RECORD OF DECISION
SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

FLASH CLEANERS SUPERFUND SITE
POMPANO BEACH AND LIGHTHOUSE POINT
BROWARD COUNTY, FLORIDA

PREPARED BY
THE
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA, GEORGIA

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PART 1: DECLARATION

1.0 Site Name and Location

The Flash Cleaners Superfund Site (Site) is located in Pompano Beach, Florida. The Site contamination also extends into Lighthouse Point, Florida; both cities are located in Broward County. The EPA identification number as recorded in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) data base is FLD083111005. This Site decision encompasses the entire site.

2.0 Statement of Basis and Purpose

This decision document presents the selected remedy for the Site, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code Section 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulation (CFR) Part 300, as amended. The selected remedy for the Site is Excavation with Off-site Disposal, Soil Vapor Extraction with Vapor Phase Carbon Adsorption, and Institutional Controls (Alternative S-2 and S-4, from the Feasibility Study, respectively) for the soils; and In-situ Enhanced Bioremediation with Monitoring and Institutional Controls (Alternative GW-2) for the groundwater. Further details on the selected remedy are presented below in Section 4.0 (Description of the Selected Remedy) of this Declaration (Part 1) and in Section 12.0 (Selected Remedy) of The Decision Summary (Part 2) of this Record of Decision (ROD).

This decision is based on the Administrative Record for the Site, which has been developed in accordance with Section 113(k) of CERCLA, 42 United State Code Section 9613(d). This Administrative Record file is available for review at the Lighthouse Point Library in Lighthouse Point, Florida and at the United States Environmental Protection Agency (EPA) Records Center in Atlanta, Georgia. The Administrative Record Index (Appendix D of this ROD) identifies each of the items comprising the Administrative Record upon which the selection of the remedy is based. The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP) concurs with the selected remedy.

3.0 Assessment of the Site

The response action selected in this ROD is necessary to protect public health or welfare, or the environment from actual or threatened releases of pollutants and hazardous substances into the environment.

4.0 Description of the Selected Remedy

The selected remedy is briefly described as follows. The total cost for the selected remedy is estimated to cost $3,565,000.

- Excavation of approximately 700 cubic yards of contaminated soils on the Flash Cleaners property that do not underlie the Flash Cleaners building. The depth of excavation would be down to the water table which is expected to be eight feet below surface;

- Transportation and disposal of the excavated soil to a permitted off-site waste disposal landfill;

- Installation of a soil vapor extraction (SVE) system to remove the contaminants from the soil beneath the Flash Cleaners building. A vapor phase carbon adsorption unit would be attached to the SVE system to capture the volatilized off-gasses;

- In-situ enhanced bioremediation of the groundwater on the Flash Cleaners property and to the east/northeast of the property using emulsified oil substrate (EOS) to stimulate the natural biodegradation of contaminants;

- Implementation of temporary Institutional Controls (ICs) for the groundwater where contaminant concentrations exceed cleanup levels to prevent exposure to groundwater. The ICs will restrict the use of groundwater temporarily as long as contaminants are above cleanup levels; and,

- Monitoring of the groundwater, surface water and pore water.

5.0 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. This remedy attains the mandates of CERCLA Section 121, and the regulatory requirements of the NCP.

The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e. reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). The soils on the Flash Cleaners property beneath the building which are contaminated with tetrachloroethylene, and other volatile organic compounds, are considered to be “principal threat wastes” because the contaminants are at high concentration and more importantly are mobile due to volatization and subsurface transport (leaching to the groundwater). Treatment will consist of soil vapor extraction with vapor phase carbon adsorption on the soils beneath the Flash Cleaners building.

Land use restrictions on the Flash Cleaners property are not necessary because the soil remedy will allow for unlimited use and unrestricted exposure onsite. Temporary groundwater restrictions are necessary because the selected remedy may allow for groundwater contamination to remain above cleanup levels for more than five years. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, but it will take more than five years to attain remedial action objectives and cleanup levels, a policy review may be conducted within five years of construction completion for the Site to ensure that the remedy is, or will be, protective of human health and the environment.

6.0 Data Certification Checklist

The following information is included in The Decision Summary (Part 2) of this ROD, while additional information can be found in the Administrative Record file for this Site:

a. Chemicals of concern (COCs) and their respective concentrations (see Section 7.1.1 - Identification of Chemicals of Concern);

b. Baseline risk represented by the COCs (see Section 7.1.4 – Risk Characterization);

c. Cleanup levels established for the COCs and the basis for the levels (see Section 8.0 - Cleanup Levels);

d. How source materials constituting principal threats are addressed (see Sections 11.0 - Principal Threat Wastes and 13.0 - Statutory Determinations);

e. Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the human health risk assessment and this ROD (see Sections 6.0 - Current and Potential Future Land and Water Uses);

f. Potential land and ground water use that will be available at the Site as a result of the selected remedy (see Sections 6.0 - Current and Potential Future Land and Water Uses, and **1**2.4 - Expected Outcome of the Selected Remedy);

g. Estimated capital, lifetime operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see Section 12.3 - Selected Remedy Cost); and

h. Key factors that led to selecting the remedy (see Section 12.1 – Rationale for the Remedy selection).

7.0 Authorizing Signature

This ROD documents the selected remedy for contaminated soil and groundwater at the Flash Cleaners Superfund Site. This remedy was selected by the EPA with the concurrence of the Florida Department of Environmental Protection. The Director of the Superfund Division in EPA, Region 4 has been delegated the authority to approve and sign this ROD.

United States Environmental Protection Agency Region 4

By: _____ Date: 9/30/2010

Franklin H. Hill, Director
Superfund Division

PART 2: THE DECISION SUMMARY

This Decision Summary provides a description of the Site-specific factors and analyses that led to the selection of the remedy for Flash Cleaners Superfund Site (Site). It includes background information about the Site, the nature and extent of contamination found at the Site, the assessment of human health and environmental risks posed by the contaminants at the Site, and the identification and evaluation of remedial action alternatives for the Site.

The selected remedy is for the entire Site; no operable units were identified for the Flash Cleaners Superfund Site. The nature and extent of soil and groundwater contamination was completely characterized during the Remedial Investigation (RI) for the Site and a remedy for all impacted media is selected. As a result of the RI, EPA determined that Site soils are contaminated with the dry cleaning solvent used at Flash Cleaners (tetrachloroethylene) and its chemical breakdown products. These soil contaminants are leaching into the groundwater and the contaminated groundwater has migrated into a residential area.

1.0 Site Name, Location, and Description

The Flash Cleaners Superfund Site consists of approximately a half-acre rectangular property, located at 4131 North Federal Highway, Pompano Beach, Broward County, Florida (**Figure 1**). The geographic coordinates, as measured from the northwestern corner of the Flash Cleaners building are latitude 26.2824° North (26º 16' 57") and longitude 80.0969° West (80º 5' 49"). The EPA identification number as recorded in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) data base is FLD083111005.

The Flash Cleaners property consists of a rectangular building with a covered, dilapidated shed on the west side of the building, a two-car parking lot on the east of the building, and a driveway that connects to a back alley. The building is approximately 1,790 square feet. A septic tank and drain field are located at the northwestern corner of the property. Most of the area surrounding the building is covered with pavement. Access to the land on the Flash Cleaners property is unrestricted. There is a commercial building on the property south of Flash Cleaners that abuts the property line and the Flash Cleaners building (**Figure 2)**.

Land uses surrounding the property are predominantly commercial and residential. North Federal Highway, which is a major thoroughfare running north and south and is also known is Highway 1, separates the two cities of Pompano Beach and Lighthouse Point in the immediate vicinity of the Site. The Site and the surrounding area are relatively flat and typical of south Florida. Storm water drainage from the Site flows to storm sewers on North Federal Highway then to the North Grand Canal. North Grand Canal is connected to other canals located in the City of Lighthouse Point to the east of the Site. The canals are bordered with residential properties, and the surface water in the canals flows to the Hillsboro River, and ultimately to the Atlantic Ocean.

EPA is the lead agency for the Site and the Florida Department of Environmental Protection (FDEP) is the support agency. The Potentially Responsible Parties (PRPs) identified for the Site did not participate in the RI or the Feasibility Study (FS) and are not participating in the remedial action.

2.0 Site History and Enforcement Activities

Flash Cleaners operated as a dry cleaning facility from 1977 to approximately 2001. Dry cleaning operations may have been conducted earlier than this under a previous owner, but it is not known for how long or to what extent. The facility is currently being used as a drop-off location for outsourced dry cleaning services.

In February 1999, FDEP conducted an inspection of the facility and found dry cleaning machines located on a concrete floor with no secondary containment structures. FDEP personnel also noted that the machine contained dry cleaning product, waste containers located inside the facility lacked secondary containment, and waste material was possibly disposed of onto the ground surface. That same month, the non-operational machine at Flash Cleaners was drained and removed. The PCE that was in the non-operational unit was transferred to the operational machine and the filters in the non-operational unit were disposed of as hazardous waste.

Also in 1999, the owner of Flash Cleaners submitted an application for participation in the state Drycleaning Solvent Cleanup Program; however, the application was denied by the state. In a letter dated May 25, 1999, FDEP notified the owner of Flash Cleaners that the facility was ineligible for the program due to the lack of secondary containment. The letter indicated that failure to have secondary containment constitutes "gross negligence." FDEP further stated in the May 25, 1999, letter that "facilities operated in a grossly negligent manner at any time on or after November 19, 1980, shall not be eligible to participate in this Program."

In 2000, a consultant for the property owner conducted site assessment activities at the Flash Cleaners property. Subsurface soil samples that were collected on the property showed Site-related hazardous substances were present (tetrachloroethylene (PCE), cis-1,2- dichloroethene (DCE), and trichloroethene (TCE)). TCE and DCE are degradation products of the PCE, which was used as a dry cleaning solvent at the Flash Cleaners facility. A sample from a permanent monitoring well that was installed on the property to a depth of 15 feet below land surface (bgs) showed that hazardous substances were also present in the groundwater (cis-1,2- DCE and trans-1,2DCE).

In 2001, the consultant collected a sludge sample from the Flash Cleaners septic tank and analyzed it for total halogenated volatile organic compounds (VOCs) and for halogenated VOCs using the toxicity characteristics leaching procedure (TCLP). Total VOC results indicated the presence of PCE (61,000,000 micrograms per kilogram [µg/kg]) and cis-1,2-DCE (4,900,000 µg/kg); and TCLP VOC results indicated the presence of PCE (270 milligrams per liter [mg/L]) and TCE (30 mg/L). Concentrations of

PCE and TCE were above the Resource Conservation and Recovery Act (RCRA) TCLP regulatory limits; therefore, the sludge removed from the septic tank was considered a hazardous waste that exhibited the characteristic of toxicity.

In January 2002, the Broward County Department of Pollution and Environmental Protection (BCDPEP) issued the Flash Cleaners owner a Notice of Violation and Notice of Hearing to Assess a Civil Penalty because the owner did not submit the site assessment report that had been requested for the property. A Final Order was issued on March 28, 2002 concluding that the owner was in default, and civil penalties were assessed.

A small diesel fuel spill occurred at the rear of the facility on June 5, 2003. The spill of approximately 30 gallons of diesel fuel reportedly occurred while a partially filled, aboveground storage tank (AST) was being loaded onto a truck by Lank Oil Company. FDEP investigated the spill on June 11, 2003. The spill areas were cleaned up through excavation and removal of the impacted soils and confirmation sampling on June 26, 2003 by H2O Environmental, a private contractor for Lank Oil. On February 28, 2004, BCDPEP notified Lank Oil Company that based on the results of the confirmation sampling, no further activities related to the petroleum discharge were necessary. Further, the discharge was recorded in the State of Florida petroleum tank registration and cleanup database as "Discharge Minor, Cleanup Not Required."

In August 2002, FDEP conducted a Superfund preliminary assessment (PA) in cooperation with EPA on the Flash Cleaners Site. The PA concluded that further Superfund action should be conducted at the property based on the proximity of municipal drinking water wells. In 2003, FDEP, and its contractor, conducted a Superfund site inspection (SI) in cooperation with EPA at the Site. During the SI, four surface soil and three subsurface soil samples were collected. Results of the surface and subsurface soil samples collected north of the Flash Cleaners septic tank and beneath the floor of the Flash Cleaners building confirmed previous sampling results. Site-related hazardous substances were present (TCE, 13 J µg/kg; and PCE, 700 µg/kg). The "J" qualifier indicates that the laboratory reported an estimated concentration. Eleven ground water samples were collected. Two ground water samples were collected from the existing monitoring wells and two were collected from monitoring wells installed during the SI. The other seven ground water samples were collected using direct push technology. The ground water samples were collected from three intervals, including shallow, 15 feet bgs; intermediate, 35 feet bgs; and deep, 50 feet bgs. Site-related hazardous substances and their concentrations in the shallow wells were cis-1,2-DCE (5,600 micrograms per liter [µg/L]; trans-1,2-DCE (31 µg/L), PCE (12 µg/L), TCE (34 µg/L), and vinyl chloride (6,800 µg/L) Analytical results of the ground water samples collected from the intermediate and deep wells also contained elevated concentrations of site-related hazardous substances. PCE, cis-1,2-DCE, TCE, and vinyl chloride were detected above their respective EPA maximum contaminant levels (MCL). Based on the results of the SI, EPA and FDEP agreed that further Superfund action was necessary at the Site.

In 2005, Weston, on behalf of EPA, conducted an expanded site inspection (ESI) at Flash Cleaners. During the ESI, Weston collected six surface soil, five subsurface soil, and 13 ground water samples from various locations throughout the property. Ten ground water samples were collected from temporary wells installed using direct push technology and three groundwater samples were collected from existing permanent monitoring wells on the property. The highest concentration of PCE in the soils (72 µg/kg) was detected south of the septic tank drain field. Site-related hazardous substances found in the shallow groundwater samples were (and highest concentrations): cis-1,2-DCE (3,500 µg/L); trans-1,2-DCE (14 µg/L); PCE (29 µg/L); TCE (180 µg/L); and vinyl chloride (950 µg/L). Site-related hazardous substances found in the deep groundwater samples and their highest concentrations were: cis-1,2-DCE (220 µg/L); PCE (88 µg/L); TCE (1,700 µg/L); and vinyl chloride (58 µg/L). All these concentrations exceed the MCL for that contaminant. Groundwater samples collected in the vicinity (northeast) of the septic tank contained the highest concentrations of hazardous substances.

EPA issued an Information Request Letter to the PRPs (owner/operator) in 2007 and, based on the response, determined that the PRPs did not have the financial capability to conduct the RI/FS. EPA initiated a fund-lead RI/FS in 2008. Another Information Request Letter to the PRPs was issued in 2009 and based on the response, EPA has determined that a fund-lead cleanup action will be conducted at the Site. In May 2010, a federal lien was placed on the Flash Cleaners property and filed in the Broward County property records office. The previous owner of the property who may have conducted dry cleaning operations at the Site is now deceased.

3.0 Community Participation

EPA has been actively engaged with the affected community and has strived to maintain a collaborative relationship with those interested residents during the RI and the remedy selection process. The community relations activities meet the public participation requirements in CERCLA and the NCP.

The Community Involvement Plan (CIP) for the Site was prepared in November 2009. The CIP specifies the community involvement activities that EPA has undertaken and will continue to undertake during the remedial activities planned for the Site. A copy of the CIP is in the Administrative Record for the Site.

EPA conducted two community availability sessions (open houses) at the Lighthouse Point library building during the RI for the Site, one at the start and one midway in the RI. Prior to the first open house, approximately 500 fact sheets about the Site were mailed out to the community. FDEP and Florida Department of Health also participated in the open house. The purpose of these sessions was to answer questions about the investigation and encourage the community's participation. EPA also went door-to-door during most of the five sampling events to talk to the residents about the sampling that was being conducted near their homes. Fact sheets about the sampling

events were prepared and distributed to the residents. EPA also conducted interviews with officials during the early phase of the RI.

The RI and FS reports and Proposed Plan for the Flash Cleaners Site were made available to the public in August 2010. These documents can be found in the Administrative Record file and the information repository maintained at EPA Region 4 in Atlanta, Georgia and the Lighthouse Point Library in Lighthouse Point, Florida. The notice of the availability of these two documents was published in the Sun Sentinel on August 1st, 2010. EPA hosted a public meeting on August 12, 2010, at the Dixon Ahl Hall in Lighthouse Point, Florida. At this meeting EPA presented the RI and FS results and the Proposed Plan for the Flash Cleaners Site. The preferred alternative presented at the meeting is the same as the selected remedy described in this ROD, with the exception that EPA is not including any contingencies. In the Proposed Plan and at the Pubic Meeting, EPA included Alternative GW-6, the Permeable Reactive Barrier (PRB), as a contingency remedy. The PRB could still be implemented after an evaluation of the monitoring data, however if EPA and FDEP determine that a PRB is warranted, EPA would issue another Proposed Plan, host another public meeting, and issue another ROD (Amendment).

At the public meeting, EPA and FDEP discussed the Site and the Proposed Plan with the 17 attendees and answered questions. A court reporter transcribed the meeting and the transcript is included in the Administrative Record file. A public comment period on the Plan was held from August 12, to September 11, 2010. No written comments regarding the proposed plan or the Site were received. EPA's response to the questions received at the public meeting is included in the Responsiveness Summary, which is Part 3 of this ROD.

The purpose of the local Site repository is to provide the community a convenient location to review information about the Site, such as that in the Administrative Record. The address for the local repository is

Lighthouse Point Library
2200 Northeast 38th Street
Lighthouse Point, Florida 33064
Phone #: 954-943-6500

4.0 Scope and Role of the Response Action

The selected remedy will address the entire Site and all the contaminated media associated with the Site. This Site has not been divided into operable units. The response action will be conducted under the Superfund remedial program and will be conducted using EPA contractors. A scope of work will be prepared by EPA for tasking the remedial design. Another contractor will implement the remedial action. No past removal actions fit into EPA's cleanup strategy.

EPA will implement the groundwater treatment in at least two stages. A second bioremediation treatment will be conducted after the first groundwater treatment and three years of monitoring data is collected. The second injection and potentially subsequent injections would be used to treat remaining hot spots within the plume. This Selected Remedy is intended to attain remedial action objectives and cleanup levels, and would be the final response action for the Site.

5.0 Site Characteristics

EPA conducted the Remedial Investigation for the Flash Cleaners Superfund Site from September 2008 until July 2010. The RI evaluated the soil, groundwater, ambient air, indoor air (vapor intrusion), surface water and sediment pore water. A comprehensive sampling regime confirmed previous findings: that the dry cleaning solvent, PCE, and its breakdown products are present in the soil and groundwater. The RI further found that groundwater contamination had migrated into the Lighthouse Point community. The RI Report, dated September 2010, presents the results of the RI. The information presented here is only a portion of the details contained in the report. The RI Report is part of the Administrative Record.

5.1 Geology

The RI was primarily a groundwater investigation, therefore the geologic and hydrogeologic conditions were important in determining the ultimate nature and extent of the subsurface contamination. Flash Cleaners is located in Broward County in southeast Florida in the Atlantic Coastal Ridge. The geologic makeup of the Site's region consists of a thick sequence of unconsolidated to semi-consolidated coastal plain sedimentary formations that range from Jurassic to Holocene. The most geologically recent, surface unit is the Pamlico sand, which consists of unconsolidated quartz sand and reaches a maximum thickness of approximately 40 feet in this area. In Pompano Beach, the Pamlico sand is underlain by the Miami oolite, which consists of massive cross-bedded oolitic limestone that is soft and generally perforated with vertical solution holes. This unit is approximately 40 feet thick in the vicinity of the site. The Anastasia formation underlies the Miami oolite and consists of marine sandy limestone and calcareous sandstone that is partially coquinoid, and shelly sand. This formation represents the primary component of the Biscayne aquifer and is approximately 120 feet thick in the vicinity of the site. The oldest formation of interest for this investigation is the Fort Thompson formation. This formation is comprised of alternating marine, brackish-water and freshwater marls, limestones, and sandstone and is approximately 150 thick in the area of the site. The Pamlico sand, the Miami oolite, the Anastasia formation, and the Fort Thompson formation comprise the Biscayne aquifer.

5.2 Hydrogeology

The Biscayne aquifer below the Site is an unconfined, single hydrologic unit composed of limestone, sandstone, and sand, all permeable materials; however, in Broward County, the aquifer is primarily composed of sand. It is approximately 350 feet

thick in the vicinity of the Site. Practically speaking, the top of the system may be considered to be the land surface. Based on observed water level measurements at the Site, the water table is 2.84 to 7.16 feet below ground surface (bgs). The base of the system is defined hydraulically by a significant contrast in average permeability. The Tamiami Formation forms the upper part of the intermediate confining unit that separates the Biscayne from the underlying confined Floridan aquifer system. In Broward County, this unit is a 550- to 800-foot thick sequence, consisting of green clay, silt, limestone, and fine sand. A few zones within this sequence may be minor aquifers, but in general, the sediments are relatively impermeable. The top of the Floridan aquifer system is about 950 to 1,000 feet below sea level.

Groundwater in the aquifer generally flows eastward toward the coast, but based on the RI, beneath the Site it generally flows toward the northeast. A southward component of flow was also observed in the intermediate zone (40-45 feet bgs) immediately east of the Flash Cleaners property. Groundwater flow in the lower zone (95 – 100 feet bgs) is primarily to the east with an upward gradient in the northern portion of the plume area. The aquifer is very transmissive and has a very low hydraulic gradient in the vicinity of the Site.

Based on the water level measurements and the potentiometric surface elevations developed during the RI, the hydraulic gradient in the shallow zone (5 -11 feet bgs) ranges from 0.011 foot of hydraulic head per foot (ft/ft) in the southwestern portion of the plume to 0.0017 ft/ft in the northeastern portion of the plume. The hydraulic gradient in the intermediate zone is approximately 0.0014 ft/ft within the plume boundary. The hydraulic gradient in the lower zone ranges is approximately 0.001 ft/ft within the plume boundary.

The water table within the aquifer is highly variable and fluctuates in response to recharge (rainfall), and natural discharge (seepage into streams, canals, or the sea) and artificial discharge (pumping from wells). It is possible that heavy precipitation could lead to temporary mounding in areas not covered by asphalt or in the vicinity of roof drains.

The Biscayne aquifer was designated as a sole-source aquifer by EPA because it is a source of freshwater supplies for Broward County and for most of southeast Florida. Because the aquifer is highly permeable and lies at shallow depths everywhere, it is readily susceptible to contamination. Pollutants enter the aquifer by direct infiltration from land surface or controlled canals, septic tank and other drain fields, drainage wells, and solid waste dumps. Most of the pollutants that enter the aquifer are concentrated in the upper 20 to 30 feet of the aquifer. The ultimate fate of pollutants in the aquifer is the ocean, although some may be adsorbed by the aquifer materials en route to the ocean, and some are diverted to pumping wells.

There are nine monitoring wells on the Flash Cleaners property, all installed in the Biscayne aquifer. No wells were installed in the Floridan aquifer, since this aquifer is not the source of drinking water and it is at approximately 950 feet bgs. One well (MW-5) is the upgradient well on the west side of the property. Additional monitoring wells, MW-

9 and MW-11 through MW-21 were installed as part of the RI in areas downgradient of the site, to the east side of North Federal Highway. No substantial low permeability layers were encountered during the RI which would act to retard vertical groundwater flow, even locally with the Flash Cleaners plume or immediately outside of the plume. A significant upward vertical hydraulic gradient was observed in the monitoring well installed closest to the North Grand Canal. A difference in head of 0.97 feet over the 87 feet between the uppermost and lowermost screened intervals was encountered, equaling a vertical hydraulic gradient of 0.011 ft/ft, suggesting upward flow into the North Grand Canal.

5.3 Surface Water

A complex water-management system in this area, part of the South Florida Water Management System, has been developed to adapt the natural environment to man's needs. Water-conservation areas, bounded by levees and canals, cover most of the area that was previously the Everglades in Broward County. These conservation areas store rainfall and excess wet-season water which is pumped from drainage districts in Broward County. The stored water is used during periods of low water levels to maintain flow to Everglades National Park to the south, to provide recharge for municipal well fields, and to maintain groundwater levels near the coast for preventing or retarding saltwater intrusion. Numerous canals throughout the county are used for rapid removal of excess water. Gates or locks on canals regulate elevations, and retard saltwater intrusion.

Downgradient of the Flash Cleaners Site, a canal complex exists which ultimately receives both storm water via storm drains in the Site vicinity and groundwater recharge through direct infiltration. A series of these canals exist in and around Lighthouse Point east, northeast and southeast of the Site (**Figure 3**). These canals are lined with residences and boat docks. The north-south trending canals in the site vicinity are intersected by a primary east to west trending canal referred to as the North Grand Canal, approximately 1,500 feet northeast of the site. North Grand Canal lies at the downgradient end of the northeast trending groundwater contamination plume. The Grand Canal is approximately 90 feet in width and runs west to east to the Intracoastal Waterway.

5.4 Remedial Investigation

The Flash Cleaners RI work was conducted by EPA's contractor in accordance with an EPA-approved Sampling and Analysis Plan (SAP) and subsequent SAP addenda as more field events were added to the original work plan. The investigation was conducted during five field events. In February 2009, direct push technology (DPT) and an onsite mobile laboratory were used to locate positions for permanent monitoring wells; monitoring wells were installed; and, groundwater, soil and soil vapor samples were collected. In September 2009, a Sonic drilling rig was used to further define the extent of groundwater contamination in downgradient areas. In November 2009, the primary focus of the work included installation of a permanent monitoring well network in the

Lighthouse Point community. In January 2010, additional soil vapor sampling was conducted at mostly residential properties. Lastly, in April 2010, EPA and its contractors conducted indoor air sampling and sampling of pore water and surface water in the North Grand Canal.

5.4.1 Soil Contamination

During the RI, soil samples collected below the building slab and beneath the shed at the rear of the building contained the highest concentrations of VOCs. Of the 26 soil samples on the Flash Cleaners property, 20 samples contained PCE and other VOCs when analyzed by the onsite mobile laboratory. One sample located 3.5 feet to 5 feet beneath the building where the dry cleaners machine is located contained the highest concentration of PCE. The sample concentration of 1,000 micrograms per kilogram (µg/kg) exceeded the EPA Residential Soil Screening Level for PCE (550 µg/kg). However, its split sample (along with a duplicate) was sent to an EPA Contract Laboratory Program (CLP) laboratory, and the average concentration of PCE was 2,250 µg/kg.

Nine of the 20 soil samples exceeded FDEP Leachability to groundwater screening criteria for PCE in soils (30 µg/kg). This accounted for all soil boring locations except two. Three of the 20 soil samples exceeded FDEP Leachability screening criteria for TCE in soils (30 µg/kg) with a maximum concentration of 108 µg/kg. One sample was also analyzed for SVOCs and there were no detections in excess of screening criteria for SVOCs. While the detailed sampling results for each sample are presented in the RI Report (Table 5-1), **Figure 4** depicts the sampling locations and the concentrations that exceed screening criteria.

The results of the soil sample investigation suggest that the source area for contamination underlies the western end of the Flash Cleaners building. The previous investigations in 2000 and 2005 noted that highest concentrations of PCE in soil were near the septic tank and the septic tank drain field, suggesting the septic tank as the primary source area. However, soil samples were not collected beneath the building slab in those investigations.

Soil contamination is limited to the footprint of the Flash Cleaners building and the area near the west end of the building. An area calculated to be about 40 feet by 90 feet or 3600 square feet in areal extent was identified to be the source area. Soil contamination is assumed to exist from land surface to the water table at the Site. Based on an 8 foot average depth to groundwater, the total volume of contaminated soil is estimated to be 28,800 cubic feet or 1600 tons.

5.4.2 DPT and Sonic Drilling Drive-point Groundwater Field Events

DPT and Sonic drill rigs were utilized to collect vertical groundwater profile samples to delineate and characterize the contaminant plume. **Figures 5** and **6** show the sampling locations and the contaminants with their concentrations. Those concentrations

shown in bold font exceeded screening levels. The highest concentrations of VOCs in shallow groundwater were noted at the rear of and beneath the Flash Cleaners building, confirming soil sample results suggesting that the source area underlies the rear of the building. The highest concentration of VOCs onsite was located on the west side of the dry cleaner machine at the rear of the building, in a groundwater sample collected 9 feet bgs, and which had 61,400 µg/L cis-1,2-DCE, 16,000 µg/L PCE, 3,700 µg/L TCE, and 7,700 µg/L vinyl chloride. These concentrations exceed the MCLs.

Results from the DPT investigation on the east side of the Flash Cleaners property show that the VOC groundwater contaminant plume is narrow in width as it leaves the Flash property and deepens as it migrates to the east/northeast. Immediately across North Federal Highway from the Flash Cleaners property, the zones with the highest VOC contamination are in the 25-foot and 45-foot bgs zones. On the east side of the Dunn Jewelers and Lighthouse Point Condominiums (**Figure 6**), the greatest VOC concentrations are found in the 45- to 68-foot zone, although VOC exceedances were found (to a lesser extent) at 93 feet and 102 feet bgs at two locations. Results suggest a further deepening and broadening of the VOC groundwater plume east of Dunn Jewelers.

Results from the DPT investigation in the area of the apartments and the condominiums behind the commercial buildings (i.e. Dunn Jewelers) on North Federal Highway, indicated that the VOC groundwater plume turns toward the North Grand Canal in a northeasterly direction. At the deepest sample at 121 feet bgs, cis-1,2-DCE was detected at a concentration just above its MCL.

FCB45 was the northernmost location of the DPT investigation to the south of the North Grand Canal, and it had VOC exceedances of screening criteria at 11 feet, 25 feet, and 45 feet bgs. Groundwater samples collected at 68 feet and 100 feet bgs were below detection limit, suggesting a shallowing of the VOC groundwater plume as it approaches the North Grand Canal. The highest concentrations of VOCs at this location were at 45 feet bgs, which had detections of 1,900 µg/L for cis-1,2-DCE, 130 µg/L for trans-1,2-DCE, and 45 µg/L for vinyl chloride. All these concentrations are above the respective MCL for each contaminant. In addition to the 45 foot depth, vinyl chloride (19 µg/L) also exceeded its MCL at a depth of 11 feet bgs at this location.

Samples were collected from one DPT location on the north side of North Grand Canal to confirm that the VOC groundwater plume did not travel beyond the Grand Canal. Samples were collected at 11, 24, 45, 68, and 100 feet bgs. Although, no site-attributable VOCs were found at this location, benzene and toluene were found at the 45 foot and 68 foot depth. The benzene concentration at the 45 foot depth was equal to the MCL (5 ug/l) in one sample and less than the MCL (4 ug/l) in the duplicate sample.

5.4.3 Monitoring Well Results

Samples were collected from 17 newly installed monitoring wells and four monitoring wells previously installed at the Flash Cleaners property. A total of nine wells are now located on the Flash Cleaners property and 12 wells are located in the

Lighthouse Point community. The RI Report provides a table (Table 5-3) showing all the positive detection results from the two phases of the monitoring well sampling with screening criteria listed and exceedances highlighted. **Figure 7** of this ROD presents the groundwater monitoring results from onsite and nearby areas and **Figure 8** provides results from downgradient areas exceeding the screening criteria (EPA MCLs, Florida Groundwater Cleanup Target Levels (GCTLs), and EPA Tap Water Regional Screening Level (RSL)).

Six of the nine wells on the Flash Cleaners property contained VOCs; five of those six wells had samples of VOCs with concentrations above their MCLs or GCTLs. Four of the Flash Cleaners monitoring wells are screened at approximately 15 feet bgs and the other five are each screened at 25, 35, 45, 68, and 100 feet bgs. The highest concentrations in the groundwater from the monitoring wells onsite were found in the well northeast of the building (screened from 20 to 25 feet bgs); the VOCs found were cis-1,2-DCE at 17,000 μg/L, PCE at 38,000 μg/L, TCE at 8,200 μg/L, and vinyl chloride at 2,000 μg/L. All of these concentrations exceed their respective MCLs for each contaminant. Next to this well in the northeast portion of the property, a deep well was installed (screened from 95 to 100 feet bgs) which had only one VOC (TCE at 20.0 μg/L) above its MCL.

Of the 12 wells in the Lighthouse Point community, half of them are continuous multi-channel tubing (CMT) wells. They were installed and sampled with depth intervals of 9 to 11 feet bgs, 23 to 25 feet bgs, 43 to 45 feet bgs, 66 to 68 feet bgs, and 98 to 100 feet bgs. These wells are located around the boundary of the VOC groundwater plume. Out of the 12 wells in the Lighthouse Point community, five had groundwater samples with concentrations of VOCs above MCLs or GCTLS, at depths that ranged from 11 to 68 feet bgs. Five of the wells that had no site-attributable groundwater contaminants are located on the eastern, western and southern edges of the plume and serve to identify the extent of the downgradient contamination. Two monitoring wells in the middle of the horizontal extent of the plume are the deepest wells at depths of 95 feet and 145 feet. Both of the samples collected from these wells had no site-attributable VOCs above their federal or state drinking water standards, indicating that the vertical extent of the Flash Cleaners plume had been defined.

The CMT well that is just south of the North Grand Canal and which is the northernmost monitoring well in the plume had concentrations of VOCs above drinking water standards at the following depths: vinyl chloride (present at 14 μg/L at 11 feet bgs, 49 μg/L at 25 feet bgs, and 35 μg/L at 45 feet bgs) and cis-1,2-DCE (present at 840 μg/L at 45 feet bgs).

5.4.4 Aquifer Testing

Both rising head and falling head slug tests were performed at the newly installed monitoring wells. The calculated hydraulic conductivity values for those monitoring wells screened in the shallow zone (11 to 25 feet bgs) ranged from 1.5×10^{-3} cm/sec to 3.1×10^{-3} cm/sec with a geometric mean hydraulic conductivity value of 2.15×10^{-3} centimeters per second (cm/sec). Using the range of calculated hydraulic conductivity

values and the average hydraulic gradient for shallow zone of 0.0011 ft/ft (November 2009) and assuming an effective porosity of 32 percent [mean of range in porosity values for unconsolidated sands], the range of average linear groundwater velocities in the shallow zone within the plume beneath the Flash Cleaners is computed to be approximately 2.1×10^{-2} ft/day.

Similarly, utilizing the average hydraulic conductivity monitoring wells in the intermediate zone (45 to 68 feet bgs) of 4.5×10^{-3} cm/sec, an effective porosity of 15 percent based on the limestone content observed below 40 feet, and the hydraulic gradient calculated intermediate zone of 0.0015 ft/ft, the approximate linear groundwater velocity in the intermediate zone for the Flash Cleaners site computed to be 1.27×10^{-1} ft/day.

The calculated geometric mean value of hydraulic conductivity determined from those monitoring wells screened in the lower zone at the Flash Cleaners site is 3.1×10^{-3} cm/sec. Using the mean hydraulic conductivity value and the hydraulic gradient for the lower zone of 0.0012 ft/ft, and, assuming an effective porosity of 15 percent based on limestone content within the zone, the estimated average linear groundwater velocity for the lower zone is calculated to be 7.05×10^{-2} ft/day.

5.4.5 Contaminant Distribution and Evaluation

The groundwater beneath Flash Cleaners property and immediately across North Federal Highway exhibited the highest concentrations of PCE and TCE. It is likely that Dense Non Aqueous Phase Liquid (DNAPL) may be present in the subsurface beneath the Flash Cleaners building and possibly as far east as the east side of North Federal Highway. Although no direct NAPL was obtained in samples collected, it is suspected that NAPL may be sorbed into subsurface materials and based on the distribution of concentrations it may be present in both the 25-foot depth and 45-foot depth zones.

The PCE daughter products cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride are also present in samples collected in these areas but they predomininate further downgradient in the plume, where the PCE and TCE is not seen in the groundwater samples. This suggests significant natural degradation of the PCE and daughter products and that the degradation is occurring from the Flash Cleaners, downgradient all the way to potential discharge points in the North Grand Canal. In addition, the benzene, toluene, and ethylbenzene, constituents not related to the Flash Cleaners property, but found within the contaminant plume, may serve as a carbon source enhancing the biodegradation process.

The distance from Flash Cleaners to the farthest northeast point of potential canal discharge is thought to be about 1875 feet from the Site. The widest and deepest portions of the plume are estimated to be 900 feet and 121 feet, respectively, in the plume center. The groundwater plume is estimated to comprise an area of 27 acres given the shallowing at the northern edge near the canal. The plume contains approximately 263,000,000 gallons of contaminated groundwater. **Figure 9** shows the total VOC plume area and

represents the largest potential area that the plume may occupy. Individual contaminant maps show smaller areas of contamination and can be found in the RI (Section 5).

5.4.6 Surface Water and Sediment Pore Water

Nine surface water and thirty pore water samples were collected from the North Grand Canal at locations shown on **Figure 10**. The depths and results are shown for the contaminants that exceeded their screening criteria are shown. Detailed results are found in the RI (Tables 5-4 and 5-5).

Out of the nine surface water samples collected in the canal, four samples contained very low levels of cis-1,2-DCE (0.26 ug/L and below) and two samples contained very low levels of vinyl chloride (both at 0.29 ug/L). The vinyl chloride concentrations exceeded the Ambient Water Quality Criteria (AWQC) for human health (consumption of water & organisms) (0.025 μg/L). None of the concentrations exceeded Florida Surface Water Criteria for Marine or Freshwater. Surface water samples were collected at the bottom of the water column just above the sediment.

Pore water samples were collected at various depths from 2.5 to 7 feet below the sediment surface water interface. Thirteen of the thirty pore water samples contained cis-1,2-DCE or vinyl chloride. Vinyl chloride concentrations exceeded Florida's Marine and Freshwater Surface Water Criteria (2.4 ug/l) in eight samples. These criteria are based on human health. There are no ecological screening values for the cis-1,2-DCE or vinyl chloride. The maximum concentration of 230 μg/L was found at a location close to the southern bank of the canal about 100 feet northeast of the northernmost monitoring well.

5.4.7 Soil Vapor and Indoor Air

Soil vapor samples were collected in three field events and analyzed by a mobile laboratory. The first field event focused on sub-slab soil vapor samples collected at the Flash Cleaners building and results are presented on **Figure 11** and discussed below. The second field event focused on near-slab soil vapor samples collected around the Lighthouse Point condominiums immediately across the street from the Flash Cleaners building. The results from this field event were all less than detections limits and the locations are presented on **Figure 12**. The last field event focused on sub-slab and near-slab soil vapor samples collected in residential houses along Grand Canal at the downgradient end of the groundwater plume as determined in the DPT investigation. The results from this field event were all below detection limits and the locations are presented on **Figure 13**. The RI (Section 5 and Appendix C) shows further detail on the soil vapor sampling results.

The soil vapor analysis showed that only the Flash Cleaners building area had significant concentrations of VOCs. All of the sub-slab soil vapor samples collected at the Flash Cleaners building showed elevated concentrations of PCE, TCE, and cis-1,2-DCE. Samples SVGW01 and SV4131S1 were located on either side of the dry cleaner machine and showed the highest concentrations of VOCs. PCE and cis-1,2-DCE were

detected at concentrations greater than the Draft EPA Vapor Intrusion Guidance (EPA, 2000) Tier 2 secondary screening levels.

To assess the potential for VOCs in the indoor air of the Flash Cleaners building, 8-hour composite VOC ambient air samples were collected inside the building and the adjacent former 4 Wheel Parts building to the south of Flash Cleaners (it is currently a mattress store). The sample collected beside the dry cleaning machine at the rear of the Flash Cleaners building contained PCE, TCE, and benzene at concentrations in excess of screening criteria. The sample collected along the north wall in the former 4 Wheel Parts building immediately to the south of the Flash Cleaners building contained PCE, ethylbenzene, and benzene at concentrations in excess of screening criteria. The outdoor background sample also contained benzene at a concentration in excess of screening criteria. **Table 1** shows the results from the 8-hour composite VOC ambient air samples with screening criteria listed and exceedances highlighted. The indoor air sample results confirm that PCE is present. Its presence could be attributable to dry cleaning operations and vapor intrusion.

5.4.8 Private irrigations wells

Florida Department of Health assisted EPA with conducting a survey of private wells within a 0.25 mile radius. Five private irrigation wells were identified for sampling. Two wells contained groundwater concentrations of cis-1,2-DCE at very low levels well below drinking water standards. These wells were located at the northeast edge of the plume and southeast of the Site. The RI (Section 5) contains further detail on the private well sample results.

5.5 Conceptual Site Model

A conceptual site model developed for the Flash Cleaners site is depicted in **Figure 14**. It describes the pathways for contaminant transport and the potential points of impact to receptors. The figure highlights the Flash Cleaners building as the point of origin where source DNAPL was introduced to the soil beneath and around the building in the form of the dry cleaning solvent, PCE. Adsorbed DNAPL in shallow soils beneath the building and within the aquifer is likely acting as a continuous source for dissolved phase constituents that comprise the contaminant plume. Contaminants are present in soils onsite at concentrations exceeding EPA human health risk screening levels (RSLs) and FDEP Soil Cleanup Target Levels (SCTLs).

In addition, vapor intrusion, resulting from the high levels of VOCs in the shallow soils and groundwater on the Flash Cleaners property, into the onsite building and adjacent building is occurring and presents a potential human health risk to onsite workers.

Leaching of contaminants and dissolution of DNAPL sorbed into subsurface soils has occurred over time resulting in an extensive dissolved phase contaminant plume that has migrated over 1,800 feet from the site in multiple depth zones prior to discharging

into the North Grand Canal. Although PCE is present in groundwater, no off-site receptors located between the dry cleaning facility and the surface water channel are directly exposed to groundwater. VOCs in the groundwater plume exceed human health RSLs and FDEP GCTLs, but residents and businesses in the area of the plume and the immediate surrounding area are supplied drinking water by municipal wells located more than half a mile or more up-gradient or side-gradient of the Site.

The soil vapor sampling conducted in the area of the shallow groundwater plume areas did not find VOCs, indicating the soil vapor pathway is not complete in the downgradient plume.

The groundwater plume shallows as it approaches and ultimately discharges into the Grand Canal. The fresh/brackish water interface within the sediment occurred at approximately 3 feet below the bottom of the canal. Sample results from this interval showed the presence of both cis-1,2,-DCE and vinyl chloride at levels exceeding screening criteria; however, surface water data collected at these same points suggested significant attenuation is occurring within the shallow sediment beneath the canal, which may serve to reduce or eliminate risk to the benthic ecological community and to any human receptors. Swimmers or boaters are the only likely receptors being potentially exposed to contaminants in the surface water.

6.0 Current and Potential Future Land and Water Uses

Current land use of the Flash Cleaners property is as a commercial drop off/pick up location for dry cleaning. It is bounded by commercial businesses to the north and south and is on a high-traffic commercial street so future land use is likely to also be commercial. Although the land use is residential to the west and across North Federal Highway to the east, this Site is only a half acre and not likely to become residential with the commercial buildings north and south abutting the property line. The reasonably anticipated land use is as another small commercial business or parking lot given its small size. While the building could be re-used, it is unlikely the shed would remain for future use. The residents at the public meeting expressed an interest in tearing the building down, but the owners have not indicated a willingness to cease operations and raze the building. However, it is likely a future owner would raze the building.

Currently the groundwater in this area is not being used for drinking water and it is not likely that it will be. Most of the plume is in a residential area where municipal wells would not likely be placed. The closest municipal wells are over half a mile away from the site. Both Broward County and the Town of Hillsboro have wells located within 0.5 to 1 mile from the Flash Cleaners facility. The Broward County wells are northwest and the Town of Hillsboro wells are west of Flash Cleaners.

7.0 Summary of Site Risks

The response action selected in this ROD is necessary to protect public health or welfare, or the environment from actual or threatened releases of pollutants and

hazardous substances into the environment. The human and ecological risks are presented in this section below.

7.1 Human Health Risk Assessment

The RI report (Section 7) contains the human health risk assessment (HHRA) for the Site. Preparation of a HHRA is required by the National Contingency Plan (NCP), which states that the lead agency for a Superfund site shall conduct a site-specific HHRA as part of the RI process (40 CFR §300.430). The data collected for the Flash Cleaners RI was found to meet the data quality objectives of the project and were determined to be of adequate quality for use in the Risk assessment.

The risk assessment estimates what risks the site poses if no action were taken at the Site. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. To assess potential public health risks, three major aspects of chemical effects and exposure must be considered: 1) the presence of chemicals with toxic characteristics; 2) the existence of pathways by which human receptors may contact site-related chemicals; and 3) the presence of human receptors. The absence of any of these three aspects would result in an incomplete exposure pathway and an absence of quantifiable risk.

7.1.1 Chemicals of Concern

Based on the data collected during the RI, chemicals of potential concern (COPC) were identified for each media. The COPCs included any chemicals that were detected in the specific media and that are site-related. Typically, a chemical is selected as a COPC and retained for further quantitative risk evaluation if the maximum detected concentration in a sampled medium across a defined area of exposure, i.e., an exposure unit, exceeds the RSL. For the Flash Cleaners Site, the exposure units for human receptors are places of employment, residential housing units, and recreational areas for which individual samples of media were collected. Therefore, for each individual exposure unit, a chemical that was detected was retained as a COPC.

The focus of this investigation is how contamination from a dry cleaning facility has impacted media at the site and the surrounding community. Retention of all positively detected contaminants as COPCs may seem overly conservative toward protection of human health, but the limited analysis per potential exposure unit (e.g., individual residence) ensures that COPCs are not overlooked. **Table 2** presents the COPCs identified for Flash Cleaners. The table also includes the range of concentrations detected for each COPC, as well as the frequency of detection.

Further analysis of the risk levels led to identification of the Contaminants of Concern (COCs) during the FS, based on exceedance of a risk range of 1×10^{-4} to 1×10^{-6} or a hazard index (HI) quotient of 1.0. Chemicals were also identified as COCs if their concentration exceeded chemical-specific standards, such as MCLs. Further details on the COCs can be found in the FS (Section 3). The four COCs identified for soil are PCE, TCE, cis-1,2-DCE, and vinyl chloride and are based on those contaminants

exceeding chemical-based state standards. These VOCs were found at concentrations in the onsite soils exceeding their FDEP leachability SCTLs. PCE also exceeded its FDEP residential SCTL and is the principal contributing contaminant to total risk. The cancer risks for residential and industrial exposures to soil at the Flash Cleaners facility fall within EPA's target risk range.

Five COCs were identified for groundwater based on exceedances of MCLs or GCTLs: PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride. The principal contributors to the total risk are PCE, TCE and vinyl chloride. Cancer risks and HIs associated with direct exposure to groundwater exceed EPA's acceptable targets in approximately 23 percent of the samples collected. However, there is not any direct ingestion of groundwater in this area.

7.1.2 Exposure Assessment

An exposure assessment identifies pathways where receptors may be exposed to site contaminants and estimates the frequency, duration, and magnitude of such exposures. Exposure assessment involves: 1) characterization of the physical setting of the area, 2) identification of potential receptors and exposure pathways, 3) identification of exposure point concentrations and doses, and 4) identification and discussion of uncertainties.

The foundation of an exposure assessment is the CSM (previously discussed in Section 5.5.) The CSM integrates information on the potential chemical sources, release mechanisms, affected media, potential exposure pathways, and known receptors to identify complete exposure pathways. A pathway is considered complete if: 1) there is a source or chemical release from a source; 2) there is an exposure point where contact can occur; and 3) there is a route of exposure (oral, dermal, or inhalation) at the contact point through which the chemical may be taken into the body.

The primary source of contamination at the site was the accidental release of PCE, a dry cleaning solvent. PCE reaches the soil by passing through cracks in the concrete and migrates through the soil to reach the shallow groundwater. PCE is located in the lower depths of the aquifer (approximately 25 feet bgs) and is migrating offsite to the northeast and released into a surface water channel. PCE has reached greater depths in the groundwater. As PCE reaches the surface water channel, PCE migrates closer to ground surface. PCE may also volatilize from the shallow groundwater and diffuse through the vadose zone and enter buildings through vapor intrusion.

On-site workers at the Flash Cleaners building could primarily be exposed through vapor intrusion. Off-site migration of the PCE through groundwater flow could also result in off-site receptors, such as residents or workers, being exposed to PCE primarily through vapor intrusion. Although PCE is present in groundwater, no off-site receptors located between the dry cleaning facility and the surface water channel are directly exposed to groundwater. These residents obtain their water from a municipal water supply. Swimmers or boaters are the only likely receptors being potentially exposed to contaminants in the surface water.

Risk Assessments are conducted using a representative Exposure Point Concentration (EPC). For this Risk Assessment, EPCs are only derived for COPCs. Ideally, the EPC should be the true average concentration within the exposure unit. However, because of the uncertainty associated with estimating the true average concentration, the 95% Upper Confidence Limit (UCL) of the arithmetic mean is used to determine the EPC. The 95% UCLs were compared to the maximum concentration found for each analyte and the smaller of the two was chosen as the EPC and used for the dose calculations. In cases where the data set was small, the maximum concentration was used as the exposure point concentration. For Flash Cleaners, surface water is the only medium for which an appropriate number of samples could be used to derive an EPC based on the 95 percent UCL of the mean. Because of the limited amount of data for each potential receptor location, the positively detected contaminants in indoor air, soil gas, groundwater, and soil were identified as COPCs for this risk assessment and their maximum concentrations represent the EPCs. **Table 2** shows the COPCs and their EPCs detected in each media. The RI (Appendix D) presents the exposure assumptions and calculations.

To evaluate risks, cancer risk and hazard indices for COPCs detected in the various media were determined using the following simple "risk-ratio" technique, which involves the selection (or development) of risk-based concentrations, i.e., RSL, established at the 1×10^{-6} cancer risk level or a hazard quotient (HQ) of 1.0 and the calculation of cancer and non-cancer risks based on the EPC and the risk-based concentration:

$$RSL_{cancer} / EPC = 1 \times 10^{-6} / \text{Cancer Risk for COPC}$$
$$RSL_{noncancer} / EPC = 1.0 / HQ \text{ for COPC}$$

This technique accounts for the linear relationship between intake and risk. HQ is the ratio of exposure to toxicity. For evaluating residential and industrial exposures, the EPA RSLs were used. The exposure assumptions are the standard default values for these receptors and represent the reasonably maximum exposed (RME) individual. These exposure assumptions are presented in the RI (Appendix D).

The response action for the groundwater is based on the concentrations of the site-attributable COCs in the groundwater exceeding chemical-specific, drinking water standards (MCLs and GCTLs), which define acceptable risk levels of contaminants. The five pollutants and hazardous substances attributable to the Site are at concentrations in the groundwater above their respective MCL or GCTL. The aquifer at the Site is a sole source aquifer and it provides all the drinking water in southwest Florida.

Although vinyl chloride was detected at concentrations above the EPA AWQC, this criteria is based on a receptor consuming fish from the channel in combination with drinking two liters of water per day from the channel. If the receptor in the channel is recreational, the consumption of water would be significantly less than two liters of water per day. The risk level calculated for the recreational receptor would be much less than the target risk range and therefore no response action is necessary for the surface water.

Similarly, the cancer risk associated with cumulative industrial exposure to indoor air and soil at the Flash Cleaners site falls within EPA's target risk range and the corresponding HI is less than one. If the site were to be used for residential use in the future, the cancer risk associated with cumulative residential exposure to indoor air and soil still falls within EPA's target risk range, albeit near the high end of the range. The corresponding HI is also less than one.

7.1.3 Toxicity Assessment

The objective of a toxicity assessment is to identify the potential for human health hazards and adverse effects in exposed populations. A significant portion of the toxicity assessment of the HHRA has been completed because cancer slope factors (CSF) and reference doses (RfD) were selected by the EPA during the development of the residential and industrial RSLs for soil, groundwater, surface water, and air. A CSF is an indicator of the potency of a carcinogen (i.e., the greater the CSF, the more potent the carcinogen). An RfD is the dose at or below which adverse non-carcinogenic effects are not anticipated. These factors represent quantitative estimates of the relationship between the magnitude and types of exposures and the severity or probability of human health effects and were used to develop RSLs. A summary of the toxicity factors is presented in the RI (Appendix D).

Table 3 provides carcinogenic risk information which is relevant to the COCs in both soil and groundwater. At this time slope factors are not available for the dermal route of exposure. Thus the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50% absorption via the ingestion route. However, adjustment is not necessary for the chemicals evaluated at this Site. Therefore, the same values presented above were used as the dermal carcinogenic slope factors for these contaminants. TCE found in the groundwater lacks sufficient toxicity information via the inhalation route to support the development of specific inhalation carcinogenic toxicity criteria.

Table 4 provides non-carcinogenic hazard information which is relevant to the COCs in both soil and groundwater. Four of the five COCs have toxicity data indicated their potential for adverse non-carcinogenic health effects in humans. The chronic toxicity data available for the four COCs, PCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride for oral exposures , have been used to develop oral reference doses. The available toxicity data from the chronic animal studies indicate that the COCs primarily affect the blood and the liver. Reference doses are not available for TCE, neither are dermal RFDs, or inhalation RfDs for any of the COCs. As was the case of the carcinogenic data, dermal RFDs can be extrapolated from the oral RfDs applying an adjustment factor as appropriate. However, for the four COCs shown in the table, no adjustment is necessary, and the oral RfDs were used as the dermal RfDs. At this time, no inhalation reference concentration is available for cis-1,2-DCE.

7.1.4 Risk Characterization

The final step of the HHRA is risk characterization. This section provides a characterization of the human health risks associated with the potential exposures to chemicals in indoor air, groundwater, soil and surface water at the Flash Cleaners Site and the surrounding community. The results of the risk characterization are discussed below. Potential risks (non-carcinogenic and carcinogenic) for individual chemicals detected in the various media were estimated using the simple risk ratio technique presented in Section 7.1.2.

To interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates are compared to typical risk benchmarks. Calculated cancer risks are interpreted using the EPA's target range of $1x10^{-6}$ to $1x10^{-4}$ (i.e., a one-in-one-million chance to a one-in-ten-thousand chance of developing cancer) and the state of Florida goal for a total cancer risk of $1x10^{-6}$. HIs are evaluated using a value of 1.0.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk (ELCR) is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where: ELCR = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer
CDI = chronic daily intake averaged over 70 years, expressed as mg/kg-day
SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$

EPA has defined the range of $1x10^{-6}$ to $1x10^{-4}$ as the target range for hazardous waste facilities addressed under CERCLA and the Resource Conservation and Recovery Act (RCRA). Individual or cumulative cancer risks greater than $1x10^{-4}$ are generally not considered as protective of human health. The state of Florida has established a cumulative cancer goal of $1x10^{-6}$ for receptors exposed to contaminated environmental media at a site. These benchmarks are used in the interpretation of the risk characterization results. An ELCR of 1.0×10^{-6} indicates that an individual experiencing the RME estimate has a 1 in 1,000,000 chance of developing cancer as a result of Site-related exposure. This is referred to as an ELCR because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three.

For non-carcinogens (systemic toxicants), potential effects are evaluated by comparing an exposure level over a specified time period (e.g., exposure duration) with a RfD derived for a similar exposure period. An HQ, the ratio of exposure to toxicity, of less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to

which a given individual may reasonably be exposed. An HI of less than 1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI greater than 1 indicates that Site-related exposures may present a risk to human health. When an HI exceeds unity, target organs effects associated with exposure to COPCs are considered.

The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI}/\text{RfD}$$

where: HQ = Hazard quotient (unitless)
CDI = Chronic daily intake (mg/kg-day)
RfD = reference dose (mg/kg-day)

Tables 5 through 10 provide risk estimates and hazard indices for each significant route of exposure. The risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a worker or future resident's exposure to each media, as well as the toxicity of the COCs. The RI (Section 7.0 and Appendix D) presents the risk and calculations for exposure.

Risks Associated with Exposure to Soil

The cancer risks for residential and industrial exposures to soil at the Flash Cleaners facility fall within EPA's target risk range. Because of the limited amount of soil samples collected at the facility, the maximum detected concentrations of contaminants were the basis for the exposure point concentrations. The risks associated with soil at the Flash Cleaners property to a current industrial worker are associated with direct contact and inhalation of dust. The residential and industrial cancer risks for soil samples analyzed at the mobile laboratory are 2×10^{-6} and 4×10^{-7}, respectively. The residential and industrial cancer risks for soil samples analyzed at the fixed-base laboratory are 5×10^{-6} and 1×10^{-6}, respectively. The residential and industrial HIs for soil samples analyzed at the mobile laboratory are 0.004 and 0.0006, respectively. The residential and industrial HIs for soil samples analyzed at the fixed-base laboratory are 0.008 and 0.001, respectively. The principal contributor to total risk was PCE.

Risks Associated with Exposure to Groundwater

Risks were calculated for exposure to groundwater; however, there is no direct contact with groundwater at the locations where groundwater samples were collected. Only those risks derived using groundwater data collected from monitoring wells were used in calculations. The principal contributors to total risk are PCE and its breakdown products, TCE, and vinyl chloride.

Current industrial receptors at the Flash Cleaners facility are not directly exposed to groundwater. Therefore, there is no risk associated with groundwater at the Flash

Cleaners facility. However, if the site were to become residential and potential future residential receptors were to use groundwater as the principal potable water source, the maximum carcinogenic risk and HI would be 5×10^{-1} and 250, respectively. The maximum carcinogenic risk and HI associated with direct exposure to groundwater by an off-site resident would be 3×10^{-3} and 16, respectively.

Cis-1,2-DCE was also detected in two of five irrigation well water samples with a maximum detected concentration of 15 ug/L. The concentrations of cis-1,2-DCE were less than the EPA tap water RSL of 370 ug/L and less than the MCL of 70 ug/L. In addition, irrigation well water is not used for drinking or other household purposes.

Risks Associated with Exposure to Surface Water

In the surface water samples collected from the canal, only vinyl chloride was detected at concentrations greater than the EPA AWQC (National Recommended Water Quality) for human health (consumption of water and organisms). The maximum detected concentration of vinyl chloride (0.29 µg/L) is approximately ten times greater than the AWQC (0.025 ug/L). This criterion is based on a human receptor consuming fish from the channel in combination with drinking 2 liters of water per day from the channel. If the receptor in the channel is recreational, the consumption of water would be significantly less than 2 liters of water per day. Assuming that the recreational receptor lives on the channel, realizing that water consumption during recreational swimming in the channel would be approximately 10 milliliters per hour and one hour per day [according to Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS) Region 4 Bulletins, Human Health Risk Assessment Bulletins (2001)], and assuming that the receptor goes into the water 350 days per year for 30 years, the risk would be 4×10^{-8}, less than EPA's risk range.

Risk associated with Exposure to Indoor Air

The cancer risks for residential and industrial exposures to indoor air at the Flash Cleaners site fall within EPA's risk range. The average residential and industrial cancer risks for indoor air, excluding the contribution associated with ambient air, are 8×10^{-5} and 2×10^{-5}, respectively. The maximum residential and industrial cancer risks for indoor air, excluding the contribution associated with ambient air, are 1×10^{-4} and 2×10^{-5}, respectively. The average HI for residential and industrial exposures to indoor air are also acceptable. The average residential and industrial HIs for indoor air, excluding the contribution associated with ambient air, are 0.1 and 0.04, respectively. The maximum HI for residential and industrial exposures to indoor air, excluding the contribution associated with ambient air, are 0.2 and 0.04, respectively. The principal contributor to total risk was PCE.

Soil gas samples collected across the street from the dry cleaning facility and at residences located to the northeast of the facility (following the groundwater flow direction), toward the surface water channel, had no detectable concentrations of VOCs,

despite their presence in groundwater samples. Therefore, indoor air risks associated with potential vapor intrusion at these off-site locations are expected to be negligible.

Risks Associated with Exposure to Indoor Air through Vapor Intrusion

Soil gas samples were collected to determine if there was a potential for vapor intrusion at the Flash Cleaners facility and at residences in the surrounding community. PCE and cis-1,2-DCE were detected in the soil gas samples collected beneath the dry cleaning facility at concentrations greater than the Draft EPA Vapor Intrusion Guidance (EPA, 2000) Tier 2 secondary screening levels, which correspond to a cancer risk of 1 x 10^{-6} or an HI of 1.0. The indoor air sample results in the Flash Cleaners building confirm that PCE is present. Its presence could be attributable to dry cleaning operations and vapor intrusion. Because indoor air concentrations were available (see above), risks associated with the potential intrusion of soil gas contaminants into indoor air by using an assumed attenuation factor to derive predicted indoor air concentrations were not used in the HI calculation. As shown above, the cancer risks and HI for residential and industrial exposures to indoor air at the Flash Cleaners site fall within EPA's target risk range.

Soil gas samples collected across the street from the dry cleaning facility and at residences located to the northeast of the facility (following the groundwater flow direction), toward the surface water channel, had no detectable concentrations of VOCs, despite their presence in groundwater samples. Therefore, indoor air risks associated with potential vapor intrusion at these locations are expected to be negligible.

Uncertainties

There are sources of uncertainty inherent in the risk assessment, most of which are expected overestimate the potential risk. Uncertainty associated with the exposure assessment included the values used as input variables for a given intake route or scenario and the assumptions made to determine EPCs. Use of maximum concentrations because of limited data within each exposure unit may have overestimated risk, but had no significant impact on the conclusions of the analysis. Use of the default exposure assumptions for an RME residential or industrial receptor provided estimates of risk within the typical range estimated in risk assessments and ensured adequate protection of human health. Uncertainty in the toxicity assessment included the quality of the existing toxicity data needed to support dose-response relationships and the weight-of-evidence used to determine the carcinogenicity of COPCs. The application of uncertainty and modifying factors to the data of toxicological studies used to form the basis of the development of the toxicity factors provides a level of conservatism to ensure protection of human health. Uncertainty in risk characterization was associated with exposure to multiple chemicals and the cumulative uncertainty from combining conservative assumption made in earlier steps of the risk assessment process. The interaction between chemicals may result in synergistic or antagonistic effects, thus resulting in potential overestimates or underestimates of total risk.

7.2 Ecological Risk Assessment

The ecological risk assessment that was done for the Site, as is described in the RI (Section 8), was a screening level evaluation of potential risks to ecological receptors. This ecological risk assessment was conducted to evaluate potential risks to ecological receptors resulting from contamination associated with the Flash Cleaners site. The ecological risk assessment consisted of Steps 1 through 3A of EPA's 8-step ecological risk assessment process (EPA, 1997; 2001). Steps 1 through 3A consist of the following:

Step 1	Screening-Level Problem Formulation and Ecological Effects Evaluation
Step 2	Screening-Level Exposure Estimate and Risk Calculation
Step 3A	Refinement of Preliminary COPCs

7.2.1 Chemicals of Potential Concern

Tables 11 and 12 show the chemicals detected in the pore and surface water, and their range of concentrations, number of detections, ecological screening values and hazard quotients. Based on the contaminants' maximum concentration and its ecological screening value, it was determined whether or not it would be retained as a COPC. For the Flash Cleaners site, the pore water data and the surface water data were compared to the lower of the freshwater and marine screening values. Ecological screening values (ESVs) used in the initial screening of pore water and surface water were the lower of those established by EPA Region 4 (EPA, 2001) and FDEP (2008) Class III Criteria. If the maximum concentration of pore water and surface water was less than the surface water ESV, the chemical was eliminated from further consideration. If the maximum concentration equaled or exceeded the ESV, or if a screening value was not available, the chemical was then considered to be an ecological COPC and was retained for further evaluation.

Four VOCs were detected in pore water (**Table 11**). Two VOCs detected in the pore water sampling were found at concentrations below their ecological screening value and thus the hazard quotient was less than one. Cis-1,2-DCE and vinyl chloride were the remaining two COPCs for the pore water. Cis-1,2-DCE and vinyl chloride were retained as COPCs in pore water because ESVs were not available. Cis-1,2-DCE and vinyl chloride were the only VOCs detected in surface water, and both compounds were retained as COPCs, again because ESVs were not available (**Table 12**). The full pore water and surface water datasets are presented in the RI (Appendix C).

7.2.2 Exposure Assessment

Flash Cleaners is located in an urbanized area of Pompano Beach. Almost all the ground surface surrounding the site is covered by buildings, structures, concrete, asphalt, or gravel. A few narrow strips of grass and ornamental shrubbery occur in the vicinity of the Site. The area in the vicinity of Flash Cleaners provides an extremely limited terrestrial habitat of poor quality. Ecological receptors in the vicinity of the Site consist of those typically found in urban areas, such as grass, ornamental plants, weeds,

invertebrates such as earthworms and insects, lizards, songbirds, and exotic rodents such as the Norway rat, black rat and house mouse.

Significant soil erosion due to storm water runoff and wind erosion does not occur at the Flash Cleaners site due to the flat terrain and the soil cover of impervious material. Although subsurface soil at the site is contaminated with VOCs, the subsurface soil contamination does not provide a complete pathway for ecological receptors. The only significant contamination migration pathway for ecological receptors is the groundwater to surface water pathway.

The nearest surface water body is the North Grand Canal and has been described in previous sections. Striped mullet and Atlantic needlefish were observed from the NE 22nd Avenue bridge during a site visit in January 2010, and a turtle and three different fishes, species unknown, were observed near the same location in August 2010. There are no oysters or oyster reefs in the Grand Canal. No sea grasses were seen in the canal during two visits in 2010. Wading birds such as herons and egrets forage along the edges of the canal system. **Table 13** shows the Ecological Exposure Pathways of Concern for the surface water and sediment in the canal.

7.2.3 Ecological Effects Assessment

An assessment endpoint is "an explicit expression of the environmental value that is to be protected," while a measurement endpoint is "a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint" (EPA, 1997b). Measurement endpoints represent the assessment endpoints chosen for a site, and are measures of biological effects.

EPA Region 4 has specified that assessment endpoints for the screening-level assessment should be broad and generic. For the Flash Cleaners screening level assessment, the preliminary assessment endpoint is the protection of aquatic and benthic biota from adverse effects of chemicals on their growth, survival, and reproduction.

The preliminary measurement endpoints are chemical concentrations in surface water and sediment pore water that are associated with no adverse effects on growth, survival, and reproduction of aquatic organisms. The measurement endpoints are represented by EPA Region 4 ESVs for surface water or other ecological screening values from appropriate sources. The surface water ESVs are based on conservative endpoints and sensitive ecological effects data, and thus, the screening values represent chemical concentrations associated with a low probability of unacceptable risks to ecological receptors.

7.2.4 Ecological Risk Characterization

The ecological risk characterization was carried out on the two COPCs: 1,2- DCE and vinyl chloride.

Cis-1,2-DCE

While EPA and Florida have not established an ESV for cis1,2-DCE, FDEP (2010) has recently developed a provisional marine surface water cleanup target level of 340 µg/L for total 1,2-DCE in marine surface water. FDEP considers this value to be protective of ecological receptors (**Table 14)**. Concentrations of total 1,2-DCE in pore water exceeded 340 µg/L in only one sample. Specifically, at FCPW14, the total 1,2-DCE concentration was 402 µg/L; this would result in an HQ of 1.2. As shown on **Figure 10,** total 1,2-DCE concentrations in all other samples were well below 340 µg/L.

Pore water sample FCPW14 was collected at a depth of 3.5 to 4.0 feet below the sediment surface. Most benthic invertebrates are found in the upper 6 inches of sediment, and although a maximum sediment burrowing depth for benthic invertebrates is not available, certainly no benthic invertebrates would be found at depths of 3.5 to 4 feet. Thus, benthic receptors would not be exposed to the 402 µg/L concentration at this depth. Likewise, upper level receptors such as fish, birds, and mammals would not be exposed to sediments at this depth.

The highest concentrations of cis-1,2-DCE in surface water was 0.26 µg/L in 2009 and 0.1 µg/L in 2010 (**Table 12**). Thus, the highest total 1,2-DCE concentration in surface water was 0.26 µg/L.

In summary, pore water concentrations of total 1,2-DCE exceeded 340 µg/L in only 1 of 30 samples, at a concentration of 402 µg/L. This sample was collected from a sediment depth of 3.5 to 4 feet, where benthic receptors are not found. Because concentrations were not elevated in other pore water samples or in surface water, and since the detection limits in non-detect samples were adequately low (0.5 µg/L), the single slightly elevated concentration at FCPW14 does not indicate significant potential risk to ecological receptors in the canal.

Vinyl Chloride

Neither EPA Region 4 nor FDEP has established ESVs for vinyl chloride in surface water. Some states, such as Georgia, use 525 µg/L as a chronic freshwater criteria, but this value is actually based on human health rather than ecological receptors. Specifically, it is the AWQC for protection of human health for the consumption of fish and shellfish (EPA, 1980). The Texas Commission on Environmental Quality (TCEQ) ESV for vinyl chloride in fresh surface water is 2,820 µg/L (TCEQ, 2006). According to TCEQ's Water Quality Standards Group, the 2,820 µg/L value is derived from a toxicity test using channel catfish (Ictalurus punctatus). The Michigan Department of Environmental Quality (MDEQ) ESV for vinyl chloride in freshwater is 930 µg/L (MDEQ, 2002). According to MDEQ, 930 µg/L is a Final Chronic Value, which is defined by MDEQ as the level "that does not allow injurious or debilitating effects in an aquatic organism resulting from repeated long-term exposure to a substance relative to the organism's lifespan."

The maximum pore water vinyl chloride concentration of 230 μg/L is less than all three of these protective values. Detected concentrations in the other samples ranged from 0.22 to 76 μg/L **(Table 11**). Vinyl chloride was detected in two surface water samples collected in 2010; both concentrations were 0.29 μg/L (**Table 12**).

In conclusion, while the groundwater-to-surface water migration pathway is complete, the pore water and surface water data indicate relatively low contamination. Based on current data from sediment pore water and surface water samples, the groundwater plume from the Flash Cleaners site poses minimal ecological risks.

Conclusion

The pore water and surface water data indicate relatively low contamination. Pore water samples collected for ecological risk assessments are typically are taken from 0 to 6 inches below the sediment surface, because chemical concentrations in this interval are considered to be indicative of chemical concentrations to which benthic organisms are exposed. However, pore water samples for this study could not be collected shallower than 2.5 feet due to the fine grained sediment. Field measurements of temperature, conductivity, and salinity were obtained at each pore water sample location and used to identify the zone of groundwater discharge, with the objective of collecting pore water from this zone rather than from the overlying canal surface water intrusion zone.

As a result, pore water samples were collected from various depths between 2.5 and 7.0 feet below the sediment surface. Because pore water in the sediment zone of biological inhabitation would be somewhat diluted by overlying surface water, and because surface water concentrations of VOCs were negligible, concentrations of COPCs in sediment pore water within the zone of biological inhabitation is likely much less than what was measured at the deeper intervals. Furthermore, because only one pore water sample at the 3.5 to 4 foot depth exceeded a screening benchmark, and pore water samples taken near this sample location showed no exceedances, it appears that the spatial area of benchmark exceedances in pore water is small. Therefore, the pore water and surface water data indicate no appreciable biological impact from Flash Cleaners contamination in Grand Canal given the current conditions.

Uncertainties

Groundwater discharge has resulted in minimal contamination, but there is uncertainty regarding future conditions. Aquatic toxicity data are sparse for the VOCs detected in North Grand Canal, so the resulting uncertainties may overestimate or underestimate potential risks to some extent. However, the safety factors used in generating the screening values for vinyl chloride and total 1,2-DCE probably provide adequate margins of safety for these chemicals.

8.0 Remedial Action Objectives

CERCLA and the NCP define remedial action objectives (RAOs) that are applicable to all Superfund sites. They relate to the statutory requirements for the development of remedial actions. Site-specific RAOs relate to potential exposure routes and specific contaminated media, such as soil, and are used to identify target areas of remediation and contaminant concentrations. RAOs provide a general description of what the cleanup will accomplish.

They require an understanding of the contaminants in their respective media and are based upon the evaluation of risk to human health and the environment, protection of ground water, information gathered during the RI, applicable guidance documents, and federal and state Applicable or Relevant and Appropriate Requirements (ARARs). RAOs must be identified as specifically as possible without unduly limiting the range of alternatives that can be developed for detailed evaluation.

The RAOs for the Flash Cleaners Site were developed based on the current land use as commercial property and future potential use as residential property, with the objective of protecting the public from potential current and future health risks, as well as to protect the environment. These goals serve as the basis for the alternatives that are identified and evaluated for the Site. The goals for each media are as follows:

- Soil:

    1. Prevent human exposure to soil with contaminants above levels that pose unacceptable risks and allow for unrestricted use.

    2. Prevent migration of contaminants in soil, with concentrations exceeding leachability-based state criteria, to groundwater

- Groundwater

    1. Prevent human exposure to groundwater with contaminants above levels that pose unacceptable risk.

    2. Restore groundwater to drinking water standards (federal and state).

<u>Cleanup Levels</u>

Cleanup Levels are concentrations of contaminants in environmental media that, when attained, should achieve RAOs. In general, cleanup levels are established with consideration to the following:

- Protection of human receptors from adverse health effects
- Protection of the environment from detrimental impacts from Site-related contamination

- Compliance with federal and state ARARs

Cleanup levels for the Flash Cleaners site are based on chemical-specific ARARs. ARARs are those substantive cleanup or control standards or environmental protection requirements, criteria, or limitations, promulgated under other federal environmental or state environmental or facility siting laws and regulations which are either:

- Directly "Applicable" to the contaminants, proposed remedial action, location, or other circumstances found at a particular CERCLA site, or;

- Are "Relevant and Appropriate" for use at a CERCLA site because they address problems or situations sufficiently similar to those encountered at the Site such that their use is well suited to the Site.

The NCP identifies three categories of ARARS: chemical-specific, location-specific, and action-specific. The federal and state ARARs identified for the Flash Cleaners Site in each of these three categories are presented in **Tables 15 through 18.**

Soil cleanup levels were determined for the soil COCs based on Florida's enforceable SCTLs for residential and industrial exposure scenarios and for leachability based on groundwater criteria, whichever is more protective. These SCTL values are applicable as chemical-specific ARARs. The SCTLs and cleanup levels selected for soil COCs at the Site are presented in **Table 19** and **Table 21**, respectively.

Groundwater cleanup levels were established based on protection of human health from direct exposure to contaminated groundwater and compliance with ARARs. The cleanup levels for groundwater COCs are based on the EPA MCL or the FDEP GCTL, whichever is more protective (**Table 20**). Cleanup levels selected for groundwater COCs at the Site are presented in **Table 21.**

Institutional Controls (ICs)

The NCP states that institutional controls, while not actively cleaning up the contamination at the site, can control exposure, and therefore, are considered to be limited action alternatives. The NCP preamble states: "Institutional controls will usually be used as supplementary protective measures during implementation of groundwater remedies." Consistent with the RAOs developed for the site, the specific performance objectives for the ICs to be implemented at the Site are to prevent human exposure to groundwater with contaminants above levels that pose unacceptable risk and do not allow for drinking water purposes. EPA will use ICs also to maintain the integrity of the any existing or future monitoring or remediation system. FDEP will take responsibility to maintain, monitor, and enforce the ICs according to the ROD.

The following generally describes those ICs to be considered for implementation at the Site to achieve the performance objectives:

- Well permitting and water use restrictions by the local authorities for the area of groundwater contamination

- Property record notices could be implemented to inform anyone performing a search of property records to important information about contamination and response actions on the Site. The language comprising the property record notice would be filed at the Broward County Clerk's Office, in accordance with state law.

- Restrictive covenants could be executed by the property owners that outline the prohibition of any residential, industrial, or recreational reuse of the site unless prior written approval is obtained from EPA and FDEP. The covenant could also prohibit interference with the integrity of any existing or future groundwater monitoring or remediation system without prior EPA and FDEP approval. The restrictive covenant is recorded at the Broward County Clerk's office in accordance with applicable state law and federal law. Notice of the application of ICs to the Site via the restrictive covenant would be provided to the local regulatory agencies.

Should any IC remedy fail, EPA and FDEP will ensure that appropriate actions are taken to reestablish the remedy's protectiveness and may initiate legal action to either compel action by a third party and/or to recover costs for remedying any discovered IC violations.

9.0 Description of Alternatives

In the Feasibility Study and the Proposed Plan prepared for the Site, four alternatives for soil (S-1 to S-4) and six alternatives for groundwater (GW-1 to GW-6) were developed. Contaminants with concentrations above cleanup levels and technologies which most effectively address the contaminants were considered in the development of remedial action alternatives. The goal in developing remedial action alternatives is to provide a range of cleanup options together with sufficient information to adequately compare alternatives against each other.

A description of each alternative, along with estimated costs for capital, O&M, and total present worth are provided below, with the exception of No Action which has no cost. All the costs are calculated with an annual discount rate of 7.0% with the exception of the No Action Alternatives. The alternatives for soil and groundwater are as follows:

9.1 Soil Alternatives

- Alternative S-1: No Action

This alternative is required by NCP as a baseline for comparison to other alternatives. The No Action alternative for soils maintains the Site as is. This alternative does not address any of the risks posed by the soil contamination. This alternative is

retained to provide a baseline for comparison to other alternatives. This alternative would not meet any ARARs.

- Alternative S-2: Excavation, Off-Site Disposal, Institutional Controls (ICs), and Monitoring

  Estimated Capital Cost: $583,000
  Estimated O&M Cost: $120,000 (30 years)
  Total Present Worth Costs: $703,000
  Time to Design & Construct: Three months
  Time to achieve ARARs: Immediately if the building were demolished, but if not, would not attain chemical specific ARARs beneath the building

This alternative was developed to address the area where soil contamination exceeds EPA and or FDEP residential or leachability to groundwater criteria for Site COCs. This alternative would consist of physically removing the contaminated soil to decrease the risk of exposure to receptors and prevent leaching to groundwater. The proposed excavation area is depicted in **Figure 15**. Contaminated soil would be transported to a RCRA approved landfill based upon analytical data. Soil would be removed down to the water table, which is estimated to be at about 8 feet bgs. The excavated area would be backfilled with clean soil. Institutional controls would be required for the soil with contaminants above cleanup levels remaining beneath the footprint of the Flash Cleaners building. It was assumed that the building would still be used as it is currently. If the owners decided that the building could be demolished, EPA could raze it and ICs would not be required as all soil exceeding criteria could be excavated and removed. Monitoring of indoor air would be required to detect potential vapor intrusion into the Flash Cleaners building or adjacent buildings.

Neither treatment nor containment is part of this alternative. Institutional controls and monitoring requirements are further described below in Section 9.1.1. Operations and maintenance would consist of a review of the effectiveness and protectiveness of the remedy every five years. The NCP requires a five-year review if the remedial action results in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. This would be the case as long as the contaminated soils beneath the building remain above cleanup levels.

- Alternative S-3: Capping, ICs, and Monitoring

  Estimated Capital Cost: $170,000
  Estimated O&M Cost: $114,000 (30 years)
  Total Present Worth Costs: $284,000
  Time to Design & Construct: One month
  Time to achieve ARARs: Would not attain chemical-specific ARARs

This alternative was developed to address the area where soil contamination exceeds EPA and or FDEP residential or leachability to groundwater criteria for Site

COCs. This alternative would place an impermeable cap over the impacted soil areas. The proposed area to be capped is depicted on **Figure 16**. ICs would be required for the impacted areas to maintain the integrity of the cap and prevent any exposure to contaminated soil. Monitoring of indoor air would be required to detect potential vapor intrusion into the Flash Cleaners building or adjacent buildings. Institutional controls and monitoring requirements are further described below in Section 9.1.1.

The primary component of the remedy is containment. As required by CERCLA, a review of Site conditions and risks would be conducted every 5 years since contamination would remain on site above levels that allow for unlimited use and unrestricted exposure.

This alternative would not meet the chemical-specific ARARs, but it would meet the federal ARARs for closure of a RCRA hazardous waste management unit, which pertains to landfill cover, design and construction, in accordance with 40 CFR §264.310.

- Alternative S-4: Soil Vapor Extraction (SVE) with Vapor Phase Carbon Adsorption and Monitoring

  Estimated Capital Cost: $481,000
  Estimated O&M Cost: $274,000
  Total Present Worth Costs: $755,000
  Time to Construct: Six months
  Time to achieve Soil ARARs: Five years

This alternative was developed to address the area where soil contamination exceeds EPA and or FDEP residential or leachability criteria for Site COCs. An SVE system consisting of SVE wells installed in the vadose zone, would be installed to physically remove (volatilize) the COCs from the soil (**Figure 17**). An impermeable membrane would be placed over the ground surface to increase the radius of influence of the SVE wells and prevent short circuiting. The soil vapor system consists of a vacuum blower that pulls air from the wells. Air will first pass through a moisture separator and an air filter before being directed through the pump and on to the vapor phase carbon adsorption unit. The adsorption unit will remove the volatilized contaminants. Monitoring of indoor air would be required to detect potential vapor intrusion into the Flash Cleaners building or adjacent buildings. Monitoring requirements are further described below in Section 9.1.1.

This alternative involves treatment of source materials. The operation of the system will require periodic maintenance to ensure the SVE vacuum rates are properly maintained and the system is running per specifications. In addition, the adsorption capacity of carbon has to be checked and periodically changed to ensure VOC removal in the off-gas. Air samples will be collected to verify off-gas concentrations. System inspections will be more frequent in the beginning and less frequent once the system is up and functioning properly.

Institutional Controls would only be necessary if after treatment, contaminants in the soil did not achieve soil cleanup levels.

9.1.1 Common Elements of Soil Alternatives

Monitoring is the common element of each soil remedial alternative presented in the feasibility study and the Proposed Plan, except Alternative S-1, No Action. Institutional Controls are also common elements of Alternative S-2 and S-3 and potentially S-4 if the contaminants in the soil did not achieve soil cleanup levels. Also, each of the alternatives, with the exception of the No Action, will address the same area of soil contamination. Alternatives S-2 and S-4 both use of treatment as primary components of the alternative. A Five-Year review would be necessary for all the alternatives, with the possible exception of alternative S-4 if the treatment was completely successful.

Institutional Controls

ICs, such as restrictive covenants, conservation easements, zoning controls and permitting prohibitions, will be implemented to protect the integrity of the soil remedy and restrict the use of soil with concentrations of contaminants above cleanup levels. The owner of the property, current and future, will be responsible for implementing and maintaining these controls. The covenants or easements will be properly recorded with the appropriate authority's records to help ensure proper notice and effectiveness of the control. Documentation regarding the IC will be provided to FDEP and FDEP will be responsible for overseeing these controls after they are executed. FDEP has procedures in place to enforce ICs in the state of Florida. FDEP's Division of Waste Management maintains the state's Institutional Controls Registry (ICR).

Monitoring

Monitoring would consist of collecting air samples on an annual or biennial basis in the Flash Cleaners building and adjacent attached building. This would provide a warning system for potential vapor intrusion from any remaining contaminated soil beneath the building.

9.2 Groundwater Alternatives

- Alternative GW-1: No Action

This alternative was developed and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. The No Action groundwater alternative maintains the site as it exists currently and does not address any of the risks posed by the groundwater contamination. No treatment, containment, ICs, monitoring or O&M would be conducted at the site. As required by CERCLA, a review of Site conditions and risks would be conducted every 5 years since contamination would remain on site above levels that allow for unlimited use and unrestricted exposure. This alternative would not meet any ARARs.

- Alternative GW-2: In-Situ Enhanced Bioremediation, ICs, and Monitoring

  Estimated Capital Cost: $1,202,000
  Estimated O&M Cost: $1,091,000 (13 years)
  Total Present Worth Costs: $2,293,000
  Time to Construct: 3 months
  Time to achieve ARARs: 13 years

Alternative GW-2 would consist of in-situ groundwater treatment using emulsified oil substrate (EOS) to stimulate the natural biodegradation of COCs. **Figure 18** depicts the location of the proposed injection points. EOS was chosen for injection into the source zone in an effort to enhance the natural degradation that is already occurring. For costing purposes, it was assumed a total of 91 injection points would be installed into the groundwater source zone using direct push technology (DPT). Each injection point was assumed to have a radius of influence of 5 feet with an injection zone of 30 feet in length. Each injection point would have 196 liters of EOS injected over the 30-foot interval. The second injection would be used to treat remaining hot spots within the plume. For costing purposes, the second injection was assumed the same size as the first injection.

The use of ICs would be used to prevent the use of contaminated groundwater until the cleanup levels are achieved. Monitoring would be conducted to provide evidence of groundwater contaminant migration. Further details about the ICs and monitoring components are provided below in Section 9.2.1. A review of Site conditions and risks would be conducted every five years until remedial action objectives and cleanup levels are attained, to ensure that the remedy is, or will be, protective of human health and the environment.

- Alternative GW-3: In-situ Air Sparging/SVE, ICs, and Monitoring

  Estimated Capital Cost: $1,403,000
  Estimated O&M Cost: $824,000 (13 years)
  Total Present Worth Costs: $2,228,000
  Time to Construct: 6 months
  Time to achieve ARARs: 13 years

This alternative would consist of in-situ groundwater treatment of the source zone using air sparging (AS) and soil vapor extraction, monitoring of the remaining plume, and ICs. The air sparging system would be used to volatilize (strip) the COCs from groundwater. The SVE system would then be used to capture the volatilized COCs as they migrate vertically through the saturated zone toward the vadose zone beneath the Site. **Figure 19** depicts the proposed AS/SVE well locations. An impermeable membrane will be placed over the ground surface to increase the radius of influence of wells and prevent short circuiting. A geomembrane was assumed for this alternative but other impermeable covers (e.g., concrete) can be used based upon Site use factors.

For costing purposes, it was assumed that 30 AS wells (60 feet in depth) and15 vertical SVE wells (8 feet in depth) would be installed. Each air sparging well was assumed to have a 15-foot radius of influence while the SVE wells were assumed to have a 25-foot radius of influence. The AS and SVE wells would then be tied into a pre-packed AS/SVE skid unit available as a rental unit from a qualified environmental vendor.

The use of ICs would be used to prevent the use of contaminated groundwater until the cleanup levels are achieved. Monitoring would be conducted to provide evidence of contaminant migration. Further details about the ICs and monitoring components are provided below in Section 9.2.1. A review of Site conditions and risks would be conducted every five years until remedial action objectives and cleanup levels are attained, to ensure that the remedy is, or will be, protective of human health and the environment.

The operation of the system will require periodic maintenance to ensure the AS and SVE vacuum/blower rates are properly maintained and the system is running per specifications. In addition, the carbon has to be periodically checked and changed to ensure VOC removal in the off-gas. Air samples will be collected to verify off-gas concentrations. System inspections will be more frequent in the beginning and less frequent once the system is up and running.

- Alternative GW-4: In-situ Chemical Oxidation, ICs, and Monitoring

  Estimated Capital Cost: $2,161,000
  Estimated O&M Cost: $295,000 (13 years)
  Total Present Worth Costs: $2,456,000
  Time to Construct: 3 months
  Time to achieve ARARs: 13 years

This alternative would consist of in-situ injection of a chemical oxidant (persulfate) into the groundwater source zone using DPT, monitoring of the remaining plume, and ICs. **Figure 20** depicts the proposed chemical oxidation points. The injection of persulfate would rapidly oxidize the COCs present in the source zone beneath the Site. For costing purposes, it was calculated that 91 injection points would be installed using DPT. It was assumed that each injection point would have a 5-foot radius of influence. Approximately 644 pounds of persulfate and 37 gallons of sodium hydroxide (activator) would be injected over a 30-foot depth interval (source zone) in each injection point. It was assumed that a second injection would be required following review of monitoring data. The second injection would be used to treat remaining hot spots within the plume. For costing purposes, the second injection was assumed the same size as the first injection.

The use of ICs would be used to prevent the use of contaminated groundwater until the cleanup levels are achieved. Monitoring would be conducted to provide evidence of any contaminant migration. Further details about the ICs and monitoring components are provided below in Section 9.2.1. A review of Site conditions and risks

would be conducted every five years until remedial action objectives and cleanup levels are attained, to ensure that the remedy is, or will be, protective of human health and the environment.

- Alternative GW-5: Monitored Natural Attenuation (MNA)

  Estimated Capital Cost: 0
  Estimated O&M Cost: $376,000
  Total Present Worth Costs: $376,000
  Time to Construct: 0
  Time to achieve ARARs: 15 years

  This alternative was developed as a potential contingency option for groundwater following evaluation of monitoring data from the plume. Insufficient data is currently unavailable to determine if MNA is a viable treatment option, but additional monitoring data can be collected during the design, implementation, and following any of the alternatives. This alternative would consist of monitoring groundwater VOC and geochemical parameters within the plume to document the natural attenuation of contaminants over time. The evaluation of MNA data would be used to determine contaminant degradation rates and predict when RAOs could potentially be met and ICs removed. The actual sampling locations and frequency of data collection will be based on the Conceptual Site Model (CSM) at the time the remedial action work plan is written. **Figure 21** depicts the location of existing monitoring wells that could be used for MNA.

  For costing purposes, it was determined that groundwater samples would be collected from up to 20 existing monitoring wells for VOCs and MNA parameters to evaluate the progress of natural attenuation. Sampling frequency would be quarterly for the first year, semi-annual for years two through four, and annually thereafter. Monitoring results would be evaluated with respect to the exit strategy decision flow charts that would be developed in the remedial work plan. If natural attenuation has progressed to a point that meets the decision point requirements, the monitoring program could be modified or discontinued.

  It was assumed that this alternative would only be implemented along with another treatment alternative and as it is a contingency it would only be done after the treatment alternative has been in place. Therefore, 15 years instead of 30 years is being used as the time to achieve ARARs.

- Alternative GW-6: In-situ Permeable Reactive Barrier (PRB)

  Estimated Capital Cost: $925,000
  Estimated O&M Cost: 0
  Total Present Worth Costs: $925,000
  Time to Construct: 3 months
  Time to achieve ARARs: 30 years

This alternative was developed as a contingency remedy for the down gradient portion of the plume in the event that COC concentrations in the North Grand Canal exceed surface water criteria and action is required after a minimum of three years of monitoring. Alternative GW-6 is being included as a conservative alternative and as a contingency alternative in the event that monitoring shows that groundwater contamination is negatively affecting the surface water in the Grand Canal. The PRB could be installed near the groundwater and surface water interface. The PRB would reduce the contaminant concentrations in groundwater that flow through the PRB and prevent continued migration of groundwater contaminants to surface water. **Figure 22** depicts the proposed PRB location. It should be noted that the PRB was placed in the street parallel to the Grand Canal as access immediately along the canal is prevented by residential housing.

A PRB would prevent continued discharge of contaminated groundwater into the Grand Canal. The proposed PRB would consist of zero valent iron particles injected as slurry into the subsurface using specialized drilling and injection equipment. For costing purposes, it was assumed 41 injection points spaced 10 feet apart (5-foot radius per injection point) would be installed to approximately 30 feet bgs. This would create a PRB with the dimensions of 10 feet wide, 400 feet long, and 30 feet deep.

9.2.1 Common Elements & Distinguishing Features of Groundwater Alternatives

Treatment of the groundwater, institutional controls and monitoring are common elements of most of the groundwater remedial alternatives. Alternatives GW-1, No Action and GW-5, MNA, are the only two alternatives that do not have treatment as a component to the remedy. Although Alternatives GW-5, MNA, and GW-6, PRB, did not include Monitoring or ICs in the FS and the Proposed Plan, the PRB would actually need some type of IC in place to maintain its integrity and restrict access in the location of the barrier, such as from underground work in the vicinity of the barrier. Alternative GW-2, In-situ Enhanced Bioremediation is unique in that it is considered more of a green alternative (less impact to the environment). Alternatives GW-3, In-situ AS/SVE, and GW-4, In-situ chemical oxidation, are considered the more aggressive remedial actions. All of the alternatives would require a review of Site conditions and risks every five years until remedial action objectives and cleanup levels are attained, to ensure that the remedy is, or will be, protective of human health and the environment.

Institutional Controls

ICs would be developed specifying groundwater use restrictions to prevent unacceptable risks from exposure to contaminated groundwater. At a minimum, installation of potable water wells would be prevented. The specifics of the controls would be stated in the remedial design. Controls would be maintained for as long as they are required to prevent unacceptable exposure to contaminated groundwater or to preserve the integrity of the selected remedy. Regular inspections would be performed to verify the continued implementation of the groundwater use restrictions. The local

authorities, such as the county health department, the state water management district, and FDEP have the authority to implement different ICs. It is likely for this Site, FDEP will be responsible for enforcing these controls. ICs would remain in place until the groundwater cleanup levels are achieved.

Monitoring

Monitoring would consist of the periodic collection of groundwater, surface water, and air samples for evidence of contaminant migration. Groundwater samples would be collected from approximately 20 monitoring wells for VOCs and natural attenuation parameters. Sampling frequency would be quarterly for the first year, semi-annual for years two through four, and annually thereafter. Surface water and pore water samples would be collected annually for three years, in the North Grand Canal to verify that groundwater was not discharging to surface water in exceedance of water quality criteria. Indoor air samples on the Flash Cleaners property would be collected annually, and analyzed to verify there are no vapor intrusion risks, until the concentrations of the soil and groundwater contaminants achieve cleanup levels. Monitoring results would be evaluated with respect to the exit-strategy decision flow charts that would be developed in the remedial design plans. If contaminants in groundwater have decreased in concentration to below the cleanup levels, the monitoring program could be modified or discontinued, and a technical basis would be available to negotiate the removal of ICs with EPA and FDEP.

9.3 Other Common Elements and Distinguishing Features of both Soil and Groundwater Alternatives

Common elements and distinguishing features unique to each alternative include key ARARs and long-term reliability of the remedy. Two of the four soil alternatives (S-2 and S-4) would comply with the chemical-specific ARARs for the Site. Four of the six groundwater alternatives (GW-2 thru GW-5) would eventually comply with the chemical-specific ARARs for the Site. The No Action alternatives for soil and groundwater would not comply with ARARs or be effective long-term. The key ARARs for the Flash Cleaners site are chemical-specific: federal MCLs from the Safe Drinking Water Act (SDWA) regulations, and state Soil Cleanup Target Levels and Groundwater Cleanup Target Levels from Chapter 62 the Florida Administrative Code.

10.0 Summary of the Comparative Analysis of Alternatives

The NCP provides that the ROD must explain how the nine criteria were used to select the remedy. The nine criteria are divided into three categories: two threshold criteria (Overall Protection of Human Health and the Environment and ARARs), five primary balancing criteria (Long-Term Effectiveness and Permanence, Reduction of Toxicity, Mobility, or Volume through Treatment, Short-term Effectiveness, and Implementability), and two modifying criteria (State and Community Acceptance). Below is a summary of the detailed comparative analysis of alternatives against the nine criteria that was presented in the FS Report (Section 5).

10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether the alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or ICs.

Alternatives S-1 and GW-1 (No Actions) are not protective of human health or the environment. Soil Alternatives S-2, S-3, and S-4 are all protective of human health and the environment by eliminating, reducing, or controlling risks posed by the Site through treatment of soil contaminants, engineering controls, and/or ICs. S-2 and S-4 would be more protective of human health and the environment than S-3, and S-2 would be the most protective because it would permanently remove contamination from the site. S-3 would be less protective than S-2 and S-4 because it does not involve treatment and only prevents exposure. Although the soils have not been treated, capping would mitigate the risk associated with receptor contact with the contaminated surface soils.

Alternative GW-5 would not be protective, because it is a contingency remedy that was not designed to treat the groundwater contamination and it is not fully known when MNA would become protective. GW-2, GW-3 and GW-4 are all equally protective because they all depend on treatment at the source along with long-term controls to prohibit groundwater use until RAOs are met (via the natural attenuation of COCs). The only difference between them is the type of in-situ technology used to treat the source zone of the plume. Alternative GW-6 would possibly be protective of the environment, but it is not protective of human health, because it is included as a contingency remedy for surface water protection and was not designed to treat the contaminant plume.

10.2 Compliance with ARARs

Section 121(d) of CERCLA and the NCP §300.430(f)(l)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA §121(d)(4). Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable or relevant and appropriate. In accordance with 40 CFR §300.400(g), FDEP and EPA have identified specific ARARS for the selected remedy

In addition, per 40 CRF 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (known as TBC).

Alternatives S-1 and GW-1 do not comply with the chemical-specific ARARs, and action-specific ARARs do not apply since no action would be taken. S-2 and S-4 would comply with all the ARARs for the Site. S-3 would comply with the location and action-specific ARARs but would not comply with the chemical-specific ARARs.

Alternatives GW-1 and GW-5 may eventually attain compliance with chemical-specific ARARs because of natural attenuation, but it would never be known for GW-1 since it would not include monitoring. GW-2, GW-3, and GW-4 will comply with all the ARARs by using ICs until the chemical-specific ARARs are achieved and monitoring to verify that the cleanup levels have been achieved. GW-6 would not meet chemical-specifc ARARs for the groundwater since it is designed to be address surface water only.

10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-site following remediation and the adequacy and reliability of controls.

Alternatives S-1 and GW-1 would not be effective in the long term and offer no permanent solution. S-2, S-3, and S-4 would offer different degrees of long-term effectiveness and permanence. S-2 is effective immediately and would be permanent but requires ICs until the Flash Cleaners building is removed and the excavation can be completed. S-3 would be effective upon implementation, but IC and periodic maintenance would be required to sustain the cap. S-4 would be effective once it was completed and would be permanent. Therefore, S-2 and S-4 are more protective than S-3. S-2 and S-4 are both effective in the long-term but S-2 ranks higher than S-4 because it is more permanent (no chance of rebounding of contaminant concentrations).

Alternative GW-6 would not be effective in the long term and would offer no permanent solution; although GW-6 would provide protection of surface water. GW-5 could provide effectiveness and permanence but it does not include Institutional Controls that would ensure protection of public. GW-2 and GW-3 would be more effective in the long term than GW-4. GW-4 will likely have a negative effect on the natural attenuation that is currently occurring in the groundwater. GW-3 would be effective more quickly than GW-2 but both are effective. All three of these alternatives would offer permanence

because of the implementation of monitoring and Institutional Control programs. Overall, GW-2 would be the most effective and permanent alternative because it facilitates the natural attenuation that is occurring more than the other alternatives. GW-3 would then rank ahead of GW-4.

10.4 Reduction in Toxicity, Mobility, and Volume

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

No treatment would occur under Alternatives S-1, S-2, S-3, GW-1, or GW-5. S-4 is the only alternative that would employ treatment to reduce toxicity, mobility, and volume. S-2 and S-3 do not reduce the toxicity, mobility and volume of the contaminated soil. However, S-2 physically removes the contamination from the site and places it in a controlled landfill, thus removing the risks from the site. S-4 would rank highest. S-2 ranks higher than S-3 because it removes the contaminated soil from the site and places it in a more controlled environment (Resource Conservation and Recovery Act landfill).

GW-2, GW-3, and GW-4 employ active treatment to achieve a reduction in toxicity and mobility, and the reduction in toxicity and mobility would be tracked through monitoring. GW-4 is the most aggressive treatment followed by GW-3 and then GW-2 (least aggressive). However, GW-2 would be the best at reducing the toxicity, mobility and volume because it would not negatively affect the natural attenuation processes that are ongoing in the plume. Alternative GW-4 would, and there is the potential for GW-3 to, negatively alter the natural attenuation that is currently reducing the toxicity, mobility, and volume. Alternative GW-6 would provide limited in situ treatment and reduction in toxicity (i.e., concentrations) over time, but only for a small portion of the plume.

10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternatives S-1, GW-1, and GW-5 do not provide short-term effectiveness and while they would not have any short-term risks to workers since no activities would be undertaken, there is the continued risk to community through no action, and for the groundwater, the continued risk to the environment through discharge to the surface water. The other three soil alternatives all involve short term risks. Alternatives S-2, S-3, and S-4 involve potential short-term risks that result from handling contaminated soils during excavation and installation of the treatment wells. The short-term risks include dermal contact with contaminated soils, inhalation of vapors and dust, and potential dangers associated with operating excavation or drilling equipment. These onsite risks will be mitigated by implementing a project-specific Health and Safety Plan to minimize

exposure, as well as by performing the remedial action following best management practices. Further, short-term risks would be properly mitigated by application of engineering controls and adherence to Occupational Safety and Health Administration requirements.

Alternatives S-1 and GW-1 would not achieve their respective RAOs. S-2, S-3, and S-4 would attain the soil RAOs immediately upon completion of their respective action. The time to implement and complete the remedial action for Alternatives S-2, S-3 and S-4 is estimated at two to six months.

Risks to workers during construction of Alternatives GW-2, GW-3, GW-4 and GW-6 would be minimized through adherence to OSHA regulations and site-specific health and safety procedures. There are some short-term concerns to workers during the treatment process because of the injection process and handling of chemicals; however, these concerns could also be adequately mitigated with site-specific health and safety procedures. Alternatives GW-2, GW-3, GW-4, and GW-6 all pose some short-term risk to the community and the environment, since they will be implemented in the community but, again, proper planning will minimize risks.

GW-2, GW-3, and GW-4 would meet groundwater RAOs 1 and 3 upon implementation of Institutional Controls and the monitoring plan and could eventually meet RAO 2 and 4. GW-5 would not meet any of the RAOs in the short-term. GW-6 would only achieve groundwater RAO 3 (protect surface water) and not meet groundwater RAOs 1, 2, and 4.

10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternatives S-1 and GW-1 are easily implemented, and do not require any actions other than statutory 5-year reviews. The remedial actions for the other alternatives can be implemented with correct planning. These technologies have been used successfully at other sites to address similar VOCs in soil and groundwater.

Implementation requires readily obtainable materials. S-4 technically would be the most difficult to implement because of unknown operational and efficiency variables. S-3 and S-4 both require specialized contractors to perform the work. S-2 would be more difficult than S-3 but easier than S-4. The technical difficulty in S-2 would be the required sheeting for supporting the surrounding soil that adjacent buildings use for structural load bearing. Operation of the earth-moving equipment in S-2 would require engineering measures to control fugitive dust. Alternative S-3 would be the easiest of the three active soil alternatives to implement and could be installed by a multitude of contractors. Construction of the cap for Alternative S-3 is relatively straightforward and

materials and equipment necessary for the soil cover and cap construction are readily available. S-2, S-3, and S-4 are all equally feasible to implement from an administrative stand point.

Besides Alternative GW-1, GW-5 would be the easiest to implement because it does not require construction and only requires sampling of existing wells. GW-6 would have to deal with physical obstructions. Being located in a residential neighborhood, GW-6 would require special injection equipment to ensure proper installation. Alternatives GW-2, GW-3, and GW-4 are fairly equal in their technical feasibility to implement, maintain, and monitor. GW-2 and GW-4 are easier to implement than alternative GW-3 due to simpler technology. Each of these alternatives, except GW-5 and GW-6, would involve administrative implementability requirements because of the need to maintain Institutional Controls and monitoring for a long period of time. GW-5 and GW-6 would have less administrative activities. The services and materials necessary to implement all of these alternatives are readily available to implement. Based on implementability, GW-5 would be the easiest to implement followed by GW-2 and GW-4 and then GW-3 and GW-6.

10.7 Cost

Alternatives S-1 and GW-1 have no costs. The total present worth costs for Alternatives S-2 to S-4 range from approximately $219,000 to $688,000. S-4 is the most expensive; however, S-2 is close behind at $625,000. S-3 is the least expensive.

Alternatives GW-2 through GW-6 range in estimated total present worth costs of $614,000 for GW-5 to $3.5 million for GW-4. GW-2 and GW-3 are also estimated in the millions: GW-4 is $3.2 million and GW-3 is $2.6 million. The total present worth of GW-6 is estimated to be $925,000. Estimated costs associated with each of the remedial alternatives were presented previously with the description of each alternative. The detailed estimated costs associated with each alternative are found in the FS (Appendix B) for the Site.

10.8 State Acceptance

The State of Florida, as represented by FDEP, has expressed its support for Alternatives S-2 (Excavation and offsite Disposal) and S-4 (SVE with Vapor Phase Carbon Adsorption) for the Soils and GW-2 (In-Situ Enhanced Bioremediation) for the groundwater. They support all the components of the alternatives, such as ICs and Monitoring.

10.9 Community Acceptance

The EPA and FDEP conducted a public meeting on August 12, 2010 to present the Proposed Plan (EPA 2010) to the public. The preferred alternative in the Proposed Plan and presented at the public meeting was Alternative S-2 (Excavation and offsite Disposal) and S-4 (SVE with Vapor Phase Carbon Adsorption) for the Soils and GW-2

(In-Situ Enhanced Bioremediation) for the groundwater. The community indicated support for these alternatives, including all the components such as ICs and Monitoring; however, many expressed a desire for S-2 only, without S-4. They would have liked to see the building removed so that all the soils could be excavated.

11.0 Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (40 CFR §300.430(a)(1)(iii)(A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied.

Principal threat waste at this Site is limited to the soils on Flash Cleaners property beneath the building that are contaminated with Site-attributable VOCs at concentrations above chemical-specific ARARs. The soils on the Flash Cleaners property beneath the building are considered to be "principal threat wastes" because the contaminants are at high concentration and are mobile due to volatization and subsurface transport (leaching to the groundwater). The contaminated soils are distributed both beneath and to the west of the building onsite, with the highest concentrations of contaminants existing beneath the Flash Cleaners building. These soils are a source of groundwater contamination. Treatment of the principal treat waste by soil vapor extraction is an acceptable and appropriate action.

12.0 SELECTED REMEDY

12.1 Rationale for the Selected Remedy

The Preferred Alternatives for cleaning up the soils at the Flash Cleaners Superfund Site are Alternative S-2 (Excavation and Off-site Disposal) and Alternative S-4 (Soil Vapor Extraction with Vapor Phase Carbon Adsorption). The Preferred Alternative for groundwater is Alternative GW-2 (In-situ Enhanced Bioremediation) with Institutional Controls and Monitoring. ICs will be implemented to prevent the use of contaminated groundwater until the cleanup levels have been attained.
Monitoring will be conducted to measure the COC concentrations in the groundwater and the surface and pore water over time to evaluate the remedy performance. This combination of alternatives is recommended because it will achieve substantial risk reduction by both treating the source and providing safe management of remaining material.

Based on the information available at this time, EPA and FDEP believe the Preferred Alternatives would satisfy the following statutory requirements of CERCLA Section 121(b): 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element. This combination of alternatives will achieve substantial risk reduction in an accelerated manner.

12.2 Description of the Selected Remedy

The major components of the selected remedy, for the soil and groundwater, include:

Soils

- Excavation of soils with COCs above the cleanup levels, that are located on the Flash Cleaners property and that are not underneath the Flash Cleaners building. The proposed estimated excavation area is depicted in **Figure 15**. It is estimated that soils would be removed down to the water table, which during the RI averaged 8 feet bgs.

- Side-wall shoring may be required to retain the integrity of the soil beneath the Flash Cleaners building.

- Collection of samples from the excavated soil and analysis for total VOCs and RCRA characteristics (TCLP)

- Transportation of excavated soils to an approved RCRA landfill, based on those sampling results above

- Backfilling the excavated area with clean soil

- Installation of the Soil Vapor Extraction (SVE) system beneath the Flash Cleaners building where concentrations of COCs in soils exceed soil cleanup levels. The SVE wells would be installed in the vadose zone to physically remove (volatilize) the COCs from the soil. The soil vapor system would consist of a vacuum blower that pulls air from the wells. Air will first pass through a moisture separator and an air filter before being directed through the pump and on to the vapor phase carbon adsorption unit.

- Attachment of a vapor phase carbon adsorption unit to the SVE system to capture and treat the soil gas. COCs will be removed from the air by physical adsorption onto activated carbon grains.

- Periodic maintenance of the system to ensure the SVE vacuum rates are properly maintained and the system is running per specifications and to ensure VOC removal in the off-gas. Air samples will be collected to verify off-gas concentrations. System

inspections will be more frequent in the beginning and less frequent once the system is up and functioning properly.

- Monitoring of indoor air in the Flash Cleaners building during the implementation of the remedial action. This would be required to detect potential vapor intrusion into the Flash Cleaners building.

Groundwater

- Installation of the injection wells for the bioremediation treatment of the groundwater. The in-situ groundwater treatment would use emulsified oil substrate (EOS) to stimulate the natural biodegradation of COCs. **Figure 18** depicts the general location of the proposed injection points.

- Re-injection of the EOS after three years of monitoring data is collected. The second injection, and any additional injections, would be used to treat remaining hot spots within the plume.

Development and implementation of ICs specifying groundwater use restrictions to prevent unacceptable risks from exposure to contaminated groundwater. At a minimum, installation of potable water wells would be prevented. The specifics of the controls would be stated in the remedial design, but the ICs would likely be implemented by the South Florida Water Management District and/or the Broward County Health Department which have the authority to prohibit the construction of water wells located within the area of the contaminated groundwater. Controls would be maintained for as long as they are required to prevent unacceptable exposure to contaminated groundwater or to preserve the integrity of the selected remedy. Regular inspections would be performed to verify the continued implementation of the groundwater use restrictions. FDEP will be responsible for enforcing these controls. The temporary ICs would be removed once groundwater cleanup levels have been achieved.

- Collection of groundwater samples to monitor the groundwater remedy. Groundwater samples would be collected from approximately 20 monitoring wells for VOCs and natural attenuation parameters. Sampling frequency would be quarterly for the first year, semi-annual for years two through four, and annually thereafter.

- Collection of surface water and pore water samples annually in the North Grand Canal at least for three years.

- After three years from the remedy implementation, evaluate water samples to determine if results show improving or stable conditions. If not, then the monitoring shall continue on an annual basis to be evaluated during the Five-Year Review process.

- Evaluate monitoring results with respect to the exit-strategy decision flow charts that would be developed in the remedial work plan. If COCs in groundwater decrease in

concentration to below the cleanup levels, the monitoring program could be modified or discontinued as determined by EPA and FDEP.

A policy review will be conducted within five years of construction completion to ensure that the remedy is, or will be, protective of human health and the environment. The review will evaluate the effectiveness and protectiveness of the remedy.

If the owners of the Flash Cleaners property change their mind before or during the remedial design is completed to allow their building to be demolished, EPA would implement only S-2 and not S-4.

Table 21 specifies the Cleanup Levels for the Site for both the soil and the groundwater.

During the time between EPA's release of the Proposed Plan and hosting the public meeting and EPA's finalization of the ROD, it was determined that the RI and FS reports contained minor errors. The RI and FS report errors were corrected and the final RI and FS reports were issued in September 2010. Significant changes are described in Section 14 of this ROD.

Principal threat waste at this Site is considered to be the soil with contaminant concentrations above cleanup levels underneath the Flash Cleaners building. This source material leaches to the groundwater causing COCs in groundwater above MCLs and GCTLs. Soils on the Flash Cleaners property located outside the footprint of the Flash Cleaners building are not Principal threat waste and they will be excavated and disposed offsite. Principal threat waste located underneath the Flash Cleaners building will be treated using SVE with carbon adsorption

The estimated time it will take to reach cleanup levels is uncertain at this time; however, after three years of groundwater and surface water monitoring, EPA will have the data to develop feasible estimates. Therefore, when the Five-Year Review is prepared, time to achieve cleanup levels will be developed based on the rate of degradation of the COCs. Supplemental groundwater treatments beyond the two estimated in this ROD may be necessary to accelerate the natural degradation process. This will be evaluated in the five-year review if necessary.

Lack of progress in attaining groundwater cleanup levels or failure of the institutional controls would result in the evaluation of alternatives to correct the issue.

12.3 Selected Remedy Cost

The estimated total cost for the Selected Remedy is $3,565,000 as is shown in **Table 22.** A detailed cost estimate for the selected remedy is included as **Appendix A**. The cost summary table is based on the best available information regarding the anticipated scope of the remedial action. Changes in the cost elements are likely to occur as a result of new information and data collected during the remedial design phase.

Major changes may be documented in the form of a memorandum to the Administrative Record file, an Explanation of Significant Differences (ESD), or a ROD amendment. The projected cost is based on an order-of-magnitude engineering cost estimate that is expected to be within +50 or -30 percent of the actual project cost. Costs are based on the conservative estimate of a 30-year timeframe until all the cleanup levels are met.

12.4 Expected Outcome of the Selected Remedy

The selected remedy will provide protection of human health and the environment by eliminating, reducing, or controlling risk at the Site through removal, treatment, and Institutional Controls. ICs will formalize groundwater use restrictions at within the plume. Future land use of the Flash Cleaners property is expected to be commercial, while future land use in the area of the downgradient plume is likely to remain as it is currently, a mixture of residential and commercial use. Ongoing operation of the current business on the Flash Cleaners property (pick up and drop off for dry cleaning) will likely be impacted during the excavation of the contaminated soils and installation of the soil and groundwater treatment systems. There is the potential need for the business to temporarily shut down. The time to achieve the groundwater cleanup levels is unknown but a rough estimate based on how long other dry-cleaning sites in Broward County have required is 12 years. EPA will develop a more precise estimate after collecting three years of groundwater monitoring data and present the information in the first Five-Year Review report. This report will then be added to the Administrative Record.

The Biscayne Aquifer will likely remain the sole source of drinking water in southeast Florida so it is not likely that groundwater use will change in this area. All the residents in the area of the Flash Cleaners site obtain their drinking water from public water supply wells more than half a mile away from the site.

If the Flash Cleaners property owner decides that the building can be demolished prior to implementation of the remedial action, then there will be some potential for community revitalization based on the input received during the Proposed Plan public meeting. Due to the small size of the property, it is not likely that there would be a significant increase in jobs beyond the current single worker. There are no anticipated adverse socio-economic impacts for the selected remedy.

Implementation of the selected remedy and achievement of the cleanup levels will accomplish the remedial action objectives for the Site. The final cleanup levels determined for this remedy are the same as those determined during the FS and are shown in **Table 21.**

13.0 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-

effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

Protection of Human Health and the Environment

The Selected Remedy will provide protection of human health and the environment by eliminating, reducing, or controlling risk at the Site through the excavation and/or treatment of contaminated soils and groundwater containing Site COCs above cleanup levels at the Flash Cleaners Site. In-situ enhanced bioremediation of the ground-water aquifer will restore ground water to health-based criteria at the Site. The Selected Remedy will eliminate the threat of exposure to the COCs via direct contact with contaminated soil, ingestion of contaminated groundwater, and inhalation of soil vapors. Short term threats associated with the Selected Remedy will be controlled through monitoring and engineering controls such as dust control during excavation. Institutional Controls will be used to prohibit extraction of groundwater from the surficial aquifer. During excavation of soils, EPA would ensure adequate health and safety precautions are used and that excavated soils are properly managed. The remedial design would include specifications for meeting proper health and safety precautions during implementation of all the components of the Selected Remedy. No adverse cross-media impacts are expected from the Selected Remedy.

Compliance with Applicable or Relevant and Appropriate Requirements

The NCP §§300.430(f)(5)(ii)(B) and (C) require that a ROD describe the Federal and State ARARs that the Selected Remedy will attain or provide justification for any waivers. The Selected Remedy for the Flash Cleaners Site will comply with all Federal and any more stringent State ARARs for the Site. CERCLA §121(d) states that remedial actions must attain or exceed ARARs. The chemical-specific and activity-specific ARARs applicable to the Site are presented in **Tables 15 through 18**.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs) for This Remedial Action

In implementing the Selected Remedy, a number of non-binding criteria are TBCs. These include:

Guidance for the Data Quality Objectives Process, EPA QA/G-4. August 2000.

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, EPA Region 4, November 2001.

EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Final, QA/R-5. March 2001.

Cost-Effectiveness

In EPA's judgment, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: A remedy shall be cost-effective if its "costs are proportional to its overall effectiveness." (40 CFR §300.430(f)(1)(ii)(D)). EPA evaluated the overall effectiveness of those alternatives that satisfied the threshold criteria (were both protective of human health and the environment and ARAR-compliant) by assessing three (3) of the five (5) balancing criteria in combination. Those three criteria are long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the Selected Remedy is reasonable given the combination of alternatives that are components of the remedy. This combination offers a high degree of protectiveness and overall effectiveness than any of the other alternatives because it offers the best treatment for the soils and groundwater versus no action, capping, or other treatment that may interfere with the natural attenuation processes occurring in the aquifer. The excavation of the soils offers the most long-term effectiveness and permanence and short-term effectiveness.

The estimated present worth total cost of the Selected Remedy is **$3.5 million.**

Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Flash Cleaners Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against off-site treatment and disposal, and considering State and community acceptance.

The Selected Remedy treats a portion of the COC-contaminated soils constituting principal threats at the Site. However, if the Flash Cleaners owner does allow EPA to remove the onsite building, then the treatment of the soils will not be necessary, and all the soils will then be excavated and removed for offsite disposal. This will allow for a more permanent remedy and immediate attainment of ARARs.

The Selected Remedy satisfies the criteria for long-term effectiveness by removing the COC contaminated soils on the Flash Cleaners property around the building. Off-site disposal will effectively reduce the mobility of and potential for leachability of contaminants into the groundwater. The Selected Remedy does not present short-term risks different from the other treatment alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

Preference for Treatment as a Principal Element

The Selected Remedy satisfies the statutory preference for treatment as a principal element because a portion of the contaminated soils will undergo *in situ* treatment (Soil Vapor Extraction) as part of the remedial action. However, if the Flash Cleaners owner does allow EPA to remove the onsite building, then the treatment of the soils will not be necessary, and all the soils will then be excavated and removed for offsite disposal. This will allow for a more permanent remedy and immediate attainment of ARARs.

Five-Year Review Requirements

Section 121(c) of CERCLA and the NCP §300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, but it will take more than five years to attain remedial action objectives and cleanup levels, a policy review may be conducted within five years of construction completion for the Site to ensure that the remedy is, or will be, protective of human health and the environment.

Institutional controls and Five-Year Reviews will be required until all soil and groundwater cleanup levels have been achieved.

14.0 Documentation of Significant Changes

To fulfill CERCLA §117(b) and NCP §300.430(f)(5)(iii)(B) and §300.430(f)(3)(ii)(A), the ROD must document and discuss the reasons for any significant changes made to the Selected Remedy from the time the Proposed Plan was released for public comment to the final selection of the remedy. At the time of the Proposed Plan and the Pubic Meeting, EPA included Alternative GW-6, the PRB, as a contingency remedy. However, this ROD and the Selected Remedy does not include any contingencies. The data collected from the surface and pore water sampling that will be conducted as part of the Selected Remedy, will still be evaluated for potential further response action. As contemplated in the Proposed Plan, after three years the data will be evaluated and if EPA determines that the groundwater contamination is discharging to the surface water and is above the acceptable risk range, EPA will consider the PRB. The PRB could still be implemented after an evaluation of the monitoring data, however it would however require another public meeting and decision document. If EPA and FDEP determine that a PRB is warranted, EPA would issue another Proposed Plan, host

another public meeting, and issue another ROD (Amendment), rather than include the PRB as a contingency in this decision document.

PART 3: RESPONSIVENESS SUMMARY

Introduction

This Responsiveness Summary for the Flash Cleaners Superfund Site has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Contingency Plan (NCP), 40 CFR §300.430(f). The Responsiveness Summary documents, for the public record, EPA's response to comments received on the Proposed Plan during the public comment period.

Overview of Comment Period

The Proposed Plan for the Flash Cleaners Site was issued on August 12, 2010. A public meeting was held on August 12, 2010 at the Dixon Ahl Hall in Lighthouse Point, Florida, within a mile of the Site. A written transcript from the meeting is included in the Administrative Record file. The 30-day public comment period started on August 12, 2010 and ended on September 11, 2010. No written comments were received by EPA and no request for extension of the comment period was made. However, a number of questions were asked at the public meeting by the attendees after EPA's presentation. These are presented below.

Summary of Questions and Comments Received During the Proposed Plan Public Meeting on August 12, 2010 and EPA's Responses:

1. The building is old, and if you're going to excavate dirt and go through a process of trying to get the vapors out from under the building, would it make more sense to remove the entire building?

Response: EPA cannot remove the building because we do not force owners to remove their buildings, if it is not necessary. If the property owner is willing to have us remove the building, we could demolish it and remove the materials and excavate beneath the building. Based on our conversation with the owners, they were not willing to commit to having the building taken down. So, it could not be a component in our proposed remedy.

2. That concentration that's there under that building now, wouldn't the best way to get at it would be to eliminate it, rather than control it? Just get it out all at once without having to worrying about waiting two or three years or whatever time? Why not just get rid of that bucket of poison that's in one spot, get rid of it totally?

Response: Only if the owners change their mind and decide to give us permission to tear the building down before we get to the construction of the soil

vapor system could we even consider excavation beneath the building. But even then, there is a good reason for doing the soil vapor treatment. The contamination exists underneath the building, between the building and the edge of Federal Highway, and on east side of the highway. So it's not just a small excavation, and it is at quite a considerable depth. Under the building, it's 25 feet below the land surface. Just on the east side of Federal Highway, it is 45 feet below land surface. There is over 35 feet of groundwater below the water table. It is not that easy to just excavate the contaminated soils.

3. If the most of the contamination came from one particular spot, and that's all leaching out, could you do that, dig down 25 feet in the whole site and remove it?

Response: It would be difficult to dig below the water table, which is at about eight feet. So it would be necessary to conduct some further action to get to the contaminations below the water table. The composition of the soils are mostly sand in this Florida environment and so excavation that deep where a building is located would be difficult. Shoring would be necessary to maintain the integrity of the building next door and the gigantic billboard that is on the property as well. The shoring requirement to not impact the other buildings was something EPA considered.

4. If we asked the owners, as a community, to knock down the building and make it easier, would there be value in that?

Response: Yes, there could be value in that, but EPA believes the selected remedy will address the soil contamination effectively.

5. Theoretically, if Flash Cleaners was the only place there and to the east was nothing but vacant land (not Federal Highway, not Lighthouse Point) how would it be treated then? Would you demolish the building, and what would they do with all that land that is contaminated, in theory?

Response: That is really hard to predict. EPA has a preference to cleanup using treatment rather than just excavation and removal. But if we were able to get to all the soil without the obstructions that are there, excavation of all the soils to the water table might be the preferred alternative. EPA would still have to do the treatment for the deeper contamination.

6. What is the cost of doing the vapor treatment under the building, because that building probably isn't worth that much?

Response: The capital cost estimate to construct the soil vapor extraction part of the remedy is roughly half a million dollars.

7. In the two block area near the canal that showed a higher parts per billion and more depth, was that just because the canal wall was holding the contaminants back from going in the canal, and will that be a problem over the years as rainwater causes it to go into the canal? And will anything have to be done to remove any of that soil?

Response: The proposed remedy is going to treat the soil and groundwater contamination. The bioremediation injections will encourage more of the degradation of the contaminants in the groundwater and will facilitate cleaning up the plume naturally. EPA does not believe that the seawall holds back the plume or the contamination. The vapor sampling in the residents' garages was conducted because EPA was concerned about the volatization of contaminants through the soils up to ground surface and then potentially into the buildings. EPA believes the pore water data shows the concentrations of contaminants at the point they discharge from the subsurface below the canal, not through the seawall, The highest concentrations of contaminants are found a little ways out into the center of the canal. One location had a higher concentration and EPA will be focusing on that area during the surface water monitoring. A possible reason for the higher concentration at that one location is that the subsurface sediments could be coarser at that location. There could be greater groundwater flow through this one channeled area or it could be an artifact of the geology in that particular area.

Further, EPA is going to be re-sampling the canal during the monitoring, so more will be known about the plume after a few more years. The data will be presented in the Five-Year Review.

8. Since 1977, when the dry cleaning started, to when the operations stopped, how much of this stuff was dumped on that site? Any estimate?

Response: EPA and FDEP believe that there is no way to determine an estimate for this Site, since there are no property inventory or materials handling records. Before 1994, when the state Drycleaning Solvent Cleanup Program began, nobody knew dry cleaning solvents were a contaminant, and anybody could purchase the chemicals. Now the chemicals are highly regulated and dry cleaning businesses have to report on these regulated chemicals. The quantities of chemicals used at every dry cleaning business now can be calculated.

9. So there is no way to determine whether it's a thousand gallons or a million gallons?

Response: No, not really. FDEP responded to this question saying that it is very likely that it was not that much and that dry cleaners did not need that much solvent (not a million gallons) to operate. EPA responded that some sort of calculation could be done using concentration volumes, but it would be difficult to account for how much is actually already naturally attenuated or may have escaped as vapors up through the building.

10. About the barrier on 44th Street, would that be putting something next to the road or the canal?

Response: It is not a barrier like a solid wall. The barrier is a zone of treatment that the groundwater flows through. The groundwater comes out relatively clean on the other side.

11. Does that change the flow of where this contaminant could go? If you put up the barrier, would the contamination just keep going down straight?

Response: That is one of the reasons why feasibility studies or pilot scale testing is done. One of the problems with these kind of treatments is that algae can potentially grow and clog up the pore spaces, and then it essentially creates an impermeable barrier, and that would allow the contaminated groundwater to bypass the barrier. All that would be taken into consideration during our design process.

12. Would this treatment keep the contamination from flowing?

Response: The groundwater flows about 100 or 200 feet a year. It depends on just exactly where in the aquifer you're looking, but EPA is planning to control the source and then watch what happens to the dissolved portion to see if there's more that we have to do once we've controlled the source area.

13. What responsibility does Flash Cleaners have?

Response: The responsible parties associated with Flash Cleaners have financial responsibilities to pay for the investigation and cleanup if they can. EPA does recover our costs and we seek the responsible party to pay their fair share, but we also look at their ability to pay. EPA has determined that the responsible parties at this site do not have the ability to pay for the investigation and cleanup. However, a federal lien has been placed on the property.

14. You mentioned all five of these chemicals are heavier than water in their pure form and that they just go down deep. So how deep can this go, hundreds of feet?

Response: No contamination was found in a sample collected at our deepest well a depth of 150 feet. The deepest the contamination was found was at 138 below land surface. At 138 feet, that is the dissolved phase contamination. The contamination that is at 45 feet just on the east side of Federal Highway is closer to being the DNAPL. The chemical gets spilled on the ground and then it has to go in between all the sand grains and gets slowed down by the soil grains, so it is not like it is just going down a drain spout. Sometimes the pore spaces are so small that the chemical gets hung up in the pore spaces. It could remain there

until enough water flows that it dissolves into the water. As part of the cleanup EPA will be monitoring the groundwater so we will be able to tell if it migrates to a deeper depth.

The Florida Department of Environmental Protection's representative also added the following statements. The state consistently uses soil vapor extraction as a remedy for most of the dry cleaners in the Drycleaning Solvent Cleanup Program. Many of the dry cleaning sites in Broward County have an SVE system. The technology works well because of the sand and cleanup is achieved fairly rapidly. It doesn't add extra oxygen into the environment and allows the bio-augmentation to happen. In this environment in south Florida, the microbes are present and enhance the contaminant degradation process. At this site, the PCE is mostly limited to the Site and very close to the Site, and then after that, it degrades down to the other chemicals, which is a good thing because it shows that the natural process is taking place.

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FIGURES

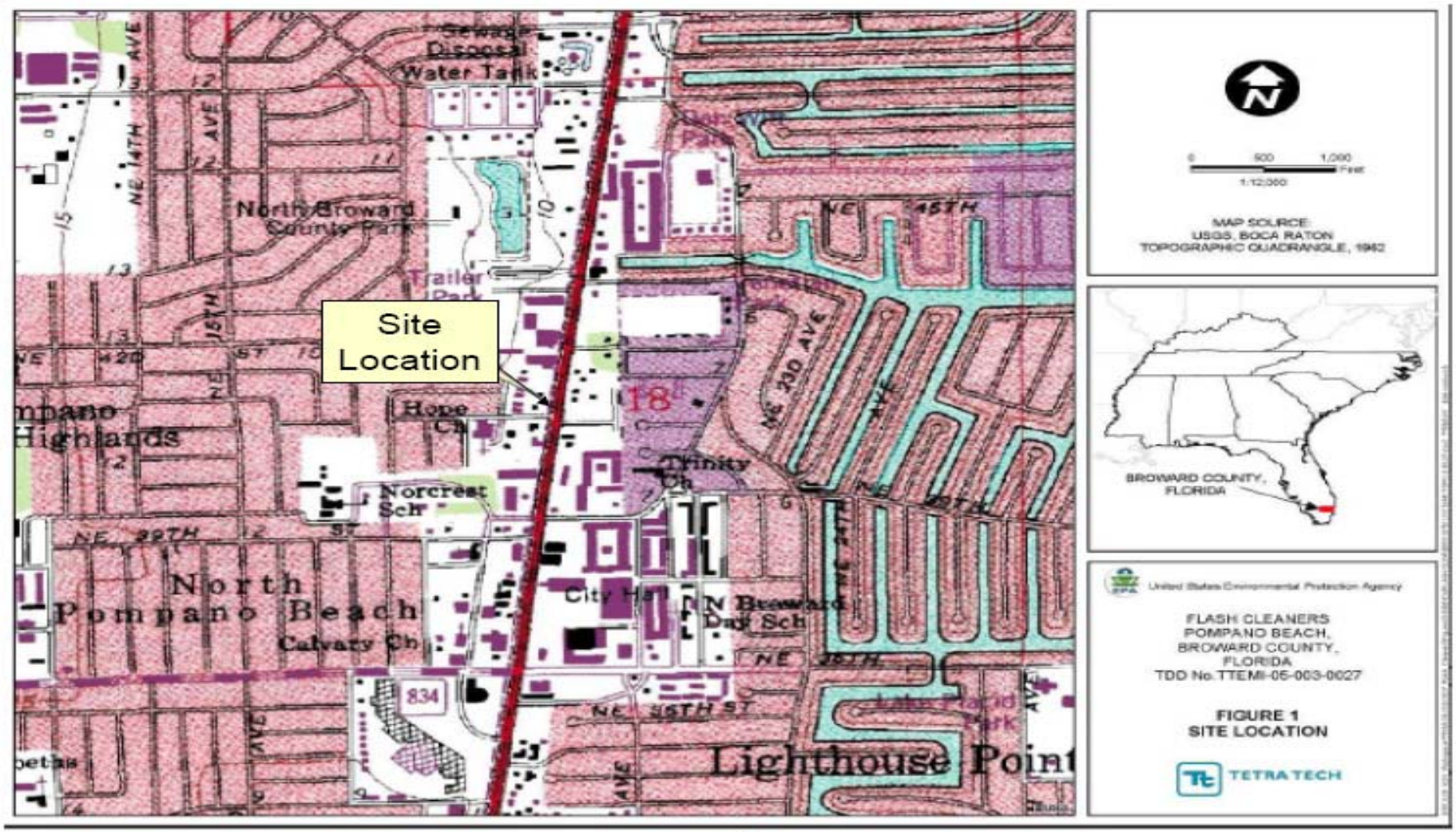

Figure 1- Flash Cleaners Superfund Site – Broward County, Florida, Location Map

Figure 2 – Flash Cleaners Site

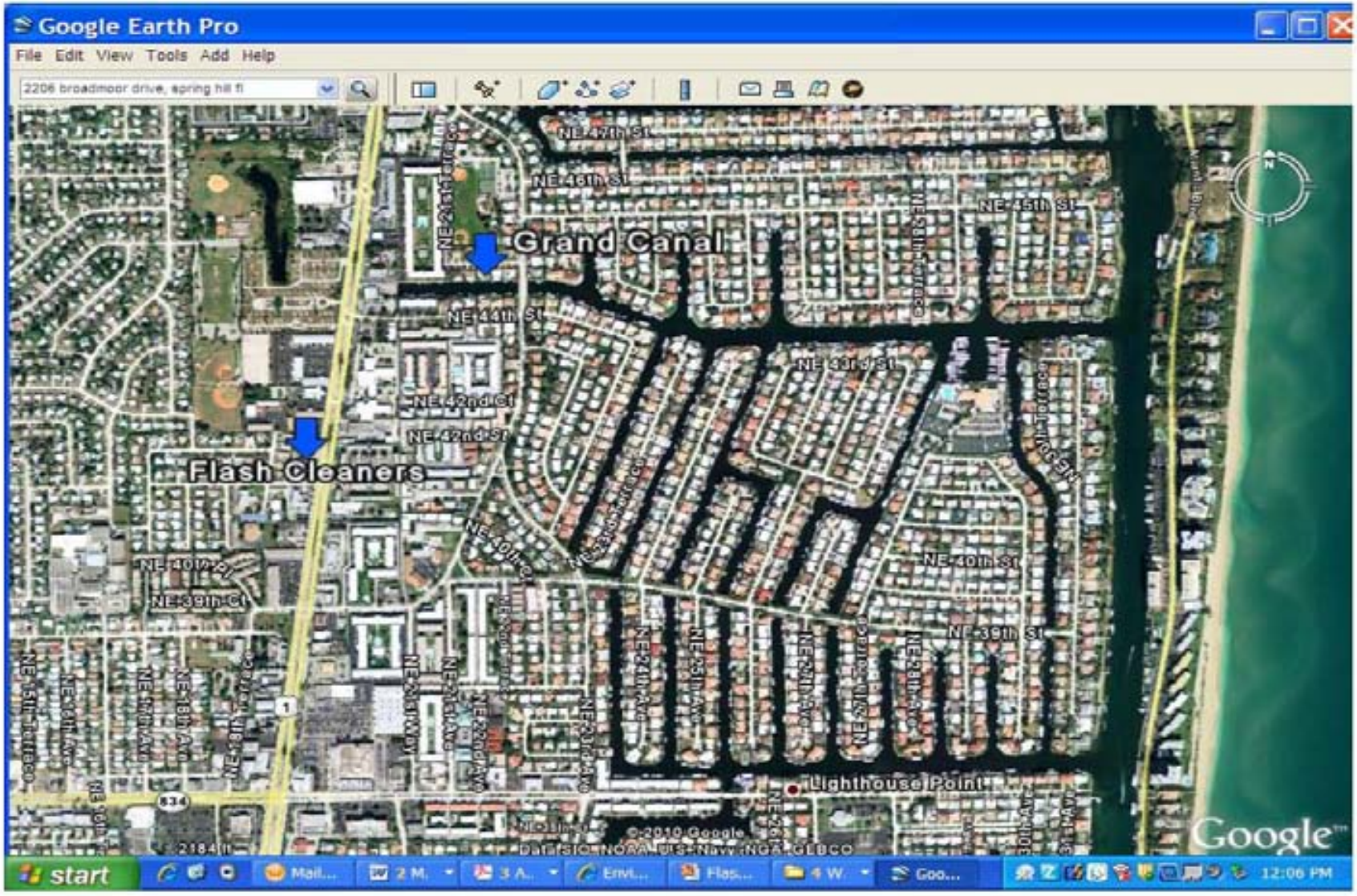

Figure 3 – Surface Water Features in Vicinity of Flash Cleaners

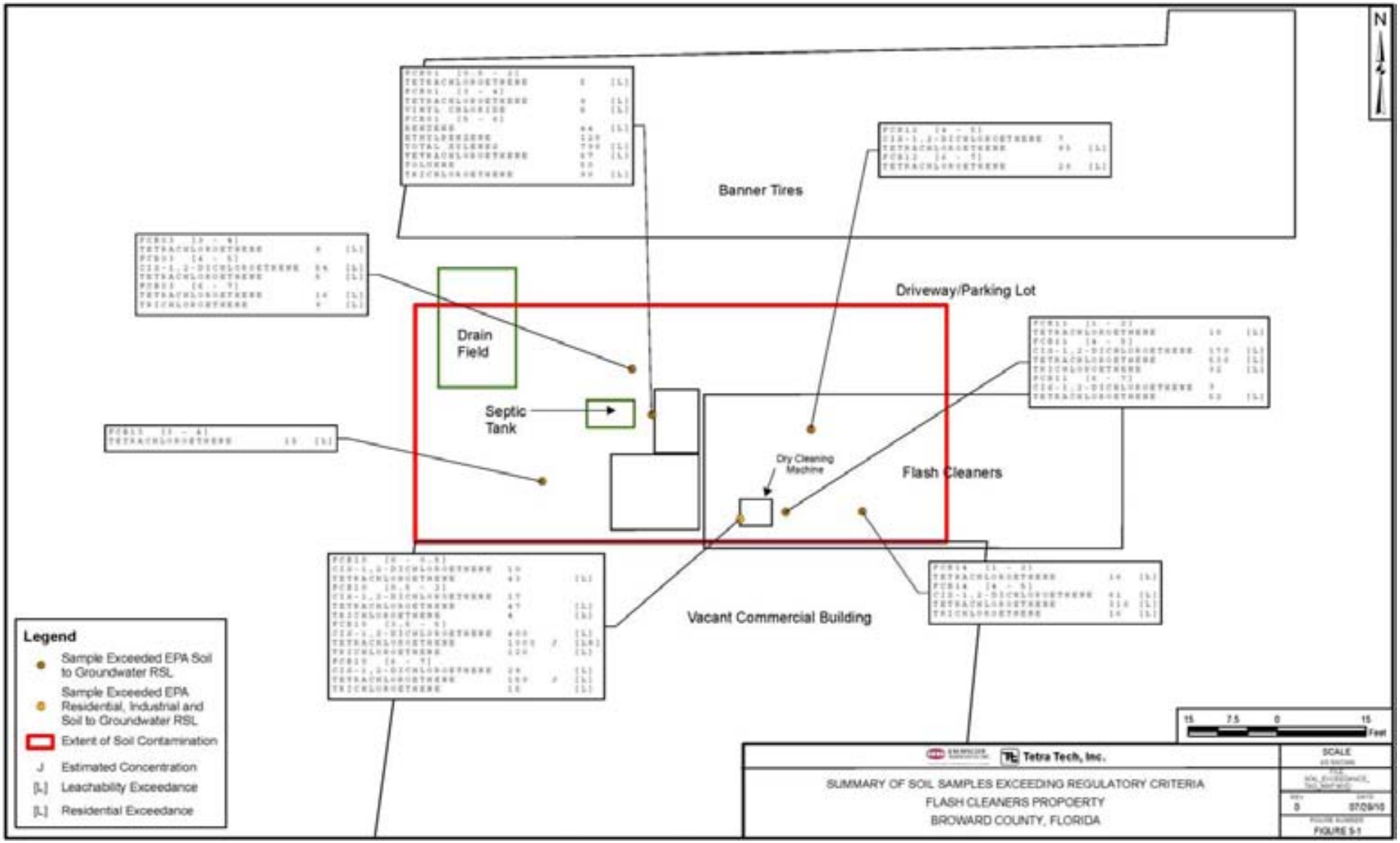

Figure 4 – Soil Sampling at Flash Cleaners Property

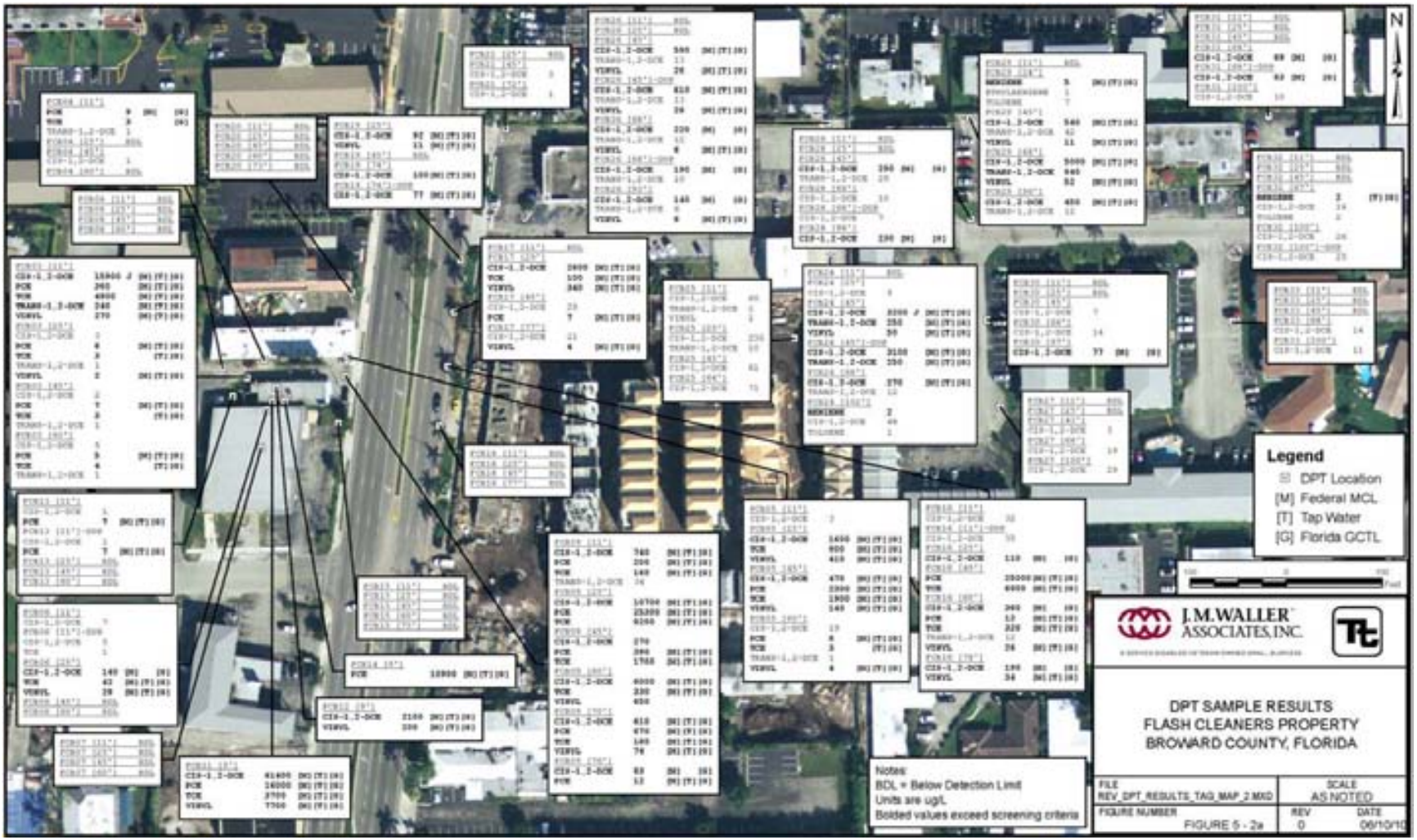

Figure 5 – DPT and Sonic Drill Rig Groundwater Sampling Results at Flash Cleaners and East of Hwy 1

Figure 6 – DPT and Sonic Drill Rig Groundwater Sampling Results in Downgradient End of Plume

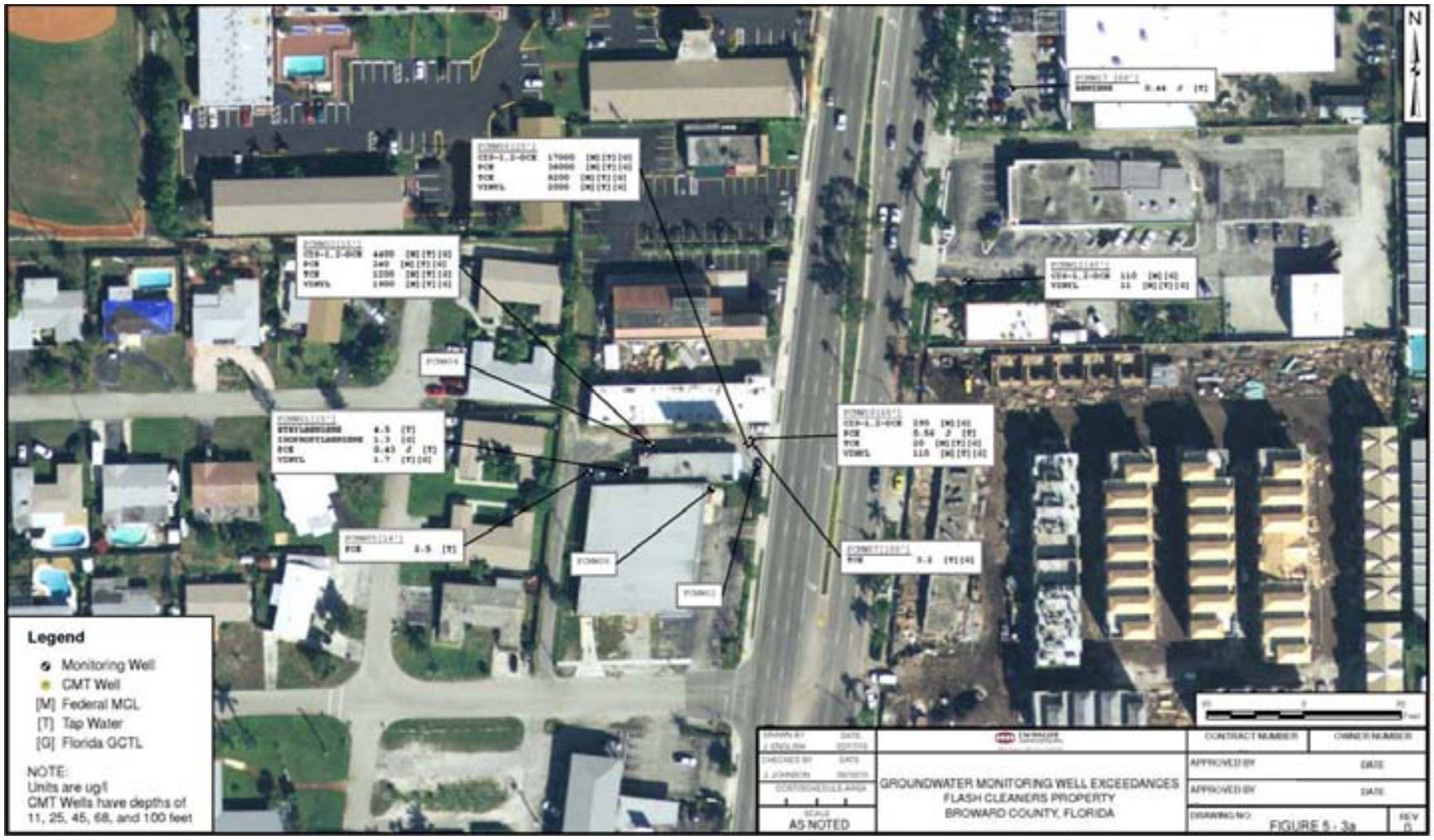

Figure 7 – Groundwater Monitoring Well Results at Flash Cleaners and immediately East of Hwy 1

Figure 8 – Groundwater Monitoring Well Sampling Results in Downgradient Plume

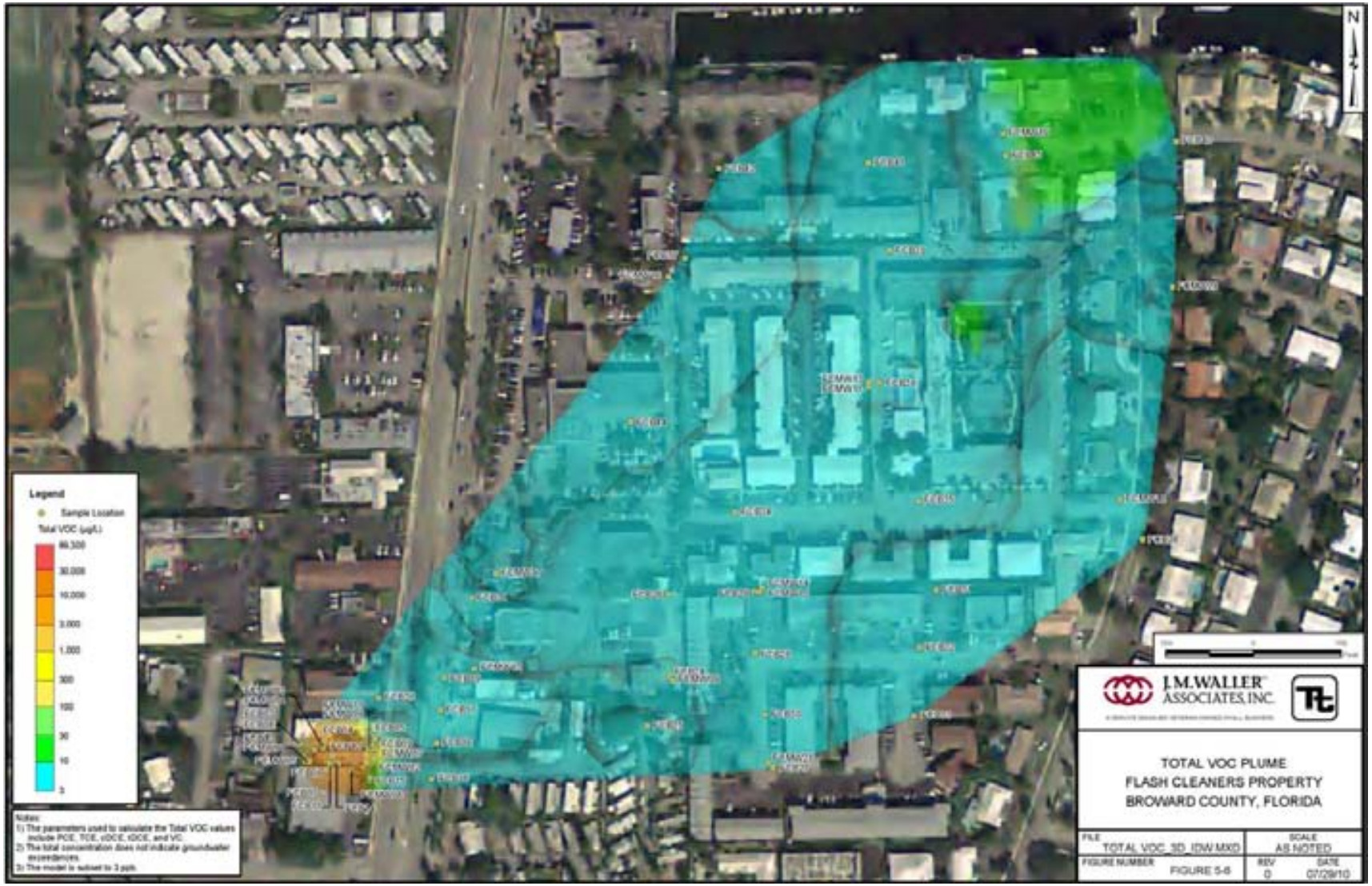

Figure 9 – Total VOC Plume Map

Figure 10 – Surface and Pore Water Sampling in North Grand Canal

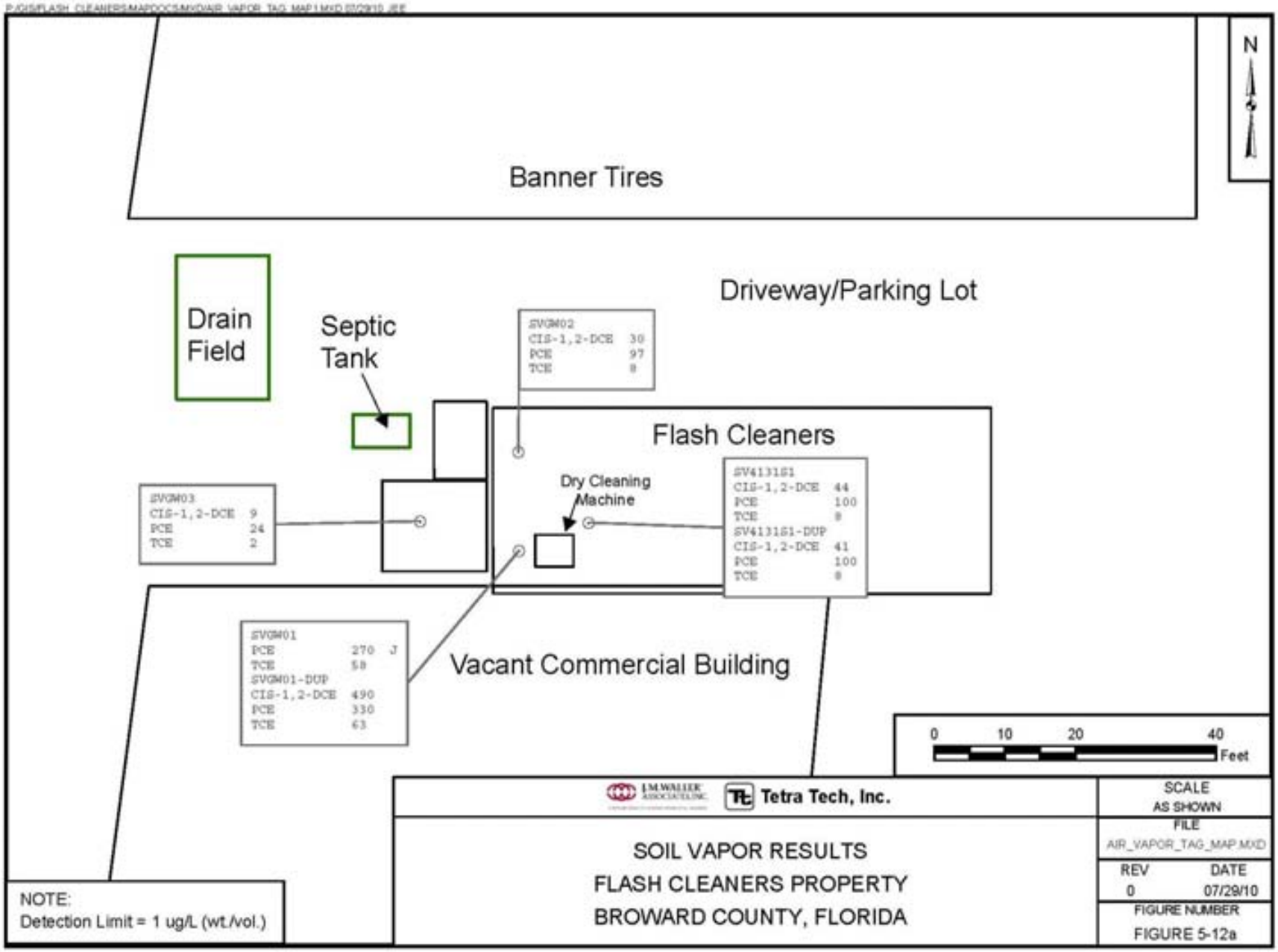

Figure 11 – Soil Vapor Results at Flash Cleaners Property

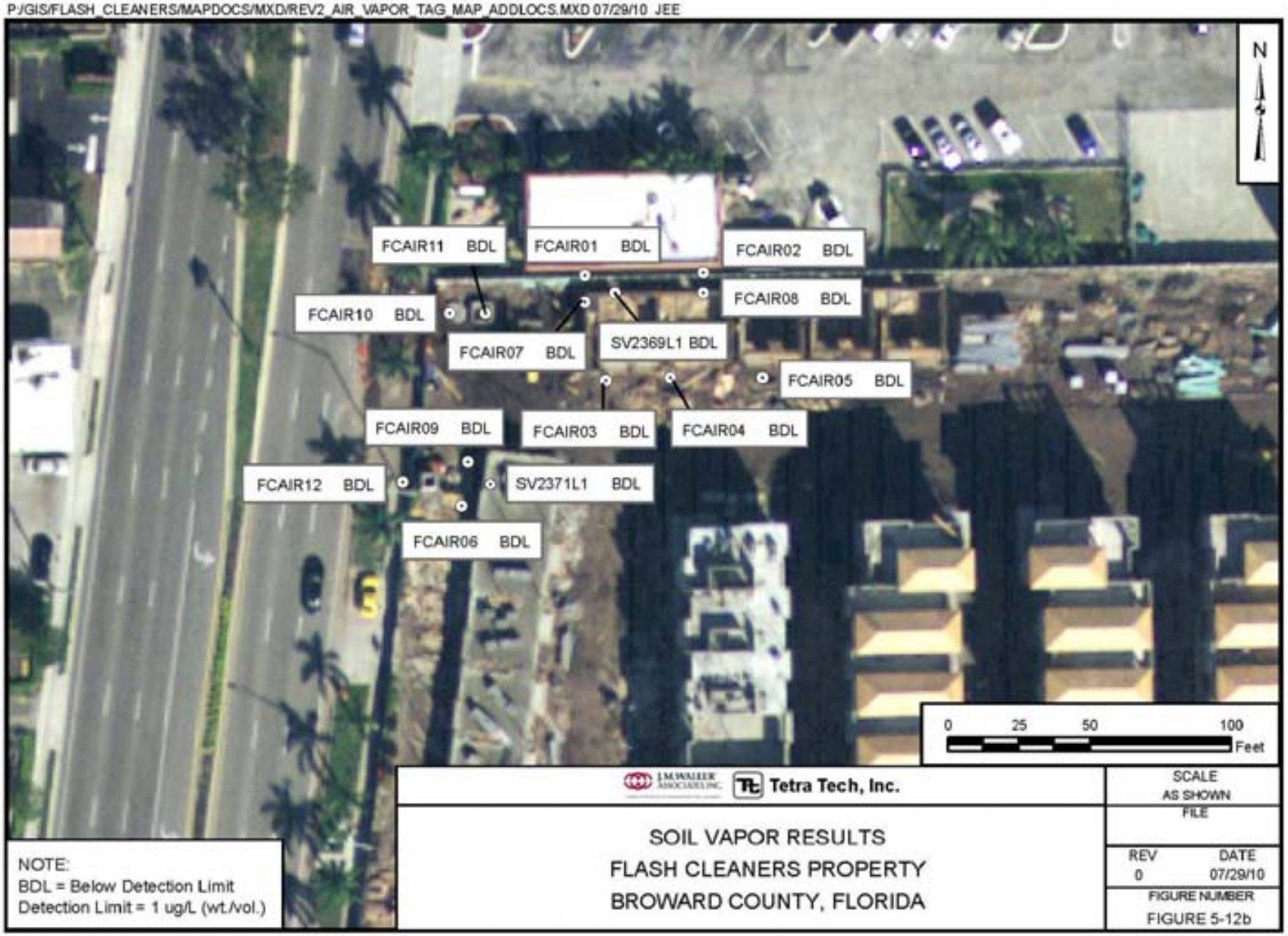

Figure 12 – Soil Vapor Results East of Hwy 1 in Lighthouse Point

Figure 13 – Soil Vapor Results at Residences

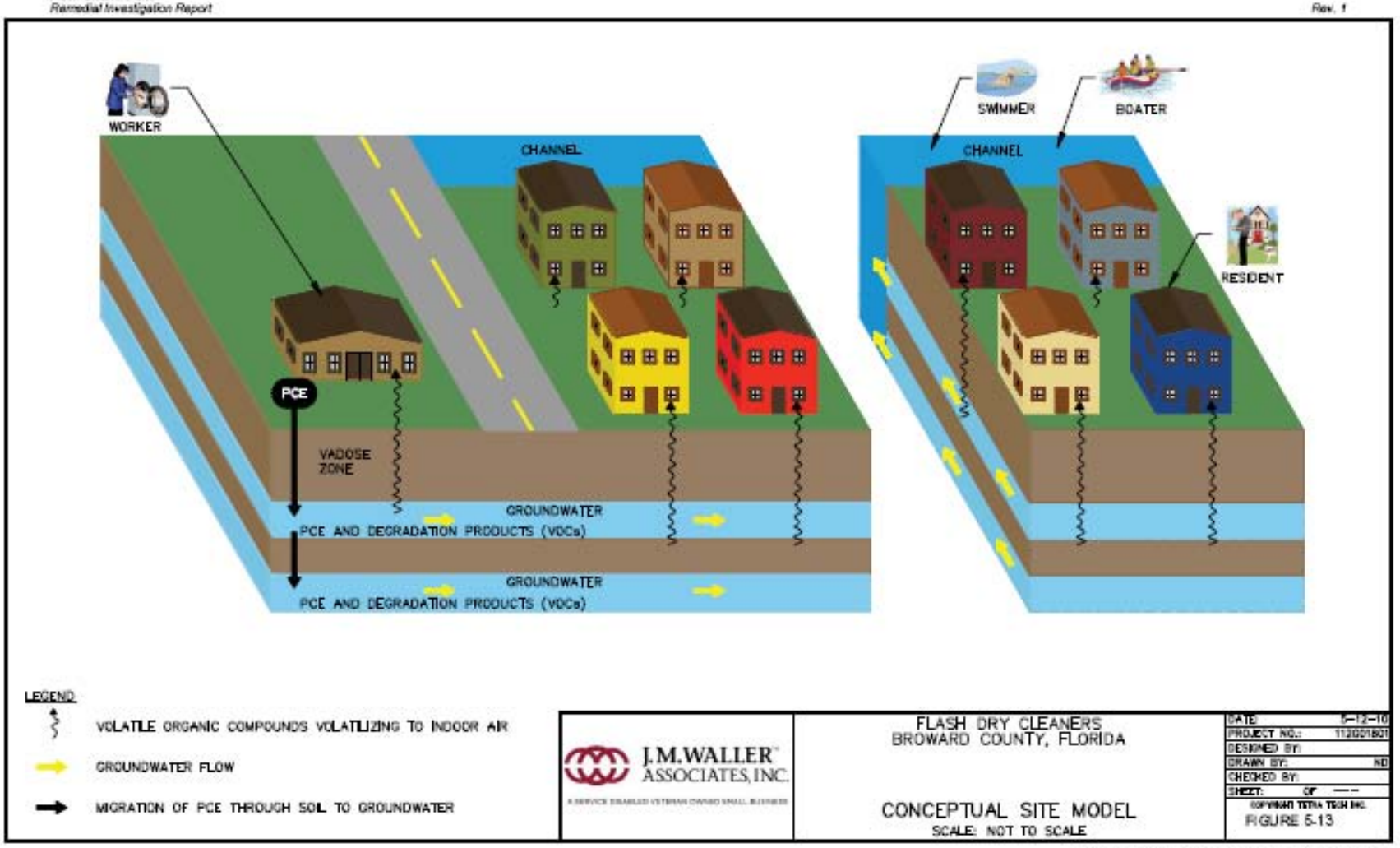

Figure 14 – Conceptual Model

Figure 15 – Alternative S-2 Area of Excavation

Figure 2 – Alternative S-3 Area of Capping

Figure 3 – Alternative S-4 Soil Vapor Extraction

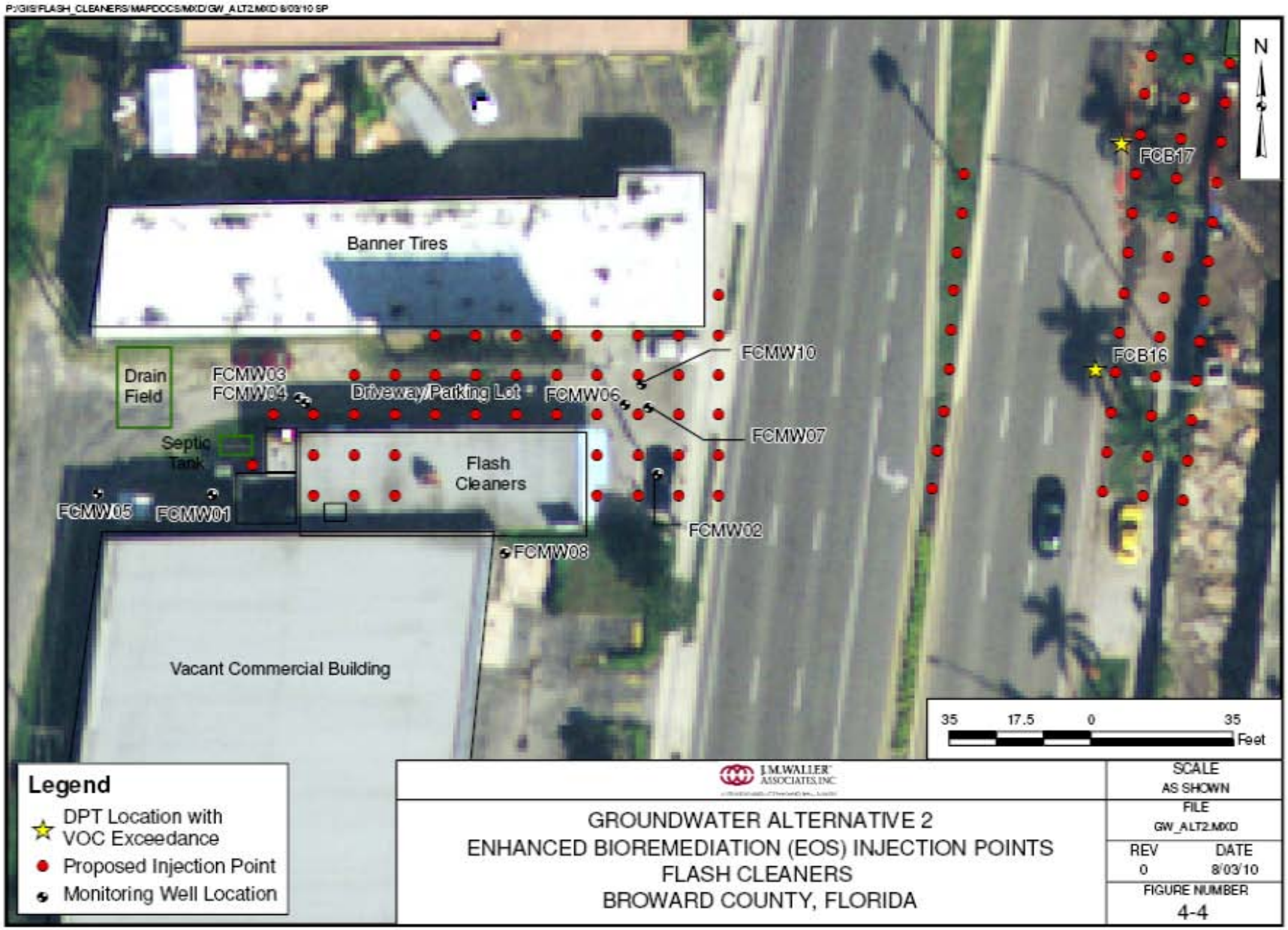

Figure 4 – Alternative GW-2 Enhanced Bioremediation EOS Injection Points

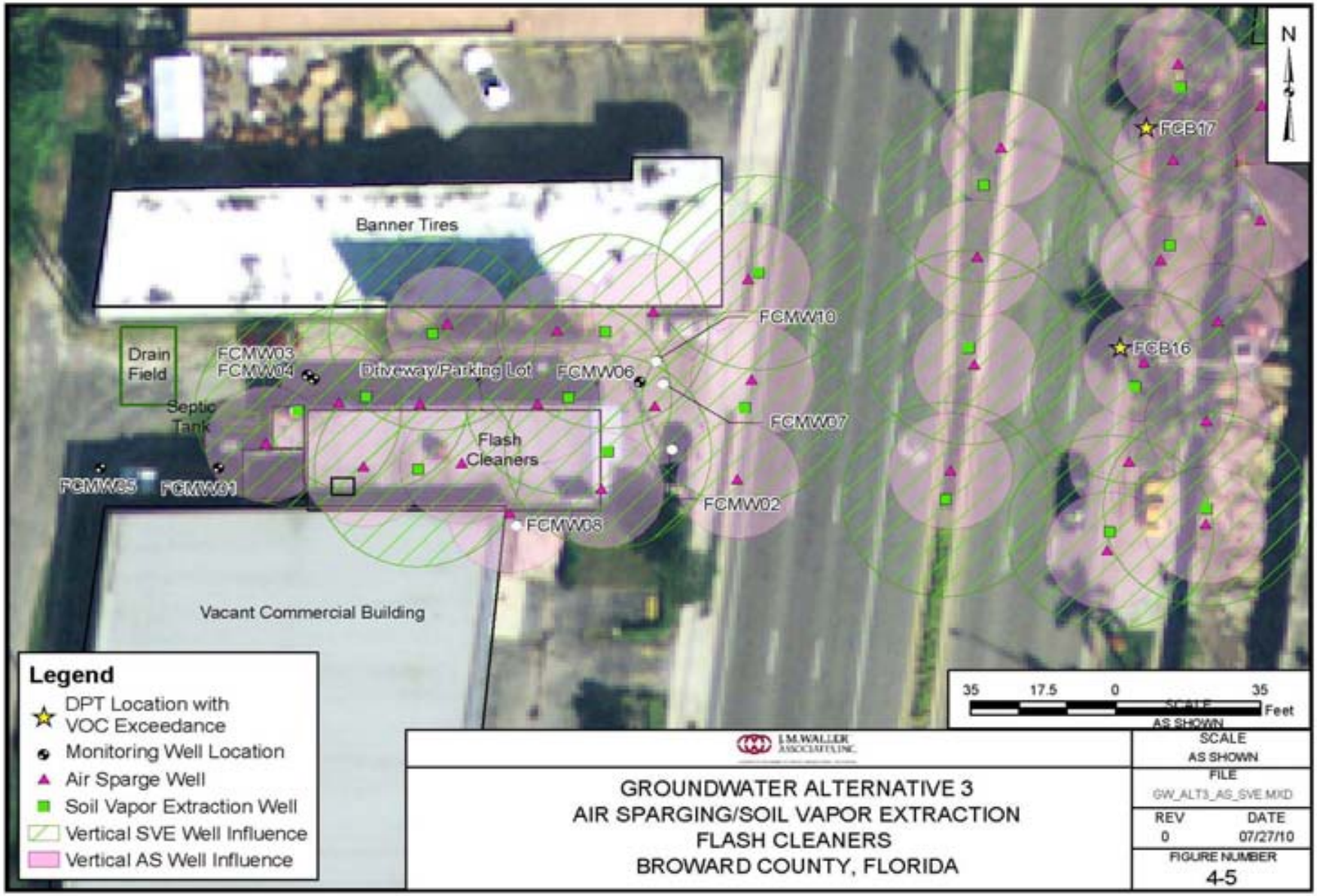

Figure 19 – Alternative GW-3 Air Sparging/Soil Vapor Extraction

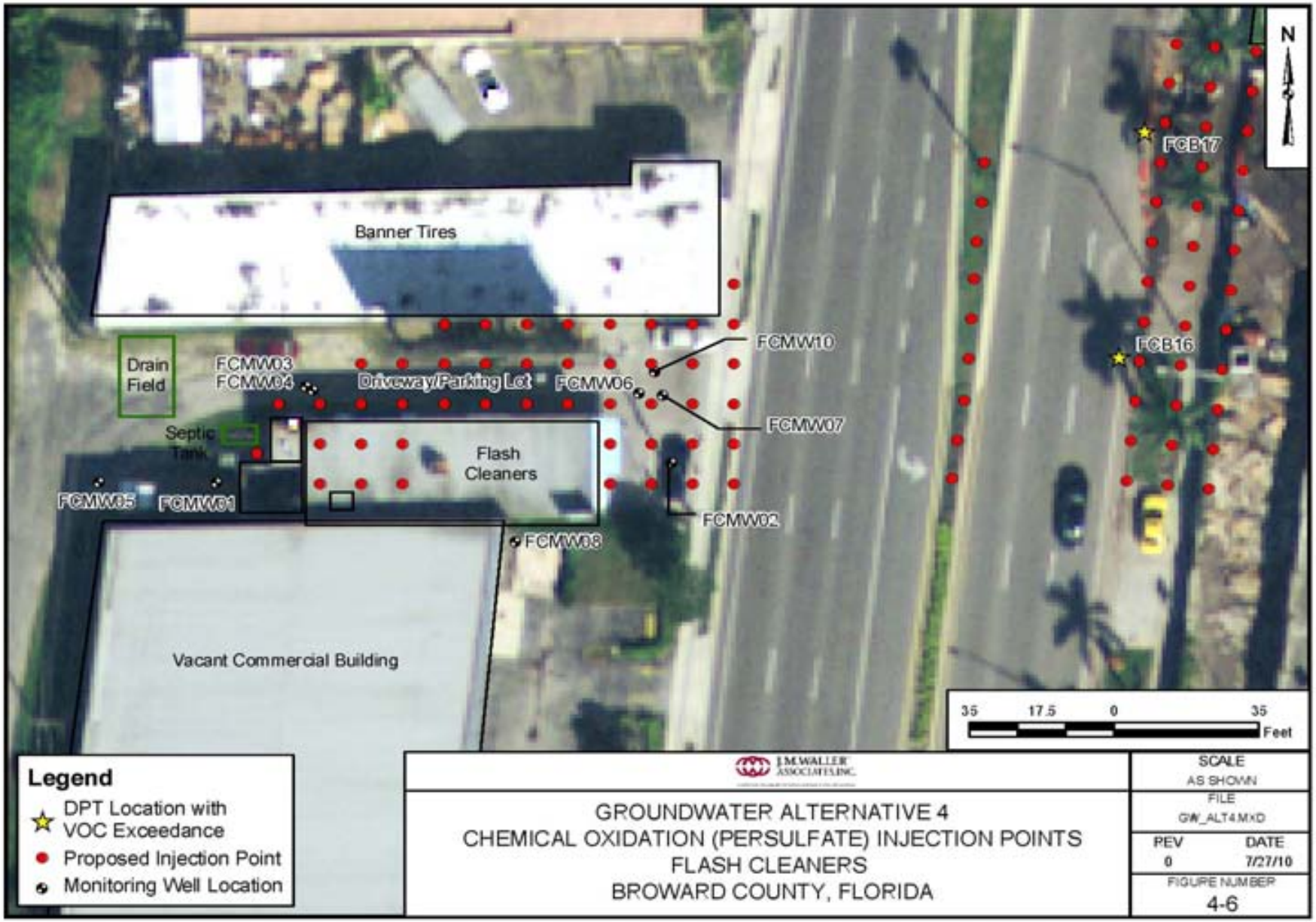

Figure 20 – Alternative GW – 4 Chemical Oxidation Injection Points

Figure 21 – Alternative GW – 5 Monitoring Wells to be sampled for MNA

Figure 22 – Alternative GW- 6 Permeable Reactive Barrier

TABLES

Table 1

SUMMARY OF INDOOR AIR ANALYTICAL RESULTS
REMEDIAL INVESTIGATION REPORT
FLASH CLEANERS
POMPANO BEACH, FLORIDA

				4 Wheel Auto	Flash Cleaners		
LOCATION	USEPA	USEPA	FC-AA-BG	FC-AA-4101	FC-AA-4131		
SAMPLE ID	RESIDENTIAL	INDUSTRIAL	FC-AA-BG	FC-AA-4101	FC-AA-4131	FC-AA-4131-AVG	FC-AA-4131-D
SAMPLE DATE	AIR	AIR	20100412	20100412	20100412	20100412	20100412
SAMPLE CODE	CRITERIA	CRITERIA	NORMAL	NORMAL	ORIG	AVG	DUP
MATRIX	VALUE	VALUE	AS	AS	AS	AS	AS
SAMPLE TYPE			BACKGROUND	NORMAL	NORMAL	NORMAL	NORMAL
SUBMATRIX			NA	NA	NA	NA	NA
VOLATILES (UG/M3)							
BENZENE	0.31	1.6	0.32	0.32	0.33	0.34	0.35
CIS-1,2-DICHLOROETHENE*	63	260	0.16 U	0.66	6.3	6.9	7.5
ETHYLBENZENE	0.97	4.9	0.81 U	1.1	0.81 U	0.64	0.64
M+P-XYLENES	NC	NC	0.81 U	3.2	1.8	1.85	1.9
O-XYLENE	730	3100	0.81 U	1.6	0.81 U	0.72 U	0.63 U
TETRACHLOROETHENE	0.41	2.1	0.16 U	**17**	**45**	**48**	**51**
TOLUENE	5200	22000	0.81 U	31	0.96	1.03	1.1
TRICHLOROETHENE	1.2	6.1	0.16 U	1.2	2.1	2.3	2.5

1) The Background Sample, FC-AA-BG was not evaluated for criteria exceedances. The benzene result in this sample; however, exibits a result greater than the established criteria value for residential air.

2) All detected results were considered to be greater than the background results. One exception was the benzene result for FC-AA-4101 which was equal to the background result for benzene.

Shaded cells indicate exceedance of criteria.

U Not detected at that concentration

J Esimated concentration

NC No criteria

*Criteria corresponds to trans-1,2-dichloroethene.

Table 2
Summary of Chemicals of Potential Concern and
Medium-Specific Exposure Point Concentrations
Flash Cleaners, Pompano Beach, Florida

EXPOSURE POINT	CHEMICAL OF CONCERN	DETECTED CONCENTRATION		UNITS	FREQUENCY OF DETECTION	EXPOSURE POINT CONCENTRATION	UNITS	STATISTICAL MEASURE
		MINIMUM	MAXIMUM					
Indoor Air (Flash Facility)	PCE	17	51	ug/m^3	3/3	51	ug/m^3	Maximum
	TCE	1.2	2.5	ug/m3	3/3	2.5	ug/m3	Maximum
Soil (Flash Facility)	PCE	5	2700	ug/kg	21/28	2700	ug/kg	Maximum
	TCE	4	140	ug/kg	10/28	140	ug/kg	Maximum
	cis-1,2-DCE	7	400	ug/kg	11/28	400	ug/kg	Maximum
	Vinyl Chloride	6	6	ug/kg	1/28	6	ug/kg	Maximum
Groundwater (Flash Facility)	PCE	0.43	38000	ug/L	5/8	38000	ug/L	Maximum
	TCE	0.61	8200	ug/L	5/8	8200	ug/L	Maximum
	Vinyl Chloride	1.7	2000	ug/L	4/8	2000	ug/L	Maximum
	cis-1,2-DCE	0.16	17000	ug/L	7/8	17000	ug/L	Maximum
Groundwater (Non-Flash Facility)	Vinyl Chloride	11	49	ug/L	7/37	49	ug/L	Maximum
	cis-1,2-DCE	0.11	3500	ug/L	26/37	3500	ug/L	Maximum
	trans-1,2-DCE	0.11	620	ug/L	14/37	620	ug/L	Maximum
Soil Gas (Flash Facility)	PCE	163	2237	ug/m^3	6/6	2237	ug/m^3	Maximum
	TCE	11	338	ug/m^3	6/6	338	ug/m^3	Maximum
	cis-1,2-DCE	36	1940	ug/m^3	5/6	1940	ug/m^3	Maximum
Surface Water (Channel)	Vinyl Chloride	0.29	0.29	ug/L	2/10	0.29	ug/L	Maximum

ug/kg - micrograms per kilogram
ug/L - micrograms per liter
ug/m^3 = micrograms per cubic meter
DCE = dichloroethene
PCE = tetrachloroethene
TCE = trichloroethene

Table 3

CANCER TOXICITY DATA SUMMARY – Flash Cleaners Site

PATHWAY: Ingestion, Dermal, Inhalation

Chemical of Concern	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Cancer Unit Risk $(ug/m^3)^{-1}$	Weight of Evidence/Cancer Guideline Description	Source	Date
cis-1,2-Dichloroethene	NC	NC	NC	NC	NC	NC
Tetrachloroethene	0.54	0.54	5.90E-06	NA	CAL-EPA	2009
trans-1,2-Dichloroethene	NC	NC	NC	NC	NC	NC
Vinyl chloride	0.72	0.72	4.40E-06	A / Known/likely human carcinogen	IRIS	2010

Notes:
NA = not applicable
NC = no criteria available
CAL-EPA = California Environmental Protection Agency
IRIS = Integrated Risk Information System

Table 4

NONCANCER TOXICITY DATA SUMMARY – Flash Cleaners Site								
PATHWAY: Ingestion, Dermal, Inhalation								
Chemical of Concern	Chronic/ Subchronic	Oral Reference Dose mg/kg-day	Dermal Reference Dose mg/kg-day	Inhalation Reference Concentration mg/m^3	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source	Date
cis-1,2-Dichloroethene	Chronic	0.01	0.01	NC	Blood	3000/1	PPRTV	3/1/2006
Tetrachloroethene	Chronic	0.01	0.01	0.27	Liver	1000/1	*	2010/1997
trans-1,2-Dichloroethene	Chronic	0.02	0.02	0.06	Blood	1000/1	**	2010
Vinyl chloride	Chronic	0.003	0.003	0.1	Liver	30/1	IRIS	2010

Notes:
NC = No Criteria Available
* IRIS for oral and dermal and ATSDR for inhalation
** IRIS for oral and dermal and PPRTV for inhalation

Table 5
Risk Characterization Summary - Carcinogens
Current Industrial Worker
Flash Cleaners
Pompano Beach, Florida

Scenario Timeframe:			**Current**					
Receptor Population:			**Industrial**					
Receptor Age:			**Adult**					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Air	Indoor Air	Indoor Air Flash Facility	PCE	NA	2.4E-05	NA	--	2.4E-05
							Indoor Air Total	**2.4E-05**
Soil	Soil	Soil On Site Direct Contact	PCE	5.1E-07	NA	NA	--	5.1E-07
	Dust	Soil On Site Inhalation of Dust	PCE	NA	5.1E-07	NA	--	5.1E-07
							Soil Total	**1.0E-06**
							Total Risk Across All Media	**2.5E-05**

NA = not applicable
PCE = tetrachloroethene

Table 6

Risk Characterization Summary - Noncarcinogens
Current Industrial Worker
Flash Cleaners
Pompano Beach, Florida

Scenario Timeframe:			**Current**						
Receptor Population:			**Industrial**						
Receptor Age:			**Adult**						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Noncarcinogenic Hazard Quotients				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Air	Indoor Air	Indoor Air Flash Facility	PCE	Liver	NA	4.2E-02	NA	--	4.2E-02
								Indoor Air Total	**4.2E-02**
Soil	Soil	Soil On Site Direct Contact	PCE	Liver	2.7E-04	NA	NA	--	2.7E-04
	Dust	Soil On Site Inhalation of Dust	PCE	Liver	NA	9.0E-04	NA	--	9.0E-04
								Soil Total	**1.2E-03**
								Total Hazards Across All Media	**4.3E-02**

NA = not applicable
PCE = tetrachloroethene

Table 7
Risk Characterization Summary - Carcinogens
Future Resident
Flash Cleaners, Pompano Beach, Florida

Scenario Timeframe:			**Future**					
Receptor Population:			**Resident**					
Receptor Age:			**Lifetime**					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Air	Indoor Air	Indoor Air Flash Facility	PCE	NA	1.2E-04	NA	--	1.2E-04
							Indoor Air Total	**1.2E-04**
Groundwater	Groundwater	Aquifer-Tap Water	PCE	3.2E-01	4.6E-02	NA	--	3.5E-01
			TCE	7.5E-04	3.4E-03	NA	--	4.1E-03
			Vinyl Chloride	1.2E-01	6.3E-03	NA	--	1.2E-01
							Groundwater Total	**4.8E-01**
Soil	Soil	Soil On Site Direct Contact	PCE	2.3E-06	NA	NA	--	2.3E-06
	Dust	Soil On Site Inhalation of Dust	PCE	NA	2.7E-06	NA	--	2.7E-06
							Soil Total	**4.9E-06**
							Total Risk Across All Media	**4.8E-01**

NA = not applicable

PCE = tetrachloroethene

TCE = trichloroethene

Table 8

Risk Characterization Summary - Noncarcinogens
Future Resident
Flash Cleaners, Pompano Beach, Florida

Scenario Timeframe:			**Future**						
Receptor Population:			**Resident**						
Receptor Age:			**Lifetime**						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Noncarcinogenic Hazard Quotients				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Air	Indoor Air	Indoor Air Flash Facility	PCE	Liver	NA	1.8E-01	NA	--	1.8E-01
								Indoor Air Total	**1.8E-01**
Groundwater	Groundwater	Aquifer-Tap Water	PCE	Liver	1.0E+02	6.7E+01	NA	--	1.7E+02
			Vinyl Chloride	Liver	1.8E+01	1.0E+01	NA	--	2.8E+01
			cis-1,2-DCE	Blood	4.6E+01	NA	NA	--	4.6E+01
								Groundwater Total	**2.5E+02**
Soil	Soil	Soil On Site Direct Contact	PCE	Liver	3.0E-03	NA	NA	--	3.0E-03
	Dust	Soil On Site Inhalation of Dust	PCE	Liver	NA	4.0E-03	NA	--	4.0E-03
								Soil Total	**7.0E-03**
								Total Hazards Across All Media	**2.5E+02**

NA = not applicable
DCE = dichloroethene

Table 9
Risk Characterization Summary - Carcinogens
Current Offsite Resident
Flash Cleaners, Pompano Beach, Florida

Scenario Timeframe:			**Current**					
Receptor Population:			**Offsite Resident**					
Receptor Age:			**Lifetime**					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Groundwater	Groundwater	Aquifer-Tap Water	Vinyl Chloride	2.9E-03	1.5E-04	NA	--	3.1E-03
Groundwater Total								**3.1E-03**
Total Risk Across All Media								**3.1E-03**

NA = not applicable

Table 10
Risk Characterization Summary – Noncarcinogens
Current Offsite Resident
Flash Cleaners, Pompano Beach, Florida

Scenario Timeframe:			**Current**						
Receptor Population:			**Offsite Resident**						
Receptor Age:			**Lifetime**						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Noncarcinogenic Hazard Quotients				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Route Total
Groundwater	Groundwater	Aquifer-Tap Water	Vinyl Chloride	Liver	4.5E-01	2.3E-01	NA	--	6.8E-01
			cis-1,2-DCE	Blood	9.5E+00	NA	NA	--	9.5E+00
			trans-1,2-DCE	Blood/Liver	8.5E-01	4.8E+00	NA	--	5.6E+00
								Total Hazards Across All Media	**1.6E+01**

NA = not applicable
DCE = dichloroethene

Table 11

Pore Water Ecological Chemicals of Potential Concern
Ecological Risk Assessment
Flash Cleaners
Pompano Beach, Florida

Chemical	Frequency of Detection	Range of Detected Concentrations (µg/L)		Location of Maximum Concentration	Range of Non Detects (µg/L)	Ecological Screening Value (µg/L)	Hazard Quotient[(1)]	COPC (Yes/No)
		Minimum	Maximum					
ORGANICS (µg/L)								
1,1-DICHLOROETHENE	1/30	0.52	0.52	FCPW14	0.5	3.2[(2)]	0.2	No
CIS-1,2-DICHLOROETHENE	13/30	0.23	400	FCPW14	0.5	NA*	NA	Yes
TRANS-1,2-DICHLOROETHENE	4/30	0.21	2.2	FCPW14	0.5	1350[(3)]	0.002	No
VINYL CHLORIDE	9/30	0.22	230	FCPW14	0.5	NA**	NA	Yes

Footnotes:

(1) Hazard quotient = maximum detected concentration ÷ ecological screening value

(2) Florida Chronic Class III Surface Water Criteria (annual average) for marine and fresh water; .A.C. 62-302.530 (FDEP, 2008).

(3) EPA Region 4 chronic freshwater screening value (marine screening value not available).

NA: Ecological screening value not available from EPA (2001) nor FDEP (2008) However,.

* Concentrations of total dichloroethene in pore water exceeded 340 µg/L (FDEP provisional screening value) in only one sample (402 µg/L) at FCPW14.

**Concentrations of vinyl chloride in pore water were less than all available toxicity values.

Table 12

Surface Water Ecological Chemicals of Potential Concern
Ecological Risk Assessment
Flash Cleaners
Pompano Beach, Florida

Chemical	Frequency of Detection	Range of Detected Concentrations (µg/L)		Location of Maximum Concentration	Range of Non Detects (µg/L)	Ecological Screening Value (µg/L)	Hazard Quotient[(1)]	COPC (Yes/No)
		Minimum	Maximum					
2009 Data								
CIS-1,2-DICHLOROETHENE	2/4	0.19	0.26	FCSW04	0.5	NA*	NA	Yes
2010 Data								
CIS-1,2-DICHLOROETHENE	1/5	0.1	0.1	FCSW05	0.5	NA*	NA	Yes
VINYL CHLORIDE	2/5	0.29	0.29	FCSW05 & FCSW07	0.5	NA**	NA	Yes

Footnotes:

(1) Hazard quotient = maximum detected concentration ÷ ecological screening value

*All total dichloroethene concentrations were less than 340 µg/L (FDEP provisional screening value)

**Concentrations of vinyl chloride in surface water were less than all available toxicity values.

Table 13

Ecological Exposure Pathways of Concern
Flash Cleaners
Pompano Beach, Florida

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered or Threatened Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Surface Water	N	Fish, aquatic organisms	N	Ingestion, direct contact	Protection of aquatic biota from adverse effects of chemicals on growth, survival, and reproduction	Chemical concentrations in surface water that are associated with no adverse effects on growth, survival, and reproduction of aquatic organisms.
Sediment	N	Benthic organisms	N	Ingestion, direct contact	Protection of benthic biota from adverse effects of chemicals on growth, survival, and reproduction	Chemical concentrations in sediment pore water that are associated with no adverse effects on growth, survival, and reproduction of aquatic organisms.

Table 14

COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors
Flash Cleaners
Pompano Beach, Florida

Habitat Type (Name)	Exposure Medium	COC	Protective Level	Basis	Assessment Endpoint
Brackish water (Grand Canal)	Sediment pore water	1,2-DCE	340 µg/L[(a)]	Provisional marine surface water cleanup target level (FDEP, 2010)[(b)]	No adverse effects on growth, survival, and reproduction of aquatic and benthic organisms.

(a) Value shown is for total (*cis* plus *trans* isomers) 1,2-DCE.

(b) Florida Department of Environmental Protection, 2010. Letter to Ligia Mora-Applegate, Bureau of Waste Cleanup, from Leah D. Stuchal and Stephen M. Roberts, University of Florida, Center for Environmental & Human Toxicology. Subject: Marine surface water cleanup target level for cis-1,2-dichloroethene developed for the Flash Cleaners site. May 6.

Table 15
Federal Chemical-Specific ARARs
Flash Cleaners
Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Safe Drinking Water Act (SDWA) Regulations, Maximum Contaminant Levels (MCLs)	40 Code of Federal Regulations (CFR) Part 141 Subpart G	Relevant and Appropriate	Establishes enforceable standards for public water supplies for specific contaminants that have been determined to affect adversely human health.	Would be used as protective levels for groundwater that is a potential drinking water source.

Notes:

ARARs = Applicable or Relevant and Appropriate Requirements

Table 16
State Chemical-Specific ARARs (Identified by FDEP)
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Florida Contaminant Cleanup Target Levels	Chapter 62-777.170, F.A.C. and Rule 62-777.100(2)	Relevant and Appropriate	This rule provides standard criteria in tables and an explanation for deriving cleanup target levels (CTLs) for soil, groundwater and surface water that can be used for site rehabilitation (i.e. cleanup).	CTLs for groundwater in Table 1 of this rule were used to establish cleanup goals for some of the COCs in groundwater at this site. Soil CTLs for Leachability Based on Groundwater Criteria from Table II were used to establish cleanup goals for some COCs.
Florida Drinking Water Standards, Monitoring and Reporting	Rule 62-550.310, F.A.C.	Relevant and Appropriate	This rule provides primary drinking water standards and maximum contaminant levels (MCLs) for public water supply systems.	Cleanup goals for some of the contaminants of concern (COCs) in groundwater are based upon USEPA MCLs listed in Table 4 of this rule.
Florida Groundwater Classes, Standards and Exemptions	Chapter 62-520, and Rule 620520.420, F.A.C.	Applicable	This rule designates the groundwater of the state into five classes and establishes minimum criteria. This rule also specifies that classes I and II must meet primary drinking water standards listed in Chapter 62-550, F.A.C.	This rule was used to classify groundwater and establish cleanup goals for groundwater. Groundwater at this site is considered a source of drinking water (Class-G1)

Notes: ARARs = Applicable or Relevant and Appropriate Requirements
F.A.C. = Florida Administrative Code

Table 17
Federal Action-Specific ARARs
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and Listing of Hazardous Wastes	40 CFR Part 262.11 and 264.13	Potentially Applicable	Defines the listed and characteristic hazardous wastes subject to RCRA. Appendix II contains the Toxicity Characteristic Leaching Procedure.	These regulations would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, as described in the regulations. These would apply to response actions that include removal and off-site disposal of excavated material from the Site.
RCRA Land Disposal Restrictions (LDRs) and Treatment Standards	40 CFR Part 268.7and 268.40(a)	Applicable	40 CFR Part 268.7 requires determination of whether waste has to be treated before land disposal by testing in accordance with prescribed methods or by use of generator knowledge of the waste. Under 40 CFR 268.40(a) prohibited waste may be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40.	Remediation wastes including secondary waste determined to be hazardous waste must be evaluated for treatment prior to off-site disposal at an appropriate facility.
RCRA Regulations, Land Disposal Restrictions (LDRs)	40 CFR Part 268.49	Potentially Applicable	Prohibits the land disposal of untreated hazardous wastes and provides criteria for the treatment of hazardous waste prior to land disposal.	Response actions that involve excavating, treating, and re-depositing hazardous soil would comply with LDRs.

Table 17 (continued)
Federal Action-Specific ARARs
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
RCRA Regulations, Use and Management of Containers	40 CFR Part 265.171 to 173	Applicable	Establish requirements for use and management of hazardous waste in containers.	Containers that may be used for temporary storage of hazardous waste (i.e., contaminated soil) on site prior to off-site treatment and disposal will comply with these requirements.
RCRA Regulations – Storage of Hazardous Waste in Staging Pile	40 CFR Part 264.554(a)(1)(i)-(iii) and 40 CFR 264.554(i)(1)	Relevant and Appropriate	Provides requirements for temporary storage and closure of non-flowing hazardous remediation waste in a staging pile to prevent or minimizes releases of hazardous substances or constituents into the environment.	Storage area for contaminated soil temporarily staged on-site and intended for off-site treatment or disposal will consider these requirements.
RCRA Regulations – Transportation of Hazardous Waste	40 CFR Part 262.10(h)	Applicable	An owner or operator who initiates a shipment of hazardous waste from a treatment, storage, or disposal facility must comply with the generator standards established in this part, including the requirements of 40 CFR 262.20-23 for manifesting; Section 262.30 for packaging; Section 262.31 for labeling; Section 262.32 for marking; Section 262.33 for placarding; Section 262.41(a) for record-keeping; and Section 262.12 to obtain EPA ID number.	Hazardous waste requiring off-site disposal will meet transportation requirements.
Federal Hazardous Materials Transportation Law (49 U.S.C. 5101 et seq.) Regulations	49 CFR Part 171.1(c)	Applicable	This regulation applies to any person, including a person under contract with a department or agency of the federal government, that transports, or causes to be transported or shipped in commerce, a hazardous material.	Hazardous material requiring off-site disposal will meet transportation requirements.

Notes: CFR = Code of Federal Regulations
U.S.C. = United States Code

Table 18
State Action-Specific ARARs
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
*Florida Contaminated Site Cleanup Criteria – Active Remediation	Rule 62-780.700(4)(a), F.A.C.	Relevant and Appropriate	This rule provides the criteria and requirements for active remediation of a site, including use of a vacuum extraction system.	This remedy includes SVE for the soils, which includes collection of volatile organic compounds in accordance with this rule.
Florida Solid Waste Management Facilities	Chapter 62-701.300, F.A.C.	Relevant and Appropriate	Prohibits storage, processing, or disposal except at a permitted solid waste management facility.	Waste generated on site and deemed nonhazardous solid waste will be stored, transported, or disposed of properly.
Florida Post Active Remediation Monitoring Regulation	Chapter 62-780.750(4)(a) thru (c), F.A.C.	Relevant and Appropriate	Specifies minimum number of wells and sampling frequency for conducting groundwater monitoring as part of post active remediation monitoring.	Post active remediation monitoring will consider the relevant requirements of this rule.**
Florida Active Remediation Regulation for Groundwater In-situ Systems	Chapter 62-780.700(12)(g) and (h), F.A.C.	Relevant and Appropriate	Specifies that operational parameters for in-situ system(s) should include measurements of biological, chemical, or physical indicators that will verify the radius of influence at representative monitoring locations, weekly for the first month, monthly for the next 2 months, quarterly for the first 2 years, and semi-annually thereafter.	In-situ groundwater remediation will consider the relevant requirements of this rule.**

Table 18 (continued)
State Action-Specific ARARs
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Florida Hazardous Waste Rules	Chapter 62-730, F.A.C.	Relevant and Appropriate	Adopts by reference sections of the federal hazardous waste regulations and establishes minor additions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous wastes.	These regulations were applied when determining whether waste on site is hazardous, either by being listed or by exhibiting a hazardous characteristic, as described in the regulations.
Florida Regulation of Stormwater Discharge	Chapter 62-25.025(7) F.A.C.	Relevant and Appropriate	Establishes requirements for stormwater discharges to ensure protection of the surface water of the state.	Erosion and stormwater control best management practices will be implemented during construction to retain sediment on site.
Florida Groundwater Permitting and Monitoring Requirements	Chapter 62-522.300 and 522.300(2)(e), F.A.C.	Applicable	Establishes permitting and monitoring requirements for installations discharging to groundwater to prevent contaminants from causing a violation of water quality standards and criteria of the receiving groundwater.	A zone of discharge is allowed for primary standards for groundwater for closed-loop reinjection systems and for the prime constituents of the reagents used to remediate the contaminants.
Florida Underground Injection Control Regulations	Chapter 62-528.605, 528.610, 528.615, 528.625, and 528.645 F.A.C.	Applicable	Establishes standards and criteria for construction, operation, monitoring, plugging, and abandonment for Class V wells.	Regulations pertaining to Class V Group 4 injection wells associated with aquifer remediation projects will be followed.

Table 18 (continued)
State Action-Specific ARARs
Flash Cleaners, Pompano Beach, Florida

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Florida Hazardous Waste - Requirements for Remedial Action	Chapter 62-730.225(3), F.A.C.	Applicable	Requires warning signs at sites suspected or confirmed to be contaminated with hazardous waste.	This requirement will be met during active remediation of soil.
Florida General Pollutant Emission Limitation Standards	Chapter 62-296.320, F.A.C.	Applicable	Establishes requirements for generation of unconfined emissions of particulate matter from any activity.	Requires reasonable precautions such as application of water or other dust suppressants to control emission from construction and land clearing activities.
Florida Water Well Permitting and Construction Requirements	Chapter 62-532.500, F.A.C.	Applicable	Establishes minimum standards for the location, construction, repair, and abandonment of water wells.	The requirements for the construction, repair, and abandonment of monitoring, extraction, and injection wells will be met.

Notes:F.A.C. = Florida Administrative Code

ARARs = Applicable and Relevant and Appropriate Requirements

* ARARs identified by Florida Department of Environmental Protection

** The designated number of wells, sampling time frames/frequency, and specific parameters for analyses will be provided in a Monitoring Plan that is included in a post-ROD document prepared as part of the Remedial Design or Remedial Action which is approved by EPA and FDEP.

Table 19
Florida Soil Cleanup Target Levels
Florida Department of Environmental Protection
Flash Cleaners
Pompano Beach, Florida

COCs	FDEP Residential SCTL (mg/kg)	FDEP Industrial SCTL (mg/kg)	FDEP Leachability SCTL (mg/kg)
PCE	8.8	18	0.03
TCE	6.4	9.3	0.03
cis-1,2-DCE	33	180	0.4
Vinyl Chloride	0.2	0.8	0.007

Notes:

COC = Chemical of concern
DCE = Dichloroethene
FDEP = Florida Department of Environmental Protection
PCE = Tetrachloroethene
SCTL = Soil cleanup target level
TCE = Trichloroethene

Table 20
EPA MCLs and Florida Groundwater Cleanup Target Levels
Flash Cleaners
Pompano Beach, Florida

COCs	EPA MCL (µg/L)	FDEP GCTL (µg/L)
PCE	5	3
TCE	5	3
cis-1,2-DCE	70	70
trans-1,2-DCE	100	100
Vinyl Chloride	2	1

Notes:
COC = Chemical of concern
EPA = Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
GCTL = Groundwater cleanup target level
MCL = Maximum Contaminant Level

Table 21
Cleanup Levels for the Selected Remedy
Flash Cleaners
Pompano Beach, Florida

COCs	Soil Cleanup Goals mg/kg	Groundwater Cleanup Goals ug/L
PCE	0.03	3
TCE	0.03	3
Cis-1,2-DCE	0.4	70
Trans-1,2-DCE	--	100
Vinyl Chloride	0.007	1

COC = Chemical of concern
DCE = Dichloroethene
PCE = Tetrachloroethene
SCTL = Soil cleanup target level
TCE = Trichloroethene

Note: There is no soil cleanup level for trans-1,2-DCE since this contaminant is not a soil COC.

Table 22
Cost Summary for the Selected Remedy

	Capital Costs	O&M	Total Costs
S-2 Excavation around the building	583,000	*	583,000
S-4 SVE (just underneath the building)	415,000	274,000	689,000
GW-2 Bioremediation Injection	1,202,000	1,091,000	2,293,000
TOTAL SUM COST OF THE SELECTED REMEDY			**3,565,000**

* Soil O&M costs included in S-4

APPENDIX A

SELECTED REMEDY COST DETAIL

FLASH CLEANERS
Broward County, Florida
Alternative S2: Excavation and Disposal
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	250	hr			$37.00		$0	$0	$9,250	$0	$9,250
1.2 Prepare Permits	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
1.3 Prepare LUCs	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	6	ea			$177.00	$610.00	$0	$0	$1,062	$3,660	$4,722
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	1	mo				$360.00	$0	$0	$0	$360	$360
3.2 Field Office Equipment, Utilities, & Support	1	mo		$470.00			$0	$470	$0	$0	$470
3.3 Storage Trailer	1	mo				$92.50	$0	$0	$0	$93	$93
3.4 Survey Support	2	day	$1,075.00				$2,150	$0	$0	$0	$2,150
3.5 Site Superintendent	23	day		$188.00	$384.64		$0	$4,324	$8,847	$0	$13,171
3.6 Site Health & Safety and QA/QC	23	day		$188.00	$307.68		$0	$4,324	$7,077	$0	$11,401
3.7 Underground Utility Clearance	1	ls	$7,350.00				$7,350	$0	$0	$0	$7,350
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$771.00	$0	$0	$0	$771	$771
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$693.00	$0	$0	$0	$693	$693
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 EXCAVATION, DISPOSAL, AND RESTORATION											
5.1 Foundation Shoring	2,080	sf	$8.60				$17,888	$0	$0	$0	$17,888
5.2 Excavator, 2.5 cy	11	day			$355.20	$1,784.00	$0	$0	$3,907	$19,624	$23,531
5.3 Skid-Steer, 78 hp	11	day				$291.00	$0	$0	$0	$3,201	$3,201
5.4 Compactor, ,125 hp	5	day			$343.60	$633.02	$0	$0	$1,718	$3,165	$4,883
5.5 Site Labor, (3 laborers)	69	day			$264.80		$0	$0	$18,271	$0	$18,271
5.6 Transport & Dispose Excavated Soil, nonhazardous	812	ton	$85.00				$69,020	$0	$0	$0	$69,020
5.7 Transport & Dispose Excavated Soil, hazardous	203	ton	$225.00				$45,675	$0	$0	$0	$45,675
5.8 Waste Disposal Characterization / Analytical	2	ea	$850.00	$30.00	$50.00	$30.00	$1,700	$60	$100	$60	$1,920
5.9 Backfill, common fill	657	cy		$17.96			$0	$11,800	$0	$0	$11,800
5.10 Backfill, gravel	21	cy		$35.00			$0	$735	$0	$0	$735
5.11 Pavement Replacement	1,145	sf	$3.03				$3,469	$0	$0	$0	$3,469
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
6.2 Remedial Action Closeout Report	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
Subtotal							$148,237	$28,633	$83,227	$37,402	$297,498
Overhead on Labor Cost @ 30%									$24,968		$24,968
G & A on Cost @ 10%							$14,824	$2,863	$8,323	$3,740	$29,750
Tax on Materials and Equipment Cost @ 6%								$1,718		$2,244	$3,962
Total Direct Cost							$163,061	$33,214	$116,517	$43,386	$356,178
Indirects on Total Direct Cost @ 20%			(excluding transportation and disposal cost)								$48,100
Profit on Total Direct Cost @ 10%											$35,618
Subtotal											$439,896

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Health & Safety Monitoring @ 2%											$8,798
Total Field Cost											$448,694
Engineering on Total Field Costs @ 10%											$44,869
Contingency on Total Field Costs @ 20%											$89,739
TOTAL CAPITAL COST											**$583,302**

FLASH CLEANERS
Broward County, Florida
Alternative S4 - SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	300	hr			$37.00		$0	$0	$11,100	$0	$11,100
1.2 Prepare Permits	250	hr			$37.00		$0	$0	$9,250	$0	$9,250
1.3 Prepare LUCs	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	3	ea			$177.00	$610.00	$0	$0	$531	$1,830	$2,361
2.3 Well Equipment Mobilization/Demobilization	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	1	mo				$360.00	$0	$0	$0	$360	$360
3.2 Field Office Equipment, Utilities, & Support	1	mo		$470.00			$0	$470	$0	$0	$470
3.3 Storage Trailer	1	mo				$92.50	$0	$0	$0	$93	$93
3.4 Survey Support	3	day	$1,075.00				$3,225	$0	$0	$0	$3,225
3.5 Site Superintendent	15	day		$188.00	$384.64		$0	$2,820	$5,770	$0	$8,590
3.6 Site Health & Safety and QA/QC	15	day		$188.00	$307.68		$0	$2,820	$4,615	$0	$7,435
3.7 Underground Utility Clearance	1	ls	$7,350.00				$7,350	$0	$0	$0	$7,350
4 DECONTAMINATION											
4.1 Decontamination Services	0.5	mo		$1,220.00	$2,245.00	$1,550.00	$0	$610	$1,123	$775	$2,508
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	500	gal		$0.20			$0	$100	$0	$0	$100
4.4 Decon Water Storage Tank, 6,000 gallon	0.5	mo				$771.00	$0	$0	$0	$386	$386
4.5 Clean Water Storage Tank, 4,000 gallon	0.5	mo				$693.00	$0	$0	$0	$347	$347
4.6 Disposal of Decon Waste (liquid & solid)	0.5	mo	$985.00				$493	$0	$0	$0	$493
5 SVE SYSTEM											
5.1 Well Installation	24	lf	$100.00				$2,400	$0	$0	$0	$2,400
5.2 Well Materials	1	ls	$500.00				$500	$0	$0	$0	$500
5.3 Well Vault	1	ea		$1,200.00	$287.00	$113.00	$0	$1,200	$287	$113	$1,600
5.4 Backhoe/Loader	5	day			$355.20	$337.80	$0	$0	$1,776	$1,689	$3,465
5.5 Site Labor, (3 laborers)	30	day			$264.80		$0	$0	$7,944	$0	$7,944
5.6 Fence Skid Area	1	ls	$1,360.00				$1,360	$0	$0	$0	$1,360
5.7 SVE Treatment System	1	ea		$5,000.00			$0	$5,000	$0	$0	$5,000
5.8 Carbon	2,000	lb		$3.00			$0	$6,000	$0	$0	$6,000
5.9 Piping & Valves	1	ls		$1,180.00	$2,015.00		$0	$1,180	$2,015	$0	$3,195
5.10 Electrical Service	1	ea	$7,350.00				$7,350	$0	$0	$0	$7,350
5.11 Pavement Repair	1	ls	$300.00				$300	$0	$0	$0	$300
5.12 System Startup & Testing	1	ls		$100.00	$1,500.00		$0	$100	$1,500	$0	$1,600
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
6.2 Remedial Action Closeout Report	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
Subtotal							$30,478	$25,800	$69,260	$9,817	$135,354
Overhead on Labor Cost @ 30%									$20,778		$20,778
G & A on Cost @ 10%							$3,048	$2,580	$6,926	$982	$13,535
Tax on Materials and Equipment Cost @ 6%								$1,548		$589	$2,137
Total Direct Cost							$33,525	$29,928	$96,964	$11,387	$171,805
Indirects on Total Direct Cost @ 35%											$60,132
Profit on Total Direct Cost @ 10%											$17,180

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Subtotal											$249,117
Health & Safety Monitoring @ 4%											$9,965
Total Field Cost											$259,082
Engineering on Total Field Costs @ 30%											$77,724
Contingency on Total Field Costs @ 30%											$77,724
TOTAL CAPITAL COST											**$414,531**

FLASH CLEANERS
Broward County, Florida
Alternative S4 - SVE
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
YEAR 1						
1	Energy - Electric	32,675	kWh	$0.13	$4,248	
2	System Maintenance	1	ls	$11,382.30	$11,382	15% of Installation Cost
3	Sampling labor, travel & living, supplies	52	ea	$610	$31,720	1 person once per week
4	Analysis of Offgas sampling	4	ea	$150	$600	VOCs quarterly
5	Quarterly Reports	4	ea	$4,000	$16,000	
			O & M per year for year 1		**$63,950**	

FLASH CLEANERS
Broward County, Florida
Alternative S4 - SVE
Sampling Cost

Item	Item Cost years 1 through 5	Notes
Site Inspection: Visit	$2,240	One-day visit to verify ICs and collect air samples annually
Site Inspection: Report	$800	
Surface Soil Sampling	$4,240	Labor and supplies to collect soil samples using a hand auger using a crew of two, once annually.
Soil Analysis	$1,120	Analyze soil samples for VOCs
Sampling Report	$3,500	
Subtotal	$11,900	
Contingency @ 10%	$1,190	
TOTAL	**$13,090**	

FLASH CLEANERS
Broward County, Florida
Alternative S4 - SVE
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate 7.0%	Present Worth
0	$480,992			$480,992	1.000	$480,992
1		$66,074	$13,090	$79,164	0.935	$73,985
2		$40,640	$13,090	$53,730	0.873	$46,930
3		$40,640	$13,090	$53,730	0.816	$43,860
4		$40,640	$13,090	$53,730	0.763	$40,991

FLASH CLEANERS
Broward County, Florida
Alternative G2 - Enhanced Bioremediation (EOS Injection) with Monitoirng
Injection 1 - Year 0
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	300	hr			$37.00		$0	$0	$11,100	$0	$11,100
1.2 Prepare Permits	250	hr			$37.00		$0	$0	$9,250	$0	$9,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	2	ea			$177.00	$610.00	$0	$0	$354	$1,220	$1,574
2.3 DPT Mobilization/Demobilization	1	ea	$2,000.00				$2,000	$0	$0	$0	$2,000
2.4 Drill Rig Mobilization/Demobilization	1	ea	$2,000.00				$2,000	$0	$0	$0	$2,000
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	2.5	mo				$360.00	$0	$0	$0	$900	$900
3.2 Field Office Equipment, Utilities, & Support	2.5	mo		$470.00			$0	$1,175	$0	$0	$1,175
3.3 Storage Trailer	2.5	mo				$92.50	$0	$0	$0	$231	$231
3.4 Survey Support	2.0	day	$1,075.00				$2,150	$0	$0	$0	$2,150
3.5 Site Superintendent	50	day		$188.00	$384.64		$0	$9,400	$19,232	$0	$28,632
3.6 Site Health & Safety and QA/QC	50	day		$188.00	$307.68		$0	$9,400	$15,384	$0	$24,784
3.7 Underground Utility Clearance	1	ls	$7,350.00				$7,350	$0	$0	$0	$7,350
4 DECONTAMINATION											
4.1 Decontamination Services	2.5	mo		$1,220.00	$2,245.00	$1,550.00	$0	$3,050	$5,613	$3,875	$12,538
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	2,500	gal		$0.20			$0	$500	$0	$0	$500
4.4 Decon Water Storage Tank, 6,000 gallon	2.5	mo				$771.00	$0	$0	$0	$1,928	$1,928
4.5 Clean Water Storage Tank, 4,000 gallon	2.5	mo				$693.00	$0	$0	$0	$1,733	$1,733
4.6 Disposal of Decon Waste (liquid & solid)	2.5	mo	$985.00				$2,463	$0	$0	$0	$2,463
5 EOS INJECTIONS											
5.1 Bench-Scale Treatability Study	1	ls	$30,000.00				$30,000	$0	$0	$0	$30,000
5.2 DPT Rig (Injections)	46	day	$3,300.00				$151,800	$0	$0	$0	$151,800
5.3 Injection Point Supplies (Injections)	2,730	lf	$4.00				$10,920	$0	$0	$0	$10,920
5.4 EOS	4,550	gal		$16.80			$0	$76,440	$0	$0	$76,440
5.5 Mix Water	58,500	gal		$0.20			$0	$11,700	$0	$0	$11,700
5.6 Mix Tank, 4,000 gallon	2.5	mo				$693.00	$0	$0	$0	$1,733	$1,733
5.7 Pumps & Hoses	46	day				$37.60	$0	$0	$0	$1,730	$1,730
5.8 Pavement Core & Repair	50	ea	$116.00				$5,800	$0	$0	$0	$5,800
5.9 Transport & Dispose Drill Soil, nonhazardous	5	ton	$85.00				$425	$0	$0	$0	$425
6 INSTALL MONITORING WELLS											
6.1 Monitoring Well Installation, 10 wells	600	lf	$78.00				$46,800	$0	$0	$0	$46,800
6.2 Vault & Cover	10	ea	$750.00				$7,500	$0	$0	$0	$7,500
6.3 Transport & Dispose Drill Soil, nonhazardous	20	ton	$85.00				$1,700	$0	$0	$0	$1,700
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
7.2 Remedial Action Closeout Report	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
Subtotal							$270,908	$117,165	$76,883	$17,573	$482,528
Overhead on Labor Cost @ 30%									$23,065		$23,065
G & A on Cost @ 10%							$27,091	$11,717	$7,688	$1,757	$48,253
Tax on Materials and Equipment Cost @ 6%								$7,030		$1,054	$8,084
Total Direct Cost							$297,998	$135,911	$107,636	$20,385	$561,930
Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$167,203
Profit on Total Direct Cost @ 10%											$56,193

FLASH CLEANERS
Broward County, Florida
Alternative G2 - Enhanced Bioremediation (EOS Injection) with Monitoirng
Injection 1 - Year 0
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Subtotal											$785,326
Health & Safety Monitoring @ 2%											$15,707
Total Field Cost											$801,033
Engineering on Total Field Costs @ 20%											$160,207
Contingency on Total Field Costs @ 30%											$240,310
TOTAL CAPITAL COST											**$1,201,549**

FLASH CLEANERS
Broward County, Florida
Alternative G2 - Enhanced Bioremediation (EOS Injection) with Monitoirng
Injection 2 - Year 3
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
1.2 Prepare Permits	250	hr			$37.00		$0	$0	$9,250	$0	$9,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	2	ea			$177.00	$610.00	$0	$0	$354	$1,220	$1,574
2.3 DPT Mobilization/Demobilization	1	ea	$2,000.00				$2,000	$0	$0	$0	$2,000
2.4 Drill Rig Mobilization/Demobilization	1	ea	$2,000.00				$2,000	$0	$0	$0	$2,000
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	2.5	mo				$360.00	$0	$0	$0	$900	$900
3.2 Field Office Equipment, Utilities, & Support	2.5	mo		$470.00			$0	$1,175	$0	$0	$1,175
3.3 Storage Trailer	2.5	mo				$92.50	$0	$0	$0	$231	$231
3.4 Survey Support	2.0	day	$1,075.00				$2,150	$0	$0	$0	$2,150
3.5 Site Superintendent	50	day		$188.00	$384.64		$0	$9,400	$19,232	$0	$28,632
3.6 Site Health & Safety and QA/QC	50	day		$188.00	$307.68		$0	$9,400	$15,384	$0	$24,784
3.7 Underground Utility Clearance	1	ls	$7,350.00				$7,350	$0	$0	$0	$7,350
4 DECONTAMINATION											
4.1 Decontamination Services	2.5	mo		$1,220.00	$2,245.00	$1,550.00	$0	$3,050	$5,613	$3,875	$12,538
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	2,500	gal		$0.20			$0	$500	$0	$0	$500
4.4 Decon Water Storage Tank, 6,000 gallon	2.5	mo				$771.00	$0	$0	$0	$1,928	$1,928
4.5 Clean Water Storage Tank, 4,000 gallon	2.5	mo				$693.00	$0	$0	$0	$1,733	$1,733
4.6 Disposal of Decon Waste (liquid & solid)	2.5	mo	$985.00				$2,463	$0	$0	$0	$2,463
5 EOS INJECTIONS											
5.1 Bench-Scale Treatability Study	0	ls	$30,000.00				$0	$0	$0	$0	$0
5.2 DPT Rig (Injections)	46	day	$3,300.00				$151,800	$0	$0	$0	$151,800
5.3 Injection Point Supplies (Injections)	2,730	lf	$4.00				$10,920	$0	$0	$0	$10,920
5.4 EOS	4,550	gal		$16.80			$0	$76,440	$0	$0	$76,440
5.5 Mix Water	58,500	gal		$0.20			$0	$11,700	$0	$0	$11,700
5.6 Mix Tank, 4,000 gallon	2.5	mo				$693.00	$0	$0	$0	$1,733	$1,733
5.7 Pumps & Hoses	46	day				$37.60	$0	$0	$0	$1,730	$1,730
5.8 Pavement Core & Repair	50	ea	$116.00				$5,800	$0	$0	$0	$5,800
5.9 Transport & Dispose Drill Soil, nonhazardous	5	ton	$85.00				$425	$0	$0	$0	$425
6 INSTALL MONITORING WELLS											
6.1 Monitoring Well Installation, 10 wells	0	lf	$78.00				$0	$0	$0	$0	$0
6.2 Vault & Cover	0	ea	$750.00				$0	$0	$0	$0	$0
6.3 Transport & Dispose Drill Soil, nonhazardous	0	ton	$85.00				$0	$0	$0	$0	$0
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
7.2 Remedial Action Closeout Report	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
Subtotal							$184,908	$117,165	$73,183	$17,573	$392,828
Overhead on Labor Cost @ 30%									$21,955		$21,955
G & A on Cost @ 10%							$18,491	$11,717	$7,318	$1,757	$39,283
Tax on Materials and Equipment Cost @ 6%								$7,030		$1,054	$8,084
Total Direct Cost							$203,398	$135,911	$102,456	$20,385	$462,150
Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$137,779
Profit on Total Direct Cost @ 10%											$46,215

FLASH CLEANERS
Broward County, Florida
Alternative G2 - Enhanced Bioremediation (EOS Injection) with Monitoirng
Injection 2 - Year 3
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Subtotal											$646,144
Health & Safety Monitoring @ 2%											$12,923
Total Field Cost											$659,067
Engineering on Total Field Costs @ 20%											$131,813
Contingency on Total Field Costs @ 30%											$197,720
TOTAL CAPITAL COST											**$988,600**

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Sampling Cost

Item	Item Cost years 1 & 2	Item Cost year 3 & 4	Item Cost year 5 to 13	Item Cost Every 5 years	Notes
Groundwater Sampling	$57,500	$31,320	$18,230		Labor and supplies to collect samples from 20 wells using a crew of two, quarterly years 1 & 2, semi-annual years 3 & 4, annual years 5-13. Annual pore water and air sampling is included in this cost.
Groundwater Analysis	$43,750	$22,750	$12,250		Analyze groundwater samples for MNA & VOCs and pore water samples for VOCs.
Sampling Report	$14,000	$7,000	$3,500		
5-Year Site Review				$33,000	
Final Sampling Report			$12,500		Only at year 13 or year sampling data indicates PRG have been achieved.
Subtotal	$115,250	$61,070	$46,480	$33,000	
Contingency @ 10%	$11,525	$6,107	$4,648	$3,300	
TOTAL	**$126,775**	**$67,177**	**$51,128**	**$36,300**	

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Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 7.0%	Present Worth
0	$1,201,549		$1,201,549	1.000	$1,201,549
1	$0	$126,775	$126,775	0.935	$118,481
2	$0	$126,775	$126,775	0.873	$110,730
3	$988,600	$67,177	$1,055,777	0.816	$861,829
4	$0	$67,177	$67,177	0.763	$51,249
5	$0	$87,428	$87,428	0.713	$62,335
6	$0	$51,128	$51,128	0.666	$34,069
7	$0	$51,128	$51,128	0.623	$31,840
8	$0	$51,128	$51,128	0.582	$29,757
9	$0	$51,128	$51,128	0.544	$27,810
10	$0	$87,428	$87,428	0.508	$44,444
11	$0	$51,128	$51,128	0.475	$24,291
12	$0	$51,128	$51,128	0.444	$22,701
13	$0	$51,128	$51,128	0.415	$21,216
				TOTAL PRESENT WORTH	**$2,292,589**