FIVE-YEAR REVIEW REPORT
DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE
MORRIS COUNTY, DOVER, NEW JERSEY

Prepared by

U.S. Environmental Protection Agency
Region 2
New York, New York

September 2015

Approved by:

Date:

Sept. 23, 2015

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366936

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Executive Summary

This is the first five-year review for the Dover Municipal Well No. 4 Superfund site located in Dover, Morris County, New Jersey. The purpose of this five-year review is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this policy five-year review was the signature date of the Preliminary Close Out Report in September 2010.

The site is being addressed in two remedial phases or Operable Units (OUs). In September 1992, EPA issued a Record of Decision (ROD) selecting a remedy for OU1, which addressed the groundwater contamination present in the three aquifers beneath the Dover Municipal Well No. 4 site. In September 2004, EPA issued a ROD for OU2, which addressed the source investigation for the groundwater contamination found at Dover Municipal Well No. 4 site.

The assessment of this five-year review determined that the OU1 remedy is protective of human health and the environment because groundwater use is prevented by the designation of this area as a groundwater classification exception area. The OU2 remedy is protective of human health and the environment. Source excavation activities and *in-situ* chemical oxidation activities conducted to date have reduced contaminant concentrations in the source area. Additional chemical oxidant injections are anticipated to continue until the source has been sufficiently addressed to allow for natural attenuation of the groundwater plume.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Dover Municipal Well No. 4 Superfund Site		
EPA ID: NJD980654131		
Region: 2	**State:** NJ	**City/County:** Morris County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*:** Click here to enter text.
Author name (Federal or State Project Manager): Diego Garcia
Author affiliation: Remedial Project Manager
Review period: 9/30/2010 to 9/30/2015
Date of site inspection: 9/16/2015
Type of review: Policy
Review number: 1
Triggering action date: 9/30/2010
Due date *(five years after triggering action date)*: 9/30/2015

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Protectiveness Statement(s)		
Operable Unit: OU1	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The OU1 remedy is protective of human health and the environment.		

Protectiveness Statement(s)		
Operable Unit: OU2	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The OU2 remedy is protective of human health and environment.		

Sitewide Protectiveness Statement	
Protectiveness Determination: Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: Both remedies for OU1 and OU2 are considered protective of human health and the environment because the contaminated groundwater is not being used and the remedy is reducing the contaminant concentrations within the plume. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risk.	

Introduction

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment and is functioning as intended by the decision documents. The methods, findings, and conclusions of reviews are documented in the FYR report. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

This is the first FYR for the Dover Municipal Well No. 4 site (Site), located in Dover, Morris County, New Jersey. This FYR was conducted by the United States Environmental Protection Agency (EPA) Remedial Project Manager (RPM) Diego Garcia. The review was conducted in accordance with the *Comprehensive Five-Year Review Guidance*, OSWER Directive 9355.7-03B-P (June 2001). This report will become part of the Site file.

The triggering action for this policy review is the signature date of the Preliminary Close Out Report. An FYR is required at this Site due to the fact that the remedial action will not leave hazardous substances, pollutants or contaminants on Site above levels that allow for unlimited use and unrestricted exposure, but requires five or more years to complete. The Site consists of two Operable Units (OUs). OU1 addresses groundwater contamination at the Dover Municipal Well No. 4 site and OU2 addresses the sources of the groundwater contamination. Both OUs are addressed in this FYR.

Site Chronology

See Table 1 for the site chronology.

Background

Physical Characteristics

Although most of the Town of Dover is residential, the Site is located in a commercial and industrial section, approximately 1.5 miles east of three potable water production wells which serve a community of approximately 22,000 people. The Dover Water Commission owns and operates this municipal well field. The Dover Municipal Well No. 4 (DMW-4) public water supply well is located approximately 450 feet north of the Rockaway River, on Lot 15, Block 2314. The location of DMW-4 and surrounding area is shown on figure 1.

The up-valley limits of the Site are the Princeton Avenue Well Field, which is 7,000 feet west of DMW-4. The northern and southern limits extend to the edges of the unconsolidated valley-fill deposits. The limits roughly coincide with the sloping topography. The eastern limit ends at Roy Street.

The source of contamination (i.e., source area) to the DMW-4 groundwater is the property located at 272 U.S. Route 46, which is bounded by Route 46 to the north, the former Walt's Radiator Shop and a residential house to the east, Richards Avenue to the south, and Grecco Auto Body to the west (figure 2). The property is covered with coarse gravel and slopes generally from the north to the south. The property is secured by an eight-foot high chain-link fence with a locked double-swing gate. The property is accessed via Route 46 (main entrance) and also along Richards Avenue via two locked secondary sliding gates. The Rockaway River is located approximately 450 feet south of the property.

Site Geology/Hydrogeology

The Site lies within the Rockaway River Valley, which contains a complex three-aquifer, buried-valley hydrogeologic system. In the portion of the valley near the Site, two silt layers separate permeable sands into a "shallow aquifer," an "intermediate aquifer," and a "deep aquifer." The shallow aquifer ranges from 2 feet to 15 feet thick and shallow groundwater flows south toward the Rockaway River. The intermediate aquifer ranges from 6 feet to 32 feet in thickness and is separated from the deep aquifer by a discontinuous confining layer of silt. This silt layer is as much as 50 feet thick in some areas and not present in others. Groundwater in the intermediate and deep aquifers generally flows toward the east. The deep aquifer does not exist beneath the source area property. Groundwater in the area is classified as class II-A, a current source of drinking water.

Land and Resource Use

Site use for Dover Municipal Well No. 4

Currently, DMW-4 is not in use. The Town of Dover owns the property where DMW-4 is located. The Town of Dover does not have any current plans for the DMW-4 property; however, the town may consider bringing the well back to service in the future if needed.

Site use for source area property

Currently, the source area property is unoccupied and secured by a fence. The property located at 272 U.S. Route 46 is zoned as commercial, while the former residential properties located along Richards Avenue are zoned as residential. All of the properties are currently owned by the United States Government on behalf of EPA. Under the terms of a settlement agreement with EPA, the former dry cleaner property owner transferred title of the source area property to the United States Government.

The residential properties directly adjacent to the former dry cleaner property were also acquired, in order to address contaminated soil found in close proximity to the former structures on the United States Government properties.

The owner of a property adjacent to the source area property owned by the United States Government has expressed an interest in acquiring all the properties once EPA’s activities are completed. At this time, no change in land use is anticipated.

History of Contamination

Drilled in 1962, DMW-4 began pumping in June 1965, and was one of Dover’s primary water supply wells with an average pumping rate of 1,100 gallons per minute (gpm). In March 1980, the Town of Dover and the New Jersey Department of Environmental Protection (NJDEP) documented the presence of chlorinated volatile organic compounds (VOCs), specifically 1,1,1-trichloroethane, tetrachloroethene (PCE), and trichloroethene (TCE), in the groundwater collected from DMW-4. Based on this information, the Town of Dover voluntarily removed DMW-4 from service and replaced it with standby well No. 3 in September 1980.

The Site was placed on the National Priorities List (NPL) in September 1983.

In the mid to late 1980s, a remedial investigation (RI) conducted by NJDEP identified chlorinated VOCs in all three aquifers near DMW-4. PCE was detected north of DMW-4 in the intermediate and deep glacial sand and gravel aquifers. Chlorinated VOCs were also detected in the shallow, intermediate, and deep glacial sand and gravel aquifers at various locations throughout the area. The 1990 RI Report, however, did not identify the source of groundwater contamination.

Initial Response

In October 1992, NJDEP requested that EPA assume the lead for addressing the contamination at the Site. In March 1993, EPA initiated a further investigation to determine the source of the chlorinated VOCs in the shallow, intermediate, and deep aquifers. While EPA's investigation located numerous potential sources, EPA was unable to identify the specific source of the groundwater contamination.

Basis for Taking Action

Based upon the results of the OU1 RI, a baseline risk assessment was conducted to estimate the risks associated with current and future site conditions. The human health risk assessment concluded that carcinogenic risk was within the range of acceptable exposure and the Hazard Index exceeds one, only for children under a future residential land use scenario. However, cleanup is warranted because groundwater contaminants are present at concentrations exceeding New Jersey Maximum Contaminant Levels (MCLs) in each of the three aquifers. Further, elevated concentrations of PCE are present in the intermediate aquifer at the source area. These concentrations of PCE and other contaminants in the shallow and intermediate aquifers can migrate into the deeper aquifer because the confining layers between the aquifers are not impermeable.

An environmental evaluation was also conducted for OU1 at that time. It concluded that there was some indication that the potential exists for elevated inorganics in groundwater to produce adverse environmental effects in the event that no response action were taken.

After discovering the source of contamination to DMW-4, EPA conducted an OU2 RI. The OU2 risk assessment did not find unacceptable risks to human health from potential exposure to contamination in subsurface soils. The risk assessment reaffirmed the OU1 RI results that elevated concentrations of PCE and TCE in groundwater would not present an unacceptable cancer risk and non-cancer hazard to future residents and outdoor commercial/industrial workers. However, the non-cancer hazard index for the future construction/utility workers exposed dermally to PCE and TCE in groundwater could exceed EPA's threshold value of 1.

Remedial Actions

Based on the OU1 RI, EPA selected a remedy for OU1 (groundwater) in a September 1992 Record of Decision. The remedial action objectives (RAOs) for the groundwater remedy were as follows:

- Continue to prevent exposure, due to groundwater ingestion and inhalation, to contaminants at levels exceeding MCLs;

- Minimize further contamination of DMW-4 and prevent contamination of additional existing wells by minimizing the migration of contaminants; and
- Restore contaminated groundwater for future use.

The selected remedy included:

- Extraction of contaminated groundwater and restoration of the groundwater to drinking water standards;
- Treatment of extracted groundwater to levels attaining drinking water standards;
- Discharge of treated groundwater to the public water supply system to the extent practicable, with reinjection of any surplus quantity; and
- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

Between 1999 and 2003, EPA conducted a preliminary design investigation (PDI) as part of the OU1 remedial design, which also focused on identifying the source of groundwater contamination. Based on that work, EPA identified a property located at 272 U.S. Route 46 as the source of the VOCs found in DMW-4. EPA then began a study to determine the extent of the source-related contamination.

After the RI was completed for OU2, EPA signed a ROD in September 2005, for the source area soils and groundwater, and modified the OU1 sitewide groundwater restoration remedy. The 2005 ROD identified the following soil and groundwater RAOs and modified the OU1 sitewide groundwater OUs as follows:

Soil

- Reduce the potential for further migration of contaminants from the contaminated soil into groundwater.

Source Area Groundwater

- Prevent exposure by direct contact with or ingestion of shallow contaminated groundwater.

- Reduce the potential for exposure via inhalation of vapors that may migrate from shallow groundwater.

Site Groundwater

- Prevent public exposure to contaminated groundwater that presents a significant risk to human health and the environment.

- Restore the shallow, intermediate, and deep groundwater contamination to drinking water standards within a reasonable time frame.

- Reduce the potential for exposure via inhalation of vapors that may migrate from shallow groundwater.

Remedy Selection

The major components of the 2005 Remedy included:

- Demolition without replacement of the dry cleaner building to allow for the excavation of contaminated soil beneath it and off-site disposal of demolition debris;
- Excavation of an estimated 2,100 cubic yards of contaminated soil, sampling to verify the soil cleanup criteria or standards were met, and backfilling with clean fill;
- Off-site treatment and/or disposal of contaminated soil; and
- Chemical oxidation of any remaining sources of groundwater contamination.

In addition, the 2005 ROD modified, the 1992 OU1 sitewide groundwater remedy as follows:

- No extraction, treatment, or discharge of contaminated groundwater;
- Establishment of a network of groundwater monitoring wells;
- Environmental monitoring to ensure the effectiveness of the remedy and the ability of the groundwater to achieve the more stringent of the federal or New Jersey MCLs and/or New Jersey Groundwater Quality Standards; and
- Institutional controls, such as the implementation of a Classification Exception Area (CEA) to restrict the use of groundwater within the area until the aquifer is restored.

Remedy Implementation

Building Demolitions

In August 2007, EPA entered into an Agreement for Recovery of Response Costs (the "Agreement") with the former owner of the dry cleaner property which resolved EPA's claims under Section 107(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under the terms of the Agreement, the former owner paid the proceeds of an insurance claim to EPA and NJDEP, and transferred title of the source area property to EPA.

In order to facilitate implementation of the OU2 source area remediation activities, EPA acquired the former dry cleaner property. Following real estate closing on the source area property, EPA demolished the former dry cleaner building in December 2007. Soil sampling conducted as part of the soil excavation design determined that soil contamination was present in close proximity to three adjacent residential houses. Due to the poor structural condition of these houses, EPA determined that any excavations could compromise the structures. Therefore, EPA acquired the three residential properties and relocated the tenants in August 2008. Demolition of the houses took place in October 2008.

Soil Excavation Activities

A Design Report for the soil excavation portion of the work was approved by EPA in March 2009. Extensive sampling of the contaminated areas was conducted prior to completion of the Design Report. Information from the Design Report was used to pre-determine the areas to be excavated. During excavation activities, multiple soil samples were collected from various depths and several locations for delineation purposes. Based on the analytical results, the excavation was either discontinued or expanded to encompass contaminated material. No post-excavation samples were collected below the groundwater table. The depth to groundwater ranged from 8.5 feet along the southern portion to 12.5 feet along the northern portion of the Site.

The depth of excavation varied from 3.5 feet to approximately 12.5 feet below ground surface. The total volume of soil excavated and disposed of off-site was approximately 1,258 cubic yards. All physical work associated with the soil excavation was completed in spring 2009.

Chemical Oxidation Activities

A remedial design (performance work statement) for the chemical oxidation portion of the remedy was completed in June 2009. In April 2010, the contractor completed a work plan outlining the plans for implementing the chemical oxidation program. A total of 33 shallow, intermediate, and deep injection wells were installed throughout the source area property in March 2010 for the chemical oxidation portion of the work. The wells were installed to varying depths (up to 36 feet below ground surface). In addition to the injection wells, two vent wells were also installed to provide subsurface pressure relief and a means for monitoring the gases produced during the injection reactions.

Prior to the April 2010 *in-situ* chemical oxidation activities (ISCO) program, monitoring wells (designated as "PW" in the figures and tables) were installed at the former dry cleaner property in May 2009. Baseline groundwater samples prior to ISCO treatment were collected June 2009 and October 2009. Existing monitoring wells at the dry cleaner property were also included in the ISCO performance monitoring program.

In April 2010, June 2011, October 2012 and October 2014, a contractor to the U.S Army Corps of Engineers performed ISCO activities at the source area property. This technology utilized chemical oxidants (hydrogen peroxide and sodium permanganate) to break down soil and groundwater contamination into harmless byproducts, such as water and carbon dioxide. A two-phased approach was developed utilizing hydrogen peroxide to address the bulk of the contaminant mass, and a subsequent sodium permanganate injection to provide a longer-lasting oxidant breakdown of the contamination.

In-situ Chemical Oxidation Monitoring

During the four injection phases, monitoring was performed to continuously evaluate the ISCO program effectiveness in reducing contaminant source mass. The monitoring programs include the sampling and analysis of groundwater generated as a result of the oxidation reactions. The overall results of the monitoring program verified that the pre-established performance criteria were met, including the successful demonstration of oxidant distribution (measuring and/or observing oxidants in monitoring wells) and verification of oxidant loading (meeting or exceeding the remedial design required oxidant volumes).

Additional ISCO events are currently being planned and groundwater and soil gas sampling will be conducted.

Potential Site impacts to climate change have been assessed, and the performance of the remedy is currently not at risk due to the expected effects of climate change.

Progress Since Last Five-Year Review

This is the first five-year review for the Site.

Five-Year Review Process

Administrative Components

The FYR team included Diego Garcia (EPA-RPM), Rob Alvey (EPA-Hydrologist), Urszula Filipowicz (EPA-Human Health Risk Assessor), Mindy Pensak (EPA-Ecological Risk Assessor) and Pat Seppi (EPA-Community Involvement Coordinator (CIC)). This is a Fund-lead Site.

Community Involvement

On September 25, 2015, a notice was sent to the Dover Free Public Library, indicating that the EPA would be conducting an FYR to ensure that the remedy implemented at the Site remains protective of human health in the short term and is functioning as designed. Also included in the notice were the addresses of the EPA RPM and CIC, as well as telephone numbers for questions related to the FYR process or the Site. The Dover Free Public Library subsequently reported that the notice had been posted on the library bulletin board and website. The RPM did not receive any public questions regarding the FYR.

Once the FYR is completed, the results will be made available at the local site repository, which is at the Dover Free Public Library located at 32 East Clinton Street Dover, New Jersey. In addition, efforts will be made to reach out to local public officials to inform them of the results.

Document Review

The documents, data and information which were reviewed in completing this FYR are summarized in Table 3.

Data Review

Results of Source Area Chemical oxidation performance monitoring:

The results of the July 2010 effectiveness monitoring program indicated that while the Phase 1 ISCO program was successful in treating soil containing VOCs, residual dissolved-phase VOCs still existed in the shallow, intermediate, and deep aquifers at concentrations above the ROD cleanup criteria, most notably PCE and associated degradation byproducts in the vicinity of the MW-14 well cluster.

The Phase 2 ISCO was implemented in June 2011. Post-injection groundwater monitoring well sampling in September 2011 indicated a Site-wide reduction in PCE concentrations. The highest PCE concentrations remained in the vicinity of the MW-14 well cluster with concentrations in

monitoring wells MW-14D (980 micrograms per liter, or µg/L) and MW-14I (180 µg/L). Elevated PCE concentrations were also seen in MW-14D (1,600 µg/L) and MW-14I (480 µg/L) in the February 2012 sampling event. The increase in PCE concentrations in these two wells is likely due to desorption of residual contaminant mass in the soil into the groundwater.

The Phase 3 ISCO implementation was conducted in October and November 2012. According to the post-injection groundwater sampling data from February and November 2013, significant VOC concentrations remained in the intermediate aquifer (between 6 and 32 feet below ground surface), most notably *cis*-1,2-dichloroethene, PCE, TCE, and vinyl chloride. The largest remaining contaminant mass of PCE reported in the November 2013 groundwater sampling event was located in the subsurface surrounding existing monitoring wells MW-14S (140 µg/L), MW-14I (600 µg/L), and MW-14D (1,300 µg/L).

The Phase 4 ISCO injection event was conducted in November 2014 to address the elevated contaminants around the MW-14 well cluster. Post-treatment effectiveness monitoring of two wells in the treatment area (MW-14D and MW-14I) was conducted in December 2014 and March 2015. The PCE concentration at MW-14D was reduced from 207 µg/L in July 2014 to 27 µg/L in December 2014. The PCE concentration at MW-14I increased slightly from 56 µg/L in July 2014 to 90 µg/L in December 2014. Although the March 2015 data show slightly increased PCE concentrations at MW-14D and MW-14I (240 ug/L and 65 ug/L, respectively) compared to the July 2014 measurements, current PCE concentrations are two orders of magnitude below the maximum PCE concentrations measured at these wells. Sampling results from March 2015 indicate the source is continuing to be reduced, but has not yet been fully mitigated.

These decreasing trends in source area MW-14 cluster indicate that the ISCO process is working and the contaminant concentrations are reducing. Since contaminant concentrations remain elevated, EPA anticipates at least another round of ISCO injections will be performed following future groundwater monitoring.

Groundwater monitoring:

Because the remedy called for allowing the groundwater at the Site to naturally attenuate instead of being actively remediated, an environmental monitoring program was established to ensure the effectiveness of the remedy. The program assesses the aquifer's ability to achieve the more stringent of the federal or New Jersey MCLs and/or New Jersey Groundwater Quality Standards. Groundwater monitoring commenced in September 1998 through several phases of the RI and RD and continues as part of the long term groundwater monitoring program for the Site. The current Site-wide groundwater monitoring plan includes 21 wells (7 in the shallow aquifer, 9 in the intermediate aquifer, and 5 in the deep aquifer). Three of the shallow aquifer wells and two of the intermediate aquifer wells are located near the source area (i.e., on or immediately downgradient of the former dry cleaner property). The remainder of the monitoring wells are located within the plume areas and downgradient of the plume areas (i.e., sentinel wells). The groundwater monitoring program includes quarterly sampling between September 2013 and September 2015 and semiannual monitoring slated to start in March 2016. Groundwater samples from all three aquifers are analyzed for contaminants of concern (COCs) concentrations.

Groundwater samples were collected in November 2013 from the shallow aquifer wells to assess intrinsic biodegradation. Biodegradation assessment parameters included alkalinity, total organic carbon, chloride, nitrate, sulfate, and dissolved gases (methane, ethane, and ethene). Previous groundwater data have indicated that intrinsic biodegradation is not a significant natural

attenuation mechanism in the intermediate and deep aquifers. However, adsorption, advection, dispersion and diffusion are expected to reduce contamination.

Shallow Aquifer

Review of groundwater monitoring data in the shallow aquifer indicates an overall decline in levels of COCs. PCE levels in MW-15S (near the source area) have been reduced from a peak of approximately 16,000 ug/L in 2005 to current levels (69 ug/L) during the September 2014 sampling event. Similarly, MW-11S (immediately downgradient of the source area) demonstrates an overall decline in PCE subsequent to all four rounds of ISCO injections; however, a slight increase was observed over the last sampling event (September 2014) to 13 ug/L. PCE concentrations at the four wells down gradient of the source area, including the sentinel well (MW-16S) have generally been non-detect. There was a detection of PCE at MW-5S (1.5 ug/L) during the September 2014 sampling event following three prior quarterly non-detect results. The non-detect results at the sentinel well (MW-16S) and at the majority of the other down gradient wells indicate that the shallow plume remains contained. See (figures 3a, 4a).

Intermediate Aquifer

The intermediate aquifer area is larger than in the shallow aquifer. The overall trend of contaminants is declining; however current sampling events indicate some evidence of rebounding in source area wells (both MW-15I and MW-5I showed PCE rebound in the June 2014 sampling event, although concentrations at both wells declined again during the September 2014 sampling event). The highest concentrations of PCE are currently detected at MW-6I, downgradient of the source area; there is no discernible trend in PCE concentrations at MW-6I. PCE concentrations at the sentinel well for the intermediate aquifer (MW-7C) have consistently been non-detect, indicating that the plume remains contained. See (figures 3b, 4b).

Deep Aquifer

The downgradient extent of the deep aquifer continues to be in the vicinity of MW-2D (figure 4c). PCE concentrations at this well have fluctuated from non-detect to 2.6 µg/L (December 2002) over the monitoring period from September 1998 to September 2014. The most recent sample in March 2015 had a PCE concentration of 0.62 ug/L. A slight downward trend is currently noted. Approximately 500 feet upgradient from the MW-2D location, MW-19DR is located. Sampling has detected PCE in MW-19DR at 27 ug/L, 33 ug/L and 25 ug/L during quarterly monitoring rounds 17, 18 and 19 (March 2014, June 2014, and September 2014, respectively) and at 41 ug/L in March 2015. Closer to the source area, the PCE results from MW-6D indicate an overall increasing trend, but it is believed that the ISCO source reduction actions have not yet affected this deeper monitoring point. The levels of PCE at MW-2D are expected to fluctuate as the remaining deep aquifer plume concentrations migrate from MW-19DR toward MW-2D, but should have little impact due to natural diffusion and dispersion.

Based on the long-term monitoring conducted to date, the shallow, intermediate, and deep aquifer PCE plumes are stable or shrinking. The southern (downgradient) boundary of the shallow aquifer PCE plume has been shifted to the north, reducing the plume footprint (PCE has not been detected at MW-17S, since it was installed in 2013). The northeast (side-gradient) boundary of the deep aquifer plume boundary has been adjusted (i.e., the plume width has been narrowed) based on geologic information obtained at MW-19 (abandoned), which indicates that

the deep aquifer is not present in this portion of the Rockaway River Valley. The results of the long-term groundwater monitoring program indicate that the CEA boundaries established in 2013 are still appropriate. ROD cleanup criteria were not exceeded at any of the sentinel monitoring wells.

Vapor intrusion:

In 2003, EPA initiated a monitoring program to determine whether contaminated groundwater present beneath residential homes in the vicinity of the Site was a source of vapor intrusion (VI). EPA performed subslab soil gas sampling, and indoor and ambient outdoor air sampling in 12 homes located in close proximity to the Site. Six of the homes indicated a potential for exposure to PCE and TCE. Three of the six homes were demolished as part of the remedy, with the remaining three homes requiring further investigation. EPA will continue to monitor those houses and make any necessary adjustments to the monitoring program based on groundwater sampling results.

Site Inspection

The inspection of the Site was conducted on September 16, 2015. In attendance were Diego Garcia and Matt Creamer from the U.S. Army of Engineers. The purpose of the inspection was to assess the protectiveness of the remedy.

The inspection revealed that the fence around the perimeter of the Site is intact, the gates preventing access to the Site are locked and intact, the injection and monitoring wells are in good condition and maintenance activities are being performed according to schedule. No issues were found that would impact remedy performance or require discussion in this FYR.

Interviews

No interviews were conducted during the FYR. However, there has been considerable interaction with local residents and officials during remedy implementation.

Institutional Controls Verification

Due to the groundwater contamination, a CEA was established by the NJDEP for this Site to prevent the installation of any new potable wells into the contaminated aquifer. The CEA includes all three aquifers and adequately addresses the extent of the plume. The CEA, preventing groundwater use and well installation, was established by NJDEP on September 6, 2013. The CEA will remain in place until the contaminated groundwater meets the cleanup criteria.

Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

The primary objectives of the RODs are to remove the continuing sources of contamination into the groundwater, prevent potential future ingestion of Site-related contaminated groundwater, restore the quality of the groundwater and mitigate the off-site migration of the Site-related contaminated groundwater. EPA's review of Site documents and the results of the Site inspections and a review of all monitoring data indicate that the remedy is functioning as

intended.

The source has been identified and excavated. Excavation activities effectively removed source contamination in the vadose zone. Treatment zone effectiveness monitoring after the 2009 soil removal and four ISCO injection events shows a significant decrease in PCE concentrations from pre-RA levels. Calculated aqueous PCE mass in the treatment area has been reduced by approximately 88 percent from pre-injection baseline. Moreover, groundwater concentrations in the source area have decreased to levels which no longer indicate the presence of dense non-aqueous phase liquid (DNAPL) (i.e., 1 percent of PCE solubility).

Downgradient plume monitoring shows a general reduction in PCE concentration in the shallow and intermediate aquifers. PCE concentrations in the deep aquifer portion of the plume, while stable, do not appear to have been affected by the remedial actions thus far. ISCO injections are not targeted in this aquifer. Therefore, it is anticipated that concentrations will decrease over time due to the migration of chemical oxidants and the decrease of mass flux from the overlying aquifer zones. The monitoring results indicate that the downgradient monitoring network is sufficient to delineate the plume and determine that the plume is contained by natural attenuation.

Vapor intrusion data collected within the past five years show elevated concentrations of PCE are present in sub-slab samples collected from beneath some homes; however, indoor air detections of PCE continue to be below levels of concern. Although TCE has been detected in indoor air samples, the corresponding sub-slab results are generally non-detect or low. This trend of higher TCE concentrations in indoor air as compared with the sub-slab is evident in both recent and historical data. These findings imply a source or sources other than the subsurface are impacting indoor air. This is further supported by ambient air results which have shown the presence of TCE in elevated concentrations. Based on the review of all available VI data, it appears that the potential risks/hazards from exposure to Site-related chemicals remain below levels of concern. However, because elevated VOC concentrations remain in shallow groundwater, VI monitoring will continue.

The NJDEP established a CEA for the Site in 2013. The CEA covers the aerial extent of the plume in all three aquifer zones. The CEA prevents the consumption of groundwater and installation of new extraction wells.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?

There have been no physical changes to the Site that would adversely affect the protectiveness of the remedy. The exposure assumptions and the toxicity values that were used to estimate the potential risks and hazards to human health followed the general risk assessment practice at the time the risk assessment was performed. Although the risk assessment process has been updated and specific parameters and toxicity values may have changed, the risk assessment process that was used is still consistent with current practice and the need to implement a remedial action remains valid.

The human health risk assessment (HHRA) evaluated the following current and future scenarios: residents (adult and child) in the vicinity of the former dry cleaner who may contact soil in their yards, or who, in the future, may consume or utilize local groundwater; workers in the vicinity of the dry cleaner who may contact soil or may consume or utilize local groundwater; and

construction workers whose work may expose them to soil and/or shallow groundwater during work around an excavation. These exposure assumptions are still valid.

Soil cleanup criteria selected in the 2005 ROD were the more conservative of the New Jersey Residential Direct Contact Soil Criteria (NJ RDCSC) and the New Jersey Impact to Groundwater Soil Criteria. Soil COCs and their corresponding cleanup goals were as follows: *cis*-1, 2-dichloroethene, 1 mg/kg, PCE, 1 mg/kg, TCE, 1 mg/kg and vinyl chloride, 2 mg/kg. The ROD-selected cleanup goals were compared to current NJ RDCSC; vinyl chloride is the only chemical for which the current NJ RDCSC of 0.7 mg/kg is lower than the ROD-established cleanup goal (2 mg/kg). However, when the ROD-established cleanup goal for vinyl chloride was compared to EPA's risk-based residential soil Regional Screening Levels (RSLs), it fell within an acceptable risk range. Therefore, the ROD-established cleanup goals for all soil COCs at the Site remain protective of human health.

Cleanup criteria for groundwater included the more stringent of the federal or New Jersey Safe Drinking Water Act MCLs and the New Jersey Groundwater Quality Standards (NJ GWQS). Groundwater COCs and their corresponding cleanup standards were as follows: *cis*-1,2-dichloroethene, 10 µg/L, PCE, 1 µg/L, TCE, 1 µg/L, vinyl chloride, 2 µg/L, and 1,1,2-trichloeoethane, 3 µg/L. All cleanup levels are still consistent with federal and State promulgated standards with the exception of vinyl chloride. The current NJ GWQS for vinyl chloride is 1 µg/L which is lower than the ROD-selected cleanup goal of 2 µg/L and should be considered when evaluating the completion of the groundwater remedy.

Several media-specific RAOs were identified in the 2005 ROD to mitigate the potential risks associated with the Site. The following RAO was established for the contaminated soil at the former dry cleaner property: reduce the potential for further migration of contaminants from the contaminated soil into groundwater. To address the source area groundwater, the following RAOs were identified for the contaminated shallow groundwater at the dry cleaner property: 1) prevent exposure by direct contact with or ingestion of shallow contaminated groundwater, and 2) reduce the potential for exposure via inhalation of vapors that may migrate from the shallow groundwater. The following RAOs for Site groundwater address shallow, intermediate, and deep groundwater plumes that have migrated from the source area: 1) prevent public exposure to contaminated groundwater that presents a significant risk to human health and the environment; 2) restore the shallow, intermediate and deep groundwater plumes to drinking water standards within a reasonable time frame; and 3) reduce the potential for exposure via inhalation of vapors that may migrate from shallow groundwater.

The soil and groundwater RAOs selected at the time of the RODs remain valid for the Site. Due to the shallow water table, EPA continues to collect sub-slab and indoor air samples from three residences overlying the plume. Based on the recent changes in toxicity for TCE, the residential indoor air vapor intrusion screening levels have decreased to 2 micrograms per cubic meter (µg/m3). Changes in toxicity for PCE have increased the screening levels to 42 µg/m3. These changes are not expected to impact the protectiveness of the selected remedy since EPA reviews and compares the collected soil vapor intrusion data with current screening levels. Monitoring of this potential pathway will continue.

A Screening-Level Ecological Risk Assessment was conducted for both RODs and determined that no ecological risks were present at the Site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light that would call into question the protectiveness of the remedy.

Technical Assessment Summary

The ISCO process conducted to date in source area MW-14 cluster indicates that the ISCO process is working and the contaminant concentrations are reducing. Since contaminant concentrations remain elevated, EPA anticipates at least another round of ISCO injections will be executed.

Issues, Recommendations and Follow-Up Actions

The FYR did not identify any issues that impact current or future protectiveness.

Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: OU1	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The OU1 remedy is protective of human health and the environment.		

Protectiveness Statement(s)		
Operable Unit: OU2	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The OU2 remedy is protective of human health and environment.		

Sitewide Protectiveness Statement	
Protectiveness Determination: Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: Both remedies for OU1 and OU2 are considered protective of human health and the environment because the contaminated groundwater is not being used and the remedy is reducing the contaminant concentrations within the plume. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risk.	

Next Review

The next FYR for the Dover Municipal Well No. 4 Superfund Site is required five years from the completion date of this review.

Attachments

Attachment 1: Tables

Attachment 2: Figures

	Table 1 – Chronology of Events
Date	**Event**
1962	DMW4 is drilled and installed.
June 1965	DMW4 starts operating as a municipal well with an average pumping rate of 1,100 gpm.
March 1980	Groundwater samples collected from DMW4, by the Town of Dover, identified the presence of chlorinated hydrocarbons; 1,1,1 trichloroethane (118 ppb), tetrachloroethylene (122 ppb), 1,2 dichloroethylene (4-9 ppb), and trichloroethene (2 ppb).
July-September 1980	NJDEP conducts additional groundwater sampling which showed the presence of trichloroethene.
September 1980	DMW4 is voluntarily removed from service by the Town of Dover and DMW3 is used in place of DMW4.
1980 -1983	NJNG's Phase II investigation showed that the shallow and intermediate aquifers were contaminated with various organic compounds.
June 1986	Howmet and NJNG were issued directives from NJDEP to pay for a remedial investigation/feasibility study (RI/FS) at DMW4. Howmet and NJNG did not comply, however both companies were under NJDEP Administrative Consent Orders to remediate their properties.
September 1990	The final Phase I RI report for the Site is submitted to NJDEP and the EPA.
August 7, 1992 - September 15, 1992	RI/FS report is released for public review and comment.
September 30, 1992	A Record of Decision (ROD) is issued for OU1 (groundwater).
October 1992	NJDEP requests that EPA assume the lead for addressing the contamination at the Site.
March 1996	A Final RI Work Plan is submitted to the EPA.
February 1999	A Draft RI Report is submitted to the EPA.
May 2002	A Final Preliminary Design Investigation Report is submitted to the EPA.
November 2002	Indoor/outdoor ambient air sampling is performed at ten residences on Richards Avenue.
July 2003	An addendum to the Final Preliminary Design Investigation Report is submitted to the EPA.
July 2003	Supplemental RI Sampling is conducted near the dry cleaner.
August 2003	The EPA conducts additional indoor/outdoor ambient air and sub-slab soil gas sampling at nine residences on Richards Avenue.

	Table 1 – Chronology of Events
Date	**Event**
August 2005	Final RI Report is submitted to the EPA.
September 2005	A ROD is issued for OU2 (source area) which also modified the OU1 remedy.
April 2007 - January 2008	A pre-design investigation is performed at OU2. Advancement of 28 deep soil borings and 20 shallow soil borings to delineate soil contamination is performed. Also includes collection of groundwater samples from Site wells.
December 2007	Former dry cleaner building demolished.
May 2009	Approximately 1,258 cubic yards of soil are excavated from areas adjacent to the former dry cleaner building. Soil is transported off-site for disposal.
May 2009	Performance monitoring wells for in situ chemical oxidation (ISCO) effectiveness monitoring installed, and baseline (pre-treatment) soil samples collected.
June 2009 and October 2009	Baseline (pre-treatment) groundwater samples collected for ISCO effectiveness monitoring.
March 2010	Installation of 33 ISCO injection wells and 2 vent wells.
April-May 2010	ISCO injection performed to treat groundwater and saturated soil at OU2.
July 2010	Saturated soil and groundwater samples collected for ISCO effectiveness monitoring.
October 2010	Supplemental sampling event to delineate volatile organic compounds in the area around the MW-14 well cluster.
March 2011	Installation of nine additional ISCO injection wells.
April 2011	Sampling of the nine new ISCO injection wells to determine whether additional injection wells would be required.
June-July 2011	Phase 2 ISCO injections performed to treat groundwater and saturated soil at OU2.
September 2011	Groundwater samples collected for ISCO effectiveness monitoring.
February 2012	Groundwater samples collected for ISCO effectiveness monitoring.
October-November 2012	Phase 3 ISCO injections performed to treat groundwater and saturated soil at OU2.
February 2013	Groundwater samples collected for ISCO effectiveness monitoring.
November 2013	Groundwater samples collected for ISCO effectiveness monitoring.

	Table 1 – Chronology of Events
Date	**Event**
December 2013 to present	First of eight planned long-term response action (LTRA) monitoring events initiated for OU1 in December 2013. Subsequent quarterly monitoring events conducted in March 2014, June 2014, September 2014, December 2014, March 2015, and June 2015. Last (8^{th}) quarterly monitoring event planned for September 2015.
July 2014 and October 2014	Pre-Phase 4 ISCO polishing sampling of MW-14I and MW-14D
October - November 2014	Phase 4 ISCO polishing injection in the vicinity of the MW-14 monitoring well cluster.
December 2014 and March 2015	Groundwater samples collected from MW-14I and MW-14D for ISCO effectiveness monitoring

Table 2a - Selected Soil Cleanup Criteria

Dover Municipal Well No. 4 Superfund Site
Dover, New Jersey

Compounds	Residential Direct Contact Soil Cleanup Criteria (mg/kg)	Impact to Groundwater Soil Cleanup Criteria (mg/kg)
cis-1,2-Dichloroethylene (cis-1,2-DCE)	79	**1**
Tetrachloroethylene (PCE)	4	**1**
Trichloroethylene (TCE)	23	**1**
Vinyl Chloride	**2**	10

Footnote: The value shown in **bold** type is the selected standard. The selected standard is the most stringent cleanup criterion for a specified chemical.

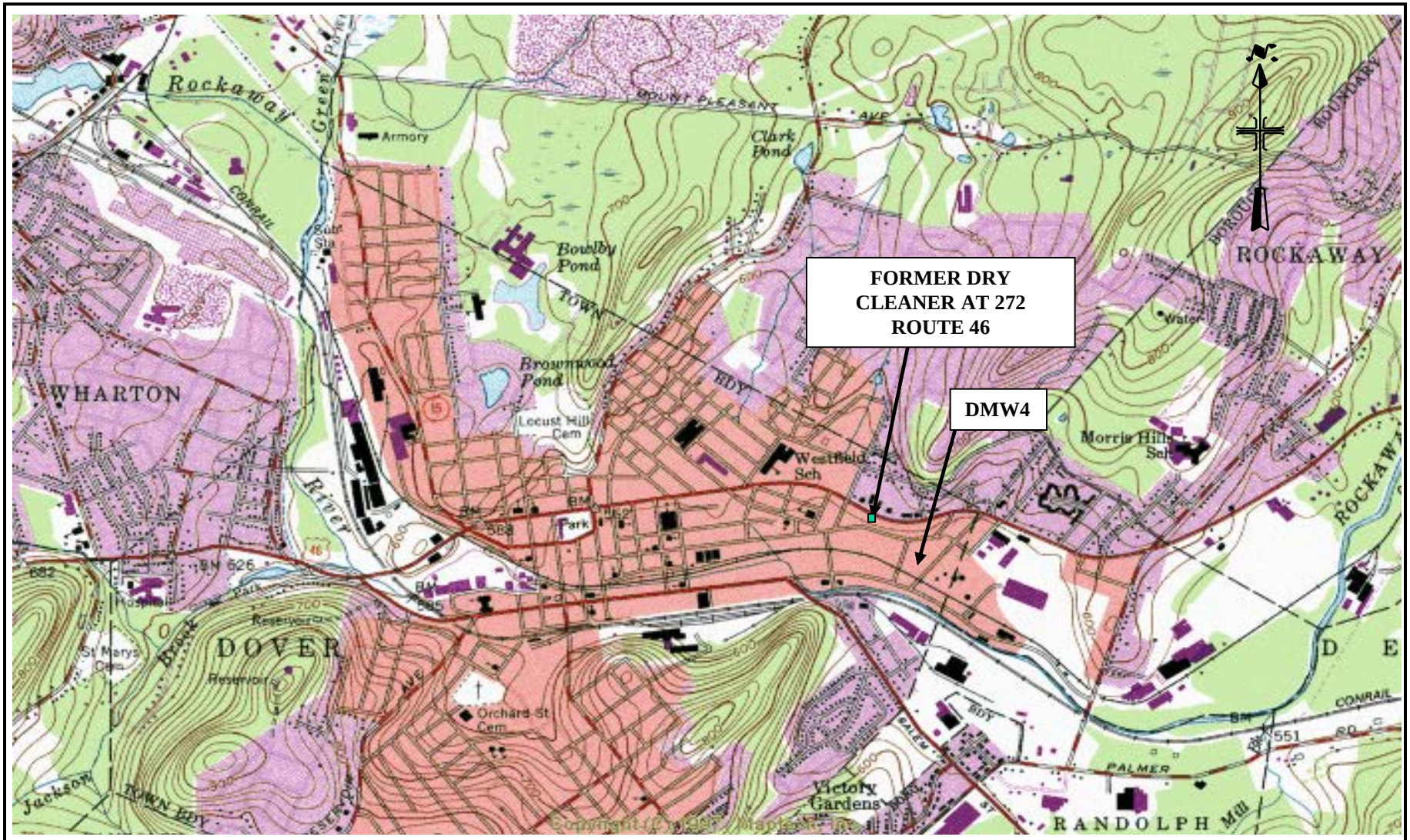
Table 2a - Selected Groundwater Cleanup Criteria

Dover Municipal Well No. 4 Superfund Site
Dover, New Jersey

Compound	NJDEP Groundwater Quality Criteria (ug/L)	NJDEP Practical Quantification Limit (ug/L)	Modified Groundwater Quality Criteria (ug/L)	Federal MCLs (ug/L)	NJDEP Drinking Water MCLs (ug/L)
cis-1,2-Dichloroethylene (cis-1,2-DCE)	10	2	**10**	70	70
Tetrachloroethylene (PCE)	0.4	1	**1**	5	1
1,1,2-Trichloroethane (1,1,2-TCA)	3	2	**3**	5	3
Trichloroethylene (TCE)	1	1	**1**	5	1
Vinyl Chloride	0.08	5	5	2	**2**

Footnote: The value shown in **bold** type is the selected standard. The selected standard is the most stringent cleanup criterion for a specified chemical.

Table 3: Documents, Data and Information Reviewed in Completing the Five-Year Review	
Document Title, Author	**Submittal Date**
Record of Decision Operable Unit 1	September 1992
Record of Decision Operable Unit 2	September 2005
Final Performance Work Statement for *In-Situ* Chemical Oxidation	June 2009
Final Interim Remedial Action Report for *In-Situ* Chemical Oxidation Activities	January 2011
Draft Final First Annual Long-Term Response Action Groundwater Monitoring Report	August 2015



Source: Dover, NJ USGS, 1981. Excerpted from First Annual Long-Term Response Action Groundwater Monitoring Report (September 2013 to September 2014) (LBG/ARCADIS, 2015)

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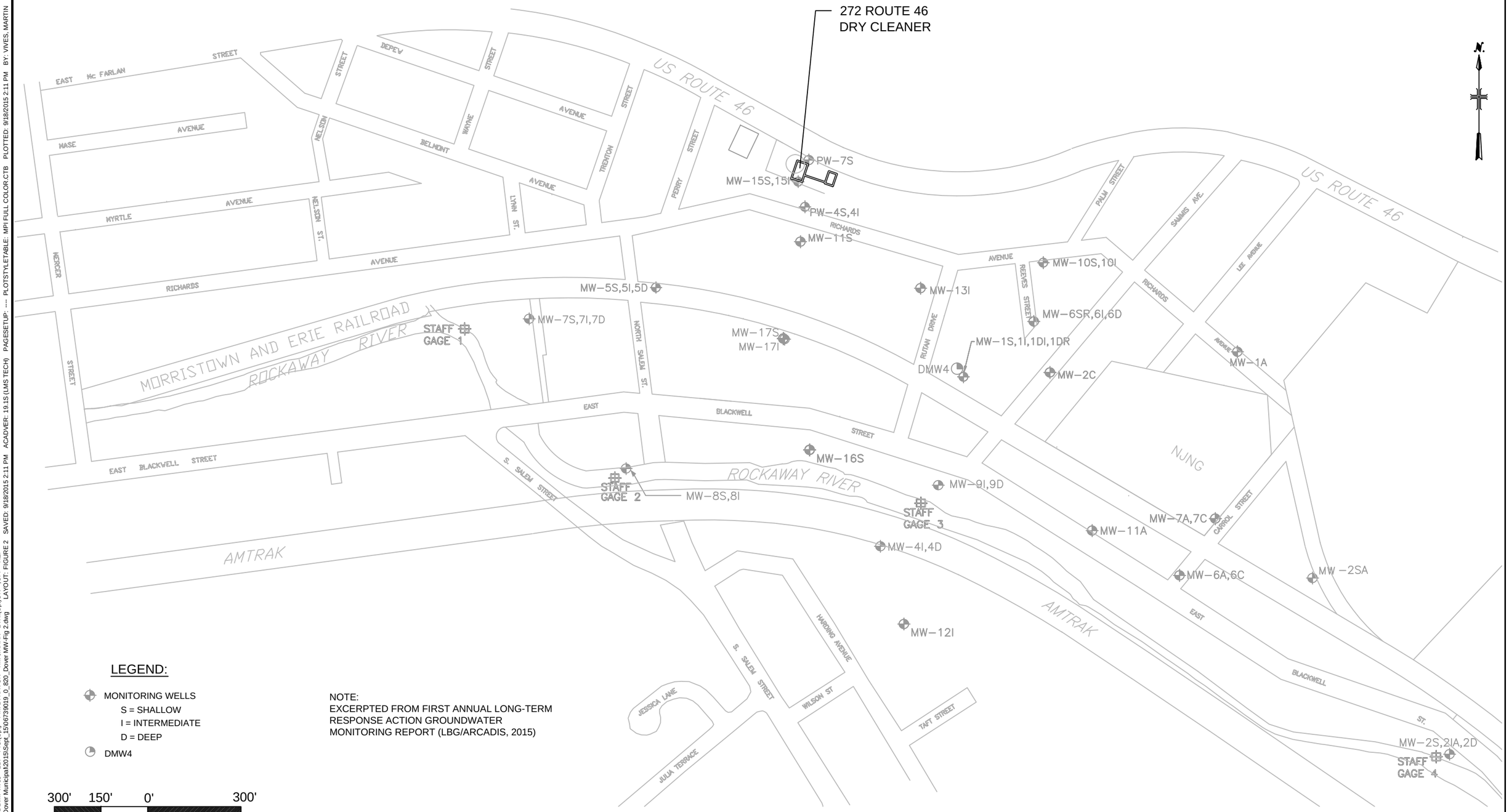
REGIONAL TOPOGRAPHIC MAP
DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE
DOVER, NEW JERSEY

FIGURE 1

CITY:Tampa DIV/GROUP:EN-SER /1 DB:M. Vives LD: PIC:(Opt) PM:D. NAVON TM:J.KARN LYR:(Opt)ON=*;OFF=*REF*
G:\ENV\CAD\TAMPA\ACTIVITY\06739019_Dover Municipal\2015\Sept_15\06739019_0_820_Dover MW-Fig 2.dwg LAYOUT: FIGURE 2 SAVED: 9/18/2015 2:11 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: MPI FULL COLOR.CTB PLOTTED: 9/18/2015 2:11 PM BY: VIVES, MARTIN



LEGEND:

- MONITORING WELLS
  - S = SHALLOW
  - I = INTERMEDIATE
  - D = DEEP
- DMW4

NOTE:
EXCERPTED FROM FIRST ANNUAL LONG-TERM RESPONSE ACTION GROUNDWATER MONITORING REPORT (LBG/ARCADIS, 2015)

300' 150' 0' 300'

NOTE: THE PROPERTY BOUNDARIES ARE APPROXIMATE

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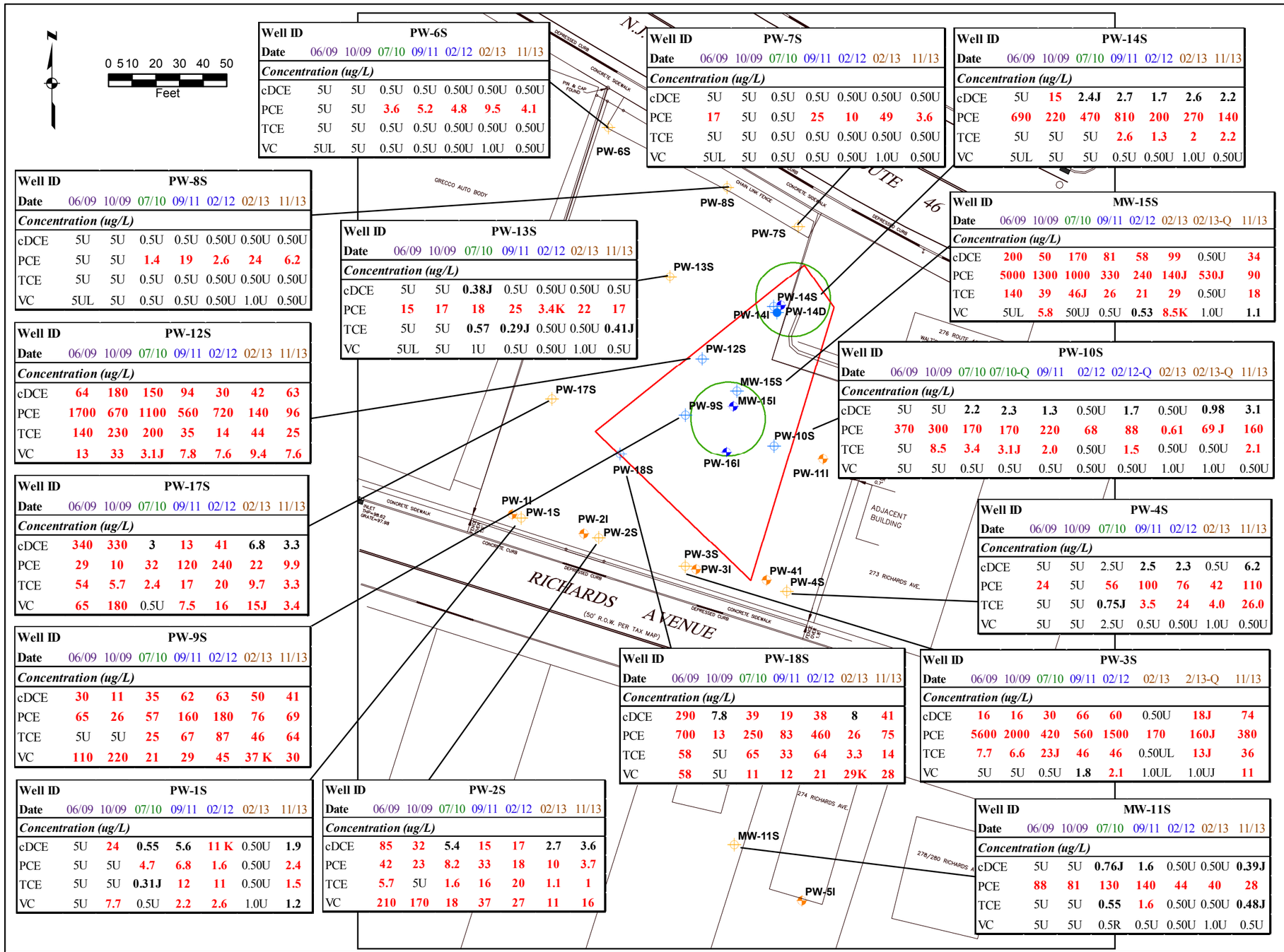
DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE
DOVER, NEW JERSEY

LOCATION OF DOVER MUNICIPAL WELL No. 4 AND SURROUNDING VICINITY

FIGURE 2



Well ID	PW-6S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	5U	5U	**3.6**	**5.2**	**4.8**	**9.5**	**4.1**
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5UL	5U	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-7S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	**17**	5U	0.5U	**25**	**10**	**49**	**3.6**
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5UL	5U	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-14S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	**15**	**2.4J**	**2.7**	**1.7**	**2.6**	**2.2**
PCE	**690**	**220**	**470**	**810**	**200**	**270**	**140**
TCE	5U	5U	5U	**2.6**	**1.3**	**2**	**2.2**
VC	5UL	5U	5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-8S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	5U	5U	**1.4**	**19**	**2.6**	**24**	**6.2**
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5UL	5U	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-13S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	**0.38J**	0.5U	0.50U	0.50U	0.5U
PCE	**15**	**17**	**18**	**25**	**3.4K**	**22**	**17**
TCE	5U	5U	**0.57**	**0.29J**	0.50U	0.50U	**0.41J**
VC	5UL	5U	1U	0.5U	0.50U	1.0U	0.5U

Well ID	MW-15S							
Date	06/09	10/09	07/10	09/11	02/12	02/13	02/13-Q	11/13
Concentration (ug/L)								
cDCE	**200**	**50**	**170**	**81**	**58**	**99**	0.50U	**34**
PCE	**5000**	**1300**	**1000**	**330**	**240**	**140J**	**530J**	**90**
TCE	**140**	**39**	**46J**	**26**	**21**	**29**	0.50U	**18**
VC	5UL	**5.8**	50UJ	0.5U	**0.53**	**8.5K**	1.0U	**1.1**

Well ID	PW-10S									
Date	06/09	10/09	07/10	07/10-Q	09/11	02/12	02/12-Q	02/13	02/13-Q	11/13
Concentration (ug/L)										
cDCE	5U	5U	**2.2**	**2.3**	**1.3**	0.50U	**1.7**	0.50U	**0.98**	**3.1**
PCE	**370**	**300**	**170**	**170**	**220**	**68**	**88**	**0.61**	**69 J**	**160**
TCE	5U	**8.5**	**3.4**	**3.1J**	**2.0**	0.50U	**1.5**	0.50U	0.50U	**2.1**
VC	5U	5U	0.5U	0.5U	0.5U	0.50U	0.50U	1.0U	1.0U	0.50U

Well ID	PW-17S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	**340**	**330**	**3**	**13**	**41**	**6.8**	**3.3**
PCE	**29**	**10**	**32**	**120**	**240**	**22**	**9.9**
TCE	**54**	**5.7**	**2.4**	**17**	**20**	**9.7**	**3.3**
VC	**65**	**180**	0.5U	**7.5**	**16**	**15J**	**3.4**

Well ID	PW-4S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	2.5U	**2.5**	**2.3**	0.5U	**6.2**
PCE	**24**	5U	**56**	**100**	**76**	**42**	**110**
TCE	5U	5U	**0.75J**	**3.5**	**24**	**4.0**	**26.0**
VC	5U	5U	2.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-9S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	**30**	**11**	**35**	**62**	**63**	**50**	**41**
PCE	**65**	**26**	**57**	**160**	**180**	**76**	**69**
TCE	5U	5U	**25**	**67**	**87**	**46**	**64**
VC	**110**	**220**	**21**	**29**	**45**	**37 K**	**30**

Well ID	PW-18S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	**290**	**7.8**	**39**	**19**	**38**	**8**	**41**
PCE	**700**	**13**	**250**	**83**	**460**	**26**	**75**
TCE	**58**	5U	**65**	**33**	**64**	**3.3**	**14**
VC	**58**	5U	**11**	**12**	**21**	**29K**	**28**

Well ID	PW-3S							
Date	06/09	10/09	07/10	09/11	02/12	02/13	2/13-Q	11/13
Concentration (ug/L)								
cDCE	**16**	**16**	**30**	**66**	**60**	0.50U	**18J**	**74**
PCE	**5600**	**2000**	**420**	**560**	**1500**	**170**	**160J**	**380**
TCE	**7.7**	**6.6**	**23J**	**46**	**46**	0.50UL	**13J**	**36**
VC	5U	5U	0.5U	**1.8**	**2.1**	1.0UL	1.0UJ	**11**

Well ID	PW-1S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	**24**	**0.55**	**5.6**	**11 K**	0.50U	**1.9**
PCE	5U	5U	**4.7**	**6.8**	**1.6**	0.50U	**2.4**
TCE	5U	5U	**0.31J**	**12**	**11**	0.50U	**1.5**
VC	5U	**7.7**	0.5U	**2.2**	**2.6**	1.0U	**1.2**

Well ID	PW-2S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	**85**	**32**	**5.4**	**15**	**17**	**2.7**	**3.6**
PCE	**42**	**23**	**8.2**	**33**	**18**	**10**	**3.7**
TCE	**5.7**	5U	**1.6**	**16**	**20**	**1.1**	**1**
VC	**210**	**170**	**18**	**37**	**27**	**11**	**16**	

Well ID	MW-11S						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	**0.76J**	**1.6**	0.50U	0.50U	**0.39J**
PCE	**88**	**81**	**130**	**140**	**44**	**40**	**28**
TCE	5U	5U	**0.55**	**1.6**	0.50U	0.50U	**0.48J**
VC	5U	5U	0.5R	0.5U	0.50U	1.0U	0.5U

LEGEND

- SHALLOW AQUIFER TREATMENT AREA
- INTERMEDIATE AQUIFER TREATMENT AREA
- SHALLOW MONITORING WELL
- INTERMEDIATE MONITORING WELL
- SHALLOW TREATMENT AREA MONITORING WELL
- INTERMEDIATE TREATMENT AREA MONITORING WELL
- DEEP TREATMENT AREA MONITORING WELL

NOTES

1. Baseline groundwater samples were collected by USEPA in June 2009 and October 2009, prior to ISCO treatment.
2. Concentrations in red exceed the 2005 ROD criteria. Concentrations with a bold font (black) indicate detections below 2005 ROD criteria.
3. Basemap prepared by Stewart Surveying and Engineering, LLC (January, 2010).
4. Q designation in sample name indicates that the sample contained permanganate and was quenched with sodium thiosulfate.
5. Four phases of in situ chemical oxidation (ISCO) injections have been performed to date: Phase 1 in April/May 2010, Phase 2 in June/July 2011, Phase 3 in October/November 2012, and Phase 4 in November 2014.
6. Excerpted from Second Interim Data Summary Report for In Situ Chemical Oxidation Effectiveness Monitoring at OU2 (LBG/ARCADIS, 2012). Figure updated with sampling data in 2013.

Laboratory Qualifiers
J: Reported value is an estimate
U: Analyte was not detected above the reporting limit
R: Result was rejected
L: Reported value may be biased low
K: Reported value may be biased high

06/09	Baseline sampling event
07/10	Post-Phase 1 ISCO sampling event
09/11	Post-Phase 2 ISCO sampling event
02/13	Post-Phase 3 ISCO sampling event

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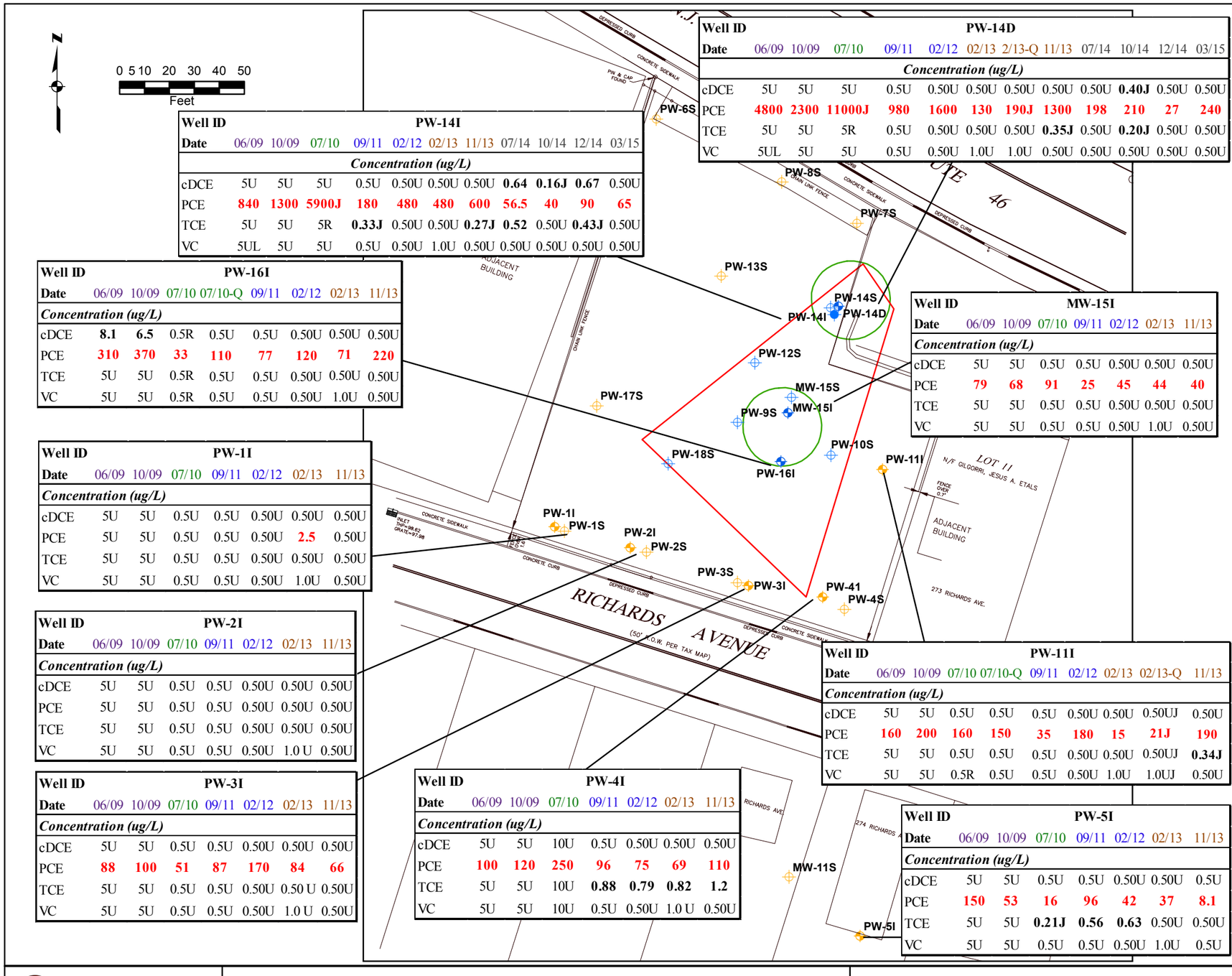
DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE
DOVER, NJ

OU2 ISCO TREATMENT: COMPOUNDS OF CONCERN IN SHALLOW WELLS

FIGURE 3a



Well ID	PW-14D											
Date	06/09	10/09	07/10	09/11	02/12	02/13	2/13-Q	11/13	07/14	10/14	12/14	03/15
Concentration (ug/L)												
cDCE	5U	5U	5U	0.5U	0.50U	0.50U	0.50U	0.50U	0.50U	**0.40J**	0.50U	0.50U
PCE	**4800**	**2300**	**11000J**	**980**	**1600**	**130**	**190J**	**1300**	**198**	**210**	**27**	**240**
TCE	5U	5U	5R	0.5U	0.50U	0.50U	0.50U	**0.35J**	0.50U	**0.20J**	0.50U	0.50U
VC	5UL	5U	5U	0.5U	0.50U	1.0U	1.0U	0.50U	0.50U	0.50U	0.50U	0.50U

Well ID	PW-14I										
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13	07/14	10/14	12/14	03/15
Concentration (ug/L)											
cDCE	5U	5U	5U	0.5U	0.50U	0.50U	0.50U	**0.64**	**0.16J**	**0.67**	0.50U
PCE	**840**	**1300**	**5900J**	**180**	**480**	**480**	**600**	**56.5**	**40**	**90**	**65**
TCE	5U	5U	5R	**0.33J**	0.50U	0.50U	**0.27J**	**0.52**	0.50U	**0.43J**	0.50U
VC	5UL	5U	5U	0.5U	0.50U	1.0U	0.50U	0.50U	0.50U	0.50U	0.50U

Well ID	PW-16I							
Date	06/09	10/09	07/10	07/10-Q	09/11	02/12	02/13	11/13
Concentration (ug/L)								
cDCE	**8.1**	**6.5**	0.5R	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	**310**	**370**	**33**	**110**	**77**	**120**	**71**	**220**
TCE	5U	5U	0.5R	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5U	5U	0.5R	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	MW-15I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	**79**	**68**	**91**	**25**	**45**	**44**	**40**
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5U	5U	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-1I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	5U	5U	0.5U	0.5U	0.50U	**2.5**	0.50U
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5U	5U	0.5U	0.5U	0.50U	1.0U	0.50U

Well ID	PW-2I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
TCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
VC	5U	5U	0.5U	0.5U	0.50U	1.0 U	0.50U

Well ID	PW-3I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.50U
PCE	**88**	**100**	**51**	**87**	**170**	**84**	**66**
TCE	5U	5U	0.5U	0.5U	0.50U	0.50 U	0.50U
VC	5U	5U	0.5U	0.5U	0.50U	1.0 U	0.50U

Well ID	PW-4I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	10U	0.5U	0.50U	0.50U	0.50U
PCE	**100**	**120**	**250**	**96**	**75**	**69**	**110**
TCE	5U	5U	10U	**0.88**	**0.79**	**0.82**	**1.2**
VC	5U	5U	10U	0.5U	0.50U	1.0 U	0.50U

Well ID	PW-11I								
Date	06/09	10/09	07/10	07/10-Q	09/11	02/12	02/13	02/13-Q	11/13
Concentration (ug/L)									
cDCE	5U	5U	0.5U	0.5U	0.5U	0.50U	0.50U	0.50UJ	0.50U
PCE	**160**	**200**	**160**	**150**	**35**	**180**	**15**	**21J**	**190**
TCE	5U	5U	0.5U	0.5U	0.5U	0.50U	0.50U	0.50UJ	**0.34J**
VC	5U	5U	0.5R	0.5U	0.5U	0.50U	1.0U	1.0UJ	0.50U

Well ID	PW-5I						
Date	06/09	10/09	07/10	09/11	02/12	02/13	11/13
Concentration (ug/L)							
cDCE	5U	5U	0.5U	0.5U	0.50U	0.50U	0.5U
PCE	**150**	**53**	**16**	**96**	**42**	**37**	**8.1**
TCE	5U	5U	**0.21J**	**0.56**	**0.63**	0.50U	0.50U
VC	5U	5U	0.5U	0.5U	0.50U	1.0U	0.5U

LEGEND

- SHALLOW AQUIFER TREATMENT AREA
- INTERMEDIATE AQUIFER TREATMENT AREA
- SHALLOW MONITORING WELL
- INTERMEDIATE MONITORING WELL
- SHALLOW TREATMENT AREA MONITORING WELL
- INTERMEDIATE TREATMENT AREA MONITORING WELL
- DEEP TREATMENT AREA MONITORING WELL

NOTES

1. Baseline groundwater samples were collected by USEPA in June 2009 and October 2009, prior to ISCO treatment.
2. Concentrations in red exceed the 2005 ROD criteria. Concentrations with a bold font (black) indicate detections below 2005 ROD criteria.
3. Basemap prepared by Stewart Surveying and Engineering, LLC (January, 2010).
4. Q designation in sample name indicates that the sample contained permanganate and was quenched with sodium thiosulfate.
5. Four phases of in situ chemical oxidation (ISCO) injections have been performed to date: Phase 1 in April/May 2010, Phase 2 in June/July 2011, Phase 3 in October/November 2012, and Phase 4 in November 2014.
6. Excerpted from Second Interim Data Summary Report for In Situ Chemical Oxidation Effectiveness Monitoring at OU2 (LBG/ARCADIS, 2012). Figure updated with sampling data in 2013, 2014, and 2015.

Laboratory Qualifiers
J: Reported value is an estimate
U: Analyte was not detected above the reporting limit
R: Result was rejected
L: Reported value may be biased low

06/09	Baseline sampling event
07/10	Post-Phase 1 ISCO sampling event
09/11	Post-Phase 2 ISCO sampling event
02/13	Post-Phase 3 ISCO sampling event
03/15	Post-Phase 4 ISCO sampling event

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DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE
DOVER, NJ

OU2 ISCO TREATMENT: COMPOUNDS OF CONCERN IN INTERMEDIATE AND DEEP WELLS

FIGURE 3b

C:\TY:Tampa DIV/GROUP:ENV-SER /1 DB:M. Vives LD: PIC:(Opt) PM: D. NAVON TM: J.KARN LYR:(Opt)ON=*;OFF=*REF* LAYOUT: FIGURE 4A SAVED: 9/18/2015 2:54 PM BY: VIVES.
G:\ENVCAD\TAMPA\ACTIVE\060739019_Dover Municipal\2015\Sept_150673901 9_0_810_Dover MW-Fig 4a.dwg PLOTTED: 9/18/2015 2:54 PM BY: MARTIN
PAGESETUP: --- PLOTSTYLETABLE: MPI FULL COLOR.CTB ACADVER: 19.1S (LMS TECH)

MW-15S (Round 4/5/6/7/9/10/11/12/13/15/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	5,700/8,300/4,700/8,300/16,000B/2,200J/5000/1300/1000/330/73/130/69
cis 1,2-DCE	10	480J/470/590/920/800/140J/200/50/170/81/120/78/190/94
TCE	1	ND/140/98J/ND/ND/70J140/39/46J/26/26/19/30/31
Vinyl chloride	2	ND/0.5J/0.92/ND/ND/1/ND/5.8/50UJ/ND/6.9/1.8/ND/3.4
1,1,2-TCA	3	ND/ND/ND/89J/ND/ND/ND/ND/ND/ND/ND/ND/ND/ND

PW-8S (Round 11/12/13/15)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	ND/ND/1.4/19

PW-6S (Round 11/12/13)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	ND/ND/3.6/5.2

PW-7S (Round 11/12/13/15/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	17/ND/ND/25/24/140/160/65
TCE	1	ND/ND/ND/ND/ND/0.945/ND/1.3

PW-14S (Round 11/12/13/15)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	690/220/470/810
TCE	1	ND/ND/ND/2.6
cis 1,2-DCE	10	ND/15/2.4J/2.7

HP-27 (ROUND 6)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	2.9J
cis 1,2-DCE	10	4J
TCE	1	2.4J
Vinyl chloride	2	R

PW-4S (Round 11/12/13/15)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	24/ND/56/100
TCE	1	ND/ND/0.75J/3.5
cis 1,2-DCE	10	ND/ND/ND/2.5

MW-10S (ROUND 3)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-6SR (ROUND 1/2/3)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-11S (Round 3/7/9/10/11/12/13/15/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	210/25/20/49K/88/81/130/140/5.8/3.4/4.3/13
cis 1,2-DCE	10	21/0.93J/0.37J/1.6K/ND/ND/0.76J/1.6/ND/ND/0.12J/0.39J
TCE	1	4/0.89J/0.49J/1.2K/ND/ND/0.55/1.6/ND/ND/0.13J/0.23J
Vinyl chloride	2	10/ND/ND/ND/ND/0.5R/ND/ND/ND/ND/ND
1,1,2-TCA	3	ND/0.36J/ND/ND/ND/ND/ND/ND/ND/ND/ND/ND

PW-1S (Round 11/12/13/15)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	ND/ND/4.7/6.8
cis 1,2-DCE	10	ND/24/0.55/5.6
TCE	1	ND/ND/0.31J/12
Vinyl chloride	2	ND/7.7/ND/2.2

SP-4B (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

SP-4A (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-1A (ROUND 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-7A (ROUND 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-7S (Round 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
TCE	1	1/1
cis-1,2-DCE	10	0.6J/0.6J

MW-5S (Round 1/2/9/10/14/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	ND/ND/0.82/1.7/ND/ND/ND/ND/1.6
cis 1,2-DCE	10	ND/ND/0.13J/2.1/ND/ND/ND/ND/1.5
TCE	1	ND/ND/ND/ND/ND/ND/ND/ND/0.50

HP-25 (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
Vinyl chloride	2	0.85
cis-1,2-DCE	10	2.4
PCE	1	0.72

MW-17S (Round 16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
cis 1,2-DCE	10	ND/ND/ND/0.23J
TCE	1	ND/ND/0.72/ND

MW-1S (Round 1/2/3/9/10/14/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-8S (Round 1/2/14)

Compound	Cleanup Std. ug/L	Conc. ug/L
TCE	1	2/2/1.2

MW-16S (Round 7/9/10/14/16/17/18/19)

Compound	Cleanup Std. ug/L	Conc. ug/L
CIS 1,2-DCE	10	ND/ND/ND/ND/ND/0.098J/ND/ND

MW-6A (ROUND 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

SP-1B (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
PCE	1	0.3J

SP-6 (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

SP-10 (ROUND 1)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-11A (Round 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-2SA (Round 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

MW-2S (Round 1/2)

Compound	Cleanup Std. ug/L	Conc. ug/L
NO COCS DETECTED		

LEGEND:

- SIMULPROBE BORING
- MONITORING WELL
- DMW4
- HYDROPUNCH SAMPLE LOCATION
- MONITORING WELL IN LTRA MONITORING NETWORK
- J ESTIMATED VALUE
- K BIASED HIGH
- ND NON-DETECT
- GROUNDWATER THAT EXCEEDS PCE CLEANUP STANDARD OF 1ug/L

CLEANUP STD. - THE CLEANUP STANDARD SELECTED IS THE LOWER OF THE FEDERAL OR STATE MCLs FOR EACH COMPOUND OF CONCERN.

NOTE:
EXCERPTED FROM FIRST ANNUAL LONG-TERM RESPONSE ACTION GROUNDWATER MONITORING REPORT (LBG/ARCADIS, 2015)

200' 100' 0' 200' 400'

ROUND DATES: 1=9/1998, 2=11/1998, 3=3/2000, 4=10/2000, 5=11/2000, 6=8/2001, 7=12/2002, 8=2/2003, 9=12/2004, 10=5/2007, 11=6/2009, 12=10/2009 13=7/2010, 14=7/2011, 15=9/2011, 16=12/2013, 17=3/2014, 18=6/2014, 19=9/2014

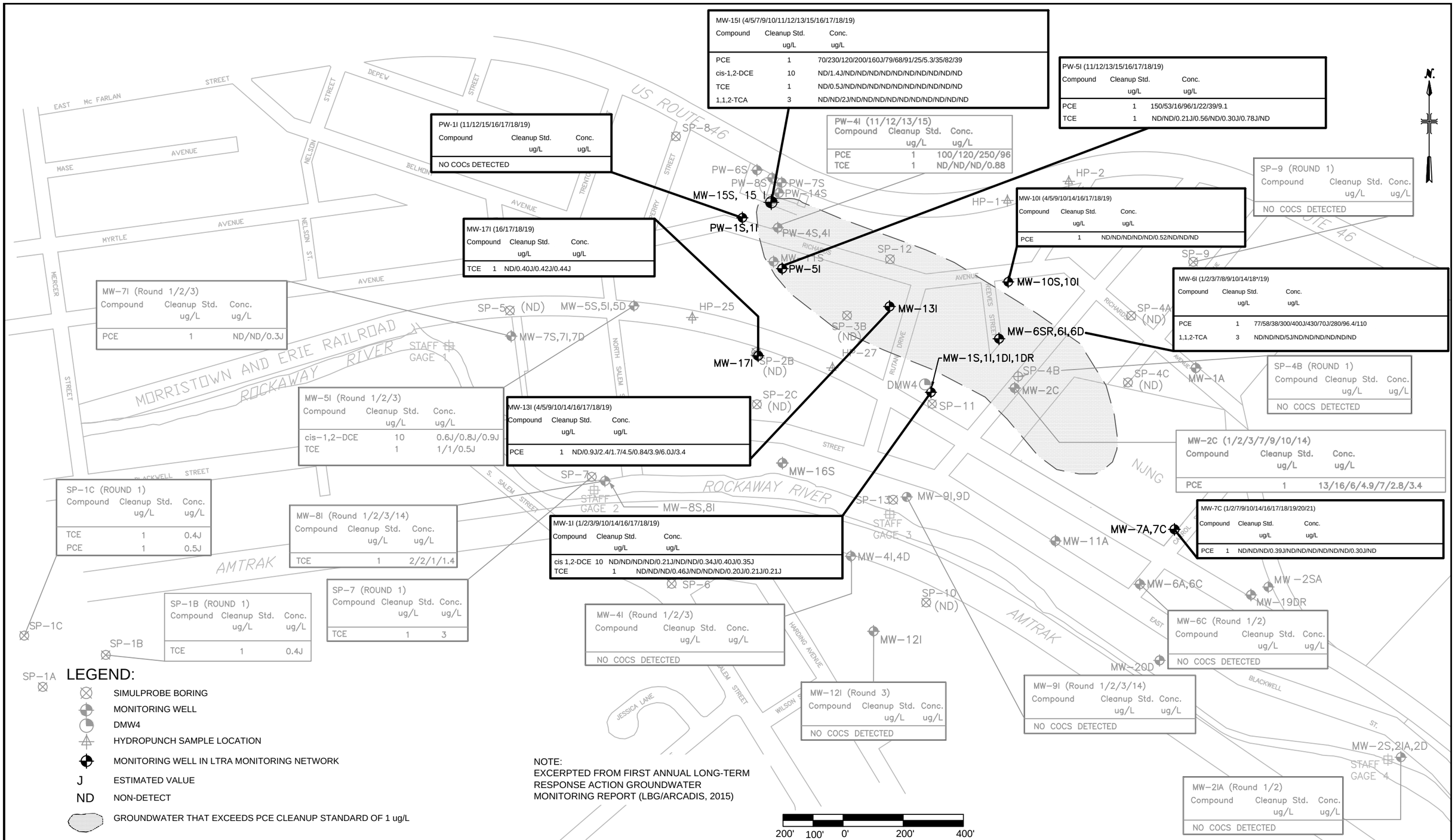
ARCADIS

DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE
DOVER, NEW JERSEY

HISTORICAL GROUNDWATER CONCENTRATIONS AND LTRA MONITORING NETWORK SHALLOW AQUIFER

FIGURE 4a

CITY:Tampa DIV/GROUP:ENSER /1 DB:M. Vives LD: PIC:(Opt) PM: D. NAVON TM: J.KARN LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\TAMPA\ACTIVE\JN\06739019_Dover Municipal\2015\Sept_15\06739019_0_820_Dover MW-Fig 4b.dwg LAYOUT: FIGURE 4B SAVED: 9/18/2015 11:31 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: MPI FULL COLOR.CTB PLOTTED: 9/18/2015 2:59 PM BY: VIVES, MARTIN



CLEANUP STD. - THE CLEANUP STANDARD SELECTED IS THE LOWER OF THE FEDERAL OR STATE MCLs FOR EACH COMPOUND OF CONCERN.

ROUND DATES: 1=9/1998, 2=11/1998, 3=3/2000, 4=10/2000, 5=11/2000, 6=8/2001, 7=12/2002, 8=2/2003, 9=12/2004, 10=5/2007, 11=6/2009, 12=10/2009, 13=7/2010, 14=7/2011, 15=9/2011, 16=12/2013, 17=3/2014, 18=6/2014, 18*=7/2014, 19=9/2014

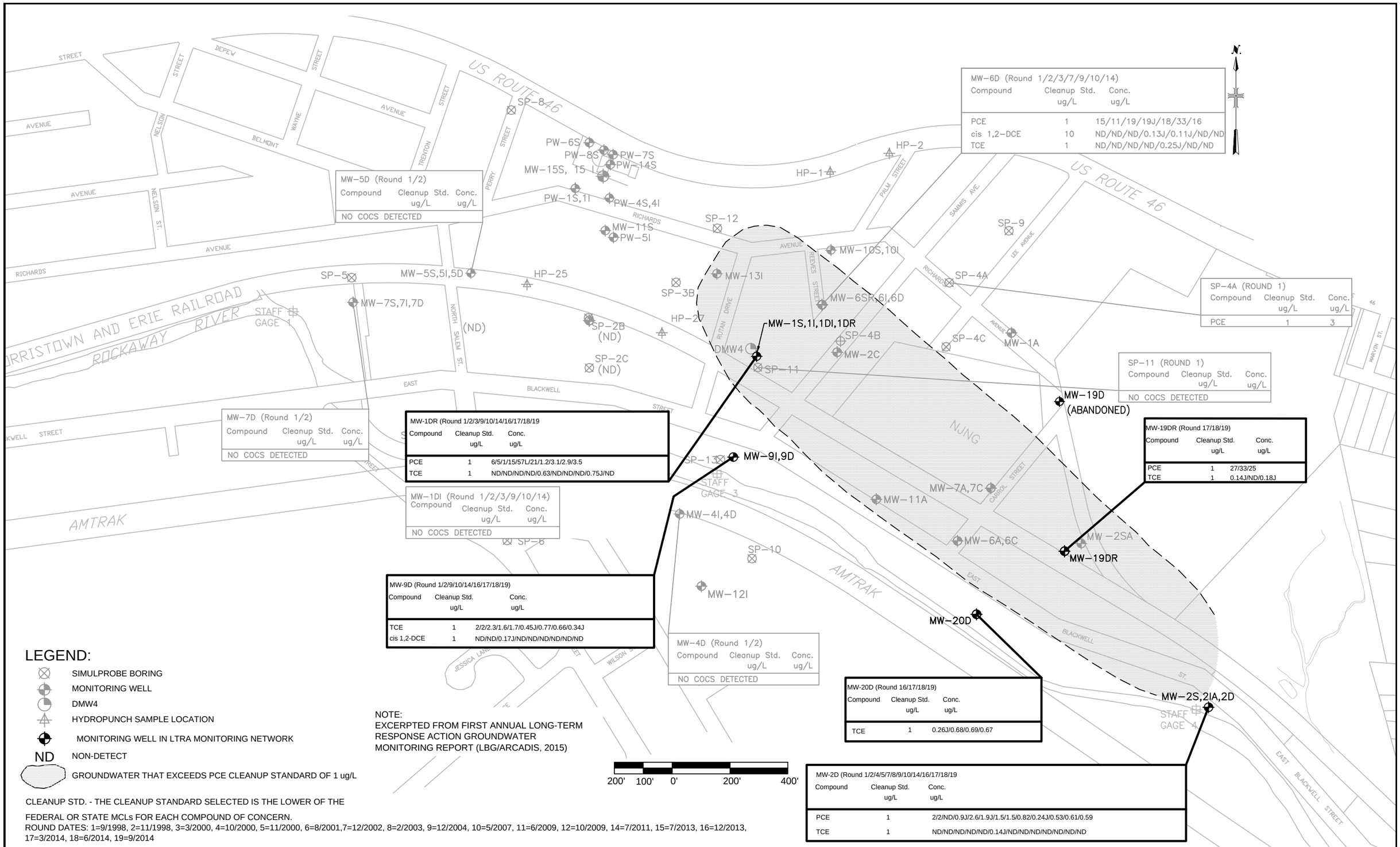
ARCADIS

DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE
DOVER, NEW JERSEY

HISTORICAL GROUNDWATER CONCENTRATIONS AND LTRA MONITORING NETWORK INTERMEDIATE AQUIFER

FIGURE 4b

CITY:Tampa DIV/GROUP:ENVSER/1 DB:M. Vives LD: PIC:(Opt) PM: D. NAVON TM: J.KARN LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\TAMPA\ACTIVE\NJ\6739019_Dover Municipal\2015\Sept_150673901 9_0_820_Dover MW-Fig 4c.dwg LAYOUT: FIGURE 4C SAVED: 9/18/2015 2:48 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: MPI FULL COLOR.CTB PLOTTED: 9/18/2015 3:02 PM BY: VIVES, MARTIN



LEGEND:

- SIMULPROBE BORING
- MONITORING WELL
- DMW4
- HYDROPUNCH SAMPLE LOCATION
- MONITORING WELL IN LTRA MONITORING NETWORK
- ND — NON-DETECT
- GROUNDWATER THAT EXCEEDS PCE CLEANUP STANDARD OF 1 ug/L

NOTE:
EXCERPTED FROM FIRST ANNUAL LONG-TERM RESPONSE ACTION GROUNDWATER MONITORING REPORT (LBG/ARCADIS, 2015)

CLEANUP STD. - THE CLEANUP STANDARD SELECTED IS THE LOWER OF THE FEDERAL OR STATE MCLs FOR EACH COMPOUND OF CONCERN.
ROUND DATES: 1=9/1998, 2=11/1998, 3=3/2000, 4=10/2000, 5=11/2000, 6=8/2001,7=12/2002, 8=2/2003, 9=12/2004, 10=5/2007, 11=6/2009, 12=10/2009, 14=7/2011, 15=7/2013, 16=12/2013, 17=3/2014, 18=6/2014, 19=9/2014

ARCADIS

DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE
DOVER, NEW JERSEY

HISTORICAL GROUNDWATER CONCENTRATIONS AND LTRA MONITORING NETWORK
DEEP AQUIFER

FIGURE 4c