January 2022

Project No.: 0609-356-04-01

ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES

CITY OF ELKHART

Former Walter Piano Site

700 W. Beardsley Avenue

Elkhart, Indiana

Brownfield Site #4120904

Indiana Brownfields Program/IFA RLF CA# BF-00E48101-F

City of Elkhart

PREPARED BY

Weaver Consultants Group

City of Elkhart

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1 INTRODUCTION

On behalf of the City of Elkhart (City), **Weaver Consultants Group North Central, LLC** (Weaver Consultants) has prepared this *Analysis of Brownfields Cleanup Alternatives* (ABCA) report, in coordination with the Indiana Brownfields Program (IBP), for the property located at 700 West Beardsley Avenue in Elkhart, Indiana, as shown on **Figure 1 – Property Location Map** (the Site). The ABCA report, required by the United States Environmental Protection Agency (USEPA), was prepared in support of ongoing IBP activities to identify and evaluate cleanup alternatives to mitigate potential risks to human health and the environment from identified subsurface environmental impacts at the Site.

Previous assessment activities were completed at the Site and funded under the Indiana Brownfields Program (IBP) and under a USEPA Hazardous Substances and Petroleum Brownfields Coalition Assessment Grant (RP-00E14606-0). Subsequent assessment and monitoring activities were funded by the City of Elkhart.

The proposed cleanup activities described herein will be funded under the IBP/ Indiana Finance Authority (IFA) Revolving Loan Fund (RLF#00E48101-F). The RLF Subgrant Agreement between the City of Elkhart and IFA, who manages the RLF, was executed November 3, 2021.

The remediation area, addressed under this ABCA report, is contained within the approximate 3.7-acre Site (refer to **Figure 2 – Property Layout Map**). The purpose of this proposed cleanup is to meet environmental regulatory requirements for the Site to support redevelopment for commercial property uses.

This ABCA report has been prepared in support of the Site's Community Involvement Plan, submitted to the IBP for review and approval. As part of the Community Involvement Plan, the existing Administrative Records (AR) file and the Information Repository (IR) for the Site will be updated to be made available for public review and comment. The AR/IR will be available at the City of Elkhart's offices and through a website hosted by the City of Elkhart. Reasonable public notice will be provided that the required documents are being prepared and will be available for public review and comment. The City of Elkhart will also conduct public meetings to gather community input regarding the cleanup process.

The City of Elkhart and its environmental consultant, Weaver Consultants, shall consider all comments received and provide responses to those comments at the end of the public comment period. Comments that may change or supplement the Remediation Work Plan will be provided to the IBP Project Manager for review. All public comments will be summarized and documented and included in the AR, as well as any responses to public comments.

After the designated, required public review/comment period and issuance of the Decision Memorandum (summarizing the selected cleanup alternatives and serving as a notice to proceed with federally funded cleanup actions), the City of Elkhart will obtain Request for Proposals/Qualifications and Bids from multiple contractors, including local MBE/WBE/DBE qualified companies. Pending community input and IBP approval, Weaver Consultants and the City of Elkhart tentatively plan on conducting a remedial pilot program from late spring to fall 2022, followed by the implementation of the remedial program in late fall 2022.

2 BACKGROUND

2.1 Property Description

The Site is located in northwest Elkhart and is bordered to the south by Beardsley Avenue and residential properties, to the north by a Conrail/CSX railroad line followed by commercial properties, to the east by Michigan Street and commercial/industrial properties, and to the west by commercial/industrial properties (refer to **Figure 1** and **Figure 2**). The Site is also referred to as the Former Walter Piano Site. The Site consists of one parcel with an approximate area of 3.7 acres. As shown on **Figure 2**, no structures are present on the Site.

A review of the Elkhart, Indiana, 2016, 7.5-minute quadrangle topographic map published by the United States Geological Survey (USGS) suggests that the Site is at an elevation of approximately 750 feet above mean sea level (msl). The topography of the Site and surrounding area is generally flat.

2.2 Property History

The 3.7-acre Site was first occupied by the Elkhart Carriage and Harness Manufacturing Company in 1892. The use of the Site property prior to 1892 is unknown. After 30 years of occupancy, the Site was later used by many tenants for a wide variety of commercial and industrial purposes, including automobile manufacturing from about 1915 to the 1930s, and various manufacturing and warehousing operations until approximately 2004. Many of these tenants are likely to have stored or utilized a variety of petroleum products or hazardous substances.

The last principal occupant was the Walter Piano Company. According to Roberts Environmental Services, LLC , the on-Site buildings were still actively being leased to numerous businesses in 2004. The Site was vacated after 2004. Following a fire in 2012, the buildings were deemed unsafe to enter by the City of Elkhart and fell into disuse (Bruce Carter Associates or BCA, 2012). BCA reported two separate fires in August and October of 2012 that heavily damaged the vacant buildings, and the City of Elkhart razed the premises in early 2013.

The Site is currently owned by the City of Elkhart, which acquired the property through a tax sale on September 14, 2012. A Bona Fide Prospective Purchaser (BFPP) Comfort Letter was issued by the Indiana Department of Environmental Managements (IDEM)/through IBP to the

City on October 18, 2012. Demolition of the former fire-damaged building(s) was funded by the Indiana Office of Community and Rural Affairs (OCRA) Blight Clearance/Demolition Program. The demolition began in February 2013 and was completed in March 2013.

2.3 Proposed Redevelopment

The proposed future use of the Site includes commercial purposes. Specific redevelopment plans have not been determined. The City of Elkhart is interested in promoting redevelopment of the Site for commercial use.

3 SUMMARY OF PROPERTY CHARACTERIZATION

3.1 Prior Investigations

The overall environmental condition of the Site has been extensively assessed since 2004. Previous environmental assessments and investigations have included the following:

1. July 16, 2004 – Phase I Environmental Site Assessment; Roberts Environmental Services Project No. 004-10109-10.
2. August 31, 2012 – Phase I Environmental Site Assessment; Bruce Carter Associates Project No. 7920/12-270.
3. January 4, 2013 – Limited Phase II Environmental Site Assessment: Bruce Carter Associates Project No. 7920/12-302.
4. April 30, 2013 (rev. May 29, 2013, rev. June 11, 2013) – Sampling and Analysis Plan (SAP): 128(a) IFA Grant for Site Characterization of Former Walter Piano Site; Weaver Boos Consultants LLC (a/k/a Weaver Consultants Group) Project No. 2339-355-03.
5. September 19, 2013 – Site Investigation and Remediation Work Plan (SI/RWP): 128(a) IFA Grant for Site Characterization of Former Walter Piano Site; Weaver Boos Consultants LLC (a/k/a Weaver Consultants Group) Project No. 2339-355-03.
6. 2014 – Further Site Characterization/Remediation Work Plan Addendum (FSI/RWP Addendum); Weaver Boos Consultants LLC (a/k/a Weaver Consultants Group) Project No. 2339-355-03.

Listed below are the reports for the Site as described in Task 1 through Task 4 as listed in the Professional Service Agreement (PSA) between the City of Elkhart and Weaver Consultants Group dated July 16, 2015. The tasks were developed at the request of IBP via Indiana Brownfields Program Letter dated October 30, 2014 and follow-up electronic correspondences dated February 3 and 12, 2015;

7. November 23, 2015 – Further Site Characterization: Sampling and Analysis; Weaver Consultants Group, LLC Project No. 0609-356-03.
8. January 26, 2016 – Further Site Characterization: Water Well Survey and Vapor Sampling; Weaver Consultants Group, LLC Project No. 0609-356-03.

Listed below are the reports for the Site as described in Task 5 through Task 8 as listed in the PSA between the City of Elkhart and Weaver Consultants Group dated April 19, 2016. The tasks were developed at the request of the Program via telephone conversation on February 1, 2016 as well as with the follow-up electronic correspondence from the Program dated February 4, 2016, and Indiana State Revolving Fund (SRF) Loan Program dated February 5 and 9, 2016 were also considered;

9. September 20, 2016 – Environmental Review; Weaver Consultants Group, LLC Project No. 0609-356-03-01.
10. December 16, 2016 – Further Site Characterization: Vapor Intrusion Sampling; Weaver Consultants Group, LLC Project No. 0609-356-03-01.
11. March 12, 2018 – Further Site Characterization: Vapor Intrusion Sampling; Weaver Consultants Group, LLC Project No. 0609-356-03-02.

Listed below are the monitoring/progress reports for the Site as described in Task 9 through Task 12 as listed in the PSA between the City of Elkhart and Weaver Consultants Group dated August 1, 2017, in addition to the updated PSA dated May 15, 2018. The updated tasks were developed at the request of the Program via electronic correspondence dated March 28, 2017 and follow-up telephone conversations on March 29, 2017.

12. 2018-2019 – Quarterly Groundwater Monitoring/Reporting; Weaver Consultants Group, LLC Project No. 0609-356-03-02.
13. October 2, 2019 – Further Site Characterization; Weaver Consultants Group, LLC Project No. 0609-356-03-04.
14. 2019-2020 – Quarterly Groundwater Monitoring/Reporting; Weaver Consultants Group, LLC Project No. 0609-356-03-03.
15. August 10, 2020 – Further Site Investigation: Off-Site Delineation; Weaver Consultants Group, LLC Project No. 0609-356-03-03.
16. March 19, 2021 – Remediation Work Plan; Weaver Consultants Group, LLC Project No. 0609-356-03-04.

The above-listed assessments and investigations indicate that surface soil, subsurface soil, and groundwater are impacted by concentrations of volatile organic compounds (VOCs, trichloroethene and vinyl chloride), polycyclic aromatic hydrocarbons (PAHs, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene) and metals (lead, chromium, and arsenic). The primary concern is the trichloroethene (TCE) contamination in shallow unsaturated soils and groundwater and vapor intrusion measured in the surrounding occupied residential and commercial structures. **Figure 3** depicts the extent and concentration of TCE in groundwater near the Site.

Surface soil over most of the Site was found to be affected by elevated concentrations of PAHs, but concentrations above commercial/industrial direct screening levels (SLs) listed in the Indiana Department of Environmental Managements (IDEM) Remediation Closure Guide (RCG) appeared limited to an area near the north end of the Site. The extent of the PAH impact in surface soil was not well defined by the site investigation activities. Arsenic and lead also exceeded residential direct contact SLs in the surface soil at several locations, but none exceeded their commercial/industrial direct contact SLs and can be managed using an Environmental Restrictive Covenant (ERC).

Except for TCE, subsurface soil was found unaffected by COCs above residential or commercial/industrial SLs. Subsurface soil just above the water table identified TCE above the residential migration to groundwater (MTG) SL in an area corresponding with elevated TCE concentrations in the shallow groundwater. The deeper groundwater identified elevated TCE as well. Upgradient sampling results were found to be consistent with contributions of TCE from upgradient sources, yet the highest concentrations were detected along the downgradient boundaries of the Site, suggesting contributions from on-Site source(s). Elevated concentrations of TCE in two "sediment" samples collected from historic pits formerly located at the south-central portion of the Site by Heartland Environmental Associates, Inc. (Heartland) imply the presence of an on-Site historical source area. Vinyl chloride was detected in several monitoring wells installed along the downgradient southern boundary of the Site, modestly exceeding residential vapor intrusion or residential tap water SLs, and is inferred to result from the natural degradation of TCE.

A uniquely elevated concentration of total chromium was detected in a single temporary groundwater monitoring well (WBP-7) during the 2013 SI, possibly consistent with the presence of soluble hexavalent chromium or chromate released from historic plating or tanning operations reported to have occupied the Site in the 2004 Phase I Environmental Site

Assessment by Roberts Environmental Services, LLC. Total chromium was not detected above 10.0 ug/l in groundwater samples collected elsewhere during the 2013 SI.

Environmental conditions at the Site, current land use, and its future commercial/industrial redevelopment indicate the following existing or potential risks onsite and/or down gradient:

- Intrusion of primarily trichloroethene soil vapor emanating from shallow groundwater into occupied structures that may be built on the Site or down gradient (southeast) from the Site.
- Potential risk of exposure by direct contact, ingestion, vapor intrusion, and/or inhalation of trichloroethene, chromium, or possibly vinyl chloride detected in shallow groundwater beneath the Site if water supply wells are installed onsite or down gradient.
- The inferred downgradient migration of groundwater containing trichloroethene at concentrations above residential SLs beyond the south and east property boundaries represents a potential risk to affected areas to the south and east of the Site.

3.2 Property Geology and Hydrogeology

The following interpretation of the subsurface conditions is based upon the previous reports presented in **Section 3.1** above.

3.2.1 *Surficial / Unconsolidated Soil Geology*

The Site is located within the Kankakee Outwash and Lacustrine Plain Physiographic unit, which is characterized by layers of sand and gravel deposited as broad valley trains and outwash plains by glacial meltwaters during the late Wisconsin glaciation (Fenelon, 1994). Findings at the Site reflect these conditions; soil probes encountered sand-dominated sediments incorporating various amounts of gravel and silt depending on depth. Surface soil consists of topsoil and silty clay or sandy clay loam, underlain primarily of permeable sand (silty sand, sand, and sandy with gravel) to the limit of exploration at 40 feet below ground surface (bgs). Groundwater was encountered at depths ranging from approximately 11.40 to 13.92 feet bgs.

USGS Water-Resources Investigations Report 97-4204 by Arihood and Cohen describes an aerially-extensive layer of silt and clay that underlies most of northwestern Elkhart County, but was not encountered during Weaver Consultants' Site Investigation activities. The deepest wells extended 40 ft bgs, which may not be deep enough to reach the underlying silt and clay.

Arihood and Cohen report the average depth to the confining layer to be 47 ft. Beneath this layer, there is another sand and gravel aquifer averaging 35 ft in thickness before encountering bedrock. According to the survey of the soil probe elevations, the ground surface at the Site ranges from 746 to 749 ft above mean sea level.

3.2.2 *Bedrock Geology*

The Former Walter Piano Site is underlain by shale bedrock of Devonian and Mississippian age. The bedrock elevations range from approximately 275 to 710 ft above sea level (Arihood, 1998). The shale bedrock is of very low permeability and forms the lower hydraulic flow boundary beneath the unconsolidated aquifer system.

3.2.3 *Hydrogeology*

The Site and surrounding parts of the City are located within the St. Joseph Aquifer System and Tributary Valleys. The aquifer is composed of fine to medium sand with zones of coarse sand and gravel. Locally at Elkhart, thick clay deposits are present below the surficial sand and gravel. Due to the abundance of sand in surficial deposits throughout the region, groundwater flows quickly and water wells yielding 200 to 500 gallons per minute are common throughout the area (IDNR, 1987). Arihood and Cohen indicate that the St. Joseph River receives groundwater from the adjoining aquifer system, indicating that regional groundwater flow is southerly or southeasterly beneath the Site. The hydraulic conductivity of the upper sand and gravel layer is estimated by Arihood and Cohen in their calibrated flow model study to be 170 ft/day along the north side of the St. Joseph River.

Based on the site investigation data, the historical data collected by Bruce Carter and Associates and Heartland, and review of the professional literature, Weaver Consultants found that groundwater beneath the Site flows southeasterly toward the St. Joseph River approximately one quarter-mile distant. Groundwater was estimated to flow at a rate of 6.8 ft/day, suggesting an advective travel time of less than one year from the downgradient boundary of the Site to the St. Joseph River.

4 CLEANUP ALTERNATIVES ANALYSIS

The Site is currently vacant and unused. Future land use at the Site and remediation area is planned to be commercial. The cleanup goals reflect the objective of minimizing the environmental considerations that respective end-users may need to consider during development and construction, and subsequent operation and maintenance of remediation support facilities.

The City of Elkhart is interested in promoting redevelopment of the Site for commercial use. The cleanup is proposed to mitigate impacted groundwater and soil on the Site in support of subsequent redevelopment of the Site. Analytical results of the performance monitoring samples will determine the final extent of cleanup activities.

4.1 Cleanup Goals

The cleanup goals for the Site include the remediation of VOC groundwater impacts on-Site as well as the associated shallow unsaturated on-site VOC source soils and the reduction of VOC concentrations below IDEM's RCG Industrial/Commercial SLs to facilitate development of the Site. Remediation activities will be conducted under the oversight and review of the IBP.

4.2 Groundwater and Soil Cleanup Alternatives Analysis

The intent of the cleanup is to reduce chlorinated VOCs (CVOCs), particularly TCE, in groundwater and in shallow unsaturated soils, and mitigate exposure to human health (i.e., end-users, off-site receptors, and/or construction workers during development) and the environment. Any remaining PAH and inorganic exceedances may be addressed through optimization of the conceptual site development plan to support limited "Hot Spot" removal, construction of engineered barriers, use of institutional controls, and soil excavation and management during site development.

The cleanup alternatives considered for mitigating the risks associated with the impacted groundwater and soil are discussed below. Cleanup alternatives were evaluated based on the following criteria:

1. Effectiveness
   a. The degree in which toxicity, mobility, and contaminant volume is expected to be reduced.
   b. The degree in which a corrective action will protect human health and the environment over time.
   c. Consideration for any adverse impact to human health and the environmental during corrective action implementation.

2. Implementation
   a. Technical feasibility of corrective action at the site.
   b. Availability of materials, equipment, and services needed to carry out corrective action.
   c. Administrative feasibility of corrective action (access agreements, permits, approvals from municipal, state, and/or federal agencies).

3. Cost
   a. Initial costs – planning and implementation (contractors, laboratory, etc.)
   b. Annual operation and maintenance costs

4.2.1 *Groundwater Cleanup Alternatives Analysis*

4.2.1.1 Alternative 1a – No Action

A no-action alternative was considered as part of the ABCA process and would be the least expensive alternative. Under this scenario, the surface conditions would remain as-is. A no-action alternative does not include a cost that would be incurred; however, ongoing monitoring (which would incur costs) to assess/confirm the extent of the groundwater plume would be required as well as ongoing installation of vapor intrusion mitigation systems would be required to protect human health downgradient of the Site.

Alternative 1a – No Action/Groundwater Monitoring	Low Cost	High Cost
Semi-Annual Groundwater Monitoring/Sampling (10 Years)	$176,000	$211,200
Semi-Annual Progress Reporting (10 Years)	$100,000	$120,000
Vapor Mitigation Systems (20 Properties)	$100,000	$120,000
Probable Cost	**$376,000**	**$451,200**

Although no action is the least costly, it does not achieve the City of Elkhart's goal to situate the Site for redevelopment, creating jobs, and returning the Site to productive use. On-Site impacts to groundwater must be remediated to protect human health and the environment, increasing the marketability of the Site. Therefore, the no-action alternative was eliminated from further consideration.

4.2.1.2 Alternative 2a – Groundwater Pump and Treat

Pump-and-Treat remedial action has the potential to minimize or completely preclude the off-Site migration of impacted groundwater. Implementation would involve the installation of several remediation pumping wells along Beardsley Avenue and Michigan Street, which comprise the south and east borders of the Site, respectively. The wells would draw groundwater at a rate sufficient to ensure the capture of all impacted groundwater flowing from the Site. The impacted groundwater would then be treated and discharged, most cost effectively to a nearby storm sewer, and managed by the POTW, if possible. Monthly or quarterly National Pollutant Discharge Elimination System (NPDES) monitoring would be required to support effluent discharge. TCE would be treated on-Site by air stripping, while inorganics (if present) would require additional treatment step(s) such as anion exchange (both strong-base and weak-base), membrane filtration by nanofiltration and reverse osmosis, reduction followed by coagulation and precipitation, or adsorption can remove these constituents from groundwater (costs not included below).

Alternative 2a – Groundwater Pump and Treat	Low Cost	High Cost
Capital Construction/Installation (Not including processes to address metals)	$120,000	$240,000
Systems Operation and Maintenance (5 Years)	$225,000	$375,000
Semi-Annual Groundwater & NPDES Monitoring/Sampling (5 Years)	$105,000	$150,000
Remedial Action Reporting	$10,000	$12,000
Probable Cost	**$460,000**	**$777,000**

Potential disadvantages include relatively high operation and maintenance (O&M) costs, removal and off-Site disposal of accumulated water, the duration of time to operate the pumping system to meet cleanup goals (assumed 5 years above, could be more), and the presence and maintenance of on-site support structures for the pump and treat system.

4.2.1.3 Alternative 3a – Permeable Reactive Barrier

A permeable reactive barrier (PRB) installed along the affected downgradient boundaries of the Site (east and south) has the potential to mitigate COC concentrations in groundwater prior to its migration off-Site. Implementation would involve drilling a minimum of two staggered rows of injection points at 15-ft intervals to provide an effective spacing of 7.5 ft normal to the groundwater flow direction. The PRB will combine both biological enhanced reductive dechlorination (ERD) and abiotic in situ chemical reduction (ISCR), utilizing Regenesis' 3-D Microemulsion®, Bio-Dechlor INOCULUM® Plus, and Sulfidated MicroZVI™ (S-MZVI). The self-distributing features of 3-D Microemulsion® combined with its longevity (several years) allow for sufficient coverage with minimal pore volume displacement thereby minimizing application costs. S-MZVI is a concentrated aqueous suspension of sulfidated, colloidal zero valent iron formulated for compatibility with PlumeStop. When applied to the subsurface it imparts an ISCR mechanism that allows for the destruction of chlorinated ethenes (i.e. TCE) via abiotic degradation pathways. This unique mechanism allows for the traditional reduction pathway to be circumvented, minimizing the formation of daughter species such as vinyl chloride. Sulfidation blocks the effects of water on the ZVI particles, allowing the reagent to be effectively focused on the chemical reduction of chlorinated ethenes. This will foster rapid abiotic reduction of chlorinated solvents while reducing the potential for daughter product formation compared to a standard in situ bioremediation approach.

Approximately 10,200 pounds of 3-D Microemulsion, 12,750 pounds of S-MZVI, and 81 liters of BDI Plus would be applied over 141 injection points. The injectate would spread into the sandy soil beneath the Site, forming the PRB beginning at the top of the water table at about 14 ft bgs and extending to the base of TCE impacts believed to be at approximately 24 ft bgs. The barrier would comprise biological and reducing agents suspended in a soil matrix, so that groundwater flows freely through it. The TCE and hexavalent chromium (if present) carried by the groundwater would react with the reducing agents and either degrade into a nontoxic substance through reductive dechlorination (trichloroethene → ethene) or be reduced to a less soluble and less toxic state immobile state ($Cr^{6+} \rightarrow Cr^{3+}$).

A pilot test would be implemented before installation of the complete barrier. The pilot test will assess the effectiveness of the PRB as well as whether more toxic compounds such as vinyl chloride are formed under site-specific conditions. If the pilot test is successful, the piloted parts of the downgradient boundary would then be complete.

Alternative 3a – Permeable Reactive Barrier	Low Cost	High Cost
PRB Pilot Test Installation	$55,000	$66,000
Quarterly Pilot Test Monitoring (1 Year), Evaluation, Final Design	$20,000	$24,000
Install Remaining Portions of PRB	$275,600	$318,000

Alternative 3a – Permeable Reactive Barrier	Low Cost	High Cost
Quarterly Groundwater Monitoring & Evaluation (5 Years)	$176,000	$211,200
Remedial Action Reporting	$10,000	$12,000
Probable Cost	**$536,600**	**$631,200**

Potential disadvantages include the eventual replacement of the PRB if the on-Site contamination persists longer than the reducing agents suspended in the barrier. However, the PRB is expected to last several years based on case studies reported in the professional literature. Should residual source area remain on-Site, and continue contributing VOCs to groundwater, the PRB will eventually require replacement and exist for an extended period of time. Additionally, the PRB will not address contamination that has already migrated off-Site. Incomplete reductive dechlorination (due to breakthrough in the PRB) may also form more toxic intermediate products such as vinyl chloride that may migrate off-Site. The ERD/ISCR processes would address chlorinated ethenes and hexavalent chromium, but should additional inroganics or chlorinated ethanes be identified, additional amendments may be required.

4.2.1.4 Alternative 4a – In-Situ Chemical Oxidation

A remediation pilot test program utilizing in-situ chemical oxidation (ISCO) is proposed to address CVOCs impacts in groundwater. The ISCO groundwater treatment approach will focus on addressing impacted groundwater on-Site while mitigating the potential for migration of impacted groundwater to areas downgradient of the Site. An "inject and drift" ISCO approach could also be utilized to address to address CVOC impacts that have migrated off-Site.

The ISCO process utilizes chemical oxidants to irreversibly convert CVOCs in groundwater to carbon dioxide, chloride, and water. Conditions in the groundwater and soil matrix and the concentration of other oxidant-consuming substances (e.g., natural organic matter and reduced minerals) can affect the transport and effectiveness of the ISCO treatment process. Potassium permanganate (KMnO4) and sodium permanganate (NaMnO4) are two common forms of permanganate typically used for ISCO. $KMnO_4$ is a dry, crystalline solid from which aqueous solutions (up to 4%) can be prepared. $NaMnO_4$ is typically supplied as a concentrated liquid (40%) which can be diluted on-site and applied at lower concentrations (ITRC, 2005). Numerous laboratory and field tests have been conducted in recent years showing that permanganate is very effective in oxidizing a wide range of contaminants, including the chlorinated solvents which have been detected at the Site such as TCE, cis-1,2-dichloroethylene (DCE), and vinyl chloride (VC).

Permanganate application is generally found to result in the complete degradation of TCE, cis-1,2-dichloroethene and vinyl chloride under a wide range of conditions. Permanganate is inherently more persistent than other oxidants such as hydrogen peroxide, which tends to decompose rapidly to water and oxygen when it comes into contact with soil or groundwater. In addition, permanganate is effective in either naturally oxidizing or reducing environments. During application, contaminant destruction is accomplished via oxidation, but the environment will return to its natural oxidation state once the reaction process is complete. The effectiveness of permanganate is limited by the ability to distribute the oxidant throughout the impacted area as contact with the contaminant is required for oxidation to occur; therefore, multiple or continuous applications are generally required to achieve treatment goals.

Alternative 4a – In-Situ Chemical Oxidation	Low Cost	High Cost
Capital Costs/ISCO Pilot Test	$143,100	$171,700
Pilot Test Monitoring, Evaluation, Final Design	$17,400	$20,900
Semi-Annual ISCO Injections (3 Years)	$389,400	$467,300
Semi-Annual Performance Groundwater Monitoring & Evaluation (3 Years)	$77,100	$92,500
Remedial Action Reporting	$10,000	$12,000

Alternative 4a – In-Situ Chemical Oxidation	Low Cost	High Cost
Probable Cost	**$637,000**	**$764,400**

Potential disadvantages include diffusion of CVOCs from the soil matrix back into the groundwater following consumption of the permanganate and the return to natural oxidation state. This may require additional ISCO injection events to destroy rebounding CVOC concentrations. However, due to the low concentrations of CVOC, diffusion is not expected. In addition, due to the oxidizing strength of high concentration permanganate (40+%), careful handling of the oxidant is required to mitigate safety concerns and strong oxidizer hazards.

4.2.2 *Soil Cleanup Alternatives Analysis*

Although only two alternatives are evaluated to address shallow soil impacts at the Site (no action, soil vapor extraction), remaining shallow soil impacts can be address during the site development process. Remaining PAH and inorganic exceedances may be addressed through optimization of the conceptual site development plan to support limited "Hot Spot" removal, construction of engineered barriers, use of institutional controls, and soil excavation and management during site development.

4.2.2.1 Alternative 1b – No Action

A no-action alternative was considered as part of the ABCA process and would be the least expensive alternative. Under this scenario, the surface conditions would remain as-is. A no-action alternative does not include a cost that would be incurred.

Although no action is the least costly, it does not achieve the City of Elkhart's goal to situate the Site for redevelopment, creating jobs, and returning the Site to productive use. On-Site impacts must be remediated to protect human health and the environment, increasing the marketability of the Site. Therefore, the no-action alternative was eliminated from further consideration.

4.2.2.2 Alternative 2b – Soil Vapor Extraction

A remediation pilot test program utilizing soil vapor extraction (SVE) is proposed to address CVOCs impacts vadose zone soil. The objective of the SVE pilot test is to evaluate the effectiveness of the application of SVE technology to remediate VOCs in underlying shallow vadose zone (i.e., unsaturated) shallow soil.

The application of SVE processes is targeted at establishing an area of lower pressure within the subsurface thereby inducing, capturing, and removing VOC vapors in the subsurface soils above the groundwater table from within the impacted area. The data collected from the pilot test will focus on providing a basis of design for: 1) providing an initial indication of the technical efficacy of SVE application at the Site to remediate VOCs in underlying shallow vadose zone soil; 2) providing an initial indication of the potential radius of influence (ROI) to further evaluate the potential implementation requirements of SVE technology at the Site; and 3) if applicable, collecting preliminary engineering information to develop a design basis for an expanded SVE remediation program, including the extraction blower(s) and electrical requirements; extraction conveyance piping; and evaluating air emission permitting requirements.

SVE can be used to address shallow VOC sources contributing to groundwater impacts in combination with pump and treat, PRB, and ISCO technologies to address combined soil and groundwater impacts.

Alternative 2b – Soil Vapor Extraction	Low Cost	High Cost
Capital Costs/SVE Pilot Test	$21,900	$26,300
Pilot Test Monitoring, Evaluation, Final Design	$20,300	$24,400
SVE System Expansion Capital Costs	$38,100	$45,700
Operation, Maintenance, Monitoring (3 Years)	$42,300	$50,800
Remedial Action Reporting	$8,400	$10,100

Alternative 2b – Soil Vapor Extraction	Low Cost	High Cost
Probable Cost	**$131,000**	**$157,300**

Potential disadvantages of SVE include the duration required to remediate VOC mass from the subsurface (assumed 3 years above, consistent with the ISCO program) as well as the remaining infrastructure required to maintain and operate the system. As a result of the low VOC concentrations identified within the shallow soils, operation of the SVE for an extended period of time (i.e., 10 years) is not anticipated.

4.2.3 *Cleanup Alternatives Cost Analysis*

A cost comparison of the groundwater and soil cleanup alternatives is provided below:

Groundwater Cleanup Alternative	Cost
Alternative 1a: No Action (Groundwater Monitoring)	$376,000 - $451,200
Alternative 2a: Groundwater Pump and Treat	$460,000 - $777,000
Alternative 3a: Permeable Reactive Barrier	$536,600 - $631,200
Alternative 4a: In-Situ Chemical Oxidation	*$637,000 - $764,400*

Soil Cleanup Alternative	Cost
Alternative 1b: No Action	$0
Alternative 2b: Soil Vapor Extraction	*$131,000 - $157,300*

4.3 Proposed Remedial Action

On the basis of effectiveness, time allotment for implementation, cost, future land use goals and site development plans, regulatory criteria and technical feasibility, Weaver Consultants **recommends the combination of Alternative 4a – ISCO and Alternative 2b – SVE as the most appropriate alternatives to remediate impacted groundwater and soils, respectively.** The combined ISCO and SVE pilot test and the subsequent implementation of the ISCO/SVE remediation program would cost approximately $768,000 to $922,800. Although the probable costs are generally in line between the three active alternatives, the ISCO/SVE alternative may be the most expensive alternative should semi-annual injections be required for the three-year period, however, implementation of the ISCO program and use of the strong oxidizer sodium permanganate is believed to have the highest probability of success and destruction of CVOCs within groundwater, both on-Site and off-Site.

4.4 Cleanup Schedule

After the designated, required USEPA public review process and issuance of the Decision Memorandum, the City of Elkhart will obtain Request for Proposals/Qualifications and Bids from contractors, including local MBE/WBE/DBE qualified companies. Pending IBP approval and public comment, Weaver Consultants and the City of Elkhart tentatively plan on conducting a remedial pilot program from late spring to fall 2022, followed by the implementation of the remedial program in late fall 2022. It is anticipated the remedial pilot program will be completed within three years.

LIST OF FIGURES

Figure 1 – Property Location Map

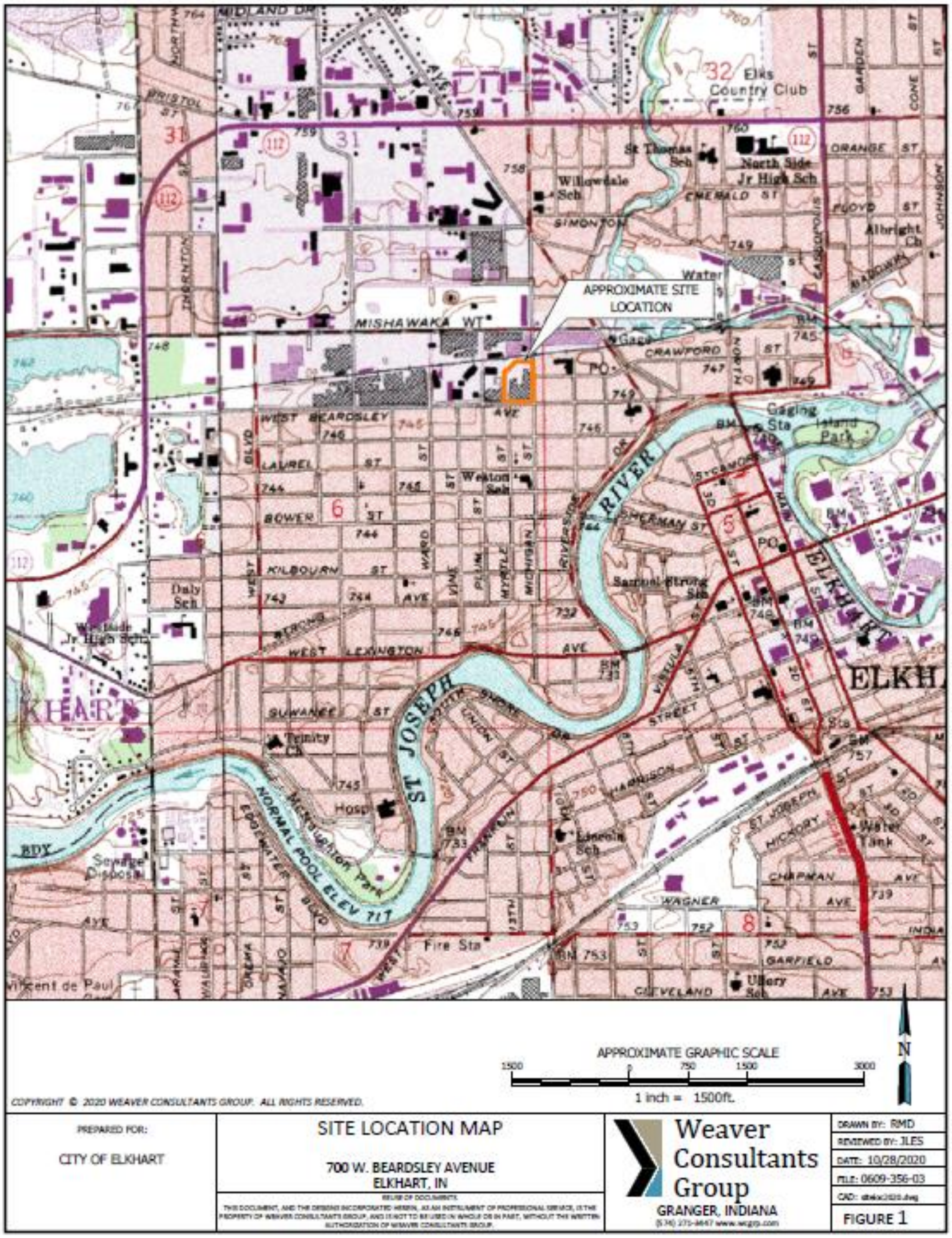
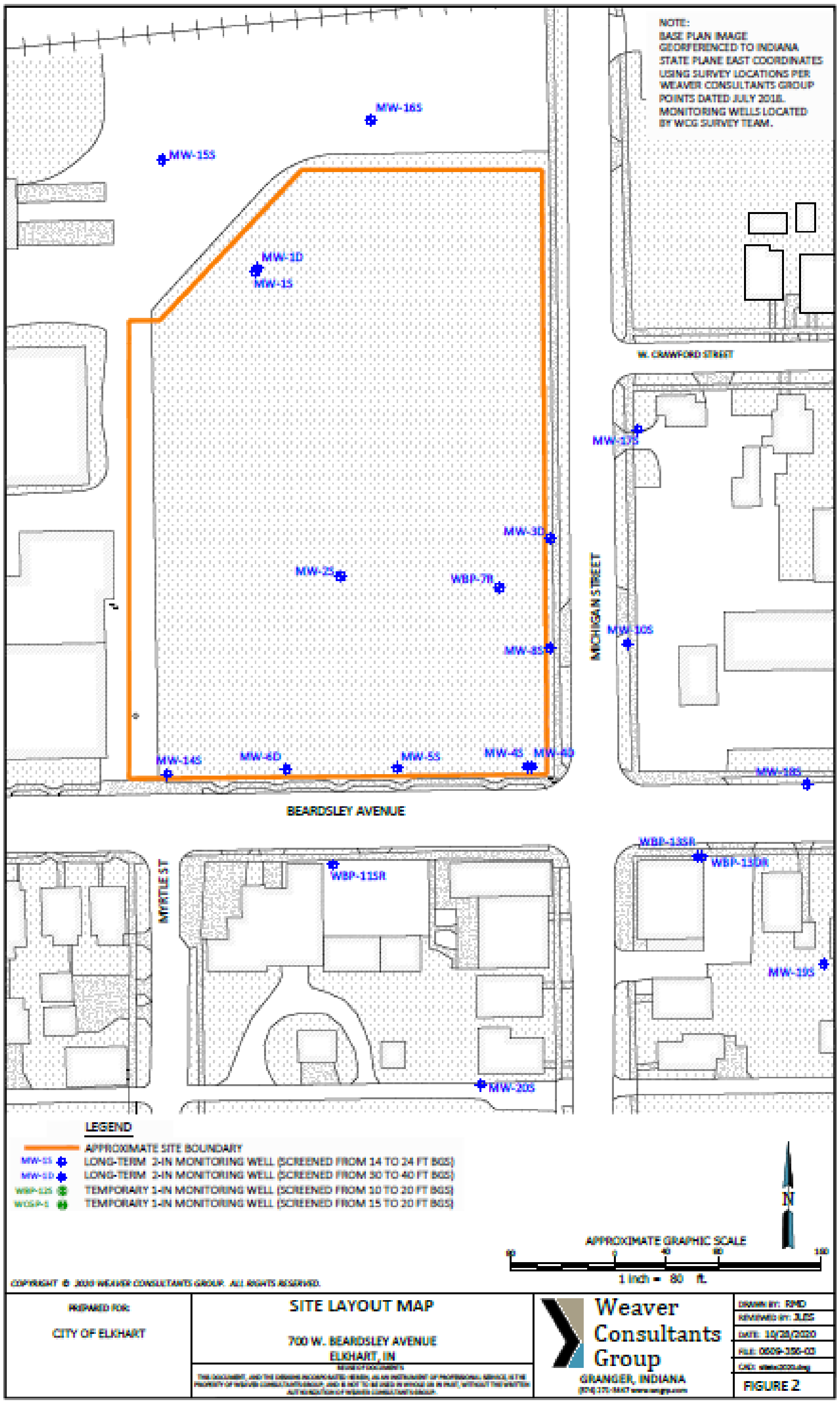


Figure 2 – Property Layout Map



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1/21/22

Figure 3 – TCE Groundwater Concentration Map