Remedial Investigation / Focused Feasibility Study Operable Unit 1

Lightman Drum Superfund Site
Winslow Township
Camden County, New Jersey

Prepared For:

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1.0 INTRODUCTION

This Remedial Investigation/ Focused Feasibility Study (RI/FFS) has been prepared by Golder Associates Inc. (Golder) on behalf of the Lightman Yard PRP Group (Group) for Operable Unit 1 (OU-1) of the Lightman Drum Company Superfund Site (Site), EPA ID#NJD014743678, located in Winslow Township, New Jersey.

A Remedial Investigation (RI) and Feasibility Study (FS) for OU-1 was completed between 2002 and 2009 (Golder 2009a,b) pursuant to an Administrative Order on Consent (AOC) (USEPA, 2000). Following approval of the RI and FS, the USEPA issued a Record of Decision (ROD, USEPA, 2009) for OU-1 selecting the following remedy to address groundwater contamination which included:

- Air Sparging and Soil Vapor Extraction (AS/SVE) of near-Property groundwater.
- Extraction and treatment of contaminated groundwater found in "hot spots" in the downgradient areas of the eastern and western groundwater plumes.
- Monitored Natural Attenuation (MNA) for the remaining portions of the plume.
- Establishment of a Classification Exception Area, as an institutional control, to minimize the potential for exposure to contaminated groundwater until the aquifer meets the cleanup goals.

The following OU-1 remedial activities have been subsequently completed pursuant to a Unilateral Administrative Order, effective June 19, 2010 (USEPA, 2010a/b):

- A Pre-Design Investigation (PDI; Golder, 2011b) providing additional data for the design of the AS/SVE system and additional investigation of the downgradient "hot spots".
- Design and construction of the AS/SVE system followed by operation commencing in February 2013.
- Installation of additional monitoring wells, in the area of the "hot spots", and sentinel wells.
- Comprehensive source area and downgradient groundwater monitoring since 2013.

Following 5 years of source area treatment and monitoring of downgradient groundwater, a Technical Memorandum was submitted to USEPA (Golder, 2018a) presenting an updated evaluation of downgradient groundwater in order to

a) confirm the plume was not expanding,

b) assess groundwater restoration timeframe based on AS/SVE source treatment and MNA, and

c) assess the benefit of downgradient groundwater extraction.

The Technical Memorandum recommended consideration be given to amending the 2009 ROD remedy for downgradient groundwater to replace extraction and treatment of contaminated groundwater found in "hot spots" in the downgradient areas with MNA. USEPA concurred with the Technical Memorandum by letter dated February 15, 2018 and requested that this RI / FFS be submitted to support consideration of a ROD Amendment.

This RI/FFS compares groundwater data collected during the original RI to data collected following the ROD. A detailed analysis of the original and amended alternatives for downgradient groundwater is also provided in accordance with the nine criteria established by the National Contingency Plan (NCP).

2.0 BACKGROUND

2.1 Description of Property

The Lightman Drum Company property (Property) covers approximately 15 acres in Winslow Township, Camden County, New Jersey and is identified as Block 4404, Lot 6 on the Winslow Township Tax Assessor's Map (Figure 1). The Property is narrow (approximately 300 feet wide) with access from Route 73. The majority of Property is wooded, and there is very little topographic relief across the Property with a maximum elevation range of 15 feet.

The Property is bordered to the east by Route 73, to the west by a rail line, to the north by farmland and wooded areas and to the south by commercial development and wooded areas. The vicinity of the Property is semi-rural with small businesses along Route 73, including a recreational vehicle storage adjacent to the south. A few residences are also located along Route 73.

2.2 Site Characteristics

2.2.1 Surface Water Hydrology

Topography generally slopes gently to the south-southwest with some relief apparent to the north of the Property. There is a retention area located near the Property entrance, which reportedly receives surface water flow from areas immediately to the west via a short culvert that runs beneath a parking area. A wetland area associated with Pump Branch Creek is located along the western fringe of the Property adjacent to the railroad track.

Pump Branch Creek is part of the Mullica-Toms watershed and eventually joins the Mullica River. As reported in the RI (Golder, 2009a), the United States Geological Survey installed a temporary stream flow station in Pump Branch Creek approximately 5 miles downgradient from the Site, and recorded an average discharge rate for the 10.81 square mile drainage basin of 13.8 ft^3/s over the recording interval. Flow in the vicinity of the Site is ephemeral.

2.2.2 Geologic Conditions

The Site is located in the Atlantic Coastal Plain Province of the eastern United States, which consists of a series of unconsolidated Cretaceous through Quaternary aged sands and clay sediments overlying Precambrian crystalline rocks. The sediments form a southeasterly-dipping wedge that gradually thickens from the outcrop areas near the Delaware River east toward the Atlantic Ocean (Hardt and Hilton, 1969). Dips range from about 11 feet to 100 feet per mile, stratigraphically deeper beds have the steepest dips and younger beds have the gentlest dips (Rhodehamel, 1973). The two near-surface units at the Site include the upper Oligocene to Holocene non-marine to marine shallow continental shelf sand and silt units: the Kirkwood Formation and the Cohansey Sand.

Most of the soils in the Site area are mapped as Downer loamy sand, Klej loamy sand, and Leon soil. All three soil units are well-drained soils with poor filtering capacity (Markley, 1966). Much of the active area of the Property has been covered by a veneer (on the order of inches) of fill material. The fill is fairly impermeable in some areas, as evidenced by the presence of large puddles after storms which remain for as long as several days after rainfall events.

2.2.3 Hydrogeological Conditions

The Site hydrogeologic model is characterized by the presence of a relatively uniform unconfined aquifer belonging to the Cohansey Sand (Zapecza, 1989), consisting of yellowish brown coarse to fine grained sand, underlain at depth by the Kirkwood Formation. The Cohansey-Kirkwood aquifer includes the Cohansey Sand and the upper, water-bearing units of the Kirkwood Formation. Lower units in the Kirkwood Formation include several confining units, the uppermost of which forms the base of the Cohansey-Kirkwood aquifer. Site-related test borings indicate that the aquifer in the vicinity of the Site extends to a depth on the order of 100 feet where a clay unit was encountered.

Regionally, the Cohansey-Kirkwood aquifer system is a water table aquifer that dips eastward toward the Atlantic Ocean. This aquifer is almost always unconfined, although local clay units in the Cohansey Sand occasionally create locally confined conditions. In the Site area, there are no such mapped continuous confining layers, nor have any been identified during the field investigations. The Cohansey-Kirkwood aquifer is used extensively as a water resource, primarily for domestic and farm-irrigation uses. Recharge to the unit is high, due to its high permeability, and therefore, the quantity of water available for use is substantial (Rooney, 1971).

Groundwater flow is generally in a south-southeasterly direction at and downgradient of the Site (Figure 2). During wet seasons and where the Pump Branch Creek is more developed (4,000 feet downgradient of the Property), the stream elevation is similar to nearby groundwater elevations. Studies during the RI showed that during dryer months the stream was dry, and groundwater levels were well below the base of the stream.

The Site falls within the New Jersey Pinelands protected area and, as such, groundwater in the area is classified as Class I-PL by the NJDEP.

2.3 Remedial Investigation (2009)

RI activities were commenced in August 2002 and were completed in March 2008 (Golder, 2009a). The RI identified two main plumes of groundwater contamination, one originating from the Former Waste Storage Tanks (eastern plume) and one originating from the former Unlined Disposal Pit Area (western plume). Both plumes were found to be relatively narrow both horizontally and in thickness. The groundwater plumes increase in depth below the ground surface with distance from the source area, resulting in a barrier of clean water above the plumes which would prevent the generation of vapors that could impact any structures above the contaminated plume in downgradient areas. At Pump Branch Creek, there is approximately 50 feet of clean groundwater between the plume and the creek bed.

The plumes contained chlorinated and aromatic volatile organic compounds (VOCs), although the aromatics (primarily toluene and xylenes) extended a relatively short distance from the sources compared to the chlorinated VOCs. The eastern plume extends further downgradient than the western plume and is also distinguished by the presence of small isolated areas of higher concentration, (primarily tetrachloroethene (PCE) and trichloroethene (TCE)), bounded by areas of lower concentration within the boundaries of the overall plume. PCE isoconcentrations from the RI are shown in Figures 3 and 4. The RI demonstrated that these “hot spots” were very narrow vertically and horizontally based on extensive aquifer profile borings. The ROD defined “hot spots” as areas exceeding 100 µg/L for PCE or TCE, and acknowledged that additional investigations would be required to further delineate the size, extent and level of contamination of the “hot spots” in order to provide adequate information to design the remedy.

Analysis of natural attenuation indicator parameters (NAPs) during the RI illustrated the presence of two geochemically distinct areas of the Site corresponding to the source areas and the downgradient plumes. In the source areas, NAPs were consistent with on-going anaerobic biodegradation of both BTEX compounds and chlorinated compounds, whereas in the downgradient plume, the geochemical environment was more aerobic. Although the downgradient conditions are not compatible with biodegradation of chlorinated compounds by the most common anaerobic pathways, degradation of chlorinated ethenes is evidenced by the presence of daughter product cis-1,2-DCE, which is present in higher concentrations in downgradient wells than parent compounds PCE and TCE. Aerobic degradation pathways have been demonstrated for PCE, TCE, and cis-1,2-DCE degradation and the daughter product of these oxygenase enzyme co-metabolic pathways is carbon dioxide (CO_2). Because of the low parent compound concentrations, CO_2 concentrations produced by this mechanism would be indiscernible from background. Regardless of the mechanism, overall the data indicated that concentrations of chlorinated ethenes continue to be reduced, likely by the range of natural attenuation mechanisms recognized in USEPA (1999), including advection, dispersion, sorption, and dilution as well as biodegradation.

2.4 Risk Summary

The Final Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment for OU-1 (Golder, 2009d) was approved by USEPA on April 23, 2009. This Baseline Human Health Risk Assessment estimated quantitative risks for industrial/commercial workers, trespassers (both pre-adolescent and adolescent), residents (adult and child), and construction workers. Cancer risks and non-cancer hazard indices were estimated for both reasonable maximum exposure (RME) and central tendency (CT) scenarios based on Site-specific exposure pathways (both current and potential future exposure) for the five media: groundwater, surface soil, subsurface soil, surface water, and sediment. The Baseline Risk Assessment did not identify any unacceptable levels of constituents within sediment or surface waters.

No current exposure pathway to contaminated groundwater was identified as homeowners are required by municipal ordinance to connect to the municipal water supply system. The risk assessment identified risks that exceeded USEPA guidelines for exposure to volatile organic compounds in groundwater by potential future industrial/commercial workers and hypothetical future on-property residents. Baseline risks were calculated prior to source area treatment and therefore do not represent current conditions. Monitoring of sentinel wells (MW-17, MW-18, MW-25, and MW-26) over the past 5 years has indicated only sporadic trace level detections of VOCs, well below the NJDEP Class IIA Groundwater Quality Standards, confirming that the current conditions and monitoring well network are protective.

3.0 REMEDY STATUS

3.1 Source Area Remediation

The AS/SVE system has been operating since February 1, 2013, removing VOCs in soil and groundwater at the Site. On-going monitoring, operations, and maintenance of the AS/SVE system (Golder, 2018b) has been reported annually demonstrating that this remedy has been effective in addressing the source areas with reductions of VOC concentrations exceeding 98% in groundwater monitoring wells within the source areas. Based on the December 2017 monitoring data, total VOCs in all source area monitoring wells are currently less than 5 µg/L (MW-2AR, MW-3, MW-7, MW-8A). The source areas and immediate downgradient groundwater have been successfully treated and remediation in these areas is nearly complete and no longer contributes to downgradient groundwater contamination. The AS/SVE system will continue to operate in 2018 to address the remaining low levels of VOCs as necessary and to address any rebound following system shut down.

During the latter stages of the RI and FS, a small area of VOC-impacted unsaturated zone soils was identified to the east of the former waste storage tank area. These impacted unsaturated soils were defined as Operable Unit 2 (OU-2). SVE was selected as the remedy for OU-2 (USEPA, 2011) and was implemented together with the OU-1 remedy. The SVE system has successfully treated unsaturated soils that have the potential to impact groundwater. As established in the OU-2 ROD, concentrations of 2.6 mg/kg for PCE and 14.0 mg/kg for TCE, are protective of groundwater. Soil sampling conducted in April 2017 identified only a small isolated area still exceeding those goals. System modifications, including three new SVE wells, were implemented in the fall of 2017 to address this area. Additional confirmation sampling is planned in 2018.

3.2 Groundwater Investigations

3.2.1 Pre-Design Investigation (2011)

A Pre-Design Investigation (PDI) was conducted in 2011 pursuant to the Remedial Design Work Plan (Golder, 2011a) that included further delineation of “hot spots” using aquifer profile borings. The results of the 2011 PDI were presented in the Field Sampling and Analysis Report (FSAR, Golder 2011b) and are summarized in Figures 5 and 6. The PDI confirmed that “hot-spots” with concentrations greater than 100 µg/L of PCE and TCE were aerially and vertically limited, and contained very limited mass. The estimated mass in the PCE “hot-spot” was 0.2 lbs. and the estimated mass in the TCE “hot-spots” was approximately 1 lb. (Golder, 2011b). Following the 2011 PDI, three additional monitoring wells (MW-22, MW-23, and MW-24) were installed to monitor the status of these “hot spots” and two additional wells (MW-25 and MW-26) were installed in 2012 further downgradient to serve as sentinel wells (Golder, 2013).

3.2.2 Groundwater Monitoring

A comprehensive downgradient monitoring program has been conducted since 2013 that has included the sentinel wells, plume periphery wells, and other downgradient monitoring wells including MW-22, MW-23, and MW-24 to monitor “hot spots” within the eastern plume. Data through 2017 was presented in the 2017 Summary Report / 2017 Operations and Monitoring Plan (Golder, 2018b). The data collected from this comprehensive monitoring effort over the past 5 years indicates the following:

- Sentinel wells (MW-17, MW-18, MW-25, and MW-26) indicate only sporadic trace level detections of VOCs well below the NJDEP Groundwater Quality Standards (and below the PQL for PCE and TCE). Sampling conducted at plume periphery wells (MW-13, MW-14, MW-15, and MW-16) shows trace or non-detect levels of VOCs. These data confirm that the plume is not expanding and the current monitoring well network is protective.
- VOC concentrations in the downgradient area have continued to decline when compared to the data collected during the RI. Iso-concentration contours for PCE indicating the overall extent of the plume (1 µg/L contour) defined during the RI in 2002-2005 and 2006-2007 (Golder, 2009a), along with data collected in 2011 (Golder, 2011b), and 2017 are shown successively in Figures 3-9 and clearly illustrate that the length and breadth of the plume have retracted since the RI.
- The plume core/former “hot spot” monitoring wells (MW-22, MW-23, and MW-24) all indicate concentrations of PCE and TCE, below 100 µg/L (December 2017), as shown on Figure 9, indicating that the remaining contaminant mass in these areas is extremely small. As shown in Figures 7-9, no “hot-spots” (PCE or TCE above 100 µg/L) have been observed in the downgradient plume through 2017.

As discussed in Section 2.3, analysis during the RI illustrated that natural attenuation processes were treating and reducing VOC concentrations. These conclusions are supported by the recent data clearly demonstrating that natural attenuation processes are effectively addressing VOCs downgradient, in conjunction with successful treatment of the source areas, and will continue to do so in the future.

4.0 DOWNGRADIENT GROUNDWATER PLUME EVALUATION

Based on source area treatment, Pre-Design Investigation activities, and subsequent monitoring described above, the selected remedy for downgradient "hot-spot" groundwater (localized groundwater extraction and treatment), warrants re-evaluation. To assist in this evaluation, Solute Transport Modeling and Advective Flushing Modeling were conducted to compare anticipated remedial timeframes for the ROD selected Extraction and Treatment and for MNA. Model results were presented in the subsequent Technical Memorandum (Golder 2018a) and are reproduced below with updates for data through 2017 as presented in the Annual Report (Golder 2018b).

4.1 Solute Transport Modeling

Solute transport modeling was used to assess the time to achieve complete groundwater cleanup[1] by natural attenuation in conjunction with source treatment. Modeling was conducted using Site data and an analytical transport model that includes advection, dispersion and sorption. Dilution is likely a significant process enhancing natural attenuation at the Site, but it is not accounted as part of the solute transport analysis, hence the results are considered to be conservative. The simulations presented below estimate complete cleanup of groundwater in 15 years or less.

The analytical model selected is that presented by Domenico and Schwartz, 1990 in which the quasi-three dimensional advection-dispersion solution with retardation and decay models the concentration of a constituent (C) with a continuous source. The solution to the governing equation is:

$$C(x,t)=\frac{C_o}{2}\exp\left\{\left(\frac{x}{2\alpha_x}\right)\left[1-\sqrt{1+4\lambda\alpha_x/v}\right]\right\}erfc\left[\frac{x-vt\sqrt{1+4\lambda\alpha_x/v}}{2\sqrt{\alpha_x vt}}\right]\left[erf\left(\frac{Y}{4\sqrt{\alpha_y x}}\right)erf\left(\frac{Z}{2\sqrt{\alpha_z x}}\right)\right]$$

where:

C=concentration (C_o is initial concentration), [M/V];

t=time [T];

x=longitudinal distance [L];

v=solute velocity (aligned in x-direction) [L/T];

α=dispersivity [L];

λ=coefficient of exponential decay [1/T].

Retardation is incorporated into the velocity term, i.e., the solute velocity is the groundwater velocity divided by the retardation coefficient, R ($R = 1 + K_d\rho_b/n$, where K_d is the distribution coefficient, ρ_b is bulk density and n is effective porosity). The coefficient of exponential decay is used to model biodegradation, with a constituent degradation half-life time ($t_{1/2}$) related to the decay rate ($\lambda = \ln[2]/t_{1/2}$).

PCE was used as the primary model species based on a higher concentration compared to TCE.

[1] i.e., To achieve class I-PL Pinelands groundwater standards (PQL of 1 µg/L for PCE).

Two model simulations were conducted, one (conservatively) assumes that no biodegradation is occurring in the downgradient plume and the other that a relatively low biodegradation rate, based on biodegradation via the aerobic co-metabolic pathway as discussed above. The parameters used in the solute transport model were based on site-specific values where available, and are tabulated below.

Parameter	Units	Value	Source
Simulation 1: No Biodegradation			
Hydraulic conductivity	Ft/day	60	Feasibility Study (FS)
Hydraulic gradient	-	0.002	FS
Effective porosity	-	0.30	FS
Dispersivity, x	Ft	41	Xu and Eckstein (1995)
Dispersivity, y	Ft	1.4	Model calibration
Dispersivity, z	Ft	1.4	Model calibration
Organic carbon partition	Log K_{oc}	2.50	Remedial Investigation (RI)
Organic carbon	Fraction	0.0004	RI data/model calibration
Bulk density	Grams/cm^3	2.7	Literature
Half-life	Years	999	No biodegradation assumed
Source area width	Ft	50	Site specific
Source area depth	Ft	10	Site specific
Simulation time	Years	40	RI
Simulation 2: With Biodegradation (same parameters as above except as below)			
Half-life	Years	11.0	Model calibration
Dispersivity, y	Ft	0.70	Model calibration
Dispersivity, z	Ft	0.057	Model calibration

The dispersivity value in the x-direction was derived from Xu and Eckstein (1995) and Al-Suwaiyan (1996) for a plume scale of 4,000 feet. Final values of dispersivity in y- and z-directions for each simulation were obtained during calibration to the monitoring well data. The organic carbon partition coefficient value is the average value of the range presented for PCE in Table 7-1 of the RI Report (Golder, 2009a). For Simulation 1, an elevated value of half-life was input to represent no biodegradation. For Simulation 2, calibration of the curve to the data was achieved with a degradation half-life of 11.0 years. This compares with summaries of studies provided by Aronson and Howard (1997) in which a range of groundwater half-life for PCE (typically under reductive dechlorination conditions) is given of 0.65 years to 10 years, and by Wiedemeier et al. (1998) of 0.03 years to 4 years. The simulated half-life of 11.0 years is greater than these published literature values based on a slower cometabolic process. The source area dimensions were estimated from the RI, and the simulation time estimated based on the known site operational history which commenced in the 1970s.

Based on the above input parameters, the following fate and transport values are calculated:

Parameter	Units	Value
Groundwater velocity	Ft/day	0.40
Solute velocity	Ft/day	0.24
Retardation	-	1.65
Distribution coefficient, K_d	milliliter/gram	0.316

Solute Transport Modeling Results

The simulations were conducted with a calibration phase followed by a predictive simulation of cleanup time.

Simulation 1

Initially, the solute transport models were calibrated to both the initial PCE concentration in the source area prior to source area remediation (4,600 µg/L at well MW-8A) and to maximum measured downgradient monitoring well concentrations[2]. The resultant model solution with the downgradient calibration data is shown below in Figures 10 and 11 (Figure 11 provides an expanded concentration scale).

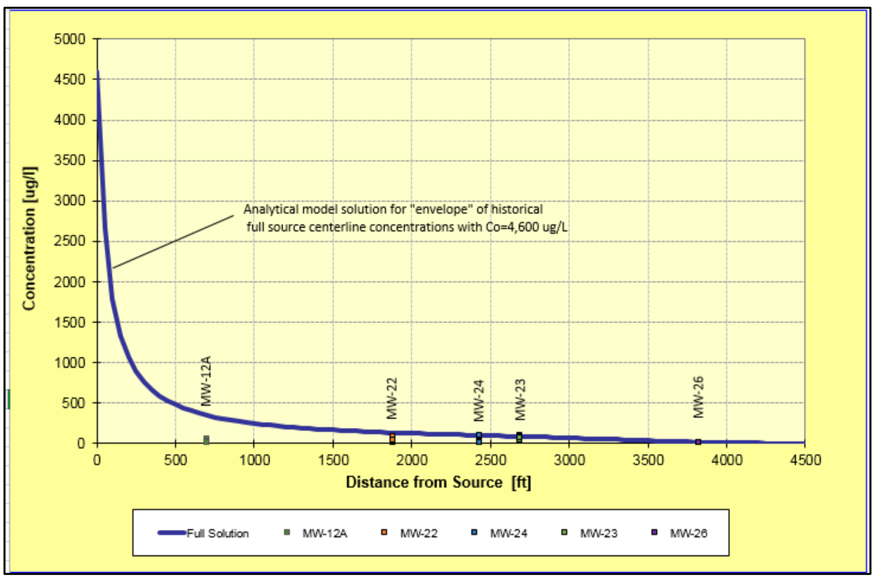


Figure 10. Simulation 1: Solute transport model calibration for PCE to source area and downgradient monitoring wells.

[2] The maximum values in the downgradient wells (installed in 2012) were taken over the monitoring period for each well from January 2013 through December 2017.

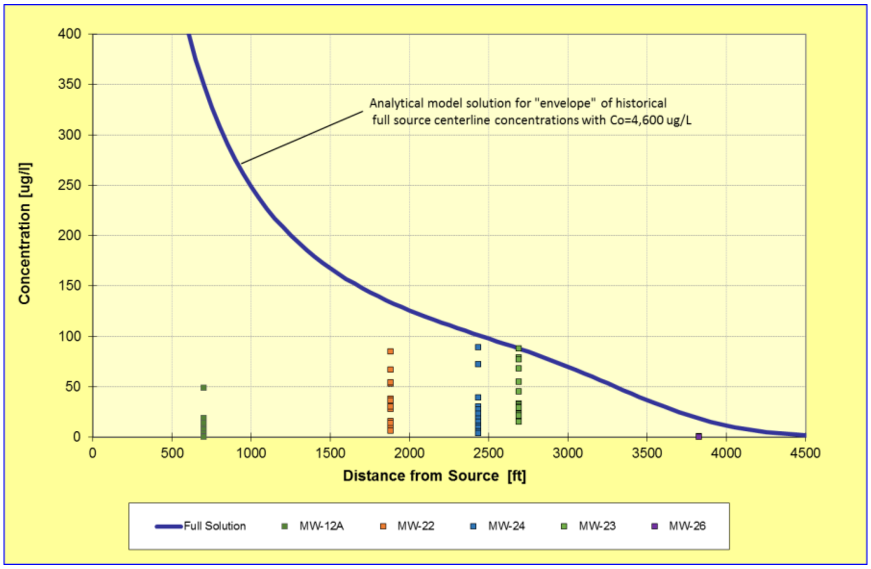


Figure 11. Simulation 1: Expanded concentration scale.

The calibrated model curve represents the "envelope" of measured maximum concentrations of PCE in the downgradient plume and, as such, is conservative.

It should be noted that the model calibrated to higher concentrations at the most downgradient location MW-26 than have been observed. This is likely due to local heterogeneity of the aquifer that can result in variability in flow in contrast with the model assumptions of constant groundwater velocity and adsorption, as well as not accounting for dilution.

The model was then run to incorporate the source remediation achieved by operation of the AS/SVE system. Source reduction is incorporated into the model using superposition by subtracting a simulation that represents the reduction in source concentration. For example, a hypothetical model simulation curve with an initial source concentration of 1,000 µg/L and a duration of 25 years is shown as the blue curve below. The contaminant distributions at 2, 5, 10 and 20 years' time after source reduction are shown in pink.

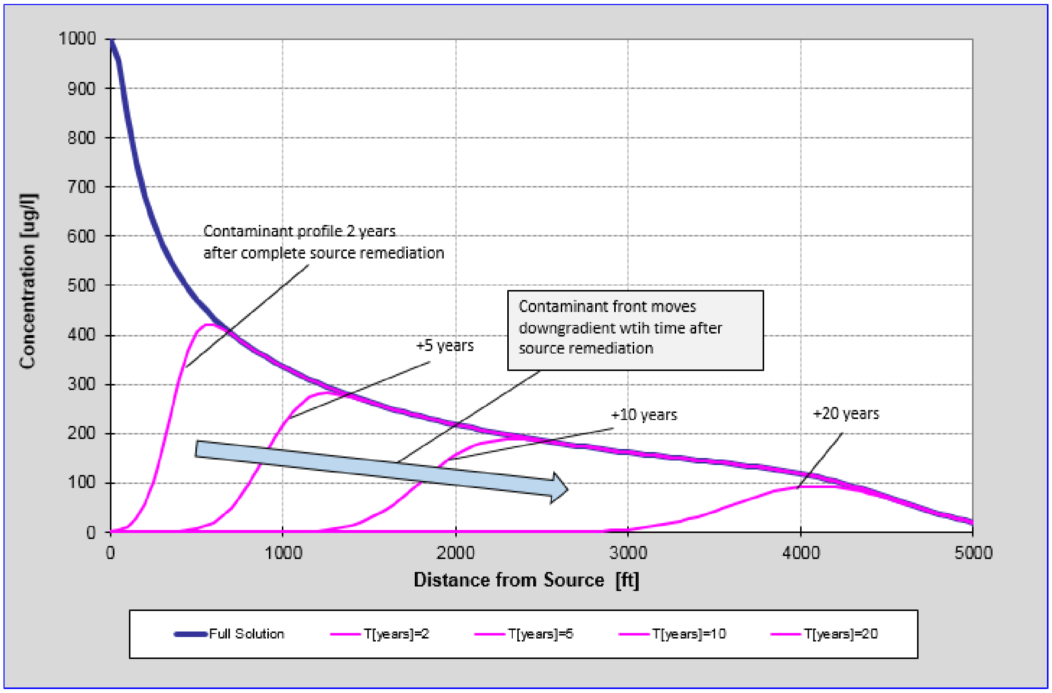


Figure 12. Hypothetical model simulation depicting analytical modeling of source remediation and subsequent plume attenuation with time.

The curve at n years' time after source reduction is derived by subtracting a model simulation that has an initial concentration of 1,000 µg/L and a duration of n years from the initial 25-year simulation with source concentration of 1,000 µg/L.

Source reduction simulations are shown below in Figures 13 and 14. The calibrated envelope of full source contaminant distribution from Figures 9 and 10 is shown in blue, and the PCE concentrations from December 2017 for wells MW-12A, MW-22, MW-23, MW-24 and MW-26 are shown. The model includes source removal by AS/SVE, and the source reduction curve matches the 2017 data closely. The remediation times are assessed using this curve solution as time zero, and additional simulations are conducted for +5 years, +10 years and +15 years. The time for this contaminant profile to attenuate and fall below 1 µg/L everywhere is approximately 15 years, as shown in Figure 14.

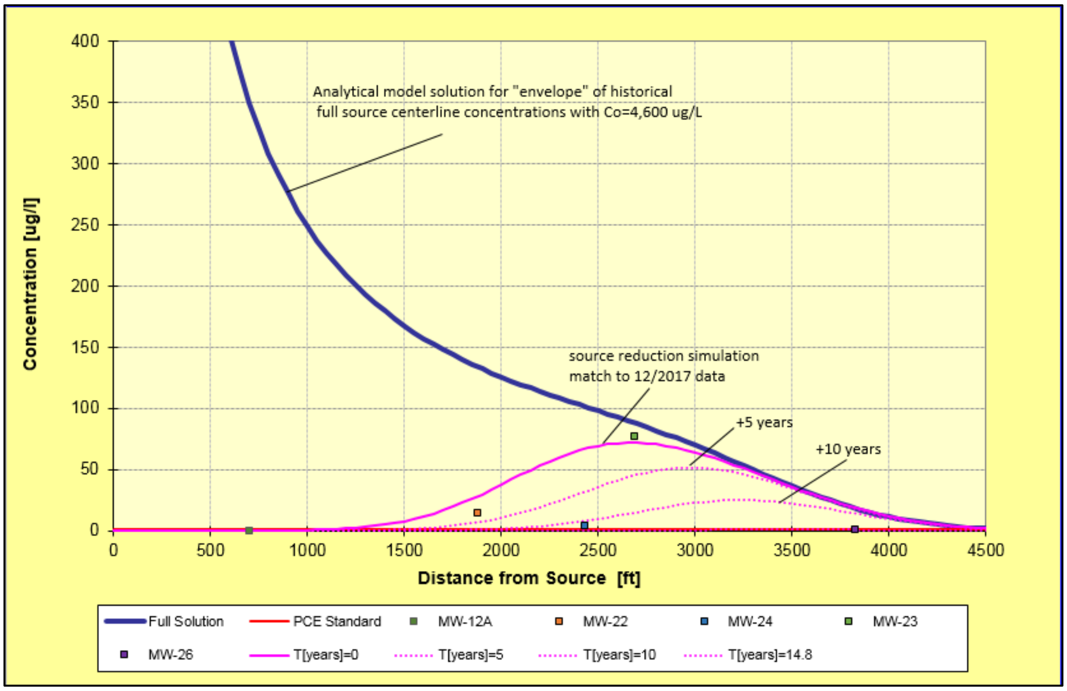


Figure 13. Simulation 1: Simulation of source reduction, calibration to December 2017 data and predictive modeling for attenuation of PCE.

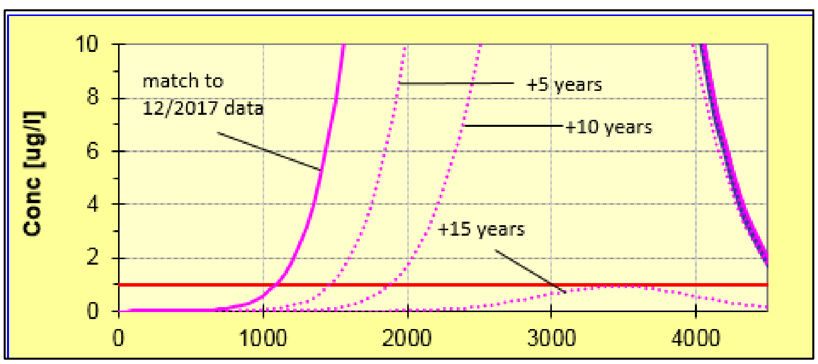


Figure 14. Simulation 1: Figure 13 with concentration scale of 0 to 10 µg/L and showing achievement of PCE <1 µg/L in 15 years.

Simulation 2

The graphs for Simulation 2 (which includes a biodegradation half-life of 11.0 years), are presented in Figures 15 to 18. Figures 15 and 16, below, present the calibration of the solution curve to the initial PCE concentration in the source area prior to source area remediation (4,600 µg/L at well MW-8A) and to maximum downgradient monitoring well concentrations. (Figure 16 provides an expanded concentration scale).

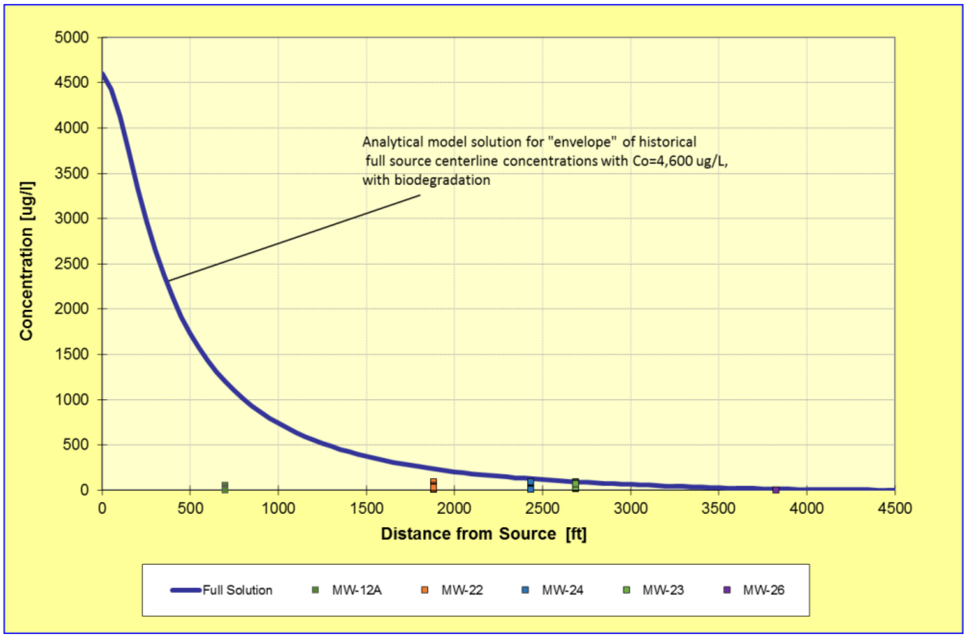


Figure 15. Simulation 2: Solute transport model calibration for PCE to source area and downgradient monitoring wells.

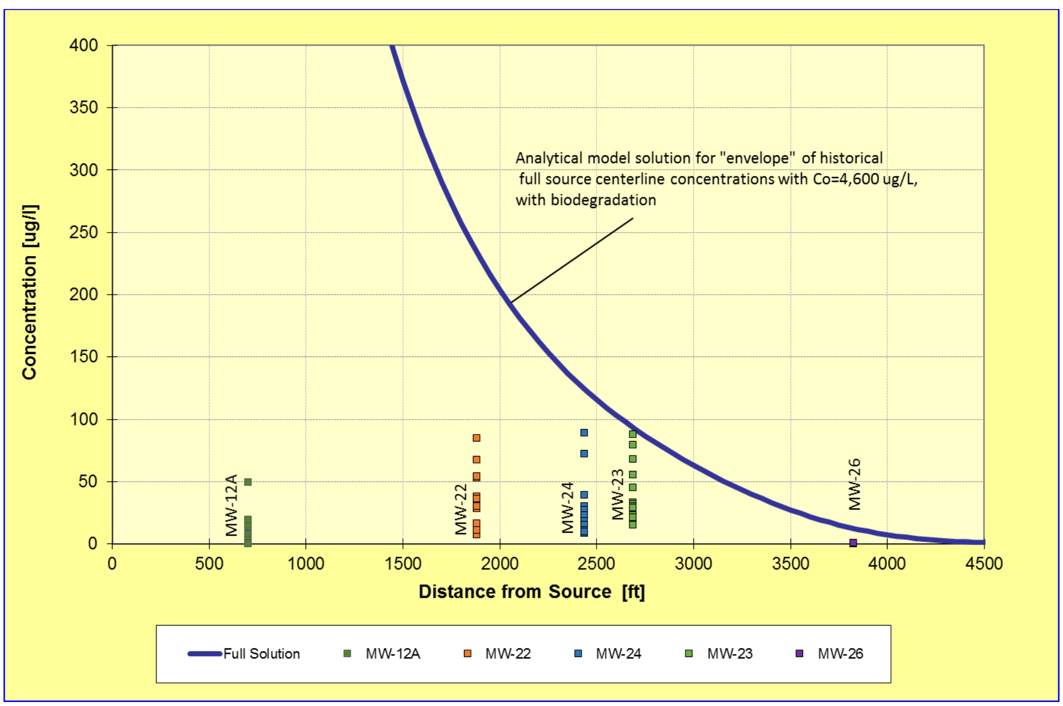


Figure 16. Simulation 2: Expanded concentration scale.

Source reduction simulations are shown below in Figures 17 and 18. The time for this contaminant profile to attenuate and fall below 1 µg/L everywhere is 14 years, as shown in Figure 18.

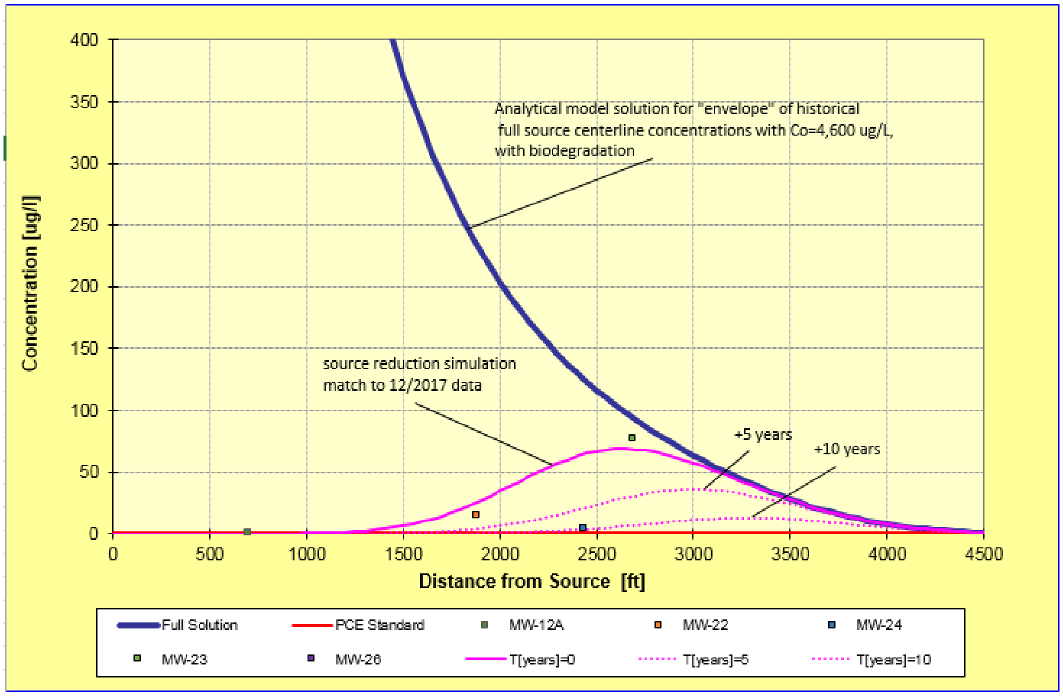


Figure 17. Simulation 2: Simulation of source reduction, calibration to December 2017 data and predictive modeling for attenuation of PCE.

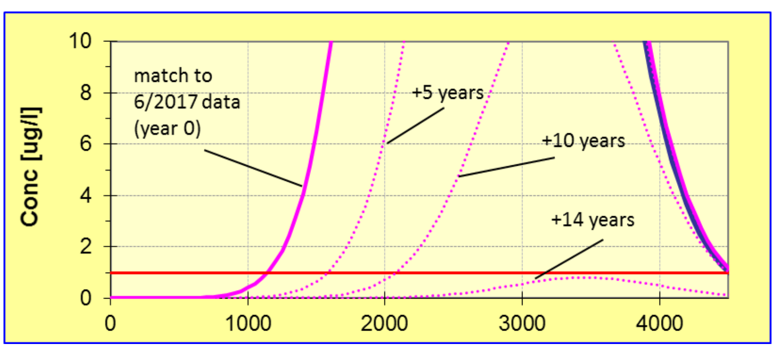


Figure 18. Simulation 2: Figure 17 with concentration scale of 0 to 10 µg/L and showing achievement of PCE <1 µg/L in 14 years.

The simulations above show complete cleanup of groundwater in 15 years or less. The analysis contains multiple conservative assumptions that tend to have the effect of increasing the estimated timeframe. Importantly, the model does not account for dilution, which is a process that would increase the attenuation rate of VOCs. The model is also based on simulation of an “envelope” of maximum PCE concentrations throughout the downgradient plume and the "calibrated" PCE concentrations at multiple well locations (MW-24 and MW-26) are higher than observed values. The model therefore likely over-estimates the time to achieve cleanup.

4.2 Advective Flushing Modeling

An advective flushing model was used to evaluate the timeframe required for a downgradient pump and treat alternative to achieve groundwater cleanup goals. Modeling was conducted using the USEPA Batch Flushing model (Cohen et al., 1997), which is based on the principle that restoration requires sufficient groundwater be flushed through the contaminated zone to remove both dissolved and sorbed contaminants. The remedial timeframe to achieve cleanup throughout the plume would be in excess of 13 years (likely on the order of 15 years) based on the analysis presented below.

The relationship between the number of pore volumes (PV) extracted and a reduction in concentration is given by:

$$\text{No. of PV} = -R \ln(C_s / C_f)$$

where

R = retardation coefficient (see Section 4.0)

C_s = starting concentration within the pore volume

C_f = final concentration within the pore volume.

Quarterly data for 2017 were used to establish maximum starting concentrations of 79 µg/L, 67 µg/L and 140 µg/L for PCE, TCE, and cis-1,2-DCE, respectively in MW-23. Given that TCE was lower in concentration and is less sorptive than PCE, TCE was eliminated from further analysis. Cis-1,2-DCE (higher concentration) and PCE (more sorptive), were retained for analysis[3] with the final concentrations set at the Class I-PL groundwater quality standards (1 µg/L for PCE and cis-1,2-DCE).

The conceptual pumping design for "hot spot" groundwater extraction was presented in the FS, and comprised a single well pumping up to 10 gpm. The design input parameters included an aquifer thickness of 35 feet, a horizontal hydraulic conductivity of 2.1×10^{-2} cm/s, and a hydraulic gradient of 2.1×10^{-3} ft/ft. The impacted aquifer thickness of 35 feet is considered conservative based on subsequent data collected during the PDI (2011) which indicated an impacted aquifer thickness of 25-30 ft ("hot-spots" were on the order of 10 feet thick). The FS conceptual modeling indicated that for a pumping rate of 10 gpm, the capture zone width was in excess of 400 feet. This is sufficient to control the entire width of the current downgradient plume as defined by the 1 µg/L contour (Figure 6). Based on the FS analysis, a pumping rate of 10 gpm was used for the batch flushing model.

The appropriate pore volume was defined by the 200-foot radius of influence of the pumping well, which equates to a calculated pore volume of 9.87×10^{6} gallons. Results of the batch flushing model calculations are shown in Table 1 below.

[3] The hydrogeologic parameters for analysis of cis-1,2-DCE include a K_{oc} of 40 ml/g (EPA RSL properties data base).

Table 1. Results of batch flushing model analysis.

	C_s (µg/L)	R	#PV	Time (yr)
PCE	79	1.63	7.1	13
Cis-1,2-DCE	140	1.08	5.3	10

The analysis shows that PCE requires the longest cleanup time (13 years, exclusive of the time that would be required to design and build a treatment system) consistent with its higher retardation. TCE, having lower concentrations than either PCE or cis-1,2-DCE, and being less sorptive than PCE, is predicted to have a shorter cleanup time than either PCE or cis-1,2-DCE.

The batch flushing analysis indicates that a cleanup time of 13 years is expected for the area of influence of the extraction well. Areas beneath the wetlands will continue to naturally attenuate after the cessation of pumping. The remedial timeframe to achieve cleanup throughout the plume will therefore be in excess of 13 years (likely on the order of 15 years).

4.3 Summary of Downgradient Plume Status

Groundwater monitoring data collected since the ROD indicate that the source areas have been successfully treated, natural attenuation processes are effectively addressing VOCs downgradient, and that a Focused Feasibility Study is warranted to re-evaluate the appropriate downgradient groundwater remedy. Specifically,

- The AS/SVE remedy for the source area has been implemented and has successfully treated the sources of contamination.
- The plume is stable and, in fact, has retracted significantly since the RI. No downgradient "hot spots" (PCE or TCE above 100 µg/L) have been detected through 2017.
- There are no current groundwater users and no complete risk pathway. A CEA/WRA Fact sheet will be submitted to NJDEP to establish a CEA/WRA to ensure protectiveness until remedial objectives are achieved.
- Groundwater modeling confirms that residual contaminants will be effectively addressed by MNA with complete cleanup expected in less than 15 years. A very similar clean-up time frame is estimated for a downgradient extraction and treatment alternative.
- A reliable network of existing monitoring wells is already in place to verify remedy performance.

5.0 FOCUSED FEASIBILITY STUDY

This FFS evaluates the remedy selected in the 2009 ROD for downgradient "hot spots" (extraction and treatment with re-injection of the treated groundwater) with the proposed amended remedy (MNA) in accordance with the criteria established in the National Contingency Plan (NCP).

5.1 Remedial Action Objectives

As defined in the 2009 ROD, the Remedial Action Objectives (RAOs) for OU-1 are to:

- Prevent unacceptable exposures to contaminated groundwater and associated vapors

- Control future migration of the contaminants of concern in groundwater
- Restore groundwater quality to regulatory levels

5.2 ARARs

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites comply with legally applicable or relevant and appropriate cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law, which are collectively referred to as "Applicable or Relevant and Appropriate Requirements" (ARARs), unless such ARARs are waived under CERCLA § 121(d)(4). "Applicable" requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. "Relevant and appropriate" requirements are those requirements that, while not legally "applicable", address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Only those State standards that are promulgated, are identified by the State in a timely manner, and are more stringent than Federal requirements may be applicable or relevant and appropriate. ARARs may relate to the substances addressed by the remedial action (chemical-specific), to the location of the site (location-specific), or the manner in which the remedial action is implemented (action-specific).

5.2.1 Chemical-Specific ARARs

Chemical-specific ARARs represent health or risk-based concentration limits in various environmental media for relevant chemicals. Because the Site falls within the New Jersey Pinelands protected area, the groundwater is classified as Class I-PL by the NJDEP and the groundwater quality standards correspond to background values or the practical quantitation limit (PQL), whichever is higher. Downgradient groundwater contaminants and their applicable clean up criteria are shown in Table 2.

5.2.2 Location-Specific ARARs

Location-specific ARARs set restrictions on the conduct of remedial activities in particular locations (e.g. floodplains). Potential State and Federal location-specific ARARs include Executive Orders on Floodplain Management and Wetlands Protection, the Federal Fish and Wildlife Conservation Act, and the New Jersey Soil Erosion and Sediment Control Act.

5.2.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions or conditions taken with respect to specific hazardous substances. Action-specific ARARs do not determine the remedial alternative; rather, they indicate how a selected alternative must be implemented. Potential Federal and State action-specific ARARs are contained in the Resource Conservation and Recovery Act (RCRA); the Clean Water Act; the Clean Air Act; and New Jersey statutes for pollutant Discharge, Surface Water Quality, and Toxic Pollutant Effluent Standards.

5.3 Remedial Alternatives

The two alternatives to be evaluated for downgradient groundwater "hot spot" areas are:

- Alternate 1: MNA
- Alternate 2: Groundwater Extraction and Treatment

The other remedial components selected by the OU-1 ROD remain common to both alternatives including:

- Air Sparging and Soil Vapor Extraction (AS/SVE) of near-Property groundwater
- Monitored Natural Attenuation for the remaining portions of the plume
- Establishment of a Classification Exception Area, as an institutional control to minimize the potential for exposure to contaminated groundwater until the aquifer meets the cleanup goals

5.3.1 Alternative 1: MNA

MNA, as defined in the USEPA Directive 9200.4-17 (1999), refers to the reliance on natural attenuation processes to achieve Site-specific remediation objectives within a time-frame that is reasonable compared to that offered by other more active methods. MNA utilizes natural in-situ processes including physical, biological or chemical methods to reduce the mass, toxicity, mobility, volume, or concentration of chemicals in groundwater (USEPA, 1999). In-situ processes include biodegradation, dispersion, dilution, sorption, volatilization, stabilization, transformation, and destruction. These natural processes are monitored via regular sampling and analysis of wells, including downgradient "sentinel wells" positioned to assure that the area of contamination is not expanding in size.

A critical component of MNA is a well-designed regular monitoring program. For purposes of this FFS, the monitoring program for the downgradient "hot-spots" would include monitoring the existing plume core wells installed in 2012 (MW-22, MW-23, and MW-24). This monitoring program for the "hot spots" areas would be included as part of an overall MNA Plan for the Site that will include monitoring of the plume periphery, source area wells and sentinel wells.

5.3.2 Alternative 2: Groundwater Extraction & Treatment

This technology consists of the physical extraction of impacted groundwater, treatment, and reinjection of the treated groundwater in "hot spot" areas.

Extraction wells are used to capture and withdraw degraded groundwater with well locations dependent on geologic and hydrogeologic conditions, and the nature and extent of contamination. Extraction wells are generally a long term remedial technology that is used to control the mobility of contaminants in groundwater. Operation and maintenance of the wells is critical to maintain effectiveness because of susceptibility to biologic growth and precipitation of metals. On-Site Treatment of extracted groundwater would require construction of a water treatment system, which may include air-stripping and/or carbon adsorption.

Effluent from the treatment system would be discharged to injection wells. Discharge permit equivalencies would be required and possible hydraulic effects on the downgradient plume must be considered. Discharge may be part of a recirculation system that may provide hydraulic containment as well as aquifer flushing. Additional treatment of extracted groundwater may be required to prevent fouling of injection points by iron precipitation or bio-mass growth.

Design and implementation of a downgradient extraction and treatment system would require a PDI which would include a pumping test to provide design parameters. An initial evaluation of potential capture zones was conducted using the approach proposed by Todd, 1980 as presented in the original Feasibility Study (Golder, 2009a). Calculations based on a hydraulic conductivity of 2.1×10^{-2} cm/s, a 35-foot aquifer thickness (based on the maximum plume thickness) and a horizontal hydraulic gradient of 2.1×10^{-3} feet/foot (Golder, 2009a) were presented in Appendix E of the original Feasibility Study. The calculations indicated that a pumping rate of 10 gpm would achieve the necessary capture zone width.

For purposes of this FFS, the installation of one (1) extraction well to address “hot spots” was assumed. The estimated pumping rate necessary to capture a “hot spot” was assumed to be 10 gpm for costing purposes, but would be determined based on the pumping test. Treatment was assumed to consist of filtration and granular activated carbon adsorption followed by reinjection utilizing one injection well located approximately 800 feet upgradient of the extraction well. It was assumed that the treatment system would include an equalization tank and discharge pump contained in an enclosure, and piping between the wells and the system would be installed below grade. Performance monitoring was assumed to include sampling of the existing wells MW-22, MW-23 and MW-24.

5.4 NCP Criteria Evaluation of Alternatives

The selection of a remedial alternative is based on an evaluation of nine criteria established in the NCP. Two of these criteria (state acceptance and community acceptance) will be addressed during the public comment period following issuance of a Proposed Remedial Action Plan (PRAP). The remaining criteria are summarized below and evaluated in subsequent sections of this FFS.

- Overall Protection of Human Health and the Environment: Under this criterion, an alternative is assessed to determine whether it can adequately protect human health and the environment, in both the short-term and long-term, from unacceptable risks posed by hazardous substances, pollutants or contaminants present at the Site, by eliminating, reducing or controlling exposures to levels established during development of remediation goals.
- Compliance with ARARs: This criterion evaluates whether and how the alternative attains applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws, or provides grounds for invoking the legal waiver of such requirements.
- Short-Term Effectiveness: This criterion evaluates the impacts of the alternative during implementation with respect to human health and the environment.
- Reduction of Toxicity, Mobility, and Volume through Treatment: Under this criterion, the degree to which an alternative employs recycling or treatment that reduces toxicity, mobility, or volume is assessed, including how treatment is used to address the principal threats posed at the Site.
- Long-Term Effectiveness and Permanence: Under this criterion, an alternative is assessed for the long-term effectiveness and permanence it affords, along with the degree of uncertainty that the alternative will prove successful.
- Implementability: This criterion addresses the technical and administrative feasibility of implementing the alternative as well as the availability of various services and materials required.
- Cost: This criterion addresses the estimated costs of implementing the alternative to the level necessary for comparison between alternatives with a typical accuracy of plus 50% and minus 30%. Costs considered include capital and operation and maintenance costs with net present worth costs calculated over a 15-year period using a discount factor of 7% based on USEPA guidance.

A summary of the alternatives analysis presented in the following sections is provided in Table 3.

5.4.1 Alternative 1: MNA

Overall Protection of Human Health and the Environment

This alternative would achieve overall protection of human health and the environment. Remediation in the source areas and immediate downgradient groundwater is nearly complete and total VOCs in source area monitoring wells[4] are currently less than 5 µg/L (MW-2AR, MW-3, MW-7, MW-8A), and therefore the source area no longer contributes to downgradient groundwater contamination. MNA will continue to address downgradient groundwater. There are no current or anticipated future receptors for contaminated groundwater as a municipal ordinance requires connection to the municipal water supply system. The downgradient plume is not expanding and will continue to be monitored by an extensive monitoring well network currently in place as part of an MNA Plan. Institutional controls in the form of a CEA will provide protective measures until the groundwater cleanup has been completed. Calibrated modeling confirms that residual contaminants will be effectively addressed by MNA within approximately 15 years.

Compliance with ARARs

This alternative would be expected to achieve ARARs as described below.

Chemical-Specific ARARs

This alternative is expected to, over time, comply with the chemical specific groundwater quality ARARs (NJDEP Groundwater Quality Standard for Class I-PL Groundwater, N.J.A.C. 7:9C) through natural attenuation processes in accordance with N.J.A.C. 7:26E-6.3. As indicated by Solute Transport modeling, this is expected to be achieved within approximately 15 years.

Location-Specific ARARs

Groundwater monitoring activities are minimally invasive and are not expected to trigger any location-specific ARARs.

Action-Specific ARARs

Purge water and any associated investigative derived waste (IDW) would characterized and transported to a licensed treatment facility. All maintenance and monitoring activities would be subject to the Occupational Safety and Health Act (OSHA, 29 USC 651-678).

Short-Term Effectiveness

There would be no construction activities, and therefore only minor and transient impacts associated with groundwater monitoring.

Reduction of Toxicity, Mobility, and Volume through Treatment

Source area treatment has significantly addressed the toxicity, mobility, and volume of contaminant mass in the source area, effectively eliminating additional mass contribution to the downgradient plume. As discussed above, natural attenuation processes are effectively treating downgradient groundwater. The overall plume is stable and has retracted significantly since the RI and as demonstrated by data collected through 2017 there are currently no downgradient “hot spots”.

[4] December 2017 data

Long-Term Effectiveness and Permanence

MNA is effective over the long term and is a permanent remedy. Monitoring will be conducted to verify performance, including USEPA five-year reviews to assess the continued protectiveness. Groundwater modeling confirms that the residual contaminants will be effectively addressed by MNA with complete clean-up in approximately 15 years.

Implementability

A reliable network of monitoring wells is already in place to verify remedy performance.

Cost

The preliminary net present worth cost estimate for Alternative 1 is $150,000 USD. As summarized in Appendix A, costs for “hot spot” MNA include regular sampling of 3 wells that would be part of the overall MNA program for the remainder of the plume together with associated laboratory analyses, and data evaluation.

5.4.2 Alternative 2: Groundwater Extraction and Treatment

Overall Protection of Human Health and the Environment

The groundwater extraction and treatment system would provide protection of human health and the environment by removal and treatment of contaminants in localized downgradient “hot spot” areas with reinjection of the treated groundwater. Remediation in the source areas and immediate downgradient groundwater is nearly complete and total VOCs in source area monitoring wells[5] are currently less than 5 µg/L (MW-2AR, MW-3, MW-7, MW-8A), and therefore the source area no longer contributes to downgradient groundwater contamination. MNA will continue to address downgradient groundwater. There are no current or anticipated future exposures to the contamination as a municipal ordinance requires connection to the municipal water supply system. The downgradient plume is not expanding and will continue to be monitored by an extensive monitoring well network currently in place as part of an MNA Plan. Institutional controls in the form of a CEA would provide protective measures until such time as the groundwater cleanup has been completed. Modeling (Section 4) suggests that clean-up would be complete within approximately 15 years.

Compliance with ARARs

This alternative would be expected to achieve ARARs as described below.

Chemical-Specific ARARs

This alternative is expected to, over time, comply with the chemical specific groundwater quality ARARs (NJDEP Groundwater Quality Standard for Class I-PL Groundwater, N.J.A.C. 7:9C) through downgradient extraction and treatment of groundwater in combination with natural attenuation processes in other areas of the plume. As indicated by the USEPA Batch Flushing model (Cohen et al., 1997) the timeframe required for a downgradient pump and treat alternative to achieve groundwater cleanup goals is estimated to be on the order of 15 years).

Location-Specific ARARs

Because the downgradient extraction and treatment system may be located in the 100-year floodplain, and may impact the hydrology of Pump Branch Creek and associated wetlands, implementation of this alternative may be subject to the ARARs regulating the protection of floodplains as well as those regulating the protection of

[5] December 2017 data

wetlands. These include the Federal National Environmental Policy Act (40 CFR 6, Appendix A) and the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13), the New Jersey Freshwater Wetlands Protection Act (N.J.A.C. 7:7A, N.J.S.A. 13:9B-1), and the Federal National Environmental Policy Act (40 CFR 6, Appendix A). Engineering controls would need to be established to minimize the disturbance and any disturbance would be restored in accordance with ARARs.

Potential ARARs also include the Federal Endangered Species Act (16 USC 1531 et seq. and 40 CFR 400), the Endangered Plant Species List Act (N.J.S.A. 13:1B et seq.), and the Federal National Historic Preservation Act (16 USC 469 et seq., 40 CFR 6301(c)). While Swamp Pink was identified as a federally-listed threatened plant species that could be located on or adjacent to the Site, a survey conducted during the RI found no evidence of the plant and indicated that the hydrologic conditions have changed and no longer provides the constant moisture required by Swamp Pink. Also, a Stage IA Cultural Resources Survey conducted during the RI indicated low to moderate potential for pre-historic archaeological remains and a low potential for historic archeological remains.

Action-Specific ARARs

Treatment processes would be subject to various regulations including the Clean Air Act (42 USC 7401); National Ambient Air Quality Standards (40 CFR 50); National Emission Standards for Hazardous Air Pollutants (40 CFR 63); the Resource Conservation and Recovery Act (RCRA, 42 USC 6901 et seq.) including 40 CFR Part 261, Part 263, part 268 and Part 270, and DOT rules including 49 CFR Parts 107, 171 and 173.

For the discharge of treated groundwater through re-injection, regulations protecting groundwater quality would be relevant and appropriate such as The Safe Drinking Water Act (40 CFR 144-147) and the New Jersey Pollutant Discharge Elimination System rules (N.J.A.C.7:14A).

All construction, maintenance and monitoring activities would be subject to the Occupational Safety and Health Act (OSHA, 29 USC 651-678) and, in some cases, may be subject to the New Jersey Soil Erosion and Sediment Control Act (N.J.S.A. 4:24-39 et seq.). Purge water and any IDW would be characterized and transported to a licensed treatment facility.

Short-Term Effectiveness

Access to private property will be required to construct and operate groundwater extraction, treatment and reinjection systems. Construction activities will result in short-term negative impacts on these properties. With proper health and safety procedures, the short-term risks to construction workers and site workers are low.

Reduction of Toxicity, Mobility, and Volume through Treatment

Source area treatment has significantly addressed the toxicity, mobility, and volume of contaminant mass in the source area, effectively eliminating additional mass contribution to the downgradient plume. As discussed above, natural attenuation processes are effectively treating downgradient groundwater. The overall plume is stable and has retracted significantly since the RI and as demonstrated by data collected through 2017 there are currently no downgradient “hot spots”. Therefore, the additional reduction in toxicity, mobility and volume contaminants within the groundwater achieved by extraction and treatment will be minimal.

Long-Term Effectiveness and Permanence

It is expected that the concentration of extracted groundwater will be low and will decrease to an asymptotic level. The groundwater extraction and treatment system will therefore have very low efficiency in treating contaminants over time due to the low mass removal rate. Long-term performance monitoring would be conducted to verify performance, including USEPA five-year reviews to assess the continued protectiveness.

Groundwater modeling indicates that residual contaminants will be effectively addressed by extraction and treatment in approximately 15 years.

Implementability

Design of the downgradient groundwater extraction and treatment system requires additional information from hydrogeologic testing. There are also multiple implementation challenges, including the need for long-term access to several private properties for the construction, operation and maintenance of extraction, conveyance, treatment, and reinjection systems that would result in long-term disruption to the affected properties. The time required to address access issues and conduct hydrogeologic testing, design, and implementation of extraction and treatment would off-set any possible gains in the anticipated remediation timeframe. Construction, operations, and maintenance of a downgradient groundwater extraction and treatment system would also result in an increased carbon footprint as a result of increased energy use and associated carbon dioxide emissions.

Cost

The preliminary net present worth cost estimate for Alternative 2 is $2,160,000 USD. The extraction and treatment costs are primarily driven by the initial engineering and construction costs, but also include estimated costs for securing access and operation and maintenance, and semi-annual performance monitoring using 3 existing wells.

5.5 Comparative Analysis of Alternatives

A comparative analysis of the alternatives presented in Section 5.4 is presented below and summarized in Table 3.

Overall Protection of Human Health and the Environment

Both alternatives provide protection of human health and the environment. Each alternative builds on the source area treatment and will remediate groundwater “hot spots”. There are no current receptors and the downgradient plume is not expanding. Institutional controls in the form of a CEA will provide protective measures until such time groundwater cleanup has been achieved.

Compliance with ARARs

Both alternatives are expected to comply with groundwater ARARs in a reasonable time frame (approximately 15 years for both alternatives).

Short-Term Effectiveness

The construction activities involved with the Alternative 2 would likely result in short-term negative impacts involving construction of pipelines, wells and treatment systems on private property and would require negotiating appropriate access agreements. Access agreements are already in place for Alternative 1 with only occasional needs for access with minimal disruption. With proper health and safety procedures, the short-term risks to workers are low for both alternatives.

Reduction of Toxicity, Mobility, and Volume through Treatment

Source area treatment has significantly addressed the toxicity, mobility, and volume of contaminant mass in the source area, effectively eliminating additional mass contribution to the downgradient plume. Natural attenuation processes (Alternative 1) has been shown to be effective in addressing "hot spot' contamination as there are currently no downgradient "hot spots" and the overall plume has retracted since the RI. Alternative 2 would also reduce the toxicity, mobility and volume of the limited mass of the residual dissolved phase contaminants, but not to any significantly greater extent than Alternative 1.

Long-Term Effectiveness and Permanence

Both alternatives will be effective in the long-term and will be permanent. There is no longer a contributing source to downgradient groundwater and natural attenuation (Alternative 1) processes will continue to address the residual contaminants. Alternative 2 will also address the residual contaminants, however, it is likely to approach an asymptotic, low rate of mass removal that is not efficient in the long term and MNA will likely be needed in any event to address residual contaminants. Both alternatives are expected to achieve clean up in approximately 15 years.

Implementability

In general, the equipment, services and materials to implement both alternatives are readily available. Alternative 1 has already been implemented and therefore is ongoing. Alternative 2, Extraction and Treatment, is less implementable as it would require construction of pipelines, wells and treatment systems on multiple private properties with subsequent operation and maintenance resulting in significant long-term disruption to the affected properties. Alternative 2 is not immediately implementable as new access agreements will be required, a PDI will be necessary to obtain design information, and the remedy will then need to be designed and constructed.

Cost

Alternative 1 ($150,000) is significantly the cost effective than Alternative 2 ($2,160,000).

6.0 CONCLUSION

The remedy selected in the 2009 OU-1 ROD for downgradient "hot spots" (extraction and treatment of contaminated groundwater with re-injection) has been evaluated against the proposed amended remedy (MNA) in accordance with the NCP criteria.

Both alternatives satisfy the threshold criteria of overall protection of human health and the environment as there is no current exposure to contaminated groundwater and a Classification Exception Area/Well Restriction Area will be in place until such time cleanup as goals are met. Both alternatives are also expected to achieve Applicable and Relevant and Appropriate Requirements (ARARs).

Both alternatives will be effective in the long-term and will be permanent, and both will reduce the toxicity, mobility, and volume of contaminants through treatment. The source area has been treated by AS/SVE and there is no continuing source to the downgradient groundwater. Ongoing monitoring has shown that MNA (Alternative 1) has been effective in addressing downgradient contaminants and these processes are expected to continue. The plume has retracted since the RI and the remaining contaminant mass in the downgradient plume is low with no current "hot spots". Downgradient extraction and treatment (Alternative 2) is also expected to achieve cleanup goals, but the cleanup time will not be materially reduced compared to MNA.

Short-term impacts associated with construction of wells, and conveyance and treatment systems on private property will occur with the groundwater extraction alternative but not with MNA. MNA has already been implemented and a reliable network of monitoring wells is in place to verify remedy performance. In contrast, downgradient extraction and treatment will face significant implementation challenges such as securing access to private property for construction and operation and maintenance of extraction, conveyance, treatment, and discharge systems, all of which would be more disruptive than an MNA approach. The time required to address these issues and conduct hydrogeologic testing, design, and implementation would further off-set any potential gain in the anticipated remediation timeframe through extraction and treatment. Also, construction, operations, and maintenance of a downgradient groundwater extraction and treatment system would result in an increased carbon footprint as a result of increased energy use and associated carbon dioxide emissions.

Finally, the additional cost for downgradient extraction and treatment (estimated to be $2.2 million), makes this alternative much less cost-effective.

7.0 REFERENCES

Al-Suwaiyan, M., 1996, Discussion of "Use of Weighted Least Squares Method in Evaluation of the Relationship between Dispersivity and Field Scale”, Ground Water, v.34, no. 4, p. 578.

Aronson, D. and Howard, P., 1997, Anaerobic Biodegradation of Organic Chemicals in Groundwater: A Summary of Field and Laboratory Studies, prepared for American Petroleum Institute et al., November 1997.

Cohen et al, 1997. Design Guidelines for Conventional Pump-and-Treat Systems, EPA/540/S-97/504, September 1997.

Domenico, P., and Schwartz, F., 1990 Physical and Chemical Hydrogeology, John Wiley and Sons, N. Y., N. Y. 1990.

Golder, 2009a. Final Remedial Investigation Report, Lightman Drum Superfund Site, Winslow Township, New Jersey, Golder Associates Inc., February 2009.

Golder, 2009b. Final Feasibility Study, Lightman Drum Superfund Site, Winslow Township, New Jersey, Golder Associates Inc., February 2009.

Golder, 2009d. Final Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment, Lightman Drum Superfund Site, Winslow Township, New Jersey, Golder Associates Inc., February 2009.

Golder, 2011a. Revised Remedial Design Work Plan, Operable Unit 1, Lightman Drum Superfund Site, Winslow Township, New Jersey, Golder Associates Inc., March 2011.

Golder, 2011b. Field Sampling and Analysis Report, Lightman Drum Company Superfund Site, Winslow Township, New Jersey, Golder Associates Inc., November 2011.

Golder, 2013. Monitoring Well Installation and Groundwater Sampling, Lightman Drum Company Site, Winslow Township, New Jersey, Golder Associates Inc., April 2013.

Golder, 2018a. Lightman Drum Site: Downgradient Groundwater, Lightman Drum Company Superfund Site, Winslow Township, New Jersey, Golder Associates, January 2018.

Golder, 2018b. 2017 Summary Report / 2018 Operations and Monitoring Plan, Lightman Drum Company Superfund Site, Winslow Township, New Jersey, Golder Associates, May 2017.

Hardt, W.F., and Hilton, G.S., 1969. Water Resources and Geology of Gloucester County, New Jersey: New Jersey Department of Conservation and Economic Development Special Report 30, 130 p.

Markley, Marco. Soil Survey of Camden County, New Jersey. U.S. Department of Agriculture, April 1966.

Rhodehamel, Edward C., 1973. Geology and Water Resources of the Wharton Tract and the Mullica River Basin in Southern New Jersey, United States Geological Survey, Water Resources Division. Special Report No. 36, 21.

Rooney, J.G., 1971. Groundwater Resources of Cumberland County, New Jersey Department of Environmental Protection, Division of Water Resources Special Report 34, 83.

Todd, D. K. 1980. Groundwater Hydrology, 2nd ed. John Wiley and Sons, N. Y., N. Y.: 121-123

USEPA, 1999. Directive 9200, 4-17, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, United States Environmental Protection Agency, April 1999.

USEPA, 2000. Administrative Order on Consent, USEPA Index No. CERCLA-02-2000-2034, November 2000.

USEPA, 2009. Record of Decision, United States Environmental Protection Agency, USEPA ID #NJD014743678, September 2009.

USEPA, 2010a. Administrative Order for Remedial Design and Remedial Action, USEPA Index # CERCLA-02-2010-2019, United States Environmental Protection Agency, June 2010.

USEPA, 2010b. Modification of Administrative Order, USEPA Index # CERCLA-02-2010-2019, United States Environmental Protection Agency, June 2010.

USEPA, 2011. Record of Decision, United States Environmental Protection Agency, USEPA ID #NJD014743678, September 2011.

USEPA, 2018. RE: Technical Memorandum on the Downgradient Groundwater, Lightman Drum Company Site, Winslow Township, NJ. February 2018.

Wiedemeier, TH, Swanson, MA, Moutoux, DE, Gordon, EK, Wilson, JT, Wilson, BH, Kampbell, DH, Haas, PE, Miller, RN, Hansen, JE, and Chapelle, FH. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128. September 1998.

Xu, Moujin and Eckstein, Yoram, 1995, Use of Weighted Least Squares Method in Evaluation of the Relationship between Dispersivity and Field Scale, Ground Water, Nov-Dec 1995 issue, v.33, no. 6, pp 905-908.

Zapecza, Otto S. Hydrogeologic Framework of the New Jersey Coastal Plan, Regional Aquifer-System Analysis; U.S. Geologic Survey Professional Paper 1404-B; 1989.

Table 2
Potential ARARs
Lightman Drum Feasibility Study
Winslow Township, NJ

Regulator	Criteria	Citation	Description	Comments
Potential Chemical Specific ARARs				
Federal Safe Drinking Water Act	National Primary Drinking Water Standards - Maximum Contaminant Level Goals (MCLGs)	40 CFR 141	The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.	The NJ groundwater quality standards for Class I-PL are applicable for the remediation of groundwater
Federal Safe Drinking Water Act	National Secondary Drinking Water Standards - Maximum Contaminant Levels (MCLs)	40 CFR 143	The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.	For Site COCs, these standards are less stringent than applicable state standards
Federal Resource Conservation and Recovery Act	Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264 subpart F	Establishes standards for groundwater protection	These standards are less stringent than applicable state standards
State of New Jersey Statutes and Rules	Drinking Water Standards - MCLs	N.J.A.C. 7:10 Safe Drinking Water Act	Establishes MCLs that are generally equal to or more stringent than the Safe Drinking Water Act MCLs	
State of New Jersey Statutes and Rules	National Secondary Drinking Water Standards -Secondary MCLs	N.J.A.C. 7:10-7 Safe Drinking Water Act	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water	Contaminants Of Potential Concern (COPCs) not addressed in 7:10-7.2 Recommended upper limits and optimum ranges for physical, chemical, and biological characteristics in drinkingwater. There is no current exposure pathway to contaminated groundwater, and new developments in the vicinity of the Site are required by municipal ordinance to connect to the municipal water supply system.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9C Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups	Includes standards for groundwater protected by the Pinelands Protection Act, N.J.S.A. 13:18A-1 et seq.
Potential Location Specific ARARs				
New Jersey Flood Hazard Control Act	Floodplain Use and Limitations	N.J.A.C. 7:13 Flood Hazard Area Control		Portions of downgradient plumes lie within 100-year floodplain
Federal National Environmental Policy Act	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	Establishes policy and guidance for carrying out Executive Order 11988 - to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development.	Portions of downgradient plumes lie within 100-year floodplain
New Jersey Freshwater Wetlands Protection Act		N.J.A.C. 7:7A N.J.S.A. 13:9B-1	Require permits for regulated activity disturbing wetlands	Potentially applicable for construction activities performed in the vicinity of a wetland or waterway (Pump Branch Creek)

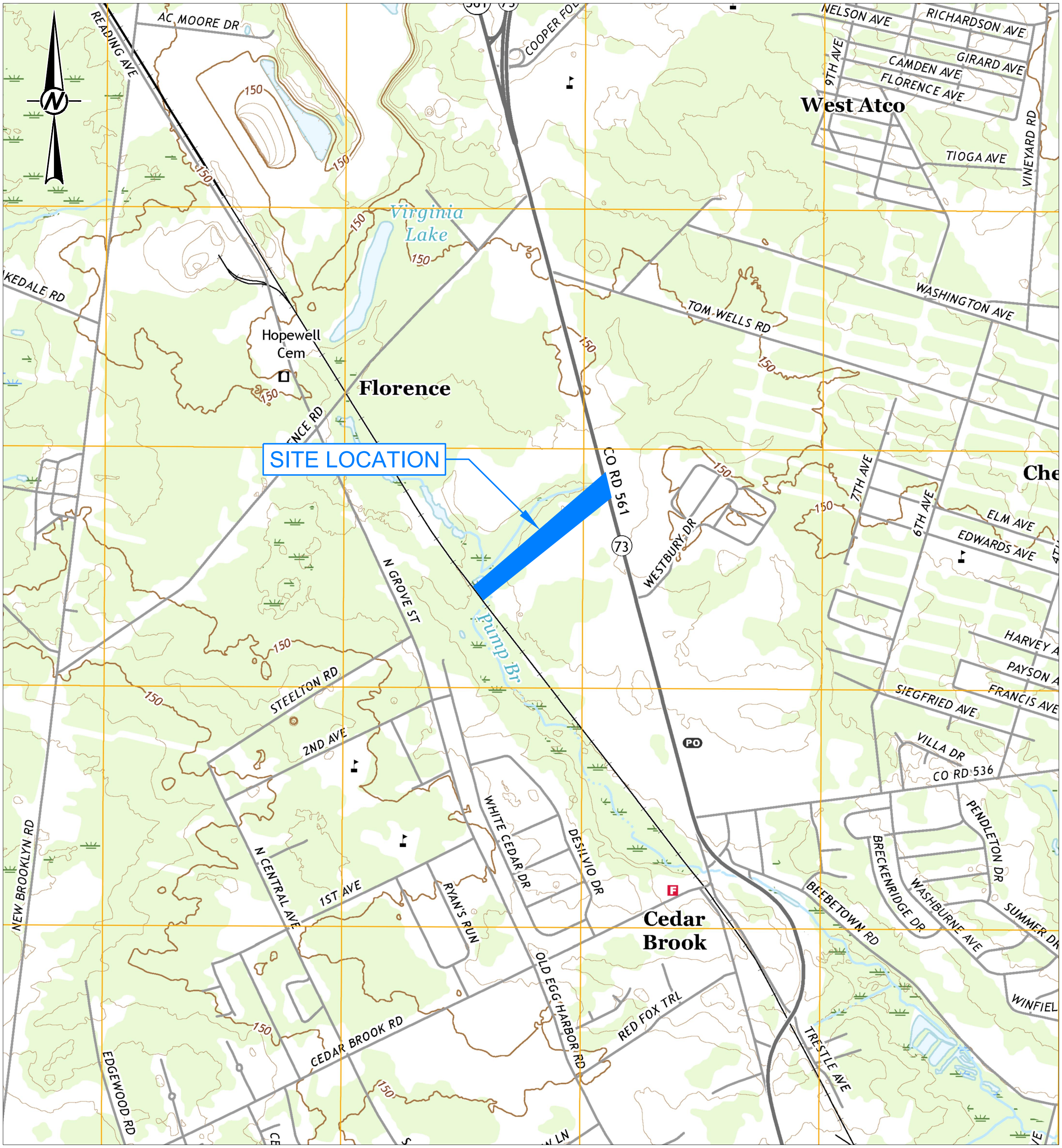
Regulator	Criteria	Citation	Description	Comments
Potential Location Specific ARARs (con't)				
Federal National Environmental Policy Act	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	Executive Order 11990 - Protection of Wetlands - to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or Indirect support of new construction in wetlands	portions of downgradient plumes lie in the vicinity of a wetland or waterway
Federal Endangered Species Act	Protection of threatened and endangered species	16 USC 1531 et seq. 40 CFR 400	Standards for the protection of threatened and endangered species	Swamp pink was identified as potentially occurring on or adjacent to the Site; A survey found no evidence of the plant
Endangered Plant Species List Act	Protection of threatened and endangered species	N.J.S.A. 13:1B et seq.	To develop and adopt a list of plant species that are endangered in New Jersey	Swamp pink was identified as potentially occurring on or adjacent to the Site; A survey found no evidence of the plant
Federal Fish and Wildlife Conservation Act	Statement of Procedures for non-game Fish and Wildlife Protection	16 USC 2901 et seq.	Established EPA policy and guidance for promoting the conservation of non-game fish and wildlife and their habitats.	Potentially applicable for construction activities performed which may impact non-game fish and wildlife and their habitats
Federal National Historic Preservation Act	Procedures for preservation of historical and archaeological data	16 USC 469 et seq. 40 CFR 6301 ('c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a Federally licensed activity or program	A Stage IA Cultural Resources Survey indicated low to moderate potential for pre-historic archaeological remains and a low potential for historic archeological remains.
Potential Action Specific ARARs				
New Jersey Soil Erosion and Sediment Control Act	Procedures for controlling erosion and sediment movement	N.J.S.A. 4:24-39 et seq.	to establish soil erosion and sediment control standards for Department of Transportation certification of its projects to the Soil Conservation Districts	Potentially applicable for construction activities
The New Jersey Pollutant Discharge Elimination System		N.J.A.C. 7:14A	Establishes standards for discharge of pollutants to surface and groundwaters	Potentially applicable if water is discharged to surface or groundwaters
Toxic Pollutant Effluent Standards		40 CFR 129	Establishes effluent standards or prohibitions for certain toxic pollutants	Pollutants regulated identified as COPCs
Resource Conservation and Recovery Act		42 USC 6901 et seq.	to manage hazardous and non-hazardous waste	
Identification and Listing of Hazardous Wastes		40 CFR 261	Identifies solid wastes which are subject to regulation as hazardous wastes	Potentially applicable to waste streams from treatment options
Standards for Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		40 CFR 263	Establishes the responsibilities regarding the handling, transportaion, and management of hazardous waste	

Table 2
Potential ARARs
Lightman Drum Feasibility Study
Winslow Township, NJ

Regulator	Criteria	Citation	Description	Comments
Potential Action Specific ARARs (con't)				
Hazardous Waste Permit Program		40 CFR 270	Establishes provisions covering basic EPA permitting requirements	
Hazardous Materials Transportation Act (HMTA)		49 USC 1801-1813		
Hazardous Material Transportation Regulations		49 CFR 107, 171-177	Regulates transportation of hazardous materials	Potentially applicable for removal of treatment waste streams
Clean Air Act (CAA)		42 USC 7401	To preserve air quality and to reduce air pollution	Potentially applicable to waste streams from Pump&Treat alternative
National Ambient Air Quality Standards		40 CFR 50	Establishes primary and secondary standards for six pollutants to protect the public health and welfare.	Potentially applicable to waste streams from Pump&Treat alternative
National Emission Standards for Hazardous Air pollutants		40 CFR 63	Establishes regulations for specific air pollutants (such as benzene and PCE)	Potentially applicable to waste streams from Pump&Treat alternative
State of New Jersey Statutes and Rules	Air Pollution Control	N.J.A.C. 7:27	Regulates Air Pollution	
Technical Requirements for site remediation		N.J.A.C. 7:26E	Establishes minimum regulatory requirements for remediation of contaminated sites in New Jersey	
Occupational Safety and Health Act (OSHA)		29 USC 651-678	Regulates worker health and safety	
Safe Drinking Water Act (SDWA)	Underground injection control regulations	40 CFR 144-147	provides for the protection of underground sources of drinking water	Potentially applicable if water is re-injected following treatment

Table 3
Comparative Summary of Remedial Alternatives
Lightman Drum Feasibility Study
Winslow Township, NJ

NCP Criteria	Alternative	
	Alternative 1	Alternative 2
	MNA	Extraction & Treatment
Overall Protection of Human Health and the Environment	Yes	Yes
Compliance with ARARs	Yes	Yes
Short-term Effectiveness	Low	Moderate
Reduction of Toxicity, Mobility, or Volume	High	High
Long-term Effectiveness and Permanence	High	High
Implementability	High	Low
Cost (NPW)	$150,000	$2,160,000



REFERENCE(S)

1. MAP TAKEN FROM U.S.G.S 7.5 MINUTE QUADRANGLE OF WILLIAMSTOWN, NEW JERSEY, DATED 2016

0 1000 2000

1" = 2000' FEET

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

CONSULTANT

GOLDER

NJ Authorization #24GA28029100

YYYY-MM-DD	2018-06-11
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

TITLE
SITE LOCATION MAP

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-001	0	1

0 200 400
1" = 200' FEET

LEGEND

— · — · —	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
— · · —	PUMP BRANCH CREEK (SEE NOTE 1)
◬	ONSITE WATER SUPPLY WELL (LOCATION APPROXIMATE)
⌖	MONITORING WELL
—121—	GROUNDWATER ELEVATION CONTOUR (DECEMBER 2017) - FT MSL
120.02	GROUNDWATER ELEVATION LEVEL (DECEMBER 2017) - FT MSL

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. MW-2A, MW-2B, AND MW-21 WERE DECOMMISSIONED DURING SOURCE REMOVAL ACTION ACTIVITIES IN NOVEMBER 2007. REPLACEMENT WELLS MW-2A-R AND MW-2B-R WERE INSTALLED IN FEBRUARY 2008.
3. MW-22 NOT CONTOURED DUE TO ANOMALOUS READING (SEE TEXT).
4. CONTOURS DRAWN USING SURFER 13.

REFERENCE(S)

1. AERIAL PHOTOGRAPH TAKEN FROM USDA GEOSPATIAL DATA GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LightmanDrum_12-20-12_PL.dwg, SURVEYED BY VARGO ASSOCIATES.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
GROUNDWATER CONTOUR MAP - DECEMBER 2017

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	HAL
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-010	1	2

LEGEND

	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
	PUMP BRANCH CREEK (SEE NOTE 1)
1	PCE 1 ug/L ISOCONCENTRATION CONTOUR (2002-2005)
100	PCE ISOCONCENTRATION CONTOUR IN AREAS ABOVE 100 ug/L
	ONSITE WATER SUPPLY WELL (LOCATION APPROXIMATE)
	MONITORING WELL
	GEOPROBE AQUIFER PROFILE BORING (2002-2004)
ND	GEOPROBE PCE CONCENTRATIONS (ug/L) 2002-2004
30	PCE CONCENTRATIONS (ug/L) FOR FEBRUARY 2005
86'-88':3	DEPTH (FT-BGS) : PCE CONCENTRATION (ug/L)

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. MW-2A, MW-2B, AND MW-21 WERE DECOMMISSIONED DURING SOURCE REMOVAL ACTION ACTIVITIES IN NOVEMBER 2007. REPLACEMENT WELLS MW-2A-R AND MW-2B-R WERE INSTALLED IN FEBRUARY 2008.
3. AQUIFER PROFILE BORING LOCATIONS ARE APPROXIMATE.
4. INSTALLED IN 2012.
5. ND = NOT DETECTED

REFERENCE(S)

1. AERIAL PHOTOGRAPH TAKEN FROM USDA GEOSPATIAL DATA GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LIGHTMANDRUM_12-20-12_PL.DWG, SURVEYED BY VARGO ASSOCIATES.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
PCE 2002-2005 REMEDIAL INVESTIGATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-002	1	3

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

Path: \\mtlaurel\cadd\Projects\Lightman_Drum\LightmanDrumSite_WinslowTwp\99_PROJECTS\0136054007_2018EnvServices\0002-RI-FFSReport\02_PRODUCTION\DWG\ | File Name: 0136054007-0002-002.dwg | Last Edited By: gsantell Date: 2018-11-08 Time: 1:23:53 PM | Printed By: AMorales Date: 2018-11-16 Time: 3:22:28 PM

0 200 400
1" = 200' FEET

LEGEND

(thick dash-dot black line)	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
(blue dashed line)	PUMP BRANCH CREEK (SEE NOTE 1)
1 (orange dashed line)	PCE 1 ug/L ISOCONCENTRATION CONTOUR (2002-2005)
100 (cyan dashed line)	PCE ISOCONCENTRATION CONTOUR IN AREAS ABOVE 100 UG/L
(triangle symbol)	ONSITE WATER SUPPLY WELL (LOCATION APPROXIMATE)
(well symbol)	MONITORING WELL
(blue dot)	GEOPROBE AQUIFER PROFILE BORING (2007)
30	PCE CONCENTRATIONS (ug/L) FOR MARCH 2006
1.4	PCE CONCENTRATIONS (ug/L) FOR FEBRUARY 2007
(31)	GEOPROBE PCE CONCENTRATIONS (ug/L) FOR JULY 2007

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. MW-2A, MW-2B, AND MW-21 WERE DECOMMISSIONED DURING SOURCE REMOVAL ACTION ACTIVITIES IN NOVEMBER 2007. REPLACEMENT WELLS MW-2A-R AND MW-2B-R WERE INSTALLED IN FEBRUARY 2008.
3. AQUIFER PROFILE BORING LOCATIONS ARE APPROXIMATE.
4. ALL GEOPROBE PCE CONCENTRATIONS WERE THE MAXIMUM CONCENTRATION DETECTED. THIS DEPTH WAS 53'-55 FT. BGS. IN GW6-2 AND IN ALL OTHERS WAS 63'-65' FT. BGS.
5. INSTALLED IN 2012.
6. ND = NOT DETECTED

REFERENCE(S)

1. AERIAL PHOTOGRAPH TAKEN FROM USDA GEOSPATIAL DATA GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LIGHTMANDRUM_12-20-12_PL.DWG, SURVEYED BY VARGO ASSOCIATES.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
PCE 2006-2007 REMEDIAL INVESTIGATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-003	1	4

0 200 400
1" = 200' FEET

LEGEND

	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
	PUMP BRANCH CREEK (SEE NOTE 1)
1	PCE 1 ug/L ISO-CONCENTRATION CONTOUR
100	PCE ISO-CONCENTRATION CONTOUR IN AREAS ABOVE 100 ug/L
	MONITORING WELL
	AQUIFER PROFILE BORING
63'-65':77	DEPTH (FT-BGS): PCE CONCENTRATION (ug/L)
190	JUNE 2011 PCE CONCENTRATION (ug/L)

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. TPZ-4 WAS DECOMMISSIONED ON AUGUST 24, 2011.
3. MAXIMUM CONCENTRATION FROM EACH AQUIFER PROFILE BORING IS SHOWN.
4. DUE TO LOSS OF ROD IN BORING GW-9, THE DEEPEST SAMPLE WAS COLLECTED AT ADJACENT GW-9R @ 83-85 FT. BGS.
5. INSTALLED IN 2012.
6. ND = NOT DETECTED

REFERENCE(S)

1. AERIAL PHOTOGRAPH TAKEN FROM USDA GEOSPATIAL DATA GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC.
3. GEOPROBE PROFILE BORINGS AND SURFACE WATER/SEDIMENT SAMPLING LOCATIONS WERE LOCATED IN THE FIELD BY GOLDER ASSOCIATES, INC. PERSONNEL USING A HANDHELD GPS UNIT AND ARE APPROXIMATE ONLY.
4. PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY.
5. AQUIFER PROFILE BORINGS LOCATED VIA GARMING ETREX VISTA HCX GPS, BY GOLDER FIELD PERSONNEL IN AUGUST 2011.
6. REPLACEMENT MONITORING WELLS MW-2A-R AND MW-2B-R SURVEYED ON APRIL 01, 2008 BY B & B HI-TECH SOLUTIONS, LLC.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
PCE 2011 PRE-DESIGN INVESTIGATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-004	1	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

LEGEND

— - - —	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
— · —	PUMP BRANCH CREEK (SEE NOTE 1)
—1—	TCE 1 ug/L ISO-CONCENTRATION CONTOUR
—100—	TCE ISO-CONCENTRATION CONTOUR IN AREAS ABOVE 100 ug/L
	MONITORING WELL
	AQUIFER PROFILE BORING
63'-65': 94	DEPTH (FT-BGS): TCE CONCENTRATION (ug/L)
87	JUNE 2011 TCE CONCENTRATION (ug/L)

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. TPZ-4 WAS DECOMMISSIONED ON AUGUST 24, 2011.
3. MAXIMUM CONCENTRATION FROM EACH AQUIFER PROFILE BORING IS SHOWN.
4. DUE TO LOSS OF A ROD IN BORING GW-9, THE DEEPEST SAMPLE WAS COLLECTED AT ADJACENT GW-9R @ 83-85 FT BGS.
5. INSTALLED IN 2012.
6. ND = NOT DETECTED

REFERENCE(S)

1. AERIAL PHOTOGRAPH TAKEN FROM USDA GEOSPATIAL DATA GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC.
3. GEOPROBE PROFILE BORINGS AND SURFACE WATER/SEDIMENT SAMPLING LOCATIONS WERE LOCATED IN THE FIELD BY GOLDER ASSOCIATES, INC. PERSONNEL USING A HANDHELD GPS UNIT AND ARE APPROXIMATE ONLY.
4. PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY.
5. AQUIFER PROFILE BORINGS LOCATED VIA GARMING ETREX VISTA HCX GPS, BY GOLDER FIELD PERSONNEL IN AUGUST 2011.
6. REPLACEMENT MONITORING WELLS MW-2A-R AND MW-2B-R SURVEYED ON APRIL 01, 2008 BY B & B HI-TECH SOLUTIONS, LLC.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
TCE 2011 PRE-DESIGN INVESTIGATION

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-005	1	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

LEGEND

(line)	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
(line)	PUMP BRANCH CREEK (SEE NOTE 1)
— 1 —	PCE 1 ug/L ISO-CONCENTRATION CONTOUR (2017)
(0.29)	PCE CONCENTRATION (DECEMBER 2017) ug/L
(1.5)	PCE CONCENTRATION (SEPTEMBER 2017) ug/L
(symbol)	ONSITE WATER SUPPLY WELL (LOCATION APPROXIMATE)
(symbol)	MONITORING WELL

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. MW-2A, MW-2B, AND MW-21 WERE DECOMMISSIONED DURING SOURCE REMOVAL ACTION ACTIVITIES IN NOVEMBER 2007. REPLACEMENT WELLS MW-2A-R AND MW-2B-R WERE INSTALLED IN FEBRUARY 2008.
3. ND = NOT DETECTED
4. NM = NOT MEASURED

REFERENCE(S)

1. AERIAL PHOTOGRAPH FROM TAKEN FROM USDA GEOSPATIAL GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LightmanDrum_12-20-12_PL.dwg, SURVEYED BY VARGO ASSOCIATES.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
PCE 2017 MONITORING

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-006	1	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

LEGEND

(black dash-dot line)	APPROXIMATE PROPERTY LINE - LIGHTMAN DRUM SITE
(blue dashed line)	PUMP BRANCH CREEK (SEE NOTE 1)
(purple dashed line) 1	TCE 1 ug/L ISO-CONCENTRATION CONTOUR
(symbol)	ONSITE WATER SUPPLY WELL (LOCATION APPROXIMATE)
(symbol)	MONITORING WELL
0.85	TCE CONCENTRATION (SEPTEMBER 2017) (ug/L)
0.5	TCE CONCENTRATION (DECEMBER 2017) (ug/L)

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. MW-2A, MW-2B, AND MW-21 WERE DECOMMISSIONED DURING SOURCE REMOVAL ACTION ACTIVITIES IN NOVEMBER 2007. REPLACEMENT WELLS MW-2A-R AND MW-2B-R WERE INSTALLED IN FEBRUARY 2008.
3. ND = NOT DETECTED
4. NM = NOT MEASURED

REFERENCE(S)

1. AERIAL PHOTOGRAPH FROM TAKEN FROM USDA GEOSPATIAL GATEWAY, DATED 2006.
2. MONITORING WELLS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LIGHTMANDRUM_12-20-12_PL.DWG, SURVEYED BY VARGO ASSOCIATES.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
TCE 2017 MONITORING

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-007	2	8

0 100 200
1" = 100' FEET

LEGEND

- PUMP BRANCH CREEK (SEE NOTE 1)
- MONITORING WELL
- AQUIFER PROFILE BORING (2011-2012)

NOTE(S)

1. APPROXIMATE CREEK LOCATION ESTIMATED FROM 1995 AERIAL PHOTO, EPHEMERAL IN VICINITY OF LIGHTMAN PROPERTY.
2. CONCENTRATIONS IN ug/L.

REFERENCE(S)

1. AERIAL PHOTOGRAPH LICENSED FROM GOOGLE EARTH PROFESSIONAL.
2. MONITORING WELLS AND PIEZOMETERS SHOWN WERE BASED ON SURVEY INFORMATION SUPPLIED BY JAMES M. STEWART, INC. MW-2A-R AND MW-2B-R WERE SURVEYED BY JOHN P. HOUWEN PROFESSIONAL LAND SURVEYOR ON APRIL 8, 2008. MONITORING WELLS MW-12A, MW-22, MW-23, MW-24, MW-25, AND MW-26 FROM MONITORING WELL CERTIFICATION FORM B SURVEYED BY VARGO ASSOCIATES ON DECEMBER 26, 2012.
3. BLOCK 4402 AND BLOCK 4004 PARCEL BOUNDARIES FROM GIS DATABASE OF NEW JERSEY. BLOCK 4411 PARCEL BOUNDARY FROM DIGITAL FILE LIGHTMANDRUM_12-20-12_PL.DWG, SURVEYED BY VARGO ASSOCIATES.
4. AQUIFER PROFILE BORINGS LOCATED VIA GARMIN ETREX VISTA HCX GPS, BY GOLDER FIELD PERSONNEL IN AUGUST 2011 AND NOVEMBER 2012.

CLIENT
LIGHTMAN YARD PRP GROUP

PROJECT
LIGHTMAN DRUM SITE
WINSLOW TOWNSHIP, NEW JERSEY
RI/FFS REPORT

TITLE
DOWNGRADIENT GROUNDWATER PCE AND TCE CONCENTRATIONS IN WELLS INSTALLED IN PDI

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	NAM
PREPARED	GLS
REVIEWED	HAL
APPROVED	RJI

PROJECT NO.	CONTROL	REV.	FIGURE
0136054007	0002-008	1	9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

APPENDIX A

Cost Tables

Monitored Natural Attenuation & Institutional Controls				
Activity	**Unit Costs**	**Units**	**Quantity**	**Estimated Cost**
Long Term Access Agreement				
Legal	$10,000	Lump Sum	1	$10,000
TOTAL LONG TERM ACCESS AGREEMENT COST				**$10,000**
Monitoring - Semi-Annual Years 1 through 15				
Sampling Costs				
Staffing	$90	Hr.	20	$1,800
Equipment	$2,000	EA	1	$2,000
IDW drums	$50	EA	1	$50
Analytical Costs				
Analysis	$1,104	Event	1	$1,104
Data Validation	$100	Hr.	11	$1,100
Project Management / Coordination	$150	Hr.	8	$1,200
SUBTOTAL - Single Monitoring Event				*$7,254*
Total Annual Sampling Cost (2 sampling events)	$7,254	Sampling Event	2	$14,508
TOTAL ANNUAL MONITORING COST - YEARS 1 TO 15 (SEMI-ANNUAL MONITORING)				**$14,508**
Semi-Annual				
Years of Monitoring	15	Years	**9.11**	
Discount Rate	7%	%		
PRESENT WORTH OF SEMI-ANNUAL MONITORING			**9.11**	**$132,138**
PRESENT WORTH - TOTAL MONITORING				**$132,138**
TOTAL PRESENT WORTH (ROUNDED TO NEAREST $10,000)				**$150,000**

Assumptions
Monitoring of 3 existing wells, sampling for VOCs only, semi-annually and that field equipment, reporting, project management etc. are captured in MNA for remainder of plume

Appendix A
Alternative Cost Calculations
Lightman Drum Feasibility Study
Winslow Township, NJ

Downgradient Extraction Treatment, Re-injection				
Activity	**Unit Costs**	**Units**	**Quantity**	**Estimated Cost**
Long Term Access Agreement				
Legal	$50,000	Lump Sum	1	$50,000
TOTAL LONG TERM ACCESS AGREEMENT COST				**$50,000**
Initial Capital Cost				
Engineering				
Design	$50,000	Lump Sum	1	$50,000
Workplans	$50,000	Lump Sum	1	$50,000
Construction Oversight	$50,000	Lump Sum	1	$50,000
System Startup	$15,000	Lump Sum	1	$15,000
Aquifer Testing/Delineation	$130,000	Lump Sum	1	$130,000
Capital Construction				
Extraction Well / Re-Injection Well	$110,000	Lump Sum	1	$110,000
Treatment Building	$130,000	Lump Sum	1	$130,000
Access Road / Utilites	$130,000	Lump Sum	1	$130,000
Contractor Overhead items	$70,000	Lump Sum	1	$70,000
Contingency	$735,000	percent	25%	$190,000
TOTAL INITIAL CAPITAL COST				**$925,000**
Annual Operation & Maintenance (O&M)				
Site Visits	$45,000	Lump Sum	1	$45,000
Maintenance	$3,000	Lump Sum	1	$3,000
Carbon Change outs	$1,300	Lump Sum	1	$1,300
Analytical (Quarterly)	$3,000	Lump Sum	1	$3,000
Property Lease / Annual improvements	$5,000	Lump Sum	1	$5,000
Utility Costs	$2,400	Lump Sum	1	$2,400
Reporting	$40,000	Lump Sum	1	$40,000
Contingency	$99,700	percent	25%	$30,000
TOTAL ANNUAL O&M COST				**$129,700**
Years of O&M	15	Years		
Discount Rate	7%	%		
PRESENT WORTH OF ANNUAL O&M COST			**9.11**	**$1,181,296**
TOTAL PRESENT WORTH (ROUNDED TO NEAREST $10,000)				**$2,160,000**