ProLogis
Taylor Way Property

Feasibility Study

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1.0 Introduction

This Feasibility Study (FS) was prepared for ProLogis Development Services Incorporated (ProLogis) to fulfill a requirement of an Agreed Order (AO) signed January 19, 2005 between ProLogis and the Washington State Department of Ecology (Ecology). The AO stipulated that ProLogis perform a remedial investigation/feasibility study (RI/FS) of the Taylor Way Site (the Site) due to concerns regarding historical land use at the adjacent CleanCare property, which may have resulted in the placement of hazardous substances on the ProLogis Site. The location of the Site is shown in Figure 1.1, and a site map is provided in Figure 1.2. The final RI report was submitted to Ecology in October 2006. Ecology approved ProLogis' request to submit the FS after submittal of the RI report to allow more time for decisions on future land use and site ownership to be clarified. For efficiency, relevant sections, tables, and figures from the RI are incorporated solely via reference to that document. This FS was prepared to be consistent with the requirements of the Model Toxics Control Act (MTCA) as specified in WAC 173-340-350.

1.1 PURPOSE

The purpose of an FS is to identify the contaminants of concern (COCs) at a site, identify cleanup levels (CULs) for those contaminants, and evaluate various cleanup alternatives. Ecology will ultimately be responsible for the selection of the cleanup action for the Site, and will document and justify their selection in a Cleanup Action Plan.

1.2 PUBLIC PARTICIPATION

Under the terms of the AO, a public participation plan was prepared by Ecology and distributed to the public. That plan summarized the RI/FS activities to be conducted at the Site. No significant public comment was received. The public will have an additional opportunity to comment and provide input on the final cleanup action as required under MTCA WAC 173-340-600.

1.3 SITE HISTORY

Refer to Section 2.0 of the RI Report.

1.4 REMEDIAL INVESTIGATION FINDINGS

Refer to Section 3.3 of the RI Report.

2.0 Conceptual Site Model

2.1 CONTAMINANT SOURCES AND CONTAMINANTS OF CONCERN

The ProLogis site was subjected to various filling operations beginning in the late 1920s to early 1930s when it was first developed. At that time, the filling occurred solely in the northern portion of the Site, on what was originally tidal marsh land. The northern two-thirds of the Site was developed with a wood manufacturing plant; the southern one-third of the Site remaining a tidal marsh. The tidal marsh to the south was gradually filled in and raised to current grade by the late 1970s or early 1980s, according to aerial photographs. Ecology suspected that part of the fill material could have contained hazardous substances including lime solvent sludge, which was apparently part of the fill placed on the adjoining CleanCare site when it was a part of the Don Oline landfill.

In the 1990s the former industrial buildings (then in use as warehouses) were demolished in preparation for site redevelopment. At that time, a detention basin was built to collect runoff from the newly developed Safeway Distribution Center directly to the east. A surcharge pile, consisting primarily of material excavated for the construction of the detention pond, was constructed on-site in preparation for site redevelopment, which did not occur. Environmental testing during the 1990s did not reveal any conditions of concern, except for a release from a gasoline tank located along the northern portion of the Site. A complete cleanup of the soil and groundwater occurred and in a letter dated June 27, 2000, Ecology determined that "No Further Action" was needed following the cleanup (Smith 2000).

Exhaustive testing conducted during the RI determined that there is no lime solvent sludge present on the ProLogis site. In several closely spaced test pits near the CleanCare site, a thin layer of a whitish-gray paste close to the ground surface was observed. Four samples of this material were tested. Solvents were not detected in any of the samples thus, designating it as a solid, non-hazardous waste. The paste, however, and/or the surrounding soil matrix did contain several heavy metals in concentrations exceeding MTCA A standards. Other inert fill material (e.g., brick, wood debris, metal wire, or sawdust) was found scattered throughout the upper few feet of fill soil across the entire Site and is thought to be the source of the metals concentrations detected during the RI. This material likely originated from on-site wood processing activities and/or demolition of former buildings, which may have involved demolition of treated wood structures, as one sample contained low concentrations of a wood preservative, pentachlorophenol. The only other organic contaminants detected in concentrations greater than MTCA A cleanup levels were polycyclic aromatic hydrocarbon (PAH) compounds and heavy oil range hydrocarbons (PAH compounds being a component of heavy oils). The source of these hydrocarbons is unknown.

Groundwater occurs in a several foot thick zone within the upper fill material, which was placed atop clayey marsh deposits that acts as an aquitard. Beneath the marsh deposits there is a more regional saturated sand deposit that is somewhat tidally influenced. The flow direction in the fill aquifer was determined to follow site topography, which slopes to the northwest. The CleanCare site lies upgradient of the ProLogis site. The reverse is true for the deeper native sand aquifer below the tidal marsh deposits.

Groundwater sampling conducted during the RI at CleanCare indicated the presence of TPH-G, TPH-D, and benzene at concentrations greater than screening levels. Similar impacts were not seen in the downgradient ProLogis wells, indicating that the CleanCare site is not significantly impacting the groundwater at the ProLogis site. Instead, groundwater contaminants in ProLogis wells included primarily arsenic (at concentrations typically found in the Tacoma Tideflats area), several metals, and pentachlorophenol and bis (2-ethylhexyl)phthalate. However, the concentration of metals were generally less than the screening levels, except during the first round of sampling where excess turbidity was thought to have caused biased-high groundwater concentrations. The phthalate is considered to be a laboratory artifact.

2.2 CONCEPTUAL SITE MODEL

The conceptual site model describes, in general terms, affected media, environmental pathways, and potential exposure routes and receptors given the specific environmental conditions and contaminants detected on the Site.

Contaminated media at the Site include on-site soil and groundwater. Exposure routes to hazardous substances in these media are similar to what was evaluated for the adjacent Phillip Services Corporation (PSC) site, as both sites are industrial, and have similar environmental settings. The primary receptor and exposure routes for on-site contaminants is to on-site industrial or temporary construction workers directly contacting or ingesting contaminated soil; construction workers ingesting or contacting contaminated groundwater, or industrial and construction worker and site visitors breathing contaminated particulates. However, unlike the PSC site, the indoor air pathway from volatile organics in soil is not viable. This is because VOCs were not detected in Site soils in concentrations greater than screening levels. The only VOCs detected in groundwater were limited to benzene and TPH-G and were found in one Geoprobe groundwater sample taken at the property boundary. Therefore, the volatilization of VOCs from either soil or groundwater to indoor air is judged to be an incomplete pathway.

The drinking water exposure route was not considered viable as well. The shallow and intermediate groundwater in the tideflats area is considered nonpotable based on the proximity and hydraulic connection to the brackish waters of Commencement Bay. Deeper aquifers are considered potable; however, strong upward gradients in deep aquifers imply that hazardous substances are unlikely to be transported to the deep groundwater. Instead, the upper aquifers discharge to surface water. The highest beneficial use is, therefore, the protection of nearby surface waters (adjacent Blair and Hylebos Waterways). Consequently, the MTCA Method B groundwater cleanup levels must be protective of surface water and the groundwater cleanup levels do not need to meet criteria for drinking water consumption. Marine water quality criteria apply to the adjacent surface water bodies.

The exposure routes that would be potentially completed by the discharge of hazardous substances in Site groundwater to the adjacent waterways include:

- Toxicity to ecological receptors (aquatic biota).
- Human contact with contaminated waters and consumption of aquatic biota that have consumed or bioaccumulated contaminants.

Ecological exposure routes from ingestion, dermal contact, and inhalation of contaminants by wildlife receptors at the Site are also considered viable, as the Site does not qualify for a terrestrial ecological exclusion per WAC 173-340-7492(2) due primarily to its acreage being greater than 4 acres, its currently unpaved, and it lies close to City of Tacoma designated wildlife habitat marsh lands.

Based on the conceptual site model, soil cleanup levels selected for the ProLogis site must consider the following viable exposure routes and receptors:

- Industrial and construction worker incidental ingestion and dermal contact with soil.
- Industrial and construction worker and site visitor inhalation of dust and air particulates.
- Construction worker ingestion and direct contact with on-site groundwater.
- Aquatic biota ingestion of groundwater (that would migrate off-site and enter surface waters).
- Human consumption of affected aquatic biota.
- Human direct contact with affected surface water.
- Wildlife ingestion, contact, and inhalation of soil (terrestrial ecological receptors).

Figure 2.1 summarizes this conceptual site model, including complete or potential complete pathways and receptors and also includes the non-viable pathways discussed above.

3.0 Contaminants of Concern, Cleanup Levels, and Points of Compliance

3.1 CONTAMINANTS OF CONCERN

Site screening levels (SSLs) were used to during the RI process to screen the soil and groundwater data collected to identify the COCs. SSLs are risk-based concentrations of contaminants for specific exposure pathways, used to screen the data so as to identify the COCs at a site (i.e., those that pose unacceptable risk and will be the focus of the cleanup action). For uniformity, the SSLs used for the Site were consistent with those developed for the nearby PSC site, as the exposure pathways were identical, except for the indoor air pathway, which was not considered at the ProLogis site due to the lack of volatile organic compounds in Site soil.

In places, some of the shallow fill material contains hazardous substances at concentrations greater than the SSLs. Nearly all of the SSL exceedances were based on metal detections in samples collected from the southern half of the ProLogis site. The exceptions were at two locations where detected concentrations of heavy oil (at Test Pit TP-1) and pentachlorophenol (at Test Pit TP-16) slightly exceeded SSLs. The COCs for soil at this Site are detailed in Table 3.1, which also selects protective cleanup levels, as discussed in Section 3.2.

The result of three rounds of groundwater sampling indicate several VOCs, semi-volatile organic compounds, total petroleum hydrocarbon, and metals in both the shallow and intermediate aquifer at the ProLogis site and CleanCare site. However, only a limited number of compounds were detected at concentrations exceeding groundwater screening levels (GWSLs). At the CleanCare site, where wells were sampled twice, the shallow aquifer wells along the northeastern boundary contained gasoline-range total petroleum hydrocarbon (TPH-G), diesel-range total petroleum hydrocarbon (TPH-Dx), and benzene at concentrations greater than GWSLs. While one Geoprobe sample collected directly downgradient of an impacted CleanCare well contained benzene and TPH-G greater than GWSLs, similar impacts were not observed in ProLogis monitoring wells, indicating that the groundwater contamination at CleanCare is not significantly impacting the ProLogis site. Detected concentrations of pentachlorophenol and metals such as lead and zinc were not reproducible in later sampling rounds. The initial exceedances were thought to be due to high sample turbidity, which may be explained by insufficient well development due to the very thin aquifer thickness. Pentachlorophenol and metals (excluding arsenic) were generally not detected at concentrations greater than GWSLs during the second and third rounds of groundwater sampling.

This leaves arsenic as the primary COC for groundwater as it exceeded GWSLs in multiple wells over multiple rounds of sampling. Although the concentrations exceed the MTCA A cleanup level, the concentrations (maximum of 27 parts per billion) are well within the range Ecology considers reflective of area-wide background concentrations for the Tacoma. For example, at the nearby Reichhold Chemical site, where arsenic is not a contaminant of concern, arsenic has been detected at concentrations in both the shallow and intermediate aquifers at concentrations greater than 100 ug/L[1]. The reported concentration of bis (2-ethylhexyl) phthalate that was detected is considered a common laboratory artifact. The full list of COCs for groundwater are detailed in Table 3.1, which also selects protective cleanup levels as discussed in Section 3.2.

3.2 CLEANUP LEVELS

3.2.1 Soil

Three basic approaches for establishing site soil CULs are presented under MTCA: Methods A, B, and C. Method A CULs are established at concentrations at least as stringent as concentrations specified in applicable state and federal laws and follow WAC 173-340-900, Tables 720-1,740-1 and 745-1. Method A CULs are applicable when the cleanup action may be routine and may involve relatively few hazardous substances. Method A includes consideration of land use, with cleanup levels that are either protective of residential or industrial site use (i.e., Method A Residential, or Method A Industrial). Method A Industrial values are potentially applicable to this site. Method B is the normal cleanup level approach for residential exposure scenarios and so is not applicable to this site. Method C cleanup levels are based on worker exposure scenarios for direct contact with contaminated soil at industrial sites, and so are applicable. Due to the routine nature of the contaminants at the Site, the industrial nature of the Site and surrounding sites, and the pathways involved, Method A CULs for soil based on industrial land use is the most straightforward approach, as they are protective of all pathways but the list of contaminants covered by MTCA A is limited.

Table 3.1 lists CULs for each of the viable exposure routes identified in the conceptual site model based on MTCA C formulas (presented in the PSC RI) for industrial land use. For two COCs, barium and chromium[2], the CUL is greater than the maximum detection. Barium and chromium are, therefore, not retained as COCs needing further consideration. Three compounds (copper, zinc, and pentachlorophenol) do not have Method A concentrations, but do have Method C concentrations (based on soil ingestion), and all the detected concentrations are much less than Method C CULs. In fact, for solely the Method C worker exposure pathway, only two COCs, arsenic and total CPAH, exceed the CUL for worker exposure. Cleanup level exceedances for most of the other COCs in soil at this Site are primarily based on the leaching of soil to the groundwater pathway, as this is usually the most conservative site CUL. For barium, lead, and chromium, however, the CUL based on protection of ecological receptors is lower than the soil leaching pathway.

[1] Such elevated arsenic concentrations are associated with the release of naturally-occurring arsenic in mineral grains that are mobilized by certain reduction-oxidation states of the aquifer.

[2] It is assumed that the chromium detected at the Site is dominantly trivalent due to the lack of industrial processes.

3.2.2 Groundwater

Based on the conceptual site model, groundwater cleanup levels selected for the ProLogis site are protective of the following complete exposure pathways:

- Human incidental ingestion and dermal contact with groundwater during site construction activities.
- Protection of surface water to aquatic biota and humans ingesting the biota.

Groundwater discharge to surface water is the highest beneficial use of groundwater at the Site. The most conservative groundwater cleanup levels are those based on the protection of this resource. For those COCs where risk-based CULs are unavailable, the CUL is based on applicable or relevant and appropriate standards (ARARs). For arsenic and the two semi-volatile COCs, the risk-based CUL was lower than the quantitation limit or natural background concentration, so the CUL was adjusted accordingly. The groundwater COCs, applicable CULs, and the selected CULs are presented in Table 3.2.

3.3 POINTS OF COMPLIANCE

The points of compliance at the Site shall be consistent with the standard MTCA definition for soils, that is, cleanup levels must be achieved for worker exposure within the upper 15 foot zone, and for protection of groundwater and soils throughout the Site, regardless of depth. The COCs were all detected in the upper fill zone of the Site; undisturbed native soils below this zone are assumed to be contaminant free. The upper fill zone is typically found in the upper 5 feet of soil at the Site, expect at the surcharge pile, where it is typically around 10 feet thick. For groundwater, the points of compliance are throughout the Site, in both the shallow and intermediate aquifers.

4.0 Selection of Remedy Alternatives

This section identifies specific alternatives that are appropriate for the contamination found at the Site (primarily metals) and the pathway the cleanup action is to protect (surface water in the surrounding marine waterways). It is important to note that the COCs at the Site were detected at concentrations far less than those necessary to protect workers, except for arsenic, which slightly exceeds the Method C standard in 1 of 25 locations (Test Pit TP-4).

The selection of the alternatives was based on their applicability to the contaminant type, implementability at the Site, and effectiveness. Advanced technologies that are technically feasible but impractical to implement (e.g., acid-extraction) or those that have extreme costs (e.g., vitrification) were not considered.

Each remedial alternative must be able to reduce or eliminate the risks to human health and the environment from the specific COCs in the soils and groundwater at the Site. Under the MTCA regulation, alternatives that are permanent are preferred; however, if a permanent remedy is not technically possible, or if the costs of a permanent remedy are clearly disproportionate to the extra degree of protection it would provide, the permanent remedy is considered impractical (WAC 173-340-350).

When non-permanent remedies are selected, institutional controls and long-term monitoring may be required. Institutional controls are measures or actions to limit or prevent activities that may interfere with the integrity of the cleanup action or result in exposure to the hazardous substances on the Site, as outlined in MTCA WAC 173-340-440(1).

4.1 REMEDIES

Specific remedy alternatives are identified below for soil and groundwater. These alternatives are discussed further in Section 4.2.1.

4.1.1 Permanent Remedies

Soil. The remedial alternatives for soil that are potentially implementable and permanent are as follows:

1. Excavation
2. Encapsulation/Stabilization

Groundwater. No permanent remedial alternative for groundwater was identified due to the area-wide distribution of arsenic in groundwater. Should arsenic at the Site be permanently cleaned up within the boundaries, natural geochemical conditions and groundwater flow would eventually re-establish concentrations greater than cleanup levels. Treatment remedies are therefore considered non-permanent.

4.1.2 Non-permanent Remedies

Soil. Non-permanent alternatives for soil are as follows:

1. Capping (with Institutional Controls)

Groundwater. The remediation alternatives for groundwater that are non-permanent are:

1. Containment (with Institutional Controls)
2. *In-situ* Treatment

4.2 DETAILED DESCRIPTION AND EVALUATION OF REMEDIAL ALTERNATIVES

The above alternatives are discussed in more detail below and screened against the seven evaluation criteria of WAC 173-340-360 (3) (f). These seven criteria are:

- Protectiveness
- Permanence
- Cost
- Short-term Risk
- Long-term Effectiveness
- Technical Implementability
- Public Concerns

4.2.1 Soils

The two permanent remedies (excavation and encapsulation/stabilization) and the one non-permanent remedy (capping with institutional controls) for soil are discussed below in more detail.

4.2.1.1 Excavation

The estimated areal extent that encompasses all site contamination is shown in the shaded areas in Figure 1.2. There are three circular "hot spots" with an assumed impacted radius of 20 feet defined by an isolated test pit soil sample. The remaining three areas are more widespread and encompass areas of multiple test pits where samples were obtained that exceeded CULs. The square footage of each area is also shown on Figure 1.2. Assuming that the entire fill thickness in each area is contaminated to an average depth of 6 feet (12 feet in the surcharge pile area), approximately 40,000 cubic yards of contaminated soil (approximately 70,000 tons) would need to be removed, transported, and disposed of at an off-site landfill. The excavated areas would be backfilled to existing grade. An approximate cost to implement this remedy is estimated to be $4,300,000 for site preparation, excavation, transport, landfill disposal, backfill, and compaction, including contingency (as the true total volume of contamination is not well known). The cost for this remedy is clearly disproportionate to the benefit provided, especially in consideration of the relatively low but widespread concentrations of metals (such as arsenic, copper, and zinc) that are driving the cleanup of the Site based on protection of the surface water pathway, not industrial worker risk.

4.2.1.2 Encapsulation/Stabilization

This alternative involves excavation of the contaminated soil, treatment on-site to immobilize the metals, and backfilling of this material following treatment. Chemically treating the soil will immobilize the metals and will ensure that they will not leach to groundwater long-term (currently, there is no evidence of leaching of metals to groundwater at levels of concern, the only contaminant found in groundwater site-wide is arsenic, and at levels reflective of area-wide background). A treatability study would first need to be conducted to demonstrate that this alternative would be substantially more effective compared to existing conditions. Institutional controls would be required for this alternative, as soil with contaminants greater than CULs will still remain on-site. This alternative would cost approximately $80 per ton to excavate the soil, encapsulate the metals with a cement binder, and backfill the treated soil for a total cost of approximately $5,600,000, without contingency. This alternative is more expensive compared to excavation, and slightly less protective, as it leaves soils in place on-site. Like excavation, however, the cost is clearly disproportional to the benefit provided.

4.2.1.3 Capping with Institutional Controls

Currently, the Site is unpaved. Future site redevelopment plans by ProLogis[3] will result in a large warehouse being developed on-site, with the remainder of the Site paved for parking. The existing stormwater detention pond would be eliminated and that area paved. Stormwater would be managed off-site or in an on-site underground vault. Therefore, contaminated soil, which mostly is found in the southern half of the Site, will be entirely covered by either buildings or asphalt.

Standard ProLogis construction specification call for a concrete floor in building. The concrete must be designed to last at least 40 years. There will be 6 inches of concrete paving in the truck court next to the building (first 60 feet) and will be designed to last a minimum of 15 years and will be repaired or crack sealed or replaced as needed. Six inches (two 3-inch lifts) of asphaltic concrete paving will be placed across the remainder of the Site and will be designed to last 15+ years. Asphaltic paving is resealed every 5 years and repaired or replaced as needed. Either concrete or asphalt paving acts as a fully protective barrier that prevents human and ecological exposure via direct contact with the contaminated soils.

The building footprint, which covers approximately one-half the Site, eliminates infiltration of rainwater and reduces the risk of leaching of contaminants in the vadose zone to groundwater. The other half of the Site will have either concrete or asphaltic concrete. Both materials are highly effective in eliminating nearly all infiltration to underlying soils. Asphaltic concrete has a higher permeability than concrete, with 2-inch asphalt lifts with 4 percent air voids typically in the 10^{-7} cm/sec range, which is equivalent to Resource Conservation and Recovery Act (RCRA) cap requirements. Concrete is impervious in comparison, except for cracks. Asphalt permeability increases gradually with age primarily as a function of the ambient temperature,

[3] Assuming ProLogis retains the site. Development plans by future owners may differ considerably.

and tire wear (Asphalt Institute 1989). Liners under the pavement are not considered necessary given the already low permeability of asphaltic concrete. More importantly, the objective of the cap is to prevent human exposure and reduce, but not eliminate infiltration, which is not seen as a significant release mechanism. This is because Site soils, especially in the southern half of the Site, are typically saturated by contact with groundwater, especially in the winter months when the water table rises.

Institutional controls, consisting of a restrictive covenant, would be implemented at the Site to ensure that it remains paved, it is inspected yearly, and repairs to the pavement are implemented. Such controls would act to prevent inadvertent human exposure. Subsurface utility work could still be performed, with proper health and safety precautions and advance notice given to Ecology. This alternative, while not permanent, offers a high degree of protectiveness, has much more limited short-term risk (as soil would not have to excavated), and has virtually no cost, as the cost for the capping and site work would be a part of the normal development process. There would, however, be costs for environmental oversight reporting, pavement inspection and repairs and repaving (once every 30 years), and 30 years of annual groundwater monitoring. The pavement costs are estimated to be $200,000–$250,000. It is expected that some of the Site monitoring wells would be permanently abandoned due to their future location under buildings, and others would be able to be retained through Site development. Aside from permanence, this remedy meets all of the evaluation criteria and is the most implementable of all three soil remedies and has widespread acceptance at sites with relatively low levels of contamination found across large areas.

4.2.2 Groundwater

The groundwater contaminants are metals (primarily arsenic), which are found in both the fill and sand aquifer, much of which is potentially reflective of area-wide conditions. In addition to arsenic, there were some isolated detections of organics that were either not reproducible, or were potentially laboratory artifacts. Groundwater technologies, therefore, focus on treatment of metals. Natural attenuation processes were not considered due to the area-wide distribution of arsenic. It is assumed that for any groundwater remedy some degree of monitoring would have to be implemented to ensure that the remedy is protective, via demonstration of stable or declining trends.

4.2.2.1 Containment

Containment involves the isolation of contaminated groundwater by the placement of a barrier wall around the impacted zone, typically either a sheet pile or slurry wall. When successfully implemented, groundwater has no ability to migrate off-site. The area of containment must be capped to prevent groundwater levels from rising to the ground surface and overflowing the barrier. The depth of the containment would have to extend to at least 20 feet below grade given that the depth of contamination in groundwater extends to at least the base of the screened interval for wells in the sand aquifer, which is approximately 20 feet below ground surface. The area of containment would essentially be the perimeter of the Site (approximately 2,500 linear feet), as arsenic concentrations greater than cleanup levels were detected in most Site wells.

Installation of a slurry wall to that depth costs approximately $400 per linear foot using a trenching arm. The cost for this remedy is approximately $980,500. This remedy, while meeting the long term protectiveness and effectiveness requirements by containing groundwater, is clearly disproportionate to cost due to arsenic naturally occurring area wide at similar concentrations.

4.2.2.2 In-situ Treatment

The contaminants found in groundwater are potentially treatable in place by the injection of oxidizing agents or chemical additives in the wells that would precipitate out the mobile and reactive species, which for arsenic is the trivalent species. Once immobilized, the arsenic would not present as significant a risk for off-site migration. This remedy, however, is subject to considerable uncertainty as there is a tendency for metal species, over time, to reestablish themselves due to equilibrium considerations. The restoration time frame for this remedy is 5 years, which allows time for repeated applications in order to judge the efficacy of treatment. This remedy involves additional study to establish if the geochemical conditions are appropriate.

The cost for this remedy is difficult to estimate, but due to the large areal extent of the arsenic, and need for repeated applications, it is estimated that $1 million will be required to implement this remedy. A pilot test will be necessary to demonstrate the effectiveness of the technology.

Appendix A contains the cost calculations to arrive at the estimated remediation costs described above. These costs are reflective of current market conditions and were verified with local contractors, technology providers, and in-house engineers. Table 4.1 contains a summary of each remedy and how it ranks with each of the evaluation criteria.

5.0 Preferred Remedy

Although Ecology will select the ultimate cleanup action, the preferred remedy for ProLogis is capping of contaminated soils by either pavement or buildings, as part of Site redevelopment plans[4]. This remedy addresses the primary pathway of exposure by eliminating the infiltration of rainwater that promotes leaching and recharge of the fill aquifer, which in turn promotes off-site groundwater flow, all of which will help to maintain groundwater quality. Figure 5.1 presents a conceptual figure showing the redevelopment plan. The existing detention pond would be filled in and paved with stormwater managed off-site or via an underground vault. The remainder of the Site would be paved with asphalt and concrete and partially covered by a warehouse. The surcharge pile would be leveled across the Site to meet grade requirements. Some imported fill would likely be brought in. No on-site soil would be exported. Institutional controls, as described above, would consist of a deed restriction informing future buyers of the Site of land use restrictions due to contaminants. In addition, a site redevelopment plan would ensure that contaminated soils are safely handled during construction activities that penetrate the pavement.

Some groundwater monitoring wells would need to be abandoned due to their interference during construction. Following construction completion they could be reinstalled and monitored, as necessary, in locations to be decided upon jointly with Ecology. It is expected that the wells would be monitored for the COCs for 30 years, at an annual frequency.

[4] Assuming ProLogis retains site ownership. If ownership changes, the preferred remedy may also change.

6.0 Terrestrial Ecological Evaluation Exclusion

This Site qualifies for an exclusion from an ecological evaluation based on this future land use per WAC 173-340-7491, as the preferred remedy is paving of the Site and covering the contaminated soils with building or pavement. The planned date for this to occur is within the next five years. This will prevent plants and animals from being exposed to soil contamination. The required institutional controls have been described above as part of the preferred remedy.

7.0 References

Smith, Dave. 2000. Letter to Mr. Steve Agni. 27 June.

The Asphalt Handbook. Manual Series No. 4 (MS-4), 1989 Edition, The Asphalt Institute, Lexington, KY.

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Feasibility Study

Tables

Final

Table 3.1
Contaminants of Concern and Cleanup Levels for Soil (mg/kg)

Primary Contaminants of Concern	Maximum Detection	Dermal Contact[1]	Inhalation of Particulates[1]	Ingestion[1]	Protection of Groundwater[2]	Ecological[3]	Site Cleanup Level	Basis of Site Cleanup Level
Arsenic	130	100	1,640	87.5	11.7	20	**20**	Ecological and MTCA C Industrial (protection of GW
Barium	330	280,000	658,000	245,000	86,200	1,320	**1,320**	Ecological
Cadmium	7.8	2,000	2,000	3,500	5.52	36	**5.5**	Protection of GW
Copper	150	148,000	NA	130,000	4.44	550	**36.4**	Protection of GW—adjusted to Natural Background
Chromium	100	12,000	15,000	10,500	220	135	**135**	Ecological
Lead	520	NA	NA	NA	2,000	220	**220**	Ecological
Mercury	10	1,200	564,000	10,500	2.09	9	**2**	Protection of GW
Zinc	610	1,200,000	NA	1,050,000	101	570	**101**	Protection of GW
TPH–Oil	2,300	NA	NA	NA	NA	15,000	**2,000**	MTCA A Concentration (ARAR)
Total carcinogenic PAH	18.4	5.14[4]	4,050[4]	2	194[4]	300[4]	**2**	Ingestion and MTCA C Industrial
Pentachlorophenol	11	313	NA	105,000	0.792	11	**3.3**	Protection of GW—adjusted to PQL

Notes:

1 Values from PSC RI Report, Table 8-7 based on Industrial Land Use (used more conservative carcinogenic if available, otherwise the non-carcinogen was used).
2 Obtained from PSC RI table 8-7, calculated using fixed parameter three-phase partition model (WAC 173-340-747{4}).
3 Based on the values in WAC 173-340-7492-Table 749-2.
4 Based on the soil concentration for Benzo(a)pyrene.
ARAR Applicable or relevant and appropriate requirements.
GW Groundwater.
MTCA Model Toxics Control Act.
NA Not available.
PQL Practical Quantitation Limit.

Table 3.2
Contaminants of Concern for Groundwater (µg/L)

Primary Contaminants of Concern	Maximum Detection	Ingestion[1]	Dermal[1]	Surface Water	Site Cleanup Level	Basis for Site Cleanup Level
Arsenic	27	1,280	3,190	0.1	**5**	MTCA A (based on State Background)
Lead	96	NA	NA	NA	**15**	MTCA A (ARAR)
Pentachlorophenol	13	53,200	205	4.91	**5**	Protection of Surface Water, adjusted to PQL
Bis(2-ethylhexyl)phthalate	11	85,200	28,100	3.56	**10**	Protection of Surface Water, adjusted to PQL
Benzene	58[3]	2,390	218,000	22.7	**22.7**	Protection of Surface Water
TPH-Gasoline	1,400[3]	NA	NA	NA	**800**[2]	MTCA Method A

Notes:

1 Values Taken from PSC Final RI Report, based on Industrial Land Use Exposure Scenarios.
2 Concentration when benzene is present in the gasoline mixture.
3 Concentration approximate. Sample collected via Geoprobe.
ARAR Applicable or relevant and appropriate requirements.
MTCA Model Toxics Control Act.
NA Not available.
PQL Practical Quantitation Limit.

Table 4.1
Comparative Analysis of Remedial Alternatives

Remedial Alternative	Permanence	Restoration Time Frame	Technical Implementability	Post-remedy Obligation or Institutional Controls	Protectiveness and Long Term Effectiveness	Short Term Risk	Estimated Cost[1]
Subsurface Soils							
Excavation of Subsurface Contamination in Known Areas—40,000 cy	Permanent	Less than 6 months	Implementable, needs dewatering when excavating in fill aquifer.	None.	Very protective of human health and environment.	Potential for worker exposure during construction to contaminated soil.	$4,300,000
Encapsulation—40,000 cy	Likely permanent	Less than 6 months	Possibly implementable, needs treatability tests first.	Institutional Controls to ensure that the soil remains on-site. Site does not need to be paved following encapsulation.	Contaminated soils will remain after remedy implementation but the risk of soil leaching metals to groundwater that discharges to surface water will be lessened. Existing groundwater data indicated that soil leaching is not significant.	Potential for worker exposure during construction to contaminated soil'.	$5,600,000
Capping as part of Redevelopment	Not a permanent Solution	5 years to complete redevelopment	Very implementable, no special consideration.	Institutional controls will be required to inspect and maintain the cap. Repaving will be likely be necessary every 30 years.	Contaminated surface soils are beneath an asphalt cover or concrete paving or building footprint which acts to prevent infiltration and block the soil pathway to onsite and ecological receptors, the two primary pathways of concern.	Very low as contaminated soil would be left in place and paved or covered, except where building footings and utilities may excavate into limited areas of contamination.	$200,000
Groundwater							
Containment	Not a permanent Solution	6 months	Implementable, install slurry wall or sheet pile to 25 feet bgs around site perimeter and the tie into cap to eliminate infiltration and buildup of groundwater levels.	Institutional Controls needed as groundwater and soil left in place above CULs. Monitoring for contamination not required inside site.	Very protective as the off site risk of contamination migration is eliminated. Long term effectiveness questionable as sheet pile may rust out and slurry wall shift during earthquake.	None.	$980,500
In-situ Treatment	Potentially a permanent solution, except for naturally-occurring arsenic will recontaminate site	6 to 24 months with post treatment monitoring and re-treatment, if necessary.	Implementable but need to perform treatability study and pilot test, may require multiple applications.	Institutional Controls and groundwater monitoring if not fully successful.	Very protective in the short term, but long term contaminant levels may reestablish due to equilibrium considerations.	None, use of chemicals may require worker safety protection.	$1,000,000
Long Term Monitoring	Not a permanent Solution	NA	Easy to implement.	Needed to demonstrate protectiveness of remedy (i.e., stable or declining contaminant trends).	Very protective of human health and environment—indicates condition of contamination in groundwater.	None.	$150,000[2]

Notes:
1 Refer to Appendix A for details on cost calculations.
2 Assumes 30 years of annual monitoring.
bgs Below ground surface.
cy Cubic yards.

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Feasibility Study

Figures

Final

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Figure 1.1
Vicinity Map

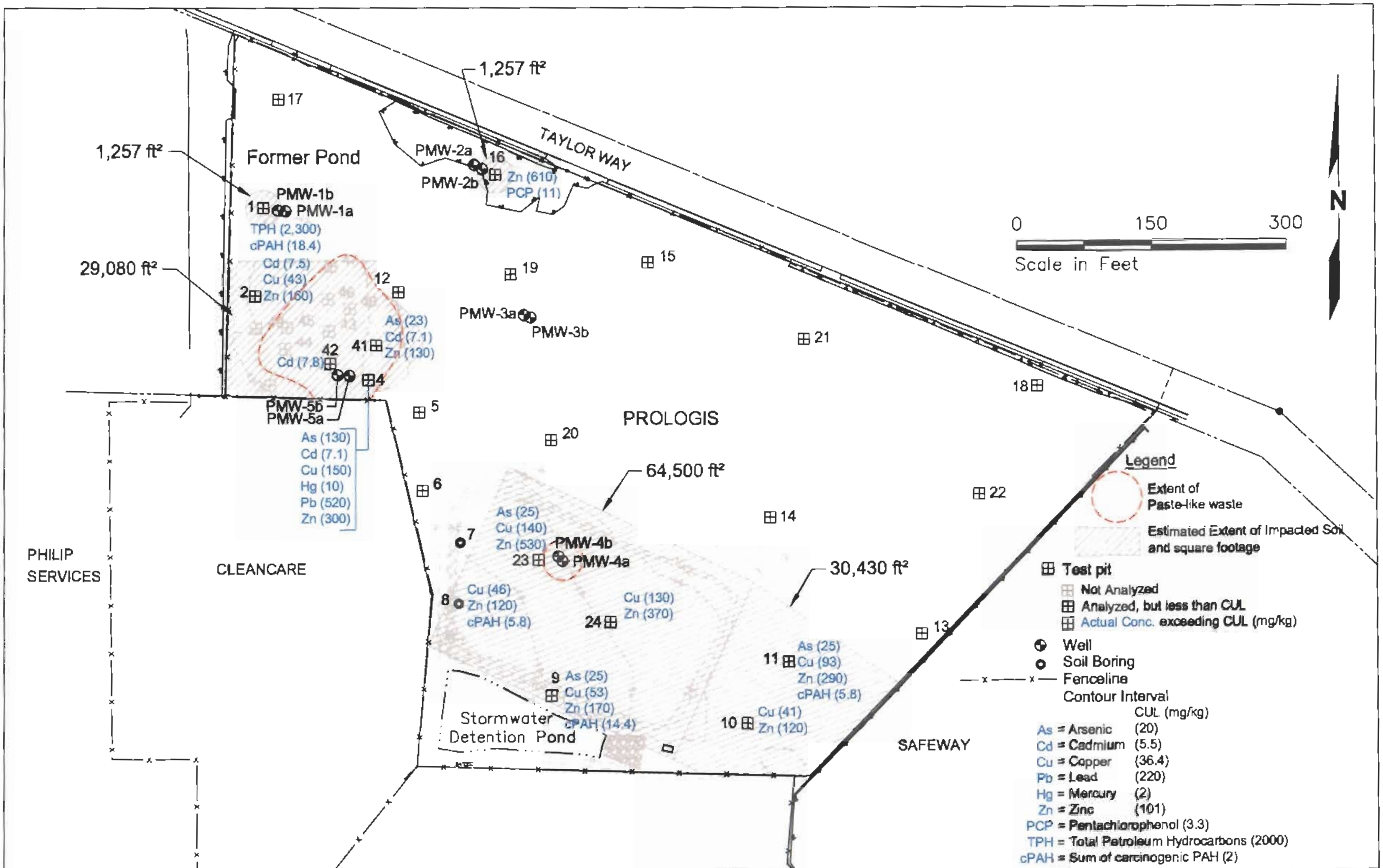

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Figure 1.2
Location and Concentration of
Samples Exceeding Soil Cleanup Levels

DATE: 11/14/06 1:24pm
DWG NAME: G:\project\Clients\Floyd and Snider\TaylorWay\FS\tayFS001mod.dwg

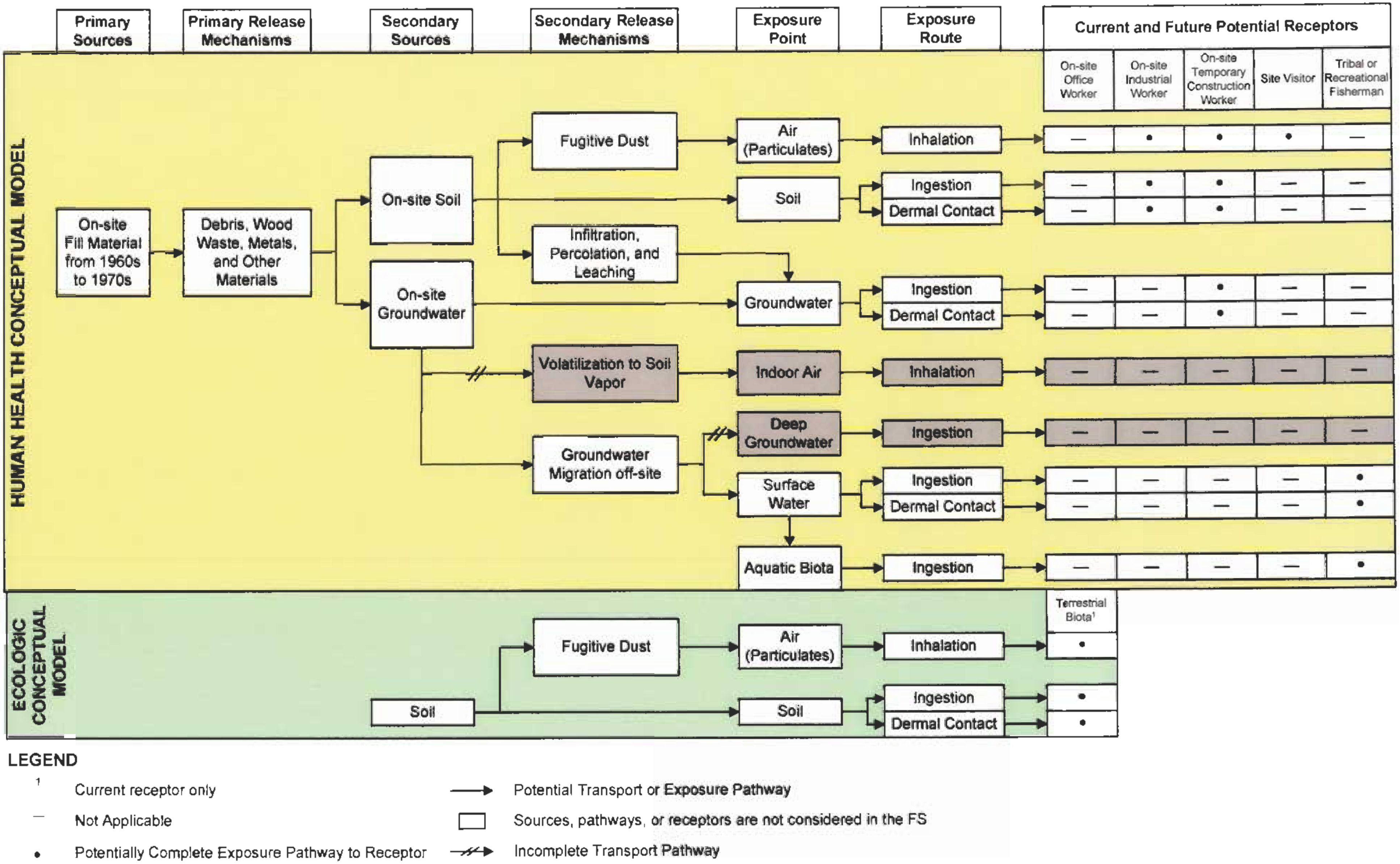

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Figure 2.1
Conceptual Site Model

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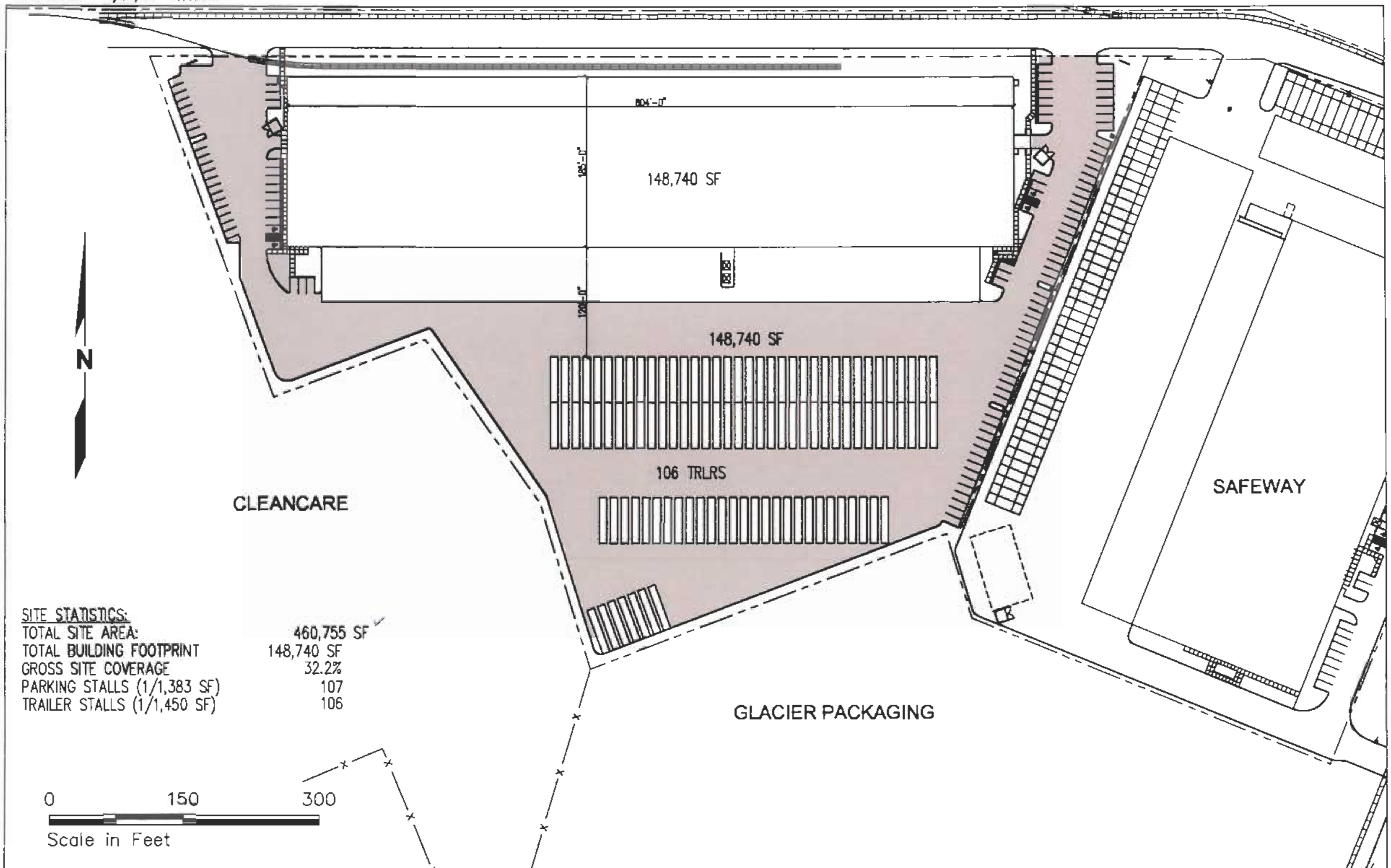

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Figure 5.1
Future Site Development Conceptual Plan

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Appendix A
Cost Calculations

Final

Table A.1
Remedial Alternatives Cost Estimate

Remedial Alternative[1]		Capital Cost[2]		Capital Cost with Construction Contingency[3]	Annual O & M or LTM Cost	
SOIL						
Excavation	Excavate, haul, and dispose of 40,000 cy of material to Subtitle D landfill.	$4,092,350	See cost calculations on backup spreadsheet.	$4,354,850	$0	No O&M required. Assumes no further groundwater monitoring will be required.
Stabilization/Encapsulation	Excavate, encapsulate on-site 40,000 cy of contaminated soil and then backfill.	$5,651,250	See cost calculations on backup spreadsheet.	$7,173,750	$50,000	No O&M required. Assumes semi-annual groundwater monitoring for five years.
Capping	Grade and level site, and cover entire site with buildings and pavement as part of site development	$0	No additional cost for remediation, as capital cost for remedy incurred as part of normal site redevelopment. However, since consultant oversight and interaction with developer and contractor will be necessary, this cost is in the contingency column.	$100,000	$200,000	Assumes annual inspection of cap and repaving 100,000 s.f. of asphalt once in 30 years at $2/sf.
Groundwater						
Containment	Install slurry wall around perimeter of site to depth of 20 feet and then tie into pavement as part of site development.	$821,500	See cost calculations on backup spreadsheet.	$980,500	$0	Groundwater monitoring would not be required for this remedy
In-situ Treatment	Inject oxidant or sequestrant in both aquifers to immobilize arsenic. Limited documentation of prior implementation. Pilot study needed to demonstrate feasibility. May require multiple applications.	$923,413	Capital Costs for pilot test and to install full scale hard piping system.	$1,102,138	$200,000	O&M costs estimated for 5 years. Assumes quarterly groundwater monitoring for 10 years. Cost for repeated applications covered in the Capital cost.
Long Term Monitoring	LTM needed to demonstrate protectiveness of remedies that leaves contaminated soil in place. Number of wells and sampling frequency/analytes TBD.	$0	Wells already installed.	NA	$150,000	Assumes annual groundwater monitoring for 30 years at $5,000/year.

Notes:

1 Refer to text for full description.

2 Includes permitting, engineering, construction, oversight, analytical and other capital costs.

3 Thirteen percent to 28 percent of construction costs, based on unknowns for each alternative.

10.28 Acre site
− 3.4 Acre Bldg
6.88 Acre lot

2.3 Acre repaved
once during 30-years
(30%)

Table A.2
Excavation

Estimated costs for removal of materials include costs for mobilization/demobilization, permitting, site preparation (fence removal, erosion controls, etc), engineering, oversight and analytical testing, loading trucks, hauling, and disposal. The estimate is based on the following assumptions:

- 40,000 cubic yards (CY) or 70,000 tons of material.
- Site preparation will be limited to fence removal, erosion controls, and haul road improvements.
- 50 days of truck loading at 40 to 45 truckloads a day for a total of approximately 2,200 truckloads
- 2 hour round trip hauling time per truck for non-hazardous material to Seattle Transfer station for use as daily cover or general landfill refuse.

CAPITAL COSTS					
Construction Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Mobilization/Demobilization, Site Preparation	LS	$50,000	1	$50,000	Temporary facilities, fence removal, erosion controls, and road building
Excavation and Transport to Transfer Station	Ton	$25	70,000	$1,750,000	Costs based on two-hr round trip to Seattle at $85/hour (or $250/truckload), $3/ton to load material, and $25/ton disposal fee.
Transportation and Disposal at Subtitle D Landfill	Ton	$30	70,000	$2,100,000	Costs based on current market conditions
Monitoring well reinstallation	EA	$3,000	3	$9,000	Assumes 3 wells will be destroyed and need to be reinstalled for long-term monitoring.
Planning, Permitting and Environmental Impact Statement	LS	$50,000	1	$50,000	EIS may be required by the City of Tacoma
Subtotal				**$3,959,000**	
Engineering and Support Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Additional Site Characterization, Engineering Design, Support and Project Reporting and Closeout at 40%	percentage			$43,600	
Construction management	LS		1	$62,500	Assumes 50 work days, one FTE at $1250 per day.
Analytical Testing at 15%				$16,350	Assumes 100 samples
Agency interactions and reporting at 10%				$10,900	
Subtotal				**$133,350**	
Pre-Contingency Total				**$4,092,350**	
Construction Contingency	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Contingency at 15%				$262,500	cleanup levels
Subtotal				**$262,500**	
Project Total				**$4,354,850**	
ANNUAL O & M COSTS					
Item	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Groundwater monitoring	semi-annual sampling, per year	$10,000	0	$0	Assumes no further groundwater monitoring.
Annual O & M Total				**$0**	
TOTAL COSTS				**$4,354,850**	

Table A.3
Contaminant Slurry Wall[1]

Estimated costs for containing and isolating groundwater within the existing perimeter include costs for site preparation, barrier installation, sealing cap materials to barrier, and O & M. The estimate is based on the following assumptions:
- Containment wall is installed around the 2500 linear feet of site perimeter .
- Containment wall is installed to 20' below ground surface (bgs) and keyed into silt aquitard unit where available.
- Cap materials will be sealed to containment wall perimeter or otherwise seal out infiltration.
- O & M will include continued groundwater monitoring

CAPITAL COSTS					
Construction Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Mobilization/Demobilization, Site Preparation	LS	$100,000	1	$100,000	Assumed. Reflects mob/demob cost estimate by Dewind of $50K, plus additional site preparation costs.
Slurry wall installation	LF	$100	2,500	$250,000	Assumes installation of 20-25-ft deep by 2-ft wide by 2,500 feet long Soil-Bentonite Slurry Wall using Dewind one-pass trenching technology.
Sheetpile wall installation	LF	$1,000	0	$0	Interlocking steel sheets, 25 feet in length, with finished concrete bulkhead.
Cap extension	LF	$60	2,700	$162,000	Assumes 10 square feet 80 mil liner ($65/SF) and 7 CY of imported pit run ($6.67/CY) for per LF of barrier, plus labor to install ($6.50/LF).
Performance monitoring well installation	EA	$3,000	3	$9,000	To ensure complete capture of leachate plume/monitor performance.
Monitoring well installation	EA	$3,000	3	$9,000	3 downgradient sentinel wells for long-term monitoring.
Subtotal				**$530,000**	
Engineering and Support Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Additional Site Characterization, Engineering Design, Support and Project Closeout at 40%				$212,000	
Construction Management at 10%				$53,000	Assumes 20 workdays, one FTE at $1250/day. (Reduced oversight reflects shortened timeline for slurry wall installation using Dewind trenching technology).
Permitting and agency negotiation at 5%				$26,500	
Subtotal				**$291,500**	
Pre-Contingency Total				**$821,500**	

Construction Contingency	Units	Unit Cost	Quantity	Estimated Cost	Comments
Contingency at 30%				$159,000	Contingency based on unknown additional trenching and unforeseen soil disposal costs.
Project Total				**$980,500**	
ANNUAL O & M COSTS					
Item	**Units**		**Quantity**		**Comments**
Groundwater monitoring			1	$0	Part of performance monitoring.
Performance monitoring	Annual	$20,000	1	$20,000	Cost based on quarterly sampling of 4 performance monitoring wells pairs, inside/outside of wall, in conjunction with other monitoring and annual reporting.
Annual O & M Total				**$20,000**	
TOTAL COSTS				**$1,000,500**	

Notes:

1 Updated with Dewind One-Pass trenching technology.

Table A.4
Soil Stabilization/Encapsulation

Assumes 40,000 cubic yards of soil to be encapsulated (70,000 tons). Encapsulation will physically isolate metals and semi-volatile organics and make soil impermeable, therefore preventing the risk of leaching to groundwater. On-site "grout plant" needed. Capacity of plant is 1,500 2,000 tons/day. Assumes that cement/pozzolan will be the binding agent, not polymer.

CAPITAL COSTS					
Construction costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Mobilization/Demobilization, Site Preparation	LS	$25,000	1	$25,000	Heavy equipment access, grading, erosion controls, etc.
Treatability Testing	LS	$5,000	2	$10,000	Assumes two treatability tests with two different vendors.
Excavaton of Soil, and Backfill	ton	$12	70,000	$840,000	Based on market conditions.
Encapuslation on Site	ton	$60	70,000	$4,200,000	Assumes that cement used for stablization, with on site grout plan. Pricing from EPA. 1,500 tons per day.
Subtotal				**$5,075,000**	
Engineering and Support Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Additional Site Characterization, Engineering Design, Support and Project Closeout at 30%				$463,750	Typical for jobs of this complexity.
Construction Management				$62,500	Assumes approximately 48 - 56 workdays, one FTE at $1250/day.
Permitting and agency negotiation				$50,000	Fill and grade permit required as well as agency approvals.
Subtotal				**$576,250**	
Pre-Contingency Total				**$5,651,250**	
Construction Contingency	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Contingency at 30%				**$1,522,500**	
Project Total				**$7,173,750**	
O & M COSTS					
Item	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Groundwater monitoring	Annual	$5,000	10	$50,000	Cost based on 5 years of semi-annual monitoring.
Annual O & M Total				**$50,000**	
TOTAL COSTS				**$7,223,750**	

Table A.5
In-situ Groundwater Treatment

Success for this alternative must be demonstrated via a pilot test before full scale implementation. Costs for treating the arsenic plume through in-situ methods include: injection point installation, pipe installation, permanent chemical injection system operation, performance monitoring, and groundwater monitoring. Costs are based on the following assumptions: assumes area to be treated is 160,000 square feet or 3.7 acres. Injection points will be 20 ft apart/400 square feet per point, for a total of 150 injection points.

CAPITAL COSTS					
Construction Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Pilot test	LS	$100,000	1	$100,000	Assumes 8 injection points ($3000), pipes/connections ($7000), ozone injection system rental ($5000), other potential system components ($5000), total labor ($20000), sampling and analytical results ($10,000), reporting ($10,000), engineering ($40,000).
Injection wells	EA	$365	150	$54,750	Assumes installation of average 10/day with limited access geoprobe rig, 1" PVC temporary wells to 20', with fees ($65) and assumes variance for manifolding.
Pipe connections from wells to system.	LS	$20,000	1	$20,000	Assumes 3000 feet 2" PVC branch lines (10 transects x 300 feet each), 400 feet main 4" PVC/HDPE to system at landfill, miscellaneous fittings/valves, labor to install.
Chemical injection system installation and startup	LS	$400,000	1	$400,000	Conservative estimate based on APT/Calgon estimates for ozone, PulseOx, permanganate or similar.
Performance monitoring well installation	EA	$3,000	4	$12,000	To monitor injection system performance.
Monitoring well installation	EA	$3,000	3	$9,000	3 downgradient sentinel wells for long-term monitoring.
Subtotal				**$595,750**	
Engineering and Support Costs	**Units**	**Unit Cost**	**Quantity**	**Estimated Cost**	**Comments**
Additional Site Characterization, Engineering Design, Support and Project Closeout at 50%				$297,875	Typical percentage based on jobs of this complexity.
Permitting and agency negotiation at 5%				$29,788	
Subtotal				**$327,663**	
Pre-Contingency Total				**$923,413**	

Construction Contingency	Units	Unit Cost	Quantity	Estimated Cost	Comments
Contingency at 30%				$178,725	Contingency based on possible additional treatment costs (technology-specific), possible additional injection wells.
Project Total				**$1,102,138**	
O & M COSTS					
Item	**Units**		**Quantity**		**Comments**
Groundwater monitoring	Annual	$10,000	5	$50,000	Cost based on semi-annual sampling for five years following end of treatment phase.
Injection system O & M	Annual	$75,000	1	$75,000	Technology specific.
Performance monitoring	Annual	$20,000	1	$20,000	Cost based on quarterly sampling of 4 performance monitoring wells in conjunction with other monitoring and annual reporting.
Annual O & M Total				**$145,000**	
TOTAL COSTS				**$1,247,138**	