ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES FORMER CITY OF FAIRBANKS LANDFILL, FAIRBANKS, ALASKA

March 2011

Submitted To:
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ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES
FORMER CITY OF FAIRBANKS LANDFILL
FAIRBANKS, ALASKA

1.0 INTRODUCTION

Shannon & Wilson has prepared this Analysis of Brownfields Cleanup Alternatives (ABCA) for the former City of Fairbanks Landfill located on Second Avenue in Fairbanks, Alaska. The Fairbanks North Star Borough (FNSB has been awarded U.S. Environmental Protection Agency (EPA) Brownfields Assessment and Cleanup grants to address contamination issues at the former landfill site. We prepared this ABCA in general accordance with EPA guidance for cleanups with EPA grant funds. The proposed scope of services included evaluating landfill refuse-removal and surface-improvement alternatives to facilitate site reuse and redevelopment.

2.0 SITE DESCRIPTION

The former City of Fairbanks Landfill is adjacent to the Chena River at 1980 Second Avenue, in Fairbanks, Alaska. The approximately 22-acre site is in Section 9, Township 1 South, Range 1 West, of the Fairbanks meridian. It is bounded on the north, east, and west by a bend in the Chena River, and on the south by other FNSB and private properties, and Second Avenue. The site is used for a baseball field, snow storage area, dog park, and parking for the Carlson Center multi-purpose arena. The project boundary is shown in Figure 1.

Groundwater is present at a depth of about 12 feet to 20 feet below ground surface (bgs) across the site. The groundwater flow direction in Fairbanks is generally to the northwest, but may be influenced locally by fluctuations of water levels in the Chena River.

3.0 SITE HISTORY AND PREVIOUS INVESTIGATIONS

3.1 Site History

The landfill was an unregulated, unlined landfill that reportedly operated from 1951 to 1965, and was primarily filled with municipal refuse, which likely included building materials, scrap metal, junk automobiles, and household goods. A 1954 U.S. Geological Survey topographic map shows the site was the location of a sand and gravel borrow pit.

A 1960 aerial photograph (Figure 2) shows two small ponds (presumably water-filled gravel pits) at the site's west end along the Chena River. Later aerial photography shows numerous demolished vehicles near the center of the landfill site, and a storage area for 55-gallon drums to the east, with an aboveground bulk storage tank in the center of the drum-storage area. A former auto-impound area is in the southeastern corner of the site along Second Avenue.

3.2 Phase I and Preliminary Phase II ESA (2005)

The landfill has been the subject of several site assessments performed for the EPA. Ecology and Environment, Inc. (E&E) and Tetra Tech, Inc. conducted assessments in 1980 and 1984, respectively. Background documents provided to Shannon & Wilson, Inc., summarized these assessments as follows:

> "… E&E performed a field investigation of approximately 4 acres of the subject property. It was determined that the former dump was used to dispose of primarily domestic wastes from 1951 through 1965. It is reported, however, that 25 drums of tar were buried in the dump. E&E concluded that it was reasonable to assume that no hazardous or chemical wastes were disposed of at the dump (E&E 1980). Tetra Tech, Inc. performed the second preliminary assessment on July 13, 1984. It was determined that the dump was used to dispose of municipal refuse, scrap metal, junk automobiles, scrap lumber, and household goods. According to this assessment, no hazardous wastes were suspected on site, although 15 to 20 drums containing solidified tar were also suspected to be buried on site."

URS Corporation (URS) conducted a Phase I and preliminary Phase II Targeted Brownfields Assessment in 2005 (URS, 2005). The project entailed compiling historical site information and conducting a geophysical survey, followed by focused subsurface soil and groundwater sampling. Key findings from their investigation are summarized below.

The geophysical survey was conducted in May 2005 to identify the approximate boundaries of the former landfill. The interpreted landfill boundary based on the magnetometer (EM-31) survey is shown on Figure 3.

URS drilled eight soil borings and installed temporary well points in four borings. URS encountered waste in four borings, as shallow as 6.5 feet bgs to as deep as 29 feet bgs. The estimated landfill boundary based on the geophysical data report is shown in Figure 3. Locations of the 2005 URS soil borings and depths of observed wastes are shown in Figure 5.

URS submitted 24 soil samples for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), diesel range organics (DRO), residual range organics (RRO), and pesticide analysis, which were detected in the soil samples at concentrations less than the project screening levels (Alaska Department of Environmental Conservation [ADEC] Method Two soil cleanup levels for organic compounds and background concentrations for metals). The following compounds were detected at concentrations exceeding their respective screening level in at least one soil sample: antimony, cadmium, chromium, lead, nickel, selenium, thallium, and the polychlorinated biphenyl (PCB) Aroclor-1254. URS concluded lead and PCB concentrations should be evaluated further. Manganese and thallium were the only compounds detected in the groundwater samples above screening levels. Presuming future development would obtain potable water from the Fairbanks municipal water utility and the groundwater beneath the site is not used as a drinking water source, URS concluded these two compounds should not pose a threat to human health or the environment. Locations of the lead and PCB soil-exceedances are presented in Figure 5.

3.3 Environmental Site Assessment (2007)

Shannon & Wilson, Inc., conducted an Environmental Site Assessment (ESA) under the FNSB's Brownfields assessment grant to evaluate the site for reuse opportunity, with an emphasis on identifying environmental conditions associated with the former landfill that could affect vertical development. The ESA activities focused on the landfill and auto impound/snow storage area areas, including a 30-meter zone around the landfill perimeter previously identified by others. This area, including a 30-meter buffer, is the "project boundary" shown in the ABCA figures. Shannon & Wilson's April 2008 Draft ESA report (Shannon & Wilson, 2008) was accepted as a final report without revisions by the FNSB.

The basic elements of the 2007 field program were a ground-penetrating radar (GPR) survey, a subsurface soil gas survey, and test pit excavation and sampling. Additional field investigations included drilling soil borings, installing monitoring wells, and collecting analytical soil and groundwater samples.

3.3.1 Geophysical Survey

The 2007 GPR survey revealed undisturbed soil at depths ranging from 8 feet to 27 feet beneath mixed waste and soil fill; this boundary is interpreted to be the base of the original gravel pit prior to its being filled with waste and soil. Figures 3, 4, and 5 show the interpreted base of disturbed soil and excavation depth contours from the GPR survey.

3.3.2 Soil Samples

Soil samples from test pits and soil borings were tested for metals, VOCs, DRO, RRO, and polynuclear aromatic hydrocarbons (PAHs). Photoionization detector (PID) results did not indicate the presence of volatile organic compounds in the soil gas, and VOCs were not detected in the analytical samples. Arsenic concentrations were above the cleanup level but within naturally-occurring background levels. One sample from test pit TP-6 contained barium, chromium, and lead above cleanup levels. DRO, two VOCs, and 17 PAHs were reported at concentrations not only less than their respective (and most restrictive) migration-to-groundwater cleanup levels, but also their less-conservative inhalation-of-outdoor-air cleanup levels. The locations and depths at which waste/debris were observed in test pits and borings are presented in Figure 5.

3.3.3 Groundwater Samples

Groundwater samples from five monitoring wells were tested for gasoline range organics (GRO); DRO; RRO; benzene, toluene, ethylbenzene, and xylenes (BTEX); and metals. DRO were reported in one well at a concentration of 0.961 mg/L in December 2007, which is below the ADEC Table C cleanup level (18 AAC 75.345). Arsenic, barium, chromium, and lead were detected. Arsenic exceeded the cleanup level in the groundwater sample from well MW-4. GRO, RRO, and BTEX were not detected in the groundwater samples.

These wells were installed outside the landfill boundary as delineated by the geophysical survey and may not fully characterize the potential impact to groundwater within and beneath the refuse mass.

3.3.4 Soil Gas Samples

Soil gas samples were analyzed using field meters, a field gas chromatograph (GC), and fixed-base laboratory testing. Field screening and GC results indicated methane and VOCs are present in the subsurface soil gas throughout the study area. The highest concentrations of methane appear to be generally near the northeast corner of the Carlson Center parking lot. Methane does not have an EPA screening (health hazard) value, although the results can be evaluated in terms of the physical hazard of flammability/explosion. In general, it is advisable to control flammable gases to less than 10 percent of the lower explosive limit (LEL). The LEL for methane is 5 percent by volume, or 50,000 parts per million by volume (ppmV). Methane was measured at levels up to 40 percent LEL in the central portion of the landfill area. Figure 3 shows the methane field meter results.

Six analytical soil gas samples were submitted to an independent laboratory for VOC analysis. The samples contained a total of 30 individual VOC compounds, including benzene and tetrachloroethene (PCE) in each sample. The highest concentrations were found in the general vicinity of the north ball field.

ADEC developed guidance for conducting vapor intrusion assessments in 2009; the screening levels presented in that guidance were not available at the time of the 2007 ESA. Using screening levels for deep soil gas (greater than 5 feet below ground surface), analytical data verified the presence of 3 VOCs exceeding ADEC screening levels for a residential scenario and only one VOC exceeding screening levels for a commercial scenario. Figure 4 shows field PID measurements (a semiquantitative measure of VOC concentrations) and benzene and PCE results for soil gas samples.

Four samples were also submitted for hydrogen sulfide (H_2S) analysis. H_2S was detected in trace quantities in two of the four analytical samples tested. H_2S does not have an EPA screening level; however, there are known health effects associated with H_2S exposure, and limits for occupational exposure have been established by the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH). None of the measurements exceeded these limits.

3.4 Drum Excavation

On September 30, 2010, a contractor working on improvements to the ARCO baseball field exposed a 55-gallon drum filled with an tar-like substance that appeared to be an asphalt product. The contractor was replacing the field's east dugout, and had excavated an area approximately 8 feet by 10 feet by 2 feet deep. The drum was damaged during the excavation and spilled about half its contents. The FNSB Land Management and Parks and Recreation departments, Shannon & Wilson, and ADEC conducted a coordinated response, removing the drum, its remaining contents, and the spilled tar.

One product and one soil sample were collected to characterize the waste for disposal and assess the potential for the drum contents to have impacted underlying soil. The drum contents were analyzed by oil-burning specification methods and VOCs. One soil sample was collected after the drum and spilled tar was removed from the excavation; this sample was analyzed for RRO. Results of the analyses showed the material met oil-burning specifications and contained twelve VOCs but no benzene. The soil sample contained RRO at 483 mg/kg, which is below the most stringent ADEC Method 2 cleanup level. The waste materials were transported off-site for thermal treatment and disposal.

4.0 CONCEPTUAL SITE MODEL

The Conceptual Site Model (CSM) describes sources of contamination, release and transport mechanisms, exposure media and pathways, and current and future receptors. The CSM for the Former City of Fairbanks Landfill site is summarized in Figure 6. The human health CSM scoping form, which was used to prepare the graphic CSM, is included in Appendix A.

4.1 Contaminant Sources

For the purpose of this ABCA, “source” is defined as the buried waste and debris in the former City of Fairbanks Landfill. Soil contamination may be associated with the buried waste, or may result from a release of liquid or leaching to subsurface soil or groundwater. Degradation of waste material may also generate methane, VOCs, and hydrogen sulfide gas. Figure 5 summarizes the locations and depths where waste material and debris were observed in test pits and borings in the 2005 and 2007 investigations.

The presence of the drum discovered in 2010 highlights the potential for additional containers of tar or other hazardous substances to be present.

4.2 Contaminants of Concern

Benzene and other VOCs were not detected above cleanup levels in the 2005 and 2007 analytical soil or groundwater samples. Lead and PCBs were detected above cleanup levels in URS’s 2005 soil samples. Arsenic, barium, chromium, and lead were detected above cleanup levels in Shannon & Wilson’s 2007 soil samples. As noted above, the groundwater samples were not collected from water-bearing formations within or beneath the former landfill and thus may not reflect highest concentrations.

Methane, VOCs, and hydrogen sulfide are present in the subsurface soil gas at the site. Figure 3 shows the methane field meter results. Thirty VOC compounds, including benzene and PCE, were measured in soil gas samples. Twelve VOC compounds are present at concentrations greater than the EPA screening levels. Figure 4 shows PID measurements and benzene and PCE results for soil gas samples.

4.3 Extent of Contamination

Waste- and debris-depth and thickness is varied across the site. Figures 3, 4, and 5 show the interpreted base of disturbed soil and excavation-depth contours from the GPR survey, as well as the extent of debris based on the 2005 geophysical survey.

The extent of lead and PCBs in soil at concentrations above soil cleanup levels cannot be determined with existing data. Additional soil contamination may be present in the buried waste, or may be associated with the former auto impound area, or other former or current uses of the site.

The absence of benzene and other VOC concentrations greater than cleanup levels in the 2005 and 2007 analytical groundwater samples suggest that groundwater has not resulted in groundwater contamination outside the limits of the landfill. Water quality within the landfill boundaries cannot be assessed with the limited data set available.

Methane and VOCs are present in the subsurface soil gas throughout the study area. Landfill gases will migrate vertically and horizontally through the soil outside the refuse mass; methane and VOCs in soil gas at this site extend laterally beyond the limits of the waste. The highest concentrations of methane appear to be generally near the northeast corner of the Carlson Center parking lot. Figure 3 shows the methane field meter results. The highest VOC concentrations were generally near the north ball field. PID measurements and benzene and PCE analytical results are shown in Figure 4.

A methane survey of the ground surface throughout the landfill area was planned for the 2007 ESA but was not implemented due to the presence of snow cover at the time of field activities. There is an absence of data on potential landfill off-gassing to ambient air with which to assess the inhalation to outdoor air exposure pathway.

4.4 Exposure Routes

The CSM in Figure 6 lists current and future receptors who could potentially be exposed to contaminants at the landfill. Current receptors could include site visitors, trespassers, or recreational site users. Potential future receptors could include residents, commercial or industrial workers, and construction workers. Receptors could be exposed to potential soil or groundwater contamination through incidental ingestion, direct contact, or inhalation of fugitive dust. Receptors could be exposed to landfill gases through inhalation of outdoor or indoor air. As described in ADEC guidance, a complete pathway does not mean the exposure results in unacceptable risk at the site.

The exposure media for the site include soil, groundwater, and air. The soil exposure pathways of incidental ingestion and dermal absorption are likely to be complete during excavation activities that expose contaminated soil. Near-surface soils are not known to be contaminated. However, sampling and analysis at the site generally did not target these soils, particularly the top 2 centimeters (cm). The ADEC CSM scoping form describes nonvolatile contaminants in the top 2 cm, and dust particles less than 10 micrometers as examples of conditions that may indicate a fugitive dust exposure pathway.

The exposure pathways for groundwater ingestion and dermal absorption could be complete if construction excavations or wells extend to groundwater. These exposure pathways are described as potentially complete for future site users. ADEC guidance requires that this pathway be considered complete, absent a determination that groundwater is not a potential source of drinking water (18 AAC 75.350)

The inhalation of outdoor air exposure pathway is potentially complete for current site users. However, the absence of data regarding methane or VOC concentrations in near-surface soil gas and outdoor air prevents confirmation or exclusion of this as an exposure pathway of concern. VOC concentrations in soil gas samples collected during the 2007 ESA were below ADEC deep soil gas screening levels. Inhalation of indoor air would only be a concern for future users if structures are built on-site. Inhalation of fugitive dust is a potential exposure pathway but there is an absence of data on the chemical and physical properties of the top 2 cm of soil around the site that might confirm or exclude this as an exposure pathway of concern.

5.0 BROWNFIELDS GRANT GOALS AND OBJECTIVES

Project-specific objectives have been developed to improve public use of the site, be protective of human health and the environment, and comply with applicable State and Federal laws.

5.1 Project Cleanup Objectives and Goals

The objective of the proposed project is to implement actions that will enable reuse/ redevelopment of: the greatest area with the available funds, subject to considerations of minimizing land-use restrictions and other institutional controls (ICs), engineering controls for vapor mitigation, and treatment time; protecting human health and the environment for the proposed land uses; and mitigating long-term contamination issues.

5.2 Applicable Regulations

Cleanup of all or a portion of the former landfill site will be conducted under the State of Alaska Oil and Other Hazardous Substances Pollution Control Regulations (18 AAC 75), which provides for protection of human health and the environment based on current and future land uses.

If hazardous waste is encountered during cleanup, Resource Conservation and Recovery Act (RCRA) standards (55 FR 30798) for generation, characterization, transport, and disposal of hazardous wastes will apply.

PCBs have been detected in soil above cleanup levels in one soil boring. If PCBs are encountered during cleanup, the Toxic Substances Control Act (TSCA; 40 CFR 761) requirements for PCB cleanup, transport, and disposal applies.

5.3 Cleanup Standards

The cleanup standards for petroleum-contaminated soil and groundwater are presented in Title 18, Chapter 75 of the Alaska Administrative Code (18 AAC 75), *Oil and Other Hazardous Substances Pollution Control* (October 2008). The cleanup standards for individual chemicals in soil are based on the ADEC's most stringent Method 2 cleanup levels listed Tables B1 and B2, 18 AAC 75.341 (October 2008), for the "under-40-inches precipitation zone." Cleanup standards for groundwater are the ADEC groundwater cleanup levels listed in Table C, 18 AAC 75.345. Note these standards are typically required for a "cleanup complete" designation by the ADEC. Alternative cleanup levels may be practicable under a cleanup complete with institutional controls determination.

The regulatory levels for soil gas are based on EPA screening levels for evaluating the vapor intrusion-to-indoor-air-exposure pathway. The individual chemical screening levels are those published by the EPA for the shallow soil gas concentration, which reflect a risk of 10^{-6} and an attenuation factor of 0.1 from the target indoor air concentrations (US EPA, 2002). The applicability of the screening levels to this site is established by the ADEC guidance document, *Draft Vapor Intrusion Guidance for Contaminated Sites* (July 2009). Although these screening levels are not promulgated standards, they are relevant and appropriate for evaluating the potential impact of landfill-gas migration on the site's suitability for vertical construction. Note that the guidance documents do not list screening standards for hydrogen sulfide or methane. Evaluation of these compounds is based largely on their presence or absence in the soil gas. Additional data assessment may be required to determine their potential effect on human health, safety, welfare, or the environment.

5.4 Land-Use Considerations

The FNSB has studied the potential for site development but recognizes current conditions limit potential future site uses. The presence of waste in the former landfill area has implications for vertical development due to generation of landfill gas, potential settlement, and geotechnical unsuitability of the soil matrix. Site improvements that are limited to surface structures, such as roads, parking areas, and athletic fields, may in some circumstances be constructed without requiring prior waste removal. Therefore, the FNSB is considering both vertical structures and other less intrusive options such as parking lot, access road, and athletic field construction.

In the east end of the former landfill area, waste appeared to be limited to a depth of 10 feet bgs. In this area, it may be practicable to remove the relatively shallow waste layer. Waste removal in other areas to the west may require excavation to more than 25 feet bgs.

Waste removal may not be necessary in all areas of the landfill in order to allow vertical construction; however, foundation solutions for areas where debris removal does not occur will likely require structural elements, such as piles or piers, to transfer structural loads through the compressible soils and/or debris to firm, unyielding soil. The decision to conduct waste removal or to use deep foundation solutions will depend on a variety of considerations, including the depth of waste, the load-bearing needs and settlement tolerance of proposed structures, landfill gas-control needs, and a cost-benefit analysis of material and labor costs for the alternative methods.

The presence of metals and PCBs in the soil may necessitate soil treatment for unconditional closure/unrestricted land use in areas where these analytes were detected. The presence of methane in subsurface soil gases indicates biological activity and organic wastes, which are a geotechnical concern for potential settlement.

Development in the former landfill vicinity will likely require engineering controls near areas where buried waste is not removed, for both vertical structures and other non-invasive site improvements. These controls would provide protection from vapor intrusion (VI) into structures that could increase human health exposure concerns and/or accumulate flammable or explosive vapors. Due to the widespread distribution of landfill gas across the area studied, these controls will likely be appropriate regardless of the proposed development location(s).

6.0 ALTERNATIVES ANALYSIS

This ABCA includes an analysis of six alternatives that vary in the extent or location of excavation and debris removal, including one alterative that consists of surface improvements but no debris removal. The first alternative is the “no action” alternative. Leaving the site in its current condition, with no remedial action taken, will require ICs and engineering controls to facilitate future development. These controls may limit or prevent development of certain areas. In contrast, complete excavation and removal of landfill debris will be a disruptive undertaking and is likely to be cost-prohibitive.

In this context, the FNSB has proposed five alternatives that focus on distinct areas within the landfill. Four alternatives entail a common remedial technology (excavation and removal of buried landfill debris), but are directed at a different areas of the project site. The fifth alternative entails surface preparation, grading, and improvements but no waste removal. This alternative is expected to have a beneficial effect on potential exposure pathways by capping selected areas of the site. These actions would reduce the potential for dust generation and vapor migration to outdoor air. Figure 7 shows the locations of the Alternatives.

6.1 Cleanup Alternatives

The cleanup alternatives are described below and evaluated in Section 6.2. The FNSB has clarified that the scope of cleanup is dictated by grant funding, and that no additional non-grant funds are available. Our remedial alternative analysis emphasizes the effect of funding limitations on each alternative.

Alternative 1: No Action. No remedial activities would be implemented for this alternative. Risks to human health and the environment would not be directly addressed. Institutional controls would likely have to be established and enforced, which may limit or prohibit development at the site.

Alternative 2: Cleanup of Eastern Portion of Landfill. This alternative consists of excavating and removing landfill debris from the northern portion of the existing snow storage area. Excavation and debris removal would take place on a portion of the northern approximately 1.2 acres of the 4-acre snow storage area. Following the successful implementation of Alternative 2, the 4-acre parcel would continue to be used as a snow storage area. Excavation in this area would likely extend to about 10.5 feet deep.

Alternative 3: Cleanup of Eastern Portion of Landfill and Relocation of Snow Storage Area. This alternative consists of the same excavation and removal activities described for Alternative 2 in addition to relocating the snow storage area to the area north of the Carlson Center parking lot/ARCO baseball field. This will make the entire 4-acre snow storage area available for development.

Alternative 4: Cleanup of Southwestern Portion of Landfill. This alternative consists of excavating and removing landfill debris from the central portion of the Carlson Center parking lot. This area is about 1 acre but debris may extend 25 feet bgs or more.

Alternative 5: Cleanup of Entire Landfill. This alternative consists of excavating and removing landfill debris from the entire identified landfill area, about 14 acres.

Alternative 6: Recreational Facility Improvements. This alternative consists of surface improvements in the vicinity of the Carlson Center parking lot and ARCO baseball field. These improvements include two parking areas, an access road, and a multi-purpose turf recreational field.

6.2 Evaluation and Comparison of Alternatives

The following subsections discuss and compare potential alternatives for the former City of Fairbanks landfill site. We evaluated the benefits and limitations of the five alternatives with respect to effectiveness, implementability, and cost.

The effectiveness criterion considers to what degree the alternative meets cleanup objectives, considering significant risks or impacts of the action, and land-use restrictions, institutional controls (ICs), or engineering controls (ECs) that may be required. ICs could include restrictions on excavation; prohibitions against using groundwater as a domestic water source; requirements for soil, groundwater, or soil gas monitoring during excavation or following construction of improvements; or similar requirements. ECs could include the design and construction of remediation systems or other protective measures to control site users’ exposure to contaminants. We also discuss the potential for VI from subsurface soil or groundwater into buildings.

The implementability criterion addresses how feasible the alternative is for the site, and how long it is expected to take to complete. We recognize there may be competing public and private interests for site development. Our analysis does not include an evaluation of possible public acceptance of each alternative at this stage of the project. We will evaluate that criterion following the public comment period.

We evaluated these alternatives in context of the Brownfields site cleanup grant funds available to the FNSB. As noted in Section 5.1, the FNSB seeks to conduct cleanup that enables use of the greatest area using available funds. We understand that approximately $195,000 will be available for field activities, administrative costs, and field oversight. The cost to fully implement these alternatives (other than the No Action alternative) is expected to exceed the available funding. Therefore, we have further evaluated whether limited cleanup may be accomplished with available funds that will result in a meaningful progress toward the project objectives.

We present order-of-magnitude costs for each alternative that include project planning and administration, and site work (excavation, confirmation sampling, transportation, disposal, and construction oversight). We have assumed landfill waste and waste-containing soil will be segregated from surrounding soil using earthmoving equipment. Additional processing, such as mechanical separation, may be used to further segregate waste and soil, thereby reducing the quantity of material requiring transportation and disposal.

We estimated landfill tipping fees at $71/ton, and have separated them from other cost elements within each alternative. Landfill tipping fees constitute 75 percent to 80 percent of the estimated cost for each alternative (except Alternative 1 and Alternative 6, which do not include a waste disposal element).

We obtained cost information from various sources, including RS Means Building Construction Cost Data, 67th Annual Edition (2009), estimates from local contractors, and our experience on similar projects.

We have not evaluated the cost of potential lost revenue resulting from the lack of development due to restrictive institutional or engineering controls.

Our cost assumptions generally include:

- Administrative costs estimated as 10 percent of the excavation/disposal costs.
- Field oversight and soil sampling costs estimated as 25 percent the excavation/disposal costs.
- No dewatering.

- Field activities will occur in the summertime (no frozen soil conditions).
- Field screening will be required for all soil and wastes.
- No mechanical separation of soil and wastes.
- Assume no hazardous waste or petroleum-contaminated soil encountered, except in Alternative 5.
- Assume all wastes can be disposed at the FNSB Landfill. Note that this may not be applicable in all situations; Alternative 5 consists of the excavation and disposal of all buried wastes on site, some of which may contain PCBs that could require more restrictive handling and disposal.
- Backfill volumes equal waste volumes unless otherwise noted.
- Overburden soil is uncontaminated and will be used as backfill.
- Backfill material obtained from off-site borrow sources is sandy gravel.

A general evaluation of the five potential alternatives considered in this ABCA is summarized in Table 1. The table is structured for comparison of alternatives by describing the benefits and limits of the effectiveness, implementability, and cost of each alternative.

6.2.1 Alternative 1: No Action

The No Action alternative is included for comparison purposes as stipulated in the ABCA process. This alternative does not include any remedial site activities and does not meet the cleanup objectives. Institutional controls will be necessary to address potential risks from VI and/or contaminated soil, and vertical construction may be limited by the presence of debris. These controls may limit a developer's interest in the property. This alternative is not effective at reducing contaminant concentrations or volume. It is easily implementable. The no action alternative would have some administrative costs associated with the development and implementation of ICs. For the purposes of this evaluation, we assume these costs to be $20,000.

6.2.2 Alternative 2: Cleanup of Eastern Portion of Landfill

Alternative 2 consists of excavation and removal of debris from the eastern portion of the landfill, as shown in Figure 7. While this area occupies about 1.2 acres in the northwestern portion of the city snow storage area, previous site investigations suggest debris may underlie only about 25 percent, or about one-third acre. We assume the successful implementation of this alternative would result in debris removal from this portion of the site. However, we understand the 4-acre parcel would continue to be used for snow storage.

Debris was observed in test pits in this area at depths ranging from 2 feet to 10.5 feet bgs. For the purposes of our evaluation, we assumed an average 4 feet of clean soil covers 5 feet of debris. Approximately 1,900 cubic yards (cy) of clean overburden and 2,400 cy of debris would require excavation; the clean overburden would be reused as fill while the debris would be transported to the FNSB landfill for disposal. A bulldozer and wheeled loader would be used to move overburden, and excavate and load debris, while dump trucks would transport debris to the landfill. We anticipate the field effort would take about 10 days.

Mechanical screening may be a cost-effective means to reduce the volume of material requiring transport and disposal, and significantly lower cleanup costs; however, this is unlikely to completely segregate debris from the soil. Moreover, using the resulting soil/debris mixture as backfill may conflict with the project goals and objectives.

Alternative 2 meets cleanup objectives in that area by removing debris from the northern portion of the snow storage area parcel, thereby making it available for development. Assuming the parcel would continue to be used for snow storage, the benefit of implementing this alternative would not be realized until the snow storage area is moved and the parcel is made available for development.

Debris removal from this area would likely reduce but not eliminate the vapor-intrusion potential and risks or impacts to human health and the environment. The potential for VI may remain from buried landfill materials adjacent to the Alternative 2 excavation area. As such, ICs and engineering controls may be necessary to document and manage VI potential. ICs and engineering controls that restrict vertical construction should not be necessary once the debris is removed.

This alternative can be readily implemented. The area is easily accessible and the work can be done using standard earthmoving equipment. If present, contaminated soil or hazardous materials can be segregated and managed for disposal, but that would add to the project complexity.

The cost to implement Alternative 2 and remove all suspected debris is estimated to be $50,000 plus $255,000 in landfill tipping fees, for a total of $305,000. This exceeds the available cleanup funds.

Limiting the scope of cleanup activities to match available funding will likely result in less than complete debris removal in this area; however, it is expected to make progress toward the project objective of increasing the area available for reuse/redevelopment without prohibitive land-use restrictions. We recommend beginning the excavation at the southern end of the landfill, where the occurrence of debris is sporadic and relatively shallow. The excavation should progress north and west, where the debris layer is more concentrated, with cleanup continuing until the funding limit has been reached. This should result in the greatest contiguous area available for development given the funding constraints.

This cost includes the following basic elements:

- dozer, loader, dump trucks, and operators/drivers;
- debris transportation to and disposal at FNSB landfill;
- reuse of clean overburden as backfill;
- regrading as needed to fill the excavation rather than importing backfill;
- construction oversight/field observation;
- confirmation soil sampling at base of excavation; and
- administrative costs.

6.2.3 Alternative 3: Cleanup of Eastern Portion of Landfill and Relocation of Snow Storage Area

Alternative 3 consists of the elements described for Alternative 2 plus the administrative measures to secure the northern portion of the project area for a snow storage area. We assume the successful implementation of this alternative would allow the entire 4 acres of the existing snow storage area to be developed. Only those elements unique to Alternative 3 are described in this section.

This alternative would be more effective than Alternative 2 in achieving the project goals because it results in a greater area available for development. Institutional and engineering controls unique to this alternative relate to stormwater and snowmelt management as needed to comply with the Alaska Pollutant Discharge Elimination System (APDES) and local requirements. Establishing a snow storage area north of the Carlson Center parking lot and ARCO baseball field will likely increase surface water runoff to the Chena River and infiltration into waste, potentially mobilizing contaminants. A hydrogeologic study of the proposed snow-dump location will be appropriate prior to implementing Alternative 3.

This alternative can be readily implemented but may require permitting to address stormwater and water-quality issues related to the snow storage area. The area proposed for the relocated snow storage area is currently open, undeveloped, and underlain by landfill material. Some level of discussion will be required between the FNSB and City of Fairbanks to formalize an agreement to use the area as a snow storage area, including a determination that such use is allowable under the municipal separate storm sewer system (MS4) permit, and an evaluation of engineering controls to manage snowmelt and stormwater runoff.

The cost to implement Alternative 3 is estimated to be $80,000 plus $255,000 in landfill tipping fees, for a total of $335,000. This estimate may vary considerably based on the actual quantities of soil and debris handled. It includes those elements described for Alternative 2, plus an estimated $30,000 in administrative costs associated with establishing the snow storage area. These administrative costs will include engineering and regulatory compliance activities related to establishing the new snow storage area.

Reducing the scope of cleanup activities to match available funding results in the same limitations as described for Alternative 2. The additional administrative and design costs to establish a new snow storage area will likely result in less debris removal.

6.2.4 Alternative 4: Cleanup of Southwestern Portion of Landfill

Alternative 4 consists of the excavation and removal of debris in the southwestern portion of the landfill within the Carlson Center's north parking lot. The purpose of this alternative is to reduce institutional and engineering controls that may affect future expansion of the Carlson Center facility, although there are currently no plans for expansion. The proposed excavation area measures about 1 acre and includes some of the deepest portions of the landfill (approximately 24 feet bgs). This area is not as well characterized as the eastern portion of the site described in Alternative 2.

The base of disturbed soil, and by inference the base of landfill debris, is estimated at depths ranging from 12 feet to 22 feet bgs, based on previous GPR surveys. For the purposes of our evaluation, we assumed an average 8 feet of clean soil covers an average 9-foot-thick layer of debris. Approximately 12,900 cy of clean overburden and 14,500 cy of debris would require excavation; the clean soil would be reused as fill while the debris would be transported to the FNSB landfill for disposal. A bulldozer, wheeled loader, and excavator (for deeper debris) would be used to move overburden and excavate and load debris, while dump trucks would transport debris to the landfill. We anticipate the field effort would take about 30 days.

Alternative 4 would have a limited ability to meet cleanup objectives; debris is removed from a small area relative to what would be desirable. Debris removal from this area would likely reduce but not eliminate the VI potential and risks or impacts to human health and the environment. The potential for VI may remain from buried landfill materials adjacent to the Alternative 4 excavation area. Elevated concentrations of methane and volatile compounds were found in soil gas in this area. As such, ICs and engineering controls may be more stringent than those needed for Alternatives 2 and 3 to document and manage VI potential from adjacent areas. ICs and engineering controls that restrict vertical construction should not be necessary once the debris is removed.

This alternative would be more difficult to implement than Alternatives 2 and 3 because of challenges posed by deeper excavation. The area is easily accessible to excavation equipment and the work can be done using standard earthmoving equipment. If present, contaminated soil or hazardous materials can be segregated and managed for disposal, but that would add to the project complexity. Debris in this area may extend much deeper than in other portions of the landfill, and may require excavation below the water table. Dewatering could be required, which would also add to the project complexity. Implementing this alternative will result in short-term disruption to the Carlson Center parking area, which would also require repair following completion of the debris removal.

The cost to implement Alternative 4 is estimated to be $410,000 plus $1,550,000 in landfill tipping fees, for a total of $1,960,000. This estimate may vary considerably based on the actual quantities of soil and debris handled.

This estimate exceeds the available funds by a factor of 10. It is unlikely progress toward the project objectives can be made by limiting the scope of cleanup activities to available funds.

This cost includes the following basic elements:

- dozer, loader, excavator, dump trucks, and operators/drivers;
- debris transportation to and disposal at the FNSB landfill;
- reuse of clean overburden as backfill;
- import of additional clean fill as needed for deep backfill;
- import, placement, and compaction of structural fill as needed for asphalt base course;
- asphalt parking lot repair;
- construction oversight/field observation;
- confirmation soil sampling at base of excavation; and

- administrative costs.

6.2.5 Alternative 5: Cleanup of Entire Landfill

Alternative 5 consists of excavation and full removal of landfill debris. The landfill is estimated to cover approximately 14 acres; this is based on geophysical surveys, and limited soil boring and test pit excavation information. The nature and extent of debris within this area is not well-defined, which presents a greater degree of uncertainty as to the implementability and cost of this alternative. While available data shows isolated occurrences of contaminants in the soil and groundwater, previous field investigations have not identified specific contaminant sources. If contaminant sources such as containers of petroleum products or other hazardous materials are present, they would be segregated from the nonhazardous waste stream and disposed of in accordance with applicable state and federal regulations. One previous site investigation (URS, 2005) found PCB Aroclor-1254 exceeding its cleanup level in one subsurface soil sample. URS recommended further evaluation of PCBs; this alternative includes field assessment of soil and wastes during removal but does not include transportation and out-of-state disposal of PCB-contaminated soils.

For the purposes of our evaluation, we assumed an average 8 feet of clean soil covers a 4-foot-thick layer of debris. Approximately 184,000 cy of clean overburden and 92,000 cy of debris would require excavation. Significant variance from these averages would be anticipated over the project area, due to the variable depth and thickness of debris and overburden. Mechanical separation would reduce the quantity of material transported to the landfill, which would reduce the cost. Because of uncertainties regarding the amount of volume reduction that could be achieved with mechanical separation, our cost assessment conservatively assumes all wastes will be disposed at the landfill.

We assume clean soil would be reused as fill while the debris would be transported to the FNSB landfill for disposal. A combination of bulldozers, wheeled loaders, and excavators would be used to move overburden, and excavate and load debris, while dump trucks would transport debris to the landfill. Rather than restoring the site to its pre-remediation condition, the post-remediation ground level could be regraded to reduce the need to import clean fill. We anticipate the field effort would take about eight months, presumably spread over two field seasons.

Alternative 5 would have the greatest ability to meet the project objectives to enable site reuse and development and eliminate the need for ICs; however, it has an estimated cost an order of magnitude greater than the other alternatives, and would be characterized by significant disruptions to site use during cleanup. By design, this alternative would eliminate the need for ICs or engineering controls by removing buried debris, contaminated soil, and other potentially hazardous materials that may be present. Long-term risks to human health and the environment would be eliminated, but short-term risks would increase due to field activities and increased equipment traffic on city streets.

This alternative would be difficult to implement because of the size and scope, the disruption to existing site uses, and the ability to secure funding.

The cost to implement Alternative 5 is estimated to be on the order of $3,000,000 plus $9,800,000 in landfill tipping fees, which exceeds available cleanup grant funds. This estimate includes the following basic elements:

- dozer, loader, excavator, dump trucks, and operators/drivers;
- debris transportation to and disposal at FNSB landfill;
- reuse of clean overburden as backfill;
- construction oversight/field observation;
- confirmation soil sampling at base of excavation; and
- administrative costs.

We did not include costs for the following elements:

- PCB-contaminated soil transportation and disposal;
- baseball-field replacement;
- asphalt parking lot replacement;
- bicycle/walking path replacement; and/or
- import of additional clean, organic-free fill as needed for backfill.

6.2.6 Alternative 6: Recreational Facility Improvements

Alternative 6 consists of constructing recreational facility improvements and includes four distinct elements, which can be implemented individually or in combination. The purpose of this alternative is to improve community use of the site, reduce risk from fugitive dust and vapor migration to outdoor air, and limit stormwater infiltration through buried debris, within the available grant funding. The four elements include:

- A 0.5-acre parking lot adjacent to ARCO baseball field. This element would require surface preparation such as grading and limited excavation and removal of nonstructural soil, base course placement, and placement and compaction of the parking area surface cover.

- A 0.9-acre overflow parking lot adjacent to the existing Carlson Center parking lot. This element would require surface preparation such as grading and limited excavation and removal of nonstructural soil, base course placement, and placement and compaction of the parking area surface cover.

- An approximately 600-foot access road connecting the north Wilbur Street extension to each parking lot. This element would require surface preparation such as grading and limited excavation and removal of nonstructural soil, base course placement, and placement and compaction of the roadway surface cover.

- A 1.3-acre multi-purpose turf field north of the existing Carlson Center parking lot. This element would require surface preparation such as grading and limited excavation and removal of nonstructural soil, placement of a drainage layer, and placement and seeding of the turf surface cover.

The parking lots and access road will be constructed of recycled asphalt pavement (RAP) or a similar compacted low-permeability surface.

The base of disturbed soil, and by inference the base of landfill debris, is estimated at depths ranging from 12 feet to 24 feet bgs, based on previous GPR surveys. As noted in the description of Alternative 4, we assume an average 8 feet of clean soil covers the landfill debris in this area. However, drums and debris may be buried as shallow as 2 feet bgs, as observed in September 2010 construction at the ARCO baseball field. We assume debris will not be encountered and no excavated material will require disposal at the landfill. The duration of field activities is dependent on the scope and sequence of construction; we anticipate the field effort would take between 30 and 60 days.

Alternative 6 would not result in debris removal, but would meet the project objectives by enabling reuse of the site with available funds while partially mitigating potentially complete exposure pathways. By constructing the access road and parking areas, the potential for site users to be exposed to fugitive dust would be reduced. Compacted parking and driving surfaces would serve as a low-permeability cover over portions of the landfill, thereby reducing the potential for site users to be exposed to outdoor vapor inhalation. However, with no similar cap at the proposed turf field, outdoor vapor inhalation may remain a complete exposure pathway, noting that data gaps exist for near-surface soil and ambient outdoor air. Final surface grading would improve stormwater drainage patterns and reduce rainfall and snowmelt infiltration through buried debris.

There is a potential for vapors to migrate from buried landfill materials adjacent to the Alternative 6 improvement areas to outdoor air. Methane and volatile compounds were detected in soil and soil gas in these areas. ICs and ECs may be necessary to restrict excavation throughout the landfill area. As the September 2010 buried drum discovery demonstrated, buried debris remains a potential hazard during even limited site improvements. ICs should include provisions that require any excavation be conducted by personnel trained in hazardous material identification and spill response.

This alternative would be relatively easy to implement. The area is accessible and the work can be done using standard earthmoving equipment. Soil excavation is expected to be limited to less than 2 feet, consisting mainly of surface preparation for parking area or roadway materials. If present, contaminated soil or hazardous materials can be segregated and managed for disposal. Implementing this alternative will result in a short-term disruption to access to the ARCO baseball field and use of the undeveloped area north of the Carlson Center parking area.

The cost to implement all four elements of Alternative 6 is estimated to be $350,000. Because this exceeds the amount of available grant funds, it may be practicable to implement this alternative in a phased manner that prioritizes the individual elements. The estimated cost for each element is described below. We developed these cost estimates in consultation with a Fairbanks-area contractor.

- Parking lot adjacent to ARCO baseball field: $66,000
- Parking lot adjacent to the existing Carlson Center parking lot: $100,000
- Access road connecting the north Wilbur Street extension to each parking lot: $92,000
- Multi-purpose turf field north of the existing Carlson Center parking lot: $92,000

These costs include the following basic elements:

- dozer, grader, and operators/drivers;
- reuse of clean overburden as backfill;

- import, placement, and compaction of structural fill and recycled asphalt as needed for parking area, roadway, and athletic field preparation and construction;
- surface grading to facilitate stormwater runoff drainage;
- athletic field seeding;
- construction oversight/field observation;
- administrative costs.

We also assume for costing purposes that the project will not incur transportation or landfill tipping fees for potentially contaminated soil and that no drums are encountered.

6.3 Recommendation of Preferred Alternative

We recommend Alternative 6, construction of Recreational Facility Improvements, as the preferred alternative for the former City of Fairbanks Landfill site. Of the five alternatives considered other than no-action, it allows beneficial reuse of the site, reduces potential site user exposures to fugitive dust and vapors, and transforms undeveloped areas into useable space, with restrictions, and result in no net loss of snow storage area. We recognize that implementing all four elements of this alternative may exceed available grant funding. We assume the FNSB will prioritize each element then proceed with construction of to the extent possible using available grant funds.

7.0 REFERENCES

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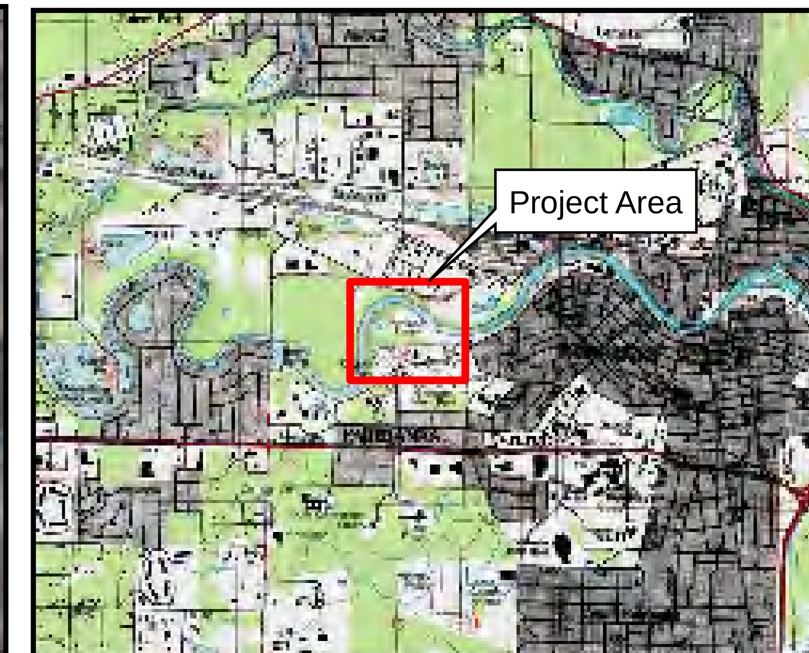
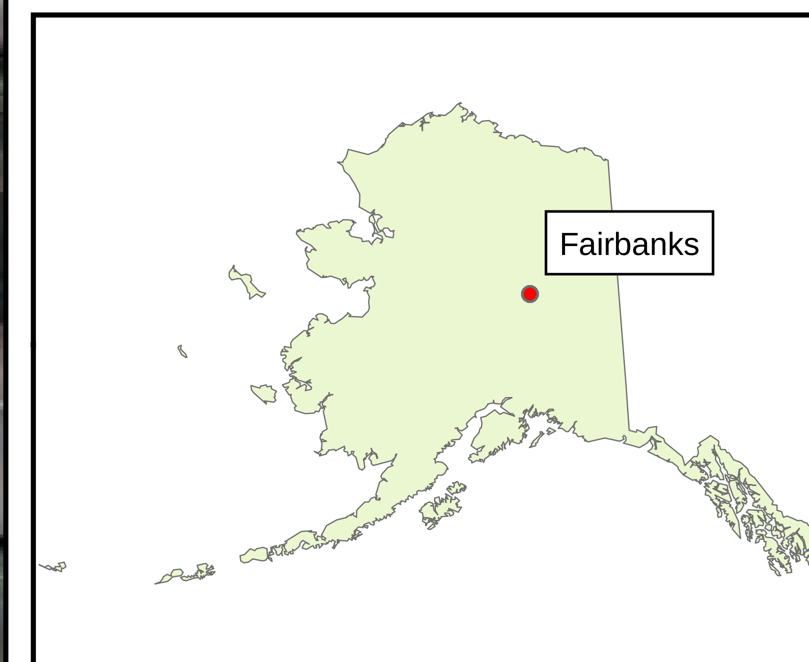
Alternative	Effectiveness: Degree of debris removal and useable land made available	Effectiveness: How/whether the alternative will meet the cleanup objectives	Effectiveness: Potential for vapor intrusion (VI)	Effectiveness: Land use restrictions or Institutional Controls (IC) Required	Effectiveness: Engineering controls required	Effectiveness: Significant risks or impacts to human health and the environment	Implementability: Feasibility of alternative for site	Implementability: Time to achieve objectives/completion	Implementability: Other considerations	Cost
Alternative 1 - No Action	No debris removal. Land is useable but will require IC, EC.	Cleanup objective will not be met.	Vapor intrusion potential could exist for future buildings.	Highly restrictive of future land use.	Controls may be needed to manage VI from buried debris;, and to restrict, prevent, or specify construction requirements for building on waste (e.g., piles, etc.) or vertical construction	No change in risk of exposure to landfill gases.	Highly implementable. No technical or administrative issues.	Not applicable, since objectives would not be achieved.	No action may limit or prevent potential future site development.	Administrative cost estimated at $20,000.
Alternative 2 - Excavate and remove landfill debris from northern portion of existing snow dump area.	Debris removal over approximately 1.2 acres.	Debris removal will facilitate reuse/redevelopment of up to 4 acres. However, this area will continue to be used for snow storage.	Vapor intrusion potential reduced as a result of debris removal. Potential for VI from buried debris area outside development (to west of Alternative 2).	IC noting potential for VI as a result of buried debris west of Alternative 2 area.	Controls may be needed to manage VI from buried debris west of Alternative 2 area.	Risk of exposure to landfill gases and VI would be reduced as a result of debris removal. Short-term exposure would increase during excavation and debris removal.	Excavation and disposal of non-hazardous soil and debris is readily implementable. Contaminated soil or hazardous materials would complicate handling and disposal.	Field work could be conducted in one field season.	Area would not be available for development as long as it remains a snow storage site.	Cleanup cost estimated at $50,000. Landfill tipping fees estimated at $255,000.
Alternative 3 - Alternative 2 plus relocate snow dump to area north of Carlson Center parking lot/ARCO baseball field.	Same source area removal as Alt 2.	Debris removal will create up to 4 acres meeting cleanup objectives.	Vapor intrusion potential reduced as a result of debris removal. Potential for VI from buried debris area outside development (to west of Alternative 2).	IC noting potential for VI as a result of buried debris west of Alternative 2 area.	Controls may be needed to manage VI from buried debris west of Alternative 2 area, and stormwater/ snowmelt runoff from new snow storage area.	Risk of exposure to landfill gases and VI would be reduced as a result of debris removal. Short-term exposure would increase during excavation and debris removal. Surface water runoff may affect Chena River. Stormwater infiltration may mobilize contaminants in waste.	Same technical issues with waste handling/disposal as Alternative 2. Permitting and/or contractual issues may need to be resolved to designate a new snow storage area.	Field work could be conducted in one field season.	Possible permitting associated with creating new snow dump area. Potential for resistance to snow storage from competing user groups.	Cleanup cost estimated at $80,000. Landfill tipping fees estimated at $255,000.
Alternative 4 - Excavate and remove landfill debris from central portion of Carlson Center parking lot.	Complete debris removal over approximately 1 acre.	Debris removal over this area will meet cleanup objectives only within the limits of debris removal.	Vapor intrusion potential reduced as a result of debris removal. Potential for VI from buried debris area outside development (to east and north of Alternative 3).	IC noting potential for VI as a result of buried debris east and north of Alternative 3 area.	If not all waste can be excavated, vertical development may require geotechnical solutions.	Risk of exposure to landfill gases and VI would be reduced as a result of debris removal. Short-term exposure would increase during excavation and debris removal.	Excavation and disposal of non-hazardous soil and debris is implementable. The estimated depth of debris in this area could limit the practical debris removal value. Contaminated soil or hazardous materials would complicate handling and disposal.	Field work could be conducted in one field season.	Temporary loss of portion of Carlson Center parking area, possibly creating the need to seek additional parking area elsewhere. No issues associated with changing/moving snow dump area.	Cleanup cost estimated at $410,000. Landfill tipping fees estimated at $1,550,000.
Alternative 5 - Excavate and remove all landfill debris.	Complete debris removal over approximately 14 acres.	Meets cleanup objectives with respect to debris removal, with no restrictions on future development.	Complete debris removal should eliminate potential for vapor intrusion.	Complete debris removal should eliminate the need for ICs.	Complete debris removal should eliminate the need for engineering controls.	Complete debris removal should eliminate long-term risks to human health and the environment; however, short-term exposure risks will increase during remediation.	Will require extensive planning and phasing to limit disruption to nearby site users. Potential technical difficulties with protecting integrity of Chena River shoreline, water quality. Contaminated soil or hazardous materials would complicate handling and disposal.	Field work could extend over several field seasons.	Possible community resistance to scope, cost of remediation.	Cleanup cost estimated at $3,000,000. Landfill tipping fees estimated at $9,800,000.
Alternative 6 - Construct recreational facility improvements a) ARCO parking lot b) Carlson Ctr parking lot c) Access road d) Multi-purpose turf field	No debris removal. Land is useable but will require IC, EC.	Reduces exposure to dust and vapors in outdoor air. Does not mitigate the presence of waste or impacted media, or improve the potential for vertical development.	This alternative consists of at-grade improvements only. VI potential is not considered because no occupied structures are planned. Outdoor vapor inhalation may remain an exposure pathway.	IC prohibiting excavation or other land uses without appropriate precautionary measures.	Surface drainage will need to be controlled to manage stormwater runoff.	Excavation should be limited to surface grading, which entails less potential exposure to impacted media than debris-removal alternatives. Risk to human health is reduced, as the compacted surfaces (road, parking area) may reduce the potential for vapor migration from buried debris to outdoor air.	This alternative consists primarily of surface grading and at-grade improvements. Planning and implementation should be relatively uncomplicated.	Field work could be conducted in one field season.	Implementation expected to be less disruptive to existing surrounding site users than Alternatives 2 through 5.	a) $66,000 b) $100,000 c) $92,000 d) $92,000 Total $350,000

Notes:
IC institutional controls
EC engineering controls
VI vapor intrusion





Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

SITE PLAN

March 2011

32-1-17166-012

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FIGURE 1

Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

PREVIOUS SITE USE
MAY 24, 1960

March 2011 32-1-17166-012

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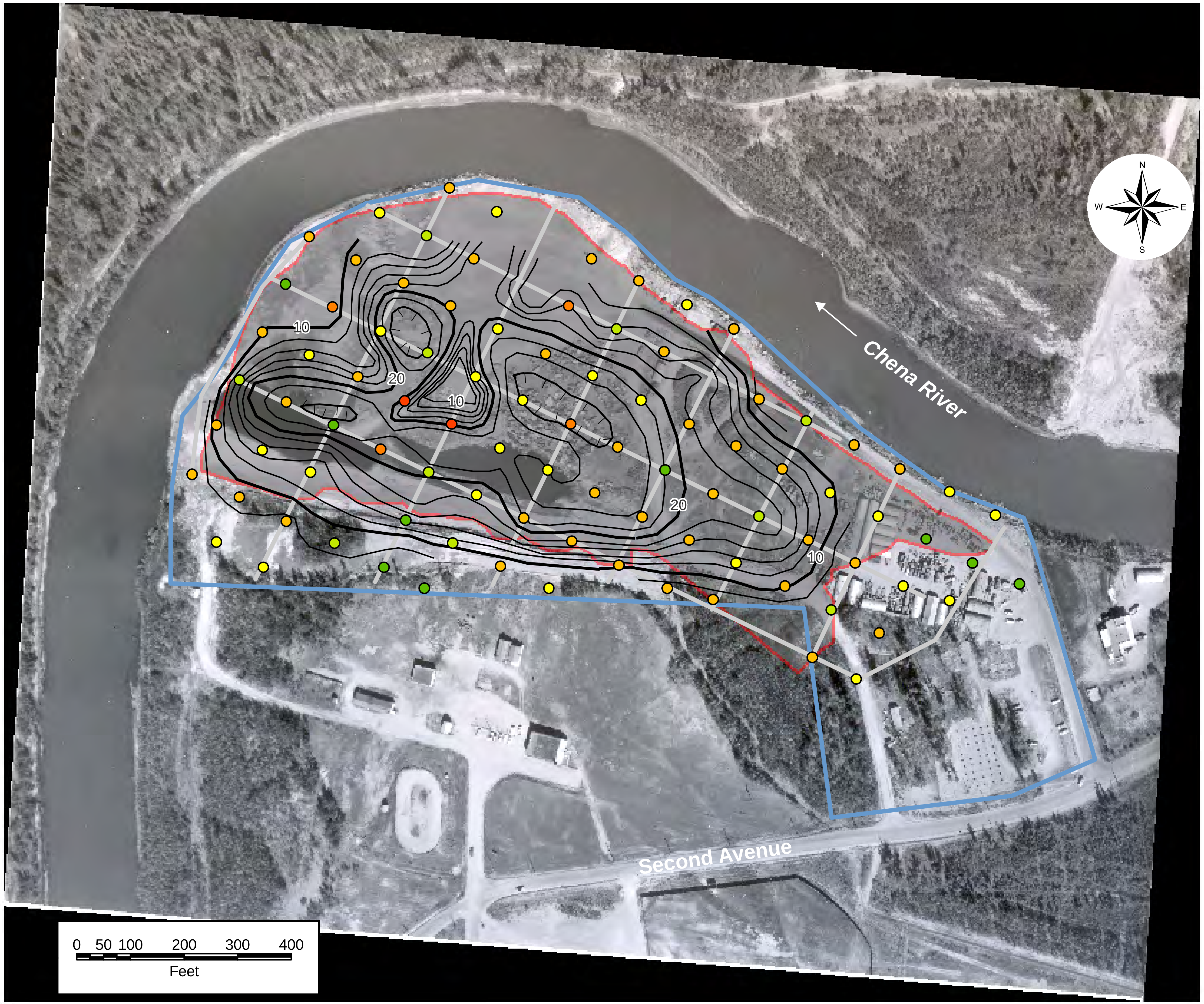
FIGURE 2



Legend

Field Meter Methane

(ppmV)

- <1
- 1 - 10
- 10 - 100
- 100 - 1,000
- 1,000- 5,000
- >5,000
- FNSB Project Boundaries
- GPR Transects (2007, GeoTek Alaska)
- Inferred depth of disturbed soil based on 2007 GPR survey (2 foot contour intervals)
- Landfill extent based on 2005 geophysical survey conducted by URS/BlackHawk

Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

METHANE SOIL GAS MEASUREMENTS (LandTech Meter)

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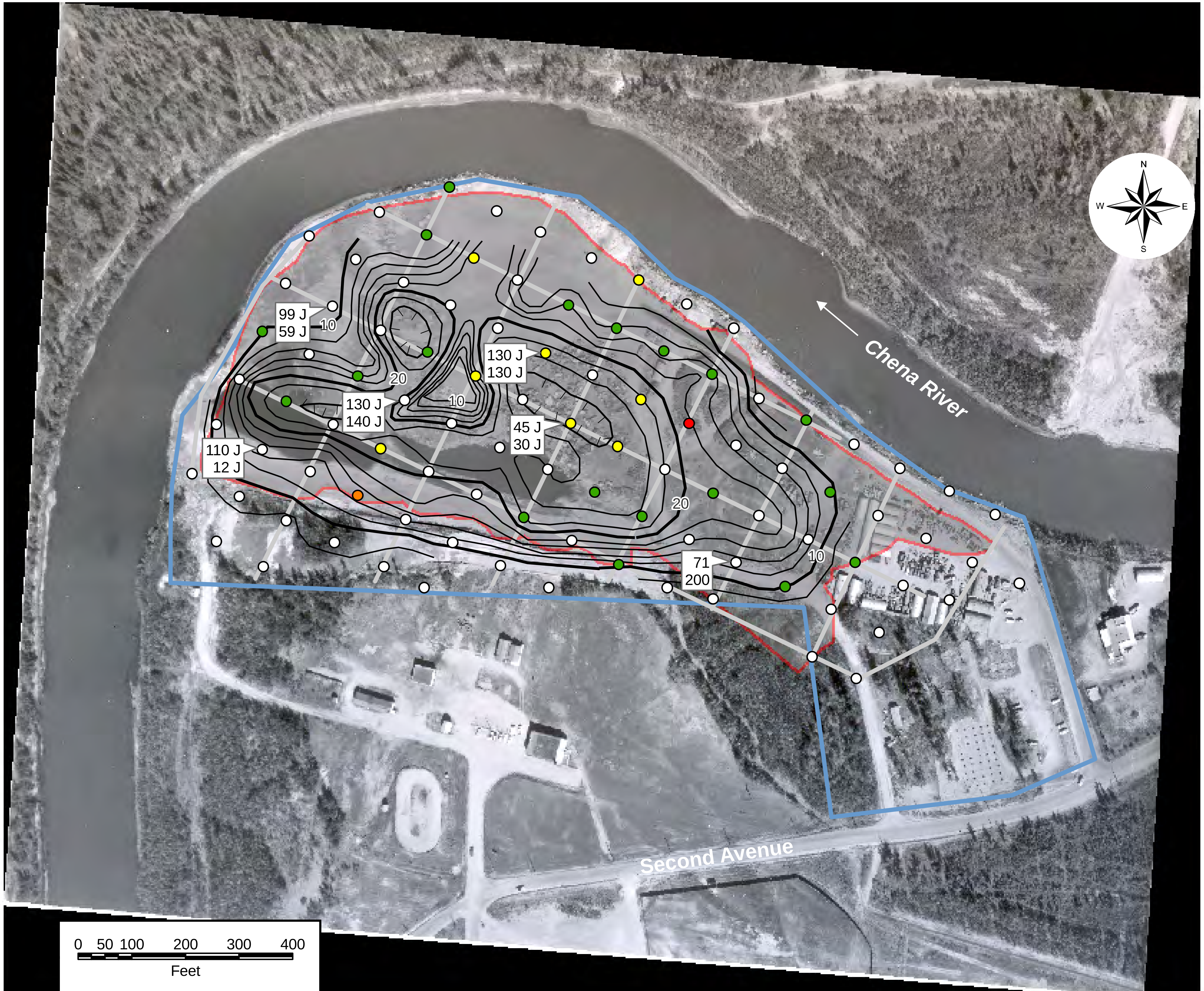
FIGURE 3



Legend

Field PID Measurements (ppmV)

- 0.0
- 0.1 - 1.0
- 1.1 - 10.0
- 10.1 - 100.0
- >100

45 J / 30 J — Project Laboratory Soil Gas Concentrations (µg/m³) : Benzene, Tetrachloroethene (PCE)

J = Estimated Concentration

FNSB Project Boundaries

GPR Transects (2007, GeoTek Alaska)

Inferred depth of disturbed soil based on 2007 GPR survey (2 foot contour intervals)

Landfill extent based on 2005 geophysical survey conducted by URS/BlackHawk

Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

VOC SOIL GAS MEASUREMENTS (PID and Project Laboratory)

March 2011 | 32-1-17166-012

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FIGURE 4

Legend

- Soil Borings (2007, Shannon & Wilson)
- Monitoring Wells (2007, Shannon & Wilson)
- Test Pits (2007, Shannon & Wilson)
- Soil Borings (2005, URS)
- Inferred depth of disturbed soil based on 2007 GPR survey (2 foot contour intervals)
- Landfill extent based on 2005 geophysical survey conducted by URS/BlackHawk

Notes:

Waste depth observed given in feet below ground surface.

Waste may have been present at direct-push monitoring wells, but could not be observed.

Analytes listed exceed cleanup levels:
Ba barium
Cr chromium
Pb lead
PCB polychlorinated biphenyls

For sample depths and analyte concentrations, see URS, 2005 and Shannon & Wilson, 2008.

Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

SOIL BORINGS, MONITORING WELLS, AND TEST PITS

March 2011 32-1-17166-012

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FIGURE 5

HUMAN HEALTH CONCEPTUAL SITE MODEL

Site: Former City of Fairbanks Landfill
Fairbanks, Alaska

Completed By: Shannon & Wilson, Inc.
Date Completed: March 2011

Follow the directions below. <u>Do not</u> consider engineering or land use controls when describing pathways.

(1) *Check the media that could be directly affected by the release.*

(2) *For each medium identified in (1), follow the top arrow <u>and</u> check possible transport mechanisms. Briefly list other mechanisms or reference the report for details.*

(3) *Check exposure media identified in (2).*

(4) *Check exposure pathways that are complete or need further evaluation. <u>The pathways identified must agree with Sections 2 and 3 of the CSM Scoping Form</u>.*

(5) *Identify the receptors potentially affected by each exposure pathway: Enter "C" for current receptors, "F" for future receptors, or "C/F" for both current and future receptors.*

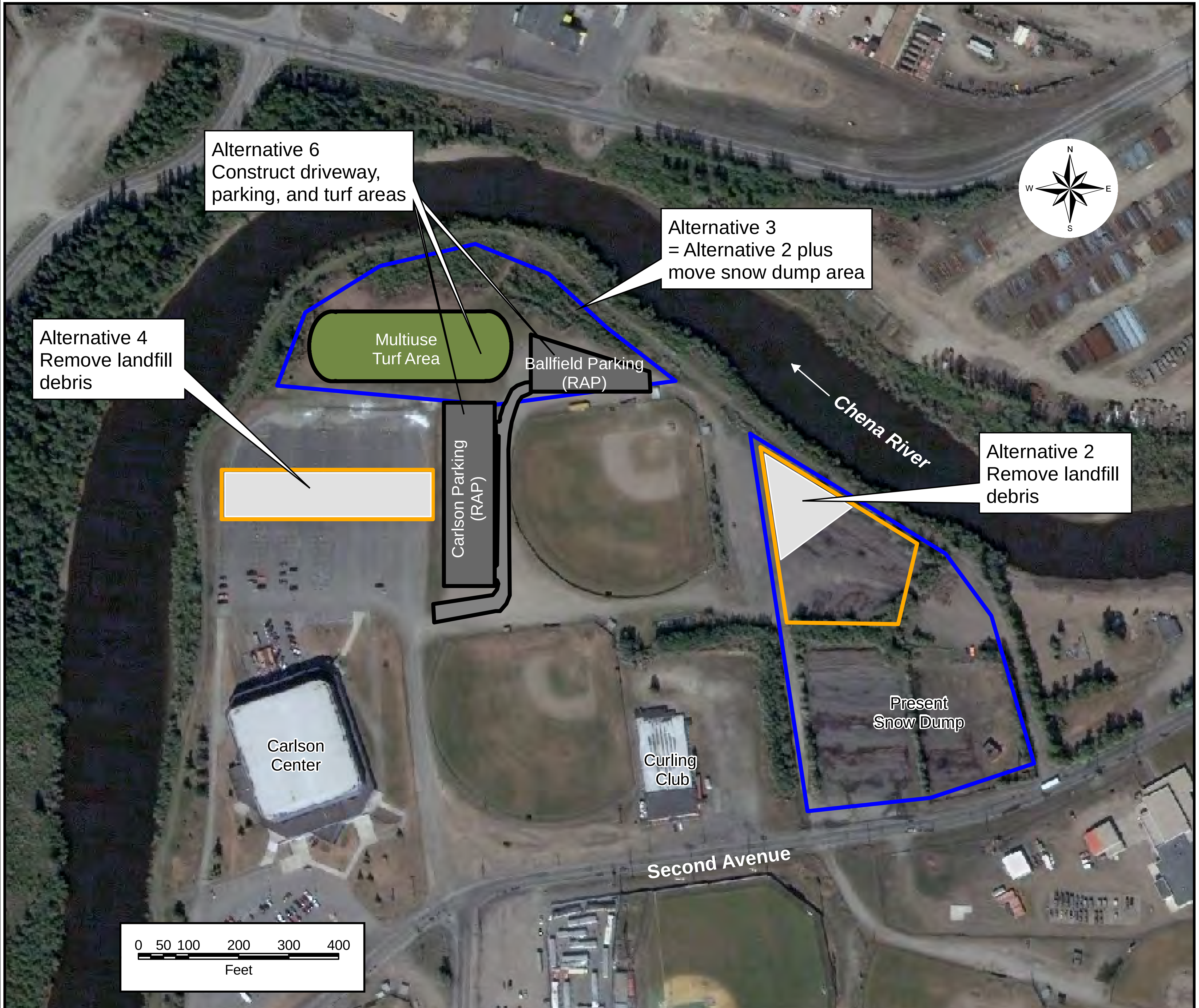
Media / Transport Mechanisms

Media	Transport Mechanisms	Check
[x] Surface Soil (0-2 ft bgs)	Direct release to surface soil	check soil
	[x] Migration or leaching to subsurface	check soil
	[x] Migration or leaching to groundwater	check groundwater
	[x] Volatilization	check air
	[ ] Runoff or erosion	check surface water
	[ ] Uptake by plants or animals	check biota
	[ ] Other (*list*): Fairbanks Old City Landfill	
[x] Subsurface Soil (2-15 ft bgs)	Direct release to subsurface soil	check soil
	[x] *Migration to groundwater*	check groundwater
	[x] *Volatilization*	check air
	[ ] *Other (list):* 102.38.138	
[ ] Ground-water	Direct release to groundwater	check groundwater
	[ ] *Volatilization*	check air
	[x] *Flow to surface water body*	check surface water
	[x] *Flow to sediment*	check sediment
	[ ] *Uptake by plants or animals*	check biota
	[x] *Other (list):* Shannon & Wilson, Inc.	
[ ] Surface Water	Direct release to surface water	check surface water
	[ ] *Volatilization*	check air
	[x] *Sedimentation*	check sediment
	[x] *Uptake by plants or animals*	check biota
	[x] *Other (list):* Unclassified wastes	
[ ] Sediment	Direct release to sediment	check sediment
	[ ] *Resuspension, runoff, or erosion*	check surface water
	[x] *Uptake by plants or animals*	check biota
	[ ] *Other (list):* Waste burial	

Exposure Media / Exposure Pathways / Current & Future Receptors

Exposure Media	Exposure Pathways	Residents (adults or children)	Commercial or industrial workers	Site visitors, trespassers, or recreational users	Construction workers	Farmers or subsistence harvesters	Subsistence consumers	Other
[x] soil	[x] Incidental Soil Ingestion	F	F	C/F	F			
	[x] Dermal Absorption of Contaminants from Soil		F	C/F	F			
[x] groundwater	[x] Ingestion of Groundwater	F	F	F	F			
	[x] Dermal Absorption of Contaminants in Groundwater				F			
	[ ] Inhalation of Volatile Compounds in Tap Water							
[x] air	[ ] Inhalation of Outdoor Air	F	F	C/F	F			
	[x] Inhalation of Indoor Air	F	F	F	F			
	[x] Inhalation of Fugitive Dust	F	F	C/F	F			
[x] surface water	[x] Ingestion of Surface Water							
	[ ] Dermal Absorption of Contaminants in Surface Water							
	[x] Inhalation of Volatile Compounds in Tap Water							
[ ] sediment	[ ] Direct Contact with Sediment							
[x] biota	[x] Ingestion of Wild Foods							

Figure 6



Legend

Area of significant debris within Alternative area

Fairbanks North Star Borough
Former City of Fairbanks Landfill
Fairbanks, Alaska

BROWNFIELDS CLEANUP ALTERNATIVES

March 2011

32 -1-17166-012

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 7

APPENDIX A

Conceptual Site Model Scoping Document

Human Health Conceptual Site Model
Scoping Form

Site Name: Fairbanks Old City Landfill

File Number: 102.38.138

Completed by: Shannon & Wilson, Inc.

Introduction

The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, a CSM graphic and text must be submitted with the site characterization work plan.

General Instructions: Follow the italicized instructions in each section below.

1. *General Information:*

Sources *(check potential sources at the site)*

- ☐ USTs
- ☐ ASTs
- ☐ Dispensers/fuel loading racks
- ☑ Drums
- ☑ Vehicles
- ☑ Landfills
- ☐ Transformers
- ☑ Other: Unclassified wastes

Release Mechanisms *(check potential release mechanisms at the site)*

- ☐ Spills
- ☑ Leaks
- ☐ Direct discharge
- ☐ Burning
- ☑ Other: Waste burial

Impacted Media *(check potentially-impacted media at the site)*

- ☑ Surface soil (0-2 feet bgs*)
- ☑ Subsurface Soil (>2 feet bgs)
- ☑ Air
- ☑ Groundwater
- ☑ Surface water
- ☐ Other:

Receptors (*check receptors that could be affected by contamination at the site)*

- ☐ Residents (adult or child)
- ☐ Commercial or industrial worker
- ☑ Construction worker
- ☐ Subsistence harvester (i.e., gathers wild foods)
- ☐ Subsistence consumer (i.e., eats wild foods)
- ☑ Site visitor
- ☐ Trespasser
- ☑ Recreational user
- ☐ Farmer
- ☐ Other:

* bgs – below ground surface

2. *Exposure Pathways:* *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) Direct Contact –

1 Incidental Soil Ingestion

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

If both boxes are checked, label this pathway complete: Complete

2 Dermal Absorption of Contaminants from Soil

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

Can the soil contaminants permeate the skin? (Contaminants listed below, or within the groups listed below, should be evaluated for dermal absorption). ☑

Arsenic	Lindane
Cadmium	PAHs
Chlordane	Pentachlorophenol
2,4-dichlorophenoxyacetic acid	PCBs
Dioxins	SVOCs
DDT	

If all of the boxes are checked, label this pathway complete: Complete

b) Ingestion –

1 Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, OR are contaminants expected to migrate to groundwater in the future? ☑

Could the potentially affected groundwater be used as a current or future drinking water source? *Please note, only leave the box unchecked if ADEC has determined the groundwater is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350.* ☑

If both the boxes are checked, label this pathway complete: Complete

2 Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water OR are contaminants expected to migrate to surface water in the future? ☐

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? *Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities).* ☐

If both boxes are checked, label this pathway complete: ________________________

3 Ingestion of Wild Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild food? ☐

Do the site contaminants have the potential to bioaccumulate (*see* Appendix A)? ☐

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. the top 6 feet of soil, in groundwater that **could be** connected to surface water, etc.) ☐

If all of the boxes are checked, label this pathway complete: ________________________

c) Inhalation

1 Inhalation of Outdoor Air

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

Are the contaminants in soil volatile (*See Appendix B*)? ☑

If all of the boxes are checked, label this pathway complete: Complete

2 Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be placed on the site in an area that could be affected by contaminant vapors? (i.e., within 100 feet, horizontally or vertically, of the contaminated soil or groundwater, <u>or</u> subject to "preferential pathways" that promote easy airflow, like utility conduits or rock fractures) ☐

Are volatile compounds present in soil or groundwater (*See Appendix C*)? ☐

If both boxes are checked, label this pathway complete: ________________________

3. *Additional Exposure Pathways:* *(Although there are no definitive questions provided in this section, these exposure pathways should also be considered at each site. Use the guidelines provided below to determine if further evaluation of each pathway is warranted.)*

Dermal Exposure to Contaminants in Groundwater and Surface Water

Exposure from this pathway may need to be assessed only in cases where DEC water-quality or drinking-water standards are not being applied as cleanup levels. Examples of conditions that may warrant further investigation include:

- Climate permits recreational use of waters for swimming,
- Climate permits exposure to groundwater during activities, such as construction, without protective clothing, or
- Groundwater or surface water is used for household purposes.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Volatile Compounds in Household Water

Exposure from this pathway may need to be assessed only in cases where DEC water-quality or drinking-water standards are not being applied as cleanup levels. Examples of conditions that may warrant further investigation include:

- The contaminated water is used for household purposes such as showering, laundering, and dish washing, <u>and</u>
- The contaminants of concern are volatile (common volatile contaminants are listed in Appendix B)

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Fugitive Dust

Generally DEC soil ingestion cleanup levels in Table B1 of 18 AAC 75 are protective of this pathway, although this is not true in the case of chromium. Examples of conditions that may warrant further investigation include:

- Nonvolatile compounds are found in the top 2 centimeters of soil. The top 2 centimeters of soil are likely to be dispersed in the wind as dust particles.
- Dust particles are less than 10 micrometers. This size can be inhaled and would be of concern for determining if this pathway is complete.

Check the box if further evaluation of this pathway is needed: ☑

Comments:

The existing data set does not include information on the chemical or physical characteristics of the top 2 centimeters of soil.

Direct Contact with Sediment

This pathway involves people's hands being exposed to sediment, such as during recreational or some types of subsistence activities. People then incidentally **ingest** sediment from normal hand-to-mouth activities. In addition, **dermal absorption of contaminants** may be of concern if people come in contact with sediment and the contaminants are able to permeate the skin (see dermal exposure to soil section). This type of exposure is rare but it should be investigated if:

- Climate permits recreational activities around sediment, and/or
- Community has identified subsistence or recreational activities that would result in exposure to the sediment, such as clam digging.

ADEC soil ingestion cleanup levels are protective of direct contact with sediment. If they are determined to be over-protective for sediment exposure at a particular site, other screening levels could be adopted or developed.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

4. Other Comments (*Provide other comments as necessary to support the information provided in this form.)*

APPENDIX A

BIOACCUMULATIVE COMPOUNDS

Table A-1: List of Compounds of Potential Concern for Bioaccumulation

Organic compounds are identified as bioaccumulative if they have a BCF equal to or greater than 1,000 or a log K_{ow} greater than 3.5. Inorganic compounds are identified as bioaccumulative if they are listed as such by EPA (2000). Those compounds in Table X of 18 AAC 75.345 that are bioaccumulative, based on the definition above, are listed below.

Aldrin	DDT	Lead
Arsenic	Dibenzo(a,h)anthracene	Mercury
Benzo(a)anthracene	Dieldrin	Methoxychlor
Benzo(a)pyrene	Dioxin	Nickel
Benzo(b)fluoranthene	Endrin	PCBs
Benzo(k)fluoranthene	Fluoranthene	
Cadmium	Heptachlor	Pyrene
Chlordane	Heptachlor epoxide	Selenium
Chrysene	Hexachlorobenzene	Silver
Copper	Hexachlorocyclopentadiene	Toxaphene
DDD	Indeno(1,2,3-c,d)pyrene	Zinc
DDE		

Because BCF values can relatively easily be measured or estimated, the BCF is frequently used to determine the potential for a chemical to bioaccumulate. A compound with a BCF greater than 1,000 is considered to bioaccumulate in tissue (EPA 2004b).

For inorganic compounds, the BCF approach has not been shown to be effective in estimating the compound's ability to bioaccumulate. Information available, either through scientific literature or site-specific data, regarding the bioaccumulative potential of an inorganic site contaminant should be used to determine if the pathway is complete.

The list was developed by including organic compounds that either have a BCF equal to or greater than 1,000 or a log K_{ow} greater than 3.5 and inorganic compounds that are listed by the United States Environmental Protection Agency (EPA) as being bioaccumulative (EPA 2000). The BCF can also be estimated from a chemical's physical and chemical properties. A chemical's octanol-water partitioning coefficient (K_{ow}) along with defined regression equations can be used to estimate the BCF. EPA's Persistent, Bioaccumulative, and Toxic (PBT) Profiler (EPA 2004) can be used to estimate the BCF using the K_{ow} and linear regressions presented by Meylan et al. (1996). The PBT Profiler is located at http://www.pbtprofiler.net/. For compounds not found in the PBT Profiler, DEC recommends using a log K_{ow} greater than 3.5 to determine if a compound is bioaccumulative.

APPENDIX B

VOLATILE COMPOUNDS

Table B-1: List of Volatile Compounds of Potential Concern
Common volatile contaminants of concern at contaminated sites. A chemical is defined as volatile if the Henry's Law constant is 1 x 10^{-5} atm-m^3/mol or greater and the molecular weight less than 200 g/mole (g/mole; EPA 2004a). Those compounds in Table X of 18 AAC 75.345 that are volatile, based on the definition above, are listed below.

Acenaphthene	1,4-dichlorobenzene	Pyrene
Acetone	1,1-dichloroethane	Styrene
Anthracene	1,2-dichloroethane	1,1,2,2-tetrachloroethane
Benzene	1,1-dichloroethylene	Tetrachloroethylene
Bis(2-chlorethyl)ether	Cis-1,2-dichloroethylene	Toluene
Bromodichloromethane	Trans-1,2-dichloroethylene	1,2,4-trichlorobenzene
Carbon disulfide	1,2-dichloropropane	1,1,1-trichloroethane
Carbon tetrachloride	1,3-dichloropropane	1,1,2-trichloroethane
Chlorobenzene	Ethylbenzene	Trichloroethylene
Chlorodibromomethane	Fluorene	Vinyl acetate
Chloroform	Methyl bromide	Vinyl chloride
2-chlorophenol	Methylene chloride	Xylenes
Cyanide	Naphthalene	GRO
1,2-dichlorobenzene	Nitrobenzene	DRO

APPENDIX C

COMPOUNDS OF CONCERN FOR VAPOR MIGRATION

Table C-1: List of Compounds of Potential Concern for the Vapor Migration

A chemical is considered sufficiently toxic if the vapor concentration of the pure component poses an incremental lifetime cancer risk greater than 10-6 or a non-cancer hazard index greater than 1. A chemical is considered sufficiently volatile if it's Henry's Law constant is 1 x 10^{-5} atm-m^3/mol or greater.

Acenaphthene	Dibenzofuran	Hexachlorobenzene
Acetaldehyde	1,2-Dibromo-3-chloropropane	Hexachlorocyclopentadiene
Acetone	1,2-Dibromoethane (EDB)	Hexachloroethane
Acetonitrile	1,3-Dichlorobenzene	Hexane
Acetophenone	1,2-Dichlorobenzene	Hydrogen cyanide
Acrolein	1,4-Dichlorobenzene	Isobutanol
Acrylonitrile	2-Nitropropane	Mercury (elemental)
Aldrin	N-Nitroso-di-n-butylamine	Methacrylonitrile
alpha-HCH (alpha-BHC)	n-Propylbenzene	Methoxychlor
Benzaldehyde	o-Nitrotoluene	Methyl acetate
Benzene	o-Xylene	Methyl acrylate
Benzo(b)fluoranthene	p-Xylene	Methyl bromide
Benzylchloride	Pyrene	Methyl chloride chloromethane)
beta-Chloronaphthalene	sec-Butylbenzene	Methylcyclohexane
Biphenyl	Styrene	Methylene bromide
Bis(2-chloroethyl)ether	tert-Butylbenzene	Methylene chloride
Bis(2-chloroisopropyl)ether	1,1,1,2-Tetrachloroethane	Methylethylketone (2-butanone)
Bis(chloromethyl)ether	1,1,2,2-Tetrachloroethane	Methylisobutylketone
Bromodichloromethane	Tetrachloroethylene	Methylmethacrylate
Bromoform	Dichlorodifluoromethane	2-Methylnaphthalene
1,3-Butadiene	1,1-Dichloroethane	MTBE
Carbon disulfide	1,2-Dichloroethane	m-Xylene
Carbon tetrachloride	1,1-Dichloroethylene	Naphthalene
Chlordane	1,2-Dichloropropane	n-Butylbenzene
2-Chloro-1,3-butadiene (chloroprene)	1,3-Dichloropropene	Nitrobenzene
Chlorobenzene	Dieldrin	Toluene
1-Chlorobutane	Endosulfan	trans-1,2-Dichloroethylene
Chlorodibromomethane	Epichlorohydrin	1,1,2-Trichloro-1,2,2-trifluoroethane
Chlorodifluoromethane	Ethyl ether	1,2,4-Trichlorobenzene
Chloroethane (ethyl chloride)	Ethylacetate	1,1,2-Trichloroethane
Chloroform	Ethylbenzene	1,1,1-Trichloroethane
2-Chlorophenol	Ethylene oxide	Trichloroethylene
2-Chloropropane	Ethylmethacrylate	Trichlorofluoromethane
Chrysene	Fluorene	1,2,3-Trichloropropane
cis-1,2-Dichloroethylene	Furan	1,2,4-Trimethylbenzene
Crotonaldehyde (2-butenal)	Gamma-HCH (Lindane)	1,3,5-Trimethylbenzene
Cumene	Heptachlor	Vinyl acetate
DDE	Hexachloro-1,3-butadiene	Vinyl chloride (chloroethene)

Source: EPA 2002.