PREFERRED PLAN

FOR THE REMEDIATION OF THE HAMILTON STANDARD CONTROLS SITE LEXINGTON, RICHLAND COUNTY, OHIO

Ohio Environmental Protection Agency
Division of Environmental Response and Revitalization
Northwest District Office
October 2014

Ohio EPA's Division of Environmental Response and Revitalization (DERR) - Remedial Response Program	Preferred Plan For the Remediation of the Former Hamilton Standard Controls Site Lexington, Richland County, Ohio

THE REMEDIAL RESPONSE PROCESS					
(1) Preliminary Assessment & Site Inspection **[Completed]**	**(2)** Remedial Investigation & Feasibility Study **[Completed]**	**(3)** Remedy Selection (Preferred Plan & Decision Document)	**(4)** Remedial Design	**(5)** Remedial Action	**(6)** Remedy Operation, Maintenance & Monitoring

Ohio EPA Announces Preferred Plan

This Preferred Plan identifies the preferred remedial alternative for the cleanup of the contaminated soil and ground water at the former Hamilton Standard Controls (HSC) site and provides the rationale for this preference. The Preferred Plan also includes summaries of other remedial alternatives evaluated for use at this site. The primary goal is to inform the public about the background and problems posed by the site, and what the Agency proposes to do to clean up the site.

Ohio EPA will select a final remedy for the site after reviewing and considering all information submitted during the public comment period for this Preferred Plan. Ohio EPA may modify the preferred remedial alternative or select another alternative presented in this Preferred Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all of the remedial alternatives presented in this Preferred Plan. Once the final remedial alternative is selected, it will be presented in a Decision Document for the project which will be available in the locations noted below.

Ohio EPA is issuing this Preferred Plan in a manner consistent with Volume 40, Code of Federal Regulations Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). It summarizes information found in detail in the remedial investigation and feasibility study reports and other documents contained in the administrative record file for this site. Ohio EPA encourages the public to review these documents to gain a better understanding of the site and the activities that have been conducted at the site.

Public Comment Period: October 31-December 24, 2014. Ohio EPA will accept written comments on the Preferred Plan during the public comment period. Written comments can be submitted during the public meeting or sent to Ohio EPA site coordinator Edward Onyia (contact information given below).

Public Meeting: Ohio EPA will hold a public meeting to explain the Preferred Plan. Oral and written comments will be accepted at this meeting, which will be held on December 16, 2014 at 6:00 PM at the Lexington Senior Depot, 67 E. Main St., Lexington, OH 44904.

Additional Information: Available from Ohio EPA's Northwest District Office, located at 347 North Dunbridge Road, Bowling Green, Ohio, Edward Onyia, site coordinator, (419) 373-3037, edward.onyia@epa.ohio.gov.

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TABLE OF ACRONYMS

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
DERR	Division of Environmental Response and Revitalization
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PEC	Probable Effects Concentration
PPB	Parts Per Billion
PPM	Parts Per Million
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
RA	Remedial Action
RAO	Remedial Action Objective
RBTC	Risk-Based Threshold Concentration
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RG	Remediation Goal
RI	Remedial Investigation
RSL	Regional Screening Levels
SDWA	Safe Drinking Water Act
SLERA	Screening Level Ecological Risk Assessment
TDC	Technical Decision Compendium
TEC	Threshold Effects Concentration
VOC	Volatile Organic Compound
WQS	Water Quality Standards

1.0 EXECUTIVE SUMMARY

On June 23, 1997, United Technologies Corporation (UTC) signed Director's Final Findings and Orders with Ohio EPA to investigate and develop remedial alternatives for the former Hamilton Standard Controls (HSC) facility located at 147 Plymouth Street, Lexington, Richland County (facility) and anywhere contamination may have migrated (site). UTC developed a Remedial Investigation (RI) work plan to determine where contamination exists at the site and at what concentrations. The RI work plan was approved by Ohio EPA to investigate the site for potential contamination of soil, ground water and surface water.

As a result of environmental conditions discovered during the RI, interim measures were instituted in an attempt to contain ground water contamination. Ground water pumping was conducted using two on-facility extraction wells; the resulting ground water was treated on-site using two packed-column air stripper towers and discharged via a National Pollutant Discharge Elimination System (NPDES) permit to an open ditch which flows northeastward across the northern portion of the facility. Additional interim measures were implemented to directly address sources of contamination at the facility. Air sparging (AS) and soil vapor extraction (SVE) systems were installed in 2001 and upgraded with additional AS wells installed along the eastern property line in November 2003. As a final interim measure, the AS-SVE systems were augmented with in-situ chemical oxidation (ISCO) treatment of targeted source contamination from November 2003 through June 2004.

On March 28, 2006 the RI report was approved by Ohio EPA. The RI report documented the existence of contamination at gravel parking areas, potential source areas beneath the facility building, an on-facility drainage ditch area, above ground storage tanks, a receiver well, the hazardous waste storage building, and ground water on the facility property as well as off-facility properties including the Containercraft, Inc. building. The primary contaminants of concern (COCs) at the site are shown in **Table 4 Contaminants of Concern/Remediation Levels** of this Preferred Plan, and include: trichloroethene (TCE), tetrachloroethene (PCE), and associated biodegradation products including cis-1,2-dichloroethene (1,2-DCE). In addition, low levels of 1,1-dichloroethene (1,1-DCE), ethylbenzene, toluene and xylenes have been detected. Additional details concerning the health risks associated with each primary COC are located in **Appendix B Primary Contaminants of Concern**.

A human health risk assessment, approved on March 28, 2006 defines the concentrations of contamination at the site which could adversely affect human health. An ecological risk assessment for potential adverse effects to the environment was conducted for the site and approved on March 28, 2006. The current and future health risks of this site result from: ingestion of contaminated ground water, direct contact with facility soils, and soil and/or ground water to indoor air resulting in the inhalation of vapors of PCE and TCE. Ecological risks were not identified with the releases from the HSC site.

Based on this information, it was determined that remedial alternatives needed to be developed to address human health risks posed by the site. On June 27, 2007, Ohio EPA approved a Feasibility Study (FS) report, which identified potential remedial alternatives. As part of the FS, a number of Remedial Action Objectives (RAOs) for the site were developed to ensure protectiveness of human health and the environment.

The initial evaluation of the potential for adverse exposure to contaminants in vapor was conducted as a modeling demonstration and the results indicated that COCs in ground water did not exceed established risk standards. In 2011 and 2012, subsequent evaluation of the ground water data trends led Ohio EPA to re-evaluate previously modeled data and the potential for exposure to vapors. The investigation consisted of several phases including soil gas sampling, sampling of the sub-slab vapors directly beneath buildings, indoor air and ambient or background air as a means to determine the source of the contamination. Data obtained through these additional investigations demonstrated concentrations of COCs in excess of established risk thresholds. Following Ohio EPA concurrence with the design specifications, UTC designed and installed sub-slab depressurization systems under five buildings east of Plymouth Street (**see Figure 2 – Property Parcel Map**) pursuant to the Additional Work provision of the 1997 Director's Final Findings and Orders.

This Preferred Plan summarizes information on the range of remedial alternatives evaluated, identifies Ohio EPA's preferred remedial alternative, and explains the reasons for selection of the preferred remedial alternative. The Preferred Plan, which forms the basis for the Decision Document (*i.e.,* the final remedy decision), is based on the Ohio EPA-approved RI, FS and supporting reports and information. All documents referenced in this Preferred Plan are available in the public repositories.

Ohio EPA's preferred remedial alternative should yield a permanent solution for risks associated with the contaminated media at the site. The expectations for the preferred alternative include:

- Reduction of human health risks to within acceptable limits, and protection of human health and the environment from exposure to COCs in soil, ground water and indoor air (**see Figures 3, 4, 5 and 6 (Soil and Groundwater Areas of Concern), and Tables 3 and 4 (Remedial Action Objectives and Contaminants of Concern/Remediation Levels**), which are above acceptable limits.

- Short and long-term protection of public health and the environment.

- Compliance with applicable or relevant and appropriate requirements (ARARs).

- Cost-effectiveness and limitation of expenses to what is necessary to achieve the preferred alternative expectations.

- Continued operation and maintenance of the existing remedial action and monitoring systems.

The three (3) major components of the preferred remedial alternative include: 1) on-facility air sparging and soil vapor extraction (AS/SVE); 2) institutional controls (*i.e.,* prohibiting the use of ground water at the site as well as the affected down gradient properties for any purpose other than investigation or remediation unless otherwise demonstrated to be protective of commercial/industrial, non-potable use, limiting the facility to only commercial/industrial uses, and prohibiting human occupancy of any buildings at the former HSC facility); and 3) soil and ground water monitoring at the facility and continuing the current ground water monitoring program associated with the affected downgradient properties.

Ohio EPA finds that these measures will protect public health and the environment by reducing risk to acceptable levels until the remedial action objectives have been achieved.

2.0 SUMMARY OF SITE CONDITIONS

2.1 Site History

The former HSC site is located in a primarily mixed residential/industrial/commercial area on approximately 9.4 acres at 147 Plymouth Street, Lexington, Richland County, Ohio, as shown in **Figure 1 Site Location Map** and **Figure 2 Property Parcel Map**.

A list of owners, operators and/or disposers that may have contributed to the contamination at the facility property is shown in **Table 1 Owners, Operators and/or Disposers**.

TABLE 1 OWNERS, OPERATORS AND/OR DISPOSERS		
Owners, Operators and/or Disposers	**Property Usage**	**Period**
Stevens Manufacturing Company	Manufacturing	1953-1969
Essex International Inc.	Manufacturing	1969-1976
Essex Group Inc.	Manufacturing	1976-1988
HSC	Manufacturing	2/1988-6/1988
Lexington Properties Inc. (LPI)		6/1988
Stemco Sensors Switches Inc. (leased from LPI	Manufacturing	6/1988-11/1992
Columbus Electric Manufacturing Company (leased from Stemco)	Manufacturing	1992-11/1995
Rubbermaid Inc. (leased from LPI)	Storage	1995-2002
LPI	“Green Space”	2002--Present

The facility property is currently owned by Lexington Properties Inc. and is used as “green space” by the Village of Lexington. Previous operations that may have contributed to the contamination at the site include: Stevens Manufacturing Company, Essex Group Inc., Stemco Sensors Switches Inc., and Columbus Electric Manufacturing Company. These entities used the facility for manufacturing activities which included metals machining, electronic component fabrication etc. between 1953 and 1995 which may have contributed to the release of contaminants including but not limited to PCE and TCE, associated biodegradation products including cis-1,2-dichloroethene (1,2-DCE), as well as low levels of 1,1 dichloroethene (1,1-DCE), ethylbenzene, toluene and xylenes. UTC is subject to Director’s Final Findings and Orders for RI/FS, effective June 23, 1997 (1997 DFFOs) to address the contamination at the site.

On August 13, 1988, Director’s Final Findings and Orders (1988 DFFOs) were issued for construction of a pump and treat system (P&T). The P&T system operated continuously from 1989 until 2004 using two on-facility production wells (Primary Well and Secondary Well) in an attempt to contain the ground water plume. Water from the P&T was treated on-facility

using two packed-column air strippers. The resulting treated effluent was discharged to an open drainage ditch which flows northeastward across the western half of the facility and eventually into the southerly flowing Clear Fork.

2.2 Site Characteristics and Investigation

In general, site geology consists of interbedded gravelly and clayey silts and silty clay overlying interbedded silty gravels, gravelly sands and sands. Bedrock below the overburden soils consists of siltstone with shale interbedding. The stratigraphy of the site, as identified in the RI report, can be divided into three major soil units, and the areal and vertical distribution of soil contamination varies within each of these units:

- The shallow zone (approximately zero to 5 feet below ground surface [bgs]) consisting of clayey silt.

- The deep zone (approximately 5 to 27 feet bgs) consisting of silty sand and gravel.

- The saturated zone (approximately 27 to 44 feet bgs) consisting of silty sand and gravel above a discontinuous clay layer. Bedrock is encountered below the clay layer.

The ground water table is approximately 25 feet bgs (on average) and groundwater flow is in an easterly direction towards the Clear Fork. An unnamed drainage ditch traverses the west-central portion of the facility. Drainage is generally toward this ditch and eastward and northeastward to its eventual confluence with the Clear Fork.

Pursuant to the 1997 DFFOs for RI/FS, UTC submitted RI and FS reports which were approved by Ohio EPA DERR on March 28, 2006 and June 27, 2007 respectively. The RI/FS activities identified the nature and extent of contamination at the site and developed alternatives to address the contamination. The investigation also provided a description of site geology, topography, hydrogeology and other site characteristics.

The RI consisted of sampling soil, sediment, surface water, and ground water for the following contaminants of concern: PCE, TCE, 1,2-DCE, 1,1-DCE, ethylbenzene, toluene, and xylenes. The site is located within an area of a mixed residential, commercial and industrial. The reasonably anticipated future land use for the facility property presented by UTC, and concurred with by Ohio EPA and interested stakeholders, is “green space”. **Figures 3 and 4** show the areas of soil contamination, and **Figures 5 and 6** show the areas of ground water contamination at the site that require remediation to an acceptable standard to comply with the current and future use of the facility property and surrounding properties.

A human health risk assessment was developed to estimate the likelihood of health problems occurring if no cleanup actions were taken at the site. An ecological risk assessment (ERA) was conducted in order to assess potential harm of COCs to the environment (*e.g.,* animals, water bodies, plants) at the site. Please refer to the RI and FS reports for more detailed information. These reports, along with other site-related materials, are located in the information repository and in Ohio EPA’s Northwest District Office.

The RI report prepared between November 2004 and May 5, 2005 by Xpert Design & Diagnostics (XDD) and SAS Environmental Inc., (SAS) on behalf of UTC, identified several known or suspected VOC source areas at the former HSC facility during previous site investigations and these areas were further evaluated during the RI:

1. Gravel Parking Areas – A soil gas survey performed by Northeast Research Institute, Inc. in 1987 indicated elevated VOCs in the gravel parking area north, west and northwest of the facility building. These areas were examined comprehensively during the historical remedial investigations which indicated VOCs in soils and ground water, and were explored further during the RI. The highest PCE concentration of 8,900 micrograms per kilogram (µg/Kg) was detected in the soil at GP-23 (Avant Ground, Inc. [Avant], 1999a). The area around GP-23 was later defined as one of the main source areas (Area 1, see **Figures 3 and 4**).

2. Potential Source Areas Beneath the Facility Building – Based on information collected during the RI, a source area below the former HSC facility building was delineated (Area 2, see **Figures 3 and 4**).

3. On-Facility Drainage Ditch Area – The drainage culvert which passes beneath the western portion of the plant and emerges north of the plant building formerly received discharge from one or more facility floor drains and from a sump in the facility's basement. The ditch area was examined during the previous on-facility remedial investigations and was not considered a source area.

4. Aboveground Storage Tanks – Two aboveground storage tanks (ASTs) are located at the southwest corner of the former HSC facility. The ASTs formerly contained PCE and/or TCE and were examined during the previous remedial investigations and are included in the Area 1 source area.

5. Receiver Well – The Receiver Well located near the northwest corner of the facility building was reportedly used for three or four years as an injection point for non-contact cooling water. The well eventually because unusable, due possibly to a fouled screen or formation damage. The status of this well and its potential impact on ground water quality were explored further during the RI. As presented in the RI Report (XDD, 2005), the Receiver Well was being contaminated by the shallow ground water plume, and was treated using in-situ chemical oxidation (ISCO) methods and permanently abandoned in 2004.

6. Hazardous Material Storage Buildings – The hazardous material storage buildings at the facility's southeast corner constitute a potential contaminant source area, and were examined during the previous remedial investigations. These areas were ultimately not identified as source areas.

Prior to on-facility IA remedial activities, maximum soil concentrations in the target areas had been detected up to 8,900 µg/Kg PCE and 1,900 µg/Kg TCE in the unsaturated zone soils. In addition, saturated zone PCE concentrations up to 170,000 µg/Kg have been detected immediately above the silt/clay unit in Area 1 in the vicinity of the receiver well (see Figure 3).

Areas of soil contamination were defined previously using Soil Screening Level (SSL) concentrations for PCE at 119 µg/Kg and TCE at 37 µg/Kg (Avant,1999b). SSLs were derived based on the "soil leachate migration to ground water" pathway. The areas of soil contamination in the shallow and deep zones above SSLs are shown in Figures 3 and 4.

A ground water contamination plume emanating from the facility was detected migrating in an easterly/south-easterly direction off-facility towards the Clear Fork. RI activities were conducted to delineate the nature and extent of the plume. The results of these investigations are described in detail in the RI Report (XDD, 2005). Ground water PCE and TCE concentrations in the source areas have been detected as high as 7,200 and 6,700 micrograms per liter (µg/L), respectively, prior to IA activities.

An evaluation of potential pesticides, PCBs and priority pollutant metals contamination was conducted during the course of the RI (XDD, 2005). Pesticides and PCBs were not detected in soil or ground water.

Two soil samples were collected in 1989 (at MW-3B and MW-5S) and both samples were analyzed for priority pollutant metals. Six priority pollutant metals were detected in the two soil samples. With the exception of arsenic (23 and 25 milligrams per kilogram [mg/Kg], respectively) and chromium (3 and 12 mg/Kg, respectively), concentrations of these metals in soils were below health-based screening levels (*i.e*., USEPA Region 9 Preliminary Remediation Goals (PRGs)), as discussed in the Human Health Risk Assessment (HHRA, Appendix U of the RI Report [XDD, 2005]). However, no historical operations were conducted at the facility that involved the use of these metals, and these are likely non-facility related/naturally occurring (*e.g.,* naturally occurring arsenic levels between 0.5 to 56 mg/Kg are typical of this region [Cox-Colvin, 1996]). For example, arsenic concentrations at boring MW-3B, which was located near the north property boundary away from operation areas (and as such likely represents a background sample), and at MW-5S, located within the operations areas, were approximately the same. Similarly, the naturally occurring chromium concentration in soils typically ranges from 1 to 2,000 mg/Kg (average 54 mg/Kg for the United States) (Argonne National Laboratory, 2005).

The most recent ground water sampling for dissolved metals was conducted in 2003. Eight wells were sampled and the majority of analytes (including antimony, arsenic, beryllium, cadmium, chromium [total and hexavalent], copper, lead, mercury, nickel, selenium, silver, thallium and zinc) were non-detect with the exception of very low concentrations of zinc in the unfiltered samples from MW-1 (13.4 µg/L) and MW-4 (10.2 µg/L).

2.3 Interim or Removal Actions Taken to Date

Pursuant to the 1988 and 1997 DFFOs, IA activities performed at the site through 1997 consisted of the following activities:

1. Several source characterization and on-/off-facility ground water sampling events to document the origin and extent of subsurface contamination (discussed in the RI Report [XDD, 2005]).

2. Continuous ground water P&T activities between 1989 and 1997 in an attempt to provide hydraulic control of the ground water VOC plume.

3. Ongoing ground water quality monitoring since June 1987 using a network of site monitoring wells.

4. Periodic analyses of ground water samples from several Village of Lexington and City of Mansfield municipal supply wells.

The more recent and ongoing IA remedial activities consist of the following:

1. Ground water, surface water and sediment sampling consisting of:

    a. Routine ground water sampling at the site. Currently, the ground water sampling is conducted on a quarterly basis and includes up to 128 wells.

    b. Quarterly surface water sampling in the Clear Fork. Sediment sampling was conducted on three occasions, but is not currently scheduled on a regular basis.

    c. Monthly sampling of Village of Lexington potable water supply Wells 5 and 6.

2. Ground water pumping was conducted from the two on-facility extraction wells (Primary and Secondary Wells) in an attempt to contain the VOC plume through October 2004. Ground water pumped from the Primary and Secondary Wells was treated on-facility using two packed-column air stripper towers. The resulting effluent was discharged via a National Pollutant Discharge Elimination System (NPDES) permit to an open ditch which flows northeastward across the northern portion of the facility, and eventually into the southerly flowing Clear Fork located approximately 1,100 feet east of the facility.

3. Air sparging (AS) and soil vapor extraction (SVE) of the on-facility source areas (SVE started June 2001; AS started August 2001).

4. Treatment of the VOC plume at the eastern and northern property lines with the barrier AS/SVE system (started in June 2001). The barrier AS system was upgraded with additional wells on the eastern property line in November 2003.

5. ISCO treatment of target source areas, conducted from November 2003 through June 2004.

6. Evaluation of ground water, soils and potential vapor intrusion conditions on several of the off-facility properties (down-gradient of the HSC facility) in 2013 resulted in the installation of the mitigation systems to address concentrations above risk goals and/or to mitigate any potential for vapor intrusion at the Shaf Enterprises Ltd. building, Containercraft building, and Walker Brothers buildings **(see Figure 2 Property Parcel Map)**. Installation of a sub slab

depressurization system in the Shaf Enterprises Ltd. building, which contains a daycare center, was completed for an extra level of protection as the daycare center did not have VOCs at concentrations above levels of concern.

2.4 Summary of Site Risks associated the Remedial Investigation

As part of the RI/FS, a baseline risk assessment was conducted, and approved by Ohio EPA on March 28, 2006, to evaluate current and potential future risks to human and ecological receptors as the result of exposure to contaminants present at the site. The results demonstrated that the existing contaminants in environmental media pose or potentially pose unacceptable risks and/or hazards to human receptors sufficient to trigger the need for remedial actions. Additional information on the primary COCs can be found in **Appendix B**.

2.4.1 Risks to Human Health

The risk assessment for human health is an estimate of the likelihood of potential health problems occurring if no remedial actions were taken at the site. To estimate baseline risk, a four-step process is undertaken.

Step 1. Data Collection and Evaluation (of Contamination): The concentrations of contaminants at the site as well as any past scientific studies on the effects these contaminants have had on people are reviewed. Comparisons of site-specific concentrations of COCs and concentrations reported in past studies help determine which contaminants are most likely to pose the greatest threat to human health.

Step 2. Exposure Assessment: The different ways that people might be exposed to the COCs, the concentrations that people might be exposed to, and the potential frequency and duration of exposures are evaluated. A reasonable maximum exposure scenario is calculated, which portrays the highest level of human exposure that could reasonably be expected to occur. Exposure scenarios that were evaluated include: residential, commercial/industrial and trespassers.

Step 3. Toxicity Assessment (of Potential Health Dangers): The ability of the potential site COCs to cause adverse effects and the estimate of the relationship between the extent of exposure and the increased likelihood and/or severity of the adverse effects are evaluated as part of the toxicity assessment. Two types of adverse effects are considered: cancer risk and non-cancer hazards.

Step 4. Risk Characterization: A determination is made as to whether site risks are substantial enough to cause potential health problems for people at or near the site. The information from Steps 2 and 3 are combined for each COC to assess potential health risks. The likelihood of cancer resulting from exposure at a site is expressed as a probability of 1 in 100,000, or $1x10^{-5}$. In other words, for every 100,000 people that could be exposed, one extra case of cancer may occur as a result of exposure to site COCs. For non-cancer health effects, a hazard quotient (HQ) or hazard index (HI) is calculated (quotient refers to the effects of an individual COC, whereas index refers to the combined effects of COCs). The key concept is that a “threshold level” (measured as an HQ or HI of 1) exists below which non-cancer health effects are not expected to

occur to exposed populations or individuals. The potential risks from the individual pathways (*e.g.,* inhalation, direct contact, ingestion), and individual chemicals as appropriate, are added together to determine the total cumulative risk to human health.

The human health risk assessment resulted in the identification of media, exposure pathways and COCs that require some remedy for the site to meet human health risk goals. Affected media include on-facility soil, on and off-facility ground water, and on and off-facility soil vapor from contaminated ground water. The risk assessment identified four COCs, tetrachloroethene (PCE), trichloroethene (TCE), arsenic and chromium. However, the primary risk drivers and the compounds that have final remediation levels are PCE and TCE. Below is a table summarizing exposure scenarios from the human health risk assessment with maximum risk or hazard estimates above acceptable levels. For additional detail see the Baseline Human Health Risk Assessment (Appendix U), dated October 7, 2005.

Table 2 – Excess Cancer Risk and Non-Cancer Hazard Estimates

Exposure Scenario	Excess Cancer Risk Estimate	Non-Cancer Hazard Estimate
On-Site Worker (future)	3x10-4	1.7
On-Site Resident Adult (future)	1x10-3	4.7
On-Site Resident Child (future)	1x10-3	22.5
Off-Site Worker (future)	2x10-4	0.7
Off-Site Resident (current)	2x10-5	0.02
Off-Site Resident (future)	1x10-3	10

Current Receptors

The primary exposure pathway is inhalation of indoor air that could potentially be affected by VOCs from the vadose zone. Indoor air concentrations were estimated with the Johnson & Ettinger model. Model input data were site-specific depth to ground water parameters and soil gas or ground water concentration data for the on- and off-facility receptors, respectively.

Hypothetical Future Receptors

For the hypothetical future receptors, the primary source of exposure is through the assumed direct contact with contaminated ground water. For the human health risk assessment, direct contact with ground water was defined as contact with ground water via ingestion, skin contact and inhalation of vapors during domestic/commercial use. Generally, the direct exposure pathways accounted for greater than 90% of the estimated cancer risks and non–cancer hazards.

Although not directly evaluated, risks to potential future building occupants is theoretically possible through a potential vapor intrusion pathway. This pathway would only be complete if newly constructed residential or commercial buildings were located over ground water contamination that exceeded their respective remediation levels and subsequent investigations confirmed a complete exposure pathway with indoor air exceeding appropriate concentrations. Because of this unlikely but possible future situation, ground water

remediation levels (RLs) were developed based on vapor intrusion estimates for both future residential and industrial/commercial scenarios.

Based on the excess risk and hazards identified in the human health risk assessment, preliminary remediation goals (PRGs) were developed for PCE and TCE for ground water and on-facility soil.

Arsenic and chromium were concluded to be naturally occurring and most likely not related to historical operations at the facility. Therefore, no RLs are needed for these metals. Final remediation levels for the affected media are given below in Section 3 (See Table 4). It should be noted that several investigations and estimates of risk have been completed for this site. Risk estimates and PRGs have changed due to updated site contaminant concentrations and locations. In addition, the toxicity criteria used to estimate risks and develop PRGs for PCE and TCE have changed significantly over time.

2.4.2 Risks to Ecological Receptors

Screening Level Ecological Risk Assessment (SLERA) was conducted as part of the RI at the site. The SLERA was conducted in order to assess potential impacts of COCs on ecological receptors (*e.g.,* animals, water bodies, plants) at the site. The results of the SLERA indicated that site-related contaminants in the Clear Fork were below applicable risk-based levels. Further, a biological assessment conducted in the Clear Fork by Ohio EPA (Ohio EPA, 2005; see Section 1.3.6.2) determined that aquatic species have not been adversely affected, which supports the results of the SLERA. The groundwater plume stability analysis (Avant, 2003) indicated that VOC concentrations in groundwater in the vicinity of the Clear Fork are stable or attenuating. VOC concentrations in the Clear Fork are not expected to increase above current levels, and will likely decrease over time as a result of ongoing IA activities being conducted at the site. Therefore, future risk to the Clear Fork is not anticipated and no PRGs for any media were developed based on ecological receptors.

2.5 Summary of Feasibility Study

An FS was completed with Ohio EPA oversight and was approved on June 27, 2007. The purpose of the FS is to evaluate remedial options to reduce soil and ground water concentrations to acceptable levels. Four (4) comprehensive remedial alternatives were analyzed and a recommendation was made on the most appropriate remedy for the site. Additional information can be found in the FS report (August 25, 2006).

2.6 Summary of Investigations Following the Feasibility Study

Soil gas surveys were performed in 2011 to investigate the potential for vapor intrusion from the HSC ground water VOC plume into off-facility buildings of concern. This work was completed in phases in accordance with Ohio EPA protocols for investigating potential vapor intrusion to indoor air. Investigation work continued in 2012 and 2013 to identify potential off-property contaminant sources similar to those originating from the HSC facility.

As part of the off-facility properties investigation and updating of the groundwater PRGs, XDD subcontracted the services of Integral Consulting, Inc. (Integral) to update risk-based

threshold concentrations (RBTCs) and PRGs for PCE and TCE. The RBTCs were calculated based on worst-case plausible estimates of potential current exposures in buildings where the groundwater plume associated with the facility has migrated or potentially migrated beneath the building. The assessment provided conservative acceptable indoor air concentrations for a commercial worker, a residential receptor, and a daycare attendant (child). The current use of the affected portions of the off-facility properties is commercial/industrial and residential. The threshold calculations were based on US EPA's updated toxicological data for PCE and TCE, acceptable risk levels published by Ohio EPA DERR, and conservative exposure parameters appropriate for the receptors of interest.

Using the same equations from the 2004 J&E vapor intrusion model that were also utilized in the 2006 FS, the off-facility groundwater PRGs were updated using the site specific soil data obtained from the October 2011 geotechnical borings and the updated RBTCs provided by Integral. The groundwater PRGs represent the highest groundwater concentrations that could exist below the off-facility properties without producing vapor concentrations that would exceed risk thresholds for each specific current use, which is commercial/industrial and daycare.

The results of samples collected in 2011 and 2012 were compared to the updated RBTCs. None of the indoor air PCE concentrations exceeded their appropriate RBTCs on the off-facility properties. However, measured indoor air TCE concentrations exceeded indoor worker RBTCs on the Containercraft, Shaf Enterprises Ltd., and Walker Brothers properties. The updated 2013 groundwater PRGs supported by the J&E modeling, show that the current shallow groundwater concentrations would not have produced indoor air concentrations that exceed the RBTCs for commercial/industrial properties and the daycare.

The initial evaluation of the potential for adverse exposure to contaminants in vapor was conducted as a modeling demonstration and the results indicated that COCs in ground water did not exceed established risk standards. Subsequent evaluation of the ground water data trends led Ohio EPA to re-evaluate previously modeled data and its potential for adverse indoor air vapor exposure. The investigation consisted of several phases including soil gas sampling, sampling of the sub-slab directly beneath buildings, indoor air and ambient air as a means to determine the source of the contamination did not originate from sources other than the subsurface. Data obtained through these additional investigations demonstrated concentrations of COCs in excess of established risk thresholds for commercial/industrial receptors but not the daycare. Following Ohio EPA concurrence with the design specifications, UTC designed and installed sub-slab depressurization systems under five buildings east of Plymouth Street (**see Figure 2 – Property Parcel Map**) pursuant to the Additional Work provision of the 1997 Director's Final Findings and Orders.

For additional information see: Off-site Vapor Investigation Report, Former Hamilton Standard Controls Facility, March 16, 2012 and Off-Site Investigation and Mitigation System Installation, Former Hamilton Standard Controls Facility, July 2, 2013.

3.0 REMEDIAL ACTION OBJECTIVES

As part of the RI/FS process, remedial action objectives (RAOs) were developed in accordance with Section 300.430 of the NCP, pursuant to the federal Comprehensive

Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C. §9601 et seq., as amended, and U.S. EPA guidance (*i.e.,* RI/FS Guidance (EPA/540/G-89/004, and others). The RAOs are goals that a remedy should achieve in order to ensure protection of human health and the environment.

The RAOs for the site include those listed below in **Table 3 Remedial Action Objectives**:

TABLE 3 REMEDIAL ACTION OBJECTIVES	
Groundwater	
Human Health Risk	Prevent ingestion/direct contact of ground water across the site containing a COC in excess of its MCL or containing carcinogens in excess of a total excess lifetime cancer risk greater than $1x10^{-5}$.
Human Health Risk	Prevent ingestion/direct contact of ground water across the site containing non-carcinogens in excess of MCLs or containing non-carcinogens in excess of a HQ or HI greater than 1.
Human Health Risk	Prevent inhalation of PCE and TCE in vapors emanating from ground water in excess of a $1x10^{-5}$ excess lifetime cancer risk.
Human Health Risk	Prevent inhalation of PCE and TCE in vapors emanating from ground water in excess of a HQ of 1.
Soil	
Human Health Risk	Prevent ingestion/direct contact with on-site soil which contains the carcinogens PCE and TCE in excess of a total excess lifetime cancer risk greater than $1x10^{-5}$.
Human Health Risk	Prevent ingestion/direct contact with on-site soil in excess of a HQ greater than 1.
Human Health Risk	Prevent inhalation of vapors emanating from soil in excess of a $1x10^{-5}$ excess lifetime cancer risk.
Human Health Risk	Prevent inhalation of vapors emanating from soil in excess of an HQ of 1.

In the process of scoping and conducting the RI, generic PRGs were established. These PRGs were converted to site-specific remediation goals (RGs) following completion of the RI and FS phase of the project. The FS includes a list of RGs for protection of human health, established using the acceptable excess lifetime cancer risk and non-cancer hazard goals identified in the DERR Technical Decision Compendium (TDC) document "Human Health Cumulative Carcinogenic Risk and Non-carcinogenic Hazard Goals for DERR Remedial Response and Federal Facility Oversight," dated August 21, 2009. These goals are given as $1x10^{-5}$ (*i.e.*, 1 in 100,000) excess lifetime cancer risk and a HQ or HI of 1, and were established using the default exposure parameters provided by U.S. EPA or site-specific information. This TDC can be found at http://www.epa.ohio.gov/portals/30/rules/riskgoal.pdf.

The contaminants of concern and the PRGs, now termed final remediation levels (RLs) for the site, are shown in **Table 4 Contaminants of Concern / Remediation Levels**.

TABLE 4 CONTAMINANTS OF CONCERN (COCs) / REMEDIATION LEVELS (RLs)			
Medium	**COC**	**RL**	**RL Basis**
Soils: Human Direct Contact	PCE	390 mg/Kg	Industrial/Commercial RSL
	TCE	19 mg/kg	Industrial/Commercial RSL
Ground Water: Potable	PCE	5 µg/L	MCL
	TCE	5 µg/L	MCL
Ground Water: Vapor Intrusion to Indoor Air	PCE	234 µg/L	Residential
	TCE	18 µg/L	Residential
	PCE	327 µg/L	Industrial/Commercial
	TCE	25 µg/L	Industrial/Commercial

During the preparation of the Preferred Plan, a review was conducted on the PRGs for ground water developed for the vapor intrusion pathway. Table 4 contains the current RLs based on site-specific soil characteristics and updated toxicity criteria. In general, the approach and inputs are the same as those used in the 2013 off-facility investigation report. Default soil parameters for soil bulk density, total porosity and soil water-filled porosity were used in the J&E modelling as an error regarding the reported soil water-filled porosity value was noted in the 2013 report. On-facility soil RLs are the current U.S. EPA industrial RSLs. Ground water RLs are U.S. EPA's maximum contaminant levels (MCLs). Information on drinking water MCLs can be found here: http://water.epa.gov/drink/contaminants/index.cfm.

4.0 SUMMARY OF REMEDIAL ALTERNATIVES

A total of four (4) comprehensive remedial alternatives were considered in the FS to address contamination exceeding human health criteria. The four comprehensive remedial alternatives included: 1) Soil Vapor Extraction and Air Sparging; 2) In-situ Chemical Oxidation and In-situ Biostimulation; 3) In-situ Chemical Oxidation and Permeable Reactive Barrier; and

4) Soil Excavation and Pump and Treat. For purposes of clarification, the four comprehensive remedial alternatives have been segmented into distinct components associated with a particular medium (*i.e.,* either Soil or Ground Water), as shown below in **Table 5 – Summary of Site Remedial Alternatives**. A brief description of the major features of each of the remedial alternatives (by medium) follows. More detailed information about the alternatives can be found in the FS report. Cost estimates for the comprehensive remedial alternatives are included in Table 11 of the FS report.

TABLE 5 SUMMARY OF SITE REMEDIAL ALTERNATIVES		
Media	**Alternative**	**Description of Remedial Alternative**
Soil	S1	No action
	S2	Soil Vapor Extraction (SVE)
	S3	In-situ Chemical Oxidation (ISCO)
	S4	Soil Excavation
Ground Water	G1	No action
	G2	Air Sparging (AS)
	G3	In-situ Biostimulation (ISB)
	G4	Permeable Reactive Barrier (PRB)
	G5	Pump and Treat (P&T)

4.1 No Action Alternatives

The "no action alternatives" for soil and ground water have been included in a single section for efficiency. The NCP requires evaluation of a no action alternative to establish a baseline for the comparison of other remedial alternatives. Under this alternative no remedial activities or monitoring are conducted at the site to prevent exposure to contaminated media.

4.2 Soil Alternatives

4.2.1 Soil Alternative S 2: Soil Vapor Extraction (SVE)

SVE is an in-situ remediation that removes VOCs from the vadose zone of the subsurface via volatilization. VOCs can remain in the vadose zone as free liquids held in the soil matrix, solutes in the soil moisture, adsorbed onto soil particles, vapor in the pore space, and entrained in micropores within soil particles. SVE removes VOCs by providing a moving stream of air that volatizes contaminants and removes them from the subsurface. The airflow produced by the resulting vacuum sweeps out the soil gas, disrupting the equilibrium between the soil and vapor phase of the VOCs, thereby increasing volatilization and removal. This technology would effectively prevent ingestion/direct contact and inhalation with soil containing carcinogens in excess of a total excess lifetime cancer risk greater than $1x10^{-5}$ as well as ingestion/direct contact with soil in excess of a HQ/HI greater than 1.

Estimated Capital Cost	N/A (Technology installed as part of Interim Action.)
Estimated Annual O&M Cost	$160,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.2.2 Soil Alternative S3: In-situ Chemical Oxidation (ISCO)

ISCO using permanganate (MnO_4) has been used extensively in wastewater treatment and drinking water purification processes. With respect to environmental remediation applications, permanganate has been demonstrated to completely mineralize chlorinated VOCs to yield innocuous end products including manganese dioxide (MnO_2), chloride ions (Cl^-), and hydrogen ions (H^+). Permanganate has been demonstrated to effectively oxidize chlorinated VOCs including PCE and TCE. ISCO is viable in higher permeability soils such as those at the former Hamilton Standards Controls. Higher permeable soils are ideal for direct injection of the oxidant; however, ISCO can be performed through hydraulic or pneumatic fracturing (in low permeability soils). Soil oxidant demand (SOD) of the site oils, if high, can significantly impact the cost of ISCO (*i.e.,* if SOD is high then a significant amount of oxidant might be necessary to achieve the desired effect). This remedial technology would effectively prevent ingestion/direct contact and inhalation with soil containing carcinogens in excess of a total excess lifetime cancer risk greater than $1x10^{-5}$ as well as ingestion/direct contact with soil in excess of a HQ or HI greater than 1.

Estimated Capital Cost	$750,000.00 - $950,000.00 (Cost provided in combination with ISB (or PRB).)
Estimated Annual O&M Cost	$110,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.2.3 Soil Alternative S4: Soil Excavation

Soil excavation typically involves the removal of impacted soils followed by disposal of the material in an approved landfill. In order to meet the required disposal regulations, it might be necessary to perform on-facility treatment of the soil prior to disposal. This remedial technology would effectively prevent ingestion/direct contact and inhalation with soil containing carcinogens in excess of a total excess lifetime cancer risk greater than $1x10^{-5}$ as well as ingestion/direct contact with soil in excess of a HQ or HI greater than 1.

Estimated Capital Cost	$3,500,000.00 (*Cost provided in combination with P&T.)
Estimated Annual O&M Cost	$110,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.3 Ground Water Alternatives

4.3.1 Ground Water Alternative G2: Air Sparging (AS)

Air sparging (AS) is a remediation technology primarily applied in order remove VOCs from ground water. It can promote remediation by a series of physical, chemical and biological processes. Conceptually, AS consists of injection of clean air beneath the water table to induce mass transfer of VOCs to a vapor phase and the addition of oxygen to the ground

water which serves to assist with aerobic biodegradation of VOCs. Contaminated vapors then migrate from the saturated zone to the vadose zone and are collected via technology such as SVE and then treated. This remedial technology would effectively prevent ingestion/direct contact with ground water across the facility property containing a COC in excess of its MCL or containing carcinogens in excess of a total excess lifetime cancer risk (for all contaminants) greater than $1x10^{-5}$ as well as containing non-carcinogens in excess of MCLs or containing non-carcinogens in excess of a HQ or HI greater than 1. The technology would prevent inhalation in on-facility structures of carcinogens PCE, TCE, and 1,2-DCE in vapors emanating from ground water in excess of a $1x10^{-5}$ excess lifetime cancer risk**.**

Estimated Capital Cost	N/A (Technology installed as part of the Interim Action.)
Estimated Annual O&M Cost	$160,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.3.2 Ground Water Alternative G3: In-Situ Biostimulation (ISB)

ISB options could potentially be feasible for treatment of the groundwater plume. In general ISB as a remedial technology would effectively prevent ingestion/direct contact with ground water across the site containing a COC in excess of its MCL or containing carcinogens in excess of a total excess lifetime cancer risk (for all contaminants) greater than $1x10^{-5}$ as well as containing non-carcinogens in excess of MCLs or containing non-carcinogens in excess of a HQ or HI greater than 1. ISB would prevent inhalation in on-facility structures of carcinogens PCE, TCE, and 1,2-DCE in vapors emanating from ground water in excess of a $1x10^{-5}$ excess lifetime cancer risk. Additional discussion of ISB options is provided as below:

4.3.2a HRC®

Hydrogen Releasing Compound (HRC®) is a proprietary technology from Regenesis Bioremediation Products, Inc. HRC® is a polylactic ester which upon hydration undergoes chemical reactions to ultimately generate hydrogen, which is used by microorganisms to degrade chlorinated compounds via reductive dechlorination. HRC® provides an electron donor to facilitate biodegradation and alter the redox conditions of the shallow ground water system.

4.3.2b Cl-out™

Cl-out™ is a patented microbial strain by CL Solutions, LLC which reportedly will aerobically degrade chlorinated compounds including PCE and TCE. Since most aquifers are anaerobic, Cl-out™ has been employed in combination with AS systems and ground water recirculation systems to increase the dissolved oxygen in the aquifer. According to literature from the vendor, the microbial strain would need to be injected on a monthly or bimonthly basis to keep the microbial population high enough for effective biodegradation.

4.3.2c Electron Donor Injection

Other electron donors such as sodium benzoate or molasses could be injected directly into the subsurface to stimulate anaerobic biodegradation. The electron donors can be delivered via a permanent well system in order to stimulate indigenous/self-sustaining populations of anaerobic bacteria.

Estimated Capital Cost	$750,000.00 (*Cost provided in combination with ISCO.)
Estimated Annual O&M Cost	$110,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.3.3 Ground Water Alternative G4: Permeable Reactive Barrier (PRB)

Zero-valent iron (ZVI) could be emplaced in a trench to form a PRB for the facility, preventing off-facility contaminant migration. The PRB wall allows contaminated groundwater to pass through and react with the iron, causing a reduction in groundwater VOC concentrations. Injection of ZVI could also be performed through pneumatic (or hydraulic) fracturing emplacement techniques to enhance distribution within target areas. Since the reaction depends upon direct contact between the target constituents and the iron, this approach would rely upon the advection or diffusional transport of VOCs to achieve contact with the emplaced iron. This remedial technology would prevent ingestion/direct contact with ground water across the site containing a COC in excess of its MCL or containing carcinogens in excess of a total excess lifetime cancer risk (for all contaminants) greater than $1x10^{-5}$ as well as containing non-carcinogens in excess of MCLs or containing non-carcinogens in excess of a HQ or HI greater than 1. ISB would prevent inhalation in on-facility structures of carcinogens PCE, TCE, and 1,2-DCE in vapors emanating from ground water in excess of a $1x10^{-5}$ excess lifetime cancer risk.

Estimated Capital Cost	$900,000.00 (*Cost provided in combination with ISCO.)
Estimated Annual O&M Cost	$110,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

4.3.4 Ground Water Alternative G5: Pump and Treat (P&T)

P&T technologies involve the extraction and treatment of impacted ground water to contain the contaminant plume. The extracted ground water is treated in-situ using an air-stripping system followed by discharge of the treated water via a National Pollutant Discharge Elimination System (NPDES) permit. This remedial technology would prevent ingestion/direct contact with ground water across the site containing a COC in excess of its MCL or containing carcinogens in excess of a total excess lifetime cancer risk (for all contaminants) greater than $1x10^{-5}$ as well as containing non-carcinogens in excess of MCLs or containing non-carcinogens in excess of a HQ or HI greater than 1. ISB would prevent inhalation in on-facility structures of carcinogens PCE, TCE, and 1,2-DCE in vapors emanating from ground water in excess of a $1x10^{-5}$ excess lifetime cancer risk.

Estimated Capital Cost	$3,500,000.00 (*Cost provided

	in combination with Soil Excavation.)
Estimated O&M Cost	$110,000.00
Estimated Present Worth Cost	
Estimated Time to Achieve RAOs	

5.0 COMPARISON AND EVALUATION OF REMEDIAL ALTERNATIVES

5.1 Evaluation Criteria

Ohio EPA considers eight criteria, as outlined in the NCP, to evaluate the various remedial alternatives individually and compare them with each other in order to select a remedy. A more detailed analysis of the comprehensive remedial alternatives can be found in the FS report. In order to adequately address contaminant impacts across various media, the FS report consolidated soil and ground water remedial elements to create the following classifications of remedial alternatives: AS/SVE; ISCO/ISB or ISCO/PRB; and, Soil Excavation and P&T. The eight evaluation criteria, including the threshold, balancing and modifying criteria, are shown below in **Table 6 Remedial Alternative Evaluation Criteria**.

TABLE 6 REMEDIAL ALTERNATIVE EVALUATION CRITERIA
Threshold Criteria (2)
Overall Protection of Public Health and the Environment - determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, treatment, etc.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) - evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.
Balancing Criteria (5)
Long-Term Effectiveness and Permanence – evaluates the ability of an alternative to maintain protection of human health and the environment over time.
Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment – evaluates the amount of contamination present, the ability of the contamination to move in the environment, and the use of treatment to reduce harmful effects of the principal contaminants.
Short-Term Effectiveness – evaluates the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
Implementability – evaluates the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

Cost – includes estimated capital and annual operation and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
Modifying Criterion (1)
Community Acceptance – considers whether the local community agrees with Ohio EPA's analyses and preferred alternative. Comments received on the Preferred Plan are an important indicator of community acceptance.

Evaluation Criteria 1 and 2 are threshold criteria required for acceptance of an alternative. Any acceptable remedy must comply with both of these criteria. Evaluation Criteria 3 through 7 are the balancing criteria used to select the best remedial alternative(s) identified in the Preferred Plan. Evaluation Criterion 8, community acceptance, is evaluated through public comment on the alternatives received during the comment period.

5.2 Analysis of Evaluation Criteria

This section examines how each of the evaluation criteria is applied to each of the remedial alternatives listed in Section 4.0 and compares how the alternatives achieve the evaluation criteria.

Overall Protection of Human Health and the Environment

Evaluation of the overall protectiveness of the alternatives focused on whether each alternative achieves adequate protection of human health and the environment and identifies how site risks posed through each pathway being addressed are eliminated, reduced or controlled by the alternative. This evaluation also includes consideration of whether the alternative poses any unacceptable short-term or cross-media concerns.

Soil Alternatives Alternative S2 adequately protects human health and the environment through removal and subsequent reduction of contamination in the subsurface soils and does not pose unacceptable short-term risks. Similar Alternative S3 protects human health and the environment via reduction and control of contamination in the subsurface soils. Alternative S3 does not pose unacceptable short-term effectiveness. Alternative S4 is protective of human health and the environment via the elimination of adverse concentrations of contaminants in the subsurface soils.
Ground Water Alternatives Alternatives G2, G3, G4, and G5 adequately protect human health and the environment through removal and subsequent reduction, as well as control of contamination in the ground water, and do not pose unacceptable short-term risks. The aforementioned protection is limited in scope to the direct contact and ingestion pathways for receptors associated with on-site exposure potential.

Because the "no action alternatives" do not meet the two threshold criteria (overall protection of human health and the environment, and compliance with applicable or relevant and

appropriate requirements), they were eliminated from consideration under the remaining criteria.

Compliance with ARARs

Soil Alternatives Alternatives S2, S3, and S4 demonstrate the ability to comply with applicable or relevant and appropriate requirements under state and federal laws. However, Alternative S3 could potentially cause an exceedance of secondary MCLs through mass loading of by-products (*i,e*., metals) that would be introduced during a large-scale application.
Ground Water Alternatives Alternatives G2, G3, G4, and G5 demonstrate the ability to comply with applicable or relevant and appropriate requirements under state and federal laws. However, establishing compliance with Safe Drinking Water Act would not be met in the short-term.

Long-Term Effectiveness and Permanence

Soil Alternatives Alternative S2 was implemented as part the Interim Action due to its applicability to site-specific conditions and the ability to treat contamination under the former HSC facility building. The results associated with Alternative S2 have demonstrated the ability to minimize the potential for off-facility plume migration. In addition, Alternative S2 has significantly influenced the distribution of contaminated groundwater at the site. Alternative S3 was applied to impacted locations within Area 1 to reduce residual contaminant mass in the saturated zone. The results of this measure are discussed in this section. While ISCO treatment was partially successful in reducing source contaminant mass in Area 1, the performance of this treatment option was limited. Remaining contaminant mass appears to be adsorbed in low permeability areas, and the chemical oxidants cannot effectively penetrate to promote contact and reaction under these conditions. Alternative S4 would be successful in providing long-term effectiveness and permanence.
Ground Water Alternatives Alternative G2 was implemented as part the Interim Action due to its applicability to site-specific conditions and the ability to treat contamination under the former HSC facility building. The results associated with Alternative G2 have demonstrated the ability to minimize the potential for off-facility plume migration. In addition, Alternative G2 has significantly influenced the distribution of contaminated ground water at the site. Alternative G3 ISB is potentially feasible for treatment of the groundwater plume; however, biodegradation of the plume is not currently a significant naturally occurring process, and as such, there would be no guarantee that the addition of amendments would substantively increase biological degradation. Alternative G4 was utilized as part of a prior interim remedial strategy to remove contaminant mass and provide some degree of hydraulic containment but the technology proved to be largely ineffective as a permanent solution. Alternative G5 would be partially successful in achieving long-term effectiveness and permanence, but the technology may be limited in the ability to achieve remedial goals.

Short-Term Effectiveness

Soil Alternatives Alternative S2 has demonstrated its ability to control off-facility plume migration and influence the distribution of groundwater impacts as part of pilot-scale testing prior to full-scale IA system implementation. Alternative S3 was applied to the most impacted locations within Area 1 as an IA remedy to reduce residual contaminant mass in the saturated zone and was partially successful in reducing source contaminant mass in Area 1. Alternative S4 could be implemented and demonstrate short-term effectiveness except for portions of the soil contamination area that would be inaccessible due to the presence of the building.
Ground Water Alternatives Alternative G2 has demonstrated its ability to control off-facility plume migration and influence the distribution of groundwater impacts as part of pilot-scale testing prior to full-scale IA system implementation. Alternative G3 could be implemented in the short-term; however, biodegradation of the plume is currently not a significant naturally occurring process, and as such, there would be no guarantee that addition of amendments would significantly increase biological degradation. Alternative G4, in the form of AVI or ZVI could be implemented in the short-term, creating a PRB thereby preventing off-facility contaminant migration. Alternative G5 could, as previously demonstrated, be implemented in the short-term to address contaminant migration.

Implementability

Soil Alternatives Alternatives S2, S3, and S4 could be implemented, or in the case of Alternatives S2, and S3, have been implemented and posed no administrative or technical obstacles to implementation.
Ground Water Alternatives Alternative G2 and Alternative G5 has been implemented and posed no administrative or technical obstacles to implementation. Alternative G3 could be implemented as an option for treatment of the groundwater plume; however, biodegradation of the plume is currently not a significant naturally occurring process, and as such, there was no guarantee that addition of amendments would significantly increase biological degradation. Alternative G4 could be implemented; however, due to the high permeability of the native soils, the possibility exists of creating a slight difference in permeability between the PRB and the soils that could result in the plume bypassing the treatment zone (*i.e.,* flowing under, or around the barrier).

Cost

Soil and Ground Water Alternatives Cost estimates were provided in the FS for the four comprehensive remedial alternatives. As AS/SVE has already been implemented at the facility, and demonstrated to be effective, there are no capital costs necessary for implementation. In comparison, significant capital costs would be required for implementation of the other soil and ground water remedial alternatives. The long-term O&M cost for AS/SVE was estimated at $160,000 per year, which exceeds the $110,000 per year O&M costs for the remaining comprehensive remedial alternative technologies. While the AS/SVE cost for O&M is $50,000 per year more than the other remedial alternative technologies, the lack of any necessary capital

costs for AS/SVE far outweighs any gains that would exist in the annual O&M cost comparison.

Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends. All comments will be summarized and responded to by the Agency in a Responsiveness Summary, attached to the Decision Document issued by the Director of Ohio EPA (after the Preferred Plan), and which provides the final remedy selection.

5.3 Summary of Evaluation Criteria

A summary of the evaluation of the site remedial alternatives is included in **Table 7 Evaluation of Site Remedial Alternatives**.

TABLE 7 EVALUATION OF SITE REMEDIAL ALTERNATIVES

Remedial Alternatives	Threshold Criteria		Balancing Criteria					Modifying Criteria
	1. Protects Human Health & Environment	2. Compliance with ARARs	3. Long Term Effectiveness	4. Reduces T, M and/or V by Treatment	5. Short Term Effectiveness	6. Implementable	7. Costs	8. Community Acceptance
Soil								
S1	□	□	□	□	□	■	■	
S2	■	■	■	■	◘	■	■	
S3	■	■	■	■	◘	◘	◘	
S4	■	■	■	◘	■	□	□	
Groundwater								
G1	□	□	□	□	□	■	■	
G2	■	■	■	■	◘	■	■	
G3	□	□	□	□	□	□	□	
G4	◘	◘	◘	◘	◘	◘	□	
G5	■	■	◘	◘	□	◘	□	

■ = Fully Meets Criteria ◘ = Partially Meets Criteria □ = Does Not Meet Criteria

6.0 OHIO EPA'S PREFERRED REMEDIAL ALTERNATIVE

Ohio EPA's preferred remedial alternative combines the following: Soil Alternative S2 (Soil Vapor Extraction) and Ground Water Alternative G2 (Air Sparging) on the facility property; institutional controls (*e.g.,* prohibiting the use of ground water at the site as well as the affected down gradient properties for any purpose other than investigation or remediation unless otherwise demonstrated to be protective of commercial/industrial, non-potable use, limiting the use of the facility to only commercial/industrial uses, and prohibiting human occupancy of any buildings at the former HSC facility); and associated soil and ground water monitoring. Institutional controls (not formally evaluated as part of the FS but required in order to protect human health and the environment) have been added to comply with legally applicable state and federal requirements.

The soil alternative was selected over the other soil alternatives because of its applicability to site-specific conditions and the ability to treat contamination under the previously existing HSC facility building. The results associated with this soils alternative, as part of the IA, have demonstrated the ability, to some extent, to minimize the potential for off-facility plume migration and significantly influence the distribution of contaminated ground water at the site. In addition, the soil alternative was successfully implemented without adverse effects to the community, workers and the surrounding environment, including ecological receptors. Finally, the soil alternative would require no additional capitalization costs for implementation.

The ground water alternative was selected over the other ground water alternatives because of its ability treat contamination under the previously existing HSC facility building. The results associated with this ground water alternative, as part of the IA, have demonstrated the ability, to some extent, to minimize the potential for off-facility plume migration and significantly influence the distribution of contaminated groundwater at the site. In addition, the ground water alternative would require no additional capitalization costs for implementation. Other ground water alternatives evaluated, such as In-situ Biostimulation, would not be as effective since biodegradation of the plume is not currently a significant naturally occurring process, and as such, there would be no guarantee that the addition of amendments would substantively increase biological degradation; or, as in the case of P&T, have proven to be relatively ineffective in mitigating the contaminant plume or its migration.

This preferred remedial alternative may change in response to Ohio EPA's consideration of public comment or new information.

Based on information presently available, it is Ohio EPA's judgment that the preferred remedial alternative best satisfies the criteria in **Table 7 - Evaluation of Site Remedial Alternatives**. The elements of the Ohio EPA modified preferred remedial alternative are as follows:

6.1 Soil Remedial Alternative

As noted previously, SVE is an in-situ remediation process designed to remove VOCs from the vadose zone of the subsurface via volatilization. VOCs can remain in the vadose zone as free liquids held in the soil matrix, solutes in the soil moisture, adsorbed onto soil particles, vapor in the pore space, and entrained in internal micropores within soil particles. SVE removes VOCs from the subsurface by providing a moving stream of air that volatizes contaminants and removes them from the subsurface. The airflow produced by the resulting

vacuum sweeps out the soil gas, disrupting the equilibrium between the soil and vapor phase of the VOCs, thereby increasing volatilization and removal.

Based on data associated with the RI, the previously implemented SVE soil remedial alternative should continue to be operated at the former HSC facility to address the extent of contamination (see **Figures 3 and 4 – Soil Areas of Concern**).

The performance standard for the soil remedial alternative is met when sampling and analyses of soil located at the former HSC facility (see **Figures 3 and 4 – Soil Areas of Concern**) demonstrate achievement of RAOs (see **Table 3**) and RLs (see **Table 4**) for soil.

6.2 Ground Water Remedial Alternative

As noted previously, AS is a remediation technology primarily applied in order to remove VOCs from ground water, and promote remediation through a series of physical, chemical, and biological processes. Conceptually, the AS process consists of injection of clean air beneath the water table to induce mass transfer of VOCs to a vapor phase and the addition of oxygen to the ground water which serves to assist with aerobic biodegradation of VOCs. Contaminated vapors then migrate from the saturated zone to the vadose zone, collected via technology such as SVE and subsequently treated. In general, AS protects human health and the environment through removal and subsequent reduction, as well as control of contamination in the ground water, and demonstrates the ability to comply with applicable, or relevant and appropriate requirements under state and federal laws.

The performance standard for the ground water remedial alternative is met when sampling and analyses of ground water at the site (see **Figures 5 and 6 – Ground Water Areas of Concern**) demonstrate achievement of RAOs (see **Table 3**) and RLs (see **Table 4**) for ground water.

6.3 Institutional Controls

Institutional controls are considered to be non-engineered instruments, such as administrative and legal restrictions, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy while treatment or engineering controls are used to address principal threat wastes. In general, institutional controls are used when residual contamination remains at a level that does not allow for unrestricted use and unlimited exposure.

6.3.1 Ground Water Prohibition

This restriction is designed to minimize the potential for adverse human exposure associated with contamination present in ground water at the site (see **Figures 5 and 6 - Ground Water Areas of Concern**) that does not meet RAOs (see **Table 3**) and RLs (see **Table 4**).

The performance standard for the ground water prohibition is met when environmental covenants prohibiting the use of ground water at the former HSC facility property as well as the affected down gradient properties for any purpose other than investigation

or remediation unless otherwise demonstrated to be protective of commercial/industrial, non-potable use, have been recorded in the Richland County Recorder's Office and documentation has been provided to Ohio EPA. Properties needing environmental covenants include those with ground water concentrations (shallow or deep) exceeding the 5 µg/L concentration for PCE or TCE (see **Figures 5 and 6 Ground Water Areas of Concern**). This includes the former HSC facility property and those properties down gradient with ground water concentrations exceeding 5 µg/L for PCE or TCE. Non-potable ground water use is also prohibited until remediation levels are met unless demonstrated to meet applicable commercial / industrial non-potable use risk goals.

6.3.2 Building Occupancy Prohibition

This restriction is designed to minimize the potential for adverse human exposure associated with contamination present in soil and ground water (see **Figures 3 – 6 – Soil and Ground Water Areas of Concern**, and **Tables 3 and 4** (RAOs and RLs)) at the former HSC facility.

The performance standard for a building occupancy prohibition is met when an environmental covenant prohibiting human occupancy of any buildings on the facility property (see **Figure 2**) has been recorded in the Richland County Recorder's Office and documentation has been provided to Ohio EPA.

6.3.3 Commercial/Industrial Land Use Restriction

This restriction is designed to minimize the potential for adverse human exposure associated with contamination present in soil (see **Figures 3 and 4 – Soil Areas of Concern**) at the former HSC facility.

The performance standard for a property use restriction is met when an environmental covenant limiting the facility property to commercial/industrial use has been recorded in the Richland County Recorder's Office and documentation has been provided to Ohio EPA.

Appendix A Glossary of Terms

Administrative Record: All documents that Ohio EPA considered or relied on in selecting a remedial action for a site.
Adsorb: The adhesion in an extremely thin layer of molecules (as of gases, solutes, or liquids) to the surfaces of solid bodies or liquids with which they are in contact.
Aquifer: An underground geological formation capable of holding and yielding water.
Applicable or Relevant and Appropriate Requirements (ARARs): Those statutes and rules that strictly apply to remedial activities at the site, or those statutes and rules whose requirements would help achieve the remedial goals for the site.
Baseline Risk Assessment: An evaluation of the risks to humans and the environment posed by a site in the absence of any remedial action, which also determines the extent of cleanup needed to reduce potential risk levels to within acceptable ranges.
Carcinogen: A chemical that causes cancer.
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, 42 U.S.C. 9601 et seq. A federal law that regulates cleanup of hazardous substances sites under the U.S. EPA Superfund Program.
Contaminants of Concern (COCs): Chemicals identified at the site that are present in concentrations that may be harmful to human health or the environment.
Decision Document: A statement issued by the Ohio EPA giving the director's selected remedy for a site and the reasons for its selection.
Ecological Receptor: Animals or plant life exposed or potentially exposed to chemicals released from a site.
Environmental Covenant: A servitude arising under an environmental response project that imposes activity and use limitations and that meets the requirements established in ORC Section 5301.82.
Exposure Pathway: Route by which a chemical is transported from the site to a human or ecological receptor.
Feasibility Study: A study conducted to ensure that appropriate remedial alternatives are developed and evaluated so relevant information concerning the remedial action options can be presented to a decision-maker and an appropriate remedy selected.
Final Cleanup Levels: Final cleanup levels identified in the Decision Document along with the RAOs and performance standards.
Hazardous Substance: A chemical that may cause harm to humans or the environment.
Hazardous Waste: A waste product listed or defined by RCRA that may cause harm to humans or the environment.
Human Receptor: A person/population exposed to chemicals released at a site.
Imminent Threat: A high probability that exposure is occurring.

Leachate: Water that collects contaminants as it migrates through wastes, pesticides or fertilizers. Leaching may occur in farming areas and landfills, and may result in hazardous substances entering surface water, ground water, soil or sediment.
Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in a public drinking water supply. The level is established by U.S. EPA and incorporated into OAC 3745-81-11 and 3745-81-12.
Monitoring Well: A well installed to collect ground water samples for the purpose of physical, chemical, or biological analyses to determine the amounts, types, and distribution of contaminants in ground water beneath a site.
NCP: National Oil and Hazardous Substances Pollution Contingency Plan, codified at 40 C.F.R. Part 300 (1990), as amended. A framework for remediation of hazardous substance sites specified in CERCLA.
Operation and maintenance (O&M): Long-term measures taken at a site, after the initial remedial actions, to assure that a remedy remains protective of human health and the environment.
Performance Standard: Measures by which Ohio EPA determines if RAOs are being met.
Preferred Plan: The plan that evaluates the preferred remedial alternative chosen by Ohio EPA to remediate the site in a manner that best satisfies the evaluation criteria.
Preliminary Remediation Goal (PRG): Initial clean-up goals that (1) are protective of human health and the environment and (2) comply with ARARs. They are developed early in the process (scoping) based on readily available information and are modified to reflect the results of the baseline risk assessment (termed RGs at this point in time). They are also used during the analysis of remedial alternatives in the RI/FS.
Present Worth Cost: Estimated current cost, or value, of the future remedial costs to be expended, typically discounted at the current market rate. Provides a solid basis for comparing costs of each of the remedial alternatives.
Project Action Level: A concentration for a COC that has been determined by regulation or through a risk assessment to be protective of human health or ecological receptors. This concentration value could be based on a preliminary remediation goal (PRG); a drinking water maximum contaminant level (MCL); or a background concentration (background).
RCRA: Resource Conservation and Recovery Act of 1976, as amended, 42 U.S.C. 6901 et seq. A federal law that regulates the handling of hazardous wastes.
Remedial Action Objectives: Specific remedial goals for reducing risks posed by the site.
Remedial Investigation: A study conducted to collect information necessary to adequately characterize the site for the purpose of developing and evaluating effective remedial alternatives.
Responsiveness Summary: A summary of all comments received concerning the Preferred Plan and Ohio EPA's response to the comments.
Sediment: Topsoil, sand and minerals washed from the land into water, usually after rain or snow melt.

Water Quality Criteria: Chemical, physical and biological standards that define whether a body of surface water is unacceptably contaminated. These standards are intended to ensure that a body of water is safe for fishing, swimming and as a drinking water source. These standards can be found in OAC Chapter 3745-1.

Appendix B Primary Contaminants of Concern

A total of two (2) primary contaminants of concern (COCs) have been identified that pose the greatest potential risk to human health and the environment at this site, specifically, PCE and TCE. Information on DCE is added for informational purposes as it has been detected in low concentrations at the site. Additional details on PCE, TCE and DCE (from the Agency for Toxic Substances and Disease Registry (ATSDR Toxicological Profiles) are provided below.

1,1-Dichloroethene (DCE) is a colorless liquid chemical that does not occur naturally in the environment. It is used to make plastics, flame retardant coatings for fiber and carpet backing, coatings for steel pipes and in adhesive applications. The main effect from breathing DCE is on the central nervous system. Breathing lower levels for a long period of time may damage the nervous system, liver and lungs. Animals that ingested high levels have had damaged livers, kidneys and lungs. U.S. EPA has determined that DCE is a possible human carcinogen. DCE has been identified as a chemical produced by the degradation of TCE and PCE.
Tetrachloroethene (PERC or PCE) is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal degreasing. It is a non-flammable liquid at room temperature and readily evaporates into the air. High concentrations of PERC can cause dizziness, headache, sleepiness, confusion, nausea, unconsciousness and death. The health effects of inhaling and ingesting low levels of PERC are not known. Results of animal studies involving high levels of PERC show that it can cause liver and kidney damage. The U.S. Department of Health and Human Services has determined that PERC may reasonably be anticipated to be a carcinogen.
Trichloroethene (TCE) is a non-flammable, colorless liquid that is not thought to occur naturally in the environment. It is mainly used as a solvent to remove grease from metal parts, but is also used as an ingredient in adhesives, paint removers and spot removers. Inhaling large amounts for long periods of time may cause impaired heart function, nerve, kidney and liver damage, unconsciousness and death. Breathing lower amounts may cause headaches, lung irritation, dizziness, and coordination and concentration problems. Ingesting large amounts may cause nausea, liver damage, unconsciousness, impaired heart function and death. Ingesting lower amounts for long periods of time may cause liver and kidney damage and impaired immune system function. Some studies have shown that mice and rats exposed to high levels of TCE have liver, kidney and lung cancer. The International Agency for Research on Cancer has determined that TCE is a probable human carcinogen.