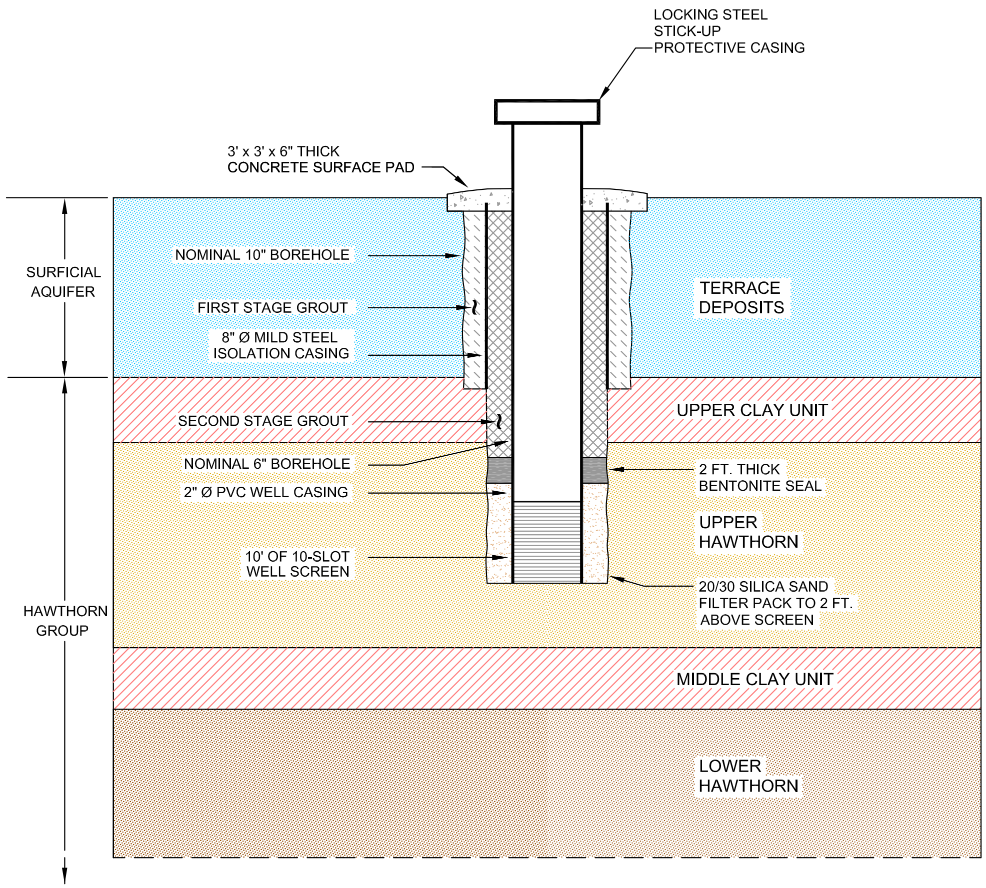

NOT TO SCALE

TITLE:

CONCEPTUAL DESIGN FOR THE FORMER SOUTH LAGOON
UPPER HAWTHORN GROUNDWATER MONITORING WELL

LOCATION:

Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

TETRA TECH

CHECKED	JE	FIGURE:
DRAFTED	CP, DB, HF, ES	B-1
PROJ. #	117-2201303	
DATE	12/5/13	

APPENDIX C

TEMPORARY INVESTIGATION POINT INSTALLATION PROCEDURES

APPENDIX C

TEMPORARY INVESTIGATION POINT INSTALLATION PROCEDURES

FORMER KOPPERS INC. SITE GAINESVILLE, FLORIDA

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1.0 INTRODUCTION

This document provides procedures for the installation of the Upper Hawthorn temporary investigation points (TIPs) for ISGS reagent injection at the former Koppers Inc. portion of the Cabot Carbon/Koppers Superfund Site in Gainesville, Florida (the Site).

The objective of the TIP installation is to provide for monitoring of DNAPL mobility. Prior to injection of the ISGS reagent, DNAPL will be recovered on a bi-weekly basis, and fluid depths and the volumes recovered will be recorded. Recovery will be continued after the reagent injection, providing information on the effectiveness of the reagent injection at reducing the mobility of the DNAPL. Upon program completion they will be abandoned by injecting ISGS reagent in the TIP screened interval, followed by grouting.

2.0 TEMPORARY INVESTIGATION POINT CONTRUCTION

2.1 DRILLING AND TIP COMPLETION

Prior to drilling, the TIP sites will be staked and the necessary permits will be obtained. Sunshine State One Call (SSOC) will be contacted (as required by law) for utility clearance of the site. Because historic subsurface structures are known to exist in the former South Lagoon (these subsurface structures will not be located by the SSOC service), TIP locations will be cleared as described in the workplan, to which this document is appended. Additionally, the borings will be advanced by hand auger or vacuum drilling to a depth of 4 feet.

Continuous approximate 3-inch diameter soil/rock core will be collected from all TIP borings and logged by the oversight geologist/engineer to characterize lithology. Core will be described and photographed before disposing of the core with the drill cuttings. Core samples will not be saved and stored, since sufficient on-Site core currently exists for the HG deposits. The well completion depth and screened intervals will be based on observations of mobile DNAPL, but will not exceed the depth to the top of the HG middle clay. Because these wells will be installed as part of a program to immobilize DNAPLs, they will not be constructed using isolation casings.

TIPs will be completed using 2-inch, schedule-40 stainless-steel casing. Screen depth will vary depending on the depths where mobile DNAPL was observed. The TIPs screen interval will consist of 10 to 15 feet of stainless-steel, wire-wrapped, 20 slot screens (Figure C-1). An end cap will be installed on the lower end of the casing. Prior to construction of the TIP, the borehole will be backfilled with bentonite chips to the base of the planned screen interval for the hole if needed. The filter pack for the TIP will consist of an appropriate sized filter pack (6/20 silica sand) and will be placed by pouring the sand inside of the drill casing. The filter pack will extend approximately 2 to 4 feet above the top of the well screen. Approximately 2 feet of bentonite will be placed above the fine sand. The remainder of the borehole will be cement-bentonite grouted to land surface either by tremie or by other positive displacement methods to ensure a good seal.

2.2 CASING GROUT

The grout slurry to be used in TIP construction will consist of ASTM Type I Portland cement, powdered bentonite, and potable city water. The cement will first be mixed into a smooth slurry using 6 to 7 (per ASTM) gallons of water for each 94-pound bag of cement; 5 pounds of powdered bentonite will be added to the cement mixture to minimize cement shrinkage during the curing process. The grout will be allowed to cure a minimum of 12 hours prior to additional work being performed inside of the casing.

2.3 EQUIPMENT DECONTAMINATION

Thorough decontamination of the downhole drilling equipment is not needed, because the investigation is designed to locate zones of mobile DNAPL. However, gross contamination such as DNAPL liquids will be removed at the direction of the site geologist/engineer before being used in another characterization boring.

2.4 TIP SURFACE COMPLETION AND DEVELOPMENT

The 2-inch diameter well casings will be completed by allowing the casing to stick up approximate 1 foot above grade. The top of the casing will be either threaded to allow for threaded cap. As-built diagrams will be constructed for each of the TIPs.

2.5 TIP ABANDONMENT

After it has been determined that the TIPs are no longer of use to the program, ISGS reagent will be placed in the well in a quantity sufficient to saturate the sand and gravel in the annular space and allowed to react with any DNAPL present there. The TIPs will be abandoned by backfilling with grout mixed to the specifications described above. The grout will be placed by pouring it down the inside of the 2-inch casing. All TIP materials, wastewater and soil generated will be disposed as Investigative Derived Waste (IDW).

2.6 INVESTIGATIVE DERIVED WASTE

All wastewater and soil generated during the activities described in this workplan, including wastewater generated from drilling, development, and sampling will be containerized in drums or bulk tanks. The aqueous fractions from drums or bulk tank(s) will be mixed with influent water to the on-Site system, prior to discharging to the permitted POTW. Soils and rock cuttings will be staged in sealed drums for characterization and off-Site disposal.

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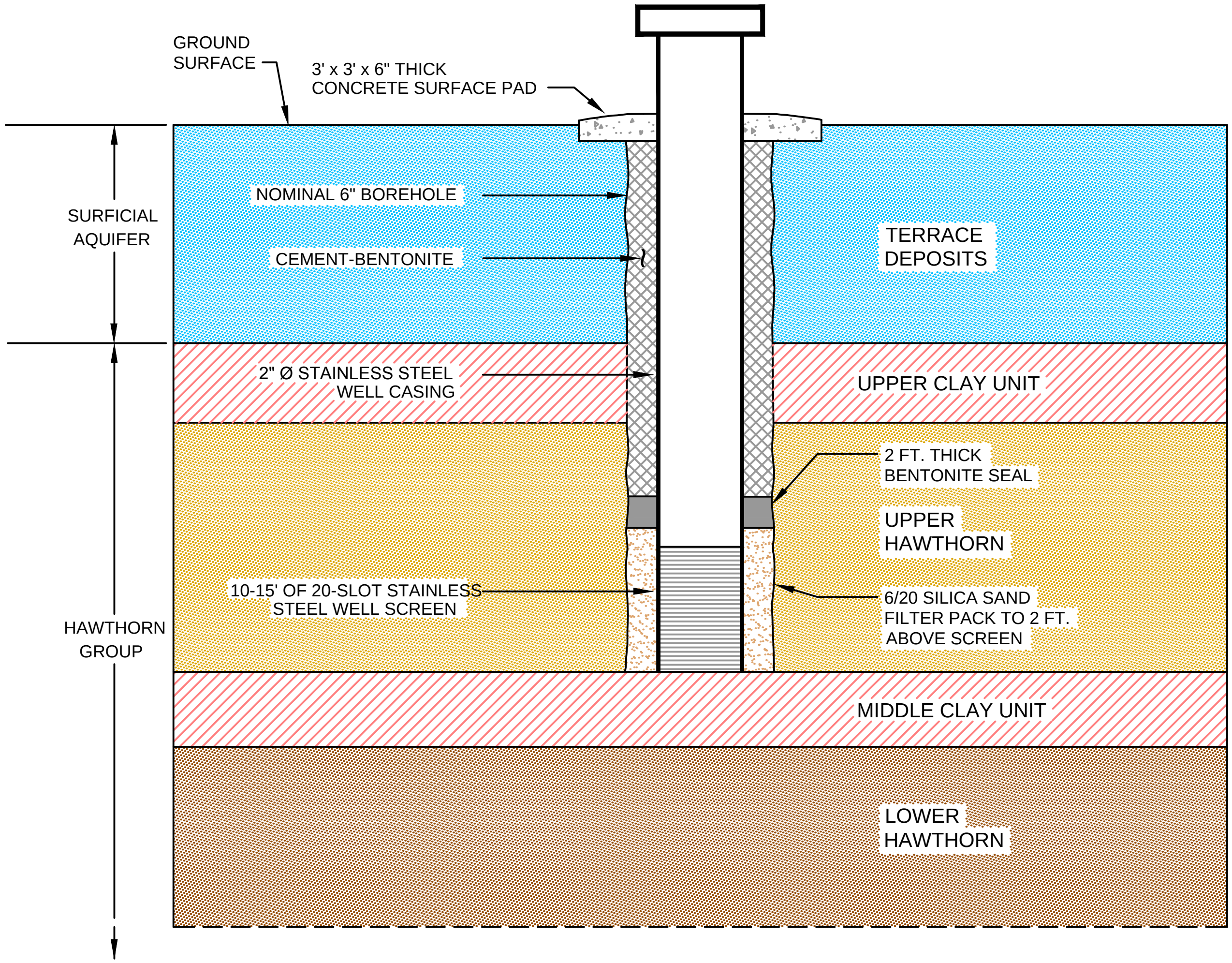

NOT TO SCALE

TITLE:

CONCEPTUAL DESIGN FOR THE FORMER SOUTH LAGOON TEMPORARY INVESTIGATION POINTS

LOCATION:

Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

TETRA TECH

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DRAFTED	CP, DB, HF, ES	C-1
PROJ. #	117-2201303	
DATE	3/22/2016	