DRAFT ANALYSIS OF BROWNFIELD CLEANUP ALTERNATIVES
Former Fertilizer Storage Plant
800 G Street
Tulelake, California

Prepared For:
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18 December 2025
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1.0 INTRODUCTION

On behalf of the City of Tulelake, California (Tulelake), Langan CA, Inc. (Langan) has prepared this Analysis of Brownfield Cleanup Alternatives (ABCA) report (report) for the property identified as the Former Fertilizer Storage Plant located at 800 G Street in Tulelake, Siskiyou County, California (site; Figure 1). This ABCA is being prepared under the United States Environmental Protection Agency (USEPA) Community-wide Assessment (CWA) Grant.

This report presents an evaluation of site conditions and potential remedial and/or mitigative alternatives proposed to address previously identified environmental conditions. This evaluation will be expanded and modified, if necessary, if additional information (e.g., environmental characterization, development plans, etc.) is made available after the date this report is prepared. Langan anticipates that this report may be presented and/or reviewed by the community, stakeholders, project partners, regulatory oversight agency (as needed), and the USEPA.

The site occupies approximately 11.35 acres and is located in the southeastern portion of Tulelake in an area that is mixed use with industrial, residential, and school properties. This site is a potential location for revitalization or redevelopment for multi-family residential use.

The site is developed with an approximately 2,385-square-feet (sf) wood storage building (Building 1), an approximately 9,492-sf warehouse building with six bays (Building 2), a weighing shed and truck scale, a mobile home, and a storage shed. The site is bordered on the north by a Pacific Power & Light electrical power station followed by the Volcanic Legacy Scenic Byway and a single family residential property, on the south by the Tulelake Volunteer Fire Department (1 Ray Oehlerich Way) and a vacant field, on the west by Tulelake High School (850 Main Street), Modoc Avenue, Shady Land Trailer Park (465 Modoc Avenue) and single family residential properties, and on the east by an industrial warehouse belonging to Union Pacific Railroad and Tule Lake Pesa Maravilla (723 Modoc Avenue) followed by a railroad and State Highway 139. Langan understands that Tulelake intends to reuse and redevelop the site for residential use.

Environmental assessments have been conducted by Stantec Consulting Services Inc. (Stantec) and Langan since 2023. These assessments were conducted under Tulelake's Department of Toxic Substances Control (DTSC) Equitable Community Revitalization Grant (ECRG) and the CWA Grant. Langan also understands that Tulelake and other stakeholders are evaluating potential additional USEPA grant funding options to support the environmental cleanup and development of the site, including a USEPA Brownfield Cleanup Grant (Cleanup Grant). Prior to submitting an application for a Cleanup Grant, an ABCA report is required to be prepared and shared with the community. This report was prepared in an effort to meet Cleanup Grant application requirements.

2.0 BACKGROUND

Langan reviewed the following environmental documents related to previous site investigations:

- Stantec, 2023. *Fertilizer Storage Site – 800 G Street, Tulelake, CA, Phase I Environmental Site Assessment (ESA)*. 6 October. (Phase I ESA).
- Stantec, 2024. *Fertilizer Storage Site – 800 G Street, Tulelake, CA, Revised Phase I ESA*. 13 May. (Revised Phase I ESA).
- Stantec, 2024. *Phase II ESA Work Plan, Former Fertilizer Storage Site, 800 G Street, Tulelake, California, Grant ID: ECRG-2021-00554*. 14 May. (Phase II ESA Work Plan).
- Langan, 2024. Pre-Demolition Regulated Building Materials Survey, Fertilizer Distribution Building, 800 G Street, Tulelake, California 96134. 27 August. (Pre-Demolition RBM Survey).
- Stantec, 2025. *Phase II ESA Report, Former Fertilizer Storage Site, 800 G Street, Tulelake, California, Grant ID: ECRG-2021-00554*. 28 January. (Phase II ESA).

Information in the above reports were used in the sections and subsections below.

2.1 Site Background

The site was previously occupied by Tri-County Agriculture until July 2021. The City of Tulelake currently owns the site. The northern portion of the site was previously utilized as a storage and distribution center for fertilizer and other agricultural products. The southern portion of the site was previously utilized as an agricultural field. Prior to the mid-1980s, the entire site was an agricultural field. During a site reconnaissance conducted by Stantec on 20 April 2023 and in March 2024, heavy equipment, unidentified substance containers, debris piles, semi-covered mounds, and miscellaneous storage was observed. Due to the previous agricultural use of the site and storage of fertilizer and heavy equipment, petroleum hydrocarbons, metals, pesticides, and fertilizers were suspected to be potentially present in the subsurface. Based on the conclusions of the Phase I ESA at the site, a Phase II ESA was recommended to further assess the subsurface conditions beneath the site.

2.2 Previous Investigations

The following is a summary of the previous investigations conducted by Stantec from 2023 to 2025, as presented in the reports listed in the subsection above.

2.2.1 2023 Phase I ESA

Stantec prepared a Phase I ESA for the site. This Phase I ESA identified two recognized environmental conditions (RECs), one business environmental risk (BER), and one de minimis condition associated with the site. Specifically, the site's historical use for agriculture and the storage of fertilizer and heavy equipment was identified as a REC.

During the Phase I ESA site reconnaissance on 20 April 2023, two unlabeled 100-gallon barrels with a viscous black liquid leaking out of them were observed. These were located within Building 2 located on the southern portion of the site. Historical spills from these barrels may have migrated to the building subsurface through cracks in the cement slab. This represented a REC associated with the site.

Stantec also observed the storage of tires, steel pieces and equipment, and polyethylene tanks located throughout the site. The tanks were staged on unpaved, vegetated surfaces. Stantec noted that the presence of these tanks represented a de minimis condition associated with the site.

During the site reconnaissance, Stantec also observed multiple debris piles and semi-covered dirt mounds throughout the site. Stantec identified this as a BER associated with the site.

Interviews with local community members of Tulelake also indicated that the site may have been used as an illegal dumping ground for a limited period of time.

Significant data gaps included not being able to access Building 1 during the site reconnaissance and not receiving documentation regarding the cleanup of a nearby, upgradient surrounding property.

Based on the aforementioned environmental conditions associated with the site, a limited subsurface investigation with soil and groundwater sampling was recommended.

2.2.2 2024 Revised Phase I ESA

Stantec prepared a Revised Phase I ESA after gaining access to Building 1 for the site reconnaissance. During the site reconnaissance of Building 1, storage of used tires, auto parts, batteries, and other miscellaneous items were observed. The flooring of the building was unpaved with vegetation. Staining from the storage of materials was observed on the floor of the building. Stantec identified this staining in Building 1 as a REC associated with the site.

2.2.3 2024 Pre-Demolition RBM Survey

A pre-demolition regulated building materials survey was conducted at the site by Langan in July of 2024. The goal of the surveys was to identify asbestos containing materials (ACM), lead-containing paint (LCP), polychlorinated biphenyls (PCB), and Universal Hazardous Waste (UHW). As presented in the 2024 Pre-Demolition RBM Survey report, Langan did not identify ACM, LCP, or PCBs in the building materials of the buildings at the site. However, Langan identified various oils and pesticides as potential UHW during a visual inventory of the site and recommended proper management in accordance with applicable federal, state, and local regulations and guidance.

2.2.4 2025 Phase II ESA

Based on the environmental conditions identified in the aforementioned Phase I ESA and Revised Phase I ESA reports, Stantec conducted a Phase II ESA that included soil and groundwater sampling. The Phase II ESA was conducted in accordance with a Phase II ESA Work Plan. The Phase II ESA Work Plan outlined planned soil and grab groundwater sampling methods and laboratory analyses.

In September 2024, Stantec contracted Cascade Drilling, LP to provide drilling services and advance 20 borings across the site (B1 through B20, Figure 2). Stantec collected three soil samples from each boring for a total of 60 soil samples collected across the site. Soil samples were collected at depths of 0.5 foot below ground surface (bgs), two feet bgs, and four feet bgs. Four grab-groundwater samples were collected at the site from borings B1, B9, B10, and B16. Groundwater was encountered at depths ranging from 3.75 to 5.5 feet bgs in eight borings located mainly in the eastern portion of the site while groundwater was not encountered in the remaining borings. Soil encountered at this site during this investigation included fine grained sands, silts and clay. Localized coarse grained fill material, including debris, was encountered at specific locations to depths of one to two feet bgs.

The soil and groundwater sample locations were selected to assess environmental concerns identified in the Phase I ESA and Revised Phase I ESA report. These concern areas included Buildings 1 and 2, the debris area, and locations where polyethylene and metal storage tanks were observed. Sample locations were also located throughout the site to provide lateral coverage and compare unused portions of the site to areas that may contain impacts from previous agricultural use. Soil and groundwater sample locations are shown on Figure 2.

Soil and groundwater samples were analyzed for constituents associated with historical agricultural use and storage of equipment and fertilizers, including petroleum hydrocarbons, volatile organic compounds (VOCs), pesticides, metals, fertilizers, and per- and polyfluoroalkyl substances (PFAS).

Soil analytical results for compounds with exceedances of applicable screening levels are listed below:

- Total petroleum hydrocarbons as diesel (TPHd) was detected in soil above applicable screening levels in B1 at 0.5 feet bgs, B2 at 0.5 feet bgs, and B12 at 0.5 and two feet bgs.
- TPH as motor oil (TPHmo) was detected in soil above applicable screening levels in B1 at 0.5 feet bgs, and B12 at 0.5 feet bgs and two feet bgs.
- Lead was detected in soil above applicable screening levels in B20 at two feet bgs. This boring is located in the southern portion of the site.
- Two soil samples (B9 at 0.5 feet bgs and B10 at 0.5 feet bgs) were analyzed for PFAS. Perfluorooctanoic acid (PFOA) was detected in both samples above applicable screening levels.

B1 and B2 are located within Building 1, B12 is located within Building 2, B20 is located in the southern portion of the site, and B9 and B10 are located in the former debris area (Figure 3). Based on these results it appears that TPHd and TPHmo are present in soil at depths up to 0.5 feet bgs in Building 1, TPHd and TPHmo are present in soil at depths up to two feet bgs in Building 2, lead is present in soil at depths up to two feet bgs at B20 in the southern portion of the site, and PFOA is present in soil at depths up to 0.5 feet bgs in the former debris area (B9 and B10) The presence of these contaminants appear to be localized, though the vertical extent has not yet been defined.

Various metals were detected at concentrations in groundwater that exceeded applicable screening levels. These detections in groundwater were attributed by Stantec to background concentrations and/or sediment suspended in the water samples. Potassium was detected in groundwater at concentrations ranging from 22.6 to 329 milligrams per liter (mg/L); however, standards have not been established for potassium in groundwater. Nitrate was also detected in groundwater at concentrations that exceeded the USEPA Regional Screening Level (RSL) for tap water. The groundwater at the site is not currently or anticipated to be used for drinking water; therefore, remediation of groundwater is not recommended. Petroleum hydrocarbons, VOCs, pesticides excluding nitrate, and PFAS were not detected or were detected below applicable screening levels in groundwater.

In summary, TPHd is present in site soil above the Tier 1 ESL, Direct Exposure Residential ESL, and Direct Exposure Commercial/Industrial ESL[1]. TPHmo is present in site soil above the Tier 1 ESL. Lead is present in soil above the USEPA Residential RSL, Soil Tier 1 ESL, and Direct Exposure Residential RSL. PFOA is present in soil above the USEPA Residential and Industrial RSLs. The presence of these compounds appears to be limited to specific locations noted above, though the vertical extent of these impacts in soil has not yet been defined. Groundwater sampling results do not indicate the need for remediation. In addition, since VOCs and TPH as gasoline (TPHg) were not detected above screening levels in soil and groundwater, soil vapor is not considered a media of concern for the site.

2.3 Project Goal and Objectives

Langan understands that Tulelake intends to reuse and redevelop the site to include potential multi-family residential uses. Based on the results from the Phase II ESA performed in September 2024, elevated concentrations of TPHd, TPHmo, lead, and PFOA above applicable screening criteria are present in soil in specific areas of the site.

The objective of this report is to identify a recommended cleanup alternative to remediate the identified environmental impacts such that the planned development will be protective of future residential site users.

3.0 REGULATIONS AND CLEANUP STANDARDS

3.1 Cleanup Oversight Responsibility

Langan understands that the site is not currently under environmental regulatory oversight. However, for the purposes of this report, Langan has assumed that local, state, and federal

[1] RWQCB, 2019. *User's Guide: Derivation and Application of Environmental Screening Levels (ESLs)*.

environmental guidelines and standards will apply to the site cleanup. We also anticipate that Tulelake and other stakeholders envision obtaining regulatory approval for residential land use.

3.2 Cleanup Standards for Major Contaminants

In the absence of a regulatory oversight agency and based on our experience with commercial and residential reuse of Brownfield sites, Langan has assumed that cleanup goals for the site will be based on the San Francisco Bay Regional Water Quality Control Board's (RWQCB) ESLs (RWQCB, 2025). Given the planned multi-family residential use of the site, compounds that have been detected previously in soil at concentrations will be compared to their respective screening criteria. As noted above, compounds detected at concentrations above their respective Tier 1 or Direct Exposure ESLs in soil include TPHd, TPHmo, lead and PFOA.

In addition to ESLs, concentrations of these contaminants will also be compared to USEPA Regional Screening Levels (RSLs) for residential and industrial soil.

4.0 EVALUATION OF BROWNFIELD CLEANUP ALTERNATIVES

The objective of this report is to recommend a cleanup alternative that will address identified presence of TPHd, TPHmo, lead and PFOA exceedances in soil and confirm the planned development is protective of future site users, including residential occupants. These contaminants appear to be localized to specific locations within the buildings, in the southern portion of the site, and in the former debris area.

4.1 Description of Alternatives

To achieve the objectives described above, the following remedial and mitigative alternatives were considered:

1. No Action;
2. Limited Excavation;
3. Cap and Institutional Controls; and
4. Soil Solidification and In-situ Stabilization.

4.1.1 Description of Alternative 1 - No Action

Under the No Action Alternative, impacted media would remain in place without treatment or removal. The No Action Alternative is included as a baseline for evaluating and comparing the remedial alternatives.

4.1.2 Description of Alternative 2 – Limited Excavation

Alternative 2 consists of limited soil excavation. This alternative will include removing TPHd, TPHmo, lead and PFOA in soil above screening levels at locations shown on Figure 3. Specifically, TPHd around boring locations B1, B2, and B12, TPHmo around boring locations B1 and B12, lead around boring location B20, and PFOA around boring locations B9 and B10 (Figure 3) as discussed in Section 2.2 above.

Due to the depth of excavation (up to at least three feet bgs), the currently undefined vertical extent of chemicals in soil exceeding screening levels and the depth of the groundwater table (between 3.75 and 5 feet bgs as per the most recently recorded measurement), Langan anticipates that groundwater dewatering may be required during soil excavation. Prior to excavation, additional soil and groundwater sampling around B1, B2, B9, B10, B12, and B20 would be needed. Based on existing groundwater sampling results, permitted discharge (e.g. under a National Pollution Discharge Elimination System [NPDES]) and settling/sand filtering is assumed.

Pre-Corrective Action Sampling and Limited Excavation

Langan plans to collect the following pre-excavation soil samples (as shown on Figure 4):

- Up to eight additional soil samples across four boring locations in Building 1 around B1 to further delineate the TPHd and TPHmo in soil.
- Up to eight additional soil samples across four boring locations in Building 1 around B2 to further delineate the TPHd in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B9 to further delineate the PFOA in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B10 to further delineate the PFOA in soil.

- Up to eight additional soil samples across four boring locations in Building 2 around B12 to further delineate the TPHd and TPHmo in soil.

- Up to eight additional soil samples across four boring locations around B20 to further delineate the lead in soil.

Based on the results of the pre-excavation soil characterization sampling, the excavation boundaries may be revised or updated to address elevated concentrations above screening criteria. Figure 4 shows the planned limited excavation boundaries around TPHd and TPHmo impacts at B1 (Excavation 1), TPHd impacts at B2 (Excavation 2), TPHd and TPHmo impacts at B12 (Excavation 3), lead impacts at B20 (Excavation 4), PFOA impacts at B9 (Excavation 5), PFOA impacts at B10 (Excavation 6). Currently, each excavation is anticipated to be approximately 10 feet by 10 feet. The table below details the anticipated excavation depths, depth to groundwater and estimated volume of soil to be removed.

Excavation/Boring	Estimated Depth (feet bgs)	Estimated Volume (cubic yards)	Surface Condition	Estimated Groundwater Depth (feet bgs)
1 (B1)	1.5	5.56	Soil	5
2 (B2)	1.5	5.56	Soil	Not encountered to 4.5 feet bgs
3 (B12)	3	11.1	Concrete Slab	3.75
4 (B20)	3	11.1	Vegetation	Not encountered to 4.5 feet bgs
5 (B9)	1.5	5.56	Vegetation	4.8
6 (B10)	1.5	5.56	Vegetation	5
Estimated Total		44.5		

Prior to conducting excavation, drawings with excavation boundaries, depths and shoring or sloping plans (if needed) will be prepared under a separate cover. Due to the depth of the groundwater table (between 3.75 and 5 feet bgs as per most recently recorded measurement), and the fact that the vertical extent of concentrations in soil above screening levels is not known, Langan anticipates that groundwater dewatering may be required during soil excavation, as discussed in the following section. To the extent possible, pre-excavation sampling and excavation will be conducted in the dry season.

After pre-excavation sampling is complete, analytical results associated with soil samples will be compared to applicable screening criteria (i.e., RWQCB ESLs). If needed, the boundaries of the planned excavations will be refined based on the comparison of these results to applicable screening criteria. After the excavation boundaries are confirmed, the excavation activities will be conducted. Langan assumes that material will be excavated and stockpiled onsite pending off-haul to a licensed disposal facility. Excavation confirmation samples will be collected to confirm final excavation extents, as discussed below.

Post-Excavation Confirmation Sampling

When the excavation to remove soil is complete, confirmation sampling will be conducted at excavation areas shown on Figure 4. Langan anticipates that excavation sidewall samples will be collected to confirm the lateral extent of the excavation. Sidewall confirmation samples will be collected from each of the exposed walls of the excavation. Samples will be collected at a frequency of one sample every 10 linear feet along the excavation sidewalls at depths where contamination was previously encountered (as discussed in Section 2.2, above).

Available groundwater grab sample results indicate that groundwater is non-hazardous. For Excavation 1 (Figure 4), Langan does not anticipate that excavations will exceed five feet bgs due to the likely presence of saturated soil at depths greater than five feet (Langan notes that recent measured depths of groundwater located at approximately five feet bgs at B1). For Excavation 3 (Figure 4), Langan does not anticipate that excavations will exceed 4.8 feet bgs due to the likely presence of saturated soil at depths greater than 4.8 feet (Langan notes that recent measured depths of groundwater located at approximately 4.8 feet bgs at B9). For Excavation 4 (Figure 4), Langan does not anticipate that excavations will exceed five feet bgs due to the likely presence of saturated soil at depths greater than five feet (Langan notes that recent measured depths of groundwater located at approximately five feet bgs at B10). For Excavation 5 (Figure 4), Langan does not anticipate that excavations will exceed 3.75 feet bgs due to the likely presence of saturated soil at depths greater than 3.75 feet (Langan notes that recent measured depths of groundwater located at approximately 3.75 feet bgs at B12). As a result, excavation bottom samples would not be collected.

Excavation sidewall soil samples from Excavations 1, 2, and 5 would be analyzed for TPH-multi range by USEPA Method 8015B and would be compared to its respective RWQCB ESLs. Excavation sidewall soil samples from Excavations 3 and 4 would be analyzed for PFAS by USEPA Method 537 modified and would be compared to their respective RWQCB ESLs. Excavation sidewall soil samples from Excavation 6 would be analyzed for lead by USEPA Method 6020and would be compared to its respective RWQCB ESL.

If the sidewall sample concentrations exceed their RWQCB ESLs, the excavation will be extended an additional one foot horizontally, if feasible. After excavation is complete, an additional confirmation sample would be collected from the newly exposed sidewall from the same height as the original sample that exceeded the ESL criteria. The excavation will continue in an iterative manner, until confirmation samples meet screening criteria.

Groundwater Dewatering and Treatment

Groundwater may be encountered during the proposed excavation activities, which are anticipated to reach depths of approximately 1.5 to 3 feet below ground surface (Figure 4). If groundwater intrusion occurs, dewatering will be conducted to facilitate safe and effective excavation.

If groundwater is encountered, dewatering will be performed via mechanical pumping from the excavation area. Extracted groundwater will be temporarily stored on-site in appropriate containment systems such as Baker tanks or other approved holding vessels. These systems will be designed to prevent overflow, minimize exposure to stormwater, and allow for sampling and characterization of the water prior to discharge or disposal.

Stored groundwater will be evaluated for potential contaminants of concern as outlined above. If analytical results indicate that the water meets discharge criteria, it may be discharged under the applicable National Pollutant Discharge Elimination System (NPDES) General Order for construction dewatering discharges. If contamination is present, the water will be managed as a non-hazardous waste, as appropriate, and transported off-site to a permitted treatment or disposal facility in accordance with applicable federal and state regulations.

Depending on site-specific conditions and discharge options, the following groundwater discharge permits may be required:

- General Waste Discharge Requirements/NPDES Permit for Limited Threat Discharges to Surface Waters, Order R5-2016-0076, or similar; and/or
- Local municipal discharge permits if discharging to Tulelake-managed storm drain systems.

Permit applicability will be confirmed with the appropriate RWQCB and/or Tulelake prior to initiation of dewatering activities.

If groundwater is found to be contaminated or if discharge to surface waters under a NPDES or sewer permit is not feasible, groundwater will be off-hauled by a licensed contractor to a permitted disposal facility. Transportation and disposal will comply with applicable Department of Transportation (DOT) and RCRA requirements.

Waste Disposal

Excavated soil would be stockpiled onsite in a roll-off bin, pending waste characterization sampling. Langan assumes most of the soil excavated would be disposed of as Class II Non-Hazardous material; however, waste characterization of excavated soil will likely be required to confirm waste classification prior to acceptance by the receiving facility. Waste characterization samples will be collected in general accordance with the California DTSC's Information Advisory Clean Imported Fill Material Fact Sheet dated October 2001. Waste characterization samples may be analyzed for some of the following constituents:

- TPH as gasoline, diesel and motor oil by USEPA Method 8015B;
- VOCs by USEPA Method 8260;
- California assessment metals (CAM) 17 by USEPA Method 6020;
- Semi-volatile organic compounds (SVOCs) by USEPA Method 8270C;
- Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) by USEPA Method 8081A/8082;
- Chlorinated herbicides by USEPA Method 8151; and
- Asbestos by California Air Resources Board (CARB) Method 435.

If any total metal concentration exceeds 10 times its soluble threshold limit concentration (STLC), a STLC test will be required for that metal. If STLC concentrations exceed State of California disposal criteria, then a total characteristic leaching procedure (TCLP) will be required.

Once characterized, the excavated soil would be transported off-site for disposal at an appropriately licensed treatment/disposal facility. The excavation would be backfilled and compacted with acceptable material. Analytical sampling data for the proposed backfill material must be sourced, reviewed and approved by the development team prior to placement.

4.1.3 Description of Alternative 3 – Cap and Institutional Controls

This alternative includes the physical cover of soil in areas with concentrations above screening levels and implementing institutional controls. Under this alternative, the soils that present a potential risk will be isolated by installing caps or covers that close the potential exposure pathway. Elements of the redevelopment would be incorporated into the cap to prevent direct contact with the impacted material. The cap will mitigate human contact to the soils with contaminant concentrations above applicable screening levels. The cap will also lessen the potential for vertical migration of contaminants in the vadose zone to underlying groundwater.

Pre-Corrective Action Characterization Sampling

Langan plans to collect the following pre-capping soil samples (as shown on Figure 4):

- Up to eight additional soil samples across four boring locations in Building 1 around B1 to further delineate the TPHd and TPHmo in soil.
- Up to eight additional soil samples across four boring locations in Building 1 around B2 to further delineate the TPHd in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B9 to further delineate the PFOA in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B10 to further delineate the PFOA in soil.
- Up to eight additional soil samples across four boring locations in Building 2 around B12 to further delineate the TPHd and TPHmo in soil.
- Up to eight additional soil samples across four boring locations around B20 to further delineate the lead in soil.

Based on the results of the pre-capping soil characterization sampling, the boundaries may be revised or updated to address elevated concentrations above screening criteria.

Once the boundaries of the cap have been further defined, a cap will be applied to the six impacted areas (Figure 4). The types of engineering controls can include the following:

- Building Cap: Concrete slab within the footprint of the building.

- Concrete Pavement: Pavement within parking stalls or sidewalks.
- Light/Heavy Duty Asphalt Pavement: Light duty asphalt pavement in parking and driveway areas.
- Lawn or Landscaping Cap: Trees, shrubs, lawns, or groundcover plantings placed over certified clean fill above a demarcation layer.

Caps will include a durable material that will not break, erode, or deteriorate such that the underlying soil becomes exposed.

Institutional controls will be based on the intended reuse for the site. A deed notice is an example of an institutional control and is a legal document that compels the property owner to monitor and maintain the engineering control (i.e., cap) to ensure the long-term protection of human health and the environment. The deed notice will include as-built plans and details of the cap. Once the engineered cap is installed, the deed notice will be filed with the Siskiyou County Clerk's Office.

A monitoring and maintenance plan will be implemented that includes annual inspections of hardscaped caps and semi-annual inspections of landscaped caps. The frequency of inspections may be changed if deemed appropriate. The inspections will be completed to confirm that the cap has not been impaired, and should include visual inspection with documentation, and photos referenced to known features. Inspections should be completed by properly trained personnel who understand the cap construction, maintenance requirements, and the requisite inspection documentation. Inspection reports should identify the inspector's name, title, and company, be signed by the inspector, and kept on file for periodic reporting.

4.1.4 Description of Alternative 4 – Soil In-Situ Stabilization

Alternative 4 consists of treating soil through in-situ stabilization (ISS). Alternative 4 would include the same pre-application sampling and confirmation sampling outlined above for Alternative 2.

ISS is a well-established remediation technologies for the treatment of contaminated material, including soil, sediment, sludge, and waste. ISS involves addition of soil solidification agents and reagents. This process involves mixing contaminated soil with binding agents (such as Portland cement, fly ash or asphalt) and treatment reagents. This mixing creates a relatively impermeable mass or block of material that reduces the ability of contaminants to migrate (i.e. reduced leachability) to the surrounding subsurface. Treatment reagents cause physical (i.e., trapping through precipitation) and/or chemical changes (i.e., transformation to less soluble forms or to non-harmful byproducts) that result in reduced environmental impact of the contaminated material to the surrounding subsurface. ISS is a remedial alternative that can optimize both the immobilization of contaminants through addition of a binding agent and the reduction of the toxicity of contaminants through the application of chemical reagents.

Similar to the other alternatives presented in this report, there are six areas where soil ISS will be conducted (Figure 4). The solidification agent applied to each area is planned to be Portland cement and will be applied to the six application areas, regardless of the contaminant present. However, given that there are three different types of contaminants present in shallow soil at the six areas (petroleum hydrocarbons, lead and PFOA), three different stabilization products are proposed to be applied. The following is a summary of the application areas, the environmental boring, contaminant of concern and planned solidification agent and ISS reagents for each area.

Application Areas (associated boring)	**Contaminant of Concern**	**Solidification Agent**	**ISS Reagent**
1 (B1)	TPHd and TPHmo	Portland Cement	Chemical oxidant (Klozur[2])
2 (B2)	TPHd	Portland Cement	Chemical oxidant (Klozur[1])
3 (B12)	TPHd and TPHmo	Portland Cement	Chemical oxidant (Klozur[1])
4 (B20)	Lead	Portland Cement	Reductant (Metafix[3])
5 (B9)	PFOA	Portland Cement	Adsorbent (Fluorosorb[4])
6 (B10)	PFOA	Portland Cement	Adsorbent (Fluorosorb[3])

Petroleum hydrocarbons are planned to be treated by addition of a chemical oxidant (e.g., Klozur). The chemical oxidant uses persulfate to facilitate the degradation of organic compounds. Lead is proposed to be treated using a reducing and precipitating reagent (e.g, Metafix). Reagents like Metafix stabilizes lead in soil through a combination of chemical reduction, precipitation, and adsorption processes that convert soluble lead into insoluble mineral forms. Metafix contains zero-valent iron (ZVI) and iron sulfides, which act as strong reductants. This product would result in transforming lead into stable sulfide and iron sulfide precipitate, which would be immobilized in place. PFOA is planned to be treated using a surface modified clay adsorbent (e.g., Fluorosorb).

[2] https://active-oxygens.evonik.com/en/products-and-services/persulfates/klozur-persulfates
[3] https://active-oxygens.evonik.com/en/products-and-services/soil-and-groundwater-remediation/metafix-reagents
[4] https://www.mineralstech.com/cetco/water-and-remediation/fluoro-sorb-adsorbent

When mixed, PFOA will sorb directly to the surface modified clay particles and reduce contaminant mobilization and leachability.

Pre-Corrective Action Sampling

Prior to conducting soil solidification and ISS, and similar to Alternative 2, Langan plans to collect the following pre-application soil samples (as shown on Figure 4) from the six impacted areas:

- Up to eight additional soil samples across four boring locations in Building 1 around B1 to further delineate the TPHd and TPHmo in soil.
- Up to eight additional soil samples across four boring locations in Building 1 around B2 to further delineate the TPHd in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B9 to further delineate the PFOA in soil.
- Up to eight additional soil samples across four boring locations in the former debris area around B10 to further delineate the PFOA in soil.
- Up to eight additional soil samples across four boring locations in Building 2 around B12 to further delineate the TPHd and TPHmo in soil.
- Up to eight additional soil samples across four boring locations around B20 to further delineate the lead in soil.

In addition to the above the collected soil samples will be analyzed for the following constituents:

- Soil TOC by Method 9060A
- pH by Method 9045C; and
- Moisture content.

Based on the results of the pre-corrective action soil characterization sampling, the ISS application area boundaries may be revised or updated to address elevated concentrations above screening criteria.

Site Preparation

The six ISS application areas will be prepared before the ISS products are applied to the impacted material. If needed, soil will be excavated from each area at depths ranging from two to three feet bgs or the material will be mixed with product in-situ. If excavated, the material will be temporarily staged next to each impacted area on plastic sheeting. Excavated soil will be screened for organic compounds using a photoionization detector (PID) equipped with a 10.6 electron volt (eV) bulb, and for visual and olfactory indications of environmental impacts (e.g., staining and odor).

Pre-probing for obstructions in the six areas will be completed to the extent practicable during pre-excavation. Obstructions exposed during pre-excavation activities will be removed if feasible, and the excavation will be dewatered, if necessary, as detailed in Alternative 2 above. The extents of the application areas are shown in Figure 4.

Soil Solidification and ISS Application

The solidification agent and ISS reagents will be applied through bucket mixing operated by a remediation contractor under Langan observation. A bucket attached to a standard excavator will be used to mix the soil in approximately 10-foot-long and 5-foot-wide ISS grids at each area from surface grade to the terminal treatment depth (approximately two to three feet bgs). The agent and reagent mix will be pumped directly into the ISS grid from the batches of product mixed at the surface while the soil is being simultaneously mixed to achieve uniform distribution. Each ISS grid will be mixed for a minimum of 35 minutes. The soil moisture may be adjusted during application through water addition to promote chemical reactions, as needed. Solidification and ISS implementation will end a minimum of one-foot below the target treatment interval as a buffer. Mixing parameters including mixing time, agent and reagent addition per grid, grid dimensions, treatment depth, and grid elevation pre- and post-mixing will be recorded for each area.

It is anticipated that excess soil or swell (approximately 15 to 20% of the total volume treated) is expected to be produced during the soil solidification and stabilization process. This material will likely need to be characterized and disposed of at licensed off-site disposal facility. Information regarding

Groundwater Dewatering and Treatment

Groundwater may be encountered during the proposed application activities, which are anticipated to reach depths of approximately two to three feet below ground surface (Figure 4).

Though not expected, if groundwater intrusion occurs, dewatering will be conducted to facilitate safe and effective excavation.

If groundwater is encountered, dewatering will be performed via mechanical pumping from the excavation area. Extracted groundwater will be temporarily stored on-site in appropriate containment systems such as Baker tanks or other approved holding vessels. These systems will be designed to prevent overflow, minimize exposure to stormwater, and allow for sampling and characterization of the water prior to discharge or disposal.

Stored groundwater will be evaluated for potential contaminants of concern as outlined above. If analytical results indicate that the water meets discharge criteria, it may be discharged under the applicable National Pollutant Discharge Elimination System (NPDES) General Order for construction dewatering discharges. If contamination is present, the water will be managed as a non-hazardous waste, as appropriate, and transported off-site to a permitted treatment or disposal facility in accordance with applicable federal and state regulations.

Depending on site-specific conditions and discharge options, the following groundwater discharge permits may be required:

- General Waste Discharge Requirements/NPDES Permit for Limited Threat Discharges to Surface Waters, Order R5-2016-0076, or similar; and/or
- Local municipal discharge permits if discharging to Tulelake-managed storm drain systems.

Permit applicability will be confirmed with the appropriate RWQCB and/or Tulelake prior to initiation of dewatering activities.

If groundwater is found to be contaminated or if discharge to surface waters under a NPDES or sewer permit is not feasible, groundwater will be off-hauled by a licensed contractor to a permitted disposal facility. Transportation and disposal will comply with applicable Department of Transportation (DOT) and RCRA requirements.

Post-Corrective Action Confirmation Sampling

When the ISS is complete, confirmation sampling will be conducted at application areas. Confirmation samples will be collected at a frequency of one sample every 10 feet within the ISS application grid where contamination was previously encountered.

Confirmation soil samples from application areas 1, 2, and 5 would be analyzed for TPH-multi range by USEPA Method 8015B and would be compared to its respective RWQCB ESLs. Confirmation soil samples from application areas 3 and 4 would be analyzed for PFAS by USEPA Method 537 modified and would be compared to their respective RWQCB ESLs. Confirmation soil samples from application area 6 would be analyzed for lead by USEPA Method 6020 and would be compared to its respective RWQCB ESL.

If the confirmation samples exceed their RWQCB ESLs, additional agents and/or reagents will be applied to impacted soil at the six application areas. After additional application is complete, an additional confirmation sample would be collected from the same location as the original sample that exceeded the ESL criteria. The application will continue in an iterative manner, until confirmation samples meet screening criteria.

Waste Disposal

Excavated soil would be stockpiled onsite in a roll-off bin, pending waste characterization sampling. Langan assumes most of the soil excavated would be disposed of as Class II Non-Hazardous material; however, waste characterization of excavated soil will likely be required to confirm waste classification prior to acceptance by the receiving facility. Waste characterization samples will be collected in general accordance with the California DTSC's Information Advisory Clean Imported Fill Material Fact Sheet dated October 2001. Waste characterization samples may be analyzed for some of the following constituents:

- TPH as gasoline, diesel and motor oil by USEPA Method 8015B;
- VOCs by USEPA Method 8260;
- California assessment metals (CAM) 17 by USEPA Method 6020;
- Semi-volatile organic compounds (SVOCs) by USEPA Method 8270C;
- Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) by USEPA Method 8081A/8082;
- Chlorinated herbicides by USEPA Method 8151; and
- Asbestos by California Air Resources Board (CARB) Method 435.

If any total metal concentration exceeds 10 times its soluble threshold limit concentration (STLC), a STLC test will be required for that metal. If STLC concentrations exceed State of California disposal criteria, then a total characteristic leaching procedure (TCLP) will be required.

Once characterized, the excavated soil would be transported off-site for disposal at an appropriately licensed treatment/disposal facility. The excavation would be backfilled and compacted with acceptable material. Analytical sampling data for the proposed backfill material must be sourced, reviewed and approved by the development team prior to placement.

4.2 Alternative Evaluation Criteria

The remedial alternatives were evaluated based on the following criteria: technical effectiveness, implementability, remedial time frame, and relative cost range. These criteria were ranked as ‘low,’ ‘medium,’ and ‘high’ as described below.

Technical Effectiveness – Ability to meet project goals objectives under site-specific conditions, regardless of time frame:

- Low – Unlikely to meet objectives
- Medium – Likely to meet objectives partially
- High – Highly likely to meet objectives.

Implementability – Potential to be implemented as planned, without need of any extraordinary measures that affect the cost and/or implementation time frame of the remedial plan and/or cause disruption to the site or site tenants:

- Low – Unlikely to be implemented as planned and will likely require measures that may affect the cost and/or implementation time frame of the remedial or mitigative plan and/or will cause disruption to the site.
- Medium – May be implemented as planned and may not require measures that may affect the cost and/or implementation time frame of the remedial or mitigative plan and/or may not cause disruption to the site.
- High – Highly likely to be implemented as planned, and not expected to require measures that may affect the cost and implementation time frame of the remedial or mitigative plan, or not expected to cause disruption to the site.

Remedial Time Frame – Range of minimum to maximum system operation, active data collection and/or active management time required to meet remedial objectives, as applicable to the alternative.

- Short – one to six months

- Medium – six to 12 months
- Long – > One year

Cost Range – Range of minimum to maximum estimated cost for implementation and performance monitoring of the remedial alternatives. The cost includes implementation, operation and maintenance, and performance monitoring. Costs were estimated based on similar projects and are presented with a ± 25% cost range. Costs that apply equally to all alternatives, such as routine site-wide monitoring, project management and other tasks are not included in the cost estimates.

- Low - < $500,000
- Moderate – $500,000 – $1,000,000
- High - > $1,000,000

4.3 Alternative Evaluation

The following is an analysis of the potential Brownfield cleanup alternatives. Each subsection includes an analysis of the estimated technical effectiveness, implementability, timeframe and cost range. Each section also includes an estimate of the sustainable nature of each alternative.

4.3.1 Evaluation of No Action

Under the No Action Alternative (Alternative 1), impacted media would remain in place without treatment. This alternative would not lower concentrations of contaminants known to pose a potential risk to future visitors and construction workers at the site. For this reason, Alternative 1 would not be effective with respect to the protection of human health. This alternative is easily or highly implementable. No cost would be incurred during the implementation of this alternative, so this alternative is considered low cost.

4.3.2 Evaluation of Alternative 2 – Limited Excavation

The Limited Excavation (Alternative 2) will involve the physical removal of soil at the six excavation areas to address TPH, lead and PFOA impacts in shallow soil. Prior to excavation, additional, pre-excavation characterization sampling around previous environmental borings associated with the six areas (i.e., B1, B2, B12, B20, B9, and B10) would be needed to refine the boundaries at the planned excavation areas.

This alternative is considered highly effective in addressing the soil impacts since soil with elevated concentrations of TPH, lead and PFOA about screening levels will be removed and disposed of off-site and confirmation samples will be collected to ensure all soil impacts are removed. This alternative involves soil excavation, that may be conducted concurrently with development of the site. As a result, the implementability of Alternative 2 is considered high.

The time frame to implement this alternative is estimated to be approximately one month with excavation and backfill activities. As a result, the time frame for this alternative is considered short.

A breakdown of the estimated costs for this alternative is presented in Table 1. This alternative can be implemented for a low cost ($280,000 to $370,000), based on the engineering cost estimates prepared.

From a sustainability perspective, this alternative may be a carbon emission intensive option as it involves excavation and, off haul and disposal of large quantities of soil over large distances.

4.3.3 Evaluation of Alternative 3 – Cap and Institutional Controls

This alternative would involve the physical cover of impacted soil and implementing institutional controls. The soils that present a potential risk would be isolated with caps or covers such that the pathway of exposure to these impacts left in place would be removed. Institutional controls (i.e., deed notice) that are based on the intended reuse for the site would be implemented along with a monitoring and maintenance plan that includes inspections of caps/covers.

The goal of this alternative is to create a barrier between the impacted soil and the potential receptors to prevent exposure to the impacted soil. However, given that the impacted soil will remain in-place, this alternative is considered to be low for effectiveness.

This alternative involves capping the soil which will be conducted concurrently with development of the site. Development plans will incorporate the soil capping designs. As a result, the implementability of Alternative 3 is considered high.

The time frame to implement this alternative aligns with the time frame of site redevelopment. Given the uncertain timeline of site redevelopment and the need for long-term monitoring as part of the institutional control, this alternative is considered to have a medium to long time frame.

A breakdown of the estimated costs for this alternative are presented in Table 2. This alternative can be implemented for a low cost ($260,000 to $320,000), based on the engineering cost estimates prepared.

From a sustainability perspective, this alternative is not anticipated to be carbon emission intensive.

4.3.4 Evaluation of Alternative 4 – Soil Solidification and In-situ Stabilization

Alternative 4 involves treating the soil through ISS. Pre-corrective action soil sampling at each of the six impacted areas will occur prior to implementing ISS. The six application areas will be prepared by excavation followed by application of ISS reagents specific to each contaminant of concern: chemical oxidant (Klozur[2]) at application areas 1 (B1), 2 (B2), and 3 (B12); reductant (Metafix[3]) at application area 4 (B20); and adsorbent (Fluorosorb[4]) at application areas 5 (B9) and 6 (B10). After addition of the reagents and soil mixing occurs, compaction of soil and/or application of a solidification agent/binder (i.e., Portland cement) will occur.

Given the subsurface conditions encountered during the January 2025 Phase II ESA, the site is underlain with some fine-grained materials (sand, silt, and clay). Clays and silts are highly effective for ISS and solidification due to their low permeability and cohesive nature which allow uniform mixing with the reagents and solidification binders. The presence of sands with some fines is also effective with ISS and solidification due to their ability to bind the matrix. The goal of this alternative is to degrade the petroleum hydrocarbons, stabilize and immobilize lead in place, and reduce the PFOA mobilization and leachability. This means that the contaminants of concern are left in place but in a less mobile form. As a result of the soil conditions at the site and goal of the alternative, the effectiveness of Alternative 4 is considered medium to high.

The implementability would also be considered medium given the site's layout, depth of subsurface impacts, and estimated volumes of soil mixing. ISS is a remediation method that is typically done on a larger scale with the majority of the cost being mobilization to the site.

Including the pre-application soil characterization sampling, site preparation, and ISS activities, the time frame is estimated to be approximately one to three months; therefore, the time frame for this alternative is considered to be short.

A rough estimated of anticipated costs associated with this alternative are presented in Table 3. This alternative can be implemented for a low cost ($265,000 to $299,000), based on the engineering cost estimates.

From a sustainability perspective, this alternative is anticipated to be a carbon intensive option as it involves excavation, soil mixing with construction equipment and off haul/disposal of soil impacted over large distances.

4.4 Selection of the Preferred Alternative

Table 4 – Summary of Alternatives Evaluation

Evaluation Criteria	Alternative 1 – No Action	Alternative 2 – Limited Excavation	Alternative 3 – Cap and Institutional Controls	Alternative 4 – Soil Solidification and In-Situ Stabilization
Technical Effectiveness	Low	High	Low	Medium to High
Implementability	High	High	High	Medium
Remedial Time Frame	NA	Short	Medium	Short
Cost	Low	Low	Low	Low

Alternative 1, the no action alternative, would not meet the goals or objectives for this project and is hence dismissed without additional evaluation.

Alternative 3 is also a less preferred alternative because of the following reasons:

- Given that this alternative involves capping in place rather than remediating impacts, the technical effectiveness of this alternative is low.
- The implementability is high; however, given the institutional controls and potential long term monitoring, the time frame for this alternative is medium to long.

Alternative 4 is also a less preferred alternative because of the following reasons:

- The implementability is medium; however, given that this alternative involves solidification and stabilization in place, the technical effectiveness of this alternative is medium to high.

Of the four remedial and mitigative alternatives evaluated above, Alternative 2 offers the best combination of effectiveness, implementability, time frame, and cost. This alternative addresses both the petroleum, lead and PFOA impacted soil through excavation and offsite disposal. This alternative is anticipated to effectively reduce the potential for exposure to residual impacts to current or future site users at the site. This alternative is expected to have a higher effectiveness and higher implementability than the other alternatives. This alternative is anticipated to be completed within a short timeframe and at a cost that is less than or comparable to the other alternatives considered.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis detailed in the preceding sections, the recommended Brownfield cleanup alternative for the site is Alternative 2.

TABLES

FIGURES