Remedial Alternatives Focusing Study
Sudbury Road Landfill
Walla Walla, Washington

November 8, 2013

Prepared for:

City of Walla Walla

Prepared by

Schwyn Environmental Services

In Association With

FLOYD | SNIDER

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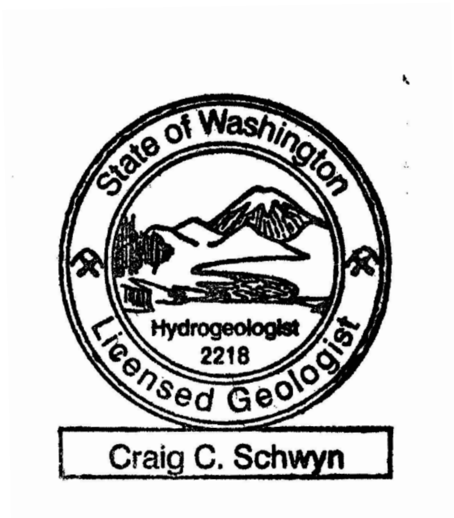
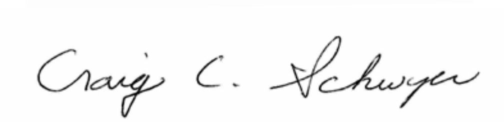
The technical material and data contained in this document were prepared by Schwyn Environmental Services, LLC, with assistance from Floyd|Snider, Inc., under the supervision and direction of the undersigned Washington Licensed Hydrogeologist.





November 8, 2013

Craig C. Schwyn, LHG — Date
Principal Hydrogeologist

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LIST OF ABBREVIATIONS AND ACRONYMS

AO	Agreed Order No. 8456
ARARs	Applicable or relevant and appropriate requirements
bgl	Below ground level
City	City of Walla Walla, Washington
cm/sec	Centimeters per second
CAO	Cleanup action objective
CFR	Code of Federal Regulations
COC	Constituent of concern
DCA	Disproportionate cost analysis
Ecology	Washington State Department of Ecology
Freon 11	Trichlorofluoromethane
Freon 12	Dichlorodifluoromethane
FS	Feasibility Study
HHWF	Household Hazardous Waste Facility
LFG	Landfill gas
µg/L	micrograms per liter
MCL	Maximum contaminant level
MSW	Municipal solid waste
MTCA	Washington State Model Toxics Control Act
PCE	Tetrachloroethene
RCW	Revised Code of Washington
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
Site	Sudbury Road Landfill
TCE	Trichloroethene
TDS	Total dissolved solids
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound
Work Plan	Data Summary and Remedial Investigation Work Plan
WAC	Washington Administrative Code
WSP	Washington State Penitentiary

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1.0 INTRODUCTION

This remedial alternatives focusing study has been conducted as part of the Remedial Investigation (RI)/ Feasibility Study (FS) of the City of Walla Walla, Washington (City) Sudbury Road Landfill (Site). This study identified and screened remedial technologies that could mitigate risks due to groundwater contamination at the Site by reducing the contaminant concentrations to levels that are protective of human health and the environment, and proposes cleanup action alternatives that will be fully developed and evaluated in the FS. The purpose of this study was to identify viable remedial alternatives for evaluation in the FS by means of the preliminary screening of a range of remedial alternatives that are applicable to Site conditions and to eliminate remedial technologies and alternatives that are not practicable.

The work was conducted pursuant to Agreed Order No. 8456 (AO) between the City and the Washington State Department of Ecology (Ecology) effective May 26, 2011. This remedial alternatives focusing study was prepared in accordance with the AO, and the Washington State Model Toxics Control Act (MTCA) [Chapter 70.105D Revised Code of Washington (RCW) and Chapter 173-340 Washington Administrative Code (WAC) (Ecology 2007)]. The alternatives focusing approach is consistent with WAC 173-340-350(8)(b).

1.1 REPORT ORGANIZATION

The report is organized as follows:

- Section 1 summarizes existing data and information related to the Site.
- Section 2 identifies the cleanup action objectives, describes the preliminary technology screening, and identifies cleanup alternatives to be evaluated in the FS.
- Section 3 presents a basic outline of the components of the FS.
- Section 4 provides references for the sources of information cited throughout the report.

The following Site information is condensed from the RI Report (Schwyn 2013). Complete Site information and history, the RI methods and findings, the development of the conceptual site model, and the proposed constituents of concern (COCs) and development of cleanup levels are described in the RI Report.

1.2 SITE DESCRIPTION AND SETTING

1.2.1 SITE LOCATION

The Sudbury Road Landfill is generally located at 414 Sudbury Road (now Landfill Road), Walla Walla, Washington 99362, about 4 miles west of the city of Walla Walla and 0.25 mile north of Highway 12 (Figure 1). The landfill itself covers approximately 125 acres and is composed of seven disposal areas (Areas 1 through 7). The landfill is located within the western portion of an 828.86-acre City-owned parcel of land that is zoned and used for various waste management purposes (Figure 2). The landfill is located in rural southeastern Washington and entirely surrounded by large expanses of rolling land used for dry-land wheat farming.

1.2.2 LOCAL POPULATIONS

The nearest residence north of the landfill is more than 7,500 feet away. The Washington State Penitentiary (WSP) and its inmate population are located immediately east of the Site property boundary and more than 1.2 miles east of the landfill itself. Groundwater under the WSP property is hydraulically upgradient of the Site and is not affected by landfill activities. Rural residential populations are located approximately 2,000 feet or more south of the landfill.

Four residential properties located northwest, west, and southwest of the landfill maintain their own domestic wells for water supply (Figure 2) and are, in general, hydraulically downgradient of the landfill:

- The Camp well is located approximately 0.75 mile northwest of the landfill. Low concentrations of tetrachloroethene [PCE; up to 0.88 micrograms per liter (µg/L)], have been detected in groundwater samples collected from the Camp Well.
- The Small well is located approximately 0.75 mile west of the landfill. Low concentrations of volatile organic compounds (VOCs), including chloroform (up to 0.67 µg/L), PCE (up to 1.5 µg/L), and trichloroethene (TCE; up to 0.62 µg/L) have been detected in groundwater samples collected from the Small well.
- The Kinman well is located approximately 1.5 mile west of the landfill. VOCs have not been detected in groundwater samples collected from the Kinman well.
- Two wells are located on the Schmidt property, which is located approximately 1.5 mile southwest of the landfill. One well is 122 feet deep and designated for domestic purposes. The other is 780 feet deep, constructed in basalt, and designated for irrigation purposes. VOCs have not been detected in groundwater samples collected from the Schmidt well that is used for domestic purposes, and the deep basalt well has not been sampled.

1.2.3 SITE GEOLOGY

The Site lies on the northern flank of the Walla Walla Valley. The subsurface geology beneath the landfill consists of (from upper to lower) Palouse silt; reworked lacustrine silt and clay of the Touchet beds; interbedded alluvial gravels in a clayey, silty, or sandy matrix, informally termed the "old gravel and clay"; and Columbia River basalt. The unconsolidated to semi-consolidated deposits overlying the Columbia River basalts may be 600 feet or more in thickness.

Vadose zone soils in the landfill area consist of silt, clayey silt, and fine sandy silt, which are interpreted to be soils of the Palouse Formation and the Touchet beds. These silty soils exhibit laboratory permeabilities in the range of 10^{-6} to 10^{-5} centimeters per second (cm/sec). Underlying the silty soils is a unit consisting of consolidated to semi-consolidated, poorly-graded gravel, silty gravel, and silt, which are interpreted to correlate with the “old gravel and clay” unit.

1.2.4 HYDROGEOLOGY

Groundwater beneath the Site is first encountered at depths from approximately 30 to 87 feet below ground level (bgl) in the lower silt horizon of the Touchet beds and/or the underlying alluvial gravel aquifer. The inferred groundwater flow direction is to the west and southwest, with an approximate horizontal gradient of 0.004 feet per foot beneath the landfill. The groundwater levels in the vicinity of the landfill have been declining, and since 1997, the water level in MW-12 has declined as much as 10 feet.

The horizontal hydraulic conductivity (geometric mean) of the uppermost gravel aquifer beneath the Site is 1.4 x 10^{-2} cm/sec, based on pumping tests conducted in pumping well MW-15D and observation wells MW-3, MW-15, MW-18, and MW-27. Using this hydraulic conductivity and an effective porosity of 0.3, the average groundwater flow velocity beneath the Site was calculated to be approximately 1.9 x 10^{-4} cm/sec (193 feet per year). The geometric mean of the testing results yielded an estimated transmissivity of 4,000 square feet per day (ft^2/day) and a storativity of 2 x 10^{-3}. The storativity is consistent with semi-confined aquifer conditions.

A second, more regional, deep aquifer is present in the underlying Columbia River basalts. Information from the driller's water well reports, within the vicinity of the Site, indicated that the basalt aquifer had a potentiometric surface in the range of 150 to 200 feet bgl and a positive upward gradient (EMCON 1995).

1.3 LANDFILL AND GROUNDWATER MONITORING HISTORY

The Sudbury Road Landfill is currently operating in accordance with the standards of Chapter 173-351 WAC, Criteria for Municipal Solid Waste Landfills (Ecology 1993) and a Solid Waste Disposal Permit issued by the Walla Walla County Health Department. The initial Conforming Permit for the landfill was issued on June 27, 1977, and news publications announced that the “New City Landfill on Sudbury Road” was opened to the public on July 10, 1978 (*Walla Walla Union Bulletin* 1978). Municipal solid waste (MSW), asbestos waste, and medical waste have been placed on the landfill property since that time. Hazardous wastes have never knowingly been accepted at the landfill. MSW has been placed in five separate areas, commonly referred to as Areas 1, 2, 5, 6, and 7. Asbestos waste has been disposed of in two separate cells (4a and 4). A single medical waste cell has been used. In 2006, a temporary compositing facility was constructed above the former asbestos and medical waste cells, and a permanent facility that complied with Chapter 173-350 WAC was constructed and opened in 2009. The approximate limits of the refuse disposal areas are shown on Figure 2. The practices used to fill the waste disposal areas are fully described in the RI Report (Schwyn 2013).

Groundwater monitoring has been conducted on a quarterly schedule since July 1978. In July 2001, monitoring well MW-15 was installed in the northwest corner of the landfill to monitor the groundwater quality of the uppermost aquifer immediately downgradient of Area 5. VOCs, including TCE, PCE, trichlorofluoromethane (Freon 11), dichlorodifluoromethane (Freon 12), vinyl chloride, chloroethane, 1,1-dichloroethane, and cis-1,2-dichloroethane, and inorganic constituents, including calcium, sodium, bicarbonate/alkalinity, chloride, and total dissolved solids (TDS), were detected at higher concentrations in MW-15 relative to the concentrations in other Site wells and background concentrations. Concentrations of all of these constituents except chloride and TDS have exceeded the site-specific Chapter 173-351 WAC compliance levels (prediction intervals) on at least two consecutive occasions. These exceedances prompted the ongoing RI/FS of the Site.

1.4 REMEDIAL INVESTIGATION

In 2012 and 2013, a RI was conducted in accordance with the AO. The scope of work was detailed in the RI Work Plan (Schwyn 2011). Initial field studies were conducted in April and May 2012, and additional field studies were conducted in August 2012 to achieve the Work Plan objectives. The methods and findings of the RI were presented in the Final Draft RI Report (Schwyn 2013), which was approved by Ecology for review and comment by the public. The following sections are based on the findings of the RI.

1.4.1 SOIL

Soil is not considered a medium of concern at the Site. No human exposure is possible because the contaminated soils were found beneath the permitted landfill cells at depths greater than 15 feet bgl, the areas of contamination are capped, and institutional controls [such as those described in WAC 173-340-440(1)(a)(b)(c) and (d)] are in effect for the landfill as a requirement of the Municipal Solid Waste Permit.

1.4.2 GROUNDWATER

1.4.2.1 Area-Wide and Domestic Well Groundwater

Groundwater monitoring data have indicated the presence of low concentrations of chloroform, PCE, and TCE in groundwater extending from the eastern boundary of the City property (6,300 feet east and hydraulically upgradient of the landfill boundary) and as far west as the Small domestic supply well (located 4,600 feet west of the landfill boundary). One or more of these constituents were present in all of the wells tested during the RI, except the Schmidt and Kinman domestic supply wells. Based on the RI data, these contaminants observed upgradient of the landfill, and at least in part beneath and downgradient of the landfill originate from and upgradient source.

1.4.2.2 Localized Groundwater near MW-15

Groundwater is considered a medium of concern at MW-15. The contaminants detected in groundwater samples collected from MW-15 and from wells downgradient of MW-15 are distinct from those detected in all of the other Site wells and downgradient domestic wells in that they consist of a broader list of VOCs than those detected area-wide. The constituent list includes PCE, TCE, chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethane, Freon 12, Freon 11, and vinyl chloride but not chloroform. The concentrations of PCE and vinyl chloride in MW-15 exceeded the cleanup levels proposed in the RI Report. No constituents in the downgradient well samples exceeded the screening levels.

Inorganic constituents, including calcium, sodium, bicarbonate, chloride, alkalinity, and TDS, were also detected in groundwater samples from MW-15, at slightly higher concentrations than the concentrations reported in samples from the other Site wells. The concentrations of these constituents did not exceed the screening levels; these constituents are not COCs for the Site but are possible indicators of landfill leachate impacts on groundwater.

1.4.2.3 Landfill Area Groundwater

Common contaminants detected in groundwater monitored by the Site monitoring wells include chloroform, PCE, Freon 11, and Freon 12. TCE was also detected in five of the Site wells located in the vicinity of Area 5.

The average PCE concentrations in most Site wells are slightly higher than the average PCE concentrations detected in wells upgradient of the landfill, indicating possible landfill contribution of PCE to groundwater. The presence of Freon 11 and Freon 12 likely indicates landfill impacts on groundwater. These findings indicate that the landfill is likely affecting groundwater in areas distant from MW-15; however, concentrations of none of the detected constituents exceeded a screening level. Therefore, groundwater in the landfill area (with the exception of MW-15) does not appear to be contaminated by concentrations greater than the cleanup levels proposed in the RI Report.

1.4.3 LANDFILL GAS

The landfill gas (LFG) studies conducted during the RI indicate that while off-Site methane migration has not occurred, the VOCs found in LFG in Areas 1 and 5 are at high enough concentrations to pose a risk of contaminating groundwater (cross-media pathway). Area 6 has an LFG collection system (active since 2010); Areas 1 and 5 do not. Based on the RI findings, soil vapor intrusion at the Household Hazardous Waste Facility (HHWF) is not considered a significant concern.

1.4.4 STORMWATER

Stormwater itself is not considered a potentially contaminated medium because there are no pathways for stormwater at the Site to encounter hazardous materials before flowing off-Site. However, stormwater infiltration through or adjacent to the municipal solid waste (MSW) and the subsequent generation and downward migration of leachate to groundwater has been identified as a possible cause of groundwater contamination. The areas of concern are the following:

- The engineering controls at the north drainage ditch implemented during the 2010 interim action promote drainage past Area 5. However, the constructed drainage pathway is filling with soil and vegetation, which is impeding water movement off-Site. It appears that the existing drainage ditch is approximately 30 to 40 feet from the MSW in Area 5.
- Stormwater run-on occurs at the southwest side of Area 5, in the vicinity of the entrance to the compost facility.
- Stormwater flow on the surface of Area 5 has caused erosion of the soil cover on the west side of Area 5.
- Two linear road cuts located on the north slope of Area 5 likely impede stormwater flow and potentially promote infiltration.
- The soil cover thickness over Area 2 may be insufficient to prevent the infiltration of precipitation and stormwater.

1.5 PROPOSED CLEANUP LEVELS AND CONSTITUENTS OF CONCERN

A detailed evaluation of groundwater screening levels and cleanup levels was presented in the RI Report. There are currently no complete exposure pathways for groundwater at the Site itself, because groundwater from the Site wells is not used as potable water and state law forbids the drilling of wells within 1,000 feet of landfills. Additionally, the Site is not located within 2,000 feet of any perennial creeks or waterways; therefore, protection of surface water resources from groundwater discharges was not considered as a pathway of exposure. There is a complete exposure pathway for the Small and possibly the Camp residents near the landfill who currently use their wells for domestic purposes and in whose wells VOCs have been detected. Therefore, groundwater cleanup levels at the Site were established on the basis of the protection of human health related to drinking water as the highest beneficial use.

The only constituents with concentrations greater than the screening levels are PCE and vinyl chloride, which were identified as the COCs for the Site. Proposed groundwater cleanup levels were developed in the RI for the COCs. The rationale for the proposed cleanup levels is as follows:

- The proposed cleanup level for PCE is based on the most stringent of the applicable or relevant and appropriate requirements (ARARs) and is, therefore, equal to the screening level of 5 µg/L.
- The proposed cleanup level for vinyl chloride was adjusted upward from the screening level of 0.029 µg/L. In accordance with WAC 173-340-720, groundwater cleanup levels for

> individual hazardous substances may be adjusted provided that in making these adjustments, (1) the cleanup level is at least as stringent as the most stringent concentration established under applicable state and federal laws [in this case, the maximum contaminant levels (MCLs)], and (2) the cleanup level is at least as stringent as the concentrations that protect human health. A concentration is sufficiently protective if the hazard index does not exceed 1 and the total excess cancer risk does not exceed 1 in 100,000 (1 x 10^{-5}).

The proposed adjusted cleanup level for vinyl chloride is provided in the following table, along with the associated risk. The table indicates that this value, even with the upward adjustment, meets the intent of WAC 173-340-720. The value is less than the state and federal MCL of 2 µg/L and satisfies the risk requirements, with a total excess cancer risk of 1.0 x 10^{-5} and a hazard index of 0.11 (including the risk posed by PCE). The values indicated in the following table were, therefore, proposed as groundwater cleanup levels for PCE and vinyl chloride.

Constituent of Concern	**Proposed Cleanup Level (µg/L)**	**Associated Risk Values**	
		Excess Cancer Risk	**Hazard Quotient**
Tetrachloroethene	5	2.3E-07	0.1
Vinyl chloride	0.29	9.9E-06	0.01
	Total Risk	1.0E-05	0.11

µg/L = micrograms per liter

Although low concentrations of PCE have been detected throughout the Site, PCE has been detected at concentrations exceeding the proposed cleanup level only in MW-15. The extent of vinyl chloride is also limited to MW-15, where it has been detected at concentrations exceeding the proposed cleanup level during all sampling events associated with the RI and historical sampling events. The maximum concentrations of PCE and vinyl chloride detected in the MW-15 samples during the RI were 6.8 and 1.2 µg/L, respectively.

1.6 SUSPECTED SOURCES OF HAZARDOUS SUBSTANCES

Based on the available Site data, the suspected sources of hazardous substances found in groundwater at the landfill include the following:

- MSW in contact with groundwater
- Leachate
- LFG.

1.6.1 Municipal Solid Waste in Contact with Groundwater

During the RI, MSW in contact with groundwater was discovered in Area 5. However, this situation appears to be limited to a small area located within the northern disposal trench in Area 5. MSW occurrence below the water table was observed only in SB-20, where the MSW extended approximately 11 feet beneath the groundwater table (based on February 2013 water table elevations). However, wet soils were observed near the base of the MSW in several other borings in the vicinity of SB-20. This is not considered a significant source of contaminants based on the sampling results from the multiple monitoring wells installed upgradient and downgradient of this limited area. In addition, the area-wide groundwater levels appear to be on a long-term downward trend; therefore, this situation may be resolved over time without intervention.

1.6.2 Leachate

Leachate could be a contributing source of hazardous substances as a result of the following:

- Infiltration of precipitation and surface water traveling through an insufficient soil cover and the MSW. Thin landfill cover soils were observed over most of Area 2 and portions of Area 5.
- Infiltration of stormwater into, or near the MSW, that may saturate or wet the MSW, allowing leachate to percolate downward. There are three areas of concern:
  - An unlined stormwater drainage channel that extends along the north side of Area 5 approximately 30 to 40 feet from the MSW disposal trench
  - Stormwater run-on observed in the southwestern portion of Area 5
  - Boggy areas and erosion channels observed in the southwestern portion of the Area 5 cover soil.
- Improper grading of soil cover, which promotes surface water retention and infiltration. Two linear road cuts on the north slope of Area 5 and erosion channels and boggy areas on the west side of Area 5 likely impede stormwater flow and potentially promote infiltration.
- VOCs detected in soil samples collected beneath the MSW in Areas 1, 2, and 5. The VOCs in soil may be an indicator of downward leachate migration or an indicator of LFG impact on soil, or a combination of both.

1.6.3 Landfill Gas

During the RI, LFG was observed in all of the MSW disposal areas. Laboratory analysis of the LFG indicated the presence of VOCs at significant concentrations; if not controlled, the LFG has the potential to transfer contaminants to underlying groundwater by means of chemical equilibrium processes. An evaluation of the existing LFG extraction system indicates that it is effectively controlling LFG in Area 6.

2.0 REMEDIAL TECHNOLOGY ALTERNATIVES SCREENING

This section identifies the cleanup action objectives (CAOs), describes potentially applicable remedial technologies for cleanup of the VOCs in groundwater, and discusses the preliminary screening of technologies performed to eliminate those that clearly would not achieve the CAOs or whose implementation would be onerous when weighed against their environmental benefit. Technologies that are likely to achieve the CAOs and are practical to implement under the site-specific conditions were retained for development and a detailed evaluation in the FS.

2.1 CLEANUP ACTION OBJECTIVES

Based on the RI findings, the only environmental medium that requires cleanup is groundwater. Exceedances of the proposed groundwater cleanup levels have been detected only at MW-15. Off-property migration of contaminants in groundwater has occurred; however, there were no exceedances of the proposed cleanup levels in samples from the nearest off-Site wells. There are no complete exposure pathways from groundwater at the landfill itself, because groundwater from Site wells is not used for potable purposes.

The suspected sources of hazardous substances detected in groundwater at the landfill are the following:

- Contact of MSW with groundwater (considered a minor source)
- Leachate
- LFG.

Protection of human health and the environment can be achieved through the fulfillment of the following CAOs:

- Protection of groundwater resources by eliminating, reducing, or controlling the suspected sources of hazardous substances detected in groundwater at the landfill
- Protection of downgradient users of groundwater resources by reducing or controlling the migration of contaminant-bearing groundwater.

Potentially applicable cleanup actions for groundwater at the Site can be categorized as follows:

- Limited or no action
- Containment
- In-situ treatment
- Collection and ex-situ treatment
- Source control.

2.2 SCREENING OF CLEANUP TECHNOLOGIES

A list of potential cleanup action technologies was compiled on the basis of the nature and sources of the COCs identified for the Site, the environmental medium of concern (groundwater), and the potential exposure pathway (drinking water). Potentially applicable cleanup action technologies were screened against the criteria described in WAC 173-340-350(8)(b) and WAC 173-340-360(2)(a)(b). Relevant cleanup action technologies were developed from screening information prepared by the Center for Public Environmental Oversight (CPEO 2010), the U.S. Environmental Protection Agency (USEPA), and experience with other cleanup actions at similar sites.

2.2.1 SCREENING CRITERIA

Three general criteria were established to screen the potential cleanup technologies identified for the Site. These criteria provide a basis to evaluate the minimum requirements and procedures for selecting cleanup actions described in WAC 173-340-360(2)(a)(b) and help form a basis for whether a potential cleanup technology, if implemented, would meet the baseline standards established for alternatives screening in WAC 173-340-350(8)(b)

- **Technical Feasibility/Effectiveness**: The technical feasibility criterion relates to engineering factors associated the ability of the technology to function effectively and achieve meaningful progress toward the CAOs, based on site-specific characteristics, including the nature and extent of the COCs, waste/source type and locations, site hydrogeology, and time required to achieve the proposed cleanup levels. The effectiveness criterion relates to the ability of the technology to achieve the CAOs.
- **Implementability**: This criterion relates to administrative and field issues associated with the technology, including ARARs, construction schedule, constructability, access, monitoring, operation and maintenance, and community concerns.
- **Cost**: Both relative cost and cost-effectiveness are considered for this criterion. For this screening, knowledge of typical technology costs for prior projects and engineering judgment were used to determine the cost of a technology relative to that of other similar technologies. A potential technology was considered cost-effective if its cost is not disproportionate to the environmental benefit that would result from its implementation. Cost is generally ranked as low, moderate, and high relative to the costs of other technologies or alternatives applied under similar circumstances.

2.2.2 TECHNOLOGIES RETAINED FOR FURTHER EVALUATION

Potentially applicable cleanup action technologies for the Site are presented in Table 1, which includes detailed information and judgments related to the potential benefits and constraints of each technology and provides the rationale for the rejection or retention of each technology for further evaluation. Based on the preliminary screening, the following technologies were retained and are proposed for detailed evaluation in the FS:

- No or limited actions
  - No action
  - Limited action:
    - Institutional controls
    - Long-term monitoring
- In-situ biological, chemical, and physical treatment:
  - Monitored natural attenuation
- Hydraulic containment: groundwater extraction with ex-situ treatment by one of the following methods:
  - Carbon adsorption
  - Evaporation
  - Sprinkler irrigation
- Source elimination or controls:
  - LFG extraction and destruction
  - Leachate controls:
    - Geosynthetic/multimedia cap
    - Low-permeability or evapotranspiration soil cover
    - Manipulation and/or reconstruction of existing soil cover
  - Stormwater controls:
    - Surface regrading
    - Stormwater channel construction
    - Run-on prevention.

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3.0 FEASIBILITY STUDY WORK PLAN

The purpose of the FS is to develop and evaluate cleanup alternatives that will achieve the CAOs for the Site. The FS will accomplish the following:

- Identify ARARs for site cleanup
- Identify the media and locations where remedial action is needed
- Review and identify the CAOs
- Develop and evaluate cleanup alternatives
- Perform a disproportionate cost analysis, if required
- Identify and recommend a preferred alternative

The following sections expand on each of these components.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

In accordance with MTCA, all cleanup actions must comply with applicable state and federal laws [WAC 173-340-710(1)]. MTCA defines applicable state and federal laws to include legally applicable requirements and requirements that are relevant and appropriate. Collectively, these requirements are referred to as ARARs. For the purposes of the FS Work Plan, only a preliminary list of ARARs can be identified. Other ARARs related to the cleanup action itself may be identified in the FS report. The preliminary list of potential ARARs for this project includes the following:

- MTCA Cleanup Regulation, Chapter 173-340 WAC
- Criteria for Municipal Solid Waste Landfills, Chapter 173-351 WAC
- Solid Waste Handling Standards, Chapter 173-350 WAC
- Dangerous Waste Regulations, Chapter 173-303 WAC
- State Environmental Policy Act (SEPA) Rules, Chapter 197-11 WAC
- Safe Drinking Water Act, Primary Drinking Water Regulations [Code of Federal Regulations Title 40, Part 141 (40 CFR 141)]
- State Water Code and Water Rights (Chapters 173-150 and 173-154 WAC)
- Underground Injection Control Program, Chapter 173-218 WAC
- State Water Pollution Control Act (Chapter 90.48 RCW)
- Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 RCW)
- Washington Clean Air Act (Chapter 70.94 WAC)
- General Regulations for Air Pollution Sources, Chapter 173-400
- Operating Permit Regulation, Chapter 173-401
- Occupational Safety and Health Act (29 CFR 1910.120)
- Washington Industrial Safety and Health Act (Chapter 49.17 RCW)
- Accreditation of Environmental Laboratories, Chapter 173-50 WAC

In addition, the FS will identify permits that likely apply to the implementation of the cleanup action and the substantive requirement of those permits.

3.2 POINTS OF COMPLIANCE

The media of concern, the COCs, the pathways of exposure, and the locations of the exceedances of the proposed cleanup levels were identified during the RI process. Based on any exceedances, the FS will identify the applicable points of compliance and the areas that require remedial action to meet the cleanup levels at the point or points of compliance. Because groundwater is the only identified medium of concern, the points of compliance will be identified for groundwater only.

3.3 IDENTIFICATION OF CLEANUP ACTION OBJECTIVES

The preliminary CAOs developed for the purposes of this study will be reviewed in the FS. The CAOs must address all of the affected media, and that the cleanup alternative must achieve all of the CAOs to be considered a viable cleanup action. The CAOs can be action-specific, medium-specific, or both. Action-specific CAOs are based on actions required for environmental protection that are not intended to achieve a specific chemical criterion. Medium-specific CAOs are based on actions to achieve the numerical cleanup levels. The CAOs will specify the COCs, the potential exposure pathways and receptors, and the acceptable contaminant concentrations or range of concentrations for each exposure pathway, as appropriate. The extent to which each alternative meets the CAOs will be determined by applying the specific evaluation criteria identified in the MTCA regulation.

3.4 EVALUATION OF CLEANUP ALTERNATIVES

MTCA requires that cleanup alternatives be compared to a number of criteria, as set forth in WAC 173-340-360, to evaluate the adequacy of each alternative in achieving the intent of the regulations, and to serve as a basis for comparing the relative merits of the developed cleanup alternatives. Consistent with MTCA, the alternatives described in Section 2 will be evaluated with respect to compliance with threshold requirements, permanence, and restoration timeframe; the results of the evaluation will be documented in the FS Report.

3.4.1 THRESHOLD REQUIREMENTS

As specified in WAC 173-340-360(2)(a), all cleanup actions must meet the following threshold requirements:

- Protection of human health and the environment
- Compliance with cleanup levels specified under MTCA
- Compliance with applicable state and federal laws

- Provisions for compliance monitoring.

3.4.2 Requirement for Permanent Solution to the Maximum Extent Practicable

WAC 173-340-200 defines a permanent solution as one in which cleanup levels can be met without the requirement for further action at the original site or any other site involved in the cleanup action, other than the approved disposal site for any residue from the treatment of hazardous substances. Ecology recognizes that permanent solutions may not be practicable for all sites. To determine whether a cleanup action is permanent to the "maximum extent practicable," MTCA requires the use of a disproportionate cost analysis (DCA) [WAC 173-340-360(3)(b)]. In accordance with WAC 173-340-360(3)(f), the following criteria are used to evaluate and compare each technology when conducting a DCA:

- ***Overall protectiveness*** of human health and the environment, including the degree to which site risks are reduced, the risks during implementation, and the improvement of overall environmental quality
- ***Long-term effectiveness,*** including the degree of certainty that the alternative will be successful, the long-term reliability, the magnitude of residual risk, and the effectiveness of controls required to manage treatment residues and remaining waste
- ***Management of short-term risks,*** including the protection of human health and the environment during construction and implementation
- ***Permanent reduction in toxicity, mobility, and volume of hazardous substances,*** including the reduction or elimination of hazardous substance releases and sources of releases
- ***Implementability,*** including consideration of whether the alternative is technically possible; the availability of necessary off-site facilities, services, and materials; administrative and regulatory requirements; scheduling, size, and complexity of construction; monitoring requirements; access for construction, operations, and monitoring; and integration with existing facility operations
- ***Cleanup costs,*** including capital costs and operation and maintenance costs
- ***Consideration of public concerns,*** which will be addressed by the receipt of public comments on the cleanup action plan.

The procedures that will be used for conducting a DCA are described in Section 3.5.

3.4.3 Requirement for a Reasonable Restoration Timeframe

WAC 173-340-360(4)(b) specifies that the following factors be considered in establishing a "reasonable" timeframe:

- Potential risks to human health and the environment
- Practicability of achieving a shorter restoration timeframe
- Current use of the Site, surrounding areas, and associated resources that are, or may be, affected by releases from the Site

- Potential future use of the Site, surrounding areas, and associated resources that are, or may be, affected by releases from the Site
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor migration of hazardous substances from the Site
- Toxicity of the hazardous substances at the Site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar site conditions.

3.4.4 REQUIREMENT FOR CONSIDERATION OF PUBLIC CONCERNS

The draft final RI and FS Reports will be issued for public comment to provide the public an opportunity to express any concerns. Those concerns will be considered by Ecology and, if appropriate, a responsiveness summary will be prepared and the RI/FS Report will be modified in response to the public concerns.

3.5 DISPROPORTIONATE COST ANALYSIS PROCEDURES

MTCA requires that cleanup actions be permanent to the maximum extent practicable and requires that a DCA be used when the cleanup alternatives being considered are not permanent as defined under WAC 173-340-200. Evaluation of the practicability of a given alternative is a comparative evaluation of whether the incremental increase in cost associated with increasingly protective cleanup actions is substantial and disproportionate to the incremental increase in environmental benefit. In the DCA, cleanup alternatives are arranged from most to least permanent based on the criteria specified in WAC 173-340-360(f). Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental benefits achieved by the lower cost alternative [WAC 173-340-360(3)(e)(i)]. Alternatives that exhibit disproportionate costs are considered “impracticable.” When the benefits of two alternatives are equivalent, MTCA specifies that Ecology select the least costly alternative [WAC 173-340-360(e)(ii)(c)].

3.6 RECOMMENDATION OF REMEDIAL ACTION ALTERNATIVES

This section of the FS will recommend a remedial action alternative based on the results of the comparative evaluation. The recommended alternative will meet the minimum requirements for cleanup actions: protection of human health and the environment, compliance with cleanup levels, compliance with applicable state and federal laws, provision of compliance monitoring, use of permanent solutions to the extent practicable, provision of a reasonable timeframe, and consideration of public concerns.

4.0 REFERENCES

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TABLE 1
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
Sudbury Landfill Remedial Investigation/ Feasibility Study
City of Walla Walla, Washington

General Response Action	Implemented by	Remedial Technology	Description	Technical Feasibility/ Effectiveness	Implementability	Cost	Retained/ Rejected
Groundwater Cleanup Action Objective: Protect groundwater by reducing or controlling migration of contaminant-bearing groundwater.							
No Action	No Action	None	No activities taken to address groundwater beyond current compliance monitoring activities.	Does not achieve CAOs.	High	Low	**Retained.** Retained for baseline comparison purposes.
Limited Action	Institutional Controls	Land Use Restrictions	Land use restrictions are measures undertaken to limit or prohibit activities that may interfere with the integrity of a cleanup action or result in exposure to hazardous substances at a site.	This control could be effective for the Site because it could restrict the use of groundwater or the construction of structures in the impacted areas. It does not directly address contamination removal or treatment.	This can be an acceptable method for preventing human contact with hazardous media and institutional controls are commonly in effect at landfill sites. It can be difficult to implement on private property due to potential public resistance, and the necessary cooperation of multiple agencies and local governments.	Low	**Retained.** Retained for evaluation in combination with other response actions.
	Long-Term Monitoring	Groundwater Monitoring	Periodic monitoring of groundwater is conducted to assess changes in groundwater quality that might be attributed to contaminant leaching, migration, natural attenuation processes, or active remediation.	Long-term monitoring can be an effective method in evaluating chemical changes in groundwater and is likely feasible at the Site. It does not directly address contamination removal or treatment.	This is an established and accepted technology. An adequate groundwater monitoring system is available at the Site.	Low to Moderate	**Retained.** Retained for evaluation in combination with other response actions.
In-Situ Treatment	Physical/ Chemical Treatment	Air Sparging	Injected air strips volatiles from the groundwater. VOCs which partition into the rising air are collected by a vacuum extraction system installed in the unsaturated zone. Oxygen may enhance biodegradation.	Air sparging can be an effective technology for removal of VOCs; however, the mass transfer efficiency drops off for VOCs at very low concentrations such as those reported at the Site. The effectiveness of this technology can be affected by very small changes in soil permeability/heterogeneity, which can lead to localized treatment around the sparge points or leave areas untreated. Oxygen added to the contaminated groundwater can enhance aerobic biodegradation of contaminants below and above the water table, but may have adverse effects on anaerobic degradation.	This is an established and accepted technology. It may be difficult to implement at the Site due to subsurface conditions, fine-grained horizons, matrix of the gravel aquifer, and Site geology. Pilot testing would likely be needed to evaluate the use of air sparging at the Site before proceeding with full-scale remedial action using this technology. A performance monitoring program would be required to assess the effectiveness of this technology. This approach has low O&M requirements.	Low to Moderate	**Rejected**. Rejected due to low level VOCs in groundwater and heterogeneous soil profile.
		In-well Air Stripping	Compressed air is injected at depth in a double cased well with an upper and lower screen. The injected air lifts the water in the well and causes it to flow out the upper screen, wile groundwater enters the well through the lower screen. VOCs are partially stripped through the air-lift process. Vapors are drawn off by a vacuum extraction system and treated. The discharge of water from the upper screen and intake of water through the lower screen establishes an in-situ hydraulic circulation cell through which groundwater is repeatedly circulated and treated.	In-well air stripping may be technically feasible at the Site; however, in-well air strippers are most effective at sites that contain high concentrations of dissolved contaminants. Effective installations require a well-defined contaminant plume and well-placed screens to prevent the spreading of contamination. The treatment effectiveness can also be limited by the groundwater flow regime around the well and can be limited by the pumping capacity and resulting radius of influence.	Pilot scale system testing would likely be required to determine if the technology is implementable at the Site. Air sparging or pump and treat technologies likely provide greater assurance of success.	Moderate	**Rejected.** Other technologies likely provide greater assurance of success.

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General Response Action	Implemented by	Remedial Technology	Description	Technical Feasibility/ Effectiveness	Implementability	Cost	Retained/ Rejected
In-Situ Treatment (cont.)	Physical/ Chemical Treatment (cont.)	Chemical Oxidation	Injection of oxidizing agents such as ozone, hydrogen peroxide, or permanganate to rapidly destroy organic compounds.	Chemical oxidation can be an effective technology for destruction of VOCs from groundwater. The effectiveness of this technology can be limited by low permeability soils and rapid groundwater flow, both of which are present at the Site. Chemical oxidation can interfere with anaerobic degradation processes and can potentially mobilize metals. A treatability study and reaction transport modeling is normally required to assess feasibility.	This is an established and accepted technology. It may be difficult to implement at the Site due to the heterogeneous soil profile. Proper and uniform distribution of oxidant can be difficult in heterogeneous materials. A pilot testing and performance monitoring program would be required to assess the effectiveness of this technology. This approach has high O&M requirements.	Medium to High	**Rejected**. Rejected due to heterogeneous soil profile.
	Chemical Treatment	Permeable Reactive Barrier (PRB), with or without funnel and gate.	Installation of an engineered subsurface treatment zone across the flow path of a dissolved contaminant plume. As groundwater passes through the zone, it is treated in-situ by reactive media. Often used in conjunction with impermeable wall sections (funnels) to force groundwater to flow through the permeable sections containing the reactive media.	Permeable-reactive barriers can be an effective method for the reductive dechlorination of chlorinated constituents; however, PRBs can lose permeability with age and can affect groundwater flow vectors. A PRB could increase the downward gradient in the Site aquifer if the barrier is not tied into an underlying low permeability soil zone.	Potentially implementable as a partially penetrating barrier to a depth of 50 ft. Construction of a deeper barrier is not considered feasible. May need other technologies to funnel the contaminants through the PRB (funnel and gate system).	High	**Rejected**. Full-scale barrier along property boundary considered infeasible. Would require prohibitive periodic replacement of reactive material.
	Biological Treatment	Enhanced Anaerobic Biodegradation	Enhance biodegradation accelerates the natural biodegradation process by providing nutrients, electron acceptors, and/or microorganisms to degrade (metabolize) organic contaminants in groundwater. Typical enhancements include oxygen, nitrates, or solid phase peroxide products such as an oxygen releasing compound (ORC).	Enhanced bioremediation can be an effective technology for removing VOCs from groundwater. Effectiveness can be limited by the spacing of injection points and heterogeneity of the subsurface materials. Under anaerobic conditions, contaminants may be degraded to a product that is more hazardous than the original contaminant. For example, TCE frequently biodegrades to the persistent and more toxic vinyl chloride.	This is an established and accepted technology. It would likely be difficult to implement at the Site due to the heterogeneity of the subsurface soil. Pilot testing and microcosm testing would likely be needed to evaluate the use of enhanced bioremediation at the Site before proceeding with full-scale remedial action using this technology. This approach has high O&M requirements to ensure continued effectiveness of the contact technologies.	Moderate to high	**Rejected**. Effectiveness limited by heterogeneity of the subsurface materials. Possibility of increasing vinyl chloride levels in groundwater. Pilot testing costs.
	Biological, Chemical, and Physical Treatment	Monitored Natural Attenuation (MNA)	Reliance on one or more physical, chemical, or biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. Typically requires source control and long-term monitoring to verify performance.	Monitored natural attenuation is an accepted technology that has been implemented at numerous sites across the country. It can be easy to implement because little to no aggressive action is required. A long-term groundwater monitoring system would be required to verify the effectiveness of this approach. Institutional controls may be required.	Preliminary groundwater quality data suggest that natural biodegradation is already occurring locally at the site as evidenced by increased vinyl chloride and cis-1,2-dichloroethene concentrations at MW-15. MNA is readily implemented using the existing monitoring well system, or with additional wells, and/or additional geochemical testing. This approach has low O&M requirements with moderate monitoring requirements.	Low to moderate	**Retained.** Retained for evaluation in combination with other response actions.

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City of Walla Walla, Washington

General Response Action	Implemented by	Remedial Technology	Description	Technical Feasibility/ Effectiveness	Implementability	Cost	Retained/ Rejected
Containment	Vertical Barriers	Slurry Wall/Sheet Piles/Grout Curtains	A subsurface vertical wall constructed with impermeable material such as low permeability trench fill (slurry), sheet piles, or grout curtains. The wall is often keyed into a low permeability natural base, such as clay or competent bedrock.	This can be an effective technology for preventing horizontal migration of contaminants. However, the barrier can affect groundwater flow vectors and may not retain the contaminants if the barrier is not tied into a low permeability soil horizon. It provides containment only; it does not treat groundwater or provide source removal. Because no active treatment is occurring, additional remedial action may be required to control contaminant concentrations. Degradation of the slurry wall over time may occur.	Potentially implementable at the Site as a partially penetrating barrier to a depth of 50 feet. Construction of a deeper barrier is not considered feasible. May need other remedial technologies to treat contaminants. May increase the downward gradient in aquifer and contaminated groundwater may naturally flow around the barrier.	Moderate to High	**Rejected.** No base formation to tie barrier wall into.
	Hydraulic Containment	Pumping	Uses groundwater pumping to form a hydraulic barrier and control off-site migration of contaminants. May require groundwater treatment before discharge	This can be an effective technology for preventing contaminant migration, and is commonly coupled with an ex-situ treatment technology. Capture zone modeling would likely be necessary to design a system to adequately prevent contaminant migration.	This is a common and accepted technology. Limitations can include long duration to meet cleanup goals and rebound (pumping depresses the groundwater level, leaving residuals sorbed to the soil, and after the groundwater level returns to its normal level, contaminants sorbed onto soil become dissolved.) This approach has high O&M requirements.	Moderate to High	**Retained.** Retained as a contingent technology to control offsite migration, not as a primary treatment of MW-15 groundwater.
Ex-Situ Treatment of Extracted Groundwater	Physical Treatment	Air Stripping	Transfer of VOCs from the aqueous phase to the vapor phase by contacting the groundwater with air, typically in a counter current manner using packed towers or bubble tray aerators.	Air stripping can be an effective technology for removing moderate to high VOC concentrations from groundwater; however, the mass transfer efficiency can drop off for VOCs at very low concentrations such as those reported at the Site. It can be effective for removing miscible compounds such as vinyl chloride. Air strippers transfer the VOCs from groundwater to air and do not destroy contaminants. Additional waste streams are generated that may require treatment.	This is a common, well-established, and accepted technology. Small systems for point-of-use treatment are available. Off-gas treatment by activated carbon adsorption or catalytic oxidation may be added. This approach has average O&M requirements.	Moderate	**Rejected.** Inefficient at removing low level VOC concentrations.
		Carbon Adsorption	Removal of dissolved VOCs from groundwater by adsorption onto granular activated carbon (GAC).	GAC can be an effective technology for removal of most VOCs; however, its effectiveness can be limited for water-soluble compounds such as dichloroethane. GAC has a short-term duration, especially for high concentrations and would require a high frequency of operation and maintenance. This process requires transport and disposal or regeneration of spent carbon.	This is a common, well-established, and accepted technology that could be implementable. This approach has high O&M requirements including monitoring of influent and effluent stream, replacement of carbon, and backwashing.	Medium to High	**Retained.** Retained for evaluation in combination with hydraulic containment.

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General Response Action	Implemented by	Remedial Technology	Description	Technical Feasibility/ Effectiveness	Implementability	Cost	Retained/ Rejected
Ex-Situ Treatment of Extracted Groundwater (cont.)	Physical Treatment (cont.)	Evaporation Pond	An evaporation pond is used to remove VOCs from extracted groundwater using natural biological, physical, and chemical processes.	An evaporation pond can effectively remove VOCs from extracted groundwater in warm, dry climates. The system can cause the direct release of contaminants to the atmosphere and emission control is generally not feasible. A large amount of space and storage capacity for winter months is required. The extraction rate and volume for full-time groundwater extraction would be required to size the pond and determine ultimate feasibility.	Evaporation ponds are not commonly used for treatment of contaminated groundwater. The climate is acceptable for evaporation, and land for pond construction is likely available at the Site. There are potential regulatory issues related to volatilization to the atmosphere. This approach has moderate to high construction costs and low O&M requirements.	Low to Moderate	**Retained.** Retained for evaluation in combination with hydraulic containment.
		Sprinkler Irrigation	The process uses pressure to force water contaminated with VOCs through a sprinkler irrigation system. The pressure change transfers the contaminants from the dissolved phase to the vapor phase.	Sprinkler irrigation can be an effective technology to treat low-concentration VOCs in groundwater. It is used primarily to treat contaminants that readily transfer from the dissolved phase to the vapor phase. The system causes the direct release of contaminants to the atmosphere and emission control is not feasible.	Sprinkler irrigation technology could be implemented at the Site. There are potential regulatory issues related to volatilization to the atmosphere. There is a potential for direct release of contaminants to soil. Sprinkler irrigation could potentially be coupled with evaporation pond treatment. This approach has low O&M requirements.	Low to Moderate	**Retained.** Retained for evaluation in combination with hydraulic containment.
Source Control Cleanup Action Objective: Protect groundwater by reducing or controlling the source of VOC contaminants available to groundwater.							
Source Removal	MSW Removal	Excavation of MSW from Area 2 and beneath the water table in Area 5, with disposal in a permitted landfill (Area 7)	Excavation and disposal in a permitted landfill is used to remove the contaminant source (MSW) from the environment.	Excavation and removal of MSW is impractical in most cases due to the health hazards, construction difficulties, and high cost. Removal of the MSW from Area 2 is likely feasible if proper health and safety controls are applied; however, the volume of waste that would require excavation and transportation would be impractical. Removal of MSW from beneath the water table in Area 5 is not considered feasible without extensive shoring of MSW and soil. Excavation of the MSW from beneath the water table would likely only be effective in removing a small portion of the contaminant source.	Excavation and removal of MSW is not commonly implemented, except when MSW materials have high toxicity or present an elevated hazard to human health or the environment. The landfill RI did not indicate that the MSW mass in Area 2 or the MSW beneath the water table in Area 5 present a high toxicity source or large component of the overall contamination. It likely could not be implemented for MSW at depth or beneath the water table. It possibly could be implemented at Area 2, however, the MSW removal has disproportionate cost compared to other technologies.	High	**Rejected:** Rejected based on disproportionate cost and virtual infeasibility to excavate MSW from below water table.
Landfill Gas Control	Landfill Gas Extraction and Destruction	Landfill Gas Extraction and Destruction	Landfill gas is extracted using a an extraction well and vacuum-blower system. The extracted gas is destroyed using a flare system.	Landfill gas extraction and treatment is technically feasible and is currently being implemented for Area 6. It has been shown to be effective as a source control technique, and may reduce the VOC contaminants in gas that are available to partition to groundwater.	Landfill gas extraction and treatment is currently being conducted at Area 6, and the system could be expanded into other disposal areas of the Site. The existing gas treatment system is capable of accepting gas from other areas of the Site.	Moderate	**Retained.** Retained as an expansion of the existing system.
Leachate Control	MSW Cover	Low Permeability or Evapotranspiration Soil Cover	Low permeability soil or evapotranspiration soil cap installed over MSW areas to limit infiltration/recharge and leaching of contaminants into groundwater.	This can be an effective technology that forms a barrier between the contaminated media and the surface, and restricts the infiltration of surface water and limits the generation of leachate. A soil cover provides containment only, it does not treat groundwater.	This common landfill technology can be straightforward to implement and can meet WAC 173-351 requirements. Previous studies at the Sudbury Landfill have found that low permeability soil used as an evapotranspiration cover can be effective at the Site. Low permeability soil is	Low to Moderate	**Retained.** This technology has shown to be effective at the site.

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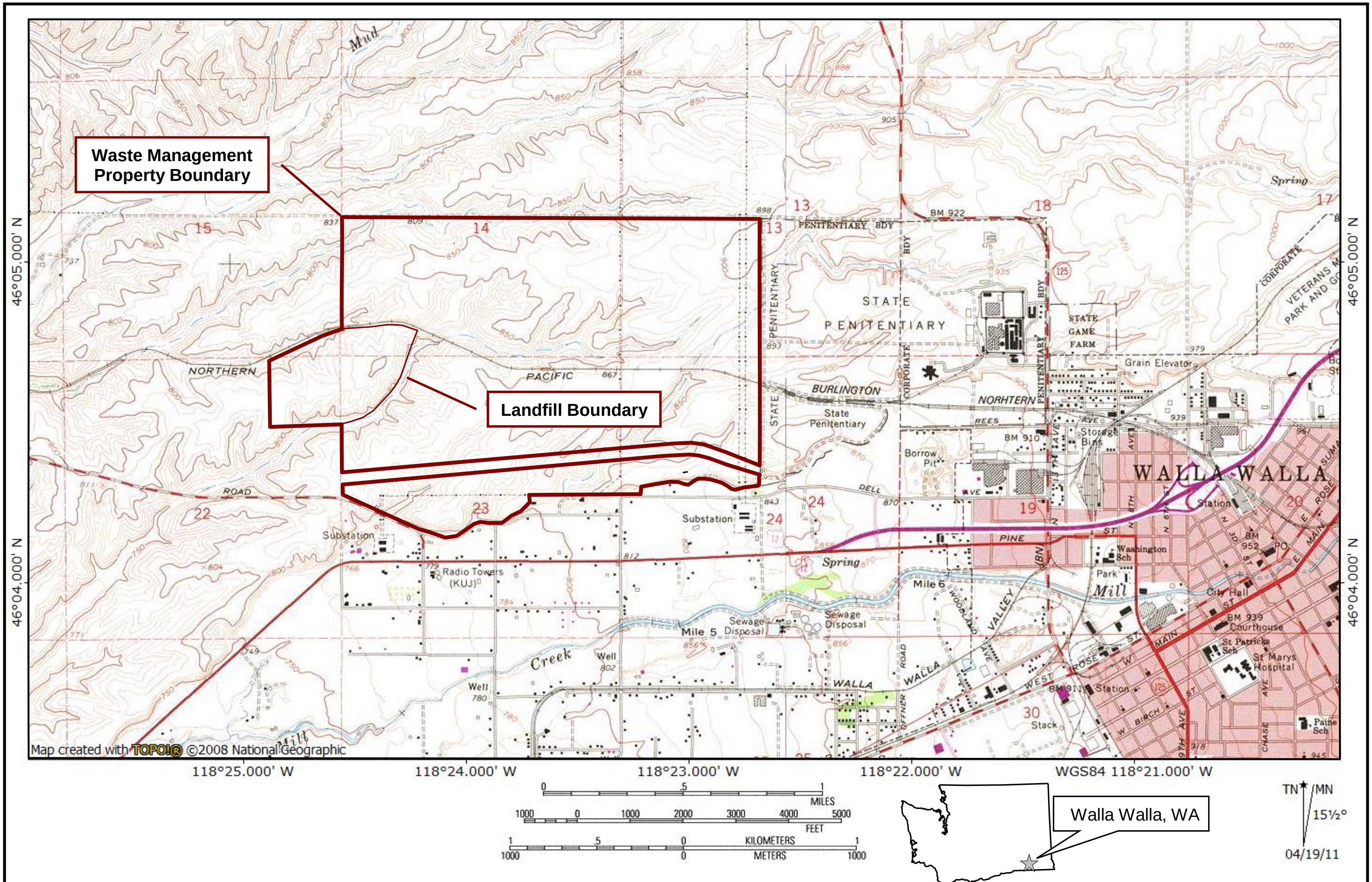
General Response Action	Implemented by	Remedial Technology	Description	Technical Feasibility/ Effectiveness	Implementability	Cost	Retained/ Rejected
Leachate Control (cont.)	MSW Cover (cont.)	Geosynthetic/ Multimedia Cap	Geosynthetic/Multimedia cap installed over MSW areas to limit infiltration/recharge and leaching of contaminants into groundwater.	This can be an effective technology that forms a barrier between the contaminated media and the surface, and restricts the infiltration of surface water and limits the generation of leachate. A cap provides containment only, it does not treat groundwater.	This common landfill technology can be straightforward to implement and can meet WAC 173-351 requirements.	Moderate to High	**Retained.** Retained as a contingent cover design.
		Reconstruct Area 5 existing soil cover	Manipulation of existing Area 5 low permeability soil cover to promote drainage and limit infiltration/recharge and leaching of contaminants into groundwater.	Reconstruction and/or manipulation of the Area 5 existing soil cover may be technically feasible, and could be effective in the minimizing the generation of leachate. Studies at the Sudbury Landfill have found that sufficient low permeability soil may cover the MSW, but the undulating surface may retain surface water and promote infiltration. This technology would enhance the effectiveness of existing cover systems.	This common landfill technology is likely easy to implement, could enhance the effectiveness of the existing cover system over Area 5, and can meet WAC 173-351 requirements.	Low	**Retained.** This technology would enhance the effectiveness of existing cover systems.
	Stormwater Controls	Surface grading, construction of stormwater channels, and run-on prevention.	Stormwater controls are implemented at landfills to prevent erosion, and stormwater run-on, pooling, and infiltration.	Construction of stormwater controls can be an effective method of preventing erosion, run-on, pooling, and infiltration, and are a requirement of the Solid Waste Permit.	Stormwater controls are commonly implemented at landfills to prevent erosion, infiltration, and the generation of leachate. Interim measures have been implemented at the landfill.	Low	**Retained.** Stormwater controls have been implemented at the Site and can be effective at minimizing leachate generation.

Notes:
cont. = Continued
CAO = Cleanup action objective
MSW = Municipal solid waste
O&M = Operations and maintenance
VOC = Volatile organic compound
WAC = Washington Administrative Code



Sudbury Landfill
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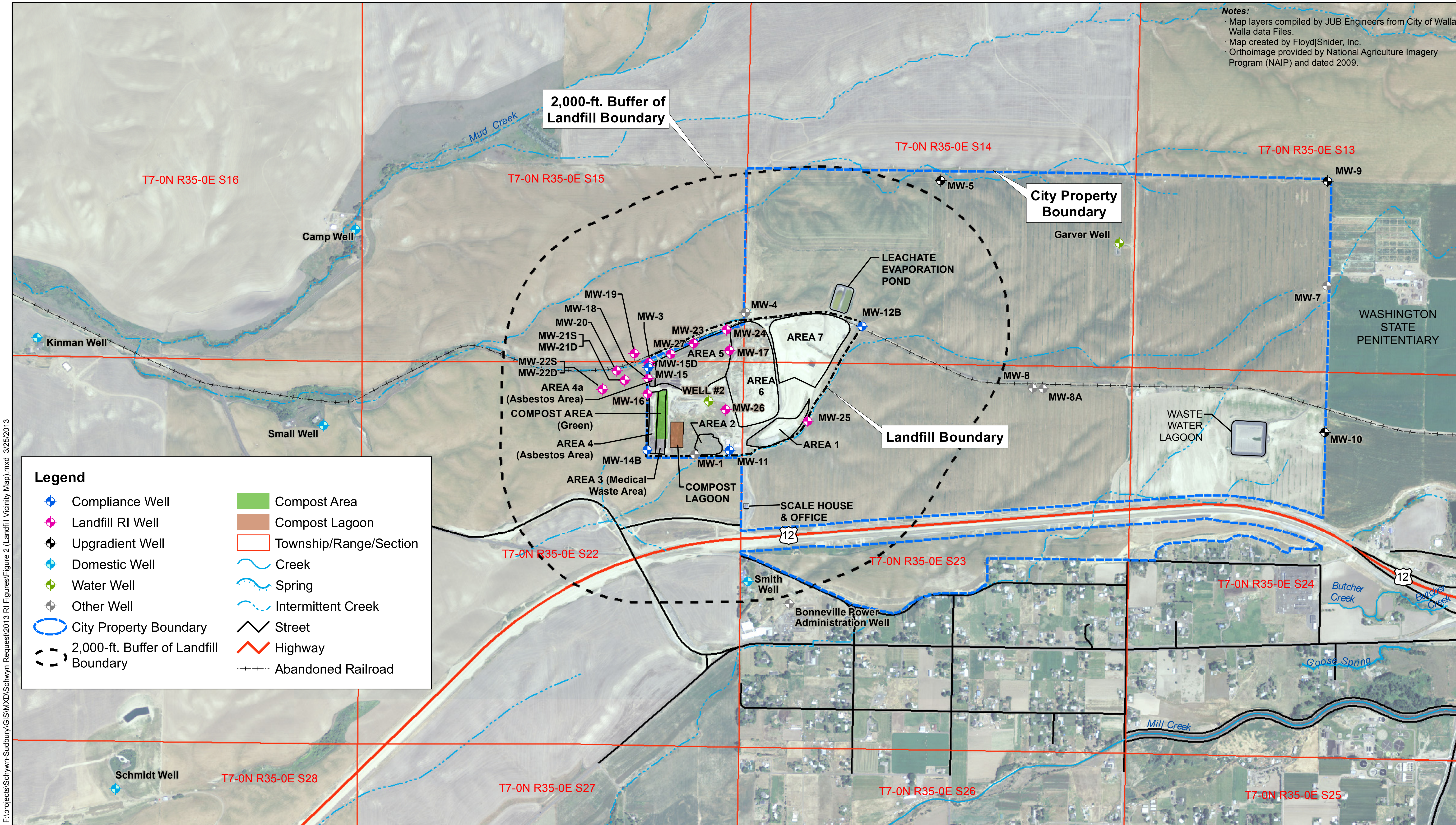
Site Location

Figure
1



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Sudbury Landfill
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Vicinity Map

Figure
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