969603

New Carlisle Landfill Superfund Site

Operable Unit 1
EPA SITE ID: OHN000509238
Clark County, Ohio

Record of Decision

U.S. Environmental Protection Agency Region 5

77 W Jackson Blvd.
Chicago, IL 60604

September 2021

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LIST OF ACRONYMS AND ABBREVIATIONS

AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
CDI	Chronic Daily Intake
CFR	Code of the Federal Regulations
CSM	Conceptual Site Model
COC	Chemicals of Concern
COPC	Chemical of Potential Concern
CWA	Clean Water Act
DHC	Dehalococcoides
DNAPL	Dense Non-aqueous Phase Liquids
ELCR	Excess Lifetime Cancer Risk
EPA	United States Environmental Protection Agency
ERD	Enhanced Reductive Dechlorination
ESI	Expanded Site Inspection
ESV	Ecological Screening Value
FML	Flexible Membrane Layer
FS	Feasibility Study
GCL	Geosynthetic Clay Liner
GW	Landfill Groundwater Remedy
HDPE	High-density polyethylene
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ICs	Institutional Controls
ISCO	In-Situ Chemical Oxidation
ISCR	In-Situ Chemical Reduction
kg	Kilogram
LF	Landfill and Gas Remedy
LUCs	Land Use Controls
MCL	Maximum Contaminant Level
MW	Monitoring Well
mg	Milligram
NCL	New Carlisle Landfill
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
Ohio EPA	Ohio Environmental Protection Agency
OAC	Ohio Administrative Code
O&M	Operation & Maintenance
OMZA	Outside Mixing Zone Average
OU1	Operable Unit 1
OU2	Operable Unit 2
PCE	Tetrachloroethene
PCBs	Polychlorinated biphenyls

PID	Photoionization detector
ppb	Parts per billion
ppbV	Parts per billion by Volume
ppm	Parts per million
ppmV	Parts per million by Volume
PRB	Permeable Reactive Barrier
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference Dose
RG	Remedial Goals
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Levels
R/T	Release/ Transport
Scarff's Nursery	Former Scarff's Nursery and Landscape
SEM	Simultaneously Extracted Metals
SF	Slope Factor
SI	Site Investigation
SL	Screening Level
SLERA	Screening Level Ecological Risk Assessment
SVOCs	Semi-Volatile Organic Compounds
TBC	To-Be-Considered
TCE	Trichloroethene
TOC	Total Organic Carbon
VAS	Vertical Aquifer Sampling
VC	Vinyl Chloride
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Levels
VOCs	Volatile Organic Compounds
ZVI	Zero Valent Iron
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
µg/m3	Micrograms per cubic meter

PART 1: THE DECLARATION

1.1. SITE NAME AND LOCATION

New Carlisle Landfill Superfund Site Operable Unit 1
CERCLA ID: OHN000509238
715 North Dayton-Lakeview Road
Clark County, Ohio 45344

1.2. STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for Operable Unit 1 (OU1) of the New Carlisle Landfill Superfund Site in Clark County, Ohio (NCL Site). The Site consists of two operable units. The NCL Site OU1 is located at 715 North Dayton-Lakeview Road, Clark County, Ohio and includes onsite landfill waste, landfill gas, and landfill groundwater, as well as vapor intrusion at properties adjacent to the landfill. Environmental Protection Agency (EPA) will develop long-term cleanup options for off-site volatile organic compounds (VOC) contaminated groundwater, Operable Unit 2 (OU2), at the NCL Site, and will discuss those options with the public in a future action for OU2 (off-site groundwater). EPA has chosen the Selected Remedy for OU1 to contain landfill media and remediate onsite landfill groundwater that is a source of downgradient groundwater contamination.

The Selected Remedy discussed in this Record of Decision (ROD) was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601 et seq. (CERCLA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 Code of Federal Regulations (CFR) Part 300 (NCP). This decision is based on information contained in the Administrative Record (AR) for the Site. The Ohio Environmental Protection Agency (Ohio EPA) has stated that they intend to concur with the Selected Remedy. The AR will be updated upon receipt of a formal concurrence letter.

The Selected Remedy at the NCL Site OU1 consists of response actions for landfill waste and gas (LF), landfill groundwater (GW), and vapor intrusion (VI). The Selected Remedy for the NCL Site OU1 is:

- Landfill and Gas Remedy LF-3 Enhancing existing cover, passive gas venting, waterline extension, and land use controls
- Groundwater Remedy GW-2: In-Situ Treatment of Groundwater
- Vapor Intrusion Remedy VI-4: Installation of Sub-Slab Depressurization Systems and Land Use Controls

These measures to remediate the landfill waste, gas, and groundwater, and address the potential for vapor intrusion, will be protective of human health and the environment, meet applicable or relevant and appropriate requirements (ARARs), be cost effective, and will be effective in the long term. The OU1 remedy will be implemented and monitored to determine what, if any, response actions are necessary to remediate downgradient groundwater contamination in OU2 after the source has been addressed.

Administrative Record documents for the New Carlisle Landfill site are available on the site website at: www.epa.gov/superfund/new-carlisle-landfill or at either of the following locations:

New Carlisle Public Library
111 E Lake Avenue
New Carlisle, OH 45344

EPA Region 5 Records Center
77 W. Jackson Blvd. (SRC-7J)
Chicago, IL 60604

(937) 845-3601	(312) 353-1063
Call for hours	Mon-Fri - 9 am to 5 pm- *Call for appointment*

1.3. ASSESSMENT OF SITE

The response actions selected in this ROD are necessary to protect human health and the environment from actual or threatened releases of hazardous substances into the environment.

1.4. DESCRIPTION OF SELECTED REMEDY

The Selected Remedy for OU1 addresses onsite landfill waste, landfill gas, and landfill groundwater, as well as vapor intrusion potential at properties adjacent to the landfill. EPA will develop long-term cleanup options for the off-site VOC contaminated groundwater, OU2, at the NCL Site after evaluating the remedy implementation at OU1, which is the source of the off-site downgradient contaminated groundwater and will discuss those options with the public in the future.

The selected remedial alternatives for OU1 are listed below and constitutes the Selected Remedy:
• Landfill and Gas Remedy LF-3 Enhancing existing cover, passive gas venting, waterline extension, and land use controls
• Groundwater Remedy GW-2: In-Situ Treatment of Groundwater
• Vapor Intrusion Remedy VI-4: Installation of Sub-Slab Depressurization Systems

The major components of the Selected Remedy related to OU1 include the following:

- Landfill cover enhancements to meet site-wide compliance with thickness and permeability requirements
- Installation of a passive gas venting system
- Municipal waterline extensions to replace potable drinking water wells within 1000 feet of the land boundary
- Treatment of groundwater emanating from the landfill parcel to reduce downgradient contaminant concentrations in groundwater
- Installation of sub-slab depressurization systems to protect against potential vapor intrusion of landfill gases into residential properties
- Land use controls will be implemented on the landfill property to prevent disturbances to the landfill remedy and prevent future exposure to landfill waste.

A detailed engineering plan for the landfill cap, landfill gas venting system, groundwater treatment system, and sub-slab depressurization systems will occur in the Remedial Design phase of this project.

EPA has not identified any principal threat wastes at the New Carlisle Landfill Superfund Site. While the landfill contents are the source of contamination at the NCL Site, no liquid source material, mobile source material, or highly toxic source material was identified during investigations at the site. Material onsite can be reliably contained.

Remediation of landfill waste at the NCL Site will follow the *1993 EPA Presumptive Remedy for CERCLA Municipal Landfill Site* guidance. A presumptive remedy is a technology that EPA believes, based upon experience, generally will be the most appropriate remedy for a specified type of site. The presumptive remedy for CERCLA municipal landfill sites calls for source containment of landfill media. Remedial components of the landfill presumptive remedy include engineering controls, a landfill cap, treatment of landfill groundwater and gas to remediate site contamination that poses a long-term threat to human health and the environment. The presumptive remedy for CERCLA municipal landfill sites was found to be appropriate at New Carlisle Landfill based on the site-specific conditions identified in the Remedial Investigation (RI).

The sequence and timing of the remedial action activities for OU1 will be determined during the Remedial Design phase.

1.5. STATUTORY DETERMINATIONS

The Selected Remedy set forth in this ROD achieves the statutory and regulatory mandates set forth in CERCLA Section 121 and the NCP. Specifically, the Selected Remedy addresses exposure to contaminants in a manner that is protective of human health and the environment, complies with federal and state ARARs, is cost-effective, and utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The Selected Remedy provides the best balance of tradeoffs in terms of the five balancing criteria, while also considering Ohio EPA and community acceptance.

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure (UU/UE), EPA will conduct a statutory review of the Selected Remedy within five years after initiation of the remedial action, and every five years thereafter, to ensure that the Selected Remedy is, or will be, protective of human health and the environment.

1.6. ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the AR for the Site, which is located on the EPA Website, EPA Region 5 Records Center, and at the New Carlisle Public Library at 111 E Lake Avenue, New Carlisle, OH 45344.

Information Item	Section in ROD
Chemicals of concern and their respective concentrations	2.5.4, 2.7.3
Baseline risk presented by the chemicals of concern	2.7, Appendix C
Cleanup levels established for chemicals of concern and the basis for these levels	2.8, 2.12.3
How source materials constituting principal threats are addressed	2.11
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD	2.6
Potential land and groundwater use that will be available as a result of the Selected Remedy	2.12.3
Estimated capital, annual 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	2.12.3
Key factor(s) that led to selecting the remedy (that is, describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision)	2.10, 2.12.1

1.7. AUTHORIZING SIGNATURES

EPA, as the lead agency for the Site, formally authorizes this ROD.

X

Douglas Ballotti, Director
Superfund & Emergency Management Division
Signed by: DOUGLAS BALLOTTI

September 21, 2021
Date

PART 2: DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

2.1.1 SITE NAME, IDENTIFICATION NUMBER, OFFICIAL SITE ADDRESS

New Carlisle Landfill Superfund Site
Operable Unit 1
CERCLA ID: OHN000509238
715 North Dayton-Lakeview Road
Clark County, Ohio 45344

2.1.2 SITE TYPE AND BRIEF DESCRIPTION

The NCL Site is located at 715 North Dayton-Lakeview Road, approximately 1.5 miles south of the city of New Carlisle in Clark County, Ohio and 17 miles northeast of Dayton. The NCL Site includes an unlined former landfill and a VOC contaminated groundwater plume. The landfill encompasses approximately 21.7 acres. The NCL Site was divided into two geographical areas, or operable units, referred to as OU1 and OU2. OU1 includes the landfill media (landfill contents, the on-site groundwater, and landfill gas) and vapor intrusion at residential and commercial properties adjacent to the eastern side of the landfill. OU1 is bounded by the legal parcel boundaries of the landfill, and the residential and commercial properties located between the landfill and North Dayton-Lakeview Road. OU1 groundwater is the groundwater located underneath the landfill and within the landfill parcel. OU2 includes the off-site groundwater plume that has migrated southward from OU1. The Site is depicted on Figures 1, 2, and 3.

EPA is the lead agency at the New Carlisle Landfill Site, and Ohio EPA is the support agency. The cost for the clean-up will be funded with federal and state-match dollars, unless Potentially Responsible Parties can be identified and conduct the work under an EPA Superfund enforcement action.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.2.1 SITE HISTORY

Prior to use as a landfill, NCL reportedly operated as a gravel pit where glacial gravel and sand were mined. The New Carlisle Landfill operated as an unlined, general refuse and solid waste landfill from the late 1950s to 1977 using the depression made from gravel mining. According to Landfill Systems, Inc., of Springfield, Ohio (Division of SCA Corporation), a layer of compacted industrial, commercial, and residential refuse approximately 15 feet thick was placed in the landfill over a period of approximately 20 years. Waste was deposited in celled areas and a landfill cover consisting of 2 to 5 feet of clay and vegetation was placed over the waste. While there is no direct contact risk to contaminated soil due to the clay landfill cover, the current landfill cover does not meet current State and Federal regulations. Two ponds exist at the NCL Site: Pond 1 is located on the landfill and Pond 2 is located southeast of the landfill. A VOC-contaminated groundwater plume extends south from the landfill for approximately 3,000 feet. The groundwater plume affected former water supply wells and residential wells located at the adjacent former Scarff's Nursery and Landscape property (Scarff's Nursery).

Several Ohio EPA investigations and EPA enforcement and removal actions focused on the contaminated groundwater and drinking water at commercial and residential properties located near the NCL Site, including at Scarff's Nursery. Groundwater contaminated with VOCs, including trichloroethane (TCE), tetrachloroethane (PCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC), were detected beneath the landfill and in a plume extending south of the landfill. Ohio EPA Division of Drinking and Ground Waters began overseeing periodic sampling of the former public well located near the main office of Scarff's Nursery and Landscape, adjacent to the New Carlisle Landfill site, starting in 1993. The former public well has a well screen depth of 60 to 70 feet below ground surface (bgs). Results show that VC was present in the former public well since 1997 at concentrations above the Ohio safe drinking water standard of 2 micrograms per liter (µg/L). (Micrograms per liter [µg/L] is equated to parts per billion [ppb] and may be used interchangeably.) Subsequent annual groundwater sampling results indicated an increasing trend and by October 2001, VC levels had increased above 8 µg/L. Based on these results, Ohio EPA issued an enforcement action resulting in a Director's Final Findings and Orders in August 2002. The administrative order required that public use of the well cease and future use of the well limited to irrigation purposes only.

In February 2003, the Ohio EPA Division of Drinking and Ground Waters received plans of a proposed new public well to be installed at Scarff's Nursery property, screened at a depth of 112 to 122 feet bgs (total depth was installed to 163 feet bgs). A new public well came into service in August 2003. The new public well is located approximately 750 feet south of the former public well (see Figure 6).

2.2.2 HISTORY OF REMEDIAL AND REMOVAL ACTIVITIES

Ohio EPA Site Investigations

After the issuance of the Director's Final Findings and Orders in August 2002, Ohio EPA began a Site Inspection (SI) to determine the nature and extent of contamination at NCL. During the SI conducted at the landfill in November 2002 and May 2003, Ohio EPA performed soil sampling and groundwater sampling in two phases. Direct-push Geoprobe® drive-point samples; residential, irrigation, and public water supply well (including the former and new public wells at Scarff's Nursery) samples; a leachate sample and a co-located soil sample were collected during the SI. Results from the SI indicated that the New Carlisle Landfill is the source of elevated levels of VC at the Scarff's Nursery former public well and TCE, PCE, and VC were detected beneath the landfill in a plume extending south from the landfill. The former public well, which is currently only being used for irrigation purposes, was the only well identified to have VC levels above drinking water standards at the time of the SI.

From December 2003 through December 2005, Ohio EPA conducted an expanded site inspection (ESI). Additional direct-push Geoprobe® drive-point samples were installed to further characterize the source of groundwater contamination at the landfill and the full extent of down-gradient groundwater contamination.

EPA proposed the NCL Site for the National Priorities List (NPL) in September 2008 and placed the Site on the NPL in April 2009 due to concerns about the potential migration of VC toward residential wells within 0.5 mile of the landfill.

EPA Removal Program Activities

Periodic groundwater monitoring conducted by Ohio EPA at the new public well exhibited detections of VC, and low concentrations of their associated parent compounds, including PCE, TCE, and 1,1,1-trichloroethane. After VC above the Maximum Contaminant Level (MCL) was measured in April 2005, EPA initiated a time-critical removal of a public water supply line extension and connection to the nursery. As a result, potable water at the nursery is now provided via city water from the city of New Carlisle. The two public wells on Scarff's Nursery, referred to as the former public well and the new public well, are now only used as irrigation wells.

EPA Remedial Program Activities

The Remedial Investigation (RI) fieldwork was completed in multiple phases between 2012 to 2015 to determine the nature and extent of the contamination and evaluate the risks to human health and the environment at the NCL Site. Fieldwork completed during the RI is described below:

- Assessment of the landfill cover determined the extent and depth of the landfill cover across OU1. Soil samples from the cap were submitted for geotechnical analysis and soil borings were collected up to 10 feet bgs to map the depth to waste and to screen for landfill gas.
- Soil borings were advanced between the landfill cap and the residential houses on the eastern side of the property.
- Permanent soil gas probes were installed and sampled.
- Co-located surface water and sediment samples from the ponds located on the former landfill property were collected.
- The vertical aquifer sampling (VAS) was conducted in six transects downgradient from the landfill extending beyond the New Public Well with soil borings advanced up to 200 feet bgs.
- Irrigation and residential well samples were collected, along with samples from a seep located at the northeast corner of the landfill property.
- Installation and sampling of a permanent groundwater monitoring network along the landfill boundary and in OU2.
- Sub-slab soil gas samples were collected at three structures located adjacent to the landfill to determine the potential for vapor intrusion at the NCL Site.
- Soil borings were advanced at the former Migrant Head Start Building across the street from the landfill and screened with a landfill gas monitor.
- A potential hotspot located on the landfill was investigated by trenching.

2.2.3 ENFORCEMENT ACTIVITIES

Under CERCLA, EPA has the authority to determine possible responsibility for cleanup of a site or to seek to recover costs that EPA has incurred in cleaning up a site. Specifically, CERCLA Sections 106(a) and 107(a) state that Potentially Responsible Parties (PRPs) may be required to perform cleanup actions to protect the public health, welfare, or the environment. PRPs may also be responsible for costs incurred by EPA in cleaning up the site, unless the PRP can demonstrate divisibility or assert one of the CERCLA 107 statutory defenses. PRPs include current and former owners and operators of a site, persons who arranged for treatment and/or disposal of any hazardous substances found at the site, and persons who accepted hazardous substances for transport and selected the site to which the hazardous substances were delivered.

Enforcement Activities

EPA reviewed CERCLA Section 104(e) information request responses submitted by Waste Management of Ohio in 2005, 2006, and 2009. Waste Management owned the NCL parcel after closure, however, did not operate as an owner or operator at the time of disposal of any waste. The 2009 CERCLA Section 104(e) information request identified customers that may have sent waste to New Carlisle Landfill. Follow-up research on the customer list identified several potential generators and arrangers; however, at this time, no viable PRPs have been identified. PRP search activities will continue.

The current owner of the New Carlisle Landfill parcel is the Van Scoyk Trust. The beneficiary of the Trust is Wilma Van Scoyk. EPA has not conducted any formal enforcement other than sending information requests to past owners in the chain of title.

2.3 COMMUNITY PARTICPIATION

The RI report, Feasibility Study (FS) report, Proposed Plan, and Proposed Plan Factsheet were made available to the public in August 2020. They can be found in the Administrative Record, the information repository maintained at the EPA Region 5 Records Center, and the New Carlisle Public Library at 11 E Lake Avenue New Carlisle, OH 45344. The notice of the availability of these documents was published in the *Dayton Daily News* on August 15, 2020 and an EPA News Release was published on August 17, 2020.

EPA began the public comment period on the Proposed Plan on August 17, 2020. In addition to mailing copies of the factsheet and notice of public meeting, EPA reached out to individual property owners adjacent to the Site, and to local representatives in Clark County, the city of New Carlisle, and Bethel Township to discuss the Proposed Plan and site status. In lieu of an in-person public meeting, EPA published a virtual public presentation to avoid in-person contact consistent with Centers for Disease Control guidance urging the postponement of public gatherings due to COVID-19. A virtual presentation regarding the proposed cleanup plan was made available on the EPA New Carlisle Landfill Superfund Site website. The public comment period ended on September 16, 2020. EPA's response to comments received during this period is included in the Responsiveness Summary, which is Part 3 of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

The OU1 Remedy selected in this ROD addresses the potential for exposure to site contaminants through exposure to landfill soil, gas, and groundwater and vapor intrusion at the site. Landfill gas poses a potential risk to human health because VOC contaminants were found in sub-slab or indoor air samples. Additionally, landfill gas poses a risk to nearby properties through vapor intrusion. Landfill groundwater poses a future risk to human health because EPA's risk range is exceeded, and because it is the source of the downgradient groundwater plume in OU2, which is a potable drinking water source. No current exposures for groundwater exist in OU1 or OU2. The OU1 Remedy will be implemented and monitored to determine what, if any, additional response actions are necessary to address downgradient groundwater contamination in OU2 after the source has been addressed.

2.4.1 PAST RESPONSE

As described in 2.2.2 above, a Removal Action taken in 2005 provided potable water to Scarff's Nursery by connecting it to municipal water, making the off-site public and private wells servicing Scarff's Nursery available as irrigation wells. No current residential well exceedances above the MCL for site-related contaminants are present in OU2.

2.4.2 ACTIVITIES PROPOSED IN THIS ROD

Specific activities addressed by this ROD include:

- Landfill cover enhancements to meet site-wide compliance with thickness and permeability requirements to be compliant with current State and Federal regulations
- Installation of a passive gas venting system
- Municipal waterline extensions to replace potable drinking water wells within 1000 feet of the land boundary
- Treatment of groundwater emanating from the landfill parcel to reduce downgradient contaminant concentrations in groundwater
- Installation of sub-slab depressurization systems to protect against vapor intrusion of landfill gases into residential properties

- Land use controls on (1) the landfill property to prevent disturbances to the landfill remedy and prevent future exposure to landfill waste; and (2) on residential properties to prevent unacceptable vapor intrusion

Remediation of OU1 landfill media at the NCL Site will follow the *1993 EPA Presumptive Remedy for CERCLA Municipal Landfill Site* guidance. Presumptive remedies were developed by EPA to streamline the selection of cleanup methods, treatment technologies, or remediation approaches that have a proven track record in the Superfund program. It is appropriate to apply the presumptive remedy for CERCLA municipal landfill sites based on the contaminant characteristics found in OU1 of the NCL Site and guidance. The presumptive remedy for landfills calls for source containment of landfill media. Remedial components of the landfill presumptive remedy include engineering controls, a landfill cap, treatment of landfill groundwater and gas to remediate site contamination that poses a long-term threat to human health and the environment.

The exact sequencing of the remedial action work will be determined during the Remedial Design phase. The Selected Remedy will meet all the Remedial Action Objectives (RAOs) that were developed for the Site. The RAOs were established to prevent current and future potential exposure to landfill media, landfill groundwater, and vapor intrusion at the Site.

2.4.3 FUTURE RESPONSE PLANS

Monitoring of contaminant concentrations in OU2 will continue during the OU1 Remedial Design and Remedial Action phases. A Remedial Investigation and Feasibility Study addendum will be conducted for OU2 to determine the effects on off-site groundwater from the OU1 implemented remedial action. When those investigations are complete, EPA will develop a Proposed Plan and ROD to determine what further actions, if any, are necessary at OU2.

2.5 SITE CHARACTERISTICS

This section of the ROD summarizes the current information available about site characteristics at the New Carlisle Landfill Site, with an emphasis on the landfill property and the three adjacent building structures. Downgradient groundwater contamination, which is part of OU2, is discussed briefly since the landfill media in OU1 is the source of groundwater contamination. Additional details are available in the Final RI Report.

2.5.1 CONCEPTUAL SITE MODEL

The NCL Site includes an unlined former landfill and a VOC-contaminated groundwater plume. The landfill parcel encompasses approximately 21.7 acres. OU1 is bounded by the legal parcel boundaries of the landfill, and the residential and commercial properties located between the landfill and N Dayton-Lakeview Road. OU1 groundwater is the groundwater located underneath the landfill and within the landfill parcel. OU2 includes the off-site groundwater plume that has migrated southward from OU1. A low permeability soil cover was placed over the historical waste area during landfill closure. The NCL Site has become heavily vegetated over the last 40 years, infiltrating the soil cover. Two surface water bodies are present at the site, including a pond in the center of the landfill (Pond 1) and a pond in a low-lying area southeast of the landfill (Pond 2). No areas of archaeological or historical importance are present in OU1.

To guide identification of appropriate exposure pathways and receptors for evaluation in the risk assessment, a conceptual site model (CSM) for human health and ecological receptors was developed for the Site based on Site characteristics and results from the RI investigation. The purpose of the conceptual site model is to provide a framework with which to identify source areas, potential migration pathways of constituents from source areas to environmental media where exposure can occur, and to identify potential human or ecological receptors.

Groundwater beneath and downgradient of the landfill is considered the primary affected medium. The overall CSM for the NCL Site suggests that the primary release/transport (R/T) mechanism at NCL includes leaching of VOCs sorbed to organic waste or soil within the landfill. Migration of contaminants could have been transported by the following mechanisms:

- The potential presence of droplets and/or residual pools of dense non-aqueous phase liquids (DNAPL) within or beneath the landfill. Although the highest measured dissolved phase concentrations at NCL do not indicate evidence of widespread DNAPL, it is possible that isolated pockets of DNAPL may exist within the landfill.
- Precipitation, or downward leakage of surface water from the pond located in the center of the landfill, infiltrating through the waste. Based on the landfill cap investigation, the soil cover mitigates surface infiltration that may cause leaching. However, the integrity of the cap has been compromised due to lack of maintenance and varying thicknesses across the soil cover.
- Direct contact of landfill waste in groundwater as a result of the intermittent rising water table. Groundwater was not found to be in contact with waste outside of the pond area. Waste in direct contact with groundwater is not expected to be a major cause of contaminant migration.

Additional contaminant R/T mechanisms include:

- Volatilization and fugitive emissions from the landfill. The ambient air is considered the primary affected medium for both mechanisms. While conducting landfill cap investigations, no methane/fuel odors or venting was observed on the landfill. While the potential for volatilization and fugitive emissions may exist with the existing landfill cap, they are unlikely to occur.
- Release of landfill gas (such as methane gas) that may occur as the result of the decomposition of organic wastes. Soil gas is the primary affected medium. Methane was especially prominent in areas surrounding the pond located in the center of the landfill.
- Erosion and runoff. The primary affected media are surface soil, surface water, and sediment. A clay and gravel cap is present across the landfill and no waste was observed in the surface soils during the RI (depth of cover shown on Figure 7). Cap erosion was observed in areas leading from Pond 1 in the center of the landfill to the east and south through topographical declines.
- Direct contact of waste with surface soil. Surface soil is considered the primary affected medium. No waste was encountered at the surface during the RI.
- Volatile contaminants in soil gas that may migrate to indoor air through vapor intrusion. Benzene, ethylbenzene, and 1,2,4-trimethylbenzene were detected in either sub-slab or indoor air samples in nearby properties. Therefore, soil gas migration to indoor air has the potential to occur.
- No sediment or surface water appears to be affected based on analytical data collected from the two ponds on the landfill property. However, future disturbances to the landfill may alter this pathway.
- Various ecological receptors (including mammalian and avian herbivores, omnivores, and insectivores) will ingest soil, while soil invertebrates will be exposed through direct contact with soil. Burrowing mammals and invertebrates may be exposed through inhalation to soil gas.
- Fugitive emissions, although unlikely to occur, can be released to the ambient air may deposit onto surface soil and upland plants.
- Contaminants in surface soil may in turn be released back into the ambient air through volatilization and fugitive emissions or subject to additional erosion and runoff.

The Human Health and Ecological Conceptual Site models are shown in Figure 4 and Figure 5 of this ROD.

2.5.2 HYDROGEOLOGY

According to flow maps from the city of New Carlisle Wellhead Protection Program, regional groundwater flow is southerly. The NCL Site is located north and upgradient of the affected wells at Scarff's Nursery. The thick sequences of sand and gravel, referred to glacial outwash, deposited beneath southwestern Clark County has a high transmissivity and constitutes the prolific Great Miami Buried Valley Sole Source Aquifer System. The sole-source aquifer designation is a federal designation used to protect drinking water supplies in areas with few or no alternative sources of drinking water. The sole-source aquifer designation protects an area's groundwater resources by requiring that EPA review any proposed projects that are receiving federal financial assistance within the designated area. The underlying unconsolidated deposits between the landfill and the nursery are estimated up to 300 feet thick. These deposits overlie bedrock consisting of poor water-bearing shale and thinly bedded limestone of Ordovician age. Depth to groundwater at monitoring wells (MW) across the site varies from 3 feet on the Gastineau property (MW-003) to 23 feet on the Scarff Property (MW-004 and MW-005).

The city of New Carlisle's public water supply production wells are 1.7 miles northeast and upgradient hydrologically of the Site. The wellhead protection area 30-year time of travel boundary for the city of New Carlisle wells is located 1.5 miles north of the Site and the wellhead protection area is not impacted by the NCL groundwater plume. The city of New Carlisle public water wells draw water from the sole-source aquifer and serve a population of approximately 6,000 people. In the rural area surrounding the city of New Carlisle and the NCL Site, some residences and businesses also obtain water from wells installed in the Great Miami Buried Valley Sole Source Aquifer. The buildings across N Dayton Lakeview Road directly across from the NCL Site and the residential community south of the Site are connected to municipal water.

Several irrigation wells exist on the Scarff's Nursery property including wells referred to as the former public well, the new public well, the shipping well, and the field well. The former public well is used for irrigation at the nursery. During peak use, "make-up" water is obtained from the new public well and the shipping well. Two residences and Scarff's Nursery were connected to the city of New Carlisle municipal water system by EPA's 2005 Emergency Removal Action. Fifteen residential wells are located within 0.5 mile of the site. Sampling have shown that residential and monitoring wells east, and south of the New Pubic Well have not had site-related VOC detections. Monitoring well locations and groundwater sampling results are shown on Figures 6, 10, and 11. Residential well locations have been removed for privacy reasons.

2.5.3 SITE GEOLOGY

The land surfaces in Clark County are the result of several episodes of ice advance and retreat that occurred in Southern Ohio. The surface topography around the NCL Site consists of a series of irregularly shaped hills or mounds known as kames. The kame that is located at the NCL Site is comprised predominantly of coarse sand and gravel with cobbles and silt. The former gravel pit operations at the site mined the sand and gravel from the kame, and after the gravel mining ceased, the resulting depression was used as a landfill. A clay layer was encountered below the waste at depths ranging from 16 to 22 feet bgs. A Type IV Wetland or a boggy wetland that is highly disturbed exists on the landfill. Approximately 3.5 acres (17% of the disposal area) of the landfill is covered by wetland.

Topographic depressions between the kames collect drainage water and are conducive to marsh conditions. Marshland covers much of the interior of the vacant property just south of the landfill that is referred to as the Gastineau Property. There are significant elevation changes across the NCL Site and the Gastineau Property. The NCL Site sits at approximately 20 feet higher elevation than the Gastineau property. The topographical depression at the Gastineau Property is in the vicinity of MW-003S/D. United States Geologic Survey has designated portions of the Gastineau Property as freshwater emergent wetlands and forested/ shrub wetlands.

VAS soil borings in OU1 and OU2 in general show the vadose zone soils typically consist of clay or silt below ground surface to depths ranging from 1 to 20 feet bgs. Clay layers appear to be discontinuous and generally not more than 10 feet thick. The exceptions are at monitoring well MW-003 (in the middle of the Gastineau Property) where the clay is about 20 to 25 feet thick. The clays and silts underneath are underlain predominantly by sand and gravel with interbedded layers of silt and clay. Monitoring wells installed to a maximum depth of 150 feet bgs at an elevation of about 720 feet above mean sea level were completed in unconsolidated material. Bedrock was not encountered in any of the borings drilled during the RI.

2.5.4 NATURE AND EXTENT OF CONTAMINATION

This section presents information on the nature and extent of contamination at OU1 and OU2. Delineation of the nature and extent of contamination is based on the analysis of geotechnical data and comparison of groundwater, soil gas, surface water, sediment, and indoor air samples collected during the RI to various screening criteria specified in the RI report. The RI identified PCE, TCE, cis-1,2-DCE, and VC as the chemicals of concern (COCs) in groundwater that pose potential risks to human health. Site-wide risks were related to future risks associated with potential consumption of COC-contaminated groundwater at properties located downgradient from the site in the OU2 groundwater plume. The RI also identified that ethylbenzene, benzene, and 1,2,4-trimethylbenzene as COCs in soil gas and indoor air may pose risks to human health at residential and commercial properties in OU1.

Landfill Contents

The landfill waste is the source of landfill gas and landfill groundwater. The investigation of the landfill focused an assessment of the soil cover placed over landfill waste during closure and on determining the presence of any hot spots in the waste. The soil cover generally ranges from 4 to 5 feet in thickness across the historical waste area and consists of silty sand with clay and silty sand with gravel. Landfill waste contents were encountered between 4 feet bgs to 16 to 22 feet bgs. The waste footprint of the landfill is about 800,000 square feet or 18.4 acres. Therefore, the landfill waste volume was estimated as 445,000 cubic yards. The extent of waste and soil cover thickness, based on RI boring information, is shown on Figure 7.

A clay layer can be found at depths ranging from 16 to 22 feet underneath the waste contents. No uncovered waste was observed at the surface of the landfill. Landfill cover surface soils were sampled during Ohio EPA's ESI. No VOCs were detected above the reporting limit of 12 micrograms per kilogram (μg/kg) in soil. Permeability results from soil cover samples indicate that, at those sampling locations, the hydraulic conductivity of the soil cover material ranges from 2.4×10^{-8} to 9.2×10^{-9} centimeters per second (cm/sec) for clay samples and 6.4×10^{-7} to 4.2×10^{-7} cm/sec for silt and silty sand samples.

Based on the relatively high photoionization detector (PID) readings observed from the soil samples in Grid H-10, three test pit trenches were excavated to 17 feet within Grid H-10 and H-9 (see Figure 8) as part of a hot spot investigation. Excavated waste materials were a mixture of soil and household waste along with automotive parts and debris found at differing depths throughout the trenches. Odors of chlorinated compounds were observed in excavated soils; however, no specific source of contamination was identified within the excavation areas. No groundwater nor significant water was encountered during trenching activities or in the test pits. The municipal landfill presumptive remedy of containment eliminated the need to further characterize the contents of the landfill. Site characterization efforts focused on landfill groundwater contamination and the extent of landfill gas.

Trees present on the landfill soil cover and steep slopes of the landfill area may undermine the integrity of the existing landfill cover by creating preferential pathways through the cover and promoting erosion, respectively. Some parts of the current landfill soil cover may be suitable for final capping purposes with modifications; however, the existing cover does not appear to meet thickness and permeability requirements throughout the entire landfill. Therefore, the potential for surface water to infiltrate through the landfill contents to groundwater exists in certain areas.

Landfill Gas

Soil gas concentrations were measured at each 100-foot by 100-foot grid location across the landfill. Elevated levels of methane were detected in the historical waste area; however, no detections were found near the residential properties in OU1. The landfill soil gas screening results are shown on Figure 8. The highest methane concentrations were generally centered in the middle of landfill near the pond. Methane and carbon dioxide screening results should be considered relative and used only as a screening tool for comparison to other locations on site and for further assessments. PID concentrations ranged in concentrations with the highest concentrations detected along the northern property boundary at the northern to eastern portion of the site, west of Pond 1 in the center of the site, and in grid H10.

Soil borings were advanced east of the landfill disposal area (between the disposal area and the adjacent house) and screened for landfill gas. Based on the soil boring data, it appears that methane vapors are not migrating beyond the property boundary to the northeast and east.

Soil gas probes installed throughout the site detected a total of 14 VOCs (benzene, chlorobenzene, chloroform, cyclohexane, dichlorodifluoromethane [CFC 12], ethylbenzene, m,p-Xylenes, o-xylene, tetrachloroethene, toluene, trichloroethene, 1,2,3-trimethylbenzene, 1,2,4-trimethylbenezne, and VC) above the Vapor Intrusion Screening Level (VISL) for exterior soil gas at various locations throughout the site (Figure 9). Each location contained at least one VOC analyte that exceeded the VISL. Methane was detected at all locations in at least one phase of the investigation.

Soil gas sampling locations installed on the landfill parcel directly off the landfill cap contained concentrations exceeding one or more EPA VISLs. Two samples contained elevated concentrations of common fuel elements benzene and toluene. Methane was detected but at concentrations ranging from non-detect to 78 parts per million by volume (ppmV). VOC and methane results at the northwest perimeter indicate the migration of common fuel constituents (benzene and toluene), methane at 45,000 ppmV or 4.5 percent, and PCE at 15 parts per billion by volume (ppbV). These results indicate the potential for soil gas migration to be moving off the landfill to the northwest.

Landfill Groundwater

Landfill groundwater samples were collected from upgradient and downgradient VAS borings, monitoring wells located north and south of the landfill, and one landfill-cased boring located in the landfill footprint. Although odors of chlorinated compounds were detected in excavated soils from landfill test pit trenches, no specific source of contamination warranting hot spot removal of landfill contents was identified.

A sample collected from the landfill-cased boring indicated that no VOCs were detected, except for carbon disulfide at a concentration of 0.12 J µg/L.

The regional groundwater flow direction is southerly. Analytical results for groundwater samples collected at locations upgradient and at the residential properties east of the landfill indicate no VOCs were detected above MCLs. Transect B, shown on Figure 10 is located just south of the OU1 boundary and is used to estimate the extent of landfill groundwater plume migrating from the OU1 boundary. VC concentrations greater than the MCL were used to define the plume edge at the southern end of the landfill. The plume is approximately 250 feet wide near the landfill and expands to approximately 500 feet wide along Transect B, extending from VAS B9 to VAS B2. The plume is approximately 45 feet thick, varying from between 12 and 55 feet bgs to between 45 and 88 feet bgs, and approximately 3,000 feet long. The highest concentrations of VOCs detected were at VAS-B8: cis-1,2-DCE at 270 ug/L (62-66 feet bgs); VC at 31 ug/L (32-36 feet bgs). At permanent monitoring well MW-002S, the highest concentration of PCE was 13 ug/L, and the highest concentration of TCE detected was 15 ug/L. No non-aqueous phase liquids were identified at the site.

The NCL Site is the source of VOCs in groundwater found downgradient in OU2. Sampling along VAS transects C, D, E, and F delineated the plume area during the RI. The highest concentrations of VOCs were found in MW-003S with VC 130 ug/L, and MW-003D, DCE at 200 ug/L located on the Gastineau property. The extent of select VOCs based on the RI results is shown on Figure 10 and 11.

Vapor Intrusion at OU1 Residential and Commercial Properties

Indoor air samples and a sub-slab soil gas sample were collected from two residential buildings located adjacent to landfill property on the east (Figure 9). Indoor air and sub-slab sample VOC results were compared to their respective EPA VISLs. A total of three VOCs (benzene, ethylbenzene, and 1,2,4 trimethylbenzene) were detected in indoor air samples at concentrations above indoor VISL. None of these VOCs were detected in sub-slab samples above EPA VISLs (Figure 9).

Indoor air and sub-slab soil gas samples were collected from a commercial building located at the northeast part of the landfill property. Indoor air and sub-slab sample VOC results were compared to their respective EPA VISLs. Two VOCs (benzene and ethylbenzene) were detected in an indoor air sample at concentrations above indoor VISL (Figure 9). However, no VOCs were detected in sub-slab samples or in exterior soil gas above VISLs. Benzene was detected in the ambient air sample at a concentration above its VISL indoor air screening level.

Although 1,2,4-trimethylbenzene, 1,2-dichloroethane, benzene, and ethylbenzene were detected in soil gas and indoor air samples at the commercial industrial property and the residential properties, there is uncertainty as to whether these analytes are landfill-related because of the inconsistency of detections and no clear migration trends showing a completed vapor intrusion pathway. The presence of VOCs above the VISLs in the indoor air sample but below the VISLs in the sub-slab soil gas sample may indicate that the VOCs detected above VISLs in indoor air are from VOC source within the building itself, as the VOCs detected are found in various household products.

The consideration for vapor intrusion at the commercial property and the two residential properties in OU1 to be site-related is based on the possibility that landfill gas is potentially migrating laterally through the vadose zone toward these properties. Landfill gas can migrate radially in all directions from the landfill, while groundwater flows in one general direction. RI results indicate that the VOC groundwater plume emanating from the landfill is migrating south (not east toward the commercial and residential properties); thus, vapor intrusion, if site related, would more likely be the result of landfill gas migration. This is consistent with the four contaminants 1,2,4-trimethylbenzene, 1,2-dichloroethane, benzene, and ethylbenzene found in soil gas and indoor air samples also being detected in the soil gas probes installed on the landfill parcel.

Additionally, during the RI soil gas samples were taken at properties on the eastern side of North Dayton-Lakeview Road. There were no detections for methane or other site related contaminants.

Ponds and Surface Water
The two freshwater ponds are the most ecologically valuable habitat associated with the site. No endangered species have been observed in the vicinity of the site. Co-located surface water (SW) and sediment locations were sampled for VOCs, semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. In addition, sediment samples were also submitted for acid-volatile sulfide and simultaneously extracted metals (AVS/SEM) laboratory analysis. Surface water sample results were compared to the EPA Screening Level (SL) for tap water, EPA MCLs, and Ohio EPA's Outside Mixing Zone Average (OMZA) for non-drinkable water. No analytes exceeded screening levels for VOCs and only one SVOC was detected above screening levels. Sampling locations and results are shown on Figure 12. One sample location contained naphthalene (6.0 μg/L) exceeding the tap water SL of 0.14 μg/L. Other SVOCs detected were below their respective screening criteria. One duplicate sample location contained beta-BHC (0.038 J μg/L) exceeding the tap water SL of 0.022 μg/L; a sample taken at the same location was laboratory estimated as non-detect. No other pesticides exceeded screening levels. PCBs were not detected in any of the surface water samples. Eight inorganic analytes (aluminum, arsenic, cobalt, iron, lead, manganese, mercury, and vanadium) were detected above the screening level in at least one surface water sample. Arsenic and lead exceeded the MCL at least one surface water samples, and mercury exceeded the OMZA at one location.

All sediment samples were analyzed for VOCs, metals, pesticides and PCBs, SVOCs and AVS/SEM laboratory analysis. Sediment sample results were compared to the residential soil EPA SLs. All sample results were below laboratory detection limits or EPA SLs for VOCs, SVOCs, pesticides, and PCBs. Arsenic exceeded EPA SLs of 0.39 milligrams per kilogram (mg/kg) at all locations with concentrations ranging from 5.8J to 12.2 mg/kg. All other metals detections were below EPA SLs. AVS/SEM results from sediment samples collected from three locations in Pond 1 and four locations in Pond 2 had SEM/AVS ratios ranging from 0.048 to 0.32. SEM/AVS ratios less than 1 indicate that inorganics present in the sediment are bound to sulfides, which limit their bioavailability to fish and invertebrates.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The New Carlisle Landfill parcel currently is a vacant property with heavy vegetation and two ponds. Access is restricted due to the topography, heavy vegetation, and lack of access from the road. The landfill is zoned for commercial industrial use. Reasonably anticipated future land use is assumed to be the same as present land use, commercial industrial. Adjacent to the landfill are two residential properties, and one commercial property that is zoned commercial industrial. Future land use on the residential and commercial buildings are not expected to differ from the current land use.

Groundwater underneath the landfill parcel is not used and is not expected to be used in the future. Groundwater is used at the two properties adjacent to the landfill parcel and upgradient from the landfill groundwater plume; no VOCs have been detected in these wells. Downgradient from the site groundwater is used for irrigation purposes in OU2. The site is located above the Great Miami Buried Valley Sole Source Aquifer System area in Clark County and there is the potential for future groundwater use for residential purposes in OU2, located approximately 2500 feet south of the landfill parcel. There is no current surface water use, and no anticipated future surface water use associated with the Site.

Institutional Controls (ICs) for the landfill media could include administrative constraints on potential land use to protect the integrity of the cap and limit direct contact of potential receptors with waste over the long term and eliminate the consumption of groundwater by prohibiting installation of water wells.

Engineering Controls (ECs) could include fencing, posted signs, or other site-security measures to restrict access to the landfill property as necessary.

2.7 SUMMARY OF SITE RISKS

This section of the ROD summarizes the current information available about the Site. Human Health Risk Assessment (HHRA) and Screening Level Ecological Risk Assessment (SLERA) technical memorandum were conducted as part of the RI for the Site. The risk assessments evaluated potentially exposed populations and pathways.

As mentioned above, the NCL Site and surrounding areas are zoned for residential or commercial/ mixed use and future land use is not expected to differ from the current land use. Therefore, a range of potential future users were evaluated including residential, commercial worker, construction worker, utility worker, and trespasser users.

Findings of the landfill investigation included analytical evidence of methane, a VOC, being produced in the landfill area, the absence of a properly engineered landfill cap, and the existence of elevated PID readings in a small area along the southern portion of the landfill. Results of the surface water and sediment investigation indicated no VOCs above the established screening criteria, however, one SVOC was detected in the surface water and inorganics were detected above the established criteria in both surface water and sediments. The vapor intrusion investigation results for the properties located on the eastern side of the landfill indicated the presence of benzene and ethylbenzene above screening levels in the indoor air sample as well as the presence of those analytes below screening levels in the sub-slab samples indicating a potentially viable pathway.

2.7 HUMAN HEALTH RISKS

2.7.1 HUMAN HEALTH RISK ASSESSMENT

The baseline risk assessment estimates the risks posed by the site if no action is taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this site. The baseline HHRA evaluated receptor exposure to site contamination associated with current and reasonably foreseeable land uses. As previously mentioned, the land use is commercial/industrial with two residential properties, and future land use is not expected to differ from the current land use. Accordingly, the current and future potential receptors for the NCL Site include residential, commercial worker, construction worker, utility worker, and trespasser users. Potential exposure to contaminants in groundwater, surface water, sediment, indoor air, and soil gas were evaluated in the HHRA.

Human health COPCs were identified in surface water, sediment, on-site soil gas, on-site indoor air, and on-site sub-slab vapor. Direct contact threat with landfill surface soils and landfill contents were found to not pose a risk due to the nature of the existent cap at the site. The two residential groundwater wells located in OU1 upgradient from the landfill have had no detections for COPCs and are acceptable for residential drinking. The utility groundwater, construction groundwater, and off-site soil gas was also assessed, but were found to not pose a risk to receptors who might be exposed to the media.

Exposure routes considered include ingestion, dermal contact, and inhalation. Standardized toxicity criteria developed and used by the EPA were used in conjunction with the exposure assessment to characterize carcinogenic risk and non-carcinogenic hazards for each media and receptor. A COPC was considered to present a current and/or future potential unacceptable risk if the risk was greater than EPA's target (acceptable) range for Excess Lifetime Cancer Risk (ELCR). Similarly, the target (acceptable) non-cancer hazard index (HI) is 1.0 or less. When the ELCR or HI is above their respective acceptable levels, action is generally warranted to mitigate the risk; when risk is below this level, action is generally not warranted unless there are adverse environmental impacts.

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

Risk = CDI x SF

where:

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

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure 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 "excess lifetime cancer risk" 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's developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all chemical(s) of concern 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<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where:

CDI = Chronic daily intake RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

A "threshold level" (measured usually as a hazard index of less than 1) exists below which non-cancer health effects are no longer predicted.

No significant human health exposure risks (>1 x 10^{-6}) or hazards (>1) were identified for Pond 1. Limited risks to on-site trespassers at low end of the acceptable risk range (2 x 10^{-6} to 4 x 10^{-6}), driven by potential exposure to heptachlor in sediment and arsenic (adult trespasser only) in surface water, were identified at Pond 2. The risk calculations for Pond 1 and 2 can be found in Table 2 of the attachments.

At the commercial property, total cancer risks from indoor air were within EPA's acceptable range for full-time commercial/industrial workers (5 x 10^{-6}) and for future potential on-site permanent residents (2 x 10^{-5}). Risks related to inhalation of indoor air were due to concentrations of benzene (resulting in a 1.1 x 10^{-5} residential risk and 2.5 x 10^{-6} full-time commercial/industrial workers risk) and ethylbenzene (resulting in a 9.9 x 10^{-6} residential risk and 2.3 x 10^{-6} full-time commercial/industrial workers risk). Significant noncancer indoor air hazards (HI >1) were identified for the commercial/industrial property only when calculated for future potential on-site permanent residents (HI=5 due to inhalation of 1,2,4-trimethylbenzene). The risk calculations can be found in Table 2 of the attachments.

Total cancer risks are within EPA's risk range for on-site permanent residents at the adjacent residential properties for indoor air, with the highest total risk value calculated for on-site permanent residents being 5 x 10^{-5}. Risks related to inhalation of indoor air were due to concentrations of benzene (highest risk calculated 2.1 x 10^{-5}), ethylbenzene (highest risk calculated 1.4 x 10^{-5}), 1,2-dichloroethane (highest risk calculated 1.0 x 10^{-5}), and 1,4-dichlorobenzene (highest risk calculated 3.2 x 10^{-6} for Property 3). Noncarcinogenic hazards (HI >1) were identified due to indoor air (vapor intrusion), to residents via inhalation of 1,2,4-trimethylbenzene. Although VOCs were detected in the indoor air residential samples that indicate unacceptable noncarcinogenic hazards, the associated sub-slab soil gas samples were below VISLs and may indicate that the VOCs detected above VISLs in indoor air are from VOC source within the building itself, and not site-related. The indoor air risk calculations can be found in Table 2 of the attachments (see Note 2).

VOC-contaminated OU1 groundwater at the NCL Site does not pose a current or future unacceptable risk to OU1 receptors. The two residential wells are located upgradient from the landfill parcel, are not impacted by landfill groundwater, and meet federal and state drinking water standards. The OU1 groundwater under that landfill waste management unit is not appropriate for use as a future drinking water source. However, contaminated groundwater does pose an unacceptable future risk to OU2 receptors. The future risks due to consumption of OU2 groundwater will be considered in the development of the presumptive remedy for landfill groundwater containment.

2.7.2 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

The purpose of the ecological risk assessment was to evaluate current and potential future ecological risks associated with ecological exposure to site-related constituents primarily in or around the two shallow ponds located on-site. Pond 1 and Pond 2 surface water and sediment concentrations were compared with surface water and sediment ecological screening values (ESV) to evaluate the potential impact of the contaminants to aquatic receptors in the freshwater ponds.

The two freshwater ponds are ecologically valuable habitat associated with the site. Concentrations of several constituents, primarily metals, cyanides, VOCs, and pesticides in the surface water and sediment at the site, exceed SLERA ESVs for benthic and aquatic receptors. Pond 1 is located on the landfill cover in an area of subsidence. Pond 1 surface water contaminants may pose a potential risk for adverse effects. Pond 1 sediment contaminants were not widespread and, therefore, were determined to not pose a potential risk for adverse effects. Remedial action is proposed at Pond 1 due to its location on top of the landfill cover and is discussed as part of landfill contents and landfill gas remedial alternatives. Pond 2 sediment contaminants were either: 1) not widespread and, therefore, were determined to not pose a potential risk for adverse effects; or 2) once re-evaluated using EPA Region 4 guidance, determined to not exceed ESVs and Regional Screening Values and, therefore, do not pose a potential risk for adverse effects. This information and the AVS/SEM data, which reported that the divalent metals and silver are bound to the sulfides in the sediment, indicate the metals in the sediments are not likely to express toxicity to the benthic organisms in Pond 2. No remedial action is proposed for evaluation at Pond 2 based on ecological risks.

2.7.3 BASIS FOR TAKING ACTION

EPA's 1988 guidance on conducting the RI/FS states, "The objective of the RI/FS process is not the unobtainable goal of removing all uncertainty but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site." The extent of contamination caused by activities at the New Carlisle Landfill Superfund Site have been adequately defined to allow for the assessment of impacts to human health and the environment and selection of an appropriate Site remedy for OU1.

Data used to adequately define the extent of soil and sediment contamination included historical Ohio EPA and EPA investigation results, publications, (site geology and academic resources), and results from EPA's remedial investigation.

The cancer and non-cancer risks posed to OU1 receptors are limited to risk posed by inhalation of benzene, ethylbenzene, 1,2-dichoroethane, 1,4-dichlorobenzene, and 1,2,4-trimethylbenzene in indoor air through the potentially viable vapor intrusion pathway from landfill gas. These contaminants are found at levels exceeding VISLs on the landfill parcel and have been detected in the sub-slab at the residential properties below VISLs. Actions will be pre-emptive because some measured indoor air risk is in EPA's acceptable risk range, and sub-slab data is not consistent with indoor air data.

The COCs for the vapor intrusion pathway are:

- Ethylbenzene
- 1,2-dichoroethane
- 1,4-dichlorobenzene
- 1,2,4-trimethylbenzene

Although groundwater emanating from the NCL landfill does not pose an unacceptable risk to current or future OU1 receptors because groundwater under the waste management unit is not appropriate for potable use, groundwater does pose an unacceptable potential risk to OU2 receptors. As such, OU2 COCs will be considered in the development of the presumptive remedy for OU1 landfill groundwater containment. The primary COCs detected in groundwater at the NCL Site are VOCs. The COCs for groundwater:

- PCE
- TCE
- cis-1,2-DCE
- Vinyl chloride.

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

2.8 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are goals for protecting human health and the environment. RAOs are developed to address the contaminant levels and exposure pathways that present unacceptable current or potential future risk to human health and the environment. For OU1, the RAOs were developed to address compliance with EPA and Ohio state laws relating to landfill closure and unacceptable risks to OU1 residents based on exposure to the vapor intrusion pathway. RAOs were developed for the NCL Site based on the contaminant levels and exposure pathways estimated to pose an unacceptable potential risk to human health and the environment, as determined during the RI. RAOs also facilitate the five-year-review determination of protectiveness of human health and the environment.

The RAOs for New Carlisle Landfill OU1 were developed based on site-specific risks and presumptive remedy for CERCLA municipal landfills. The presumptive remedy for CERCLA municipal landfill sites calls for source containment of landfill media. Components of the landfill presumptive remedy include engineering controls, a landfill cap, source area groundwater control, leachate collection and treatment (if necessary), management of landfill gas, and institutional controls to supplement engineering controls.

As mentioned above, groundwater emanating from the NCL landfill does not pose an unacceptable risk to OU1 receptors, but VOC-contaminated groundwater does pose an unacceptable risk to OU2 receptors. OU2 COCs are therefore considered in the development of the presumptive remedy for landfill groundwater containment. The primary COCs detected in groundwater at the NCL Site are the VOCs PCE, TCE, cis-1,2-DCE, and VC. Groundwater contamination is primarily present in a narrow VOC plume originating from the landfill, extending south, and currently terminating between MW-005 and MW-006.

The potential cancer and non-cancer risks posed to OU1 receptors are limited to risk posed by inhalation of benzene, ethylbenzene, 1,2-dichoroethane, 1,4-dichlorobenzene, and 1,2,4-trimethylbenzene in indoor air. While there is some uncertainty as to whether the analytes detected in sub-slab soil gas and indoor air samples are landfill-related because of the inconsistency of detections in the sub-slab, the potential for vapor intrusion from landfill gas is considered a viable pathway.

The following RAOs apply to the landfill contents and gas:

- Prevent direct contact with landfill contents
- Control surface water run-on and run-off
- Prevent migration of COCs into groundwater by minimizing infiltration
- Control landfill gas concentrations (methane) to prevent the build-up of explosive concentrations

The following RAO applies to landfill groundwater:

- Prevent site-related COCs in groundwater from migrating outside the OU1 boundary

The following RAO applies to Vapor Intrusion at on-site buildings:

- Prevent current and future permanent residents at OU1 residential properties and future full-time commercial/industrial workers at OU1 commercial/industrial properties from exposure to site-related COCs in indoor air at concentrations that pose an ELCR of 1×10^{-6} or greater or a non-cancer hazard greater than 1

Remediation goals (RGs) are established as the proposed performance requirements and the main basis for measuring the success of the response actions. The RGs are based on applicable or relevant and appropriate requirements (ARARs) or are based on risk where no ARAR is currently available or protective of potential receptor(s).

The RGs for vapor intrusion are presented in the table below in Table 1:

Table 1. RGs for Indoor Air

Media	Area	COC	RG	Units	Basis[1]
Indoor Air (Residential/ Future Residential)	Onsite residential and commercial properties	1,2-Dichloroethane	1.1×10^{-1}	µg/m^3	2017 RSL
		1,2,4-Trimethylbenzene	63	µg/m^3	2017 RSL
		1,4-Dichlorobenzene	2.6×10^{-1}	µg/m^3	2017 RSL
		Benzene	3.6×10^{-1}	µg/m^3	2017 RSL
		Ethylbenzene	1.1	µg/m^3	2017 RSL

Notes:
[1] Risk concentrations in the HHRA were calculated using the 2016 VISL (Version 3.5.1), which are identical to the June 2017 residential air RSL, with the exception of 1,2,4-trimethylbenzene; therefore, the RG for 1,2,4-trimethylbenzene has been updated to reflect the more current RSLs
µg/m3 Micrograms per cubic meter
HHRA Human health risk assessment
RSL Regional screening level
VISL Vapor intrusion screening level

Because OU1 landfill groundwater COC containment is the remedial action objective, effectiveness will be assessed based on decreasing groundwater VOC concentrations downgradient of the containment system.

2.9 DESCRIPTION OF ALTERNATIVES

To address the RAOs described above, a variety of remedial alternatives were developed for each media at the Site that posed unacceptable risk. This section identifies remedial technology types and specific process options that were found to be potentially implementable at this Site. These process options were carried through the FS for a detailed evaluation for overall effectiveness, implementability, and cost.

The effectiveness of each process option was evaluated against other options within the same technology type in accordance with Title 40 CFR Part 300.430(e)(7)(i). The evaluation focused on the following factors:

- Potential effectiveness of a process option for meeting the RAOs.
- Potential impact on human health and the environment during implementation of a process option.
- Reliability and performance of a process option over time, considering conditions at the Site.

Pursuant to 40 C.F.R. Part 300.430(e)(7)(ii), the implementability evaluation considered both the technical and the institutional feasibility of implementing each remedial technology type and process option at the Site. Institutional aspects considered in the detailed evaluation included permit requirements, available equipment, available on-Site space, and skilled labor requirements. Remedial technology types proposed have been proven and are readily available.

Each process option was evaluated to assess whether its cost was high, low, or comparable with other process options for the same remedial technology type, in accordance with 40 CFR § 300.430 (e)(7)(iii). However, cost was considered the least important criterion at this stage of evaluation. Remedial technology types and process options not considered suitable for implementation at the Site were eliminated from further consideration.

The remedial action alternatives for NCL Site OU1 are presented below. The alternatives are numbered to correspond with the numbers in the 2019 OU1 FS Report and are further explained in that document. The evaluated response actions at NCL were developed to address different media: the landfill contents and landfill gas (LF alternatives), groundwater (GW alternatives), and vapor intrusion (VI). The remedy at NCL OU1 will have a remedial technology selection for each media. A more detailed description of each alternative that was carried through the FS is provided in Appendix 2, and additional details about each alternative are contained in the FS Report, Proposed Plan, and other documents in the AR. All cost estimates assumed a 7% discount rate. A table summarizing these alternatives can be found below in Table 2:

Table 2: Remedial Action Alternatives

Alternative No.	Alternative Name
Landfill Contents and Landfill Gas	
LF-1	No Action
LF-2	Multilayer cap, Passive gas venting, waterline extensions, and land use controls
LF-3*	Enhancing existing cover, Passive gas venting, waterline extension, and land use controls
Landfill Groundwater	
GW-1	No Action
GW-2A*	In-Situ GW Treatment: ERD PRB- direct push injection
GW-2B	In-Situ GW Treatment: ISCO PRB- direct push injection
GW-2C*	In-Situ GW Treatment: ISCR (ZVI) PRB- direct push injection
GW-3	GW Extraction, Treatment, and Discharge to SW
Vapor Intrusion	
VI-1	No Action
VI-2	ICs and Monitoring
VI-3	Foundation Sealing and ICs
VI-4*	Sub-slab Depressurization Systems and ICs

*denotes the highest-ranking alternatives in each category

LF Landfill
GW Groundwater
ERD Enhanced Reductive Dechlorination
PRB Permeable Reactive Barrier
ISCO In-Situ Chemical Oxidation
ISCR In-Situ Chemical Reduction

2.9.1 LANDFILL CONTENTS AND LANDFILL GAS ALTERNATIVES

The landfill contents and landfill gas alternatives are (1) no action; (2) multilayer cap, passive gas venting, waterline extensions, and land use controls; and (3) enhancing existing cover, passive gas venting, waterline extension, and land use controls. Detailed cost estimates can be found in Appendix B.

Alternative LF-1: No Action
The no action alternative is required to be evaluated under the NCP as a baseline against which all other alternatives are compared. Under this alternative, no remedial actions would be taken to ensure proper long-term closure of the landfill or monitor the existing cover. Additionally, this alternative would not include landfill gas management or land use controls (LUCs).

Estimated Capital Cost: $0
Estimated Annual Operation and Maintenance (O&M) Cost: $0
Remedial Action Construction Timeframe: 0

Common Elements for LF-2 Multi-layer Cap and LF-3 Enhancing Existing Cover
Components that are common to the landfill content and landfill gas LF-2 and LF-3 alternatives are presented here as a group to limit redundancy in the subsequent discussion of the individual alternatives.

Both LF-2 and LF-3 follow the landfill presumptive remedy of containment. The common components between LF-2 and LF-3 are:

- LUCs include ICs and ECs: ICs for the landfill media could include administrative constraints on potential land use to protect the integrity of the cap and limit direct contact of potential receptors with waste over the long term and eliminate the consumption of groundwater by prohibiting installation of water wells. Reasonably anticipated future land use is assumed to be the same as present land use, commercial/ industrial. ECs would include fencing, posted signs, or other site-security measures to restrict access to the landfill property.
- Initial site preparation would consist of clearing, grubbing, and grading. The landfill would have to be cleared and grubbed to remove existing vegetation. The landfill would also be graded to ensure proper slopes, provide a uniform soil foundation layer, and promote drainage.
- Passive gas vents would be installed in the landfill to prevent the build-up of methane and other compounds. The design and construction of the gas venting system would be further evaluated in the predesign phase. According to typical construction guidelines, a spacing of about 200 feet between each vent is estimated, allowing for approximately 20 vents to be installed in the landfill.
- Pond 1 would be filled in with existing on-site soil. Waste may be consolidated from the landfill edges to the interior to reduce the overall footprint of the cap. Pond 2 could also be affected by the toe of the landfill cap and may also need to be backfilled or partially backfilled. As required by Ohio ARARs, compensatory wetlands would need to be created to compensate for the lost habitat associated with the pond(s) and its surrounding area. Options for wetland mitigation will be evaluated further during the design phase of the project.
- OAC on Private Water Systems (OAC 3701-28-07v1) requires new private water systems to be located a minimum distance of 1,000 feet away from operating and closed municipal solid waste, residual waste, or industrial waste landfills. Private wells at OU1 properties, do not have that required isolation distance. Therefore, although the RI data and HHRA show no significant current risk ($\geq 1 \times 10^{-6}$) or hazard (> 1) from potable water use at these locations, for future protectiveness, the option of a municipal water connection will be provided to property owners. The private wells at these three properties will be abandoned. The buildings that would be connected to the municipal public water system includes the two residential properties and one commercial/ industrial property. Should a property owner decline connection to the municipal public water system, EPA will document the denial, and the property ownership of the residence would be monitored so that future owners could be given the option for municipal connection.
- Annual inspections of the integrity of the landfill cap and preparation of annual inspection report, landfill repairs, and mowing to prevent the growth of deep-rooted plants would be conducted.
- Five-Year Review (FYR) would be required because hazardous substances would remain on site above levels that permit unlimited use and unrestricted exposure. The FYR would provide an opportunity to evaluate the implementation and performance of the remedy to determine whether it remains protective of human health and the environment.
- RAOs for landfill soils and gas would be met with successful implementation of LF-2 and LF-3.

Alternatives LF-2 and LF-3 would be designed to comply with the substantive requirements of the ARARs and To Be Considered (TBC). The key ARARs and TBCs for the LF alternatives are:

<u>Action-specific:</u>
ARARs and TBCs address the management of hazardous and/or non-hazardous
waste, capping requirements for landfills. Construction and/or excavation activities will comply with the substantive requirements of these provisions:

- Federal: Closure/ Post-Closure [RCRA 40 CFR 258.16]
    - Provides requirements site closure, Operation and Maintenance (O&M), monitoring, and site use for capping remedies

- Federal: Disposal of Non-Hazardous Solid Waste in Land Disposal Unit [RCRA 40 CFR 258.40]
  - Provides standards for design and operation for land disposal
- Federal: Corrective Action for Solid Waste Management Units [RCRA 40 CFR 50.6-50.7]
  - Provides requirements for consolidation (re-depositing) of hazardous waste on-site
- State: Air Emissions from Hazardous Waste Facilities [ORC 3704.05 (A-I)]
  - Provides requirements for air emissions at hazardous waste facilities
- State: Disturbances Where Hazardous or Solid Waste Facility Was Operated [OAC 3745-27-13 (A, C)]
  - Requires detailed plans for filling, grading, excavating, or drilling on waste facility land
- State: Sanitary Landfill Explosive Gas Monitoring [OAC 3745-27-12 (A-Q)]
  - Provides requirements for explosive gas monitoring at sanitary landfills
- State: Post-closure Care of Sanitary Landfill Facilities [OAC 3745-27-14 (A)]
  - Post-closure requirements for sanitary landfills

<u>Location-specific:</u>
ARARs and TBCs that address wetlands and endangered plants and animals:

- Federal: Wetlands Disturbance [CWA 40 CFR 230 to 233, 33 CFR 320 to 330]
  - No activity that adversely affects a wetland is permitted if a less damaging alterative is feasible.
  - Permits discharges of dredged or fill material to waters of the United States if no practicable alternatives exist that are less damaging to the aquatic environment
- State: Wetlands Antidegradation [OAC 3745-1-54 (A-D)]
  - Provides requirements for avoidance and minimization of wetlands damage as well as compensatory mitigation.

<u>*Alternative LF-2: Multi-layer Cap, Passive Gas Venting, and Land Use Controls*</u>
This alternative would consist of constructing a multi-layer cap over the landfill. A conceptual layout for this alternative is shown in Figure 13. Final landfill construction design details would be determined during the RD; however, the cap would be constructed to meet Ohio landfill closure requirements specified (OAC- 3745-27-08 (D) (24), 3745-27-11).

In addition to the common elements with LF-3 listed above, for cost estimating purposes, it is assumed that the cap would be constructed as described below and would cover an area of about 18 acres. The landfill cap would consist of the following layers, starting at the bottom:

- Engineered soil sub-base
- Geosynthetic clay liner (GCL)
- Sixty (60)-mil thick high-density polyethylene (HDPE) geomembrane
- Geocomposite layer, made up of two bonded overlapping 250-mil thick HDPE strands
- Ninety (90)-mil thick nonwoven polypropylene geotextile fabric
- Eighteen (18) inches of imported backfill
- Six (6) inches of topsoil

OAC 3745-27-8 (D) (24) requires that the flexible membrane layer (FML), also referred to as geomembrane, be placed over the clay barrier, or GCL. Both an FML and a GCL would be needed in a cap compliant with Ohio Solid Waste Rules. The FML and GCL would be placed on a soil foundation (subbase) layer. A geocomposite drainage layer would be placed on top of the geomembrane and GCL, where necessary, to provide a drainage path for water infiltrating through the vegetative and freeze/thaw layers. A 24-inch thick freeze/thaw protection layer (including a 6-inch topsoil layer) would cover the FML, GCL, and geocomposite drainage layer. The soil layer would be seeded to prevent erosion and induce evapotranspiration.

A general cost estimate for landfill cap construction of this nature is about $350,000 per acre. Given that the NCL is about 18 acres, the multi-layer cap capital cost is expected to be:

Estimated Capital Cost: $6,600,000
Estimated Land Use Controls: $187,000
Estimated O&M Cost (Present Value for 30 years): $1,331,000

Estimated Present Worth Cost: $8,118,000
Estimated Remedial Action Construction Timeframe: 3-4 months
Total Project Duration: 30 years

Alternative LF-3: Enhancing Existing Cover, Passive Gas Venting, and Land Use Controls
Alternative LF-3 is similar to Alternative LF-2; however, instead of constructing a new cap, the existing soil cover would be reworked by grading, supplementing with off-site low permeability soil, and compacting it to meet landfill closure requirements. A conceptual layout for this alternative is shown in Figure 13. Final landfill construction details would be determined during the RD; however, the cover would be constructed to meet Ohio landfill closure requirements specified in OAC- 3745-27-11.

In addition to the common elements with LF-2 listed above, for cost estimating purposes, it is assumed that the cap would cover an area of 18 acres. Based on the preliminary analysis of existing cover material, some parts of the current cover meet typical landfill thickness and exceed the OAC 3745-27-08 permeability requirement of $1x10^{-6}$ cm/sec; however, the existing cover does not appear to meet the thickness requirement throughout the entire landfill. More extensive testing would be needed to determine the level of existing cover enhancement needed to achieve site-wide compliance with the thickness and permeability requirements. Predesign studies may include, but are not limited to,: (1) a detailed topographic survey to establish the current landfill grade and develop a final grading plan; (2) additional soil type, thickness, and permeability investigations; (3) geotechnical testing of existing soil; and (4) geotechnical testing of potential borrow source soils.

Existing soil cover would also be graded and compacted as a subbase to ensure appropriate slopes, provide a uniform soil cover thickness, and promote drainage. Additional low-permeability soil and other structural fill soil would need to be imported to supplement the existing soil cover material and to achieve the necessary 3 to 5 percent slope minimum. To further reduce infiltration through the enhanced existing cover, a geocomposite drainage layer, may be added above the compacted subbase to intercept infiltration and convey it laterally off the compacted subbase. The imported soil volume calculations and the necessity of adding a geocomposite drainage layer would be determined during the RD. A vegetative soil layer consisting of at least 24 inches of imported soil to support plant growth would cover the regraded and compacted low permeability soil cover. The vegetative soil layer would include a 6-inch topsoil layer and be seeded to prevent erosion and induce evapotranspiration.

The cost of this alternative could be substantially lower than the cost for constructing a multi-layer cap. It would largely depend on the amount of suitable existing soil and how much additional low-permeability soil and structure fill soil would be needed. If predesign studies show that the RI assumptions about the current landfill cover are not valid, then the amount and cost of imported low permeability soil could increase to a point where it may be more feasible to construct LF-2. Assuming the cap is largely suitable, the enhanced cap capital cost is expected to be:

Estimated Capital Cost: $4,562,000
Estimated Land Use Controls: $187,000
Estimated O&M Cost (Present Value for 30 years): $1,331,000

Estimated Present Worth Cost: $6,080,000
Estimated Remedial Action Construction Timeframe: 2 months
Total Project Duration: 30 years

2.9.2 LANDFILL GROUNDWATER ALTERNATIVES

The groundwater remedial alternatives are: (1) no action; (2) in-situ containment and treatment of groundwater; and (3) groundwater extraction and treatment. Cost estimates are provided for the permeable reactive barrier (PRB) containment process option using enhanced reductive dechlorination (ERD), in-situ chemical oxidation (ISCO), and in-situ chemical reduction (ISCR) as individual in-situ treatment components. Therefore, groundwater Alternative GW-2 consists of an in-situ treatment PRB presented in three variations: GW-2A: ERD, GW-2B: ISCO, and GW-2C: ISCR. Pilot and treatability studies conducted as part of the RD phase may evaluate whether a combination of these in-situ technologies would be best suited for OU1 groundwater remediation. Cost estimates are in Appendix B.

Groundwater Alternative GW-1: No Action
The No Action alternative is required to be evaluated under the NCP as a baseline against which all other alternatives are compared. Under this alternative, no remedial actions would be taken to reduce existing risk at the NCL Site related to future use of OU2 groundwater and returning groundwater to beneficial use.

Estimated Capital Cost: $0
Estimated O&M Cost: $0
Remedial Action Construction Timeframe: 0

Common Elements GW-2: In Situ Groundwater Treatment
Components that are common to the groundwater alternatives GW-2 are presented here as a group in to limit redundancy in the subsequent discussion of the individual alternatives. All alternatives use a permeable reactive barrier, or PRB. A PRB is a vertical treatment wall constructed perpendicular to groundwater flow and designed to let groundwater and contaminants flow through the treatment zone. Typically, PRBs are designed to provide adequate residence time in the treatment zone for the degradation of the parent compound and all toxic intermediate products that are generated.

The groundwater monitoring well network would be expanded to monitor and evaluate contaminant concentrations upgradient of the PRB, within the PRB, and downgradient of the PRB. Because the PRB would be installed within the groundwater contaminant plume, the monitoring objectives would be performance-based rather than compliance-based. The cost estimate includes installation of 10 shallow and 10 deep monitoring wells, and (1) groundwater sampling prior to treatment to obtain a baseline (included in the pilot study cost estimate); (2) quarterly groundwater monitoring for the first 2 years after the first injection event, (3) semi-annual groundwater monitoring for the following 5 years, and (4) annual groundwater monitoring for the remaining period of the 30-year monitoring timeframe. Groundwater performance monitoring would be used to determine the effectiveness of the in-situ groundwater treatments and when additional injection events are necessary. Groundwater performance monitoring would include sample analysis for field parameters (oxidation-reduction potential, pH, dissolved oxygen, temperature, and conductivity), VOCs, total organic carbon, cations, anions, alkalinity, dissolved gases, and dissolved metals. The shallow and deep well locations shown on Figure 14 and Figure 15 are conceptual and the final locations and depths would be determined in the RD. Additionally, GW-2 alternatives would employ ICs to restrict the use of groundwater at the site.

The groundwater RAOs would be achieved using GW-2 in-situ groundwater treatment alternatives. In-situ groundwater treatments using a PRB and monitoring is consistent with the landfill presumptive remedy for containment of contaminated groundwater.

Alternative GW-2 would be designed to comply with the substantive requirements of ARARs and To Be Considered (TBC). The key ARAR for the Alternative GW-2 is:

<u>Action-specific:</u>
ARARs address underground injection. Construction activities will comply with the substantive requirements of these provisions:

- State: Underground injections Control [OAC 3745-34-06]
    - Underground injections prohibited except by permit or rule

<u>*Groundwater Alternative GW-2A: Enhanced Reductive Dechlorination Permeable Reactive Barrier*</u>
This alternative would create an in-situ treatment barrier to passively contain the contaminant plume through targeted bioremediation of groundwater upgradient of the site boundary. Figure 14 shows a conceptual layout for this alternative. Contaminated groundwater would flow through the treatment zone and treated groundwater will be discharged. The in-situ treatment barrier would be maintained for as long as a contaminant plume emanates from the landfill.

ERD is the preferred bioremediation technology since the geochemistry at the site indicates a reducing environment which is favorable toward the reducing chemical reaction between the bioamendment and VOCs. ERD would involve injection of biological amendments into groundwater. Amendments would include electron donors and bacterial cultures.

The specific ERD amendments to be used and the need for bioaugmentation would be further evaluated during the RD. Proprietary slow-release formulations containing vegetable oil or lactate are widely used and would likely be considered. Several slow-release products were considered for this alternative. The slow-release products contain or can be bioaugmented with dehalococcoides (DHC) bacteria, which stimulate dechlorination of chlorinated solvents. Pilot tests would likely be required during the RD to determine the actual design parameters, such as achievable injection flow rate, radius of influence, and injection pressure as well as the appropriate amendment dosing quantities to achieve dechlorination.

For cost estimating, it is assumed that ERD amendments and bacterial cultures would be injected into groundwater through temporary boreholes using direct-push technology. The design would require one initial injection event with additional injection events every 3 years to account for contingencies with the effectiveness of the product and potentially continuing source. An estimated 60,000 pounds of lecithin-based substrate, 6,000 pounds of pH buffering solution, and 200 liters of DHC inoculum are required for each injection event. Approximately 50 gallons of the bioamendment mix would be injected per vertical foot. Pilot testing or treatability studies would be needed during the RD to refine these estimates.

Based on an estimated 8-foot radius of influence, injection points would be evenly arranged in two staggered east-west rows with a spacing of approximately 15 feet between each injection point. The targeted treatment area would measure approximately 400 feet perpendicular to groundwater flow and 30 feet wide. Its dimension along groundwater flow would depend on treatment kinetics and would be refined during the RD. The depth of application would be throughout the entire targeted vertical contamination interval. Additional VAS may be conducted near VAS-B10 during the RD to further define the treatment depth at this location.

This alternative would have moderate capital costs and moderate to high O&M costs due to the contingency injections and groundwater monitoring events. The costs for GW-2 ERD are estimated at:

Estimated Capital Cost: $1,051,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $2,302,000

Estimated Present Worth Cost: $3,367,000
Total Project Duration: 30 years

Groundwater Alternative GW-2B: In-Situ Chemical Oxidation Permeable Reactive Barrier
This alternative would create an in-situ treatment barrier to passively contain the contaminant plume through targeted chemical oxidation in groundwater upgradient of the site boundary. Figure 15 shows a conceptual layout for this alternative. Contaminated groundwater would flow through the treatment zone, and treated groundwater would be discharged, effectively containing contaminated groundwater at the PRB. The in-situ treatment barrier would be maintained via periodic injections or continuous delivery for as long as a contaminant plume emanates from the landfill.

Permanganate and persulfate are widely used for chemical oxidation of VOCs and would be evaluated during RD design pilot or bench tests, with final selection to be made during the RD. Persulfate is typically more persistent in the aquifer than permanganate where maintaining an oxidative state for a long period of time is critical and is likely to be more cost-effective than permanganate.

Persulfate reagents typically contain sodium persulfate-based products that employ a catalyst to enhance the oxidative destruction of both hydrocarbons and chlorinated contaminants. Sodium persulfate requires the addition of heat, chelated metals, hydrogen peroxide, or base for activation to generate sulfate radicals. The site geochemistry indicates a reducing environment. This is an issue because ISCO is an oxidizing process and ISCO reagents would need to overcome the reducing geochemistry and alter the environment for oxidation to begin the degradation of the VOCs. This results in a higher application rate and a shortened longevity of the oxidant, reducing its cost effectiveness. Pilot tests would be required during the RD to determine the actual design parameters, such as achievable injection flow rate, radius of influence, and injection pressure, and the appropriate amendment dosing quantities to achieve oxidation.

For the cost estimates, it was assumed that the ISCO reagents would be continuously injected into the saturated zone using permanent wells, periodically direct-push injected, or emplaced in boreholes as slow-release formulations (for example, permanganate candles). A pilot test would evaluate various delivery techniques. For the purposes of this FS cost estimate, the most common application method, direct-push injection, is assumed. After initial injection, re-injection events would be needed to maintain an oxidizing environment. The longevity of ISCO reagents is estimated to be 2 to 3 years. For cost estimating purposes, reinjection events would occur every 2 years to maintain the oxidizing environment. Each direct-push injection event would take approximately 3 months to complete. An estimated 150,000 pounds of sodium persulfate reagent would be mixed with water to create a 10 percent solution for each injection event. Approximately 40 gallons of oxidizing mixture would be injected per vertical foot. Pilot testing or treatability studies would be needed during the RD to refine these estimates.

The targeted treatment area, shown on Figure 15, would include injection points arranged in two staggered east-west rows with each point located approximately 10 feet apart. Tighter injection point spacing is needed because the oxidants need to overcome the existing reducing environment and then maintain the oxidizing environment. The proposed dimensions of the groundwater containment zone are approximately 400 feet long and 20 feet wide. The exact spacing would be determined during the RD. The depth of application would be throughout the entire targeted approximately 45-foot vertical contamination interval. Additional VAS should be conducted near VAS-B10 during the RD to further define the treatment depth at this location.

This alternative would have moderate to high capital costs and high O&M costs because of periodic injections and groundwater monitoring events. The costs for GW-2B ISCO are estimated at:

Estimated Capital Cost: $1,436,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $5,087,000

Estimated Present Worth Cost: $6,537,000
Total Project Duration: 30 years

<u>Groundwater Alternative GW-2C: In-Situ Chemical Reduction Permeable Reactive Barrier</u>
This alternative would create an in-situ treatment barrier to passively contain and treat the contaminant plume through targeted chemical reduction of groundwater upgradient of the site boundary. Figure 14 shows a conceptual layout for this alternative. Contaminated groundwater would flow via natural hydraulic gradient through the treatment zone, and treated groundwater would be discharged, effectively containing contaminated groundwater at the PRB. The in-situ treatment barrier would be maintained for as long as a contaminant plume emanates from the landfill.

ISCR involves the addition of electrons, usually from hydrogen, substituted for other ions, such as chloride ion in chlorinated solvents. Examples of chemical reductants include sulfide salts, zero valent metals, and iron sulfide, with Zero Valent Iron (ZVI) being the most common reductant. ZVI is available in various sizes that provide increased reactivity with smaller size based on greater surface area. ISCR creates a reducing environment, and direct contact with contaminants is not required. ISCR is an abiotic process that results in less daughter product formation. Pilot tests would likely be required during the RD to determine the actual design parameters, such as achievable injection flow rate, radius of influence, and injection pressure as well as the appropriate amendment dosing quantities to achieve dechlorination.

For the cost estimate, it was assumed that the proposed ISCR amendment for Alternative GW-2C would be composed of a ZVI substrate and DHC inoculum. These reducing agents would be injected and could persist in the subsurface for 5 to 7 years but may be altered depending on site conditions. As a contingency measure, this FS cost estimate includes additional injection events every 5 years. Each injection event would take approximately 3 months to complete through direct-push injection. An estimated 260,000 pounds of ZVI substrate and 200 liters of DHC culture would be required for each injection event. Approximately 30 gallons of ISCR reagent would be injected per vertical foot of treatment zone.

The targeted treatment area would be like Alternative GW-2A, as shown on Figure 14. Injection points would be evenly arranged in two staggered east-west rows with a spacing of approximately 15 feet between each injection point. The targeted treatment area would measure approximately 400 feet perpendicular to groundwater flow and 30 feet wide. Its dimension along groundwater flow would depend on treatment kinetics and would be refined during RD. The depth of application would be throughout the entire targeted 45-foot vertical contamination interval. Additional VAS should be conducted near VAS-B10 during the RD to further define the treatment depth at this location.

This alternative would have moderate to high capital costs and low to moderate O&M costs because of follow-up injections and groundwater monitoring. The costs for GW-2C ISCR are estimated at:

Estimated Capital Cost: $1,531,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $3,009,000

Estimated Present Worth Cost: $4,554,000
Total Project Duration: 30 years

<u>*Groundwater Alternative GW-3: Groundwater Extraction, Treatment, and Discharge*</u>
This alternative involves installation of a hydraulic capture zone barrier using a groundwater extraction and ex-situ treatment system. Figure 16 shows a conceptual layout for this alternative. Extraction wells would intercept the plume of contaminated groundwater and prevent its migration off site. The system would operate as long as a contaminant plume emanates from the landfill. Three to five extraction wells would be installed along the southern site boundary within the area of groundwater containment shown on Figure 16. A pilot study, including groundwater pump tests, would be performed to improve understanding of aquifer hydraulic conductivity and provide more accurate groundwater parameter inputs for capture zone groundwater modeling. The exact number of extraction wells, locations, and flow rates will be determined during the RD.

Extracted groundwater would be treated with an air stripper to remove VOCs, and possibly other non-COC contaminants. No off-gas treatment would likely be required. For the purposes of the cost estimate, it is assumed that the air stripper system will include a 300-gallons per minute tray-type air stripper, one 1,000-gallon chemical holding tank for anti-scalant treatment chemicals, and one chemical metering pump. Predesign groundwater sampling and analysis would be conducted. The Langelier index would be calculated to determine the corrosivity and scale-forming potential of the extracted groundwater and determine the need for anti-scalant chemical treatment. All process and control equipment would be housed in a 12-foot by 50-foot prefabricated treatment building in the southwest corner of OU1, west of the extraction wells. The system operation would be monitored on a weekly basis.

Treated water would be discharged via a 6-inch diameter HDPE pipeline to an outfall on Honey Creek, located approximately 1,800 feet north of the site and approximately 2,500 feet north of the proposed location of the air stripper system. System influent and treated effluent would be monitored for pH and sampled monthly for VOCs to meet substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit. It is assumed that background metals concentrations present in the groundwater would be below NPDES effluent limits and would not require regular monitoring.

The groundwater monitoring well network would be expanded to evaluate groundwater flow patterns (including hydraulic capture zones), natural attenuation parameters, and contaminant concentrations. After the start of extraction and treatment, quarterly groundwater monitoring would be performed for the first 2 years. Semi-annual groundwater monitoring would be implemented for the following 5 years, and annual groundwater monitoring would be performed for the remaining period of the 30-year monitoring timeframe. Monitoring and extraction well monitoring would include analysis for field parameters, VOCs, total organic carbon, cations, anions, alkalinity, dissolved gases, and dissolved metals. The monitoring well locations shown on Figure 16 are conceptual and the final locations and depths would be determined in the RD. GW-3 would also employ ICs to restrict the use of groundwater at the site.

Alternative GW-3 would be designed to comply with the substantive requirements of the ARARs and To Be Considered (TBC). The key ARARs and TBCs for Alternative GW-3 are:

<u>Action-specific:</u>
ARARs and TBCs address sampling for surface water discharge and water quality standards. Construction activities will comply with the substantive requirements of these provisions:

- State: Analytical and Collection Procedures [OAC 3745-1-03]
  - Specifies analytical methods and collection procedures for surface water discharges
- State: Water Quality Criteria [OAC 3745-1-07]

- Establishes water quality criteria for pollutants without specific numerical or narrative criteria identified in Tables 7-1 through 7-5 of this rule.

This alternative would have high capital costs and moderate to high O&M costs. A general cost estimate GW-3 Groundwater Extraction, Treatment, and Discharge is:

Estimated Capital Cost: $1,820,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $8,929,000

Estimated Present Worth Cost: $10,763,000
Total Project Duration: 30 years

2.9.3 VAPOR INTRUSION ALTERNATIVES

The OU1 vapor intrusion alternatives address vapor intrusion concerns at residential and commercial properties east of the landfill parcel. Vapor intrusion at the residential and commercial properties in OU1 may be site-related based on the possibility that landfill gas is migrating laterally through the vadose zone toward these properties. While the sub-slab soil gas concentrations were detected below the VISLs during the RI, it is unknown how implementation of the landfill remedy will alter the soil-gas pathway.

Two conditions for taking action are met: (1) vapor intrusion is potentially landfill-related, and (2) indoor air contaminant concentrations are elevated (although sub-slab contaminant concentration are not elevated). At the commercial building potential vapor intrusion risks are associated with potential future residential use of this property, should the property be converted to residential in the future. At the residential buildings vapor intrusion risks are associated with current and future residential use of these properties. Vapor intrusion alternatives will monitor and mitigate against risk related to vapor intrusion prior, during, and after construction of the landfill remedy. The vapor intrusion remedial alternatives for OU1 include: (1) no action; (2) ICs and monitoring; (3) foundation sealing; and (4) sub-slab depressurization system.

Soil Vapor Alternative VI-1: No Action
The no action alternative provides a reference to evaluate other alternatives. Under Alternative VI-1, no action would be taken to remediate vapor intrusion at OU1 under a remedial action. Under the no action alternative, no mitigation or removal system would be installed.

Estimated Capital Cost: $0
Estimated Land Use Controls: $0
Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $0
Total Project Duration: 0 years

Soil Vapor Alternative VI-2: Institutional Controls and Monitoring
This alternative would use ICs to prohibit future residential use of the commercial property or to require that future residential property development include an evaluation of whether vapor intrusion mitigation, as part of the new construction design, would be needed. VI-2 would also require continued soil gas monitoring at the residential properties. ICs would only be implemented if vapor intrusion was determined to be above action levels or would pose a threat to future building occupants.

Monitoring would be conducted at the residential properties to evaluate whether the presumptive remedy for landfill gas containment would reduce the soil gas concentrations sufficiently to address the vapor intrusion concerns. A sub-slab vapor monitoring point would be installed in each residential building. Semi-annual air monitoring would include collecting a sub-slab vapor sample, an indoor air sample, and background outdoor ambient air sample at each building. Semi-annual air monitoring would be conducted to account for seasonally changing concentrations over time. An annual monitoring report would be created to interpret and summarize findings from the semi-annual sampling events. If VOC concentrations exceed residential VISLs, further action would be taken. This alternative would have low capital and low to moderate O&M costs. The majority of the cost would be from O&M for the semi-annual monitoring events and summary report. The cost for Alternative VI-2 is estimated at:

Estimated Capital Cost: $4,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $211,000

Estimated Present Worth Cost: $229,000
Total Project Duration: 30 years

Soil Vapor Alternative VI-3: Foundation Sealing and Monitoring
Alternative VI-3 includes ICs to prohibit future residential use of the commercial property and foundation sealing to inhibit vapor intrusion at the residential properties. Alternative VI-3 ICs would be the same as those discussed in Alternative VI-2. The VI-3 alternative for vapor intrusion is pre-emptive. While the sub-slab soil gas concentrations were detected below the VISLs during the RI, it is unknown how implementation of the landfill remedy will alter the soil-gas pathway. The option for pre-emptive foundation sealing will be offered to two residents of the adjacent residential properties in OU1. General foundation sealing would focus on finding the main entry routes of vapor intrusion and sealing vapor intrusion pathways within the existing building foundations at the residential properties. Examples include main entry routes such as seams between construction materials (including expansion and other joints), utility penetrations and sumps, and foundation cracks. These main entry routes would be sealed with a concrete filler or hydraulic cement. The use of Retro-Coat or epoxy paint may be considered if a large concrete floor or wall would be sealed, or to better seal previously caulked materials in the concrete wall or floor. Before sealing, as well as after the foundation sealing application, ambient outdoor air background, sub-slab, and indoor air samples would be collected within the buildings and analyzed for methane and VOCs to determine whether general foundation sealing was effective.

Foundation sealing inspections would be conducted to evaluate the integrity of the sealing material. A sub-slab vapor monitoring point would be installed in each residential building. A monitoring report would be prepared to interpret and summarize findings from sampling events and foundation sealing inspections. Should a property owner opt not to have foundation sealing installed, EPA will continue monitor soil-gas at the property as described in VI-2. This alternative would have a low capital cost and low to moderate O&M costs. Costs may increase, depending on the condition of the building sub-slabs. The estimated cost of Alternative VI-3:

Estimated Capital Cost: $67,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $279,000

Estimated Present Worth Cost: $360,000
Total Project Duration: 30 years

Soil Vapor Alternative VI-4: Sub-Slab Depressurization System

Alternative VI-4 includes ICs and SSD systems to inhibit vapor intrusion at the residential properties. Alternative VI-4 ICs would be the same as those discussed in for Alternative VI-2. The VI-4 alternative for vapor intrusion is pre-emptive. While the sub-slab soil gas concentrations were detected below the VISLs during the RI, it is unknown how implementation of the landfill remedy will alter the soil-gas pathway. The option for pre-emptive vapor intrusion mitigation using sub-slab depressurization systems will be offered to the residents of the two residential properties adjacent to the landfill in OU1. Should a property owner opt not to have the sub-slab depressurization system installed, EPA will continue monitor soil-gas at the property as described in VI-2.

Alternative VI-4 actively removes soil gas from beneath the sub-slab, as shown on Figure 17. SSD involves creating extraction points in a basement floor, which are then connected to a small vacuum blower. The extraction points typically consist of 3- or 4-inch-diameter schedule 40 PVC that is routed through the foundation slab and into the sub-slab soils. The annulus around the pipe is sealed with non-shrink grout and polyurethane or silicone caulk. The PVC piping is routed outside the building from the extraction point, where the blower is located. The blower is typically attached to the side of the building and vented through PVC piping above the roof line where no windows or vents for the building are located. SSD systems have been extensively installed for use in radon mitigation. Radon mitigation is common in parts of the country and procedures for installing SSD systems are well documented.

Pre-installation tests and foundation inspections would be performed at the residential properties prior to construction to determine the appropriate size for each SSD system. For the FS cost estimate, a typical installation assumed one suction point would be installed for every 1,200 square feet of foundation area and one fan would be provided for every 2,000 square feet of foundation area.

Pre- and post- SSD system installation, outdoor ambient air background, sub-slab, and indoor air samples would be collected at the residential properties. Samples would be analyzed for methane and VOCs. Testing would occur before and after SSD system installation to evaluate the effectiveness and quantify the change in attenuation as a result of the SSD systems. Inspections and necessary maintenance would be performed on each SSD system until remediation of the vapor intrusion source is achieved. Soil-gas probes located between the landfill cap and the residential properties would be used as compliance points. Inspections and SSD maintenance would be discontinued after compliance points remain below the VISLs for a period of time that accounts for temporal and seasonal variations at the site and other site-specific factors which may influence the migration of vapors. Locations of the compliance soil-gas probes would be determined during the RD. A monitoring report would be prepared to interpret and summarize findings from the sampling events and SSD system inspections. The property owners and tenants would be provided with details regarding how the SSD system will be installed. Property owners and tenants would also be informed of common signs to look for to ensure the SSD system is functioning properly.

If a property owner does not consent to the installation of an SSD, EPA will continue to monitor sub-slab conditions at the property as outlined in VI-2. Monitoring would be conducted at the residential properties to evaluate whether the presumptive remedy for landfill gas containment reduced the soil gas concentrations sufficiently to address the vapor intrusion concerns. Semi-annual air monitoring would be conducted for one-year after the construction of the landfill remedy to account for seasonally changing concentrations. An annual monitoring report would be created to interpret and summarize findings from the semi-annual sampling events. After the first year, annual air monitoring would be conducted to evaluate whether the landfill remedy has reduced soil-gas concentrations sufficiently to address vapor intrusion concerns. If VOC concentrations exceed residential VISLs, further action would be taken. Soil-gas probes located between the landfill cap and the residential properties would be used as compliance points. Monitoring would be discontinued after compliance points remain below the VISLs for a period of time that accounts for temporal and seasonal variations at the site and other site-specific factors which may influence the migration of vapors. Locations of the compliance soil-gas probes would be determined during the RD.

ICs would be implemented at properties where monitoring results show the exceedances above residential VISLs. At the residential properties, the ICs would require continued operation of the vapor mitigation systems until site conditions no longer pose a potential threat to human health. The ICs at the commercial property would prohibit future residential use of the commercial property or require that future residential property development include an evaluation of the need for vapor intrusion mitigation.

Estimated Capital Cost: $88,000
Estimated Land Use Controls: $14,000
Estimated O&M Cost (Present Value for 30 years): $279,000

Estimated Present Worth Cost: $381,000
Total Project Duration: 30 years

2.10 SUMMARY OF COMPARATIVE ANALYSIS

Section 121(b)(1) of CERCLA presents several factors that EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives. The purpose of this evaluation is to promote consistent identification of the relative advantages and disadvantages of each alternative, thereby guide selection of remedies offering the most effective and efficient means of achieving site cleanup goals. While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they evaluate protection of human health and the environment or compliance with federal and state requirements, standards, criteria, and limitations (threshold criteria); consider technical or economic merits (primary balancing criteria); or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria).

Each of the nine criteria used to evaluate and compare cleanup alternatives is described below, followed by a discussion of how each alternative will meet or not meet each criterion. More details regarding the evaluation and comparison of the cleanup alternatives against the nine criteria can be found in the 2019 OU1 FS Report. In addition, Table 5 through Table 10 provides a summary of how each cleanup alternative ranked against each of the nine criteria and against each other.

Explanation of the Nine Evaluation Criteria

Threshold Criteria

1. Overall Protection of Human Health and the Environment addresses whether a remedy provides adequate protection of human health and the environment and describes how risks posed by the site are eliminated, reduced, or controlled through treatment, engineering, or ICs.
2. Compliance with ARARs addresses whether a remedy will meet the applicable or relevant and appropriate federal and state requirements, known as ARARs.

Primary Balancing Criteria

3. 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.

4. Reduction of Toxicity, Mobility, or Volume Through Treatment addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at the site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.
5. 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 of the remedy until cleanup levels are achieved. This criterion also considers the effectiveness of mitigative measures and time until protection is achieved through attainment of the remedial action objectives.
6. Implementability addresses the technical and administrative feasibility of a remedy from design through construction, including the availability of services and materials needed to implement a particular option and coordination with other governmental entities.
7. Cost includes estimated capital costs, annual O&M costs, and net present value of capital and O&M costs, including long-term monitoring.

Modifying Criteria

8. State Agency Acceptance considers whether the state support agency supports the preferred alternative presented in the Proposed Plan and concurs with the selected remedy.
9. Community Acceptance addresses the public's general response to the remedial alternatives and the preferred alternative presented in the Proposed Plan.

COMPARISON OF ALTERNATIVES

1. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold determination in that this criterion must be met by any alternative for it to be eligible for selection.

No Action Alternatives LF-1, GW-1, and VI-1: Existing site conditions are not protective of human health under current land use at OU1. No Action Alternatives fail to meet the first threshold criterion because they do not effectively protect human health under the current and future scenarios (commercial/industrial worker, construction worker, or resident).

Landfill Contents and Gas Alternatives

LF-2 and LF-3 would meet this threshold criterion of protecting human health and the environment because landfill contents that may be a continuing source of contamination of groundwater would be effectively capped. LF-2 and LF-3 would reduce infiltration through the landfill, leaching of the contaminants into groundwater, and control runoff of precipitation from the landfill. In addition, the protective cap would limit direct contact with the landfill contents and control lateral landfill gas migration.

Landfill Groundwater

GW-2A, GW-2B, and GW-2C would protect human health by reducing VOC concentrations in groundwater emanating from the landfill. GW-3 would protect human health by hydraulically containing VOC concentrations in groundwater emanating from the landfill.

Vapor Intrusion Alternatives
VI-2 would be effective as an interim measure to allow assessment of the presumptive remedy for landfill gas containment. Alternative VI-2 is protective of human health when paired with a landfill content and landfill gas venting remedy. VI-3 and VI-4 would be protective of human health by eliminating the potential vapor intrusion exposure pathway. Foundation sealing or SSD systems would inhibit soil gas migration into living spaces and implementing ICs would prevent potential future residential exposure at the current commercial property.

2. Compliance with ARARs

Compliance with ARARs serves as a threshold determination in that ARARs must be met by any alternative to be eligible for selection or provide grounds for a waiver.

No action alternatives LF-1, GW-1, and VI-1: No chemical-, action- or location-specific ARARs apply since no ECs, ICs, or remedial actions would be taken. The second threshold criterion is not applicable.

Landfill Contents and Gas Alternatives
LF-2 and LF-3 would be designed to comply with federal and state ARARs identified in Appendix A; therefore, LF-2 and LF-3 meet this criterion.

Landfill Groundwater
GW-2A, 2B, 2C and 3 would be implemented to meet the potential chemical-, action-, and location specific ARARs identified in Appendix A; therefore GW-2A, 2B, 2C and 3 meet this criterion.

Vapor Intrusion Alternatives
VI-2 meets the compliance with ARARs criteria if enacted as an interim measure implemented in combination with, and pending evaluation of effectiveness of, the landfill presumptive remedy. However, VI-2 by itself would not meet ARARs, and would need to be enacted along with a landfill contents and landfill gas remedy. VI-3 and VI-4 would be implemented to meet the potential chemical-, action-, and location specific ARARs identified in Appendix A.

3. Long-term Effectiveness and Permanence

No Action Alternatives LF-1, GW-1, and VI-1: No action alternatives do not include any controls to prevent exposure of humans to landfill contents, landfill gas, or landfill groundwater by dermal contact, vapor intrusion, or domestic groundwater use; nor do they regulate the types of potential future uses of the site. The no action alternatives are not effective in providing long-term effectiveness or permanence.

Landfill Contents and Gas Alternatives
LF-2 and LF-3 would be highly effective at meeting the long-term effectiveness and permanence criterion. Alternative LF-2 meets each of the landfill contents and landfill gas RAOs because the multi-layer cap would prevent direct contact with landfill contents and reduce future leaching of contaminants into the groundwater. LF-3 meets each of landfill contents and landfill gas RAOs because the enhanced low permeability soil cap would prevent direct contact with landfill contents and future leaching of contaminants into the groundwater. The cap grading contours in LF-2 and LF-3 would be designed to eliminate surface water run-on and promote run-off from the landfill area. The passive vent systems would provide a pathway for landfill gas to escape and limit lateral landfill gas migration.

Landfill Groundwater
GW-2C provides the highest level of long-term effectiveness and permanence because the ISCR chemical dechlorination would quickly and permanently reduce VOC concentrations in groundwater and the abiotic reaction would result in less daughter product formation. GW-2C advantages over GW-2A include speed of reaction and greater likelihood of success due to the lack of reliance on microbial processes alone. The

in-situ longevity of ZVI and the reducing conditions it enhances would result in improved long-term VOC degradation via natural attenuation. GW-2A would work in conjunction with the existing reducing environment and enhance ongoing bioremediation resulting in permanently dechlorinating VOCs in groundwater. Long-term effectiveness may be impacted by the injection network's ability to effectively distribute the ERD substrate throughout the treatment zone. Advantages of GW-2A include lower cost, effectiveness at low contaminant concentrations, and ease of application. Limitations include slower reactions due to dependence on microbial processes, and production of daughter products, such as 1,2-DCE and vinyl chloride in some cases. GW-2A would be very effective in the long term.

GW-2B and GW-3 would be moderately effective in the long term. ISCO destroys contaminants on contact, making remediation timeframes shorter; however, ISCO requires full contact with contaminants for oxidation to occur. ISCO is more effective for contamination at higher concentrations, such as source areas. GW-2B would need to overcome the existing reducing environment and the aquifer's natural oxidant demand before oxidation would be effective. Typical ISCO reagents have short persistence that would likely require multiple applications to maintain oxidizing conditions. GW-3 relies on groundwater extraction to maintain a hydraulic containment zone and would require decades to achieve MCLs. Groundwater extraction results in long-term O&M that is less desirable than in-situ alternatives.

Treatability or pilot tests would be required during the RD to determine the effectiveness of GW-2A, 2B, and 2C. Performance monitoring would be required with all landfill groundwater remedies to document the level of success in containing the downgradient VOC plume.

Vapor Intrusion Alternatives

VI-4 would be very effective, and VI-3 would be moderately effective in the long term. Once ICs are implemented, if required, and the VI-3 or VI-4 remedies are installed, the residual risk of residential exposure would be low. The adequacy and reliability of controls would be better for VI-4 because it actively removes vapors; it would be readily apparent when the controlling mechanism, the blower fan, stopped working. VI-3 would rely on a sealant barrier; failure of the sealant barrier would likely not become apparent until annual sealant inspection and air monitoring showed a breach. Most other factors that could affect the long-term reliability of VI-4 mitigation systems are the results of homeowner actions, including deliberately shutting off the fan or ignoring the inoperative fan. The expected life span of an SSD system fan is typically 5 to 15 years. Periodic system inspection can mitigate potential problems related to the continued operation of the SSD systems. SSDs will be maintained until site conditions show that there is no longer a potential for vapor intrusion to pose a threat to human health at that property.

VI-2 would be slightly effective in the long term. VI-2 would provide soil gas monitoring to determine if soil gas contaminant concentrations are increasing or decreasing. VI-2 may be a reasonable interim measure, given that landfill gas venting is proposed under LF-2 and LF-3 as a component of the landfill presumptive remedy.

4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

No Action Alternatives LF-1, GW-1, and VI-1: Landfill contents, landfill gas, and landfill groundwater would not be treated, their mobility would not be restricted, nor their volume reduced under no action alternatives. Although VOCs may undergo natural attenuation, LF-1, GW-1, and VI-1 do not help or monitor this progress. Alternatives LF-1, GW-1, and VI-1 are not effective in the reduction of toxicity, mobility, or volume through treatment.

Landfill Contents and Gas Alternatives

LF-2 and LF-3 would not provide destruction of the toxic substances through treatment or reduce the total mass of toxic hazardous substances through treatment. Both caps would reduce mobility of the contaminants via containment as long as they are regularly maintained; however, the caps would not treat site contamination to reduce mobility. LF-2 and LF-3 would also similarly reduce the horizontal mobility of landfill gas accumulating under the landfill by utilizing the passive vents to harmlessly vent the methane to the atmosphere, away from residential receptors.

Landfill Groundwater

GW-2B and GW-2C would provide the highest level of reduction in toxicity, mobility, and volume of VOCs through treatment because the chemical reactions produced by both alternatives rapidly and permanently destroy the VOCs in groundwater. GW-2C has greater longevity than GW-2B, making GW-2C's ability to sustain reductions in toxicity, mobility, and volume better than GW-2B. ISCR is an abiotic process that typically results in lower concentrations of toxic daughter products, but also may increase dissolved metal concentrations.

GW-2A would be highly effective in reducing toxicity, mobility, and volume of VOCs through treatment. In addition to the VOCs destroyed within the PRB, the ERD amendments in GW-2A would migrate downgradient of the treatment barrier and enhance downgradient anaerobic bioremediation beyond the PRB and promote natural attenuation at distances of up to 100 feet. One potential issue with GW-2A is that bioremediation may stagnate resulting in production of toxic daughter products that may have a lower MCL for groundwater than some of the parent products.

In GW-3 VOCs would not be treated. VOCs would be removed from extracted groundwater by air stripping; however, the VOCs would be discharged to the atmosphere without treatment. In the atmosphere, VOCs would eventually be photo-oxidized.

RD design pilot or bench tests would be required for GW-2A, 2B, and 2C to determine effectiveness. Additionally, groundwater monitoring would be conducted to document the need for additional injection events and the level of success in containing the groundwater VOC plume.

Vapor Intrusion Alternatives

All vapor intrusion alternatives do not provide for treatment of contaminants. VI-3 would reduce the mobility of contaminants to receptors by sealing the pathway. VI-4 would reduce the mobility of contaminants to receptors by mitigating their migration to indoor air. VI-3 and VI-4 would not reduce the toxicity or volume of soil gas contaminants.

5. Short-term Effectiveness

No action alternatives LF-1, GW-1, and VI-1: there are no exposure risks to the community, workers, or the environment resulting from remedial activities because no remedial action is proposed. Alternatives LF-1, GW-1, and VI-1 are considered to be highly effective in the short-term.

Landfill Contents and Gas Alternatives

Impacts to the community during implementation of LF-2 and LF-3 would be minor. Impacts would primarily result from an increase in traffic and increased noise during construction. Work may be limited to certain hours in the day to minimize the traffic and noise disturbances caused by site activities. Workers would experience potential exposure to landfill contents and landfill gas during surface grading and passive vent installation. All personnel onsite would be exposed to heavy equipment hazards during the construction of the landfill cap. All hazards associated with LF-2 and LF-3 can be addressed by the use of proper personal protective equipment (PPE) and safe work practices during site activities. Environmental impacts include greenhouse gas emissions from heavy equipment and heavier traffic flow due to the landfill cap construction. Increased noise from construction activities, clearing and grubbing, filling Pond 1, and construction activity near Pond 2 may disturb nearby wildlife.

Active remediation is expected to be complete and achieve RAOs within 3 to 4 months for LF-2, and 2 months for LF-3. Since LF-2 requires a longer time to implement and more complex construction methods, LF-2 would be moderately effective and LF-3 would be very effective at protecting workers, the community, and the environment in the short-term.

Landfill Groundwater

Alternatives GW-2A, GW-2B, and GW-2C would have some short-term impacts. During remedial activities and groundwater monitoring, the community would be exposed to additional truck traffic and increased noise. Exposure risk to workers would be reduced with the implementation of a Health and Safety Plan and the use of PPE. GW-2A would take the least amount of time to complete construction and implementation but, may take longer to reduce contaminant concentrations. Physical hazards from heavy equipment would pose the majority of risk to workers. Handling of the ERD amendments and potential daylighting during injection pose minimal threat to workers because ERD amendments are nonhazardous. GW-2B may reduce contaminant concentrations the fastest but could pose the greatest risk to workers from exposure to the reactive reagents. Workers could be exposed to reactive ISCO reagent dust, contaminated groundwater, and ISCO reagent solution, should daylighting occur. GW-2B may require more frequent ISCO reagent injection, increasing potential worker exposure with each injection event. The ISCR amendment, ZVI, in GW-2C is relatively safe to handle, but is reactive, requiring Level D PPE. The longevity of ZVI in the environment would result in less frequent injection events. GW-2C ranks between GW-2A and GW-2B for speed of contaminant reduction and risk posed to construction workers because the ISCR amendments would be relatively safe to handle compared to the reactive ISCO reagents.

Although GW-3 would achieve hydraulic containment of the plume within days, GW-3 would be moderately effective in the short term because it involves more construction elements than the GW-2 alternatives.

Vapor Intrusion Alternatives

Workers would experience minimal impacts during remedial activities for VI-2, VI-3, and VI-4. Potential exposure associated with soil gas or contact with other media during sealing is easily addressed with properly trained employees and use of proper PPE.

VI-2 would be highly effective in the short-term. Impacts would primarily result in minor inconveniences to property owners during sub-slab vapor monitoring point installation and air sampling events. Sampling events would be closely coordinated with property owners and tenants to minimize the degree of inconvenience. There are no environmental impacts from VI-2. This alternative does not generate waste. Once access is granted, approximately 1 day per property would be required to install the sub-slab soil vapor monitoring points in each residential building. Once installation is complete, sub-slab soil vapor samples would be collected periodically. For cost estimating purposes, semi-annual sampling is assumed.

VI-3 and VI-4 would be very effective in the short-term. Installation of VI-3 or VI-4 would require coordination with the property owners but would not pose an increased risk. Sampling, inspection, and construction activities would be closely coordinated with property owners and tenants to minimize inconvenience. Neither alternative would impact the surrounding environment. The time required to implement VI-3 and VI-4 depends on the availability of property owners to grant access for sealing or SSD installation. Once access is granted, implementation of VI-3 would take approximately 1 day per property and full implementation of VI-4 would take 1 to 2 weeks. Periodic sub-slab soil vapor samples would be collected and may cause a minor inconvenience to property owners under VI-3 and VI-4. For cost estimating purposes, semi-annual sampling is assumed.

6. Implementability

No action alternatives LF-1, GW-1, and VI-1: no construction, operation, or resources would be required. As a result, Alternatives LF-1, GW-1, and VI-1 are highly implementable. Although this alternative would be technically implementable, they do not meet threshold criteria and are not eligible for selection.

Landfill Contents and Gas Alternatives
LF-2 and LF-3 are ranked very technically and administratively feasible. The landfill cap and passive venting system installation methods are well understood, and materials, equipment, and qualified laborers are readily available. For LF-2, although common, installation of the multiple layers over large acreage involves quality assurance / quality control efforts to make sure seams are well sealed and no punctures of the geomembrane result during construction. For LF-3, locating a nearby borrow source of low-permeability soil could be slightly challenging.

Landfill Groundwater
All components, methods, labor, and materials for GW-2A, GW-2B, GW-2C, and GW-3 would be readily available and easily obtained. Feasibility would be similar for each alternative. Specific details of implementation would be developed during the RD stage. These details may include traffic control, complying with substantive components of underground injection permits, groundwater monitoring, and contingency measures.

GW-2A and GW-2C would likely be more technically feasible than GW-2B and GW-3 because both alternatives would take advantage of the existing reducing groundwater conditions to enhance reductive dechlorination of VOCs in groundwater. GW-2A is effective at lower contaminant concentrations, such as those present at NCL. GW-2A would be very implementable. GW-2C is most effective in treating moderate contaminant concentrations. ISCR creates a reducing zone that would result in chemical reduction of contaminants and enhancement of the existing reducing conditions. GW-2C would be very implementable.

The technical feasibility of GW-3 would be slightly less than GW-2A and GW-2C because multiple steps of extraction and treatment would be required. Typically, groundwater extraction and treatment systems are less cost-effective than in-situ treatment remedies because long operational time is necessary to achieve MCLs.

GW-2B is the least technically feasible since the ISCO injections would need to overcome the existing reducing conditions at NCL, thus require large volumes of oxidant and multiple applications. Additionally, ISCO is more effective in treating higher contaminant concentrations, such as source areas, than dilute plume areas such as at NCL.

Vapor Intrusion Alternatives
The equipment, materials, and labor for VI-2, VI-3, and VI-4 are all readily available since they are all common practices for mitigating vapor intrusion. VI-2 has the highest implementability of the alternatives because it requires simple administrative action and passive sampling. EPA would need to obtain access to the properties to install sub-slab monitoring points and perform air monitoring. The foundation sealing and IC components of VI-3 are technically and administratively feasible, therefore, VI-3 would be very implementable. Vapor intrusion pathways would need to be located, accessed, and sealed. If sub-slab floor and walls are finished (e.g., carpet or tile on the floor and drywall on the walls), it may be difficult to find and access the main entry routes. Therefore, the technical feasibility of this option will depend on the condition of the foundation and sub-slab. EPA would need to obtain access to the properties to identify and seal entry routes. If the building's sub-slab is finished, owner's consent may be needed to remove flooring or walls. SSD systems associated with VI-4 have been successfully implemented at many sites and are technically easy to install. No permits would be necessary to implement VI-4. EPA would need to obtain access to the properties to install the systems. VI-4 would be very implementable.

7. Cost

Detailed cost estimates and the cost estimate assumptions can be found in Appendix B. These order-of-magnitude cost estimates were prepared based on vendor quotes and previous estimates (published and unpublished) for similar projects. Actual costs would depend on final RD, actual labor rates, productivity, the final project schedule, and material costs.

<u>Landfill Contents and Landfill Gas</u>

The estimated present value cost of LF-2 is $8,118,000 with total 30-year O&M costs of $1,331,000. Appendix B, Table B-4 presents the detailed cost estimate. The major capital cost items are the cover soil layer and 90-mil polypropylene geotextile fabric.

The estimated present value cost of LF-3 is $6,080,000 with total 30-year O&M costs of $1,331,000. Appendix B, Table B-5 presents the detailed cost estimate. The major capital cost item is the cover soil layer.

<u>Landfill Groundwater</u>

The estimated present value cost of GW-2A is $3,367,000 with total 30-year O&M costs of $2,302,000. Appendix B, Table B-6 presents the detailed cost estimate. The major capital cost items are the direct-push injection well system materials and labor.

The estimated present value cost of GW-2B is $6,537,000 with total 30-year O&M costs of $5,087,000. Appendix B, Table B-7 presents the detailed cost estimate. The major capital cost items are the direct-push injection well system materials and labor.

The estimated present value cost of GW-2C is $4,554,000 with total 30-year O&M costs of $3,009,000. Appendix B, Table B-8 presents the detailed cost estimate. The major capital cost items are the direct-push injection well system materials and labor.

The estimated present value cost of GW-3 is $10,763,000 with total 30-year O&M costs of $8,929,000. Appendix B, Table B-9 presents the detailed cost estimate. The major capital cost items are the electrical service components; and the control and data acquisition system used to monitor and control extraction, treatment, and discharge of groundwater.

GW-2A has the lowest cost of the active remediation alternatives and is about 35 percent less than the next cheapest alternative, GW-2C, followed by GW-2B and GW-3.

<u>Vapor Intrusion Alternatives</u>

The estimated present value cost of VI-2 is $229,000 with total 30-year O&M costs of $211,000. Appendix B, Table B-10 presents the detailed cost estimate. The major capital cost item is the IC documentation.

The estimated present value cost of VI-3 is $360,000 with total 30-year O&M costs of $279,000. Appendix B, Table B-11 presents the detailed cost estimate. The major capital cost item is the planning documentation.

The estimated present value cost of VI-4 is $381,000 with total 30-year O&M costs of $279,000. Appendix B, Table B-12 presents the detailed cost estimate. The major capital cost item is the engineering design documentation.

VI-2 has the lowest cost of the active remediation alternatives, followed by VI-3, and VI-4.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §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.

Wastes generally considered to be principal threats include, but are not limited to, the following:

- Liquid source material - waste contained in drums, lagoons or tanks, free product in the subsurface (i.e., NAPLs) containing contaminants of concern (generally excluding ground water).
- Mobile source material - surface soil or subsurface soil containing high concentrations of chemicals of concern that are (or potentially are) mobile due to wind entrainment, volatilization (e.g., VOCs), surface runoff, or subsurface transport.
- Highly-toxic source material - buried drummed non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials.

Wastes that generally are not principal threats include, but are not limited to, the following:

- Non-mobile contaminated source material of low to moderate toxicity - surface soil containing chemicals of concern that generally are relatively immobile in air or ground water (i.e., non-liquid, low volatility, low leachability contaminants such as high molecular weight compounds) in the specific environmental setting.
- Low toxicity source material - soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range were exposure to occur.

While the landfill contents are the source of contamination at the NCL Site, no liquid source material, mobile source material, or highly toxic source material was identified during investigations at the site. Material onsite can be reliably contained. Phase III of the RI was conducted to identify hot spots that could be determined to be principal threat waste. No drums or other source materials were identified during landfill trenching activities. Therefore, no principal threat waste was identified at NCL.

While there are no principal threat wastes at the NCL site, treatment as a principal element is satisfied in the selected remedy because the low-level groundwater contamination will be treated.

2.12 SELECTED REMEDY: ALTERNATIVES LF-3, GW-2, and VI-4

2.12.1 SUMMARY OF RATIONALE FOR THE SELECTED REMEDY

Based on the information available, EPA believes that the combination of LF-3: Enhancing existing cover, Passive gas venting, waterline extension, and land use controls; GW-2: In-situ Groundwater Treatment; and VI-4: Sub-Slab Depressurization Systems and ICs provides the best balance of the evaluation criteria among all the alternatives. The Selected Remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Selected Remedy satisfies the following statutory requirements of CERCLA §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.

2.12.2 DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedy consists of the following main components:

<u>LF-3 Enhancing existing cover, Passive gas venting, waterline extension, and land use controls</u>
Alternative LF-3 follow the landfill presumptive remedy of containment. LF-3 consists of:

- Extensive predesign sampling to determine the level of existing cover enhancement needed to achieve site-wide compliance with the thickness and permeability requirements. Predesign studies may include, but are not limited to, (1) a detailed topographic survey to establish the current landfill grade and develop a final grading plan; (2) additional soil type, thickness, and permeability investigations; (3) geotechnical testing of existing soil; and (4) geotechnical testing of potential borrow source soils. If predesign studies show that assumptions about the existing cover are not valid, or the amount and cost of imported low permeability soil would increase up to a point where it may be more feasible to construct the LF-2 Multi-layer cap, EPA may issue an Explanation of Significant Differences and select Alternative LF-2, or some other suitable alternative.
- Land Use Controls: ICs for the landfill media will include administrative constraints on land use to protect the integrity of the cap, limit direct contact of potential receptors with waste over the long term and eliminate the consumption of groundwater by prohibiting installation of water wells. Reasonably anticipated future land use is assumed to be the same as present land use, commercial/ industrial. ECs would include fencing, posted signs, or other site-security measures to restrict access to the landfill property as necessary.
- OAC on Private Water Systems (OAC 3701-28-07v1) requires new private water systems to be located a minimum distance of 1,000 feet away from operating and closed municipal solid waste, residual waste, or industrial waste landfills. Private wells at Properties 1, 2, and 3, do not have that required isolation distance. For future protectiveness, municipal water supply connection will be provided to these property owners. The private wells will be abandoned. If a property owner declines connection to the municipal public water system, EPA will document the denial. Property ownership will be monitored, and future owners will be given the option for municipal connection.
- Initial site preparation will consist of clearing, grubbing, and grading to remove existing vegetation and roots. Vegetation outside the consolidated waste area and access roads that will not impact the landfill cap will remain. The existing soil cover will be graded and compacted as a subbase to ensure appropriate slopes, provide a uniform soil cover thickness, and promote drainage.
- Pond 1 will be filled with existing on-site soil. Waste may be consolidated from the landfill edges to the interior to reduce the overall cap footprint. Pond 2 may be affected by the toe of the landfill cap and may need to be fully or partially backfilled. As required by Ohio ARARs, compensatory wetlands will need to be created to compensate for the lost habitat associated with the pond(s) and its surrounding area. Options for wetland mitigation will be evaluated further during the design.
- The existing soil cover will be reworked by grading, supplementing with off-site low permeability soil, and compacting to meet landfill closure requirements. A conceptual layout for this alternative is shown in Figure 13. Final landfill construction details will be determined during the RD; however, the cover will be constructed to meet Ohio landfill closure requirements

specified in OAC- 3745-27-11. It is assumed that the cap will be constructed as described below and cover approximately 18 acres.

- Additional low-permeability soil and other structural fill soil will need to be imported to supplement the existing soil cover material and to achieve the necessary 3 to 5 percent slope minimum. To further reduce infiltration through the enhanced existing cover, a geocomposite drainage layer, may be added above the compacted subbase to intercept infiltration and convey it laterally off the compacted subbase. These imported soil volume calculations and the necessity of adding a geocomposite drainage layer will be determined during the RD.
- A vegetative soil layer consisting of at least 30 inches of imported soil to support plant growth will cover the regraded and compacted low permeability soil cover. The vegetative soil layer will include a 6-inch topsoil layer and be seeded to prevent erosion and induce evapotranspiration.
- Before final grading and compaction, passive gas vents will be installed in the landfill to prevent the build-up of landfill gas. The spacing and construction of passive vents will be similar to that typically associated with municipal landfills. The actual design and construction of the gas venting system will be evaluated in the predesign phase. Additional information regarding the construction requirements will be incorporated into the RD.

The following RAOs are addressed as part of the landfill contents and landfill gas remedy LF-3:

- Prevent direct contact with landfill contents
- Minimize infiltration and resulting contaminants leaching to groundwater
- Control surface water run-on and run-off
- Prevent migration of COCs into groundwater by minimizing infiltration
- Control landfill gas concentrations (methane) to prevent the build-up of explosive concentrations

GW-2: In-Situ Groundwater Treatment

GW-2A and GW-2C rate similarly when evaluated against the nine criteria. Both alternatives include an in-situ treatment permeable reactive barrier to passively contain and treat the contaminant plume at the southern site boundary to reduce VOC concentrations in the downgradient OU2 groundwater plume.

Since pilot testing of ERD and ISCR was not done during the RI, it is difficult to determine based on the information currently available which alternative would be more effective at reaching RAOs at the NCL Site. A combination of in-situ groundwater treatments using ERD and ISCR may also be used to treat the landfill groundwater. EPA therefore has selected GW-2: In-Situ Groundwater Treatment as the preferred landfill groundwater alternative, with the specific technology and design parameters to be determined during RD pilot testing.

A Pilot study will be conducted during the RD to determine which in-situ treatment is best suited for use at the New Carlisle Landfill Site. As part of the pilot study there will be a baseline groundwater sampling event for field parameters (oxidation-reduction potential, pH, dissolved oxygen, temperature, and conductivity), VOCs, total organic carbon, cations, anions, alkalinity, dissolved gases, dissolved metals, key bacteria and functional genes, such as DHC and vinyl chloride reductase. Analysis of site conditions during the baseline groundwater sampling event will inform the selection of ERD, ISCR, or a combination of the two treatment options for use at the site. The pilot study using amendments at select locations would inform the actual design parameters, such as injection flow rate, distribution of the amendment in the subsurface, radius of influence, appropriate lateral spacing of injection points, injection pressure, and the appropriate amendment dosing quantities.

It is assumed that the injection points for the in-situ groundwater treatment remedies will be evenly arranged in two staggered east-west rows with approximately 15 feet between each injection point. The targeted treatment area will measure approximately 400 feet perpendicular to groundwater flow and 30 feet wide as shown on Figure 14. The dimensions of the direct push injection locations along groundwater flow will depend on treatment kinetics and be refined during RD. The depth of application will be throughout the entire targeted 45-foot vertical contamination interval. Additional VAS will be conducted near VAS-B10 during the RD to further define the treatment depth at this location.

Under GW-2, the groundwater monitoring well network will be expanded to monitor and evaluate contaminant concentrations upgradient, within and downgradient of the PRB. Monitoring objectives will be performance-based rather than compliance-based. Groundwater performance monitoring will determine the effectiveness of the in-situ groundwater treatment. The groundwater performance monitoring will determine when additional injection events are necessary and when additional injections would no longer be cost-effective component. Additional criteria for when groundwater treatment injections will be discontinued will be determined during the RD.

The following RAO is addressed as part of the landfill groundwater remedy GW-2:

- Prevent site-related COCs in groundwater from migrating outside the OU1 boundary

<u>*Soil Vapor Alternative VI-4: Sub-Slab Depressurization System and ICs*</u>
Alternative VI-4 includes ICs and SSD systems to mitigate vapor intrusion at the residential properties. The remedy for vapor intrusion is pre-emptive, as the risk from vapor intrusion is within EPA's acceptable risk range. The option for pre-emptive vapor intrusion mitigation using sub-slab depressurization systems will be offered to the residents of the adjacent residential properties in OU1.

Alternative VI-4 actively removes soil gas from beneath the sub-slab. SSD involves creating extraction points in a basement floor, which are then connected to a small vacuum blower. The blower is typically attached to the side of the building and vented through PVC piping above the roof line where no windows or vents for the building are located.

Pre-installation tests and foundation inspections will be performed at the residential properties prior to construction to determine the appropriate size for each SSD system.

Pre- and post- SSD system installation ambient outdoor air background, sub-slab, and indoor air samples will be collected at the residential properties. Samples will be analyzed for methane and VOCs. Inspections and necessary maintenance will be performed on each SSD system until overall remediation of the vapor intrusion source is achieved. Soil-gas probes located between the landfill cap and the residential properties will be used as compliance points. Inspections and SSD maintenance will be discontinued after compliance points remain below the VISLs for a period of time that accounts for temporal and seasonal variations at the site and other site-specific factors which may influence the migration of vapors. Locations of the compliance soil-gas probes will be determined during the RD. A monitoring report will be prepared to interpret and summarize findings from the sampling events and SSD system inspections. The property owners and tenants will be provided details regarding how the SSD system will be installed and maintained. Property owners and tenants will be informed of common signs to look for to ensure the SSD system is functioning properly.

If a property owner does not consent to the installation of a SSD, EPA will continue to monitor sub-slab conditions at the property. Monitoring will be conducted at the residential properties to evaluate whether the presumptive remedy for landfill gas containment reduces the soil gas concentrations sufficiently to address the vapor intrusion concerns. Semi-annual air monitoring will be conducted to account for seasonally changing concentrations for one-year after the construction of the landfill remedy. An annual monitoring report will be created to interpret and summarize findings from the semi-annual sampling events. After the first year, annual air monitoring will be conducted to evaluate whether the landfill remedy has reduced soil-gas concentrations sufficiently to address vapor intrusion concerns. If VOC concentrations exceed residential VISLs, further action will need to be taken. Soil-gas probes located between the landfill cap and the residential properties will be used as compliance points. Monitoring will be discontinued after compliance points remain below the VISLs for a period of time that accounts for temporal and seasonal variations at the site and other site-specific factors which may influence the migration of vapors. Locations of the compliance soil-gas probes will be determined during the RD.

ICs will be implemented at properties where monitoring results show the exceedances above residential VISLs. At the residential properties, the ICs will require continued operation until site conditions no longer pose a potential threat to human health. The ICs at the commercial property will prohibit future residential use of the commercial property or require that future residential property development include an evaluation of whether vapor intrusion mitigation, as part of the new construction design, is be needed.

This alternative has low capital costs and low to moderate O&M costs. The majority of the capital costs are associated with installation of the SSD system. The majority of the O&M costs are associated with long-term air monitoring.

The following RAO is addressed as part of the vapor intrusion remedy VI-4:

- Prevent current and future permanent residents at OU1 residential properties and future full-time commercial/industrial workers at OU1 commercial/industrial properties from exposure to site-related COCs in indoor air at concentrations that pose an ELCR of 1 x 10^{-6} or greater or a non-cancer hazard greater than 1.

2.12.3 SUMMARY OF ESTIMATED REMEDY COSTS

In addition to the items listed above, the cost estimate for the Selected Remedy includes:

- Mobilization and demobilization
- Contractor bonds
- Project management and oversight
- Implementation of institutional controls
- Contingency

The cost estimates and timeframes for the Selected Remedy are:

Table 3. Selected Remedy Cost Estimates and Timelines

Alternative	Capital costs	Annual O&M	Total O&M	Total LUCs	Total Net Present value	Construction timeline
Landfill Contents and Landfill Gas LF-3: Enhancing existing cover, passive gas venting, waterline extension, and land use controls	$4,562,000	$97,957 (Years 2-30)	$1,331,000	$187,000	$6,080,000	2 months
Landfill Groundwater GW-2: In-Situ Groundwater Treatments*	$1,531,000	$59,840 (Years 8-30)	$3,009,000	$14,000	$4,554,000	3 months/ event

Vapor Intrusion VI-4: Sub-slab Depressurization Systems and ICs	$88,000	$18,159 (Years 2-30)	$279,000	$14,000	$381,000	2 weeks

*Cost estimates for GW-2C are used as a conservative estimate for in-situ groundwater treatment since GW-2C had a highest Total Present Worth Cost of the GW-2 sub-alternatives.
Notes: Annual O&M costs for GW-2 include annual groundwater monitoring and reporting beginning Year 8. The Total O&M includes the costs for addition re-injection events every 5 years. Annual O&M costs for VI-4 include repair, monitoring and sampling costs.

Total Capital Cost: $6,181,000
Annual O&M Cost: $175,956 (beginning Year 8)
Total Present Worth Cost: $11,015,000
Timeframe for construction completion: 1 year, with subsequent groundwater treatment events

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design. Minor, significant, or fundamental changes to the selected remedy will be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.12.4 ESTIMATED OUTCOMES OF SELECTED REMEDY

The primary objective for the Selected Remedy is to reduce the risks and hazards to human health and the environment. These objectives will be accomplished by enhancing the landfill cover to minimize infiltration and direct contact exposure, treating landfill groundwater to prevent off-site migration of COCs into groundwater, and controlling landfill gas.

Groundwater under landfill parcel will not be available for drinking water and will not be restored to beneficial use as it is under the waste management unit. The enhancement of the landfill cover with a low permeability cover will minimize migration of landfill contaminants to groundwater. Treating groundwater emanating from the landfill will substantially reduce groundwater contaminants migrating off-site into the downgradient groundwater. Evaluation of additional actions (if necessary) to address OU2 off-site groundwater will be conducted after the selected OU1 remedy is implemented. The intention of the future OU2 remedy will be to restore OU2 groundwater to beneficial use, which is drinking water. The selected remedy will mitigate the potential for exposure to Site contaminants in indoor air by controlling landfill gas on the landfill parcel and installing sub-slab depressurization systems at nearby residential properties. Land use controls will be implemented to protect the remedy and ensure that future land use is appropriately protective.

At the completion of the OU1 remedial action (i.e., when construction of the landfill cap, groundwater treatments, and vapor intrusion mitigation is complete), the Site will still be subject to use restrictions, including prohibitions against any disturbance of the consolidation area cover that would interfere with the containment of the waste remaining on-site or with maintenance of the remedy, groundwater use restrictions, and residential use restrictions. These use restrictions are necessary because wastes wil be left on-site. The landfill parcel will be restricted to non-residential commercial/industrial use, although portions of the land may be designated for recreational use in the future.

Cleanup Levels

The selected cleanup levels serve as the proposed performance requirements and basis for measuring the success of the response actions. The cleanup levels are based on ARARs or are risk-based if no ARAR is available or protective of potential receptor(s). The cleanup levels for vapor intrusion are presented in the table below in Table 3:

Table 3. Cleanup Levels for Indoor Air

Media	Area	COC	Cleanup Level	Units	Basis[1]
Indoor Air (Residential/ Future Residential)	Onsite residential and commercial properties	1,2-Dichloroethane	1.1 x 10^{-1}	µg/m^3	2017 RSL
		1,2,4-Trimethylbenzene	63	µg/m^3	2017 RSL
		1,4-Dichlorobenzene	2.6 x 10^{-1}	µg/m^3	2017 RSL
		Benzene	3.6 x 10^{-1}	µg/m^3	2017 RSL
		Ethylbenzene	1.1	µg/m^3	2017 RSL

Notes:

[1] Cleanup levels were calculated using the 2016 VISL (Version 3.5.1), and are identical to the June 2017 residential air RSL, with the exception of 1,2,4-trimethylbenzene. The cleanup level for 1,2,4-trimethylbenzene is based on the more current RSL.

µg/m^3 Micrograms per cubic meter
HHRA Human health risk assessment
RSL Regional screening level
VISL Vapor intrusion screening level

Landfill containment effectiveness will be assessed based on decreasing groundwater VOC concentrations downgradient of the containment system.

2.13 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 ARARs (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 toxicity, mobility, or volume 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.

2.13.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The Selected Remedy provides overall protection of human health and the environment. The landfill cover enhancements will reduce infiltration through the landfill and leaching of the contaminants into groundwater; control runoff of precipitation from the landfill; limit direct contact with the landfill contents; and control lateral landfill gas migration. The Selected Remedy will reduce VOC concentrations in groundwater emanating from the landfill through in-situ treatment of groundwater. The Selected Remedy will eliminate the vapor intrusion exposure pathway. The Selected Remedy will reduce exposure levels to protective ARAR or risk-based cleanup levels.

The Selected Remedy will meet RAOs upon completion of construction work, which is estimated at 1 year and will include subsequent groundwater treatment events. No unacceptable short-term risks are anticipated by implementation of the remedy. Any short-term risks associated with construction activities will be minimized through adequate monitoring and appropriate mitigative measures during construction. In addition, no adverse cross-media impacts are expected from the Selected Remedy.

2.13.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Selected Remedy will meet and comply with federal and state ARARs. The landfill cap enhancements will be designed to comply with federal and state ARARs. The in-situ groundwater treatment and vapor intrusion remedies will be implemented to meet federal and State ARARs.

The full list of ARARs and TBCs for the Selected Remedy are included in Appendix A.

2.13.3 COST EFFECTIVENESS

The selected remedy is cost-effective and represents a reasonable value for the money to be spent. The NCP requires that "a remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (See the NCP at 40 CFR. §300.430(f)(1)(ii)(D)).

EPA evaluated the overall effectiveness of the alternatives that satisfied the threshold criteria (i.e., were protective of human health and the environment and ARAR compliant) by assessing three of the five balancing criteria: (1) Long-term effectiveness and permanence; (2) Reduction in toxicity, mobility, and volume through treatment; and (3) Short-term effectiveness. EPA then compared the overall effectiveness to the costs to determine cost effectiveness. The overall effectiveness of the selected remedial alternatives was determined to be reasonable for their costs and hence these alternatives are considered to be cost-effective

The estimated present worth of the selected remedy is $11,015,000. This engineering cost estimate is expected to be within +50 to -30 percent of the actual project cost.

Total Capital Cost: $6,181,000
Annual O&M Cost: $175,956 (beginning Year 8)
Total Present Worth Cost: $11,015,000
Timeframe for construction completion: One year, with subsequent groundwater treatment events

2.13.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE (OR RESOURCE RECOVERY) TECHNOLOGIES TO THE MAXIMUM EXTENT POSSIBLE

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 Site.

The selected landfill element permanently prevents exposure to waste materials and reduces migration of contaminants from the landfill media to groundwater and will require maintenance. The selected landfill groundwater remedy will treat VOC contamination and achieve reduction in toxicity, mobility, and volume through in-situ treatment of the source area contaminants and downgradient groundwater. The selected vapor mitigation element addresses the potential for exposure to Site-related indoor vapor intrusion, but it does not treat the hazardous substances to reduce mobility, toxicity, or volume. There is no reliable, cost-effective, and practicable treatment technology to address soil gas vapors after they migrate into buildings, given the circumstances of this Site.

2.13.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

By treating the contaminated landfill groundwater and downgradient groundwater through in-situ groundwater treatment, the selected remedy satisfies the statutory preference for remedies that employ treatment as a principal element.

There is no reliable, cost-effective, and practicable treatment technology to address soil gas vapors after they migrate into buildings, given the circumstances of this Site. The landfill remedy at the NCL site will follow the 1993 EPA Presumptive Remedy for CERCLA Municipal Landfill site guidance, which calls for source containment of landfill media.

2.13.6 FIVE YEAR REVIEW REQUIREMENTS

The Selected Remedy will require a statutory FYR because hazardous substances, pollutants, or contaminants will remain on site above levels that permit unlimited use and unrestricted exposure. The FYR will provide an opportunity to evaluate the performance of the remedy to determine whether it achieves and remains protective of human health and the environment.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

CERCLA Section 117(b) and NCP Section 300.430(t)(5)(iii) require an explanation of any significant changes from the remedy presented in the Proposed Plan that was published for public comment. The Proposed Plan was issued for public comment August 17, 2020 through September 16, 2020. EPA reviewed all written and verbal comments submitted during the public comment period and determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate as a result of public comment.

PART 3: REPONSIVENESS SUMMARY

This Responsiveness Summary documents public participation in the remedy selection process for the New Carlisle Landfill Superfund Site. A summary of comments received during the 30-day public comment period are included in this section of the ROD, along with EPA's responses to these comments. The public comment period for this response action ran from August 17, 2020 to September 16, 2020.

1) One commenter requested information on what above ground equipment will need to be maintained and what checks of the system will occur during the 30-year time-period.

EPA Response: To ensure the continued operation and maintenance of the remedy there will be annual inspections at the Site. Above ground equipment will be limited to the landfill gas venting system. The Selected Remedy will require the following Operation and Maintenance:

- Annual inspections of the landfill cap, maintenance will be conducted as needed
- Annual inspections of the landfill gas venting system, maintenance will be conducted as needed
- Annual inspections of the vapor mitigation systems, maintenance will be conducted as needed
- Monitoring of soil-gas at the residential properties
- Maintenance of the groundwater monitoring system, as needed
- Groundwater monitoring to assess the performance of the groundwater remedy

The landfill cap and associated monitoring/maintenance will remain/continue as long as waste remains at the site. The 30-year timeframe for Operation and Maintenance was applied only to estimate the long-term O&M costs.

2) One commenter requested clarification on whether a geocomposite drainage layer would be included in the Selected Remedy as the image on Slide 25 of the virtual presentation showed, while the Proposed Plan indicated that it "may be added".

EPA Response: The necessity of the geocomposite drainage layer and final design of the landfill cap will be determined during the Remedial Design phase. The conceptual layout of LF-3 Enhancing existing cover, passive gas venting, waterline extension, and land use controls is shown in Figure 13 of this Record of Decision. The conceptual layout includes the geocomposite drainage layer to help visualize where the geocomposite drainage layer, if installed, would be placed in relation to the compacted fill subbase and the low permeability soil, and other structural fill soil. The cost estimate for Alternative LF-3 accounts for the potential inclusion of a geocomposite drainage layer.

3) One commenter asked who maintains and mows the perennial grass cover.

EPA Response: Potentially Responsible Parties (PRPs), if identified, or the Ohio EPA will maintain the perennial grass cover at the Site after the landfill cap has been declared operational and functional (O&F) and enters the Operation and Maintenance (O&M) period.

4) One commenter expressed concern over the number of trees that would have to be cut down to build the landfill cap and what effect the Selected Remedy has on Pond 1 and Pond 2.

EPA Response: The Selected Remedy includes clearing and grubbing landfill waste areas to remove existing vegetation and roots. Trees and vegetation on the existing landfill cover have damaged the integrity of the cap and provide infiltration pathways through the landfill cover to waste material. To utilize the existing landfill cover and enhance the cap to meet current Federal and State regulations, the trees and vegetation in the landfill waste area need to be removed. Vegetation outside the consolidated waste area and access roads that will not impact the landfill cap will remain on the landfill property.

Pond 1, located in the center of the existing landfill cap, was formed due to subsiding of the waste material in that area. The landfill cap will fill in Pond 1 and level the existing landfill media to create a stable subbase. The Selected Remedy includes consolidation of landfill waste from the landfill edges to the interior to reduce the overall footprint of the cap. The southwestern portion of Pond 2 is located near the extent of waste identified during the remedial investigation. Pond 2, therefore, may be partially backfilled or backfilled depending on the extent of waste and EPA's ability to consolidate landfill waste and stabilize that portion of the cap. As required by Ohio ARARs, compensatory wetlands will need to be created to compensate for the lost habitat associated with the pond(s) and its surrounding area. Options for wetland mitigation will be evaluated further during the remedial design phase of the project.

5) One commenter asked whether there is the potential for undesirable scouring effects on the nearby banks of Honey Creek.

EPA Response: The Selected Remedy does not involve surface water discharge to Honey Creek, therefore will not impact the Creek.

Alternative GW-3: Groundwater Extraction, Treatment, and Discharge described the discharge of treated groundwater to Honey Creek. Should any information collected during the Remedial Design phase determine that Alternative GW-2 In-Situ Groundwater Treatment is not feasible at the Site, Alternative GW-3 may be implemented after documenting a change of remedy in an amendment to this ROD. The treatment system would be designed to mitigate any negative effects on Honey Creek.

6) One commenter asked for clarification on what type of vapor intrusion systems would be used and how will new buyers be made aware of and trained on O&M for these systems.

Sub-slab depressurization (SSD) systems will be used at the Site. The final property specific design will be based on an assessment done at each property. Pre-installation tests and foundation inspections will be performed at the residential properties prior to construction to determine the appropriate size for each SSD system. A typical installation assumes one suction point will be installed for every 1,200 square feet of foundation area and one fan will be provided for every 2,000 square feet of foundation area. The Selected Remedy includes a description of SSD systems.

Properties that require operation of SSD system will have institutional controls until there is no longer a risk to human health from vapor intrusion and will inform new owners of the need to operate the SSD system. The property owners and tenants will be provided with details regarding how the SSD system will be installed and maintained. Property owners and tenants will be informed of common signs to look for to ensure the SSD system is functioning properly. Inspections and necessary maintenance will be performed on each SSD system as part of the inspections until overall remediation of the vapor intrusion source is achieved and there is no longer a potential for vapor intrusion at the property.

7) One commenter requested additional information on the reactive barrier, including the depth of the reactive barrier and description of the system to ensure that there is complete dechlorination of chlorinated volatile organic compounds. The commenter expressed the importance of determining if there is sufficient Dehalococcoides present to prevent a stalling of the biodegradation, resulting in an accumulation of DCE and VC in the subsurface.

EPA Response: The finals depths of the permeable reactive barrier will be determined during the Remedial Design phase. The depth of application will be throughout the entire targeted 45-foot vertical contamination interval. Additional VAS will be conducted near VAS-B10 during the Remedial Design to further define the treatment depth at this location. A pre-design investigation will analyze the presence and quantity of microorganisms (including Dehalococcoides), functional genes, and fatty acids, and determine the necessary amendments to effectively biodegrade the COCs based on site conditions. Pilot testing will determine the appropriate amendment dosing quantities to stimulate sustained dechlorination of chlorinated solvents. Pilot testing is also necessary to determine the design parameters, such as achievable injection flow rate, radius of influence, injection pressure, and test the efficacy of the amendment. Current conditions at the Site suggest that biodegradation of COCs has occurred, but appears to be stalled at cis-1,2-DCE and VC. The remedial action will be designed to target the breakdown of cis-1,2-DCE and VC.

The groundwater monitoring network will be expanded as part of GW-2 In-Situ Groundwater Treatment. Sample analysis for field parameters, VOCs, total organic carbon, cations, anions, alkalinity, dissolved gases, and dissolved metals will monitor the performance of the groundwater remedy and the frequency of injections after the first injection event.

8) One commenter stated that pre-emptive actions to connect the adjacent residential properties to municipal water and install vapor intrusion mitigation systems are unnecessary.

EPA Response: The Record of Decision clarifies that residential owners will be offered the option to have pre-emptive remedial actions for future protectiveness taken at their properties. Both the extension of municipal water to the two residential properties and the installation of vapor intrusion mitigation systems at those properties are included in the Selected Remedy for future protectiveness. If the property owner does not consent to the installation of vapor intrusion mitigation systems at their property, EPA will continue to test the soil-gas to monitor for exceedances above the residential VISLs.

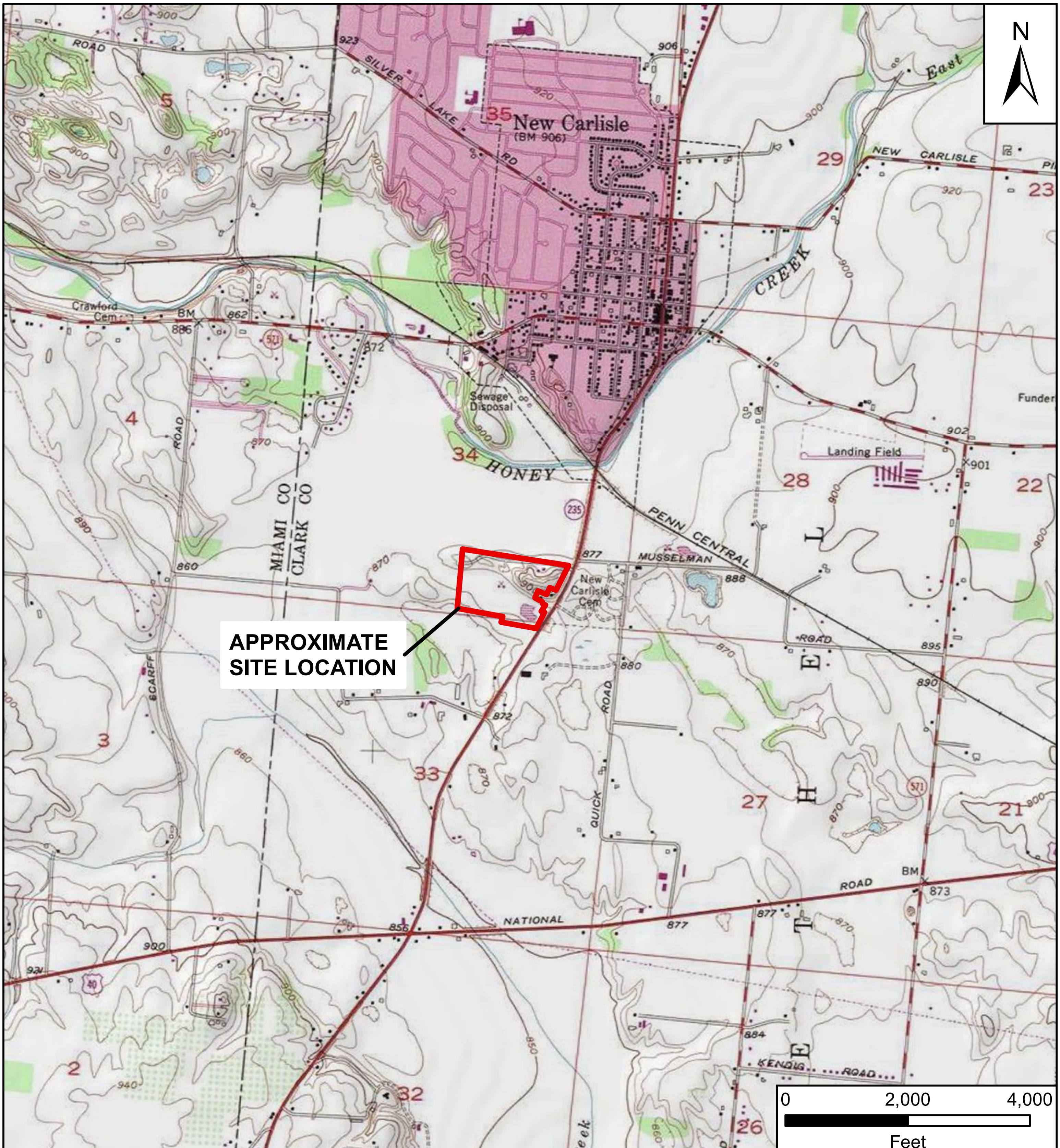
9) One commenter noted that the Proposed Plan contemplates the potential for future residential use at the commercial industrial property. The commenter asked how EPA will assess the risk to future residents and what action would be taken if VOC concentrations exceed residential VISLs.

EPA Response: The Selected Remedy includes continued soil gas monitoring at the three commercial/industrial properties to evaluate whether there are exceedances above residential VISLs that may pose a potential risk to human health. ICs will only be implemented if vapor intrusion is determined to be above residential action levels or would pose a threat to future residential building occupants. If monitoring of the soil-gas at the commercial industrial property result in exceedances above residential VISL, ICs will be implemented. The ICs on the commercial industrial property would prohibit future residential use or require that future residential property development include an evaluation of whether vapor intrusion mitigation, as part of the new construction design, would be needed.

10) One commenter asked what assessments will be done on the vapor intrusion mitigation systems to ensure that they continue to operate as designed.

EPA Response: The vapor intrusion mitigation systems will require annual inspections to ensure continued functionality. Annual inspections will be conducted as part of O&M and will be at no cost to the landowners. Vapor intrusion mitigation systems will be maintained until site conditions show that there is no longer a potential for vapor intrusion to pose a threat to human health at that property.

Should the property owner opt to not install the preemptive sub-slab depressurization vapor mitigation system, EPA will continue to conduct soil-gas sampling to evaluate whether there are exceedances above the residential VISLs that warrant installation of a vapor mitigation system to protect human health.



LEGEND

APPROXIMATE SITE LOCATION

REFERENCE MAP

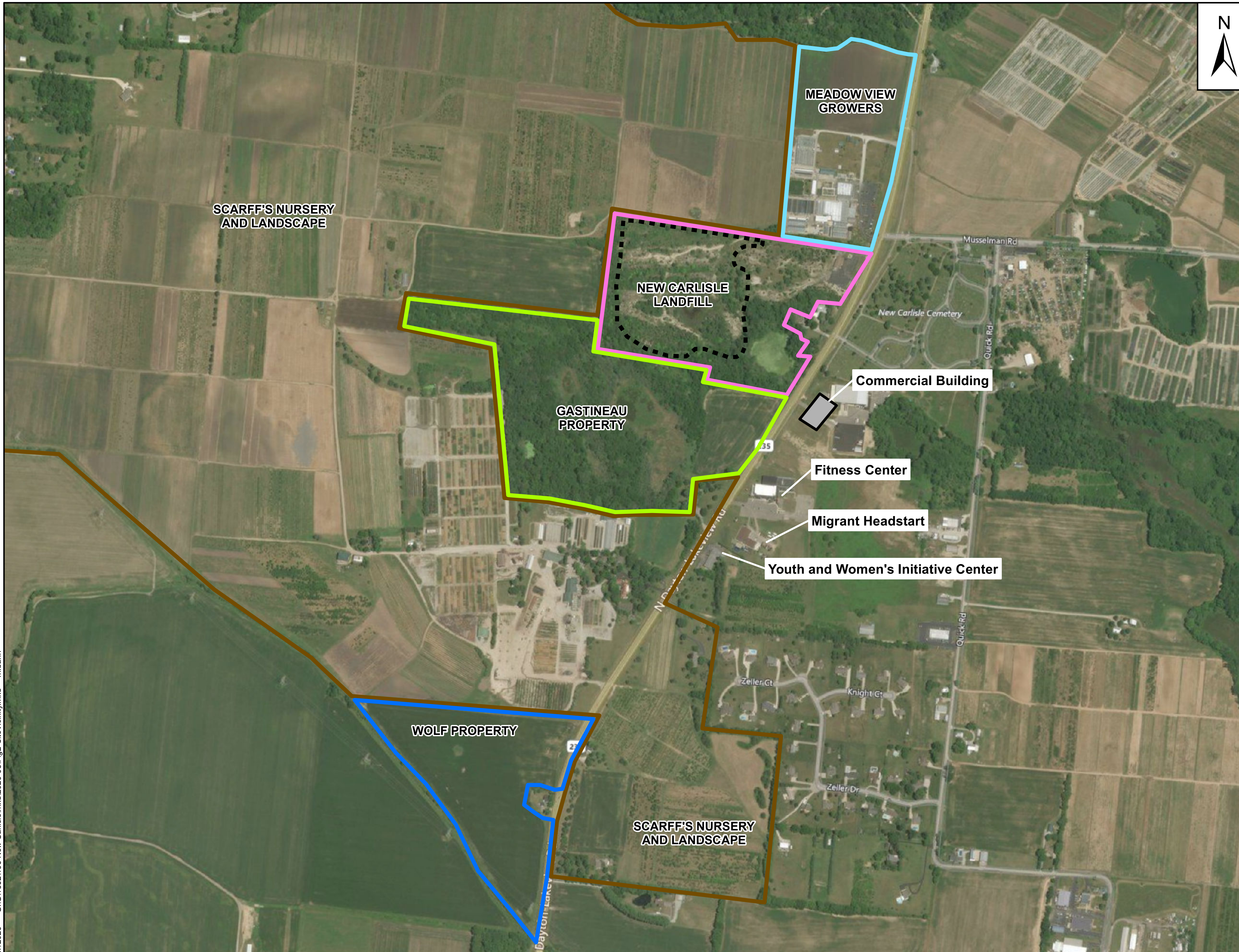
MAP SOURCE:
USGS 7.5-Minute Series Topographic Quadrangle
New Carlisle, Ohio, 1984. Scale= 1:24000

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 1
SITE LOCATION MAP

SulTRAC

3/27/2020 G:\G18521166 New Carlisle\mxd\2020-03\Fig1-SiteLocation.mxd m.banh



LEGEND

- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Wolf Property
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill

Note:

The RI was conducted in terms of "on-site" and "off-site" areas. "On-site" referred to the "Parcel Encompassing New Carlisle Landfill" (shown with pink outline). Other parcels were considered off-site.

RI - Remedial investigation

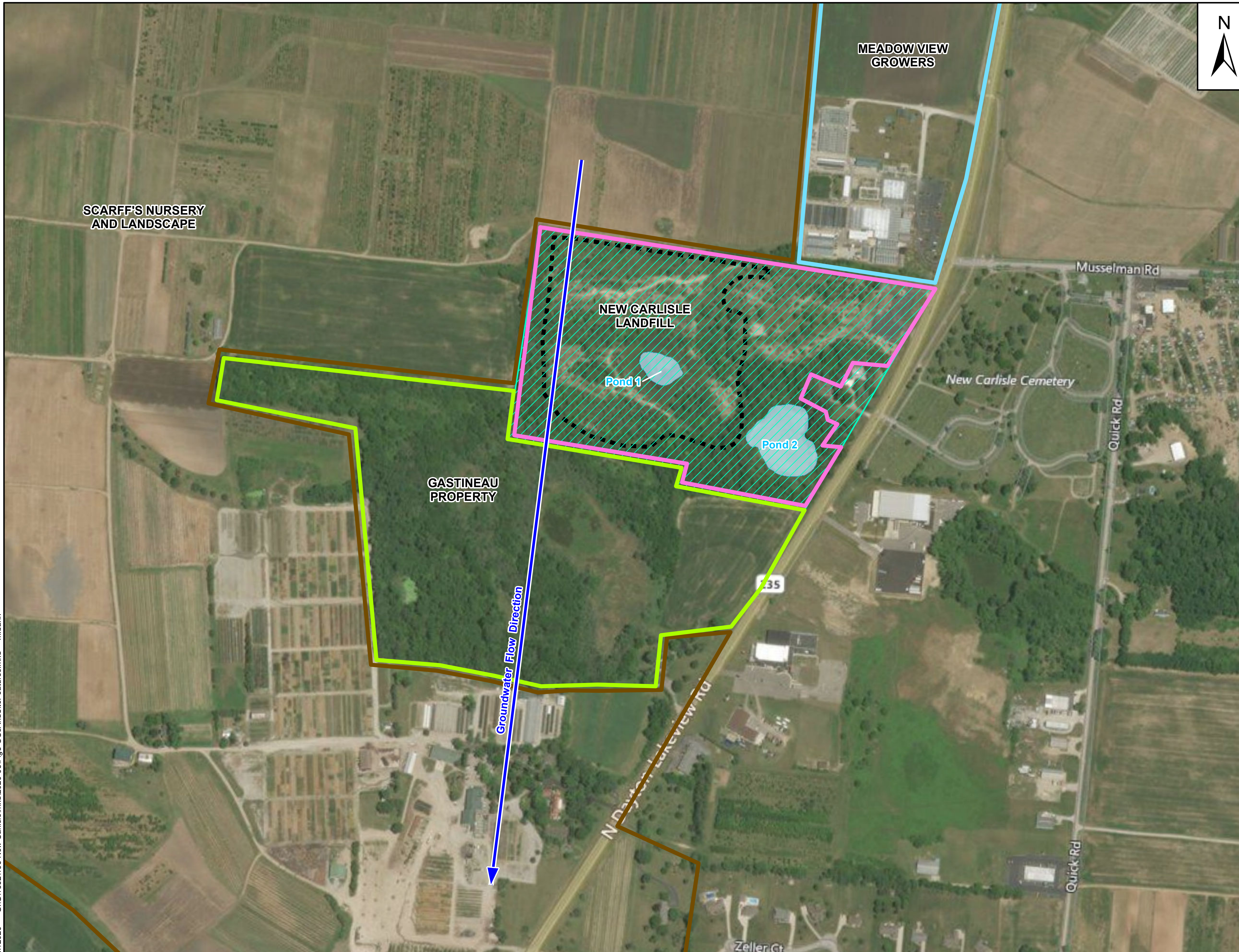
0 500 1,000
Feet

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 2
SITE VICINITY MAP

SulTRAC

3/27/2020 G:\G11852\166 New Carlisle\mxd\2020-03\Fig2-SiteVicinity.mxd m.banh



N

LEGEND

- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Parcel Encompassing New Carlisle Landfill
- Wolf Property
- Scarff's Nursery and Landscape
- Operable Unit 1 (OU 1)
- Pond

Notes:

1. Subsequent to the RI, the NCL site was divided into two geographical areas, OU 1 and OU 2. OU 1 consists of the landfill, groundwater below the landfill, and landfill gas (collectively referred to as landfill media) as well as vapor intrusion at Properties 1, 2, and 3 adjacent to the eastern side of the landfill. OU 2 consists of the VOC groundwater plume that extends south from the landfill for approximately 3,000 feet. Because groundwater conditions are dynamic, no OU 2 boundary is shown.
2. Groundwater flow direction was determined using September 2015 groundwater elevations.

NCL - New Carlisle landfill
OU - Operable unit
RI - Remedial investigation
VOC - Volatile organic compound

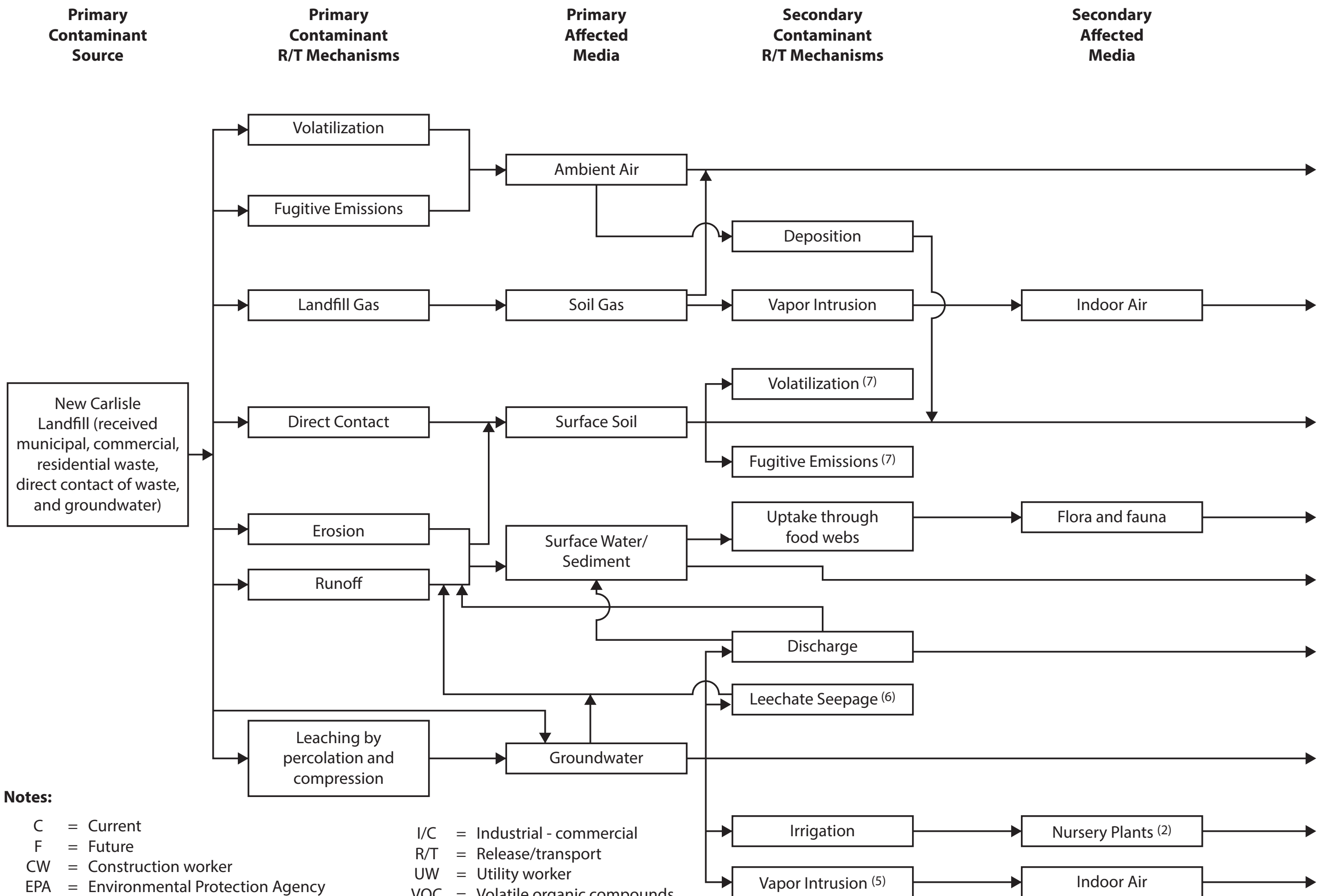
0 500 1,000
Feet

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 3
OPERABLE UNITS AND
SITE FEATURES

ST SulTRAC

3/27/2020 G:\G1852\1166 New Carlisle\mxd\2020-03\Fig3-OUsAndSiteFeatures.mxd m.banh



Potentially Exposed Human Receptors

Exposure Routes	On-Site [1] CF Trespasser	On-Site CF I/C Worker	On-Site CF UW	On-Site CF CW	On-Site F Resident	Off-Site CF Resident	Off-Site CF I/C Worker	Off-Site CF Customer	Off-Site CF Trespasser	Off-Site CF UW	Off-Site CF CW	Off-Site CF School-Staff/Students
Inhalation (5)	--	--	--	--	--	--	--	--	--	--	--	--
Inhalation	--	●	●[4]	●[4]	●	--	--	--	--	--	--	--
Explosion	--	○	○	○	○	--	--	--	--	--	--	--
Incidental Ingestion	--	--	--	--	--	--	--	--	--	--	--	--
Dermal Contact	--	--	--	--	--	--	--	--	--	--	--	--
Ingestion (8)	○	--	--	--	--	--	--	--	--	--	--	--
Incidental Ingestion	●	--	--	--	--	--	--	--	--	--	--	--
Dermal Contact	●	--	--	--	--	--	--	--	--	--	--	--
Incidental Ingestion	○	--	--	--	--	--	--	--	--	--	--	--
Dermal Contact	○	--	--	--	--	--	--	--	--	--	--	--
Ingestion	--	●[3]	○[4]	○[4]	●[3]	●[3]	●[3]	●[3]	--	○[4]	○[4]	--
Dermal Contact	--	●[3]	●[4]	●[4]	●[3]	●[3]	●[3]	--	--	●[4]	●[4]	--
Inhalation	--	●[3]	●[4]	●[4]	●[3]	●[3]	●[3]	●	--	●[4]	●[4]	--
Inhalation	--	--	--	--	--	--	○	○	○	○	○	--
Inhalation	--	●	--	--	●	●	●	●	--	○	○	○

Notes:

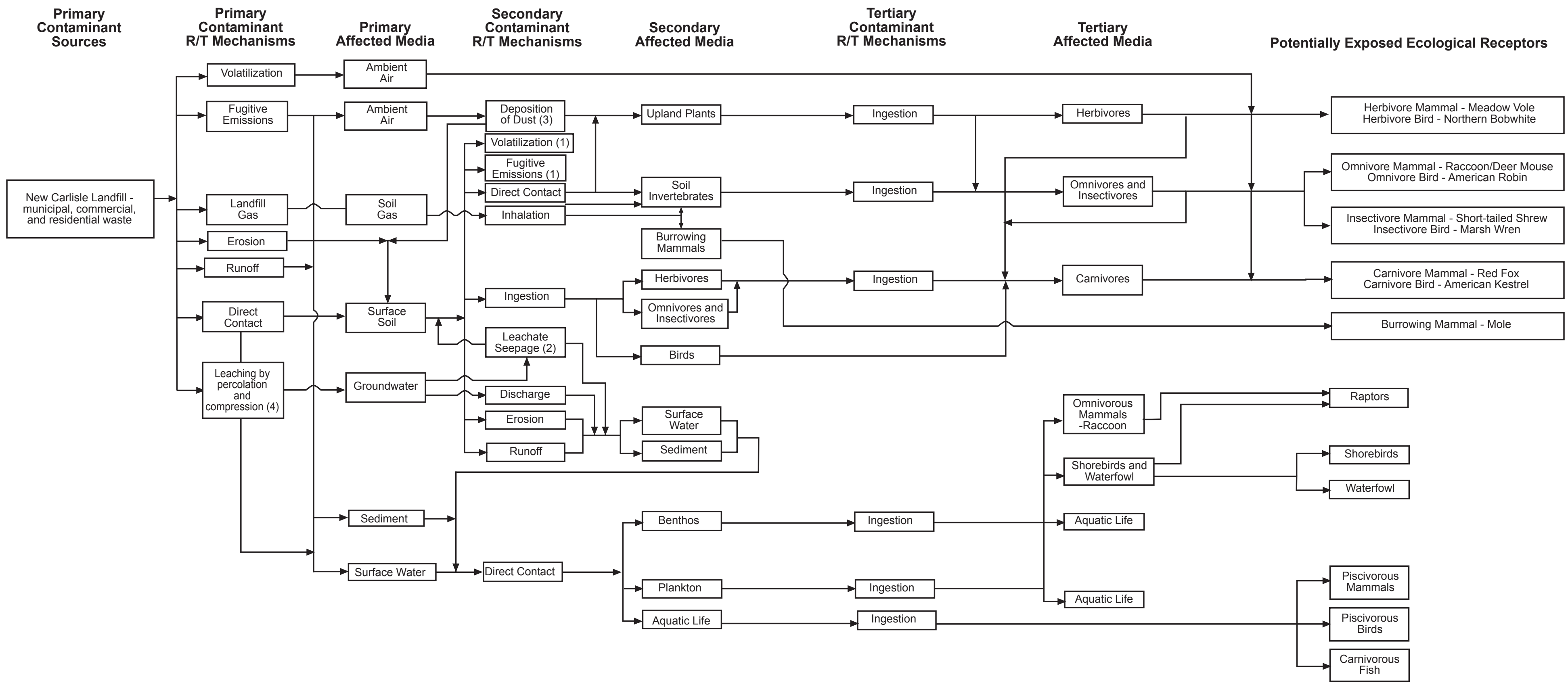
C = Current
F = Future
CW = Construction worker
EPA = Environmental Protection Agency
HHRA = Human health risk assessment
I/C = Industrial - commercial
R/T = Release/transport
UW = Utility worker
VOC = Volatile organic compounds
● = Potentially complete exposure pathway – retain for quantitative analysis
○ = Potentially complete, but insignificant exposure pathway – will not be retained for quantitative analysis
-- = Incomplete exposure pathway -- will not be considered in the HHRA

1. Consistent with EPA's presumptive remedy guidance, no on-landfill exposures will be quantified (EPA 1993); all on-site receptors are assumed to be exposed on land outside the disposal area footprint, but within the parcels encompassing the landfill.
2. Irrigation assumed to liberate VOCs into ambient air – I/C workers and residents living on nursery property assumed exposed through inhalation.
   Potential exposure to VOCs released from irrigation to both indoor and ambient air is considered to be insignificant (see text for additional information).
3. Assumed to be complete only if groundwater within contaminated plume is used as potable water in the future.
4. UW and CW assumed to be exposed to groundwater while working in a trench or foundation.
5. VOCs in groundwater assumed to be released to ambient air also. However, potential exposure to VOCs released to ambient air from groundwater is expected to be a potentially complete, but insignificant exposure pathway and was not retained for quantitative analysis.
6. Includes degassing to ambient air through seepage.
7. As shown under primary contaminant release and transport mechanisms.
8. The small, shallow ponds on and southeast of the landfill have no influent or effluent streams. While fish may theoretically develop in these ponds through the transfer of eggs to the ponds from other sources, the fish are expected to be small and short-lived. It is not reasonable to assume human receptors would regularly consume aquatic life from these small, shallow ponds.

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 4
HUMAN HEALTH
CONCEPTUAL SITE MODEL

ST SulTRAC

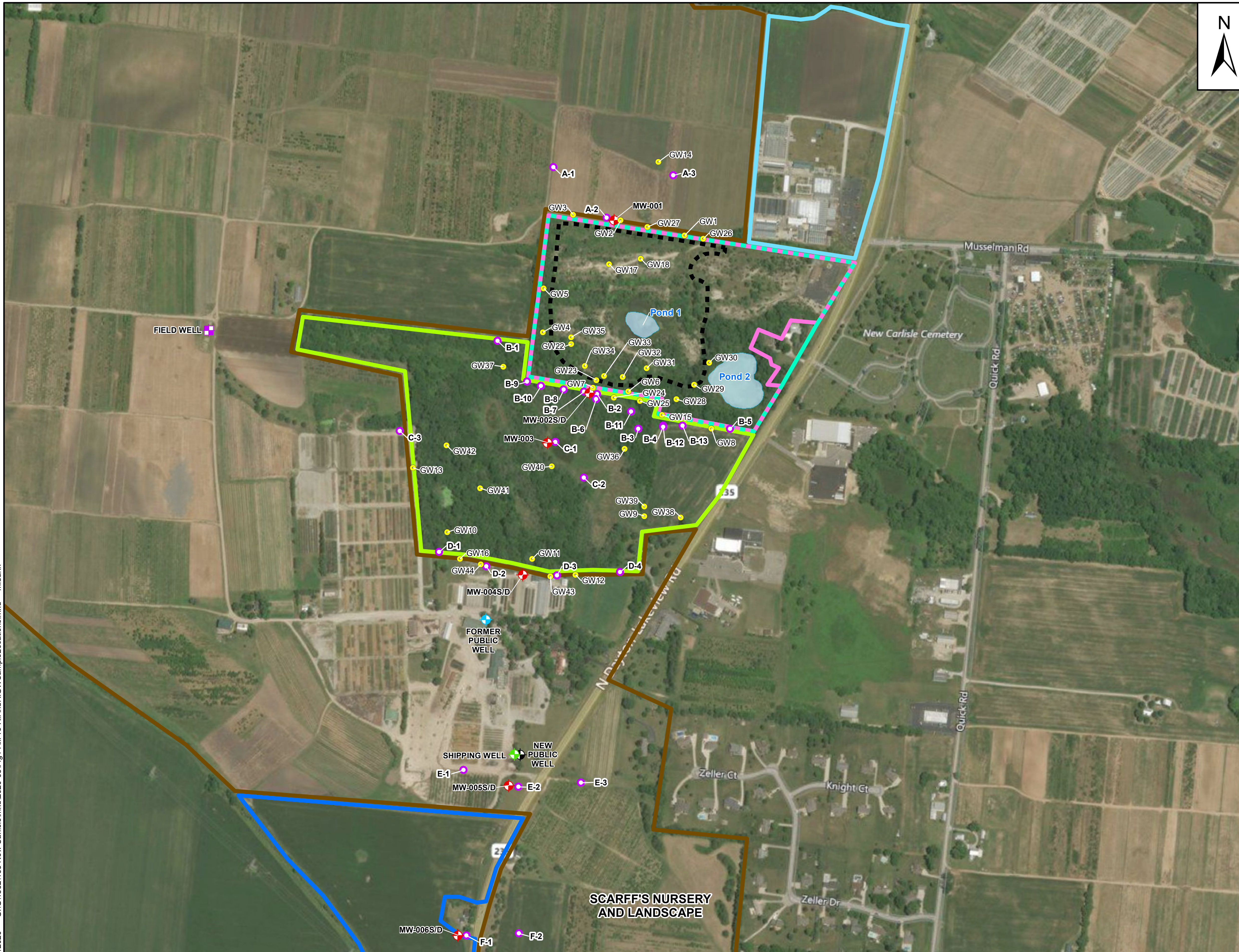


Note:
R/T = Release/Transport
1. As shown under primary contaminant R/T Mechanisms.
2. Includes degassing to ambient air through seepage.
3. Fugitive dusts are also assumed to deposit onto surface soil.
4. Includes leaching from waste in direct contact with groundwater.

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 5
ECOLOGICAL
CONCEPTUAL SITE MODEL

ST SulTRAC



LEGEND

- Ohio EPA Pre-RI Geoprobe Boring (2002-2005)
- Monitoring Well Location
- New Public Well Location
- Former Public Well Location
- Shipping Well Location
- Field Well Location
- VAS Sample Location
- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Wolf Property
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Pond

Notes:

1. All current and historical groundwater sampling locations are shown.
2. Residential Well locations removed for privacy reasons.

EPA - Environmental Protection Agency
GW - Geoprobe
MW - Monitoring well
RI - Remedial investigation
VAS - Vertical aquifer sample

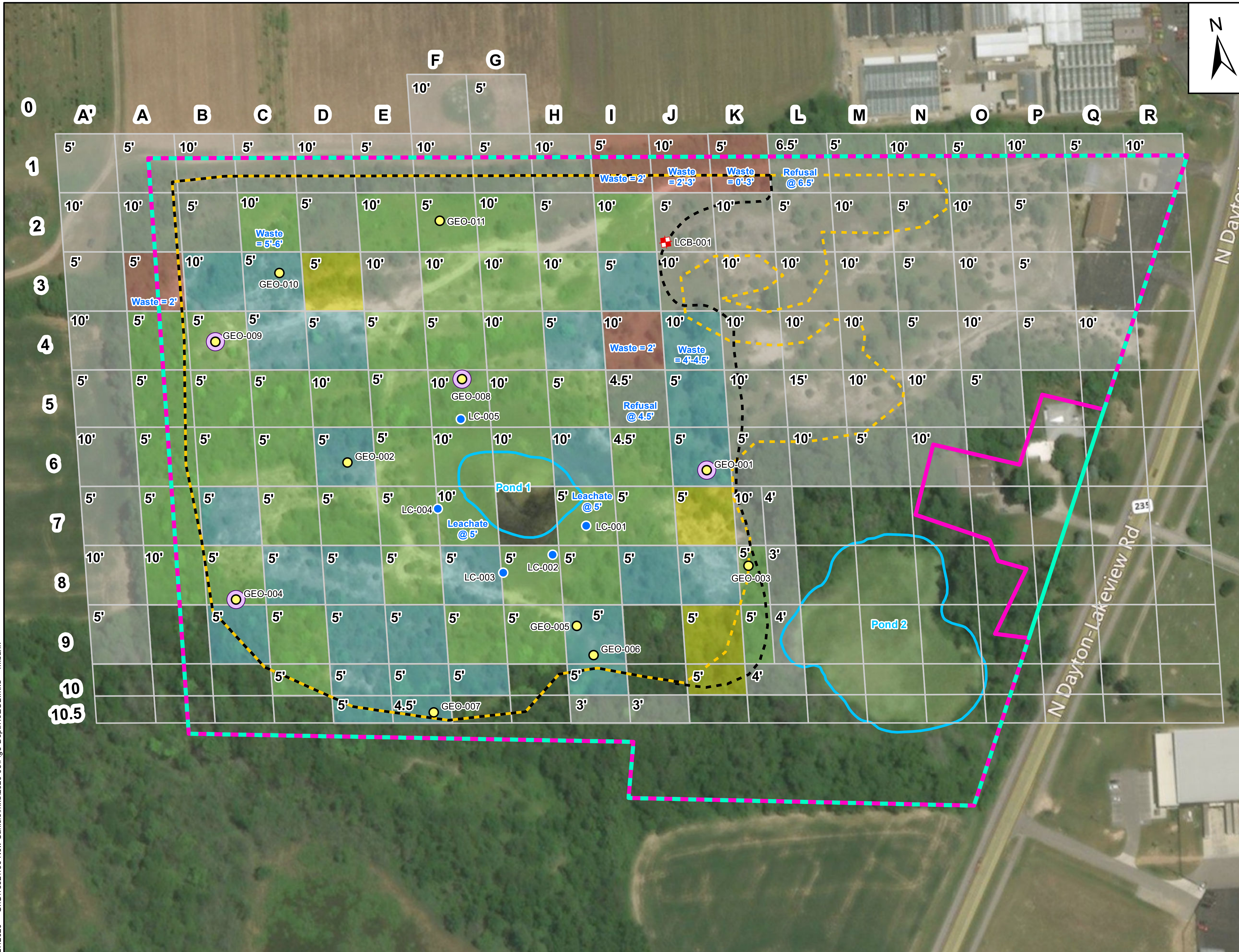
0 500 1,000
Feet

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

FIGURE 6
ALL PRE-RI AND RI GROUNDWATER SAMPLING LOCATIONS

SulTRAC

G:\G\1852\166 New Carlisle\mxd\2020-03\Fig4-AllPre-RIAndRIGWSampleLocations.mxd m.banh 4/7/2020



Legend

- LCB - Landfill Cased Boring Location
- Landfill Cap Boring Location
- Geotechnical Soil Boring Location
- Geotechnical & Permeability Sample Location
- Pond
- Operable Unit 1 Boundary
- Parcels Encompassing New Carlisle Landfill
- Disposal area interpreted from 1971 aerial photography
- Approximate extent of waste encountered during RI

Soil Cover Thickness

- Less than 3 feet
- 3 to 4 feet
- 4 to 5 feet
- Greater than 5 feet
- No waste observed

10' End of boring depth (in feet)

Notes:

1. For each grid analyzed, the color shading depicting soil cover thickness was applied to the entire 100- by 100-foot grid; however, no waste was detected outside of the disposal area.
2. During the RI, three 17-foot deep test pits were excavated within the extent of waste, starting in landfill Grid H-10 and excavating north into Grid H-9. The test pit excavations revealed automotive parts and debris with chlorinated odors throughout each trench; however, no obvious drums or containers were observed. No groundwater was encountered.
3. Field observations are noted in some of the grids. "Waste = 2'" indicates that waste was encountered at 2 feet bgs.

Bgs -Below ground surface
GEO - Geotechnica
LC - Landfill cover
LCB - Landfill cased boring
RI - Remedial investigation

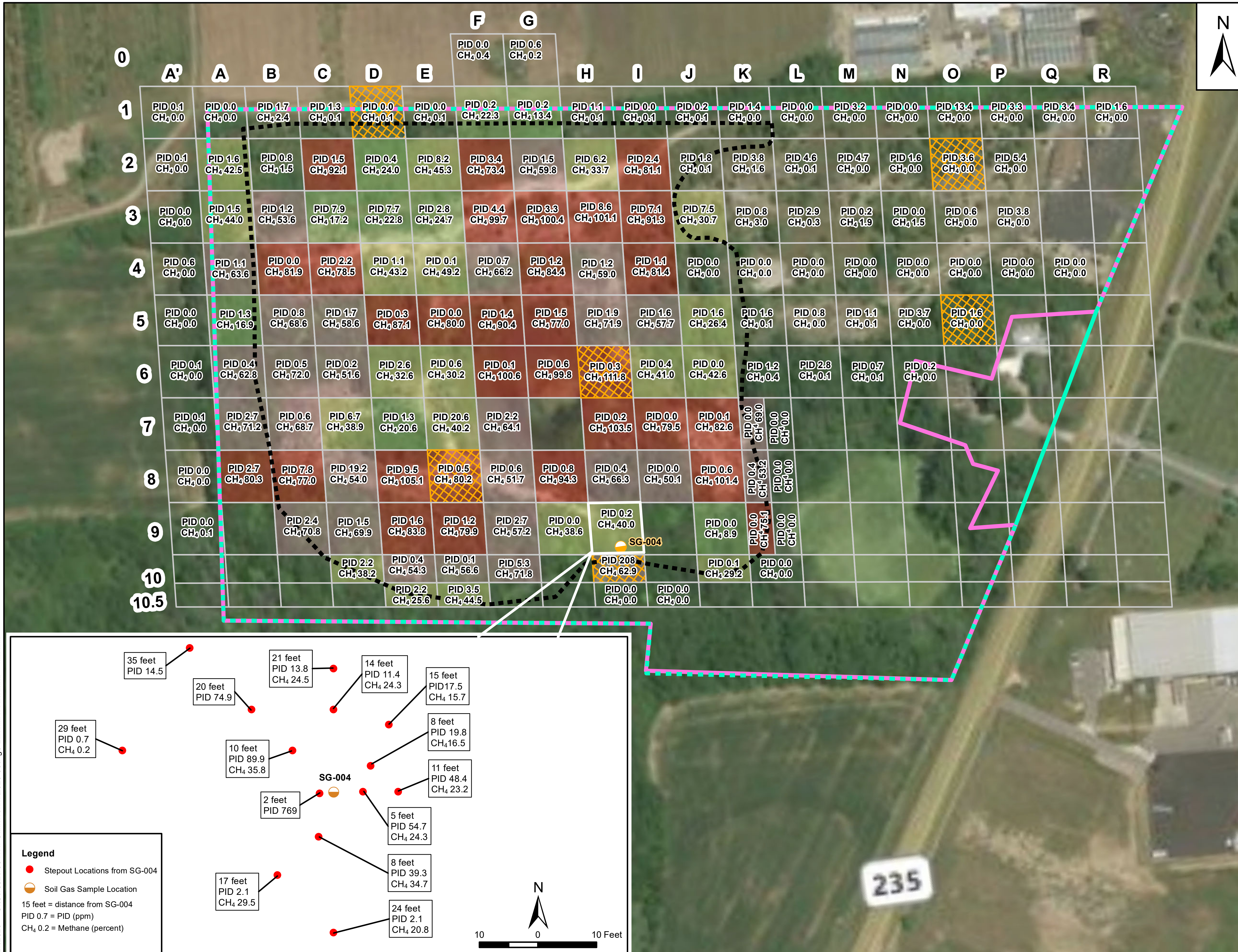
0 100 200
Feet

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 7
LANDFILL CAP INVESTIGATION RESULTS

ST SulTRAC

3/27/2020 G:\G18521\166 New Carlisle\mxd\2020-03\Fig5-DepthToEOB.mxd m.banh



N

Legend

- Soil Gas Sample Location
- 5 to 25% CH^4
- 26 to 50% CH^4
- 51 to 75% CH^4
- +75% CH^4
- 100- x 100-foot grids
- Gas Probe Location
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary

Notes:

1. At several locations, percent methane exceeds 100 percent because of instrument interferences.
2. Inset shows results of step out soil gas screening locations surrounding soil gas sampling location SG-004.

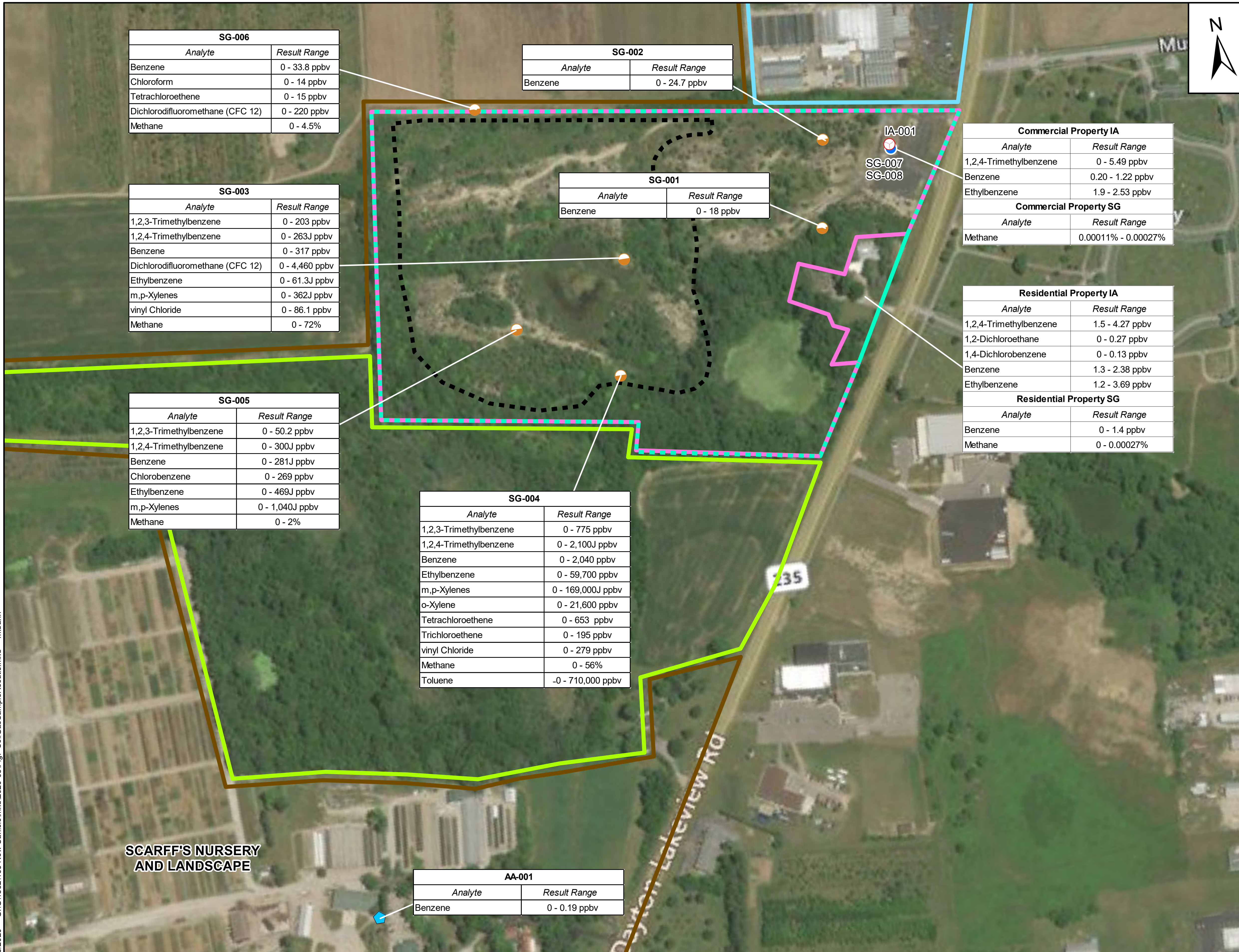
CH_4 - Methane concentration in soil gas (percent by volume)
PID - Photoionization detection (parts per million)
ppm - Parts per million
RI - Remedial investigation
SG - Soil gas

0 100 200
Feet

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 8
LANDFILL SOIL GAS SCREENING RESULTS

ST SulTRAC



SG-006

Analyte	Result Range
Benzene	0 - 33.8 ppbv
Chloroform	0 - 14 ppbv
Tetrachloroethene	0 - 15 ppbv
Dichlorodifluoromethane (CFC 12)	0 - 220 ppbv
Methane	0 - 4.5%

SG-002

Analyte	Result Range
Benzene	0 - 24.7 ppbv

SG-003

Analyte	Result Range
1,2,3-Trimethylbenzene	0 - 203 ppbv
1,2,4-Trimethylbenzene	0 - 263J ppbv
Benzene	0 - 317 ppbv
Dichlorodifluoromethane (CFC 12)	0 - 4,460 ppbv
Ethylbenzene	0 - 61.3J ppbv
m,p-Xylenes	0 - 362J ppbv
vinyl Chloride	0 - 86.1 ppbv
Methane	0 - 72%

SG-001

Analyte	Result Range
Benzene	0 - 18 ppbv

Commercial Property IA

Analyte	Result Range
1,2,4-Trimethylbenzene	0 - 5.49 ppbv
Benzene	0.20 - 1.22 ppbv
Ethylbenzene	1.9 - 2.53 ppbv

Commercial Property SG

Analyte	Result Range
Methane	0.00011% - 0.00027%

Residential Property IA

Analyte	Result Range
1,2,4-Trimethylbenzene	1.5 - 4.27 ppbv
1,2-Dichloroethane	0 - 0.27 ppbv
1,4-Dichlorobenzene	0 - 0.13 ppbv
Benzene	1.3 - 2.38 ppbv
Ethylbenzene	1.2 - 3.69 ppbv

Residential Property SG

Analyte	Result Range
Benzene	0 - 1.4 ppbv
Methane	0 - 0.00027%

SG-005

Analyte	Result Range
1,2,3-Trimethylbenzene	0 - 50.2 ppbv
1,2,4-Trimethylbenzene	0 - 300J ppbv
Benzene	0 - 281J ppbv
Chlorobenzene	0 - 269 ppbv
Ethylbenzene	0 - 469J ppbv
m,p-Xylenes	0 - 1,040J ppbv
Methane	0 - 2%

SG-004

Analyte	Result Range
1,2,3-Trimethylbenzene	0 - 775 ppbv
1,2,4-Trimethylbenzene	0 - 2,100J ppbv
Benzene	0 - 2,040 ppbv
Ethylbenzene	0 - 59,700 ppbv
m,p-Xylenes	0 - 169,000J ppbv
o-Xylene	0 - 21,600 ppbv
Tetrachloroethene	0 - 653 ppbv
Trichloroethene	0 - 195 ppbv
vinyl Chloride	0 - 279 ppbv
Methane	0 - 56%
Toluene	-0 - 710,000 ppbv

AA-001

Analyte	Result Range
Benzene	0 - 0.19 ppbv

LEGEND

- Ambient Air Sample Location
- Indoor Air Sample Location
- Soil Gas Sample Location
- Sub-Slab Soil Gas Sample Location
- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary

Notes:

1. Indoor air and ambient air sample results shown exceed the EPA VISLs for indoor air.
2. Soil gas and sub-slab soil gas sample results shown exceed the EPA VISLs for sub-slab and exterior soil gas.

% - percent by volume
Exp. Phase II - Expanded phase II
IA - Indoor air
ppbv - parts per billion by volume
EPA - Environmental Protection Agency
RI - Remedial investigation
SG - Soil gas
VISL - Vapor intrusion screening level

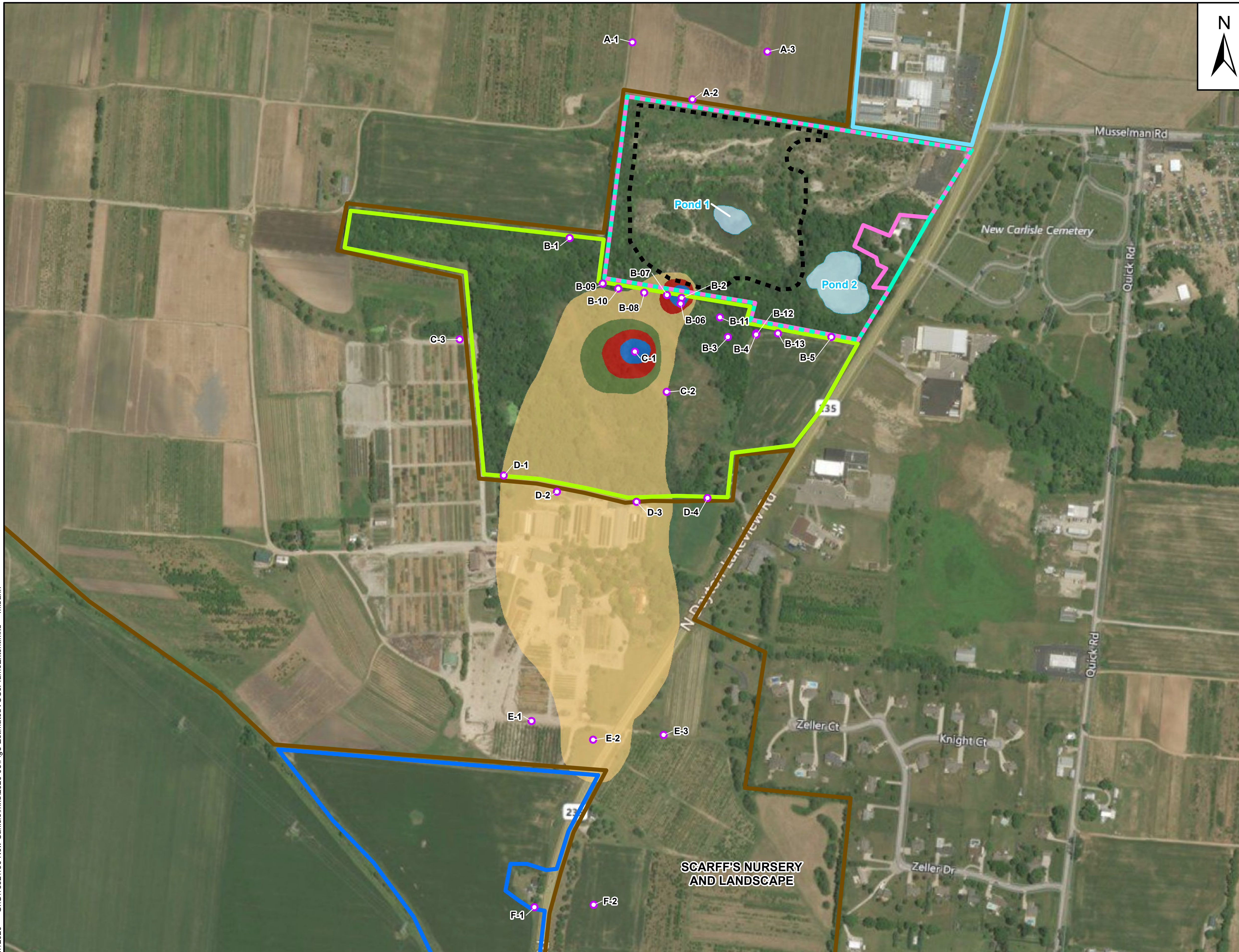
J = The analyte was positively identified; the associated value is an approximate concentration.

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 9
SAMPLE RESULTS EXCEEDING
SITE SCREENING LEVELS

ST SulTRAC

4/8/2020 G:\G\1852\166 New Carlisle\mxd\2020-03\Fig7-SoilGasSampleResults.mxd m.banh



LEGEND

- VAS Sample Location
- Pond
- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Wolf Property
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Tetrachloroethene above MCL of 5 µg/L
- Trichloroethene above MCL of 5 µg/L
- cis-1,2-Dichloroethene above MCL of 70 µg/L
- Vinyl Chloride above MCL of 2 µg/L

Note:

The estimated extent of select VOC plumes was developed using VAS sampling data that exceeded MCLs for the select VOCs.

MCL - Maximum contaminant levels
RI - Remedial investigation
VAS - Vertical aquifer sample
VOC - Volatile organic compound
µg/L - micrograms per liter

0 500 1,000
Feet

NEW CARLISLE LANDFILL
NEW CARLISLE, OHIO

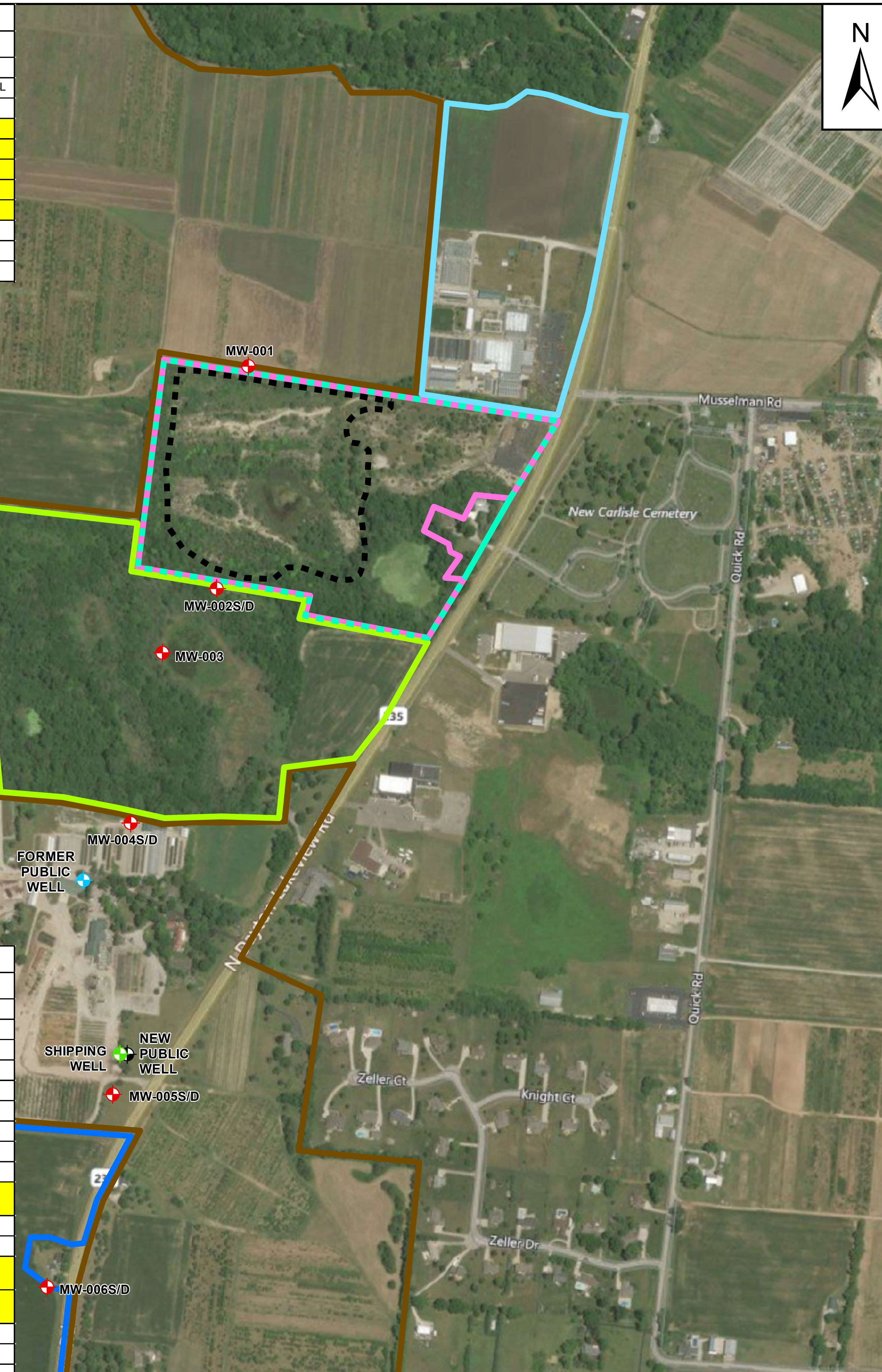
FIGURE 10
ESTIMATED EXTENT OF SELECT VOCs BASED ON RI VAS RESULTS

ST SulTRAC

3/27/2020 G:\G1852\166 New Carlisle\mxd\2020-03\Fig8-EstimatedVOCsPlumeExtent.mxd m.banh

Well ID	Depth (ft bgs)	Phase I				Phase II				Expanded Phase II				Phase III			
		PCE	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*
MW-001	65-70	NI	NI	NI	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-002S	25-35	NI	NI	NI	NI	**12**	**15**	< MCL	< MCL	**8.1**	**13**	< MCL	ND	**13**	**14**	< MCL	< MCL
MW-002D	70-80	NI	NI	NI	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-003S	70-80	NI	NI	NI	NI	ND	ND	< MCL	**95**	ND	ND	**71**	**130**	ND	ND	**110**	**44**
MW-003D	90-100	NI	NI	NI	NI	ND	< MCL	**170**	< MCL	ND	< MCL	**200**	ND	ND	< MCL	**180**	**2.4**
MW-004S	55-65	NI	NI	NI	NI	ND	ND	< MCL	**25**	ND	ND	< MCL	**36**	ND	ND	< MCL	**35**
MW-004D	100-110	NI	NI	NI	NI	ND	ND	ND	**7.9**	ND	ND	ND	**5.9**	ND	ND	ND	**4.6**
MW-005S	50-60	NI	NI	NI	NI	ND	ND	ND	**21**	ND	ND	ND	**22**	ND	ND	ND	**16**
MW-005D	115-125	NI	NI	NI	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-006S	53-63	NI	NI	NI	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-006D	115-125	NI	NI	NI	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

As discussed in the remedial investigation report, the Phase II results for wells MW-002S and MW-002D appear to be switched.
This determination was made based on Expnaded Phase II and Phase III results as well as vertical aquifer sampling results from location VAS-B2.
Therefore, this table reflects the corrected Phase II results for these two wells.



Well ID	Depth (ft bgs)	Phase I				Phase II				Expanded Phase II				Phase III			
		PCE	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*	*PCE*	*TCE*	*DCE*	*VC*
RW-17	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RW-4	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	ND	ND	ND	ND
RW-5	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS
RW-3	NA	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS
RW-10	NA	NS	NS	NS	NS	NS	NS	NS	NS	ND	ND	ND	ND	NS	NS	NS	NS
FIELD WELL	NA	NS	NS	NS	NS	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS
RW-7	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RW-15	NA	NS	NS	NS	NS	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS
RW-8	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
FORMER PUBLIC WELL	60-70	ND	ND	ND	**18**	ND	ND	ND	**18**	ND	ND	ND	**4.9**	ND	ND	ND	**13**
RW-22	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RW-13	NA	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS
SHIPPING WELL	NA	NS	NS	NS	NS	ND	ND	ND	**3.4**	NS	NS	NS	NS	ND	ND	ND	**2.6**
NEW PUBLIC WELL	112-122	ND	ND	ND	**31 J**	NS	NS	NS	NS	NS	NS	NS	NS	ND	ND	ND	**27**
RW-14	NA	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RW-1-DEC-03	NA	ND	ND	ND	ND	NS	NS	NS	NS	ND	ND	ND	ND	NS	NS	NS	NS
CAMP WELL	NA	NS	NS	NS	NS	ND	ND	ND	ND	NS	NS	NS	NS	NS	NS	NS	NS

LEGEND

- Monitoring Well Location
- New Public Well Location
- Former Public Well Location
- Shipping Well Location
- Field Well Location
- Camp Well Location
- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Wolf Property
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary

Notes:

1. Inset data table includes only RI monitoring well, residential well, and irrigation well VOC sample results that exceed MCLs (highlighted).
2. Residential Well locations removed for privacy reasons.

Results shown in table are in units of (µg/L).

J - The analyte was positively identified; the associated value is an approximate concentration.

Bgs - Below ground surface
DCE - cis-1,2-dichloroethene
Ft - Feet
MCL - Maximum contaminant level
MW - Monitoring well
NA - Information not available
ND - Not detected
NI - Well not installed during Phase I
NS - Not sampled during a particular RI phase
PCE - Tetrachloroethene
RI - Remedial investigation
TCE - Trichloroethene
VC - Vinyl chloride
VOC - Volatile organic compound
µg/L - micrograms per Liter

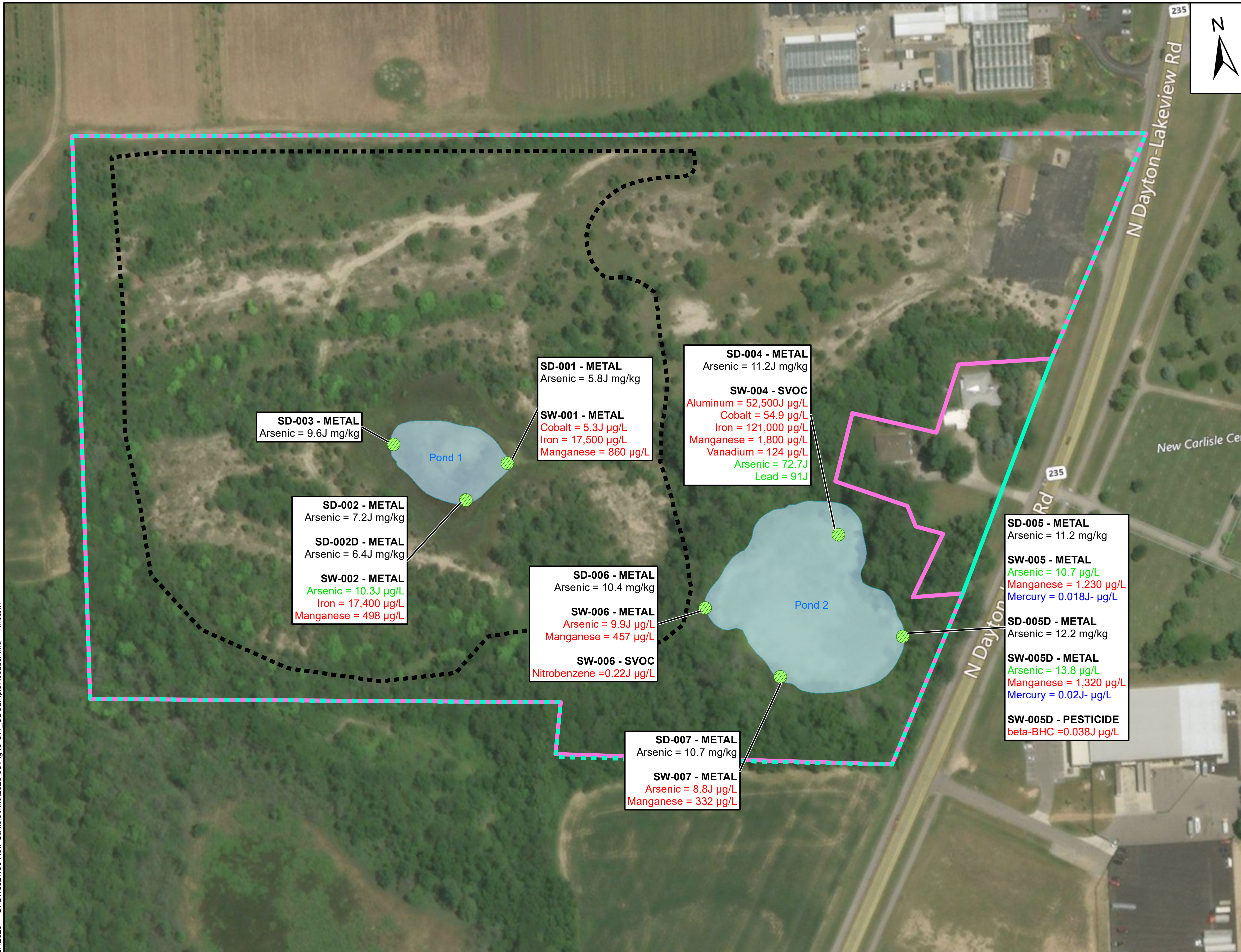
0 500 1,000
Feet

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 11
VOCs EXCEEDING RI SCREENING LEVELS IN SITE WELLS

ST SulTRAC

4/7/2020 G:\G\1852\166 New Carlisle\mxd\2020-03\Fig9-VOCsExceedingRIScreeningLevels.mxd m.banh



LEGEND

- Collocated Surface Water and Sediment Sample Location
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Pond

54.9 - Result exceeds EPA Tapwater Screening Level

10.7 - Result exceeds EPA MCL

0.02 - Result exceeds Outside Mixing Zone Average (Ohio EPA)

10.7 - Result exceeds EPA Residential Soil Screening Level

Note:

1. Co-located surface water and sediment samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides. polychlorinated biphenyls (PCBs), and metals. No analytes exceeded surface water screening levels for VOCs, pesticides, or PCBs. No analytes exceeded sediment screening levels for VOCs, SVOCs, pesticides or PCBs.

"J" = The analyte was positively identified; the associated numerical value is qualified with a J and is an approximate concentration of the analyte in the sample.

"J-" = The analyte was positively identified; the result is qualified with a J- and is an estimated quantity that may be biased low.

D - Duplicated sample
EPA - Environmental Protection Agency
MCL - Maximum contaminant level
PCB - Polychlorinated biphenyl
RI - Remedial investigation
SD - Sediment sample
SVOC - Semi-volatile organic compound
SW - Surface water sample
VOC - Volatile organic compound
mg/kg - milligrams per kilogram
µg/L - micrograms per liter

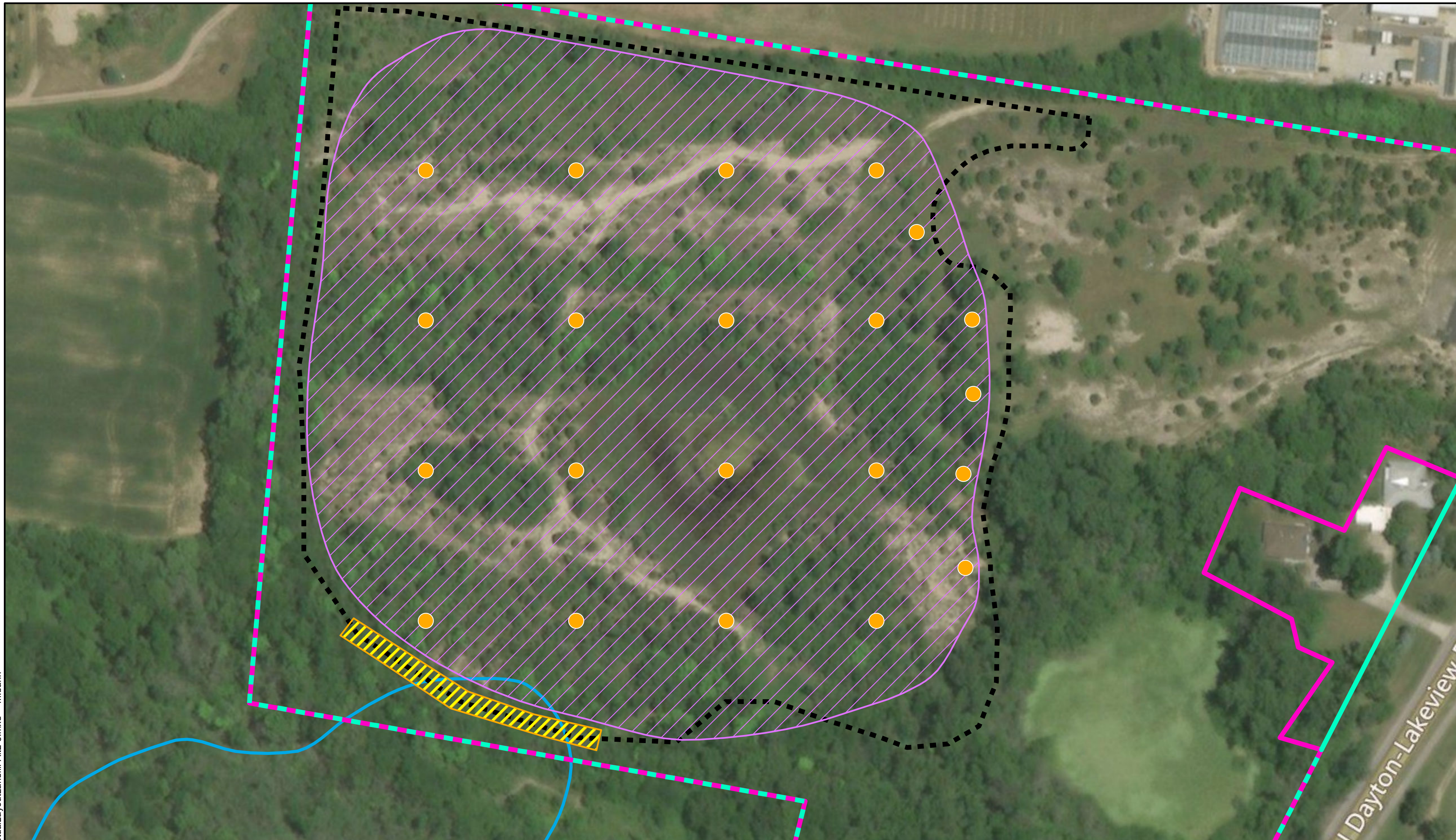
0 100 200
Feet

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 12
SURFACE WATER AND SEDIMENT SAMPLE RESULTS

ST SulTRAC

3/27/2020 G:\G\18521\166 New Carlisle\mxd\2020-03\Fig10-SW_SDSampleResults.mxd m.banh



Legend

- Approximate Proposed Landfill Gas Passive Vent Locations
- Conceptual Area for Consolidation and Capping
- Estimated area for in situ groundwater treatment barrier or groundwater extraction system (to be verified during remedial design)
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Approximate plume width at landfill boundary

Note:

The estimated plume width was developed using transect B VAS VOC sampling data that exceeded MCLs.

HDPE - High-density polyethylene
MCL - Maximum contaminant level
Mil - Millimeters
RI - Remedial investigation
VAS - Vertical aquifer sample
VOC - Volatile organic compound

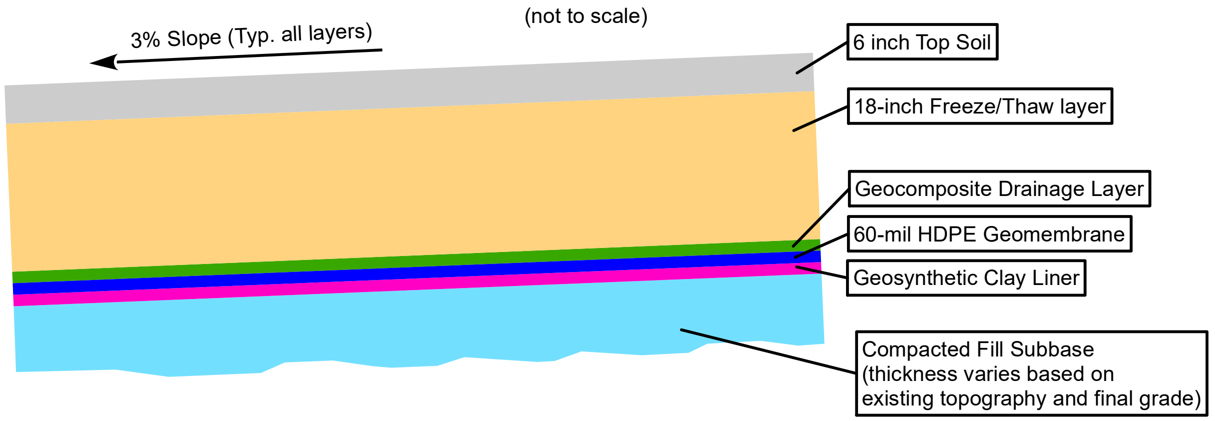
N

0 150 300

1" = 150'

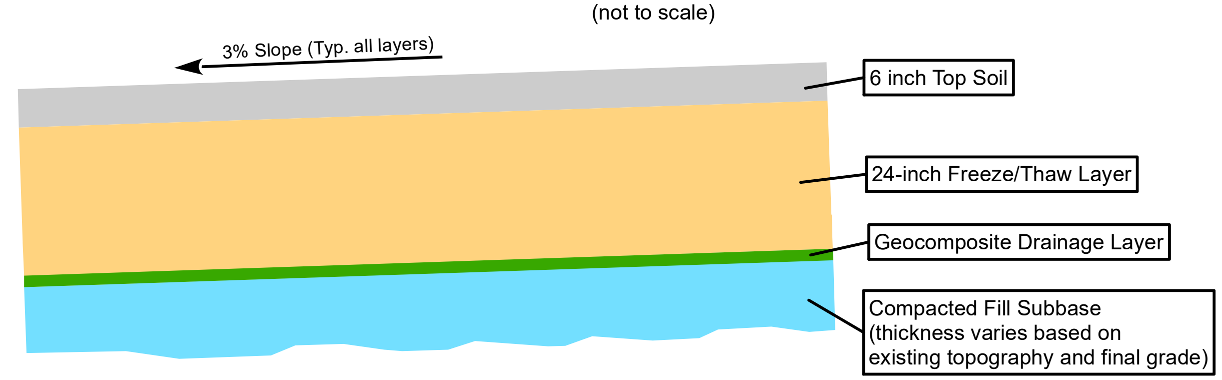
Landfill Cap Cross Section - Alternative LF-2

(not to scale)



Landfill Cap Cross Section - Alternative LF-3

(not to scale)

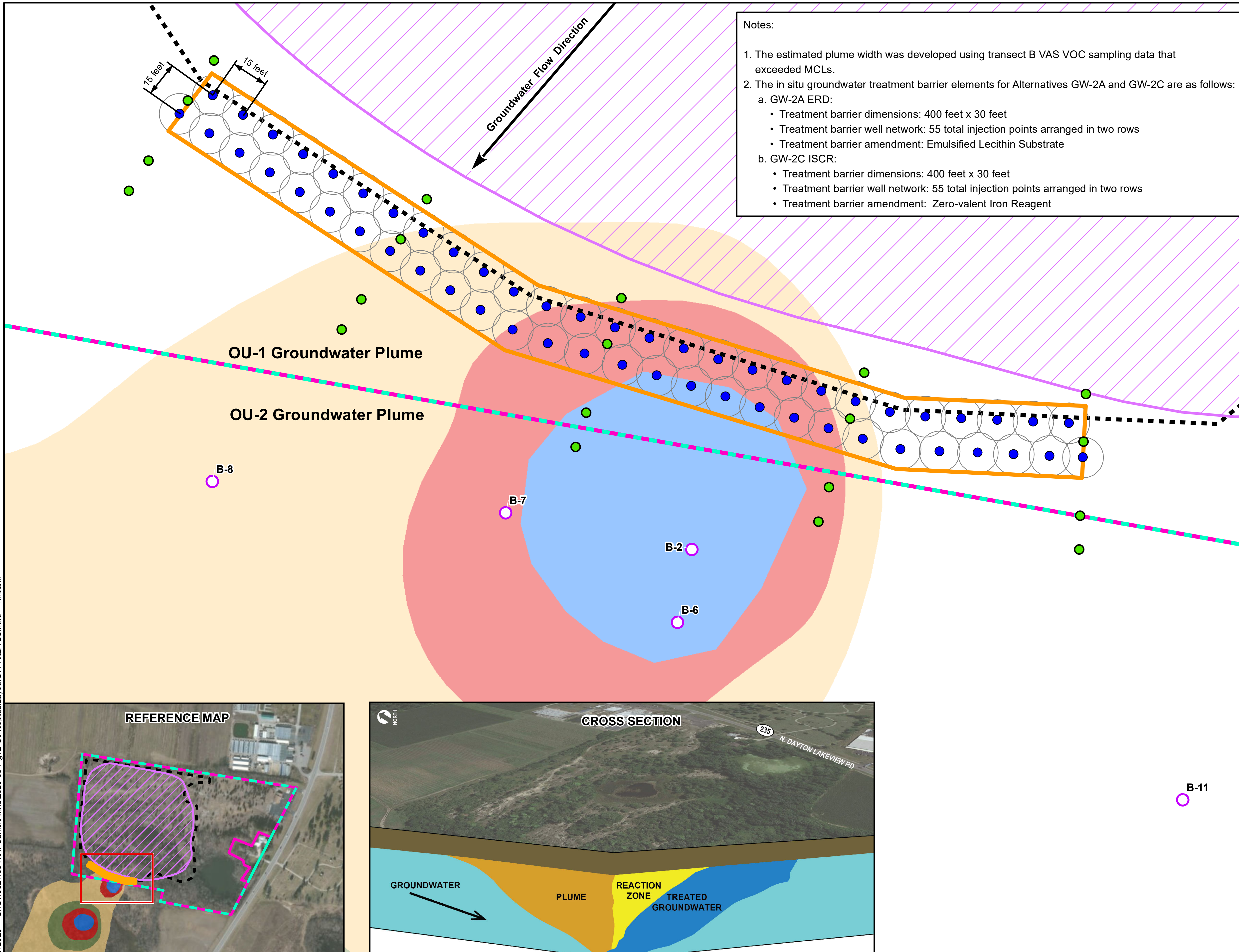


NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 13
CONCEPTUAL LAYOUT FOR
LANDFILL ALTERNATIVES 2 AND 3

ST SulTRAC

3/27/2020 G:\G18521\166 New Carlisle\mxd\2020-03\Fig11-ConceptualLayoutLandfill-Alt2-3.mxd m.banh



Notes:

1. The estimated plume width was developed using transect B VAS VOC sampling data that exceeded MCLs.
2. The in situ groundwater treatment barrier elements for Alternatives GW-2A and GW-2C are as follows:
   a. GW-2A ERD:
      - Treatment barrier dimensions: 400 feet x 30 feet
      - Treatment barrier well network: 55 total injection points arranged in two rows
      - Treatment barrier amendment: Emulsified Lecithin Substrate
   b. GW-2C ISCR:
      - Treatment barrier dimensions: 400 feet x 30 feet
      - Treatment barrier well network: 55 total injection points arranged in two rows
      - Treatment barrier amendment: Zero-valent Iron Reagent

Legend

- Proposed Direct Push Injection Location
- Proposed Performance Monitoring Well
- VAS Sample Location
- Radius of Influence (approximate 8 feet)
- Groundwater containment or treatment barrier (400 feet x 30 feet)
- Conceptual Area for Consolidation and Capping
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Tetrachloroethene above MCL of 5 µg/L
- Trichloroethene above MCL of 5 µg/L
- cis-1,2-Dichloroethene above MCL of 70 µg/L
- Vinyl Chloride above MCL of 2 µg/L

ERD - Enhanced reductive dechlorination
ISCR - In situ chemical reduction
MCL - Maximum contaminant level
OU - Operable unit
RI - Remedial investigation
VAS - Vertical aquifer sample
VOC - Volatile organic compound
µg/L - micrograms per liter

FIGURE 12
CONCEPTUAL LAYOUT FOR GROUNDWATER ALTERNATIVES GW-2A AND GW-2C

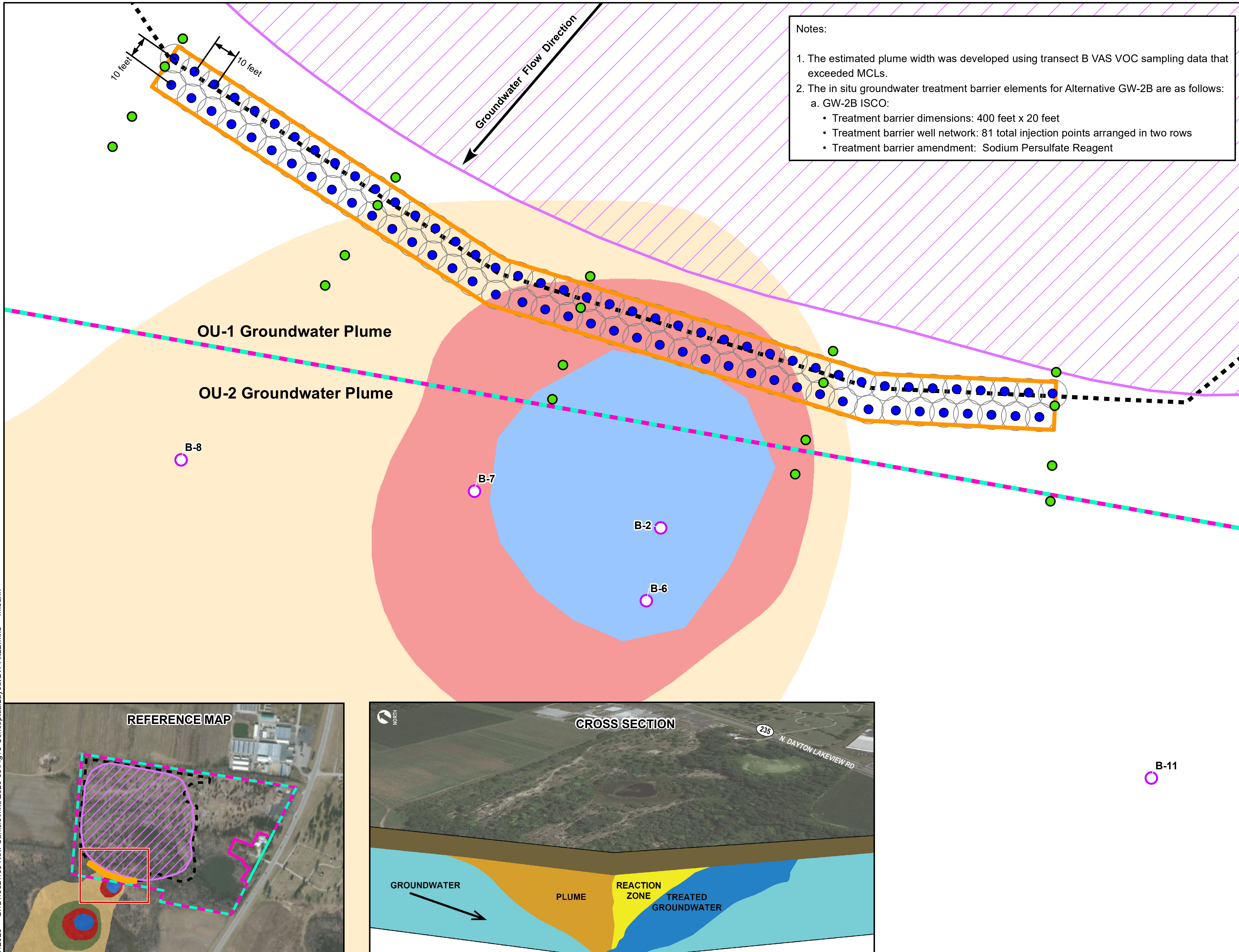
N
0 40 80
1" = 40'

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 14
CONCEPTUAL LAYOUT FOR GROUNDWATER ALTERNATIVES GW-2A and GW-2C

SulTRAC

4/7/2020 G:\G\1852\166 New Carlisle\mxd\2020-03\Fig12-ConceptualLayoutGW-Alt2A-2C.mxd m.banh



Legend

- Proposed Direct Push Injection Location
- Proposed Performance Monitoring Well
- VAS Sample Location
- Radius of Influence (approximate 5.5 feet)
- Groundwater containment or treatment barrier (400 feet x 20 feet)
- Conceptual Area for Consolidation and Capping
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Tetrachloroethene above MCL of 5 µg/L
- Trichloroethene above MCL of 5 µg/L
- cis-1,2-Dichloroethene above MCL of 70 µg/L
- Vinyl Chloride above MCL of 2 µg/L

ISCO - In situ chemical oxidation
MCL - Maximum contaminant level
OU - Operable unit
RI - Remedial investigation
VAS - Vertical aquifer sample
VOC - Volatile organic compound
µg/L - micrograms per liter

N

0 40 80

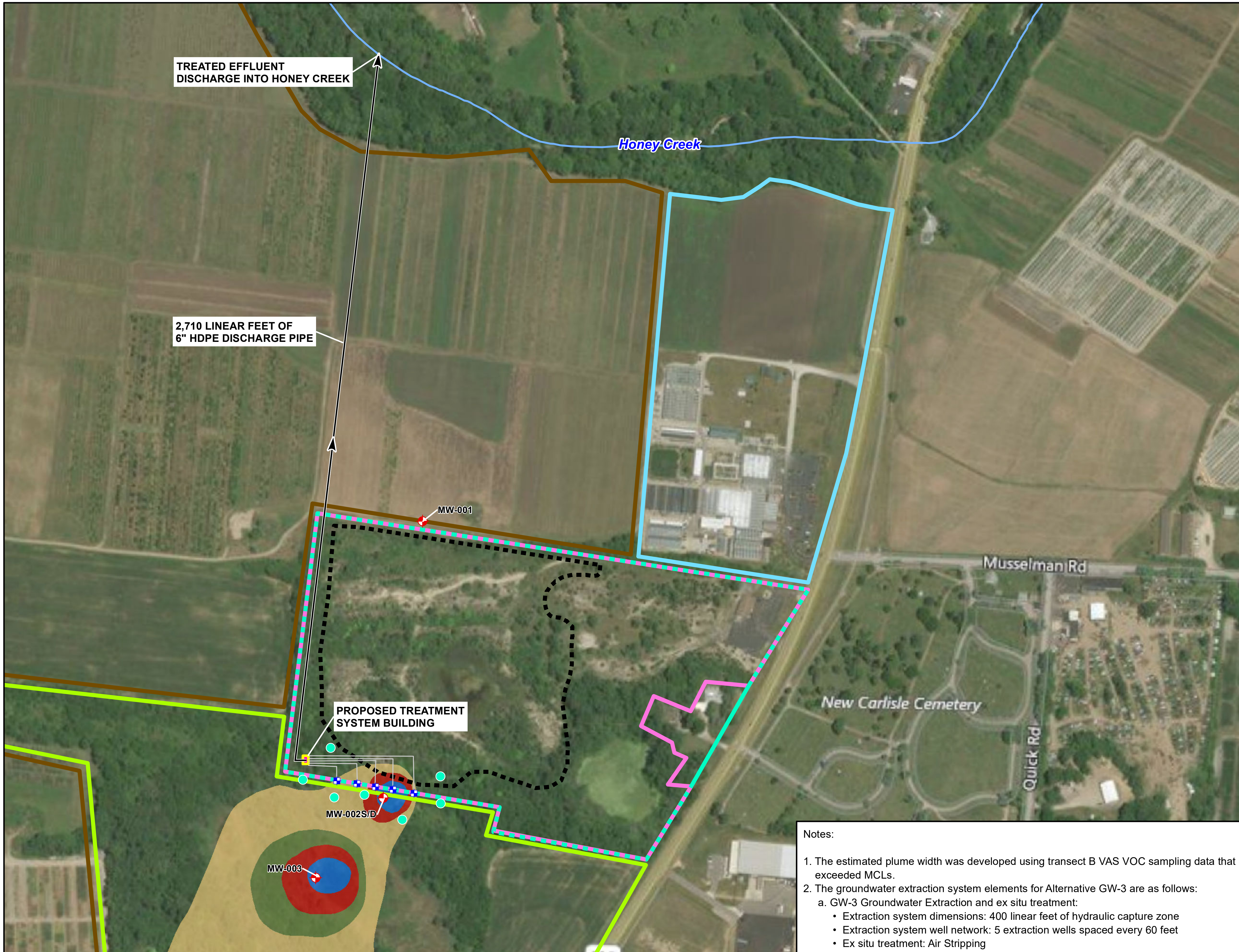
1" = 40'

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 15
CONCEPTUAL LAYOUT FOR GROUNDWATER ALTERNATIVES GW-B

ST SulTRAC

4/7/2020 G:\1852\166 New Carlisle\mxd\2020-03\Fig13-ConceptualLayoutGW-Alt2B.mxd m.banh



LEGEND

- Proposed Extraction Well Location
- Proposed Groundwater Monitoring Well Location
- Proposed Effluent Pipe Line
- Proposed Extracted Groundwater Pipeline
- Monitoring Well Location
- Approximate extent of waste encountered during RI
- Gastineau Property
- Meadow View Growers
- Wolf Property
- Scarff's Nursery and Landscape
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary
- Honey Creek
- Tetrachloroethene above MCL of 5 µg/L
- Trichloroethene above MCL of 5 µg/L
- cis-1,2-Dichloroethene above MCL of 70 µg/L
- Vinyl Chloride above MCL of 2 µg/L

HDPE - High-density polyethylene
MCL - Maximum contaminant levels
RI - Remedial Investigation
VAS - Vertical aquifer sample
VOC - Volatile Organic Compound
µg/L - micrograms per liter

N

0 360 720
1" = 360'

Notes:

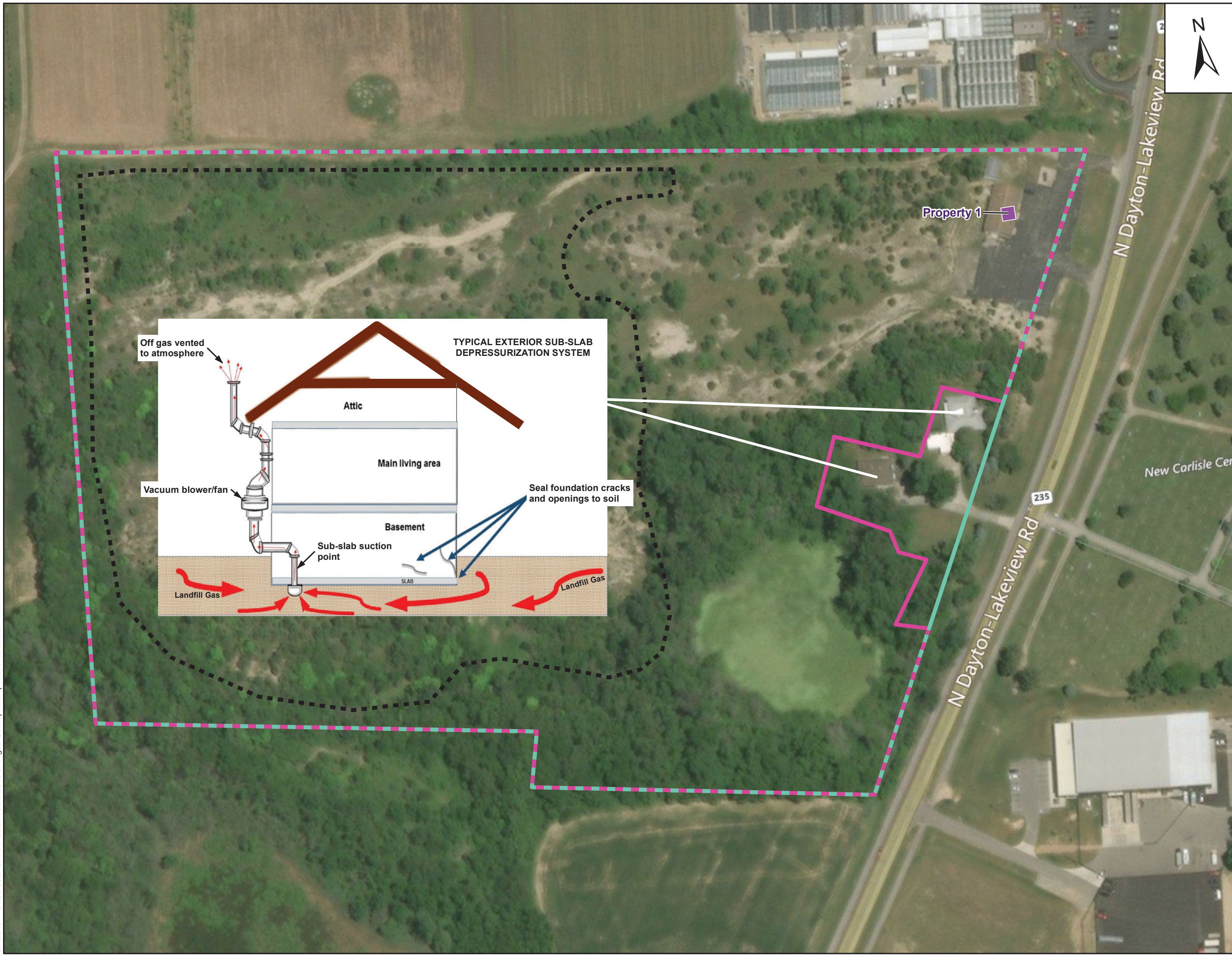
1. The estimated plume width was developed using transect B VAS VOC sampling data that exceeded MCLs.
2. The groundwater extraction system elements for Alternative GW-3 are as follows:
   a. GW-3 Groundwater Extraction and ex situ treatment:
      - Extraction system dimensions: 400 linear feet of hydraulic capture zone
      - Extraction system well network: 5 extraction wells spaced every 60 feet
      - Ex situ treatment: Air Stripping

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 16
CONCEPTUAL LAYOUT FOR GROUNDWATER ALTERNATIVES GW-3

ST SulTRAC

3/27/2020 G:\G\1852\166 New Carlisle\mxd\2020-03\Fig14-ConceptualLayoutGW-Alt3.mxd m.banh



Legend

- Human Receptor Location
- Approximate extent of waste encountered during RI
- Parcel Encompassing New Carlisle Landfill
- Operable Unit 1 Boundary

Notes:

1. Commercial Industrial Properrty alternative component would consist of LUCs to prohibit residential use of the property
2. Residential Property alternative component would consist of sub-slab depressurization systems

RI - Remedial investigation

LUCs - Land use controls

0 100 200

Feet

NEW CARLISLE LANDFILL SITE
NEW CARLISLE, CLARK COUNTY, OHIO

FIGURE 17
CONCEPTUAL LAYOUT FOR
VAPOR INTRUSION ALTERNATIVE VI-4

ST SulTRAC

8/7/2018 G:\G\1852\166 New Carlisle\mxd\2018-07\Fig20-ConceptualVaporInstrusion.mxd m.banh

TABLE 1

PREVIOUS INVESTIGATIONS SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Investigation/ Enforcement	Date	Summary of Activities	Results/Conclusions
Ohio EPA Site Discovery	1993	Since 1993, the Ohio EPA Division of Drinking and Ground Waters has been overseeing periodic sampling of the former public well located in OU 2 near the main office of Scarff's Nursery & Landscape, shown in Figure 2 of the RI report (SulTRAC 2017). The well was screened a depth of 60 to 70 feet bgs.	Annual groundwater sampling results from the former public well, collected between 1997 and 2001, indicate an increasing trend in vinyl chloride concentrations.
Ohio EPA Director's Final Findings and Order	August 8, 2002	The order required that public use of the former public well cease and future use of the well be limited to irrigation only (Ohio EPA 2006).	• In 2003, Scarff's Nursery installed a new public well on nursery property approximately 750 feet south of the former public well. The new public well was screened at a depth of 112 to 122 feet bgs.
Ohio EPA Site Inspection	November 2002 and May 2003	During the SI, Ohio EPA collected samples from: • 24 direct-push Geoprobe® drive-points located on the northern boundary and up-gradient of the landfill • 8 residential wells • 5 irrigation wells • 8 public water supply wells • 1 leachate and 1 co-located soil location SI sampling locations from the November 2002 and May 2003 sampling events are shown on Figure 3 of the RI report and results are summarized in Tables 1A and 1B of the RI report (SulTRAC 2017).	• Vinyl chloride was not detected in groundwater samples collected from up-gradient sampling locations GW-1, GW-2, and GW-3. • TCE, PCE, and vinyl chloride were detected in groundwater beneath the landfill in a plume extending south from the landfill. • The landfill is the source of elevated levels of vinyl chloride at the Scarff's Nursery former public well. • No contaminants exceeded primary drinking water standards in any of the residential wells or public drinking water wells surrounding OU 1 (Ohio EPA 2006).
Ohio EPA Expanded Site Inspection	December 2003 to December 2005	During the expanded SI, Ohio EPA collected samples from: • 70 direct-push Geoprobe® drive-points • 7 residential wells • 2 irrigation wells • 2 public water supply wells • 6 surface soil locations Expanded SI sampling locations and results from the 2003, 2004, and 2005 sampling events are shown on Figure 3 of the RI report and summarized in Tables 1C, 1D, and 1E of the RI report (SulTRAC 2017).	• VOCs were not detected in groundwater samples from upgradient sampling locations. • VOCs, specifically chlorinated ethenes (including TCE, PCE, cis-1,2-DCE, chloroethane, and vinyl chloride), were detected in groundwater at OU 1. • Highest VOC groundwater concentrations in OU 1 were detected just south of the landfill in the shallow sampling intervals at depths of approximately 20 to 24 feet bgs. • Highest VOC groundwater concentrations at OU 2 were detected at the boundary between the Gastineau and Scarff properties at depths of approximately 52 to 56 feet bgs and 60 to 64 feet bgs, respectively. • In March 2005, the VOC plume was estimated to be 2,000 feet long and 700 feet wide. • No VOCs were detected above the reporting limit of 12 µg/kg in soil.
EPA Emergency Removal Action	October 2005	Ohio EPA annual monitoring results for the new public well indicated increasing vinyl chloride concentrations. EPA/START sampling results for the new public well and 2 residential wells detected vinyl chloride at concentrations warranting action.	In October 2005, EPA completed an emergency removal action to provide an alternative source of potable water to the Scarff Nursery and 2 residential wells by extending the public water supply from the City of New Carlisle.
ATSDR Health Assessment	2006 and 2012	The Ohio Department of Health completed a health consultation for the NCL site on April 3, 2006, and issued a final Public Health Assessment on May 17, 2012.	• Previously, drinking groundwater contaminated with vinyl chloride from public and residential wells at the nursery downgradient of OU 1 for a year or longer could have harmed people's health. Non-cancer effects are not expected at the low concentrations detected. This was a public health hazard in the past; however, a safe alternative public water supply was provided by the EPA in 2005, eliminating the exposure. • Currently, drinking groundwater from public or residential wells down-gradient of OU 1 is not expected to harm people's health. • In the future, drinking groundwater from public or residential wells down-gradient of OU 1 may harm people's health. • Continued monitoring of the plume and down gradient wells is necessary and will be conducted as part of the upcoming remedial investigation for the site. • There is a potential of a complete indoor air pathway when comparing the maximum vinyl chloride concentration detected in groundwater at the nursery to the groundwater vapor intrusion guidance value. However, due to the increasing depth to the water table in this OU 2 area and the existence of a localized low-permeability clay layer between the ground surface and the water table in this area, vapor intrusion is unlikely to be an issue in OU 2. However, only limited data is available that can be used to eliminate this potential pathway.

TABLE 1

PREVIOUS INVESTIGATIONS SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Investigation/ Enforcement	Date	Summary of Activities	Results/Conclusions
Superfund National Priorities List	April 2008	Ohio EPA proposed the NCL Site for the NPL in September 2008 (Ohio Department of Health 2012).	EPA placed the NCL site on the NPL in April 2009 because of concerns about the potential migration of vinyl chloride toward residential wells within 0.5 mile of the landfill (EPA 2012).
Clark County Health Department Sampling Event	October 2011	Clark County Health Department collected drinking water samples from 4 residential properties around the NCL site.	Analytical results from samples collected from all four residential wells were found to be non-detect for VOCs (ATSDR 2012).
Remedial Investigation Phase 1	July to August 2012	During Phase I RI, SulTRAC conducted the following activities at OU 1: • Collected 11 soil samples from the landfill cap for geotechnical analysis (lithology and permeability). • Advanced 144 soil borings up to 10 feet bgs and 3 hand-augured borings up to 3 feet bgs on the landfill cap to determine depth to waste and to screen landfill gas. • Installed and sampled 6 soil gas sampling locations. • Collected 3 co-located surface water and sediment samples from Pond 1, located on the former landfill, and 1 co-located surface water and sediment sample from Pond 2, located southeast of the landfill. • Collected 1 sample from the open borehole located on the landfill. • Attempted to collect leachate samples. • Collected 1 seep sample from the northeast corner of landfill property. During Phase I RI, SulTRAC conducted the following activities at OU 2: • Collected 118 VAS samples from 19 soil borings advanced up to 200 feet bgs. • Collected 11 residential or irrigation well samples.	Conclusions presented below are based on information obtained during Phase I, II, Expanded Phase II, and Phase III field investigations of the RI. Conclusions are categorized by OU, based on the area of investigation and objectives established during the planning stages of the RI. **OU 1** • Landfill soil cover varies in thickness, from 4 to 5 feet thick, and composition, ranging from silty sand to clay; based on 4 samples, permeability ranged from 6.4 E-07 cm/sec to 9.2 E-09 cm/sec. • Large vegetation (trees and shrubs) and steep slopes likely compromise the integrity of the existing landfill cover. • Waste was encountered from about 4 feet bgs extending to 16 to 20 feet bgs. Clay was encountered below the waste at depths ranging from 16 to 22 feet bgs. • The VOC groundwater plume (relative to MCLs) at the southern boundary of the landfill (VAS transect B and MW-002 wells) is approximately 500 feet wide and 90 feet in height. • Soil gas screening and sampling results confirmed the presence of methane and VOCs throughout the disposal area at various concentrations; however, low or no detections were noted beyond the eastern extent of waste (east of Grid Line K). • Methane concentrations at the eastern cap edge were less than 5 percent and methane concentrations were less than 25 percent in on-site buildings; therefore, NCL does not exceed the EPA threshold methane concentration criteria that would require installation of an active landfill gas collection system. • Surface water and sediment sampling results indicate the presence of inorganics above screening levels; however, AVS/SEM ratios for sediment samples indicate that inorganics are bound to sulfides, limiting bioavailability (EPA 2005a). • At Properties 1, 2, and 3, the presence of benzene, ethylbenzene, and 1,2,4-trimethylbenzene in the indoor air sample above the VISL indoor air screening levels may indicate that these compounds are potentially a result of vapor intrusion. These three VOCs were also detected in the sub-slab soil gas samples collected at concentrations below VISLs (except for 1 detection of benzene above the sub-slab VISL in a duplicate sample). • The HHRA concluded that no significant risks (>1E-06) or hazards (>1) were identified for Pond 1. Limited risks to on-site trespassers were at the low end of risk range (2E-06 to 4E-06), driven by potential exposure to heptachlor in sediment and arsenic (adult trespasser only) in surface water at Pond 2. • The HHRA concluded that risks to future on-site permanent residents (2E-05) and full-time commercial/industrial workers (5E-06) at Property 1 due to inhalation of benzene (1.1E-05 [residential] and 2.5E-06 [full-time commercial/industrial workers]) and ethylbenzene (9.9E-06 [residential] and 2.3E-06 [full-time commercial/industrial workers] in indoor air. Significant non-cancer hazards (HI>1) were identified for Property 1 only for permanent residents (HI=5 due to inhalation of 1,2,4-trimethylbenzene [3.7]). • The HHRA concluded that risks and hazards to current/future permanent residents at Property 2 (5E-05, HI=3) and Property 3 (3E-05, HI=2) posed by inhalation of benzene, ethyl benzene, 1,2-dichloroethane, 1,4-dichlorobenzene, and 1,2,4-trimethylbenzene in indoor air were identified.
Remedial Investigation Phase II	October to December 2012	During Phase II RI, SulTRAC conducted the following activities at OU 1: • Advanced 3 soil gas locations using a hand Geoprobe® unit to determine depth to waste and to screen landfill gas. • Collected 4 soil samples from the landfill cap for permeability analysis. • Advanced 5 soil borings around Pond 1 to determine vertical extent of waste. • Collected 6 soil gas samples from the soil gas probes installed in Phase I. • Advanced 14 investigative soil borings surrounding the elevated PID reading found on the landfill cap during Phase I assessment. • Advanced 10 soil borings between the landfill cap and the residential houses located on the eastern side of the property. • Collected 3 co-located surface water and sediment samples from Pond 2. • Attempted to collect leachate samples. During Phase II RI, SulTRAC conducted the following activities at OU 2: • Collected 5 VAS samples from one location on the C transect. • Installed, developed, and sampled 11 permanent groundwater monitoring wells. • Collected 7 residential or irrigation well samples. • Advanced 10 soil borings using a hand auger around the Migrant Head Start Building and screened with a landfill gas monitor to determine migration of soil gas.	

PREVIOUS INVESTIGATIONS SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

<table>
<tr><th>Investigation/ Enforcement</th><th>Date</th><th>Summary of Activities</th><th>Results/Conclusions</th></tr>
<tr><td>Remedial Investigation Expanded Phase II</td><td>February to March 2013</td><td>During Expanded Phase II RI, SulTRAC conducted the following activities at OU 1:
• Collected 3 soil gas samples.
• Attempted to collect leachate samples.
• Collected 1 indoor air sample.
• Collected 2 sub-slab soil gas samples.
During Expanded Phase II RI, SulTRAC conducted the following activities at OU 2:
• Collected 11 groundwater samples from the previously installed 11 monitoring wells.
• Collected 7 residential or irrigation well samples.
• Collected 1 sub-slab soil gas sample.
• Collected 1 ambient air sample.
• Collected 2 indoor air samples.
• Completed hydrogeological testing (slug testing) on 8 of the monitoring wells.</td><td rowspan="3">• The ERA concluded that concentrations of several constituents, primarily metals, cyanides, VOCs, and pesticides in the surface water and sediment at Ponds 1 and 2 exceed SLERA ESVs for benthic and aquatic receptors. However, the SEM/AVS ratio determined from RI data indicate that the metals in the sediment are likely bound to sulfides and not bioavailable. If the landfill presumptive remedy is implemented at NCL, no further evaluation in a BERA is recommended for ecological exposure to COPECs in Ponds 1 and 2. If, however, it is determined that the ponds will remain, an evaluation of the surface water and sediment data against ESVs based on LOAELs may be appropriate.

<u>OU 2</u>
• Site geology predominantly consists of sand and gravel with some discontinuous lenses of lower permeability silts and clays present.
• The VOC plume (relative to MCLs) extends from the landfill for a distance of about 3,000 feet, to between VAS transect E (MW-005) and F (MW-006) and is bounded laterally by the eastern and western most points along the VAS transects.
• PCE and TCE were detected above MCLs in VAS samples from the “B” transect located immediately downgradient of the landfill, and only vinyl chloride was detected above its MCL in transects located further downgradient. Monitoring well results showed a similar trend where PCE and TCE were in samples immediately downgradient of the landfill (MW-002S and MW-002D) and 1,2-cis-DCE and VC in samples slightly further downgradient and only vinyl chloride in samples further downgradient still (MW-005S and MW-005D).
• Monitoring well samples were analyzed for MNA parameters and results indicate that conditions are favorable for reductive dechlorination.
• Groundwater flows from north to south with an average horizontal hydraulic gradient of 0.0034 ft/ft and a potential downward vertical hydraulic gradient.
• The aquifer’s hydraulic conductivity (based on slug test results) ranges from 5.21 to 80.78 ft/day.</td></tr>
<tr><td>Replacement Groundwater Sampling</td><td>November 2013 and February 2014</td><td>November 2013 Groundwater Sampling
• Collected groundwater samples from 6 previously installed monitoring wells (MW-001, MW-002S, MW-002D, MW-004S, MW-004D, and MW-006S) for total and dissolved metals analysis.
February 2014 Groundwater Sampling
• Collected groundwater samples from 9 previously installed monitoring wells (MW-001, MW-002S, MW-002D, MW-003S, MW-003D, MW-004S, MW-004D, MW-005S, and MW-005D) for total and dissolved metals analysis.</td></tr>
<tr><td>Remedial Investigation Phase III</td><td>September 2015</td><td>During the Phase III RI, SulTRAC conducted the following activities at OU 1:
• Excavated test pits within the suspected hot spot area in Grid H-9 of the landfill.
• Surveyed additional ground surface elevations throughout OU 1 on the landfill and the wetland area south of the landfill.
• Collected 3 indoor air and sub-slab soil gas samples from 3 buildings adjacent to the landfill.
• Measured groundwater elevations in the OU 1 monitoring wells.
During the Phase III RI, SulTRAC conducted the following activities at OU 2:
• Collected 52 VAS groundwater samples from 8 soil borings advanced up to 80 feet bgs.
• Collected 4 residential/irrigation well samples.
• Collected 11 groundwater samples from the previously installed OU 2 monitoring wells.
• Measured groundwater elevations in the OU 2 monitoring wells.</td></tr>
</table>

TABLE 1

PREVIOUS INVESTIGATIONS SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Notes:

ATSDR. 2012. Public Health Assessment, Final Release, New Carlisle Landfill, New Carlisle, Clark County, Ohio. Prepared by Ohio Department of Health. May 17. On-line Address: http://www.atsdr.cdc.gov/HAC/pha/NewCarlisleLandfill/NewCarlisleLandfillPHAFinal05172012.pdf

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EPA. 2005a. "Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc)." Office of Research and Development. EPA/600/R-02/011. January. On-Line Address: http://www.epa.gov/nheerl/download_files/publications/metalsESB_022405.pdf

EPA. 2012a. EPA Region 5 Superfund, Factsheet Website, New Carlisle Landfill. EPA ID# OHN000509238. Last Updated: July 2012. Accessed on June 27, 2013. On-Line Address: http://www.epa.gov/R5Super/npl/ohio/OHN000509238.html

EPA. 2012b. "Regional Screening Levels." November 2012. On-Line Address: http://www.epa.gov/region9/superfund/prg/

EPA. 2013. Vapor Intrusion Screening Levels (VISLs). Office of Superfund Remediation and Technology Innovation. Accessed on May 24, 2013. On-Line Address: http://www.epa.gov/oswer/vaporintrusion/guidance.html

µg/kg	Micrograms per kilogram
ATSDR	Agency for Toxic Substances and Disease Registry
AVS/SEM	Acid Volatile Sulfides/Simultaneous Extracted Metals
BERA	Baseline ecological risk assessment
bgs	Below ground surface
cis-1,2-DCE	Cis-1,2-dichloroethene
cm/sec	Centimeters per second
EPA	U.S. Environmental Protection Agency
ESV	Ecological screening value
HHRA	Human health risk assessment
LOAEL	Lowest observed adverse effect levels
MCL	Maximum contaminant limit
NCL	New Carlisle Landfill
NPL	National Priorities List
Ohio EPA	Ohio Environmental Protection Agency
PCE	Tetrachloroethene
PID	Photoionization detector
RI	Remedial investigation
SI	Site inspection
SLERA	Screening level ecological risk assessment
START	Superfund Technical Assistance and Response Team
TCE	Trichloroethene
VAS	Vertical Aquifer Sampling
VISL	Vapor Intrusion Screening Levels
VOC	Volatile Organic Compound

TABLE 2

OPERABLE UNIT 1 HUMAN HEALTH RISK AND HAZARD SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Receptor	Land Use	Medium	Location	RAGS D Table	Total Risk	COC -- Risk	Total Hazard	COC -- Hazard
Adolescent Trespasser	C/F	Sediment	Pond 1	7.1.1. RME	3.5E-07	--	1.2E-02	--
	C/F	Surface Water	Pond 1	7.1.1. RME	--	--	1.0E-03	--
				Totals	4E-07		1E-02	
	C/F	Sediment	Pond 2	7.1.1. RME	**1.7E-06**	Heptachlor (1.3E-06 - Ing+D)	2.6E-02	--
	C/F	Surface Water	Pond 2	7.1.1. RME	1.9E-07	--	1.9E-02	--
				Totals	**2E-06**		4E-02	
Adult Trespasser	C/F	Sediment	Pond 1	7.2.1.RME	4.6E-07	--	3.9E-03	--
	C/F	Surface Water	Pond 1	7.2.1.RME	--	--	1.3E-03	--
				Totals	5E-07		5E-03	
	C/F	Sediment	Pond 2	7.2.1.RME	**2.7E-06**	Heptachlor (2.2E-06 - D)	9.1E-03	--
	C/F	Surface Water	Pond 2	7.2.1.RME	**1.0E-06**	Arsenic (1.0E-06 - Ing+D)	2.6E-02	--
				Totals	**4E-06**		4E-02	
Permanent Resident	F	Groundwater	Property 1	7.3.1. RME	**2E-05**	Ethylbenzene (9.9E-06 - VI) Benzene (1.1E-05 - VI)	**5**	1,2,4-TMB (3.7 - VI)
	C/F	Groundwater	Property 2	7.3.2. RME	**5E-05**	Benzene (2.1E-05 - VI) Ethylbenzene (1.4E-05 - VI) 1,2-Dichloroethane (1.0E-05 - VI)	**3**	1,2,4-TMB (2.9 - VI)
	C/F	Groundwater	Property 3	7.3.3.RME	**3E-05**	Benzene (1.2E-05 - VI) Ethylbenzene (1.1E-05 - VI) 1,4-Dichlorobenzene (3.2E-06)	**2**	1,2,4-TMB (1.8 - VI)
Full-Time Commercial/Industrial Worker	C/F	Groundwater	Property 1	7.5.1. RME	**5E-06**	Benzene (2.5E-06 - VI) Ethylbenzene (2.3E-06 - VI)	1	--
Construction Worker	C/F	Groundwater	Property 1	7.8.1. RME	--	--	2E-04	--
	C/F	Groundwater	Property 2	7.8.2. RME	--	--	2E-04	--
	C/F	Groundwater	Property 3	7.8.3. RME	--	--	3E-05	--
Utility worker	C/F	Groundwater	Property 1	7.9.1. RME	--	--	2E-05	--
	C/F	Groundwater	Property 2	7.9.2. RME	--	--	1E-05	--
	C/F	Groundwater	Property 3	7.9.3. RME	--	--	3E-06	--

Notes:
1. RAGS Part D Tables are located in the Final Remedial Investigation Report for New Carlisle Landfill Site, Appendix F, Attachment F-1 (SulTRAC 2017).
2. Groundwater is listed as the medium of exposure for vapor intrusion at Properties 1, 2, and 3. However, Properties 1, 2, and 3 are not located in the downgradient groundwater flow direction from the landfill. The more likely medium causing potential vapor intrusion risks and hazards at Properties 1, 2, and 3 is landfill gas, which can migrate in any direction. Note that potable groundwater pathways (ingestion, dermal contact, and inhalation [domestic use]), as well as inhalation (VI) were evaluated for Properties 1, 2, and 3. No unacceptable risks (≥ 1E-06) and hazards (> 1) were identified for the potable groundwater pathways; therefore, risks and hazards associated with potable groundwater pathways are not presented in Table 2.

Bold	Total risk results ≥ 1E-06 or total hazard results > 1.
--	Not available or not applicable

C/F	Current/Future land use	RAGS	Risk Assessment Guidance for Superfund
COC	Chemical of concern	RME	Reasonable Maximum Exposure
D	Dermal contact	TMB	Trimethylbenzene
F	Future land use	VI	Vapor intrusion
Ing	Ingestion		

TABLE 3

OPERABLE UNIT 2 HUMAN HEALTH RISK AND HAZARD SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Receptor	Land Use	Medium	Location	RAGS D Table	Total Risk	COC -- Risk	Total Hazard	COC -- Hazard
Permanent Resident	C/F	Groundwater	Property 4	7.3.4. RME	**6E-06**	VC (5.6E-06 - Ing)	3E-03	--
	C/F	Groundwater	Property 5	7.3.5. RME	**9E-02**	1,1-DCA (1.2E-06 - Ing; 4.9E-06 - Vap) 1,2-DCA (2.8E-06 - Vap) Aldrin (5.0E-06 - Ing; 9.0E-05 - D; 2.0E-05 - Vap) Arsenic (8.5E-02 - Ing; 4.5E-04 - D) CT (1.3E-06 - Ing; 1.6E-06 - Vap) Heptachlor (2.0E-06 - Ing; 1.5E-05 -D; 7.9E-06 - Vap) VC (1.7E-03 - Ing; 1.3E-04 - D; 1.1E-04 - Vap)	**800**	Antimony (1.1 - Ing) Arsenic (730 - Ing; 3.2 - D) Cobalt (22 - Ing) cis-1,2-DCE (1.9 - Ing)
	C/F	Groundwater	Property 6	7.3.6. RME	--	--	0.1	--
	F	Groundwater	Property 11	7.3.7.RME	**7E-03**	Arsenic (3.9E-04 - Ing; 2.1E-06 - D) 1,1-DCA (6.8E-06 - Ing; 2.7E-05 - Vap; 4.1E-06 - VI) 1,2-DCA (2.1E-06 - Ing; 8.4E-06 - Vap) Benzene (1.8E-06 - Vap) TCE (3.2E-05 - Ing; 3.5E-06 - D; 2.8E-05 - Vap; 1.7E-05 - VI) VC (6.1E-03 - Ing; 4.7E-04 - D; 3.9E-04 - Vap; 1.2E-05 - VI) CT (1.6E-06 - total) Naphth (1.6E-06 - Vap) PCE (2.1E-06 - total)	**40**	Arsenic (3.3 - Ing) Thallium (2.0 - Ing) cis-1,2-DCE (11 - Ing; 1.2 - D) TCE (3.8 - Ing; 9.2 - Vap; 3.8 - VI) VC (2.2 - Ing)
	F	Groundwater	Property 12	7.3.8. RME	**2E-03**	Arsenic (9.6E-05 - Ing) 1,1-DCA (1.2E-06 - Ing; 4.9E-06 - Vap) VC (1.7E-03 - Ing; 1.3E-04 - D; 1.1E-04 - Vap; 1.3E-06 - VI) 1,2-DCA (2.8E-06 - Vap) CT (1.2E-06 - total)	**4**	cis-1,2-DCE (1.9 - Ing)
	F	Groundwater	Property 16	7.3.9. RME	**2E-03**	A1260 (2.3E-05 - Ing; 9.3E-05 - Vap) Arsenic (1.1E-04 - Ing) CT (1.3E-06 - Ing; 1.6E-06 - Vap) VC (1.2E-03 - Ing; 9.4E-05 - D; 7.8E-05 - Vap)	**4**	A1260 (2.3 - Ing)
	F	Groundwater	Property 17	7.3.10. RME	**2E-03**	A1260 (2.3E-05 - Ing; 9.3E-05 - Vap) Arsenic (1.1E-04 - Ing) CT (1.3E-06 - Ing; 1.6E-06 - Vap) VC (1.2E-03 - Ing; 9.4E-05 - D; 7.8E-05 - Vap)	**4**	A1260 (2.3 - Ing)
Seasonal Resident	C/F	Groundwater	Property 7	7.4.1. RME	--	--	3E-02	--
	C/F	Groundwater	Property 8	7.4.2. RME	**3E-05**	VC (2.5E-05 - Ing; 1.8E-06 - D; 1.5E-06 - Vap; 1.3E-06 - VI)	0.01	--
	C/F	Groundwater	Property 9	--	--	--	--	--
	C/F	Groundwater	Property 10	7.4.3. RME	**2E-03**	1,1-DCA (3.7E-06 - Vap) Aldrin (3.8E-06 - Ing; 6.8E-05 - D; 1.5E-05 - Vap) Arsenic (7.2E-05 - Ing) CT (1.0E-06 - Ing; 1.2E-06 - Vap) Heptachlor (1.5E-06 - Ing; 1.1E-05 - D; 6.0E-06 - Vap) VC (1.7E-03 - Ing; 1.3E-04 - D; 1.0E-04 - Vap) 1,2-DCA (2.0E-06 - Vap)	**4**	cis-1,2-DCE (1.4 - Ing)

TABLE 3

OPERABLE UNIT 2 HUMAN HEALTH RISK AND HAZARD SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Receptor	Land Use	Medium	Location	RAGS D Table	Total Risk	COC -- Risk	Total Hazard	COC -- Hazard
Full-Time C/I Worker	F	Groundwater	Property 11	7.5.2. RME	**5E-04**	Arsenic (1.1E-04 - Ing) 1,1-DCA (2.0E-06 - Ing) TCE (6.7E-06 - Ing; 2.7E-06 - VI) VC (3.6E-04 - Ing; 2.5E-06 - D)	**6**	cis-1,2-DCE (2.3 - Ing) TCE (1.7 - total)
	F	Groundwater	Property 12	7.5.3. RME	**1E-04**	Arsenic (2.9E-05 - Ing) VC (1.0E-04 - Ing)	0.9	--
	C/F	Groundwater	Property 13	7.5.4. RME	**2E-04**	Arsenic (4.9E-05 - Ing) VC (1.0E-04 - Ing)	1	--
	C/F	Groundwater	Property 14	7.5.5. RME	**1E-04**	Arsenic (2.9E-05 - Ing) VC (1.0E-04 - Ing)	0.9	--
	C/F	Groundwater	Property 15	7.5.6.RME	**1E-04**	Aldrin (1.5E-06 - Ing; 2.6E-06 - D) Heptachlor (1E-06 - Tot) VC (1.0E-04 - Ing)	0.6	--
	F	Groundwater	Property 16	7.5.7. RME	**1E-04**	A1260 (7.0E-06 - Ing) Arsenic (3.4E-05 - Ing) VC (7.2E-05 - Ing)	0.8	--
	F	Groundwater	Property 17	7.5.8. RME	**1E-04**	A1260 (7.0E-06 - Ing) Arsenic (3.4E-05 - Ing) VC (7.2E-05 - Ing)	0.9	--
	C/F	Groundwater	Property 19	7.5.9. RME	**9E-05**	Arsenic (3.2E-05 - Ing) BEHP (7.5E-06 - Ing; 4.7E-05 - D)	0.8	--
Seasonal C/I Worker	C/F	Groundwater	Property 13	7.6.1. RME	**1E-04**	Arsenic (3.8E-05 - Ing) VC (7.9E-05 - Ing)	0.8	--
	C/F	Groundwater	Property 14	7.6.2. RME	**1E-04**	Arsenic (2.2E-05 - Ing) VC (7.9E-05 - Ing)	0.7	--
	C/F	Groundwater	Property 15	7.6.3. RME	**8E-05**	Aldrin (1.2E-06 - Ing; 2.0E-06 - D) VC (7.9E-05 - Ing)	0.5	--
	C/F	Groundwater	Property 16	7.6.4. RME	**9E-05**	Aroclor 1260 (5.4E-06 - Ing) Arsenic (2.6E-05 - Ing) VC (5.6E-05 - Ing)	0.7	--
Commercial Customer	C/F	Groundwater	Property 13	7.7.1. RME	6E-07	--	3E-03	--
	C/F	Groundwater	Property 14	7.7.2. RME	6E-07	--	3E-03	--

TABLE 3

OPERABLE UNIT 2 HUMAN HEALTH RISK AND HAZARD SUMMARY
NEW CARLISLE LANDFILL SITE, NEW CARLISLE, OHIO

Receptor	Land Use	Medium	Location	RAGS D Table	Total Risk	COC -- Risk	Total Hazard	COC -- Hazard
Construction Worker	C/F	Groundwater	Property 4	7.8.4. RME	2E-10	--	3E-05	--
	C/F	Groundwater	Property 5	7.8.5. RME	7E-08	--	5E-02	--
	C/F	Groundwater	Property 6	7.8.6. RME	--	--	--	--
	C/F	Groundwater	Property 7	7.8.7. RME	--	--	6E-05	--
	C/F	Groundwater	Property 8	7.8.8. RME	1E-09	--	2E-04	--
	C/F	Groundwater	Property 9	7.8.9. RME	--	--	--	--
	C/F	Groundwater	Property 10	7.8.10. RME	7E-08	--	5E-02	--
	F	Groundwater	Property 11	7.8.11. RME	**1E-06**	--	**20**	TCE (16 - Inh)
	F	Groundwater	Property 12	7.8.12. RME	7E-08	--	5E-02	--
	C/F	Groundwater	Property 13	7.8.13. RME	7E-08	--	5E-02	--
	C/F	Groundwater	Property 14	7.8.14. RME	7E-08	--	5E-02	--
	C/F	Groundwater	Property 15	7.8.15. RME	5E-08	--	7E-03	--
	F	Groundwater	Property 16	7.8.16. RME	5E-08	--	7E-03	--
	F	Groundwater	Property 17	7.8.17. RME	5E-08	--	7E-03	--
	C/F	Groundwater	Property 18	7.8.18. RME	--	--	3E-04	--
	C/F	Groundwater	Property 19	7.8.19. RME	**3E-06**	BEHP (2.9E-06 - D)	**3**	BEHP (2.9 - D)
Utility Worker	C/F	Groundwater	Property 4	7.9.4. RME	2E-09	--	2E-06	--
	C/F	Groundwater	Property 5	7.9.5. RME	6E-07	--	4E-03	--
	C/F	Groundwater	Property 6	7.9.6. RME	--	--	--	--
	C/F	Groundwater	Property 7	7.9.7. RME	--	--	5E-06	--
	C/F	Groundwater	Property 8	7.9.8. RME	8E-09	--	1E-05	--
	C/F	Groundwater	Property 9	7.9.9. RME	--	--	--	--
	C/F	Groundwater	Property 10	7.9.10. RME	6E-07	--	4E-03	--
	F	Groundwater	Property 11	7.9.11. RME	**8E-06**	TCE (3.5E-06 - Inh) VC (1.3E-06 - D); 1,1-DCA (2.3E-06 - Inh)	1	--
	F	Groundwater	Property 12	7.9.12. RME	5E-07	--	4E-03	--
	C/F	Groundwater	Property 13	7.9.13. RME	5E-07	--	4E-03	--
	C/F	Groundwater	Property 14	7.9.14. RME	5E-07	--	4E-03	--
	C/F	Groundwater	Property 15	7.9.15. RME	4E-07	--	5E-04	--
	F	Groundwater	Property 16	7.9.16. RME	4E-07	--	5E-04	--
	F	Groundwater	Property 17	7.9.17. RME	4E-07	--	5E-04	--
	C/F	Groundwater	Property 18	7.9.18. RME	--	--	2E-05	--
	C/F	Groundwater	Property 19	7.9.19. RME	**2E-05**	BEHP (2.2E-05 - D)	0.2	--

Notes:

RAGS Part D Tables are located in the Final Remedial Investigation Report for New Carlisle Landfill Site, Appendix F, Attachment F-1 (SulTRAC 2017).

Bold Total risk results ≥ 1E-06 or total hazard results > 1.

(shaded) Total risks > 1E-04

--	Not available or not applicable
1,1-DCA	1,1-dichlorothane
1,2-DCA	1,2-dichloroethane
A1260	Aroclor 1260
BEHP	Bis(2-ethylhexyl)phthalate
C/F	Current/Future land use
C/I	Commercial/Industrial
cis-1,2-DCE	cis-1,2-dichloroethene
COC	Chemical of concern
CT	Carbon tetrachloride
D	Dermal contact
F	Future land use
Ing	Ingestion
Inh	Inhalation
Mn	Manganese
Naphth	Naphthalene
PCE	Tetrachloroethene
RAGS	Risk Assessment Guidance for Superfund
RME	Reasonable Maximum Exposure
TCE	Trichloroethene
Vap	Vapor through potable use
VC	Vinyl chloride
VI	Vapor intrusion

TABLE 4
PROPOSED VAPOR INTRUSION REMEDIAL GOALS
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Contaminant	Risk Concentrations for Vapor Intrusion (µg/m^3)[1]	
	RG	Basis
1,2-Dichloroethane	1.1E-01	2017 RSL
1,2,4-Trimethylbenzene	63	2017 RSL
1,4-Dichlorobenzene	2.6E-01	2017 RSL
Benzene	3.6E-01	2017 RSL
Ethylbenzene	1.1	2017 RSL

Notes:

1 Risk concentrations in the HHRA were calculated using the 2016 VISL (Version 3.5.1), which are identical to the June 2017 residential air RSL, with the exception of 1,2,4-trimethylbenzene; therefore, the RG for 1,2,4-trimethylbenzene has been updated to reflect the more current RSLs.

µg/m^3 Micrograms per cubic meter
HHRA Human health risk assessment
RG Remedial goal
RSL Regional screening level
VISL Vapor intrusion screening level

TABLE 5

LANDFILL CONTENTS AND LANDFILL GAS REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS AGAINST THRESHOLD AND BALANCING CRITERIA
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criterion	Alternative LF-1: No Action	Alternative LF-2: Multi-layer Cap, Passive Gas Venting, and Land Use Controls	Alternative LF-3: Enhancing Existing Cover, Passive Gas Venting, and Land Use Controls
	Comment	Comment	Comment
1. Overall Protection of Human Health and the Environment	Alternative LF-1 would not eliminate, reduce, or control the potential human health risk presented by landfill contents and landfill gas at OU 1. Under the current land use conditions (inactive landfill), the no-action alternative would not meet this criterion.	Alternative LF-2 would be protective of human health: the multi-layer cap would prevent direct contact with landfill contents and limit potential leaching of contaminants to groundwater. The passive venting system would limit potential lateral landfill gas migration. Alternative LF-2 meets this criterion.	Alternative LF-3 would be protective of human health: the low permeability soil cap would prevent direct contact with landfill contents and limit potential leaching of contaminants to groundwater; the passive venting system would limit potential lateral landfill gas migration. Alternative LF-3 meets this criterion.
2. Compliance with ARARs	No potential chemical-, location-, or action-specific ARARs apply to Alternative LF-1.	Alternative LF-2 would meet potential chemical-specific, action-specific, and location-specific ARARs. The multi-layer cap would eliminate direct contact and reduce leaching to groundwater. The multi-layer landfill cap design would be in compliance with ARARs that pertain to engineered barriers.	Alternative LF-3 would meet potential chemical-specific, action-specific, and location-specific ARARs. The soil cap would eliminate direct contact and reduce leaching to groundwater. The soil cap design would be in compliance with ARARs that pertain to engineered barriers.
3. Long-Term Effectiveness and Permanence	Alternative LF-1 does not include controls to mitigate existing risk from landfill contents and landfill gas. Alternative LF-1 would not be effective for this criterion.	Alternative LF-2 would be highly effective in the long-term. The multi-layer cap and passive venting system are reliable control methods that would meet each of the landfill contents and landfill gas RAOs. The multi-layer cap would include contouring and a specific drainage layer to control run-on, run-off, and infiltration.	Alternative LF-3 would be very effective in the long-term. The soil cap and passive venting system are reliable control methods that would meet each of the landfill contents and landfill gas RAOs. Based on the age of the landfill, the soil cap would provide sufficient release controls and would limit infiltration.
4. Reduction in Toxicity, Mobility, or Volume through Treatment	The mobility, toxicity, and volume of hazardous substances at OU 1 would not be reduced under Alternative LF-1 because landfill contents and landfill gas would not be removed, contained, or treated. Alternative LF-1 would not be effective for this criterion.	Alternative LF-2 would be slightly effective in reducing the toxicity, mobility, or volume. The passive landfill gas vents would reduce the volume and mobility of landfill gas accumulating within the landfill, but landfill gas would be discharged to the atmosphere without treatment.	Alternative LF-3 would be slightly effective in reducing the toxicity, mobility, or volume. The passive landfill gas vents would reduce the volume and mobility of landfill gas accumulating within the landfill, but landfill gas would be discharged to the atmosphere without treatment.
5. Short-Term Effectiveness	Alternative LF-1 is highly effective in the short-term because there would be no effect to the surrounding community, workers, or the environment because there is no implementation. However, it would not achieve the RAOs and would not protect future receptors or further reduce infiltration through the cap at OU 1.	Alternative LF-2 would be very effective in the short term. Community impacts would include increased truck traffic and noise. During construction, worker impacts would include potential exposure to landfill contents and landfill gas, and physical and audible heavy machinery hazards—all of which could be mitigated with safe work practices and proper PPE. Construction time is estimated to be 3 to 4 months.	Alternative LF-3 would be highly effective in the short term. Community impacts include increased truck traffic and noise. Construction methods for a soil cap are simple; however, worker impacts include potential exposure to landfill contents and landfill gas, and physical and audible heavy machinery hazards—all of which can be mitigated with safe work practices and proper PPE. Construction time is estimated to be 2 months.
6. Implementability	Alternative LF-1 would be highly implementable. No construction or administrative activities would be required to implement this alternative.	Alternative LF-2 would be very implementable. The landfill cap and passive venting system installation methods, materials, and qualified laborers are well understood and readily available. Although common, installation of the multiple layers over large acreage would involve coordinated and complex efforts to make sure seams are well sealed and no punctures occur.	Alternative LF-3 would be highly implementable. The landfill cap and passive venting system installation methods, materials, and qualified laborers are well understood and readily available. Installation of a single-layer soil cap is technically straight forward. Locating a borrow source for low permeability soil may be a challenge.
7. Estimated Cost	$0	$8,118,000	$6,080,000

Notes:

1. For the first two threshold criteria, alternatives are rated as to whether they meet the criteria or not. For the five modifying criteria, alternatives are rated as being highly effective/highly implementable, very effective/very implementable, moderately effective/moderately implementable, slightly effective/slightly implementable, or not effective/not implementable.

2. The alternatives will be evaluated against the remaining two criteria, regulatory agency and community acceptance, during the public comment period on the proposed plan. Regulatory agency and community acceptance will be considered before the final remedy is selected.

ARAR Applicable or relevant and appropriate requirement
LF Landfill
OU Operable unit
PPE Personal protective equipment
RAO Remedial action objective

TABLE 6

LANDFILL GROUNDWATER REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS AGAINST THRESHOLD AND BALANCING CRITERIA
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

	Alternative GW-1: No Action	**Alternative GW-2A: ERD PRB**	**Alternative GW-2B: ISCO PRB**	**Alternative GW-2C: ISCR PRB**	**Alternative GW-3: Groundwater Extraction, Treatment, Discharge**
Criterion	**Comment**	**Comment**	**Comment**	**Comment**	**Comment**
1. Overall Protection of Human Health and the Environment	Alternative GW-1 would not eliminate, reduce, or control the potential human health risk presented by OU 1 groundwater at NCL migrating to OU 2 receptors. Alternative GW-1 would not meet this criterion.	Alternative GW-2A would be protective of human health by containing and treating VOC-contaminated groundwater in situ. Alternative GW-2A meets this criterion.	Alternative GW-2B would be protective of human health by containing and treating VOC-contaminated groundwater in situ. Alternative GW-2B meets this criterion.	Alternative GW-2C would be protective of human health by containing and treating VOC-contaminated groundwater in situ. Alternative GW-2C meets this criterion.	Alternative GW-3 would be protective of human health by hydraulically containing VOC-contaminated groundwater and treating ex situ. Alternative GW-3 meets this criterion.
2. Compliance with ARARs	No potential chemical-, location-, or action-specific ARARs apply to Alternative GW-1.	Alternative GW-2A would be designed to meet potential chemical-, location-, and action-specific ARARs.	Alternative GW-2B would be designed to meet potential chemical-, location-, and action-specific ARARs.	Alternative GW-4 would be designed to meet potential chemical-, location-, and action-specific ARARs.	Alternative GW-3 would be designed to meet potential chemical-, location-, and action-specific ARARs.
3. Long-Term Effectiveness and Permanence	Alternative GW-1 does not include controls to mitigate existing risk from OU 1 groundwater migrating to OU 2 receptors. Alternative GW-1 would not be effective for this criterion.	Alternative GW-2A would be very effective in the long term. Once implemented, residual risk would be eliminated. ERD works in conjunction with the existing reducing environment. ERD is expected to have a longevity of 2 to 3 years. Injection events are anticipated to occur every 3 years to maintain groundwater plume containment.	Alternative GW-2B would be moderately effective in the long term. Once implemented, residual risk would be eliminated. Although chemical concentrations in the groundwater would be reduced, typical ISCO reagents have a short lifespan and would require reinjection every 2 years to maintain groundwater plume containment.	Alternative GW-2C would be highly effective in the long term. Once implemented, residual risk would be eliminated. ISCR works in conjunction with the existing reducing environment and completely and permanently dechlorinates VOCs in groundwater. ZVI is persistent in the environment and is expected to have a longevity of 5 to 7 years. Injection events are anticipated to occur every 5 years to maintain groundwater plume containment.	Alternative GW-3 would be moderately effective in the long term. Groundwater extraction has historically been commonly used as a viable alternative; however, long-term O&M make the reliability of controls less effective.
4. Reduction in Toxicity, Mobility, or Volume through Treatment	The mobility, toxicity, and volume of hazardous substances at NCL would not be reduced under Alternative GW-1 because groundwater would not be removed or treated. Alternative GW-1 would not be effective for this criterion.	Alternative GW-2A would be very effective in reducing the toxicity, mobility, and volume of VOCs in groundwater. ERD sequentially dechlorinates VOCs as groundwater flows through the treatment barrier.	Alternative GW-2B would be very effective in reducing the toxicity, mobility, and volume of VOCs in groundwater. ISCO results in rapid and complete VOC destruction as groundwater flows through the treatment barrier.	Alternative GW-2C would be very effective in reducing the toxicity, mobility, and volume of VOCs in groundwater. ISCR would irreversibly destroy VOCs as groundwater flows through the treatment barrier.	Alternative GW-3 would be moderately effective in reducing the toxicity, mobility, and volume of VOCs in groundwater. Extraction removes VOCs from the aquifer and air stripping would discharge VOCs to the atmosphere where photo-oxidation may occur.
5. Short-Term Effectiveness	Alternative GW-1 would be highly effective in the short term because there would be no effect to the surrounding community, workers, or the environment because there is no implementation; however, it would not achieve the RAOs and would not protect future receptors at OU 1 or OU 2.	Alternative GW-2A would be very effective in the short term. Community impacts would be minor. Worker impacts include potential exposure to groundwater, treatment amendments, and heavy equipment; however, the use of proper PPE and safe work practices would minimize these risks. Implementation is anticipated to take 2 months.	Alternative GW-2B would be very effective in the short term. Community impacts would be minor. Worker impacts include potential exposure to groundwater, treatment reagents, and heavy equipment; however, the use of proper PPE and safe work practices would minimize these risks. Implementation is anticipated to take 3 months.	Alternative GW-2C would be very effective in the short term. Community impacts would be minor. Worker impacts include potential exposure to groundwater, treatment reagents, and heavy equipment; however, the use of proper PPE and safe work practices would minimize these risks. Implementation is anticipated to take 3 months.	Alternative GW-3 would be moderately effective in the short term. Community impacts would be minor. Worker impacts include potential exposure to groundwater and heavy equipment; however, the use of proper PPE and safe work practices would minimize these risks. Implementation is anticipated to take 12 months.

TABLE 6

LANDFILL GROUNDWATER REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS AGAINST THRESHOLD AND BALANCING CRITERIA
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criterion	Alternative GW-1: No Action	Alternative GW-2A: ERD PRB	Alternative GW-2B: ISCO PRB	Alternative GW-2C: ISCR PRB	Alternative GW-3: Groundwater Extraction, Treatment, Discharge
	Comment	Comment	Comment	Comment	Comment
6. Implementability	Alternative GW-1 would be highly implementable. No construction or administrative activities would be required to implement this alternative.	Alternative GW-2A would be very implementable. Materials and equipment are readily available and installation methods are standard. Based on the site geochemistry, the site would be favorable toward ERD.	Alternative GW-2B would be moderately implementable. Materials and equipment are readily available and installation methods are standard. ISCO products would need to overcome the existing reducing environment at OU 1, which would require large volumes of oxidant and multiple applications.	Alternative GW-2C would be very implementable. Materials and equipment are readily available and installation methods are standard. Alternative GW-2C would take advantage of the existing reducing conditions and microbes at OU 1.	Alternative GW-3 would be moderately implementable. Materials and equipment are readily available and installation methods are standard. Authorization to discharge treated water to surface water may be challenging. Long-term O&M make Alternative GW-3 less advantageous.
7. Estimated Cost	$0	$3,367,000	$6,537,000	$4,554,000	$10,763,000

Notes:

1. For the first two threshold criteria, alternatives are rated as to whether they meet the criteria or not. For the five modifying criteria, alternatives are rated as being highly effective/highly implementable, very effective/very implementable, moderately effective/moderately implementable, slightly effective/slightly implementable, or not effective/not implementable.
2. The alternatives will be evaluated against the remaining two criteria, regulatory agency and community acceptance, during the public comment period on the proposed plan. Regulatory agency and community acceptance will be considered before the final remedy is selected.

ARAR Applicable or relevant and appropriate requirement
ERD Enhanced reductive dechlorination
GW Groundwater
ISCO In situ chemical oxidation
ISCR In situ chemical reduction
NCL New Carlisle Landfill
O&M Operation and maintenance
OU Operable unit
PPE Personal protective equipment
PRB Permeable reactive barrier
RAO Remedial action objective
VOC Volatile organic compound
ZVI Zero-valent iron

TABLE 7

VAPOR INTRUSION REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS AGAINST THRESHOLD AND BALANCING CRITERIA
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criterion	Alternative VI-1: No Action	Alternative VI-2: ICs and Monitoring	Alternative VI-3: Foundation Sealing and ICs	Alternative VI-4: Sub-Slab Depressurization System and ICs
	Comment	Comment	Comment	Comment
1. Overall Protection of Human Health and the Environment	Alternative VI-1 would not eliminate, reduce, or control the potential human health risk presented by OU 1 soil gas. Alternative VI-1 would not meet this criterion.	Because this alternative would be paired with one of the landfill contents and landfill gas alternatives, Alternative VI-2 would be effective as an interim measure to allow assessment of the presumptive remedy for landfill gas containment; and therefore, is considered to meet this criterion.	Alternative VI-3 would be protective of human health by eliminating the exposure pathway to VOCs in soil gas via foundation sealing at Properties 2 and 3. ICs would be enforced to prevent future residential exposure at Property 1. Alternative VI-3 meets this criterion.	Alternative VI-4 would be protective of human health by eliminating the exposure pathway to VOCs in soil gas via a sub-slab depressurization system at Properties 2 and 3. ICs would be enforced to prevent future residential exposure at Property 1. Alternative VI-4 meets this criterion.
2. Compliance with ARARs	No potential chemical-, location-, or action-specific ARARs apply to Alternative VI-1.	As an interim measure implemented in combination with, and pending evaluation of effectiveness of, the landfill presumptive remedy, Alternative VI-2 would meet this criterion.	Alternative VI-3 would be designed to meet potential chemical-, location-, and action-specific ARARs.	Alternative VI-4 would be designed to meet potential chemical-, location-, and action-specific ARARs.
3. Long-Term Effectiveness and Permanence	Alternative VI-1 does not include controls to mitigate existing risk from soil gas. Alternative VI-1 would not be effective for this criterion.	Alternative VI-2 would be slightly effective in the long term as VOCs would remain at the site but it would be protective of future site occupants at Property 1. Annual air monitoring at Properties 2 and 3 would indicate the presence of increased vapor intrusion and the need for additional action at Properties 2 and 3.	Alternative VI-3 would be moderately effective in the long term. Alternative VI-3 relies on effectively sealing any routes of entry and the durability of the coating to remain intact. Property 1 ICs would be effective in the long-term.	Alternative VI-4 would be very effective in the long term. VOC soil vapors would be reduced by using the sub-slab depressurization systems in Properties 2 and 3, which would ventilate the sub-slab soil gas through a pipe system leading to the outside of the home for exterior termination, thus removing the risks of VI exposure to residents. If vapor intrusion mitigation systems are installed and operated properly, residual risks would be minimized. Property 1 ICs would be effective in the long-term.
4. Reduction in Toxicity, Mobility, or Volume through Treatment	The mobility, toxicity, and volume of hazardous substances at NCL would not be reduced under Alternative VI-1 because soil gas would not be removed or treated. Alternative VI-1 would not be effective for this criterion.	Alternative VI-2 would not be effective in reducing the toxicity, mobility, or volume of chemicals in soil gas. Air monitoring would not impact the toxicity, mobility, or volume of VOCs in soil gas. ICs assigned to prevent future residential exposure at Property 1 would not impact the toxicity, mobility, or volume of VI as it relies on administrative controls to prevent exposure.	Alternative VI-3 would be slightly effective in the reduction of toxicity, mobility, or volume of VOCs in soil gas because it would limit the mobility of the soil gas to enter indoor air. ICs assigned to prevent future residential exposure at Property 1 would not impact the toxicity, mobility, or volume of VOCs in soil gas because they would rely on administrative controls to prevent exposure.	Alternative VI-4 would be slightly effective in reducing the toxicity, mobility, or volume of VOCs in soil gas. The SSD system does not destroy contaminants, it only extracts soil gas from the sub-slab and re-routes the gas to exterior termination to prevent VI exposure inside the building. However, Alternative VI-4 would limit the mobility of soil gas from entering indoor air. ICs assigned to prevent future residential exposure at Property 1 would not impact the toxicity, mobility, or volume of VOCs in soil gas because they would rely on administrative controls to prevent exposure.
5. Short-Term Effectiveness	Alternative VI-1 would be highly effective in the short term because there would be no effect to the surrounding community, workers, or the environment because there is no implementation; however, it would not achieve the RAO and would not protect future receptors at OU 1.	Alternative VI-2 would be highly effective in the short term because there would be little to no effects to the surrounding community, workers, or the environment because of its implementation. Coordination with and homeowner permission would be required to collect air samples inside the buildings of Properties 2 and 3. This may cause some nuisance to the home owners or tenants; however, semi-annual air monitoring would be completed within 48 hours for each sampling event.	Alternative VI-3 would be very effective in the short term. Community, worker, and environmental impacts would be minimal and would result from exposure to soil gas and sealing media. Installation of the sealing material would take about 1 day and RAOs are expected to be achieved immediately upon implementation.	Alternative VI-4 would be very effective in the short term. Community, worker, and environmental impacts would be minimal and would result from exposure to soil gas and construction hazards that could be mitigated by sound work practices and PPE. Installation of the SSD systems would take about 6 days each and RAOs are expected to be achieved immediately upon implementation.

TABLE 7

VAPOR INTRUSION REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS AGAINST THRESHOLD AND BALANCING CRITERIA
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criterion	Alternative VI-1: No Action	Alternative VI-2: ICs and Monitoring	Alternative VI-3: Foundation Sealing and ICs	Alternative VI-4: Sub-Slab Depressurization System and ICs
	Comment	Comment	Comment	Comment
6. Implementability	Alternative VI-1 would be highly implementable. No construction or administrative activities would be required to implement this alternative.	Alternative VI-2 would be highly implementable. Limited construction activities would be required to install the sub-slab vapor monitoring points. Sampling equipment required for air monitoring is readily available and easy to implement. ICs and monitoring are technically and administratively feasible. Both ICs and air monitoring would require coordination with the property owners.	Alternative VI-3 would be very implementable. Materials and equipment are readily available and installation methods are standard. Success of this alternative would rely on proper application of the sealant. ICs required for Property 1 would be administratively feasible in ensuring the prevention of future residential exposure.	Alternative VI-4 would be very implementable. Sub-slab depressurization systems have been successfully implemented at many sites and are technically easy to complete. Materials required for vapor intrusion mitigation systems are readily available. ICs required for Property 1 would be administratively feasible in ensuring the prevention of future residential exposure.
7. Estimated Cost	$0	$229,000	$360,000	$381,000

Notes:

1. For the first two threshold criteria, alternatives are rated as to whether they meet the criteria or not. For the five modifying criteria, alternatives are rated as being highly effective/highly implementable, very effective/very implementable, moderately effective/moderately implementable, slightly effective/slightly implementable, or not effective/not implementable.
2. The alternatives will be evaluated against the remaining two criteria, regulatory agency and community acceptance, during the public comment period on the proposed plan. Regulatory agency and community acceptance will be considered before the final remedy is selected.

ARAR Applicable or relevant and appropriate requirement
IC Institutional control
NCL New Carlisle Landfill
OU Operable Unit
PPE Personal protective equipment
RAO Remedial action objective
SSD Sub-slab depressurization
VI Vapor intrusion
VOC Volatile organic compound

TABLE 8

LANDFILL CONTENTS AND LANDFILL GAS REMEDIAL ALTERNATIVE RANKING
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criteria	Alternative LF-1: No Action	Alternative LF-2: Multi-layer Cap, Passive Gas Venting, and Land Use Controls	Alternative LF-3: Enhancing Existing Cover, Passive Gas Venting, and Land Use Controls
1. Overall Protection of Human Health and the Environment[a]	1	5	5
2. Compliance with ARARs[a]	1[b]	5	5
3. Long-Term Effectiveness and Permanence	1	5	4
4. Reduction in Toxicity, Mobility, or Volume through Treatment	1	2	2
5. Short-Term Effectiveness	5	4	5
6. Implementability	5	4	5
7. Cost	5	3	4
Score	**19**	**28**	**30**
Rank	**3rd**	**2nd**	**1st**

Notes:

Rating scale (1 = not effective; 2 = slightly effective; 3 = moderately effective; 4 = very effective; 5 = highly effective). The maximum possible score is 35.

Threshold, balancing, and modifying criteria are all assumed to have equal importance and weighting.

a For threshold criteria (1= does not meet criteria, 5 = meets criteria).
b No chemical-, location-, or action-specific ARARS directly apply to Alternative LF-1.

ARAR Applicable or relevant and appropriate requirement
LF Landfill

TABLE 9

LANDFILL GROUNDWATER REMEDIAL ALTERNATIVE RANKING
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criteria	Alternative GW-1: No Action	Alternative GW-2A: ERD PRB	Alternative GW-2B: ISCO PRB	Alternative GW-2C: ISCR PRB	Alternative GW-3: Groundwater Extraction, Treatment, Discharge
1. Overall Protection of Human Health and the Environment[a]	1	5	5	5	5
2. Compliance with ARARs[a]	1[b]	5	5	5	5
3. Long-Term Effectiveness and Permanence	1	4	3	5	3
4. Reduction in Toxicity, Mobility, or Volume through Treatment	1	4	4	4	3
5. Short-Term Effectiveness	5	4	4	4	3
6. Implementability	5	4	3	4	3
7. Cost	5	4	2	3	1
Score	**19**	**30**	**26**	**30**	**23**
Rank	**5th**	**1st**	**3rd**	**1st**	**4th**

Notes:

Rating scale (1 = not effective; 2 = slightly effective; 3 = moderately effective; 4 = very effective; 5 = highly effective). The maximum possible score is 35.

Threshold, balancing, and modifying criteria are all assumed to have equal importance and w eighting.

a For threshold criteria (1= does not meet criteria, 5 = meets criteria).
b No chemical-, location-, or action-specific ARARS directly apply to Alternative GW-1.

ARAR Applicable or relevant and appropriate requirement
ERD Enhanced reductive dechlorination
GW Groundw ater
ISCO In situ chemical oxidation
ISCR In situ chemical reduction
PRB Permeable reactive barrier

TABLE 10

VAPOR INTRUSION REMEDIAL ALTERNATIVE RANKING
OPERABLE UNIT 1, NEW CARLISLE LANDFILL, NEW CARLISLE, OHIO

Criteria	Alternative VI-1: No Action	Alternative VI-2: ICs and Monitoring	Alternative VI-3: Foundation Sealing and ICs	Alternative VI-4: Sub-Slab Depressurization System and ICs
1. Overall Protection of Human Health and the Environment[a]	1	5	5	5
2. Compliance with ARARs[a]	1[b]	5	5	5
3. Long-Term Effectiveness and Permanence	1	2	3	4
4. Reduction in Toxicity, Mobility, or Volume through Treatment	1	1	2	2
5. Short-Term Effectiveness	5	5	4	4
6. Implementability	5	5	4	4
7. Cost	5	5	4	4
Score	**19**	**28**	**27**	**28**
Rank	**4th**	**1st**	**3rd**	**1st**

Notes:

Rating scale (1 = not effective; 2 = slightly effective; 3 = moderately effective; 4 = very effective; 5 = highly effective). The maximum possible score is 35.

Threshold, balancing, and modifying criteria are all assumed to have equal importance and weighting.

a For threshold criteria (1= does not meet criteria, 5 = meets criteria).
b No chemical-, location-, or action-specific ARARS directly apply to Alternative VI-1.

ARAR Applicable or relevant and appropriate requirement
IC Institutional control
VI Vapor intrusion

Appendix A

Applicable or Relevant and Appropriate Requirements and To-Be-Considered Standards
New Carlisle Landfill, Clark County, OH

Prerequisite for ARAR	Type of ARAR	Requirement	Citation	Comments
Federal Requirements				
Closure/Post-Closure	Action-specific	Requirements for site closure, including operation and maintenance, site monitoring, and site use.	RCRA 40 CFR 258.16	Relevant and appropriate ARAR for landfill cap remedy.
Disposal of Non-Hazardous Solid Waste in Land DisposalUnit	Action-specific	Minimum design and operation criteria for land disposal of solid wastes to minimize infiltration of precipitation, erosion, and odors, and to be aesthetically pleasing.	RCRA 40 CFR 258.40	Relevant and appropriate for landfill cap remedy.
Land Disposal Restrictions	Action-specific	Establishes land disposal restrictions and treatment requirements for materials subjectto disposal restrictions.	RCRA 40 CFR 268	Relevant and appropriate for disposal restrictions on characterized contaminated soil.
Wetlands Disturbance	Location-specific	No activity that adversely affects a wetland shall be permitted if a feasible alternative	CWA 40 CFR 230; 33 CFR 320	Relevant and appropriate for disturbances of qualifying wetlands on site.
Wetlands Disturbance	Location-specific	Allows for permitting of discharges of dredged or fill material to the waters of the United States if no practicable alternatives exist that are less damaging to the aquatic environment.	CWA 40 CFR 230 to 233; 33 CFR 320 to 330	
Corrective Action for Solid Waste Management Units	To Be Considered	Provides requirements for Corrective Action Management Units at RCRA-permitted transportation, storage, and disposal facilities undergoing corrective action.	RCRA 40 CFR 264	To be considered if waste is characterized as hazardous waste and is re-depositing on site.
National Primary DrinkingWater Regulations and Implementation	To Be Considered	Establishes MCLs, which are health risk-based standards for public water systems.	SDWA 40 CFR 141 and 142	To be considered in the evaluation of the groundwater remedy to determine the remedy's effect for restoration of downgradient (OU 2) groundwater to beneficial use.
National Secondary DrinkingWater Regulations and Implementation	To Be Considered	Establishes welfare-based secondary standards for public water systems.	SDWA 40 CFR 143	
Drinking Water Quality	To Be Considered	Establishes the protection of drinking waterquality in the United States; focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources.	SDWA 42 U.S.C. Subsection 300f et seq.	

Appendix A

Prerequisite for ARAR	Type of ARAR	Requirement	Citation	Comments
State Requirement				
Monitoring Well	Action-specific	Provides standards for design and closure of wells, and compliance with DDAGW guidance.	OAC 3745-9-03 (A-C)	Relevant and appropriate for the installation or abandonment of groundwater wells.
Well Construction	Action-specific	Specifies minimum construction requirements for casing material, casing depth, potable water, annular spaces, use of drive shoe, openings to allow water entry, and contaminant entry of new groundwater wells.	OAC 3745-9-05 (A1, B-H)	
Well Grouting for Construction of Closure	Action-specific	Establishes specific grouting procedures.	OAC 3745-9-07 (A-C)	
Air Pollution Nuisances Prohibited	Action-specific	Defines air pollution nuisance as the emission or escape into the air from any sources(s) of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors and combinations of the above that endanger health, safety or welfare of the public or cause personal injury or property damage; prohibits such nuisances.	OAC 3745-15-07	Relevant and appropriate for landfill venting remedy.
Emission Restrictions for Fugitive Dust	Action-specific	Controls all emissions of fugitive dust.	OAC 3745-17-08 (A1,A2, B, D)	Relevant and appropriate for remedial activities that may result in fugitive dust emissions.
Exemptions to Solid Waste Regulations	Action-specific	Defines exemptions to solid waste regulations and establishes limitations on temporary storage of putrescible waste or any solid waste which causes a nuisance or health hazard. Storage of putrescible waste beyond seven days is considered open dumping.	OAC 3745-27-03 (B)	Relevant and appropriate for excavation or consolidation of solid waste remedy.
Sanitary Landfill Construction Standards	Action-specific	Specifies engineered components for sanitary landfills.	OAC 3745-27-08	Relevant and appropriate landfill cap remedy.

Appendix A

Prerequisite for ARAR	Type of ARAR	Requirement	Citation	Comments
State Requirement (Continued)				
Sanitary Landfill Final Closure Requirements	Action-specific	Specifies closure requirements for sanitary landfills.	OAC 3745 -27-11 (B, G)	Relevant and appropriate for landfill capping remedy.
Sanitary Landfill Explosive Gas Monitoring	Action-specific	Specifies explosive gas monitoring requirements for sanitary landfills.	OAC 3745 -27-12 (A-Q)	Relevant and appropriate for landfill capping and landfill gas venting remedy.
Disturbances Where Hazardous or Solid WasteFacility was Operated	Action-specific	Requires that a detailed plan be provided to describe how any proposed filling, grading, excavating, building, drilling or mining on land where a hazardous waste facility or solid waste facility was operated will be accomplished.	OAC 3745 -27-13 (A, C)	Relevant and appropriate or excavation and consolidation of waste.
Post-closure Care of Sanitary Landfill Facilities	Action-specific	Specifies post-closure requirements for sanitary landfills.	OAC 3745 -27-14 (A)	Relevant and appropriate for landfill cap remedy.
Underground injection control	Action-specific	Underground injections prohibited except by permit or rule	OAC 3745-34-06	Relevant and appropriate for groundwater alternatives involving injections.
Municipal Solid Waste Landfill Emissions	Action-specific	Specifies emission control requirements formunicipal solid waste landfills	OAC 3745-76	Relevant and appropriate for alternatives that involve landfill capping.
Acts of Pollution Prohibited	Action-specific	Prohibits polluting waters of the state.	ORC 6111.04	Relevant and appropriate or contaminated groundwater at OU1.

Appendix A

Prerequisite for ARAR	Type of ARAR	Requirement	Citation	Comments
State Requirement (Continued)				
Well Siting	Location-specific	Mandates that groundwater wells be: (A) located and maintained to prevent contaminants from entering well, and (B) located to be accessible for cleaning and maintenance.	OAC 3745-9-04 (A-B)	Relevant and appropriate for groundwater remedy that result in the installation of groundwater wells.
Well Construction, SpecificGeologic Conditions	Location-specific	Establishes specific requirements for wells indifferent types of aquifers.	OAC 3745-9-06 (A)	
Wetland Narrative Criteria	Location-specific	Lists criteria to be protected in wetland environments.	OAC 3745-1-51 (A-C)	Relevant and appropriate for any disturbances of qualifying wetlands on site.
Wetland Antidegradation	Location-specific	Requires that all wetlands be assigned a category classification and gives criteria for classification; discusses requirements for avoidance and minimization of wetlands damage as well as compensatory mitigation.	OAC 3745-1-54 (A-D)	Relevant and appropriate for impacted qualifying wetlands on site.
Inorganic Contaminant Monitoring Requirements	To Be Considered	Presents monitoring requirements for inorganic contaminants.	OAC 3745-81-23 (A-E)	To be considered in the evaluation of the groundwater remedy to determine the remedy's effect for restoration of downgradient OU2 groundwater to beneficial use.
Organic Contaminant Monitoring Requirements	To Be Considered	Presents monitoring requirements for organic contaminants.	OAC 3745-81-24 (A-E)	

Notes:

ARAR	=	Applicable or relevant and appropriate requirement
CFR	=	Code of Federal Regulations
CWA	=	Clean Water Act
DDAGW	=	Division of Drinking and Ground Water
MCL	=	Maximum contaminant level
OAC	=	Ohio Administrative Code
ORC	=	Ohio Revised Code
OU	=	Operable unit
RCRA	=	Resource Conservation and Recovery Act
SDWA	=	Safe Drinking Water Act
U.S.C.	=	United States Code

TABLE B-1
LANDFILL CONTENTS AND LANDFILL GAS ALTERNATIVES COST SUMMARY
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: New Carlisle Landfill OU 1
Location: New Carlisle, Ohio
Phase: Preliminary Draft Feasibility Study
Base Year: 2018
Date: May 2018

	Alternative LF-1	Alternative LF-2	Alternative LF-3
Description	**No Action**	**Multi-layer Cap, Passive Gas Venting, and Land Use Controls**	**Enhance Existing Cover, Passive Gas Venting, and Land Use Controls**
Total Project Duration (Years)	0	30	30
Capital Cost	$0	$6,600,000	$4,562,000
Land Use Control	$0	$187,000	$187,000
O&M Cost (Present value, 30 years)	$0	$1,331,000	$1,331,000
Total Present Value of Alternative (2018$)	**$0**	**$8,118,000**	**$6,080,000**

Notes: Costs are rounded to the nearest $1,000.

O&M Operation and maintenance
OU Operable unit

TABLE B-2
LANDFILL GROUNDWATER ALTERNATIVES COST SUMMARY
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site:	New Carlisle Landfill OU 1	**Base Year:**	2018
Location:	New Carlisle, Ohio	**Date:**	May 2018
Phase:	Preliminary Draft Feasibility Study		

	Alternative GW-1	Alternative GW-2A	Alternative GW-2B	Alternative GW-2C	Alternative GW-3
Description	**No Action**	**ERD PRB and Monitoring**	**ISCO PRB and Monitoring**	**ISCR PRB and Monitoring**	**Groundwater Extraction, Treatment, and Discharge**
Total Project Duration (Years)	0	30	30	30	30
Capital Cost	$0	$1,051,000	$1,436,000	$1,531,000	$1,820,000
Land Use Controls	$0	$14,000	$14,000	$14,000	$14,000
O&M Cost (Present value, 30 years)	$0	$2,302,000	$5,087,000	$3,009,000	$8,929,000
Total Present Value of Alternative (2018$)	**$0**	**$3,367,000**	**$6,537,000**	**$4,554,000**	**$10,763,000**

Notes: Costs are rounded to the nearest $1,000.

ERD Enhanced reductive dechlorination
ISCO In situ chemical oxidation
ISCR In situ chemical reduction
O&M Operation and maintenance
OU Operable unit
PRB Permeable reactive barrier

TABLE B-3
VAPOR INTRUSION ALTERNATIVES COST SUMMARY
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: New Carlisle Landfill OU 1
Location: New Carlisle, Ohio
Phase: Preliminary Draft Feasibility Study
Base Year: 2018
Date: May 2018

	Alternative VI-1	Alternative VI-2	Alternative VI-3	Alternative VI-4
Description	**No Action**	**ICs and Monitoring**	**Foundation Sealing and ICs**	**Sub-slab Depressurization System and ICs**
Total Project Duration (Years)	0	30	30	30
Capital Cost	$0	$4,000	$67,000	$88,000
Land Use Controls	$0	$14,000	$14,000	$14,000
O&M Cost (Present value, 30 years)	$0	$211,000	$279,000	$279,000
Total Present Value of Alternative (2018$)	**$0**	**$229,000**	**$360,000**	**$381,000**

Notes: Costs are rounded to the nearest $1,000.

IC Institutional control
O&M Operation and maintenance
OU Operable unit

TABLE B-4

ALTERNATIVE LF-2: MULTI-LAYER CAP, PASSIVE GAS VENTING, AND LAND USE CONTROLS

Operable Unit 1 Feasibility Study

New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Predesign study of current soil cover	1	ls	$ 100,000	$ 100,000	a
2	Predesign (includes topographic survey, geotechnical investigation, and design)	1	ls	$ 318,839	$ 318,839	a
3	Engineering design/agency approvals/access agreements	1	ls	$ 50,000	$ 50,000	a
	Planning Document Preparation Subtotal				**$ 468,839**	
General Site Preparation and Demobilization						
4	Construction contractor mobilization/demobilization, and site preparation	1	ls	$ 25,000	$ 25,000	a
5	Gravel access road	11,524	sf	$ 0.80	$ 9,166	b, 015523500050
6	Clearing and grubbing	18	acre	$ 4,896	$ 88,121	c
7	Rough grading	18	acre	$ 2,122	$ 38,202	b, 31221320017
8	Backfill Pond 1 (onsite borrow)	4,830.0	cy	$ 0.67	$ 3,233	b, 312323154080
9	Pre-construction survey	18	acre	$ 2,323	$ 41,816	b, 022113090100
10	Progress and record survey	18	acre	$ 2,323	$ 41,816	b, 022113090100
	General Site Preparation Subtotal				**$ 247,354**	
Multi-layer Cap						
11	Foundation layer fine grading	18	acre	$ 827	$ 14,884	b, 312216103300
12	GCL Layer	18	acre	$ 38,678	$ 696,204	d
13	60-mil HDPE geomembrane	18	acre	$ 21,780	$ 392,040	d
14	250-mil HDPE geonet	18	acre	$ 16,135	$ 290,430	d
15	90-mil polypropylene geotextile fabric	18	acre	$ 39,204	$ 705,668	d
16	Cover soil layer (18 inches of imported fill)	43,560	cy	$ 17.95	$ 781,902	b, 312323154080
17	Vegetative layer (6 inches of topsoil)	14,520	cy	$ 39	$ 571,725	a
18	Seeding	18	acre	$ 3,875	$ 69,741	b, 329219131000
	Multi-layer Cap Subtotal				**$ 3,522,594**	
Passive Gas Venting						
19	Install perimeter LFG monitoring probes	10	ea	$ 6,965	$ 69,650	e
20	Install passive gas vents	21	ea	$ 6,947	$ 145,884	e
	Passive Gas Ventung Subtotal				**$ 215,534**	
Wetland Work						
21	Delineate wetland	3.5	acre	$ 943	$ 3,300	f
22	Prepare permit equivalency documentation for isolated wetland permit	3.5	acre	$ 625	$ 2,188	g
23	Wetland credits	5.25	acre	$ 56,250	$ 295,313	h
	Wetland Work Subtotal				**$ 300,801**	
Residential Drinking Water						
24	Mobilization and site preparation	1	ls	$ 4,100	$ 4,100	i
25	Trenching	1	ls	$ 3,938	$ 3,938	j
26	Break pavement at Property 1	55.5	sy	$ 2.63	$ 146	b, 024113175100
27	Install water service lines, valves, and fittings	1	ls	$ 3,792	$ 3,792	i
28	Install houselines, valves, and fittings	1	ls	$ 4,100	$ 4,100	i
29	2-inch K copper service line	1200	lf	$ 30	$ 35,642	b, 331113453020
30	Residentail well abandonment	3	ea	$ 1,250	$ 3,750	k
31	Demobilization and site restoration	1	ls	$ 5,856	$ 5,856	j
32	Pavement replacement	250	sf	$ 2.93	$ 732	b, 32121640020
	Residential Drinking Water Subtotal				**$ 62,056**	
Construction Subtotal					**$ 4,817,178**	
33	Construction contractor bonds	2%			$ 96,344	
34	Project management and construction oversight	15%			$ 722,577	
35	Contingency	20%			$ 963,436	
Construction, Contractor Bonds, Project Management, and Oversight Subtotal					**$ 6,599,534**	
CAPITAL COST SUBTOTAL					**$ 6,599,534**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Land Use Control (LUC) Implementation Plan (mid-level staff with senior review)	100	hr	$ 110	$ 11,000	a
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250	$ 10,000	a
3	Deed restriction on land and groundwater use	8	hr	$ 250	$ 2,000	a
4	Fencing (12-foot tall chain-link fence with barbed wire)	4,280	ft	$ 32	$ 138,977	b
5	Signs and other site-security measures	1	ls	$ 919	$ 919	c
	Institutional Controls Subtotal				**$ 162,896**	
6	Project management land use control	15%			**$ 24,434**	
LAND USE CONTROL COST SUBTOTAL					**$ 187,330**	

TABLE B-4
ALTERNATIVE LF-2: MULTI-LAYER CAP, PASSIVE GAS VENTING, AND LAND USE CONTROLS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Annual Landfill Maintenance						
1	Vegetative layer mowing and repair	6	mo	$ 2,209	$ 13,257	l
	Annual Maintenance Subtotal				**$ 13,257**	
Annual Landfill Inspections						
2	Annual cap inspections (includes labor - 2 hours per site - and travel)	8	hr	$ 200	$ 1,600	a
3	Annual inspection report	1	ls	$ 5,000	$ 5,000	a
	Annual Inspections Subtotal				**$ 6,600**	
Quarterly Landfill Gas Monitoring (Year 1)						
4	Landfill gas monitoring (labor, equipment, travel per event)	4	ls	$ 15,000	$ 60,000	m
5	Landfill gas analysis (4 events * 4 LFG vents + 10 LFG perimeter probes)	56	sample	$ 800	$ 44,800	m
	Quarterly Landfill Gas Monitoring Subtotal				**$ 104,800**	
Semi-annual Landfill Gas Monitoring (Years 2 through 30)						
4	Landfill gas monitoring (labor, equipment, travel per event)	2	ls	$ 15,000	$ 30,000	m
5	Landfill gas analysis (2 events * 4 LFG vents + 10 LFG perimeter probes)	28	sample	$ 800	$ 22,400	m
	Semi-annual Landfill Gas Monitoring Subtotal				**$ 52,400**	
Annual O&M Subtotal (Year 1)					**$ 124,657**	
6	Project management O&M	15%			$ 18,699	
7	Contingency	20%			$ 24,931	
ANNUAL O&M COST SUBTOTAL (YEAR 1)					**$ 168,287**	
Annual O&M Subtotal (Years 2 through 30)					**$ 72,257**	
6	Project management O&M	15%			$ 10,839	
7	Contingency	20%			$ 14,451	
ANNUAL O&M COST SUBTOTAL (YEARS 2 through 30)					**$ 97,547**	

ALTERNATIVE LF-2 MULTI-LAYER CAP COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 6,600,000	
LAND USE CONTROL	$ 187,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-4A)	$ 1,331,000	
TOTAL (Rounded)	**$ 8,118,000**	

Notes:

a Professional judgement
b R.S. Means Company, Inc. 2017. "Heavy Construction Cost Data 2017.", "Site Work & Landscape Cost Data 2017."
c http://www.get-a-quote.net/QuoteEngine/costbook.asp?WCI=CostIntroFrameSet&BookId=52
d 2018. U.S. Fabric Quote # USFQ64494. April 4.
e 2009. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_046084.pdf
f 2008. http://newsletters.wetlandstudies.com/docUpload/BallParkEstimates.pdf
g 2018. http://www.epa.ohio.gov/dsw/401/permitting.aspx#116695788-fees
h 2018. http://www.ohioenvironmentallawblog.com/2015/08/articles/wetlands-and-streams/the-basics-of-wetland-and-stream-permitting/
i 2012. Tetra Tech, Inc. Agreement for Copley Square Plaza Operable Unit #1, Alternative Water Supply System, Copley, Summit County, Ohio. May.
j 2017. Tetra Tech, Inc. Final Focused Feasibility Study for East Troy Contaminated Aquifer Site, Troy, Miami County, Ohio. August 31.
k 2018. Wisconsin Department of Natural Resources (WI DNR). https://dnr.wi.gov/topic/Wells/FillingSealingFAQ.html
l 2018. https://www.lawnstarter.com/OH
m 2018. Tetra Tech-AEG quote. August 9.

cy	Cubic yard	LFG	Landfill gas
ea	Each	ls	Lump sum
ft	Foot	mil	Millimeter
GCL	Geosynthetic clay liner	mo	Month
HDPE	High-density polyethylene	O&P	Overhead and profit
hr	Hour	sf	Square foot
lf	Linear feet	sy	Square yard
LF	Landfill		

TABLE B-4A
ALTERNATIVE LF-2: MULTI-LAYER CAP, PASSIVE GAS VENTING, AND LAND USE CONTROLS
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate [1]

5-Year 7.00%

Present Value Analysis						
	Annual Discount Factor [2]	Operation and Maintenance Costs				
Year	5-year	Description	Future Cost [3]	Description	Future Cost [3]	Present Value (2018)
0	1.000					$ -
1	0.935	LF Maintenance	$ 168,287			$ 157,278
2	0.873	LF Maintenance	$ 97,547			$ 85,201
3	0.816	LF Maintenance	$ 97,547			$ 79,627
4	0.763	LF Maintenance	$ 97,547			$ 74,418
5	0.713	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 87,374
6	0.666	LF Maintenance	$ 97,547			$ 65,000
7	0.623	LF Maintenance	$ 97,547			$ 60,747
8	0.582	LF Maintenance	$ 97,547			$ 56,773
9	0.544	LF Maintenance	$ 97,547			$ 53,059
10	0.508	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 62,297
11	0.475	LF Maintenance	$ 97,547			$ 46,344
12	0.444	LF Maintenance	$ 97,547			$ 43,312
13	0.415	LF Maintenance	$ 97,547			$ 40,479
14	0.388	LF Maintenance	$ 97,547			$ 37,830
15	0.362	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 44,417
16	0.339	LF Maintenance	$ 97,547			$ 33,043
17	0.317	LF Maintenance	$ 97,547			$ 30,881
18	0.296	LF Maintenance	$ 97,547			$ 28,861
19	0.277	LF Maintenance	$ 97,547			$ 26,973
20	0.258	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 31,668
21	0.242	LF Maintenance	$ 97,547			$ 23,559
22	0.226	LF Maintenance	$ 97,547			$ 22,018
23	0.211	LF Maintenance	$ 97,547			$ 20,577
24	0.197	LF Maintenance	$ 97,547			$ 19,231
25	0.184	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 22,579
26	0.172	LF Maintenance	$ 97,547			$ 16,797
27	0.161	LF Maintenance	$ 97,547			$ 15,698
28	0.150	LF Maintenance	$ 97,547			$ 14,671
29	0.141	LF Maintenance	$ 97,547			$ 13,711
30	0.131	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 16,099

Total Present Value of Periodic Cost **$ 1,330,522**

Notes:

1 Annual discount rate = 7% (Ref: EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Protection Agency
LF Landfill

TABLE B-5
ALTERNATIVE LF-3: ENHANCE EXISTING COVER, PASSIVE GAS VENTING, AND LAND USE CONTROLS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Predesign study of current soil cover	1	ls	$ 100,000.00	$ 100,000	a
2	Engineering design/agency approvals/access agreements	1	ls	$ 50,000.00	$ 50,000	a
	Planning Document Preparation Subtotal				**$ 150,000**	
General Site Preparation and Demobilization						
3	Construction contractor mobilization/demobilization, site preparation, and submittals	1	ls	$ 25,000.00	$ 25,000	a
4	Gravel access road	11,524	sf	$ 0.80	$ 9,166	b, 015523500050
5	Clearing and grubbing	18	acre	$ 4,895.63	$ 88,121	c
6	Rough grading	18	acre	$ 2,122.31	$ 38,202	b, 31221320280
7	Backfill Pond 1	4,830	cy	$ 17.95	$ 86,691	b, 312323154080
8	Pre-construction survey	18	acre	$ 2,323.13	$ 41,816	b, 022113090100
9	Progress and record survey	18	acre	$ 2,323.13	$ 41,816	b, 022113090100
	General Site Preparation Subtotal				**$ 330,812**	
Enhance Existing Cover						
10	Add soil cover to 2.5 feet	8,067	cy	$ 17.95	$ 144,790	b, 312323154080
11	Foundation layer fine grading	18	acre	$ 826.88	$ 14,884	b, 312216103300
option	Geocomposite drainage layer	18	acre	$ 55,338.75	$ 996,098	d
12	Cover soil layer (24 inches of imported fill)	58,080	cy	$ 17.95	$ 1,042,445	b, 312323154080
13	Vegetative layer (6 inches of topsoil)	14,520	cy	$ 39.38	$ 571,725	a
14	Seeding	18	acre	$ 3,874.50	$ 69,741	b, 329219131000
	Enhance Existing Cover Subtotal				**$ 2,839,683**	
Passive Gas Venting						
15	Install perimeter landfill gas monitoring probes	10	ea	$ 6,965.05	$ 69,650	e
16	Install passive gas vents	21	ea	$ 6,965.05	$ 146,266	e
	Passive Gas Venting Subtotal				**$ 215,916**	
Wetland Work						
17	Delineate wetland	3.5	acre	$ 942.87	$ 3,300	f
18	Prepare permit equivalency documentation for isolated wetland permit	3.5	acre	$ 625.00	$ 2,188	g
19	Wetland Credits	5.25	acre	$ 56,250.00	$ 295,313	h
	Wetland Work Subtotal				**$ 300,801**	
Residential Drinking Water						
20	Mobilization and site preparation	1	ls	$ 4,100.00	$ 4,100	i
21	Trenching	1	ls	$ 3,937.50	$ 3,938	j
22	Break pavement at Property 1	56	sy	$ 2.63	$ 146	b, 024113175100
23	Install water service lines, valves, and fittings	1	ls	$ 3,792.00	$ 3,792	i
24	Install houselines, valves, and fittings	1	ls	$ 4,100.00	$ 4,100	i
25	2-inch K copper service line	1200	lf	$ 29.70	$ 35,642	b, 331113453020
26	Residentail well abandonment	3	ea	$ 1,250.00	$ 3,750	k
27	Demobilization and site restoration	1	ls	$ 5,856.00	$ 5,856	i
28	Pavement replacement	250	sf	$ 2.93	$ 732	b, 321216140020
	Residential Drinking Water Subtotal				**$ 62,056**	
Construction Subtotal					**$ 3,899,268**	
29	Construction contractor bonds	2%			$ 77,985	
30	Project management and construction oversight	15%			$ 584,890	
31	Contingency	20%			$ 779,854	
Construction, Contractor Bonds, Project Management, and Oversight Subtotal					**$ 4,562,144**	
CAPITAL COST SUBTOTAL					**$ 4,562,144**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Institutional Controls						
1	Land Use Control Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000	a
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000	a
3	Deed restriction on land and groundwater use	8	hr	$ 250.00	$ 2,000	a
4	Fencing (12-foot tall chain-link fence with barbed wire)	4,280	ft	$ 32.47	$ 138,977	b
5	Signs and other site-security measures	1	ls	$ 918.75	$ 919	c
	Institutional Controls Subtotal				**$ 162,896**	
6	Project management land use control	15%			$ 24,434	
LAND USE CONTROL COST SUBTOTAL					**$ 187,330**	

TABLE B-5

ALTERNATIVE LF-3: ENHANCE EXISTING COVER, PASSIVE GAS VENTING, AND LAND USE CONTROLS

Operable Unit 1 Feasibility Study

New Carlisle Landfill, New Carlisle, Ohio

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Annual Maintenance						
1	Vegetative layer mowing and repair	6	mo	$ 2,209.46	$ 13,257	l
	Annual Maintenance Subtotal				**$ 13,257**	
Annual Inspections						
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8	hr	$ 200.00	$ 1,600	a
3	Annual inspection report	1	ls	$ 5,000.00	$ 5,000	a
	Annual Inspections Subtotal				**$ 6,600**	
Quarterly Landfill Gas Monitoring (Year 1)						
4	Landfill gas monitoring (labor, equipment, travel per event)	4	ls	$ 15,000	$ 60,000	m
5	Landfill gas analysis (4 events * 4 LFG vents + 10 LFG perimeter probes)	56	sample	$ 800	$ 44,800	m
	Quarterly Landfill Gas Monitoring Subtotal				**$ 104,800**	
Semi-annual Landfill Gas Monitoring (Years 2 through 30)						
4	Landfill gas monitoring (labor, equipment, travel per event)	2	ls	$ 15,000	$ 30,000	m
5	Landfill gas analysis (2 events * 4 LFG vents + 10 LFG perimeter probes)	28	sample	$ 800	$ 22,400	m
	Semi-annual Landfill Gas Monitoring Subtotal				**$ 52,400**	
Annual O&M Subtotal (Year 1)					**$ 124,657**	
6	Project management O&M	15%			$ 18,699	
7	Contingency	20%			$ 24,931	
ANNUAL O&M COST SUBTOTAL (YEAR 1)					**$ 168,287**	
Annual O&M Subtotal (Years 2 through 30)					**$ 72,257**	
6	Project management O&M	15%			$ 10,839	
7	Contingency	20%			$ 14,451	
ANNUAL O&M COST SUBTOTAL (YEARS 2 through 30)					**$ 97,547**	

ALTERNATIVE LF-3 ENHANCE EXISTING CAP COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 4,562,000	
LAND USE CONTROL	$ 187,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-5A)	$ 1,331,000	
TOTAL (Rounded)	**$ 6,080,000**	

Notes:

a Professional judgement
b 2017. R.S. Means Company, Inc. "Heavy Construction Cost Data 2017.", "Site Work & Landscape Cost Data 2017."
c http://www.get-a-quote.net/QuoteEngine/costbook.asp?WCI=CostIntroFrameSet&BookId=52
d 2018. U.S. Fabric Quote # USFQ64494. April 4.
e 2009. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_046084.pdf
f 2008. http://newsletters.wetlandstudies.com/docUpload/BallParkEstimates.pdf
g 2018. http://www.epa.ohio.gov/dsw/401/permitting.aspx#116695788-fees
h 2018. http://www.ohioenvironmentallawblog.com/2015/08/articles/wetlands-and-streams/the-basics-of-wetland-and-stream-permitting/
i 2012. Tetra Tech, Inc. Agreement for Copley Square Plaza Operable Unit #1, Alternative Water Supply System, Copley, Summit County, Ohio. May.
j 2017. Tetra Tech, Inc. Final Focused Feasibility Study for East Troy Contaminated Aquifer Site, Troy, Miami County, Ohio. August 31.
k 2018. Wisconsin Department of Natural Resources (WI DNR). https://dnr.wi.gov/topic/Wells/FillingSealingFAQ.html
l 2018. https://www.lawnstarter.com/OH
m 2018. Tetra Tech-AEG quote. August 9.

cy	Cubic yard	ls	Lump sum
ea	Each	mo	Month
ft	Foot	O&P	Overhead and profit
hr	Hour	sf	Square foot
lf	Linear foot	sy	Square yard
lLFG	Landfill Gas		

TABLE B-5A
ALTERNATIVE LF-3: ENHANCE EXISTING COVER, PASSIVE GAS VENTING, AND LAND USE CONTROLS
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate[1]

5-Year	7.00%

Present Value Analysis						
	Annual Discount Factor[2]		Operations and Maintencance Cost			
Year	5-Year	Description	Future Cost[3]	Description	Future Cost	Present Value (2018)
0	1.00					$ -
1	0.9345794	LF Maintenance	$ 168,287			$ 157,278
2	0.8734387	LF Maintenance	$ 97,547			$ 85,201
3	0.8162979	LF Maintenance	$ 97,547			$ 79,627
4	0.7628952	LF Maintenance	$ 97,547			$ 74,418
5	0.7129862	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 87,374
6	0.6663422	LF Maintenance	$ 97,547			$ 65,000
7	0.6227497	LF Maintenance	$ 97,547			$ 60,747
8	0.5820091	LF Maintenance	$ 97,547			$ 56,773
9	0.5439337	LF Maintenance	$ 97,547			$ 53,059
10	0.5083493	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 62,297
11	0.4750928	LF Maintenance	$ 97,547			$ 46,344
12	0.444012	LF Maintenance	$ 97,547			$ 43,312
13	0.4149644	LF Maintenance	$ 97,547			$ 40,479
14	0.3878172	LF Maintenance	$ 97,547			$ 37,830
15	0.362446	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 44,417
16	0.3387346	LF Maintenance	$ 97,547			$ 33,043
17	0.3165744	LF Maintenance	$ 97,547			$ 30,881
18	0.2958639	LF Maintenance	$ 97,547			$ 28,861
19	0.2765083	LF Maintenance	$ 97,547			$ 26,973
20	0.258419	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 31,668
21	0.2415131	LF Maintenance	$ 97,547			$ 23,559
22	0.2257132	LF Maintenance	$ 97,547			$ 22,018
23	0.2109469	LF Maintenance	$ 97,547			$ 20,577
24	0.1971466	LF Maintenance	$ 97,547			$ 19,231
25	0.1842492	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 22,579
26	0.1721955	LF Maintenance	$ 97,547			$ 16,797
27	0.1609304	LF Maintenance	$ 97,547			$ 15,698
28	0.1504022	LF Maintenance	$ 97,547			$ 14,671
29	0.1405628	LF Maintenance	$ 97,547			$ 13,711
30	0.1313671	LF Maintenance	$ 97,547	5-Year Review	$ 25,000	$ 16,099

Total Present Value of Periodic Cost **$ 1,330,522**

Notes:

1 Annual discount rate = 7% (Ref: EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmentals Protection Agency
LF Landfill

TABLE B-6
ALTERNATIVE GW-2A: ENHANCED REDUCTIVE DECHLORINATION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Engineering design/agency approvals/access agreements	1	ls	$ 57,642	$ 57,642	a
	Planning Document Preparation Subtotal				**$ 57,642**	
Enhanced Reductive Dechlorination (ERD) Injection						
2	Construction contractor mobilization/demobilization, and site preparation	1	ls	$ 25,000	$ 25,000	a
3	Pilot test	1	ls	$ 150,000	$ 150,000	a
4	ELS Microemulsion concentrate	59,340	lbs	$ 2.80	$ 166,152	b
5	pH Buffer	5,700	lbs	$ 3.00	$ 17,100	b
6	DHC Inoculum	179	liter	$ 110.00	$ 19,690	b
7	Direct-push technology injection	34	day	$ 6,438	$ 218,892	c
	ERD Injection Subtotal				**$ 596,834**	
Install Additional Groundwater Monitoring Wells						
8	Install monitoring wells (60 feet deep)	10	ea	$ 5,355	$ 53,550	d
9	Install monitoring wells (100 feet deep)	10	ea	$ 7,014	$ 70,140	d
	Install Additional Groundwater Monitoring Wells Subtotal				**$ 123,690**	
ERD Injection Subtotal					**$ 778,166**	
10	Project management and ERD injection oversight	15%			$ 116,725	
11	Contingency	20%			$ 155,633	
ERD Injection, Project Management, and Oversight Subtotal					**$ 1,050,524**	
CAPITAL COST SUBTOTAL					**$ 1,050,524**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250	$ 10,000	a
2	Deed restriction on land and groundwater use	8	hr	$ 250	$ 2,000	a
	Institutional Controls Subtotal				**$ 12,000**	
3	Project management land use control	15%			1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Quarterly Groundwater Monitoring (Years 1 & 2)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 38,640	e
2	Sampling Equipment	1	wk	$ 525	$ 2,100	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	wk	$ 457	$ 36,564	f
	Annual Quarterly Groundwater Monitoring Subtotal				**$ 77,304**	
Semi-annual Groundwater Monitoring (Years 3 through 7)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 19,320	e
2	Sampling Equipment	1	wk	$ 525	$ 1,050	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	ea	$ 457	$ 18,282	f
	Annual Semi-annual Groundwater Monitoring Subtotal				**$ 38,652**	
Annual Groundwater Monitoring (Years 8 through 30)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 9,660	e
2	Sampling Equipment	1	wk	$ 525	$ 525	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	ea	$ 457	$ 9,141	f
	Annual Groundwater Monitoring Subtotal				**$ 19,326**	
Annual Inspections and Reports						
4	Annual groundwater monitoring report	1	ls	$ 10,000	$ 10,000	a
5	Annual ERD system assessment and annual assessment report	1	ls	$ 15,000	$ 15,000	a
6	ERD re-injection event every 3 years (see PV analysis for re-injection events)	1	ea	$ 421,834		c
	Annual Assessment Subtotal				**$ 25,000**	
Annual O&M Subtotal (Years 1 & 2)					**$ 102,304**	
7	Project management O&M	15%			$ 15,346	
8	Contingency	20%			$ 20,461	
ANNUAL O&M COST SUBTOTAL (Years 1 & 2)					**$ 138,110**	
Annual O&M Subtotal (Years 3 through 7)					**$ 63,652**	
7	Project management O&M	15%			$ 9,548	
8	Contingency	20%			$ 12,730	
ANNUAL O&M COST SUBTOTAL (Years 3 through 7)					**$ 85,930**	
Annual O&M Subtotal (Years 8 through 30)					**$ 44,326**	
7	Project management O&M	15%			$ 6,649	
8	Contingency	20%			$ 8,865.20	
ANNUAL O&M COST SUBTOTAL (Years 8 through 30)					**$ 59,840**	

TABLE B-6
ALTERNATIVE GW-2A: ENHANCED REDUCTIVE DECHLORINATION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

ALTERNATIVE GW-2A ERD PRB COST SUMMARY			
Description		**Subtotal**	
CAPITAL	$	1,051,000	
LAND USE CONTROL	$	14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-6A)	$	2,302,000	
TOTAL (Rounded)	**$**	**3,367,000**	

Notes:
a Professional judgement
b 2018. Peroxychem. Proposal 21274. April 15.
c 2018. Regenesis. Proposal. May 3.
d 2017. Tetra Tech, Inc. Final Feasibility Study for Elm Street Groundwater Contamination Site. Terre Haute, Vigo County Indiana. July 20.
e 2014. Tetra Tech, Inc. Final Focused Feasibility Study Addendum, Installation Restoration Site 24, Former Dry Cleaning Facility, Naval Station Treasure Island, San Francisco, California. October 6.
f 2015. Tetra Tech, Inc. Copley Square Plaza Remedial Action. June

DHC	Dehalococcoides	lbs	Pounds
ea	Each	ls	Lump sum
ELS	Emulsified lecithin substrate	O&P	Overhead and profit
ERD	Enhanced reductive dechlorination	PRB	Permeable reactive barrier
GW	Groundwater	VOC	Volatile organic compound
hr	Hour	wk	Week

TABLE B-6A

ALTERNATIVE GW-2A: ENHANCED REDUCTIVE DECHLORINATION PERMEABLE REACTIVE BARRIER AND MONITORING

Operable Unit 1 Feasibility Study

New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate [1]

5-Year 7.00%

Present Value Analysis						
Year	**Annual Discount Factor [2] 5-Year**	**Operation and Maintenance Costs: Description**	**Future Cost [3]**	**Description**	**Future Cost [3]**	**Present Value (2018)**
0	1.000					$ -
1	0.935	Quarterly groundwater monitoring and annual reporting	$ 138,110			$ 129,075
2	0.873	Quarterly groundwater monitoring and annual reporting	$ 138,110			$ 120,631
3	0.816	Semi-annual groundwater monitoring and annual reporting	$ 85,930	Re-injection	$ 421,834	$ 414,487
4	0.763	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 65,556
5	0.713	Semi-annual groundwater monitoring and annual reporting	$ 85,930	5-Year Review	$ 25,000	$ 79,092
6	0.666	Semi-annual groundwater monitoring and annual reporting	$ 85,930	Re-injection	$ 421,834	$ 338,345
7	0.623	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 53,513
8	0.582	Annual groundwater monitoring and annual reporting	$ 8,865			$ 5,160
9	0.544	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 234,272
10	0.508	Annual groundwater monitoring and annual reporting	$ 8,865	5-Year Review	$ 25,000	$ 17,215
11	0.475	Annual groundwater monitoring and annual reporting	$ 8,865			$ 4,212
12	0.444	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 191,236
13	0.415	Annual groundwater monitoring and annual reporting	$ 8,865			$ 3,679
14	0.388	Annual groundwater monitoring and annual reporting	$ 8,865			$ 3,438
15	0.362	Annual groundwater monitoring and annual reporting	$ 8,865	5-Year Review and re-injection	$ 446,834	$ 165,166
16	0.339	Annual groundwater monitoring and annual reporting	$ 8,865			$ 3,003
17	0.317	Annual groundwater monitoring and annual reporting	$ 8,865			$ 2,806
18	0.296	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 127,428
19	0.277	Annual groundwater monitoring and annual reporting	$ 8,865			$ 2,451
20	0.258	Annual groundwater monitoring and annual reporting	$ 8,865	5-Year Review	$ 25,000	$ 8,751
21	0.242	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 104,019
22	0.226	Annual groundwater monitoring and annual reporting	$ 8,865			$ 2,001
23	0.211	Annual groundwater monitoring and annual reporting	$ 8,865			$ 1,870
24	0.197	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 84,911
25	0.184	Annual groundwater monitoring and annual reporting	$ 8,865	5-Year Review	$ 25,000	$ 6,240
26	0.172	Annual groundwater monitoring and annual reporting	$ 8,865			$ 1,527
27	0.161	Annual groundwater monitoring and annual reporting	$ 8,865	Re-injection	$ 421,834	$ 69,313
28	0.150	Annual groundwater monitoring and annual reporting	$ 8,865			$ 1,333
29	0.141	Annual groundwater monitoring and annual reporting	$ 8,865			$ 1,246
30	0.131	Annual groundwater monitoring and annual reporting	$ 8,865	5-Year Review and re-injection	$ 446,834	$ 59,864

Total Present Value of Periodic Cost **$ 2,301,840**

Notes:

1 Annual discount rate = 7% (Ref: EPA 540-R-00-002)

2 Annual discount factor = $1/(1+i)^t$. where i = discount rate (includes inflation and interest) and t = year

3 Current dollar cost of future event

EPA U.S. Environmental Protection Agency

TABLE B-7
ALTERNATIVE GW-2B: IN SITU CHEMICAL OXIDATION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Engineering design/agency approvals/access agreements	1	ls	$ 78,819.04	$ 78,819	a
	Planning Document Preparation Subtotal				**$ 78,819**	
In Situ Chemical Oxidation (ISCO) Treatment						
2	Construction contractor mobilization/demobilization, and site preparation	1	ls	$ 25,000.00	$ 25,000	a
3	Bench test study of onsite soil	1	ls	$ 10,000.00	$ 10,000	b
4	Pilot test	1	ls	$ 150,000.00	$ 150,000	a
5	PersulfOx	145,354	lbs	$ 2.24	$ 325,593	b
6	Direct-push technology injection (91 injection locations)	55	Days	$ 6,381.00	$ 350,955	b
	ISCO Injection Subtotal				**$ 861,548**	
Install Additional Groundwater Monitoring Wells						
7	Install monitoring wells (60 feet deep)	10	ea	$ 5,355.00	$ 53,550	c
8	Install monitoring wells (100 feet deep)	10	ea	$ 7,014.00	$ 70,140	c
	Install Additional Groundwater Monitoring Wells Subtotal				**$ 123,690**	
ISCO Treatment Subtotal					**$ 1,064,057**	
9	Project Management and Oversight of ISCO Treatment	15%			$ 159,609	
10	Contingency	20%			$ 212,811	
ISCO Treatment, Project Management, and Oversight Subtotal					**$ 1,436,477**	
CAPITAL COST SUBTOTAL					**$ 1,436,477**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250	$ 10,000	a
2	Deed restrictions on land and groundwater use	8	hr	$ 250	$ 2,000	a
	Institutional Controls Subtotal				**$ 12,000**	
3	Project management land use control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

TABLE B-7
ALTERNATIVE GW-2B: IN SITU CHEMICAL OXIDATION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Quarterly Groundwater Monitoring (Years 1 & 2)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 38,640	d
2	Sampling Equipment	1	wk	$ 525	$ 2,100	d
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved	20	ea	$ 457	$ 36,564	e
	Annual Quarterly Groundwater Monitoring Subtotal				**$ 77,304**	
Semi-annual Groundwater Monitoring (Years 3 through 7)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 19,320	d
2	Sampling Equipment	1	wk	$ 525	$ 1,050	d
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved	20	ea	$ 457	$ 18,282	e
	Annual Semi-annual Groundwater Monitoring Subtotal				**$ 38,652**	
Annual Groundwater Monitoring (Years 8 through 30)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 9,660	d
2	Sampling Equipment	1	wk	$ 525	$ 525	d
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved	20	ea	$ 457	$ 9,141	e
	Annual Groundwater Monitoring Subtotal				**$ 19,326**	
Annual Inspections						
4	Annual groundwater monitoring report	1	ls	$ 10,000	$ 10,000	a
5	Annual ISCO treatment system assessment and annual assessment report	1	ls	$ 15,000	$ 15,000	a
6	ISCO re-injection event every 2 years (see PV analysis for re-injection events)	1	ea	$ 676,548		b
	Annual Assessment Subtotal				**$ 25,000**	
Annual O&M Subtotal (Years 1 & 2)					**$ 102,304**	
7	Project management O&M	15%			$ 15,346	
8	Contingency	20%			$ 20,461	
ANNUAL O&M COST SUBTOTAL (Years 1 & 2)					**$ 138,110**	
Annual O&M Subtotal (Years 3 through 7)					**$ 63,652**	
7	Project management O&M	15%			$ 9,548	
8	Contingency	20%			$ 12,730	
ANNUAL O&M COST SUBTOTAL (Years 3 through 7)					**$ 85,930**	
Annual O&M Subtotal (Years 8 through 30)					**$ 44,326**	
7	Project management O&M	15%			$ 6,649	
8	Contingency	20%			$ 8,865.20	
ANNUAL O&M COST SUBTOTAL (Years 8 through 30)					**$ 59,840**	

ALTERNATIVE GW-2B ISCO PRB COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 1,436,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-7A)	$ 5,087,000	
TOTAL (Rounded)	**$ 6,537,000**	

Notes:
a Professional judgement
b 2018. Regenesis. Proposal. May 3.
c 2017. Tetra Tech, Inc. Final Feasibility Study for Elm Street Groundwater Contamination Site. Terre Haute, Vigo County Indiana. July 20.
d 2014. Tetra Tech, Inc. Final Focused Feasibility Study Addendum, Installation Restoration Site 24, Former Dry Cleaning Facility, Naval Station Treasure Island, San Francisco, California. October 6.
e 2015. Tetra Tech, Inc. Copley Square Plaza Remedial Action. June

ea Each
GW Groundwater
hr Hour
lbs Pounds
ls Lump sum
PRB Permeable reactive barrier
VOC Volatile organic compound
wk Week

TABLE B-7A
ALTERNATIVE GW-2B: IN SITU CHEMICAL OXIDATION PERMEABLE REACTIVE BARRIER AND MONITORING
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate [1]

5-Year 7.00%

Present Value Analysis							
	Annual Discount Factor [2]	Operation and Maintenance Costs					
Year	5-Year	Description	Future Cost [3]	Description	Future Cost [3]	Present Value (2018)
0	1.000					$ -
1	0.935	Quarterly groundwater monitoring and annual reporting	$ 138,110			$ 129,075
2	0.873	Quarterly groundwater monitoring and annual reporting	$ 138,110	Reinjection Event	$ 676,548	$ 711,554
3	0.816	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 70,145
4	0.763	Semi-annual groundwater monitoring and annual reporting	$ 85,930	Reinjection Event	$ 676,548	$ 581,691
5	0.713	Semi-annual groundwater monitoring and annual reporting	$ 85,930	5-Year Review	$ 25,000	$ 79,092
6	0.666	Semi-annual groundwater monitoring and annual reporting	$ 85,930	Reinjection Event	$ 676,548	$ 508,071
7	0.623	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 53,513
8	0.582	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 428,585
9	0.544	Annual groundwater monitoring and annual reporting	$ 59,840			$ 32,549
10	0.508	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Reinejction Event	$ 701,548	$ 387,051
11	0.475	Annual groundwater monitoring and annual reporting	$ 59,840			$ 28,430
12	0.444	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 326,965
13	0.415	Annual groundwater monitoring and annual reporting	$ 59,840			$ 24,832
14	0.388	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 285,584
15	0.362	Annual groundwater monitoring and annual reporting	$ 59,840	Five Year Review	$ 25,000	$ 30,750
16	0.339	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 249,440
17	0.317	Annual groundwater monitoring and annual reporting	$ 59,840			$ 18,944
18	0.296	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 217,871
19	0.277	Annual groundwater monitoring and annual reporting	$ 59,840			$ 16,546
20	0.258	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Reinejction Event	$ 701,548	$ 196,757
21	0.242	Annual groundwater monitoring and annual reporting	$ 59,840			$ 14,452
22	0.226	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 166,212
23	0.211	Annual groundwater monitoring and annual reporting	$ 59,840			$ 12,623
24	0.197	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 145,176
25	0.184	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review	$ 25,000	$ 15,632
26	0.172	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 126,803
27	0.161	Annual groundwater monitoring and annual reporting	$ 59,840			$ 9,630
28	0.150	Annual groundwater monitoring and annual reporting	$ 59,840	Reinjection Event	$ 676,548	$ 110,754
29	0.141	Annual groundwater monitoring and annual reporting	$ 59,840			$ 8,411
30	0.131	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Reinejction Event	$ 701,548	$ 100,021

Total Present Value of Periodic Cost **$ 5,087,160**

Notes:

1 Annual discount rate = 7% (Ref: EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Protection Agency

TABLE B-8
ALTERNATIVE GW-2C: IN SITU CHEMICAL REDUCTION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Engineering design/agency approvals/access agreements	1	ls	$ 98,628	$ 98,628	a
	Planning Document Preparation Subtotal				**$ 98,628**	
In Situ Chemical Reduction (ISCR) Treatment						
2	Construction contractor mobilization/demobilization, site preparation, and submittals	1	ls	$ 25,000.00	$ 25,000	a
3	Pilot test	1	ls	$ 150,000.00	$ 150,000	a
4	EHC® ISCR reagent	254,600	lbs	$ 1.50	$ 381,900	b
5	DHC inoculum	179	liter	$ 110.00	$ 19,690	b
6	Direct-push technology injection	64	day	$ 8,047.50	$ 515,040	c
	ISCR Treatment Subtotal				**$ 1,091,630**	
Install Additional Groundwater Monitoring Wells						
7	Install monitoring wells (60 feet deep)	10	ea	$ 5,355.00	$ 53,550	d
8	Install monitoring wells (100 feet deep)	10	ea	$ 8,767.50	$ 87,675	d
	Install Additional Groundwater Monitoring Wells Subtotal				**$ 141,225**	
ISCR Treatment Subtotal					**$ 1,331,483**	
9	Project management and oversight of ISCR treatment	15%			$ 199,722	
10	Contingency	20%			$ 266,297	
ISCR Treatment, Project Management, and Oversight Subtotal					**$ 1,531,205**	
CAPITAL COST SUBTOTAL					**$ 1,531,205**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000	a
2	Deed restrictions on land and groundwater use	8	hr	$ 250.00	$ 2,000	a
	Institutional Controls Subtotal				**$ 12,000**	
3	Project management land use control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

TABLE B-8
ALTERNATIVE GW-2C: IN SITU CHEMICAL REDUCTION PERMEABLE REACTIVE BARRIER AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Quarterly Groundwater Monitoring (Years 1 & 2)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 38,640	e
2	Sampling equipment	1	wk	$ 525	$ 2,100	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases,	20	ea	$ 457	$ 36,564	f
	Annual Quarterly Groundwater Monitoring Subtotal				**$ 77,304**	
Semi-annual Groundwater Monitoring (Years 3 through 7)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 19,320	e
2	Sampling equipment	1	wk	$ 525	$ 1,050	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases,	20	ea	$ 457	$ 18,282	f
	Annual Semi-annual Groundwater Monitoring Subtotal				**$ 38,652**	
Annual Groundwater Monitoring (Years 8 through 30)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 9,660	e
2	Sampling equipment	1	wk	$ 525	$ 525	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases,	20	ea	$ 457	$ 9,141	f
	Annual Groundwater Monitoring Subtotal				**$ 19,326**	
Annual Inspections and Reports						
4	Annual groundwater monitoring report	1	ls	$ 10,000	$ 10,000	a
5	Annual ISCR system assessment and annual assessment report	1	ls	$ 15,000	$ 15,000	a
6	ISCR re-injection event every 5 years (see PV analysis for re-injection events)	1	ea	$ 916,630		c
	Annual Assessment Subtotal				**$ 25,000**	
Annual O&M Subtotal (Years 1 & 2)					**$ 102,304**	
7	Project management O&M	15%			$ 15,346	
8	Contingency	20%			$ 20,461	
ANNUAL O&M COST SUBTOTAL (Years 1 & 2)					**$ 138,110**	
Annual O&M Subtotal (Years 3 through 7)					**$ 63,652**	
7	Project management O&M	15%			$ 9,548	
8	Contingency	20%			$ 12,730	
ANNUAL O&M COST SUBTOTAL (Years 3 through 7)					**$ 85,930**	
Annual O&M Subtotal (Years 8 through 30)					**$ 44,326**	
7	Project Management O&M	15%			$ 6,649	
8	Contingency	20%			$ 8,865.20	
ANNUAL O&M COST SUBTOTAL (Years 8 through 30)					**$ 59,840**	

ALTERNATIVE GW-2C ISCR PRB COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 1,531,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-8A)	$ 3,009,000	
TOTAL (Rounded)	**$ 4,554,000**	

Notes:
a Professional judgement
b 2018. Peroxychem. Proposal 21274. April 15.
c 2018. Regenesis. Proposal. May 3.
d 2017. Tetra Tech, Inc. Final Feasibility Study for Elm Street Groundwater Contamination Site. Terre Haute, Vigo County Indiana. July 20.
d 2014. Tetra Tech, Inc. Final Focused Feasibility Study Addendum, Installation Restoration Site 24, Former Dry Cleaning Facility, Naval Station Treasure Island, San Francisco, California. October 6.
e 2015. Tetra Tech, Inc. Copley Square Plaza Remedial Action. June

DHC Dehalococcoides
ea Each
GW Groundwater
hr Hour
lbs Pounds
ls Lump sum
O&P Overhead and profit
PRB Permeable reactive barrier
VOC Volatile organic compound
wk Week

TABLE B-8A
ALTERNATIVE GW-2C: IN SITU CHEMICAL REDUCTION PERMEABLE REACTIVE BARRIER AND MONITORING
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate[1]

5-YR	7.00%

Present Value Analysis						
	Annual Discount Factor[2]		**Operations and Maintencance Cost**			
Year	**5-Year**	**Description**	**Future Cost[3]**	**Description**	**Future Cost**	**Present Value (2018)**
0	1					
1	0.935	Quarterly groundwater monitoring and annual reporting	$ 138,110			$ 129,075
2	0.873	Quarterly groundwater monitoring and annual reporting	$ 138,110			$ 120,631
3	0.816	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 70,145
4	0.763	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 65,556
5	0.713	Semi-annual groundwater monitoring and annual reporting	$ 85,930	5-Year Review and Re-injection	$ 941,630	$ 732,636
6	0.666	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 57,259
7	0.623	Semi-annual groundwater monitoring and annual reporting	$ 85,930			$ 53,513
8	0.582	Annual groundwater monitoring and annual reporting	$ 59,840			$ 34,827
9	0.544	Annual groundwater monitoring and annual reporting	$ 59,840			$ 32,549
10	0.508	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Re-injection	$ 941,630	$ 509,097
11	0.475	Annual groundwater monitoring and annual reporting	$ 59,840			$ 28,430
12	0.444	Annual groundwater monitoring and annual reporting	$ 59,840			$ 26,570
13	0.415	Annual groundwater monitoring and annual reporting	$ 59,840			$ 24,832
14	0.388	Annual groundwater monitoring and annual reporting	$ 59,840			$ 23,207
15	0.362	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Re-injection	$ 941,630	$ 362,979
16	0.339	Annual groundwater monitoring and annual reporting	$ 59,840			$ 20,270
17	0.317	Annual groundwater monitoring and annual reporting	$ 59,840			$ 18,944
18	0.296	Annual groundwater monitoring and annual reporting	$ 59,840			$ 17,705
19	0.277	Annual groundwater monitoring and annual reporting	$ 59,840			$ 16,546
20	0.258	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Re-injection	$ 941,630	$ 258,799
21	0.242	Annual groundwater monitoring and annual reporting	$ 59,840			$ 14,452
22	0.226	Annual groundwater monitoring and annual reporting	$ 59,840			$ 13,507
23	0.211	Annual groundwater monitoring and annual reporting	$ 59,840			$ 12,623
24	0.197	Annual groundwater monitoring and annual reporting	$ 59,840			$ 11,797
25	0.184	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Re-injection	$ 941,630	$ 184,520
26	0.172	Annual groundwater monitoring and annual reporting	$ 59,840			$ 10,304
27	0.161	Annual groundwater monitoring and annual reporting	$ 59,840			$ 9,630
28	0.150	Annual groundwater monitoring and annual reporting	$ 59,840			$ 9,000
29	0.141	Annual groundwater monitoring and annual reporting	$ 59,840			$ 8,411
30	0.131	Annual groundwater monitoring and annual reporting	$ 59,840	5-Year Review and Re-injection	$ 941,630	$ 131,560
Total Present Value of Periodic Cost						**$ 3,009,373**

Notes:

1 Annual discount rate = 7% (EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Protection Agency
O&M Operations and maintenance
Annual O&M includes quarterly groundwater monitoring for the first two years, semi-annual groundwater monitoring for the next five years, and annual groundwater monitoring after year 7.

TABLE B-9
ALTERNATIVE GW-3: GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Engineering design/agency approvals/access agreements/permits	1	ls	$ 136,384.81	$ 136,385	a
2	Groundwater modeling	1	ls	$ 50,000.00	$ 50,000	a
3	Pump testing	1	ls	$ 25,000.00	$ 25,000	a
	Planning Document Preparation and Permit Subtotal				**$ 211,385**	
Ex Situ Treatment System						
4	Construction contractor mobilization/demobilization, site preparation, and submittals	1	ls	$ 25,000.00	$ 25,000	a
5	Install extraction wells (60 feet deep)	5	ea	$ 32,812.50	$ 164,063	b
6	Groundwater treatment system (air stripper)	1	ls	$ 231,809.14	$ 231,809	b
7	Treatment system foundation	1,000	sf	$ 19.33	$ 19,333	c
8	Injection/extraction piping and valves	1	ls	$ 195,558.59	$ 195,559	b
9	Trenching, bedding, backfilling, compacting (2' wide x 4' deep)	2,875	ft	$ 15.58	$ 44,791	b
10	Electrical	1	ls	$ 250,000.00	$ 250,000	a
11	Outfall	1	ls	$ 1,700.00	$ 1,700	c
12	NPDES permitting	2%			$ 18,645	d, 014126500100
	Ex Situ Treatment Subtotal				**$ 950,900**	
Install Additional Groundwater Monitoring Wells						
13	Install monitoring wells (60' deep)	10	ea	$ 6,961.50	$ 69,615	b
14	Install monitoring wells (100' deep)	10	ea	$ 11,602.50	$ 116,025	b
	Install Additional Groundwater Monitoring Wells Subtotal				**$ 185,640**	
Ex Situ Treatment Subtotal					**$ 1,347,925**	
15	Project Management and Oversight of Ex Situ Treatment	15%			$ 202,189	
16	Contingency	20%			$ 269,585	
Ex Situ Treatment, Project Management, and Oversight Subtotal					**$ 1,819,699**	
CAPITAL COST SUBTOTAL					**$ 1,819,699**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000	a
2	Deed restriction on land and groundwater use	8	hr	$ 250.00	$ 2,000	a
	Institutional Controls Subtotal				**$ 12,000**	
3	Project management land use control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

TABLE B-9
ALTERNATIVE GW-3: GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price**	**Total Cost**	**Reference**
Annual Inspections						
1	Annual Ex situ treatment system assessment	208	hr	$ 200.00	$ 41,600	b
2	Annual assessment report	1	ls	$ 5,000.00	$ 5,000	b
3	System operations	12	mo	$ 2,100.00	$ 25,200	b
4	System maintenance costs	12	mo	$ 3,937.50	$ 47,250	b
5	Influent and effluent monitoring and sampling	12	ea	$ 787.50	$ 9,450	b
6	Antiscalant	1,000	gal	$ 100.00	$ 100,000	e
7	Energy cost	2,551,692	kwh	$ 0.11	$ 267,928	b
	Annual Assessment Subtotal				**$ 496,428**	
Quarterly Groundwater Monitoring (Years 1 & 2)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 38,640	e
2	Sampling equipment	1	wk	$ 525	$ 2,100	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	ea	$ 457	$ 36,564	f
	Annual Quarterly Groundwater Monitoring Subtotal				**$ 77,304**	
Semi-annual Groundwater Monitoring (Years 3 through 7)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 19,320	e
2	Sampling equipment	1	wk	$ 525	$ 1,050	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	ea	$ 457	$ 18,282	f
	Annual Semi-annual Groundwater Monitoring Subtotal				**$ 38,652**	
Annual Groundwater Monitoring (Years 8 through 30)						
1	Groundwater monitoring personnel	50	hr	$ 193	$ 9,660	e
2	Sampling equipment	1	wk	$ 525	$ 525	e
3	Sample analysis (field parameters, VOCs, total organic carbon, cation, anions, dissolved gases, alkalinity)	20	ea	$ 457	$ 9,141	f
	Annual Groundwater Monitoring Subtotal				**$ 19,326**	
Annual O&M Subtotal (Years 1 & 2)					**$ 573,732**	
7	Project management O&M	15%			$ 86,060	
8	Contingency	20%			$ 114,746	
ANNUAL O&M COST SUBTOTAL (Years 1 & 2)					**$ 774,538**	
Annual O&M Subtotal (Years 3 through 7)					**$ 535,080**	
7	Project management O&M	15%			$ 80,262	
8	Contingency	20%			$ 107,016	
ANNUAL O&M COST SUBTOTAL (Years 3 through 7)					**$ 722,358**	
Annual O&M Subtotal (Years 8 through 30)					**$ 515,754**	
7	Project management O&M	15%			$ 77,363	
8	Contingency	20%			$ 103,150.80	
ANNUAL O&M COST SUBTOTAL (Years 8 through 30)					**$ 696,268**	

ALTERNATIVE GW-3 GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 1,820,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-9A)	$ 8,929,000	
TOTAL (Rounded)	**$ 10,763,000**	

Notes:
a Professional judgement
b 2017. Tetra Tech, Inc. Final Feasibility Study for Elm Street Groundwater Contamination Site. Terre Haute, Vigo County Indiana. July 20.
c 2017. http://www.get-a-quote.net/QuoteEngine/costbook.asp?WCI=CostIntroFrameSet&BookId=52
d R.S. Means Company, Inc. 2017. "Heavy Construction Cost Data 2017.", "Site Work & Landscape Cost Data 2017."
e 2014. Tetra Tech, Inc. Final Focused Feasibility Study Addendum, Installation Restoration Site 24, Former Dry Cleaning Facility, Naval Station Treasure Island, San Francisco, California. October 6.
f 2015. Tetra Tech, Inc. Copley Square Plaza Remedial Action. June

ea Each
ft Feet
gal Gallon
GW Groundwater
hr Hour
kwh Kilowatt hour
ls Lump sum
mo Month
NPDES National pollution discharge elimination system
sf Square foot
wk Week
VOC Volatile organic compound

TABLE B-9A
ALTERNATIVE GW-3: GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate[1]
5-Year 7.00%

Present Value Analysis						
	Annual Discount Factor[2]		**Operations and Maintencance Cost**			
Year	**5-Year**	**Description**	**Future Cost[3]**	**Description**	**Future Cost**	**Present Value (2018)**
0	1					
1	0.934579	Annual O&M	$ 774,538			$ 723,867.48
2	0.873439	Annual O&M	$ 774,538			$ 676,511.66
3	0.816298	Annual O&M	$ 722,358			$ 589,659.30
4	0.762895	Annual O&M	$ 722,358			$ 551,083.46
5	0.712986	Annual O&M	$ 722,358	5-Year Review	$ 25,000.00	$ 532,855.93
6	0.666342	Annual O&M	$ 722,358			$ 481,337.64
7	0.62275	Annual O&M	$ 722,358			$ 449,848.26
8	0.582009	Annual O&M	$ 696,268			$ 405,234.26
9	0.543934	Annual O&M	$ 696,268			$ 378,723.60
10	0.508349	Annual O&M	$ 696,268	5-Year Review	$ 25,000.00	$ 366,656.03
11	0.475093	Annual O&M	$ 696,268			$ 330,791.86
12	0.444012	Annual O&M	$ 696,268			$ 309,151.27
13	0.414964	Annual O&M	$ 696,268			$ 288,926.42
14	0.387817	Annual O&M	$ 696,268			$ 270,024.70
15	0.362446	Annual O&M	$ 696,268	5-Year Review	$ 25,000.00	$ 261,420.68
16	0.338735	Annual O&M	$ 696,268			$ 235,850.03
17	0.316574	Annual O&M	$ 696,268			$ 220,420.59
18	0.295864	Annual O&M	$ 696,268			$ 206,000.55
19	0.276508	Annual O&M	$ 696,268			$ 192,523.88
20	0.258419	Annual O&M	$ 696,268	5-Year Review	$ 25,000.00	$ 186,389.33
21	0.241513	Annual O&M	$ 696,268			$ 168,157.81
22	0.225713	Annual O&M	$ 696,268			$ 157,156.83
23	0.210947	Annual O&M	$ 696,268			$ 146,875.54
24	0.197147	Annual O&M	$ 696,268			$ 137,266.86
25	0.184249	Annual O&M	$ 696,268	5-Year Review	$ 25,000.00	$ 132,893.02
26	0.172195	Annual O&M	$ 696,268			$ 119,894.19
27	0.16093	Annual O&M	$ 696,268			$ 112,050.65
28	0.150402	Annual O&M	$ 696,268			$ 104,720.23
29	0.140563	Annual O&M	$ 696,268			$ 97,869.38
30	0.131367	Annual O&M	$ 696,268	5-Year Review	$ 25,000.00	$ 94,750.88
Total Present Value of Periodic Cost						**$ 8,928,912.31**

Notes:

1 Annual discount rate = 7% (EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Proction Agency
O&M Operations and maintenance

Annual O&M includes quarterly groundwater monitoring for the first 2 years, semi-annual groundwater monitoring for the next 5 years, and annual groundwater monitoring after year 7.

TABLE B-10
ALTERNATIVE VI-2: INSTITUTIONAL CONTROLS AND MONITORING
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Vapor Monitoring						
1	Sub-slab vapor monitoring point kits	2	ls	$ 856	$ 1,713	a
2	Sub-slab vapor monitoring point installation	16	hr	$ 80	$ 1,280	b
Vapor Monitoring Subtotal					**$ 2,993**	
3	Project Management	15%			$ 449	
4	Contingency	20%			$ 599	
CAPITAL COST SUBTOTAL					**$ 4,040**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250	$ 10,000	b
2	Deed restriction for Property 3	8	hr	$ 250	$ 2,000	b
	Institutional Controls Subtotal				**$ 12,000**	
3	Project Management Land Use Control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Semi-annual Air Monitoring (indoor, sub-slab, and outdoor)						
1	Semi-annual vapor intrusion (VI) monitoring (indoor, sub-slab, and outdoor sampling)	32	hr	$ 80.00	$ 2,560	b
2	TO-15 and Methane Analysis, includes 3 6L cannisters/property/event	12	ea	$ 356.25	$ 4,275	b
3	Annual monitoring report	1	ls	$ 2,549.51	$ 2,550	c
	Annual Assessment Subtotal				**$ 9,385**	
4	Project Management O&M	15%			$ 1,408	
5	Contingency	20%			$ 1,877	
ANNUAL O&M COST SUBTOTAL					**$ 12,670**	

ALTERNATIVE VI-2 INSTITUTIONAL CONTROLS AND MONITORING COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 4,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-10A)	$ 211,000	
TOTAL (Rounded)	**$ 229,000**	

Notes:
a 2018. http://envirologek.com/shop/environmental-monitoring-equipment/gas-and-vapor-sampling/subslab-sampling/vapor-pin-subslab-sampling/
b Professional judgement
c 2017. Tetra Tech, Inc. Final Focused Feasibility Study for East Troy Contaminated Aquifer Site, Troy, Miami County, Ohio. August 31.

ea Each
hr Hour
L Liter
ls Lump sum
O&P Overhead and profit

TABLE B-10A
ALTERNATIVE VI-2: INSTITUTIONAL CONTROLS AND MONITORING
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate [1]:

5-Yr 7.00%

Present Value Analysis						
	Annual Discount Factor [2]	Operation and Maintenance Costs				
Year	5-Year	Description	Future Cost [3]	Description	Future Cost [3]	Present Value (2018)
0	1.000					$ -
1	0.935	SVE O&M	$ 12,670			$ 11,841
2	0.873	SVE O&M	$ 12,670			$ 11,066
3	0.816	SVE O&M	$ 12,670			$ 10,342
4	0.763	SVE O&M	$ 12,670			$ 9,666
5	0.713	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 26,858
6	0.666	SVE O&M	$ 12,670			$ 8,442
7	0.623	SVE O&M	$ 12,670			$ 7,890
8	0.582	SVE O&M	$ 12,670			$ 7,374
9	0.544	SVE O&M	$ 12,670			$ 6,892
10	0.508	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 19,149
11	0.475	SVE O&M	$ 12,670			$ 6,019
12	0.444	SVE O&M	$ 12,670			$ 5,626
13	0.415	SVE O&M	$ 12,670			$ 5,257
14	0.388	SVE O&M	$ 12,670			$ 4,914
15	0.362	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 13,653
16	0.339	SVE O&M	$ 12,670			$ 4,292
17	0.317	SVE O&M	$ 12,670			$ 4,011
18	0.296	SVE O&M	$ 12,670			$ 3,749
19	0.277	SVE O&M	$ 12,670			$ 3,503
20	0.258	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 9,735
21	0.242	SVE O&M	$ 12,670			$ 3,060
22	0.226	SVE O&M	$ 12,670			$ 2,860
23	0.211	SVE O&M	$ 12,670			$ 2,673
24	0.197	SVE O&M	$ 12,670			$ 2,498
25	0.184	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 6,941
26	0.172	SVE O&M	$ 12,670			$ 2,182
27	0.161	SVE O&M	$ 12,670			$ 2,039
28	0.150	SVE O&M	$ 12,670			$ 1,906
29	0.141	SVE O&M	$ 12,670			$ 1,781
30	0.131	SVE O&M	$ 12,670	Five-Year Review	$ 25,000	$ 4,949

Total Present Value of Periodic Cost **$ 211,165**

Notes:

1 Annual discount rate = 7% (EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Protection Agency
O&M Operations and maintenance
SVE Soil Vapor Extraction

TABLE B-11
ALTERNATIVE VI-3: FOUNDATION SEALING AND INSTITUTIONAL CONTROLS
Preliminary Draft Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Planning document preparation/agency approvals/access agreements for Properties 2 and 3	1	ls	$ 20,000	$ 20,000	a
	Planning Document Preparation and Permit Subtotal				**$ 20,000**	
Vapor Monitoring						
2	Sub-slab vapor monitoring point kits	2	ls	$ 856	$ 1,713	b
3	Sub-slab vapor monitoring point installation	16	hr	$ 80	$ 1,280	c
	Vapor Monitoring Subtotal				**$ 2,993**	
Foundation Sealing						
4	Contractor mobilization/demobilization, site preparation, access agreements, and submittals	1	ls	$ 15,000	$ 15,000	c
5	Seal entry routes or cracks	5400	sf	$ 1.04	$ 5,599	d, 033516304000
6	Epoxy paint larger areas	5400	sf	$ 0.37	$ 1,985	d, 033516304000
7	Baseline Sampling (pre- and post-sealing installation), TO-15 Analysis, includes 6L Summa C	12	ea	$ 356.25	$ 4,275	c
	Foundation Sealing Subtotal				**$ 26,859**	
Foundation Sealing, Monitoring, Planning Subtotal					**$ 49,852**	
8	Project Management and Oversight	15%			$ 7,478	
9	Contingency	20%			$ 9,970	
CAPITAL COST SUBTOTAL					**$ 67,300**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000	c
2	Deed restriction on land and groundwater use	8	hr	$ 250.00	$ 2,000	c
	Institutional Controls Subtotal				**$ 12,000**	
3	Project Management Land Use Control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
1	Semi-annual air sampling (sub-slab soil gas, indoor air, outdoor ambient air)	32	hr	$ 80.00	$ 2,560	c
2	Semi-annual air sample analysis: TO-15 Analysis, includes 6L Summa Cannisters	12	ea	$ 356.25	$ 4,275	c
3	Annual sealant assessment	8	hr	$ 200.00	$ 1,600	c
4	Annual assessment and monitoring report	1	ls	$ 5,000.00	$ 5,000	c
	Annual Assessment Subtotal				**$ 13,435**	
5	Project Management O&M	15%			$ 2,015	
6	Contingency	20%			$ 2,687	
ANNUAL O&M COST SUBTOTAL					**$ 18,137**	

ALTERNATIVE VI-3 FOUNDATION SEALING COST SUMMARY		
Description		
CAPITAL	$ 67,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-11A)	$ 279,000	
TOTAL (Rounded)	**$ 360,000**	

Notes:
a 2016. https://www.trcsolutions.com/writable/images/TRC-white-paper-Vapor-Intrusion-FINAL-March-2016.pdf
b 2018. http://envirologek.com/shop/environmental-monitoring-equipment/gas-and-vapor-sampling/subslab-sampling/vapor-pin-subslab-sampling/
c Professional judgement
d R.S. Means Company, Inc. 2017. "Heavy Construction Cost Data 2017.", "Site Work & Landscape Cost Data 2017."

ea Each
hr Hour
L Liter
ls Lump sum
O&P Overhead and profit
sf Square foot
VI Vapor intrusion

TABLE B-11A
ALTERNATIVE VI-3: FOUNDATION SEALING AND INSTITUTIONAL CONTROLS
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate[1]
5-YR 7.00%

Present Value Analysis							
	Annual Discount Factor[2]		Operations and Maintencance Cost				
Year	5-Year	Description	Future Cost[3]	Description	Future Cost	Present Value (2018)	
0	1						
1	0.934579439	Annual O&M	$ 18,137			$	16,950.70
2	0.873438728	Annual O&M	$ 18,137			$	15,841.78
3	0.816297877	Annual O&M	$ 18,137			$	14,805.40
4	0.762895212	Annual O&M	$ 18,137			$	13,836.82
5	0.712986179	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	30,756.26
6	0.666342224	Annual O&M	$ 18,137			$	12,085.62
7	0.622749742	Annual O&M	$ 18,137			$	11,294.97
8	0.582009105	Annual O&M	$ 18,137			$	10,556.04
9	0.543933743	Annual O&M	$ 18,137			$	9,865.46
10	0.508349292	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	21,928.79
11	0.475092796	Annual O&M	$ 18,137			$	8,616.88
12	0.444011959	Annual O&M	$ 18,137			$	8,053.16
13	0.414964448	Annual O&M	$ 18,137			$	7,526.31
14	0.387817241	Annual O&M	$ 18,137			$	7,033.94
15	0.36244602	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	15,634.92
16	0.338734598	Annual O&M	$ 18,137			$	6,143.71
17	0.31657439	Annual O&M	$ 18,137			$	5,741.79
18	0.295863916	Annual O&M	$ 18,137			$	5,366.16
19	0.276508333	Annual O&M	$ 18,137			$	5,015.10
20	0.258419003	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	11,147.49
21	0.241513087	Annual O&M	$ 18,137			$	4,380.38
22	0.225713165	Annual O&M	$ 18,137			$	4,093.82
23	0.210946883	Annual O&M	$ 18,137			$	3,826.00
24	0.19714662	Annual O&M	$ 18,137			$	3,575.70
25	0.184249178	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	7,948.00
26	0.172195493	Annual O&M	$ 18,137			$	3,123.15
27	0.160930367	Annual O&M	$ 18,137			$	2,918.83
28	0.150402212	Annual O&M	$ 18,137			$	2,727.88
29	0.140562815	Annual O&M	$ 18,137			$	2,549.42
30	0.131367117	Annual O&M	$ 18,137	Five-Year Review	$ 25,000.00	$	5,666.82
Total Present Value of Periodic Cost						**$**	**279,011.30**

Notes:

1 Annual discount rate = 7% (EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event
EPA U.S. Environmental Protection Agency
O&M Operations and maintenance

TABLE B-12
ALTERNATIVE VI-4: SUB-SLAB DEPRESSURIZATION SYSTEM AND INSTITUTIONAL CONTROLS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

CAPITAL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Planning Document Preparation						
1	Engineering design/agency approvals/access agreements for Properties 2 and 3	1	ls	$ 30,000	$ 30,000	a
	Planning Document Preparation and Permit Subtotal				**$ 30,000**	
Sub-slab Depressurization (SSD) System						
2	Construction contractor mobilization/demobilization, and site preparation	1	ls	$ 25,000	$ 25,000	b
3	Pre-installation baseline testing (labor for set-up, collection, and sample analysis)	2	ea	$ 1,530	$ 3,059	c
4	Post-installation testing (labor for set-up, collection, and sample analysis)	2	ea	$ 1,530	$ 3,059	c
5	Single home family installation	2	ea	$ 1,912	$ 3,824	c
6	Sealing and Cleanup	2	ea	$ 255	$ 510	c
	SSD System Subtotal				**$ 35,452**	
SSD Treatment, Project Management, and Oversight Subtotal					**$ 65,452**	
7	Project Management and Oversight of SSD System	15%			$ 9,818	
8	Contingency	20%			$ 13,090	
CAPITAL COST SUBTOTAL					**$ 88,360**	

LAND USE CONTROL COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Institutional Controls						
1	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000	b
2	Deed restriction on land and groundwater use	8	hr	$ 250	$ 2,000	b
	Institutional Controls Subtotal				**$ 12,000**	
3	Project Management Land Use Control	15%			$ 1,800	
LAND USE CONTROL COST SUBTOTAL					**$ 13,800**	

ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS						
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**	**Reference**
Annual Inspections						
1	Semi-annual air sampling (sub-slab soil gas, indoor air, outdoor ambient air)	32	hr	$ 80	$ 2,560	b
2	Semi-annual air sample analysis: TO-15 Analysis, includes 6L Summa Cannisters	12	ea	$ 356.25	$ 4,275	b
3	Electrical costs for the RP145 sub-slab depressuization fan (72 watts). Assumes one fan per	2	ea	$ 94	$ 188	b
4	Routine SSD system maintenance	2	ea	$ 102	$ 204	c
5	Annual SSD treatment system assessment	6	hr	$ 204	$ 1,224	c
6	Annual assessment and monitoring report	1	ls	$ 5,000	$ 5,000	c
	Annual Assessment Subtotal				**$ 13,451**	
7	Project Management O&M	15%			$ 2,018	
8	Contingency	20%			$ 2,690	
ANNUAL O&M COST SUBTOTAL					**$ 18,159**	

ALTERNATIVE VI-4 SSD SYSTEM COST SUMMARY		
Description	**Subtotal**	
CAPITAL	$ 88,000	
LAND USE CONTROL	$ 14,000	
ANNUAL O&M (30-Year Present Value Analysis Costs--see Table B-12A)	$ 279,000	
TOTAL (Rounded)	**$ 381,000**	

Notes:

a 2016. https://www.trcsolutions.com/writable/images/TRC-white-paper-Vapor-Intrusion-FINAL-March-2016.pdf
b Professional judgement
c 2017. Tetra Tech, Inc. Final Focused Feasibility Study for East Troy Contaminated Aquifer Site, Troy, Miami County, Ohio. August 31.

ea Each
hr Hour
L Liter
ls Lump sum
O&P Overhead and profit
VI Vapor Intrusion

TABLE B-12A
ALTERNATIVE VI-4: SUB-SLAB DEPRESSURIZATION SYSTEM, INSTITUTIONAL CONTROLS
PRESENT VALUE ANALYSIS
Operable Unit 1 Feasibility Study
New Carlisle Landfill, New Carlisle, Ohio

Annual Discount Rate [1]

5-Year 7.00%

Present Value Analysis						
	Annual Discount Factor [2]	**Operation and Maintenance Costs**				
Year	**5-Year**	**Description**	**Future Cost [3]**	**Description**	**Future Cost [3]**	**Present Value (2018)**
0	1.000					$ -
1	0.935	SVE O&M	$ 18,159			$ 16,971
2	0.873	SVE O&M	$ 18,159			$ 15,860
3	0.816	SVE O&M	$ 18,159			$ 14,823
4	0.763	SVE O&M	$ 18,159			$ 13,853
5	0.713	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 30,771
6	0.666	SVE O&M	$ 18,159			$ 12,100
7	0.623	SVE O&M	$ 18,159			$ 11,308
8	0.582	SVE O&M	$ 18,159			$ 10,568
9	0.544	SVE O&M	$ 18,159			$ 9,877
10	0.508	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 21,940
11	0.475	SVE O&M	$ 18,159			$ 8,627
12	0.444	SVE O&M	$ 18,159			$ 8,063
13	0.415	SVE O&M	$ 18,159			$ 7,535
14	0.388	SVE O&M	$ 18,159			$ 7,042
15	0.362	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 15,643
16	0.339	SVE O&M	$ 18,159			$ 6,151
17	0.317	SVE O&M	$ 18,159			$ 5,749
18	0.296	SVE O&M	$ 18,159			$ 5,372
19	0.277	SVE O&M	$ 18,159			$ 5,021
20	0.258	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 11,153
21	0.242	SVE O&M	$ 18,159			$ 4,386
22	0.226	SVE O&M	$ 18,159			$ 4,099
23	0.211	SVE O&M	$ 18,159			$ 3,830
24	0.197	SVE O&M	$ 18,159			$ 3,580
25	0.184	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 7,952
26	0.172	SVE O&M	$ 18,159			$ 3,127
27	0.161	SVE O&M	$ 18,159			$ 2,922
28	0.150	SVE O&M	$ 18,159			$ 2,731
29	0.141	SVE O&M	$ 18,159			$ 2,552
30	0.131	SVE O&M	$ 18,159	5-Year Review	$ 25,000	$ 5,670

Total Present Value of Periodic Cost **$ 279,275**

Notes:

1 Annual discount rate = 7% (EPA 540-R-00-002)
2 Annual discount factor = $1/(1+i)^t$, where i = discount rate (includes inflation and interest) and t = year
3 Current dollar cost of future event

EPA U.S. Environmental Protection Agency
O&M Operation and maintenance
SVE Soil vapor extraction

APPENDIX B – COST ESTIMATE

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LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

§	Section
bgs	Below ground surface
COC	Contaminants of concern
DHC	Dehalococcoides
EPA	U.S. Environmental Protection Agency
ERD	Enhanced reductive dichlorination
FS	Feasibility study
HDPE	High-density polyethylene
IC	Institutional control
ISCO	In situ chemical oxidation
ISCR	In situ chemical reduction
LUC	Land use controls
MCL	Maximum contaminant limit
mil	Millimeter
NCP	The National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National pollutant discharge elimination system
O&M	Operation and maintenance
OU	Operable unit
PRB	Permeable reactive barrier
RI	Remedial investigation
ROI	Radius of influence
SSD	Sub-slab depressurization
TOC	Total organic carbon
VOC	Volatile organic compound
ZVI	Zero-valent iron

APPENDIX B – COST ESTIMATE

B.1 INTRODUCTION

This appendix describes each feasibility study (FS) remedial alternative and the associated assumptions used to develop the cost estimate for the FS report.

This appendix is organized as follows:

- Section B.2 describes the purpose of the estimates.
- Section B.3 presents the types of cost-estimating methods used.
- Section B.4 summarizes the methodology for estimating costs.
- Section B.5 describes the components of each alternative's cost estimate.
- Section B.6 provides assumptions used for each individual cost estimate.
- Section B.7 lists the reference used in preparing the cost estimates.

Cost estimate tables are included at the end of this appendix following the reference section. Analysis and comparisons of the cost estimates are included in the FS report in Sections 5.0 through 7.0.

B.2 PURPOSE OF ESTIMATES

Cost estimates are developed as part of a feasibility study, primarily to compare remedial alternatives during the remedy selection process, and not to establish project budgets or to negotiate Superfund enforcement settlements. The cost estimate typically is carried over from the feasibility study to the proposed plan for public comment during remedy selection. The cost estimate in the Record of Decision will reflect any changes to the remedial alternative that occur during the remedy selection process as a result of new information or public comment (U.S. Environmental Protection Agency [EPA] 2000).

Cost estimates developed during the detailed analysis phase are used to compare alternatives and to support remedy selection. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) includes the following language in its description of the cost criteria for the detailed analysis and remedy selection.

> "The types of costs that shall be assessed include the following: (1) Capital costs, including both direct and indirect costs; (2) Annual operations and maintenance costs; and (3) Net present value of capital and O&M [operations and maintenance] costs (Title 40 *Code of Federal Regulations* Section [§] 300.430 [e][9][iii][G])." (EPA 2000).

Capital costs were identified for construction, equipment, land, buildings, engineering services, and project administration. Operation and Maintenance (O&M) costs were identified for labor, spare parts, materials, and administration. The present value of each alternative is calculated using a discount rate of 7 percent, which is listed as the "real" interest rate, with an implementation time of up to 30 years (EPA 2000). Costs are then compared on a common present-value basis in terms of 2018 dollars. Costs presented in this FS report are rounded to the nearest $1,000. The level of detail used to develop these estimates is considered appropriate for choosing among alternatives, but the estimates are not intended for use in detailed budgetary planning. Cost estimates at the FS Phase have an expected accuracy range of -30 to +50 percent for the detailed analysis of alternatives (EPA 1988).

B.3 TYPES OF COST ESTIMATING METHODS

The cost estimates presented in this appendix were developed using both detailed and parametric approaches; both are accepted by EPA, as described below.

The detailed approach estimates cost on an item-by-item basis. Detailed methods typically rely on compiled sources of unit cost data for each item, taken from either a built-in database (for example, if part of a software package) or from other sources (for example, cost estimating references). This method, also known as “bottom up” estimating, is used when design information is available.

The parametric approach relies on relationships between cost and design parameters. These relationships are usually statistically or model-based. Statistically based approaches rely on scaled-up or scaled-down versions of projects where historical cost data are available. Model-based approaches use a generic design linked to a cost database and adjusted for site-specific information. This method, also known as “top down” estimating, is used when design information is not available (EPA 2000).

The unit costs and quantities for the FS cost estimates were developed using a combination of RS Means, CostWorks (RS Means 2017), vendor quotes, cost estimates from similar projects, and professional judgement. Specific line item references are provided in the Appendix B alternative-specific cost estimate tables. The cost estimates assumed design information as described in the assumption sections.

B.4 METHODOLOGY

Cost estimates for this FS report were prepared in accordance with “A Guide to Developing and Documenting Cost Estimates during the Feasibility Study” (EPA 2000). Contractor’s budgetary estimates and SulTRAC’s recent experience on similar remediation projects were the primary sources of cost data. Costs were evaluated and then adjusted as necessary to account for inflation and other modifications to remedial alternatives. Excel spreadsheets were used to tabulate costs and calculate net present values in 2018 dollars.

B.5 COMPONENTS OF COST ESTIMATE

Cost estimates for the remedial alternatives include capital costs, annual O&M or periodic costs, present value costs, and contingency allowances. Each of these factors is discussed in further detail in the following sections.

B.5.1 Capital Costs

Capital costs include direct and indirect costs. Costs incurred for equipment, material, labor, construction, development, and implementation of remedial technologies are included as direct costs. Indirect costs include health and safety, site supervision, engineering, overhead and profit, and startup. Indirect costs are included in the estimate as either a separate line item or as a percentage of the direct capital cost.

B.5.2 Annual O&M or Periodic Costs

Annual O&M costs are incurred after construction. These costs are necessary to ensure the effectiveness of a remedial alternative. For active components of remediation systems, annual O&M costs typically include power, operating labor, consumable materials, purchased services (for example, laboratory analysis), equipment replacement, maintenance, sampling, permit fees, annual reports, and site reviews. For remedial approaches involving land use controls (LUC), O&M costs include inspections and the preparation of reports documenting inspections to verify that the LUC components, including engineering controls and institutional controls (IC), are functioning as intended.

Periodic costs occur once every few years or once during the entire period of O&M. Examples include 5-year reviews, equipment replacement, site closeout, and remedy failure and replacement.

B.5.3 Present Value Analysis

Remedial action projects typically involve construction costs expended at the beginning of a project (capital costs) and costs in subsequent years (O&M or periodic costs). Present value analysis is a method to evaluate expenditures that occur over various periods. This standard methodology allows for cost comparisons of different remedial alternatives on the basis of a single cost figure for each alternative. This single value, referred to as the present value, is the amount that must be set aside at the initial point in time (the base year) to assure that funds would be available in the future as they are needed. Present value analysis uses a discount rate and period of analysis to calculate the present value of each expenditure. Both factors are discussed in the subsections below.

B.5.3.1 Discount Rate

A discount rate is similar to an interest rate and is used to account for the time value of money. A dollar is worth more today than in the future because the dollar would earn interest if invested in an alternative use today. If the capital were not used in a specific use, it would have a productivity value in alternate uses. The choice of a discount rate is important because the selected rate directly alters the present value of a cost estimate, which is then used in selecting a remedy.

EPA policy on the use of discount rates for remedial investigation (RI) and FS cost analysis is set forth in the preamble to the NCP (55 Federal Register § 8722). As recommended in EPA's "A Guide to Developing and Documenting Cost Estimates during Feasibility Studies" (EPA 2000), a real discount rate of 7 percent should be used in developing present value cost estimates for remedial alternatives in the FS.

B.5.3.2 Present Value

The present value of a series of equal annual future payments, such as for annual O&M, is calculated using the equation presented as follows:

$$PV = \sum_{t=1}^{N} \frac{x_t}{(1+i)t}$$

where

PV	=	Present value
x_t	=	Payment in year t (t = 0 for present or base year)
i	=	Discount factor
t	=	Number of years after construction that expenditures start
N	=	Number of years that the stream of equal annual future payments will run

The present value of a single periodic future payment is calculated using the following equation:

$$PV = \frac{x_t}{(1+i)^t}$$

where

PV	=	Present value
x_t	=	Payment in year t (t = 0 for present or base year)
i	=	Discount factor
t	=	Number of years after construction that expenditures occur

The present value of a remedial alternative represents the sum of the present values of all future payments associated with the project. The present value for this cost estimate was calculated using 2018 dollars.

B.5.4 Contingency Allowances

Contingency is factored into a cost estimate to cover unknown costs, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate based on the data at hand when the estimate is prepared. The two main types of contingencies are scope and bid. Scope contingency covers unknown costs that would result from changes in scope that may occur during the design. Bid contingency covers unknown costs associated with constructing or implementing a project scope. Exhibit 5-6 of EPA's "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study" lists some expected ranges in contingency fees for certain remedial technologies (EPA 2000). Contingency is calculated as a percentage (20 percent) of total capital costs and O&M.

B.6 INDIVIDUAL COST ESTIMATE ASSUMPTIONS

This section identifies the assumptions and parameters used in developing cost estimates for remediation of NCL Operable Unit (OU) 1. Tables B-1, B-2, and B-3 present the cost summary for landfill waste and landfill gas, landfill groundwater, and vapor intrusion remedial alternatives, respectively. Tables B-4 through B-12 summarize the costs associated with Alternatives LF-2, LF-3, GW-2A through GW-3, and VI-2 through VI-4.

B.6.1 Cost Estimate Assumptions for Landfill Waste and Landfill Gas Alternatives

Assumptions pertaining to cost estimates for each of the landfill waste and landfill gas alternatives are presented below.

B.6.1.1 Landfill Alternative LF-2: Multi-layer Cap, Passive Gas Venting, and Land Use Controls

This section presents the related assumptions of constructing a multi-layer cap over the landfill. Final landfill construction details would be determined during the remedial design; however, the cap would be constructed to meet Ohio landfill closure requirements specified in OAC- 3745-27-08 and 3745-27-11. Preparation of engineering design documents and access agreement costs are included.

Alternative LF-2 assumes the following:

- Fencing would be installed surrounding the approximate extent of waste encountered in the RI.
- The landfill is assumed to have an area of 18 acres.
- The landfill would be cleared and grubbed to remove existing vegetation before construction activities.
- The landfill would be graded to ensure proper slopes, provide a uniform soil foundation layer, and promote drainage.
- The landfill cap would consist of the following layers, starting at the bottom:
    - Engineered soil sub-base
    - Geosynthetic clay liner
    - 60-millimeter (mil) thick high-density polyethylene (HDPE) geomembrane
    - Geocomposite layer, made up of two bonded overlapping 250-mil thick HDPE strands
    - 90-mil thick nonwoven polypropylene geotextile fabric
    - 18 inches of imported backfill
    - 6 inches of topsoil
- Pond 1 would be filled in with existing on-site soil, and waste may be consolidated from the landfill edges to the interior to reduce the overall footprint of the cap.
- A wetland credit ratio of 1:1.5 would be applied to 3.5 acres to account for Pond 1 and Pond 2, resulting in 5.25 acres.
- Twenty-one (21) passive landfill gas vents would be installed, located approximately every 200 feet north-south and east-west.
- Ten (10) landfill gas probes would be installed along the perimeter of the landfill.
- Operation and maintenance assumes annual visual inspections of cap integrity (inspection for significant settlement, water ponding, erosion, and deep burrowing animals) to ensure the effectiveness of the cap and preparation of an annual inspection report.
- Landfill repairs and mowing, to prevent the growth of deep-rooted plants, would be conducted monthly from May to September.
- Landfill gas monitoring would consist of quarterly monitoring of four centrally located landfill gas vents and all landfill gas perimeter probes during the first year after capping and semi-annual monitoring of all landfill gas perimeter probes for the remaining 29 years.
- The private drinking water wells located on Properties 1, 2, and 3 would be abandoned and the properties would be connected to the city water supply.

  - The city water supply water main is assumed to be located along the west side of North Dayton-Lakeview Road. Mobilization and site preparation would include heavy equipment and laborers to break pavement, and install service lines, valves, and fittings.
  - Pavement at Property 1 would need to be broken and repaired to install the service line.
  - A 2-inch K copper service line is assumed to connect the properties to the water main. Type K copper tubing is commonly used for underground burial, such as under sidewalks and streets, with a suitable corrosion protection coating or continuous polyethylene sleeve.
- Groundwater monitoring well installation and sampling would be performed under the groundwater alternatives and are described in the groundwater alternative assumptions.

B.6.1.2 Landfill Alternative LF-3: Enhance Existing Cover, Passive Gas Venting, and Land Use Controls

This section presents cost assumptions related to enhancing the current landfill cover by grading and compacting it to meet Ohio landfill closure requirements specified in OAC- 3745-27-08 and 3745-27-11. Final landfill construction details would be determined during the remedial design.

Alternative LF-3 assumes the following:

- Fencing would be installed surrounding the approximate extent of waste encountered in the RI.
- The landfill is assumed to have an area of 18 acres.
- The landfill would be cleared and grubbed to remove existing vegetation before construction activities.
- The landfill would be graded to ensure proper slopes, provide a uniform soil foundation layer, and promote drainage.
- The existing soil cover over the landfill is largely suitable and minimal additional low permeability soil would be imported before the vegetative layer is installed. This assumption will be assessed in predesign studies.
- Five (5) acres of the landfill would require an additional 12 inches of low permeability soil to bring the cap up to the required 2.5 feet of compacted soil, totaling 8,067 cubic yards of additional low permeability soil needed.
- A geocomposite drainage layer may be installed above the compacted subbase layer to transmit infiltrated water horizontally off the cap.
- A vegetative soil layer of 30 inches of soil, including 6 inches of topsoil, would cover the regraded and compacted soil cover. The layer would be seeded to prevent erosion and induce evapotranspiration.
- Pond 1 would be backfilled with imported soil. Pond 1 is assumed to be 10 feet deep.
- A wetland credit ratio of 1:1.5 would be applied to Ponds 1 and 2 (approximately 3.5 acres total), resulting in 5.25 acres.
- Twenty-one (21) passive landfill gas vents would be installed, located approximately every 200 feet (approximately 1 per acre) north-south and east-west.
- Ten (10) landfill gas probes would be installed along the perimeter of the landfill.

- Operation and maintenance assumes annual visual inspections of cap integrity (inspection for significant settlement, water ponding, erosion, and deep burrowing animals) to ensure the effectiveness of the cap and preparation of an annual inspection report.
- Landfill repairs and mowing, to prevent the growth of deep-rooted plants, would be conducted monthly from May to September.
- Landfill gas monitoring would consist of quarterly monitoring of four centrally located landfill gas vents and all landfill gas perimeter probes during the first year after capping and semi-annual monitoring of all landfill gas perimeter probes for the remaining 29 years.
- The private drinking water wells located on Properties 1, 2, and 3 would be abandoned and the properties would be connected to the city water supply.
    - The city water supply water main is assumed to be located along the west side of North Dayton-Lakeview Road. Mobilization and site preparation would include heavy equipment and laborers to break pavement, and install service lines, valves, and fittings.
    - Pavement at Property 1 would need to be broken and repaired to install the service line.
    - A 2-inch K copper service line is assumed to connect the properties to the water main. Type K copper tubing is commonly used for underground burial, such as under sidewalks and streets, with a suitable corrosion protection coating or continuous polyethylene sleeve.
- Groundwater monitoring well installation and sampling would be performed under the groundwater alternatives and are described in the groundwater alternative assumptions.

B.6.2 Cost Estimate Assumptions for Landfill Groundwater Alternatives

Assumptions pertaining to cost estimates for each landfill groundwater alternative are presented below.

B.6.2.1 Groundwater Alternative GW-2A: Enhanced Reductive Dechlorination Permeable Reactive Barrier and Monitoring

This alternative would create an enhanced reductive dechlorination (ERD) in situ permeable reactive barrier (PRB) to contain the contaminant plume through targeted bioremediation of groundwater at the site boundary. The contaminated groundwater would flow via natural hydraulic gradient through the treatment zone, and remediated water would exit the treatment zone at the OU1 boundary. The in situ treatment barrier would be maintained for as long as concentrations of contaminants of concern (COC) emanating from the landfill remain above maximum contaminant limits (MCL).

Alternative GW-2A assumes the following:

- The groundwater plume would be contained and treated via an ERD PRB.
- A pilot test would include a small scale ERD injection at the site to determine the radius of influence of the injections and the effectiveness of the product, and to identify any changes necessary for a successful implementation. The pilot study would include a baseline groundwater analysis conducted prior to remediation activities. Groundwater samples would be analyzed for volatile organic compounds (VOC), dissolved gases, sulfate, alkalinity, total organic carbon (TOC), dissolved arsenic, and ferrous iron. Field measurements would include oxidation-reduction potential, pH, specific conductance, dissolved oxygen, temperature, and turbidity.
- ERD products would be injected in a PRB along the south side of the landfill.

- The PRB would be approximately 400 feet long and contain two rows of staggered injection points. The injection points are assumed to have an estimated radius of influence (ROI) of 8 feet and spacing of 15 feet between injection points, resulting in 55 injection points.
- ERD amendments would be injected via direct push throughout the entire targeted 45-foot vertical interval, varying from between 12 and 55 feet below ground surface (bgs) to between 45 and 88 feet bgs.
- ERD amendments include:
    - 60,000 pounds of lecithin-based substrate
    - 6,000 pounds of pH buffering solution
    - 200 liters of dehalococcoides (DHC) inoculum
- The effective period of ERD is 2 to 3 years. As a contingency, follow-up reinjection events would occur every 3 years after the initial injection. Each injection event would take approximately 34 days to complete the application.
- The Alternative GW-2A groundwater monitoring network would be designed to monitor performance rather than compliance and consist of approximately 20 new monitoring wells: 10 shallow and 10 deep.
    - Periodic performance monitoring would be conducted post-injection. Groundwater samples would be analyzed for volatile organic compounds (VOC), dissolved gases, sulfate, alkalinity, total organic carbon (TOC), dissolved arsenic, and ferrous iron. Field measurements would include oxidation-reduction potential, pH, specific conductance, dissolved oxygen, temperature, and turbidity.
    - For cost estimating purposes, periodic performance monitoring would be conducted as follows: 2 years of quarterly groundwater monitoring are assumed, followed by 5 years of semi-annual groundwater monitoring, followed by 23 years of annual groundwater monitoring. Actual groundwater concentrations would dictate the duration of monitoring required.
    - The groundwater sampling event would last 1 week and would require 50 hours each from a Senior Project Scientist and Field Technician.
    - Investigation-derived waste associated with groundwater sampling would require disposal.

B.6.2.2 Groundwater Alternative GW-2B: In Situ Chemical Oxidation Permeable Reactive Barrier and Monitoring

This section presents the related assumptions in creating an in situ treatment barrier to contain the contaminant plume through targeted chemical oxidation in the groundwater at the site boundary. The in situ barrier would be maintained for as long as concentrations of VOCs emanating from the landfill remain above MCLs.

Alternative GW-2B assumes the following:

- The groundwater plume would be contained and treated via in situ chemical oxidation (ISCO) PRB.
- A pilot test would include a small-scale ISCO injection at the site to determine the radius of influence of the injections and the effectiveness of the product, and to identify any changes necessary for a successful implementation. The pilot study would include a baseline groundwater

analysis conducted prior to remediation activities. Groundwater samples would be analyzed for VOCs, dissolved gases, sulfate, alkalinity, TOC, dissolved arsenic, and ferrous iron. Field measurements would include oxidation-reduction potential, pH, specific conductance, dissolved oxygen, temperature, and turbidity.

- A bench-scale test would be performed to further analyze the soil and groundwater for the effectiveness of ISCO.
- ISCO reagents would be injected in a PRB located along the south side of the landfill.
- The PRB would be 400 feet long and contain two rows of staggered injection points. The injection points are assumed to have an estimated ROI of 5.5 feet and spacing of 10 feet between injection points, resulting in 81 injection points.
- ISCO would be injected via direct push throughout the entire targeted 45-foot vertical interval, varying from between 12 and 55 feet bgs to between 45 and 88 feet bgs.
- A 10 percent PersulfOx solution would be used. PersulfOx is a sodium-persulfate-based product that employs a built-in catalyst to enhance the oxidative destruction of both hydrocarbons and chlorinated contaminants. An estimated 150,000 pounds of sodium persulfate reagent is assumed.
- The longevity of ISCO is 2 to 3 years. As a contingency, re-injection events would occur every 2 years after initial injection. Each event would take 55 days to complete the application.
- The Alternative GW-2B groundwater monitoring network would be the same as described for Alternative GW-2A.

B.6.2.3 Groundwater Alternative GW-2C: In Situ Chemical Reduction Permeable Reactive Barrier and Monitoring

This alternative would create an in situ chemical reduction (ISCR) PRB to contain the contaminant plume through targeted bioremediation of groundwater at the site boundary. The contaminated groundwater would flow via natural hydraulic gradient through the treatment zone, and remediated water would exit the treatment zone at the OU1 boundary. The in situ treatment barrier would be maintained for as long as concentrations of COCs emanating from the landfill remain above MCLs.

Alternative GW-2C assumes the following:

- The groundwater plume would be contained and treated via an ISCR PRB.
- A pilot test would be performed to determine the radius of influence, necessary injection rates, and the effectiveness of ISCR. The pilot study would include a baseline groundwater analysis conducted prior to remediation activities. Groundwater samples would be analyzed for VOCs, dissolved gases, sulfate, alkalinity, TOC, dissolved arsenic, and ferrous iron. Field measurements would include oxidation-reduction potential, pH, specific conductance, dissolved oxygen, temperature, and turbidity.
- ISCR amendments would be injected in a PRB located along the south side of the landfill.
- The PRB would be 400 feet long and contain two rows of staggered injection points. The injection points are assumed to have an estimated ROI of 8 feet and spacing of 15 feet between injection points, resulting in 55 injection points.
- ISCR chemicals would be injected via direct-push injections throughout the entire 45-foot vertical interval, varying from between 12 and 55 feet bgs to between 45 and 88 feet bgs.

- ISCR chemicals would include a zero-valent iron (ZVI) substrate and a DHC inoculum. Each injection event is assumed to require the following:
    - 260,000 pounds of ZVI substrate that reacts with target contaminants and stimulates anaerobic biological degradation.
    - 200 liters of DHC inoculum.
- The longevity of ISCR products is approximately 5 to 7 years. As a contingency, follow-up injections would occur every 5 years after the initial injection. Each injection event would take 64 days to complete.
- The Alternative GW-2C groundwater monitoring network would be the same as described under Alternative GW-2A.

B.6.2.4 Groundwater Alternative GW-3: Groundwater Extraction, Treatment, and Discharge

This alternative would install a hydraulic capture zone barrier using a groundwater extraction and ex situ treatment system. Extraction wells would intercept contaminated groundwater and prevent its migration off site. The system would operate for as long as concentrations of COCs emanating from the landfill remain above MCLs.

Alternative GW-3 assumes the following:

- A pilot study would include groundwater pump tests to improve understanding of aquifer hydraulic conductivity and provide more accurate groundwater parameter inputs for capture zone groundwater modeling.
- Five extraction wells would be installed along the southern OU 1 border where the border intersects the groundwater contaminant plume. Extraction wells would extend 60 feet bgs.
- Extracted water would be treated with an air stripper to remove VOCs, and no off-gas treatment would be required.
- The air stripper system would include a 300-gallons per minute tray type air stripper, one 1,000-gallon chemical holding tank for anti-scalant treatment chemicals, and one chemical metering pump. Pre-design groundwater sampling and analysis would be conducted. The Langelier index would be calculated to determine the corrosivity or scale-forming potential of the extracted groundwater and determine the need for anti-scalant chemical treatment.
- A 20-foot by 30-foot pre-engineered metal building located in the southwest corner of OU1, west of the extraction wells, would house all process and control equipment.
- Treated water would be discharged via a 6-inch diameter HDPE pipeline to an outfall on Honey Creek, located approximately 1,800 feet north of the site and approximately 2,500 feet north of the pump house. The discharge would meet the substantive requirements of the National pollutant discharge elimination system (NPDES) permit.
- Ten (10) shallow monitoring wells (60 feet bgs) and 10 deep monitoring wells (100 feet bgs) would be installed along Transect B, south of the hydraulic capture zone.
- The 20 monitoring wells and 5 extraction wells would be sampled regularly with the following schedule: Quarterly groundwater monitoring would be performed for 2 years after the first injection event. Semi-annual groundwater monitoring would be performed for the following 5 years and annual groundwater monitoring would be performed for the following 23 years.

- Groundwater monitoring would include sample analysis for field parameters, VOCs, TOC, cations, anions, alkalinity, dissolved gases, and dissolved metals.
- Each sampling event would last 1 week and would require 50 hours each from a Senior Project Scientist and Field Technician.
- System operation would be monitored weekly.
- Air stripper trays would be cleaned by pressure washing every 6 months.
- System influent and treated effluent would be monitored for pH and sampled for VOCs monthly to meet substantive requirements of the NPDES permit. It is assumed that background metals concentrations present in the groundwater would be below NPDES effluent limits and would not require regular monitoring.

B.6.3 Cost Estimate Assumptions for Vapor Intrusion Alternatives

Assumptions pertaining to cost estimates for each of the vapor intrusion alternatives are presented below.

B.6.3.1 Soil Vapor Alternative VI-2: Institutional Controls and Monitoring

This section presents the assumptions related to implementing ICs and monitoring at Properties 1, 2, and 3. Property 1 is a commercial building; thus, ICs would prohibit future residential use and monitoring would not be necessary at Property 1. Properties 2 and 3 are currently residential buildings; therefore, monitoring would be conducted at each building to assess the need for further action.

Alternative VI-2 assumes the following:

- ICs would be implemented to prohibit future residential use of Property 1.
- Properties 2 and 3 would have a sub-slab soil gas monitoring probe installed in each building.
- Semi-annual sampling at each building on Properties 2 and 3 would consist of: one sample collected from the sub-slab soil gas monitoring probe, one sample collected from indoor air, and one ambient air sample collected outdoors.
- For semi-annual sampling, three 6-liter SUMMA canisters would be used to collect samples from each residential building on Properties 2 and 3; samples would be analyzed for toxic organics using EPA Method TO-15.
- A 30-year monitoring period is assumed.

B.6.3.2 Soil Vapor Alternative VI-3: Foundation Sealing and Institutional Controls

This section presents the assumptions related to foundation sealing vapor intrusion pathways at Properties 2 and 3 and implementing ICs at Property 1.

Alternative VI-3 assumes the following:

- ICs would be implemented to prohibit future residential use of Property 1.
- Properties 2 and 3 would have a sub-slab soil gas monitoring probe installed in each building.
- At Properties 2 and 3, main vapor entry routes would be identified and sealed with a concrete filler or hydraulic cement.
- Epoxy paint or Retro-Coat, would be used on large surface areas.

- The two residential properties are assumed to be 3,000 and 2,400 square feet, respectively.
- Pre-installation and post-installation sampling at each building on Properties 2 and 3 would consist of: one sample collected from the sub-slab soil gas monitoring probe, one sample collected from indoor air, and one ambient air sample collected outdoors.
- Semi-annual sampling at each building on Properties 2 and 3 would consist of: one sample collected from the sub-slab soil gas monitoring probe, one sample collected from indoor air, and one ambient air sample collected outdoors.
- For all sampling, three 6-liter SUMMA canisters would be used to collect samples from each residential building on Properties 2 and 3; samples would be analyzed for toxic organics using EPA Method TO-15.
- A 30-year monitoring period is assumed.

B.6.3.3 Soil Vapor Alternative VI-4: Sub-Slab Depressurization System and Institutional Controls

This section presents the assumptions related to the sub-slab depressurization (SSD) system and ICs alternative.

Alternative VI-4 assumes the following:

- ICs would be implemented to prohibit future residential use of Property 1.
- SSD systems would be installed at Properties 2 and 3.
- Pre-installation test and foundation inspections would be performed at Properties 2 and 3 prior to construction to design and size the SSD system.
- In the two residential basements, one suction point would be provided for every 1,200 square feet of area to be depressurized is assumed. The two residential properties are assumed to be 3,000 and 2,400 square feet, respectively.
- Pre- and post- sampling for VOCs would be conducted at each property for sub-slab and indoor air. Testing would occur before and after SSD system installation to demonstrate reduction in vapor intrusion.
- Maintenance cost is approximately $500 every 5 years.
- Each SSD blower has an approximate annual electrical cost of $75 (RadonAway Model RP145 and $0.12/kWh assumed)
- Annual SSD system inspections would be performed on each system by a consultant.
- Semi-annual sampling would consist of: one sample collected from each building from a sampling port in the SSD system, one sample collected from indoor air, and one ambient air sample collected outdoors.
- For semi-annual sampling, three 6-liter SUMMA canisters would be used to collect samples from each residential building on Properties 2 and 3. Samples would be analyzed for toxic organics using EPA Method TO-15.
- A 30-year monitoring period is assumed.

B.7 REFERENCE

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