

# **DRAFT REMOVAL ACTION REPORT**

## **Former Kohala Sugar Company Pesticide Mixing Site North Kohala, Hawaii**

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## ACRONYMS AND ABBREVIATIONS

ACSI	Advanced Compliance Solutions, Inc.
AST	above-ground storage tank
bgs	below ground surface
CRM	concrete rubble masonry
cy	cubic yards
DU	decision unit
EAL	environmental action level
EHMP	Environmental Hazard Management Plan
EPA	Environmental Protection Agency
HDOH	Hawaii Department of Health
HEER	Hazard Evaluation and Emergency Response
HICDC	Hawaii Island Community Development Corporation
Integral	Integral Consulting Inc.
MI	multi-increment
ND	non-detect
PAH	polycyclic aromatic hydrocarbon
PPE	personal protective equipment
RAL	removal action level
RAO	removal action objective
RCRA	Resource Conservation and Recovery Act
SVOC	semivolatile organic compound
TCLP	toxicity characteristic leaching procedure
TMK	Tax Map Key
TEQ	toxic equivalency
Weston	Weston Solutions, Inc.
XRF	X-ray fluorescence

# 1 INTRODUCTION

## 1.1 PURPOSE OF REPORT

This draft removal action report presents alternative remedies to address elevated soil arsenic and other chemicals at the former Kohala Sugar Company Pesticide Mixing Site property in North Kohala, Island of Hawaii. Each alternative is described in detail and evaluated in terms of effectiveness, implementability and cost. A recommendation is made on the preferred remedy to address the soil arsenic problem. This report has been commissioned by the Hawaii Island Community Development Corporation (HICDC), who is performing residential development on the subject property and surrounding properties.

## 1.2 LOCATION AND SITE DESCRIPTION

The subject site consists of approximately 0.5 acre of land which formerly housed pesticide mixing operations for the Kohala Sugar Company facilities (Figures 1, 2, and 3). The site is a portion of the larger TMK parcel 03-5-5-019: 025, owned by HICDC, located 1.5 miles mauka of the Pacific Ocean coastline in the vicinity of the town of Hawi, North Kohala District, Hawaii. The site is surrounded by fallow, highly vegetated former plantation land and pasture land. Residential housing on HICDC land is located within 500 ft of the site to the southwest, and the Kohala Mission School is located to the east within several hundred feet. A chain link fence has been installed around the former pesticide mixing area to prevent trespasser direct contact with site soils. Former facilities remaining on the site include two (upper and lower) concrete rubble masonry (CRM) retaining walls and four steel above-ground storage tanks (ASTs) (Figure 4). A very large banyon tree is present at the center of the site, with roots grown into the CRM walls. Further description of the site and its surroundings can be found in Weston Solutions, Inc. (Weston; 2011).

## 1.3 PREVIOUS INVESTIGATIONS

The site was listed on the Comprehensive Environmental Response, Compensation, and Liability Information System in 2009 (EPA ID No.: HIN000908796). Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) Office conducted initial soil sampling at the site in August 2009, collecting multi-increment (MI) samples from four decision units (DUs). HDOH identified dioxins/furans (dioxin), metals (arsenic, lead, and mercury) and semivolatile organic compounds (SVOCs) at concentrations at or above HDOH environmental action levels (EALs) for unrestricted (i.e., residential) land use (HDOH 2011).

In December 2010, Weston collected 10 additional MI samples (plus 2 replicate MI samples) from surface and subsurface (up to 48 in. depth) soils at the site (Weston 2011) to further

delineate the extent of soil impacts. At the same time, HDOH HEER Office staff collected MI samples from two DUs on private property adjacent to the HICDC property and two DUs to the north of the site. The HDOH sampling DUs were contiguous with Weston's sampling DUs, designed to support site characterization. HDOH conducted an additional soil sampling program in October 2011 to further delineate the lateral extent of soil impacts.



## 2 SAMPLING AND ANALYSIS FINDINGS

Site soils have been extensively sampled using DUs and the MI sampling protocols by HDOH HEER Office staff and Weston. This section summarizes the findings of those sampling and analysis programs. A map of the layout of DUs is provided as Figure 5, and a summary of soil sample analytical results (showing all compounds with one or more sample result exceeding the residential Tier 1 EAL) is provided as Table 1. Please refer to Figure 5 and Table 1 during the following discussion. Toxic equivalency (TEQ) dioxin calculations based on individual dioxin/furan congener concentrations and the World Health Organization 2005 toxic equivalency factors are provided in Table 2. TEQs are calculated considering non-detect values to be zero, and also considering non-detect values to be one-half of the detection limit.<sup>1</sup> TEQ dioxin values using one-half the detection limit (higher calculated concentrations) are used for screening purposes on Table 1.

### 2.1 MOBILIZATION 1 – HDOH, AUGUST 2009

HDOH HEER Office staff conducted initial soil sampling at the site in August 2009. They sampled four DUs laid out across the former pesticide mixing site area. MI surface soil samples were collected from the four DUs (DU-1 through DU-4), and one of the DUs was MI sampled in triplicate for quality assurance purposes. The layout of the four initial DUs is shown on Figure 5.

MI samples were analyzed for a broad suite of chemical compounds, including SVOCs, OCPs, chlorinated herbicides, carbamate pesticides, metals (arsenic, lead, and mercury), and dioxins/furans (dioxin). Laboratory reports for the HDOH August 2009 sampling are provided in Appendix A.

The MI sample from DU-1 showed the highest levels of arsenic and dioxin. Total arsenic was 820 mg/kg in the <2 mm particle size soil and 1,300 mg/kg in the <0.25 mm particle size soil; bioaccessible arsenic was 230 mg/kg (measured in <0.25 mm particle size soil). HDOH recommends the use of bioaccessible arsenic in assessment of human health direct contact hazard. The HDOH EAL for bioaccessible arsenic for unrestricted [residential] land use is 23 mg/kg. Other compounds identified at concentrations above unrestricted land use EALs included lead, mercury, polycyclic aromatic hydrocarbon compounds (PAHs; a subset of SVOC compounds) and pentachlorophenol. All four DUs sampled by HDOH showed one or more compound present at concentrations exceeding a residential EAL.

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<sup>1</sup> Test America lab reports (Appendices A through D) are not consistent in reporting dioxin/furan concentrations as “ND” (non-detect). For some reports, they reported ND if below the reporting limit, in other cases they reported ND if below the method detection limit.

## 2.2 MOBILIZATION 2 – WESTON AND HDOH, DECEMBER 2010

Weston and HDOH conducted additional soil sampling at the site in December 2010. They laid out five additional DUs on HICDC property that wrapped around the initial four HDOH DUs, identified as DU-7, DU-8, DU-10, DU-11, and DU-20. Surface soil (0–6 in. below ground surface [bgs]) MI samples were collected from these five DUs. Subsurface MI soil samples were collected beneath DU-1, DU-2, and DU-8 (the areas previously shown [DU-1 and DU-2] or anticipated [DU-8] to have the highest contaminant impacts). Subsurface soil MI samples were collected from 6 to 24 in. bgs in all three DUs, and subsurface soil MI samples from 24 to 48 in. bgs were collected from DU-1 and DU-2. At the same time that Weston was collecting the soil samples on the HICDC property, HDOH collected surface MI samples from two DUs (DU-14 and DU-15) contiguous to the Weston DUs but on an adjacent property not owned by HICDC (the Harbottle property). In addition to soil sampling, Weston collected a rinsate sample from the old, rusted ASTs on the site. Visual observations indicated that there were no residual solids in the tanks.

Samples collected during the December 2010 mobilization by Weston and HDOH were submitted to Test America laboratory for analysis of a broad suite of compounds. Analytical results are compared to the unrestricted land use EALs as shown in Table 1. EALs are based on the following scenario: 1) land use will be “Unrestricted”; 2) groundwater utility is “Drinking Water”; and 3) the distance to nearest surface water body is “greater than 150m.” Surface soil samples (0–6 in. bgs) from DU-7, DU-8, DU-10, and DU-15 exceeded unrestricted land use EALs for one or more compounds. All three subsurface samples from the 6–24 in. depth interval exceeded an EAL for one or more compounds. These samples were collected in DU-1, DU-2, and DU-8. The deeper (24 to 48 in. depth interval) subsurface sample collected in DU-2 (sample ID DU-12-4) exceeded EALs for dioxin. The 24 to 48 in. sample from DU-1 did not show an EAL exceedance. Based on this limited subsurface data set, it is likely that soil contamination exceeding EALs extends beyond 24 in. in depth in the contiguous area composed of DU-1, DU-2, and DU-8.

## 2.3 MOBILIZATION 3 – HDOH, OCTOBER 2011

HDOH HEER Office staff collected MI surface soil samples from three additional DUs in October 2011, to help further bound the lateral extent of EAL exceedances at the site. The samples were collected in DU-16 and DU-17 (north of DU-10), and in DU-18 (south of DU-15). Analytical results indicate no EAL exceedances in the DU-16 and DU-17 surface soil samples collected from the northern perimeter of the site. TEQ dioxin levels exceeded the EAL in DU-18 to the south of prior sampling areas, on the adjacent Harbottle property. See sample results summarized in Table 1.

## 2.4 EVALUATION OF HAZARDOUS WASTE POTENTIAL

Soils with high levels of arsenic, if generated (excavated) during remediation activities, could potentially be a “characteristic” hazardous waste if they exceeded the Resource Conservation and Recovery Act (RCRA) regulatory limits as determined by the toxicity characteristic leaching procedure (TCLP). The highest arsenic concentrations observed in site soils were in DU-8, with total arsenic reported at 2,030 mg/kg. This sample also exhibited high bioaccessible arsenic, at 519 mg/kg. If soils fail TCLP for arsenic, and are determined to be a hazardous waste, they would require shipping to the mainland for disposal in a hazardous waste landfill.<sup>2</sup> If soils are determined to be non-hazardous, they could be disposed in the West Hawaii Sanitary Landfill.

To evaluate hazardous waste potential, Integral/ACSI collected additional soil samples in July and August 2013 from the site. Soils were collected from areas expected to represent “worst case” conditions (highest total arsenic levels). Based on prior HDOH and Weston sampling and analysis, the highest arsenic concentrations were observed in shallow (0–6 in. depth) soils in DU-1, DU-2 and DU-8, within the lower elevation area east of (below) the lower rock retaining wall. Therefore, Integral/ACSI laid out two additional decision units to collect MI samples for waste characterization. Each of the additional decision units was 30 ft by 80 ft in dimension, as shown on Figure 6. MI samples consisting of 30 sample increments were collected from the 0 to 6 in. depth interval from each DU on July 25, 2013. Samples were identified as WC-01 and WC-02 (“WC” for “waste characterization”). Due to uncertainties on the location of increments for sample DU-02, it was recollected on August 8, 2013 and identified as WC-03. The original sample WC-02 was not analyzed.

Review of prior HDOH and Weston soil sample results for the site revealed no concentrations of compounds on the RCRA toxicity characteristic list (40 compounds) greater than 20 times the TCLP regulatory level<sup>3</sup>, with the exception of arsenic, lead and mercury. Therefore, samples Table 3 provides a summary of laboratory results, full lab reports are provided in Appendix E. WC-01 and WC-03 were analyzed for TCLP metals (the three metals identified above and the five others RCRA metals). No TCLP results were above regulatory levels for determination of hazardous waste. Arsenic was reported in WC-01 and WC-03 at 2.6 mg/kg and 0.89 mg/kg, respectively, as compared to a regulatory level of 5 mg/kg. In order to ensure that waste characterization samples reflected “worst case” conditions, total arsenic was also tested in these waste characterization samples. WC-01 and WC-03 were determined to contained 3000 mg/kg and 930 mg/kg, respectively (Table 3). Total arsenic in WC-01 was higher than reported for any previously evaluated soil sample at the site, and therefore is believed to be representative of “worst case” conditions. In summary, waste characterization sampling and analysis confirms

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<sup>2</sup> An alternative to mainland landfill disposal would be soil treatment to stabilize the arsenic such that it passed the TCLP test, effectively “de-characterizing” the hazardous waste. Evaluation of the potentially cost and efficacy of such treatment is beyond the scope of this draft removal action report.

<sup>3</sup> As a “rule of thumb”, samples with total concentrations of compounds <20 times the TCLP regulatory limit will not fail TCLP (exceed the regulatory limit) due to insufficient chemical mass.

that site soils, if excavated, would not be considered a hazardous waste and would be suitable for landfill disposal at the West Hawaii Sanitary Landfill.

## **2.5 CLEAN FILL SOIL EVALUATION**

At the request of HICDC, Integral/ACSI collected a MI sample of surface soils (0–6 in. depth) from an open field area (former agricultural and ranch land) on HICDC property approximately ¼ mile distance from the former pesticide mixing site (location shown on Figure 2), for evaluation as clean fill soil suitable for use in a site remedy. Sample CF-01 (“CF” for “clean fill”) was collected on July 25, 2013, and analyzed for total metals, organochlorine pesticides and dioxins/furans. These compounds are the most likely contaminants to be found in former agricultural fields. Results of the sampling and analysis are presented on Table 4 (original lab reports in Appendix E).

Results of sampling and analysis indicate that potential fill soils are clean, as there were no exceedences of HDOH Tier 1 EALs. Therefore, these soils would be suitable for use in construction of a remedy at the former pesticide mixing site (i.e. excavation backfill or soil cap material).

## **2.6 ESTIMATED VOLUME OF CONTAMINATED SOIL**

The volume of soil likely exceeding residential EALs for one or more compounds has been estimated based on the MI sampling of site DUs. Table 5 provides a summary of the areas and estimated depths of contaminated soil above EALs within the DUs. Uncertainty exists in the depth of soil contamination beneath DU-2 and DU-8.

Based on the interpreted depth of contamination above EALs in the various DUs (see basis for estimates in Table 5), we estimate a total contaminated soil volume of 1,300 cubic yards (cy), which includes a 20 percent contingency to account for depth uncertainty.

## 3 ENVIRONMENTAL HAZARD EVALUATION

### 3.1 CONCEPTUAL SITE MODEL

Former sugar plantation facilities and operational areas at the site, related to agricultural cultivation and processing of sugar, are believed to have been the source of release of chemical contaminants. Sampling of soils was performed at and around those facilities/operations to identify soil impacts. Releases of pesticide and herbicide chemicals are believed to have occurred at the site as chemicals were mixed and transferred to field vehicles for application. Releases of chemicals would have entered site soils from the surface and migrated downward through the soil column. Contaminated surface soils could also have been transported downslope by surface erosion. The source of PAHs in site soils is not known. However, based on observed concentrations of individual PAH compounds less than 10 mg/kg and understanding of site history, PAH residues in site soils may be the result of decayed asphalt pavement, used oil application to roadways, or vehicle exhaust.

### 3.2 ENVIRONMENTAL HAZARD EVALUATION

Chemicals detected in soil were evaluated using the HDOH EAL "Surfer" tool (HDOH 2012a). Chemical concentrations in site soils observed in DU sampling and laboratory analyses from the HDOH 2009 study, Weston and HDOH 2010 studies, or HDOH 2011 study were compared to HDOH EALs. Table 1 presents a summary of chemical concentrations in soil samples, showing only those compounds with one or more exceedence of a Tier 1 EAL. Chemicals of concern (exceeding an EAL) include TEQ dioxins, arsenic, lead, mercury, PAHs (i.e., benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene), and pentachlorophenol.

HDOH guidance recommends evaluating soil environmental hazards to include human direct contact (ingestion, dermal absorption and inhalation), vapor emissions to indoor air, terrestrial ecotoxicity, gross contamination, and leaching (potential impact to groundwater). The dominant hazard for chemicals in soil at the subject site is direct contact. Screening with the EAL Surfer also indicated that pentachlorophenol exhibited a potential leaching hazard in DU-1 and DU-2. None of the chemicals of concern is volatile; therefore, vapor emissions to indoor air are not a concern. None of the gross contamination EALs was exceeded for site conditions. HDOH has not established terrestrial ecotoxicity screening levels, and no ecological risk screening was performed by Integral for the project.

### 3.3 CHEMICALS OF CONCERN

Arsenic and dioxin were determined to be the most significant chemicals of concern in terms of human direct contact hazard. Table 1 highlights the concentrations of chemicals in site soils.

#### 3.3.1 Arsenic

Arsenic is a common soil contaminant in Hawaii, often related to its use as an herbicide in former sugar cane production. At the subject site, arsenical herbicides are believed to have been managed prior to 1950. HDOH recommends the management of arsenic by evaluation of total and bioaccessible arsenic. In recent guidance (HDOH 2012b), HDOH describes arsenic soil categories based on the magnitude of bioaccessible arsenic levels. Bioaccessible arsenic is the fraction of total arsenic that is extracted from soil using an *in vitro* laboratory test designed to simulate conditions within the human gastrointestinal tract (Drexler and Brattin 2007; Brattin et al. 2013). HDOH has developed four soil categories based on bioaccessible arsenic levels: Category A (natural background levels), Category B (minimally impacted), Category C (moderately impacted) and Category D (heavily impacted). The bioaccessible levels for each soil category are shown in the legend of Figure 7. Remediation is typically recommended for Category C and D soils.

Figure 7 shows the bioaccessible arsenic levels observed in surface soils (0–6 in. bgs) at the site, color coded by soil arsenic categories. Decision units DU-1, DU-2, DU-8, and DU-10 contain bioaccessible arsenic in surface soils at Category D levels. Arsenic Category C soils were not identified in surface soils, and the balance of soils were in Category A and B levels. Subsurface soils (6–24 in. depth) in DU-1 and DU-2 had bioaccessible arsenic at Category C levels, and subsurface soils in DU-08 had Category D arsenic soils (see Table 1, subsurface soils are not depicted on Figure 7).

#### 3.3.2 Dioxin

Dioxin is a highly toxic chlorinated organic compound, commonly observed in soils formerly used for agriculture in Hawaii where pesticides/herbicides such as pentachlorophenol were applied. Similar to arsenic, HDOH has published specific guidance for the management of dioxin, with associated dioxin soil categories based on dioxin concentrations (HDOH 2010). Like arsenic, HDOH has developed four soil categories based on TEQ<sup>4</sup> dioxin levels: Category A (natural background levels), Category B (minimally impacted), Category C (moderately impacted) and Category D (heavily impacted). The TEQ dioxin levels for each soil category are shown in the legend of Figure 8. Remediation is typically recommended for Category C and D soils.

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<sup>4</sup> TEQ is a method of summing the toxic effects of the various dioxin and furan congeners (related compounds), and generating a single TEQ value for comparison against risk-based levels.

Figure 8 shows a similar, but more extensive, pattern of surface soil contamination as observed for arsenic. Surface soils (0–6 in. bgs) in DU-1, DU-2, DU-7, DU-8, and DU-10 show dioxin Category D soils. DU-3 and DU-4, on the HICDC property, and DU-15 and DU-18 on the adjacent Harbottle property, contain dioxin Category C soils. Subsurface soils (6–24 in. bgs) in DU-1 and DU-2 contain dioxin Category C soils, and in DU-8 contain dioxin Category D soils. Deeper subsurface soils (24–48 in. bgs) in DU-2 contain dioxin Category C soils.

### 3.3.3 Other Chemicals of Concern

In addition to arsenic and dioxin, lead, mercury and PAHs were observed at concentrations above unrestricted land use EALs. Lead was reported in surface soils of DU-1 at 230 mg/kg, slightly above the EAL of 200 mg/kg. Mercury was reported in surface soils of DU-11 and DU-2 at 14 and 8 mg/kg, above the EAL of 4.7 mg/kg. SVOCs were reported in DU-1, DU-2, DU-3, and DU-4 at concentrations above EALs. Benzo(a)pyrene was reported in surface soils of DU-10 and DU-14 (on Harbottle property) above EALs.

## 3.4 SUMMARY OF ENVIRONMENTAL HAZARDS

Arsenic, lead, mercury, dioxin, PAHs, and pentachlorophenol were observed on the site above the direct contact EAL for unrestricted land use. Pentachlorophenol was observed above the EAL for leaching (potential for groundwater contamination). Mercury was reported in surface soils (0–6 in. bgs) of DU-1, DU-2, and DU-8 at 14, 8, and 6.9 mg/kg, respectively, above the EAL of 4.7 mg/kg. Four individual PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene) exceeded EALs in surface soils (0–6 in. bgs) of DU-4. One PAH (benzo(a)pyrene) was at or above the EAL in surface soils (0–6 in. bgs) in DU-3 and DU-10 on HICDC property, and in DU-14 on the Harbottle property. The EAL for pentachlorophenol was exceeded in surface soils (0–6 in. bgs) of DU-1, DU-2, and DU-4. Of the chemicals of concern, arsenic and dioxin are the most extensive (greatest lateral and vertical extent at concentrations above EALs), and can be considered the chemicals of concern driving the remediation process. If arsenic and dioxin are addressed, the other lesser chemicals of concern will be addressed in kind.

The leaching hazard from pentachlorophenol is not considered to be a significant environmental hazard, since the area of impact above the leaching EAL is small (DU-1, DU-2 and DU-4), and the concentrations are no more than four times the leaching EAL. In addition, depth to groundwater is several hundred feet, and the aquifer is thick and transmissive (large groundwater flux).

Based on a comprehensive review of chemical concentrations in site soils, we believe that the principal hazards are arsenic and dioxin by direct contact, and that these should be the basis of the removal action levels.

## 4 REMOVAL ACTION SUMMARY

Soils containing arsenic and dioxin (as well as lead, mercury and SVOCs) at the former Kohala Sugar Company property present a potential direct exposure risk to humans and may present terrestrial ecotoxicity hazards. Based on these findings a removal action is recommended. In order to determine the most appropriate removal action approach, an evaluation of removal action alternatives was performed. The goal of this process is to screen and evaluate options that would be effective, technically and administratively feasible, and cost effective at addressing the soil arsenic and dioxin issues at the subject property.

### 4.1 REMOVAL ACTION OBJECTIVES

The primary focus of the removal action is to address elevated arsenic and dioxin (and several other chemicals) in the soils at the site to provide protection of human and ecological health by preventing direct contact exposures to contaminated soils. The removal action objectives (RAOs) are as follows:

1. Remediate portions of the property anticipated for future unrestricted (residential) land use to appropriate bioaccessible arsenic and TEQ dioxin soil concentrations, herein defined as removal action levels (RALs)
2. Prevent migration of contaminants to surface or groundwater
3. Minimize potential risk to human health or ecological receptors from exposure to arsenic- and dioxin-impacted soil, during and after the removal action.

### 4.2 REMOVAL ACTION LEVELS

The RALs are the target concentration of bioaccessible arsenic and TEQ dioxins that will be achieved by the removal action to allow appropriate site land use. Considering the planned unrestricted (residential) land use at the subject property, all Category C and D soils shall be addressed. A bioaccessible arsenic RAL of less than or equal to 23 mg/kg and a TEQ dioxin RAL of 240 ng/kg are recommended for the site. Soils exceeding these RALs (Category C and D soils) will require remediation.

### 4.3 SUMMARY OF REMOVAL OPTIONS

Based on the above-stated RAOs and RAL, Integral proposes the following removal alternatives be considered. Since leaching of site contaminants and impact to groundwater do not represent a significant site risk, the removal alternatives considered consist of proven methods for



eliminating human direct contact risk and terrestrial ecological risk. There are several alternatives or options that have the potential to meet the RAOs for the site, including the following:

1. No Action (does not meet RAOs, included for comparative baseline)
- 2a. On-Island Landfill Disposal
- 2b. Mainland Landfill Disposal
- 3a. Soil Cap
- 3b. Concrete Cap.

#### 4.4 REMOVAL ALTERNATIVES EVALUATION CRITERIA

Each alternative was evaluated against the following three performance criteria:

- Effectiveness
- Implementability
- Cost.

The *effectiveness* criterion addresses the ability of the remedial alternative to provide:

- Overall protection of human health and the environment
- Achievement of RAOs
- Short-term effectiveness
- Reduction of toxicity, mobility, and volume of contaminants by treatment
- Long-term effectiveness and permanence
- Compliance with regulatory requirements.

The *implementability* criterion addresses:

- Technical feasibility (i.e., technology, reliability, and implementation limitations, e.g., terrain, logistics)
- Amount of time to implement
- Complexity (e.g., number of steps to complete)
- Administrative feasibility (local land management, permits, right-of-ways, zoning)
- Suitability of land for future uses
- Availability of equipment, materials and services.

The *cost* criterion addresses:

- Overall cost to implement the removal action (initial construction costs and long-term operations and maintenance [O&M] costs).

## **5 REMOVAL ALTERNATIVES EVALUATION**

The four alternatives carried forward are evaluated herein. Supporting cost estimates for each alternative are provided in Tables 6 through 9. Only arsenic- and dioxin-contaminated soils on the HICDC property are considered in the following removal alternatives. Removal or remedial actions on the adjacent Harbottle and Westrum properties are not considered.

### **5.1 ALTERNATIVE 1 – NO ACTION**

The No Action alternative, included as a comparative baseline, consists of no removal actions and leaving the site in its current condition. Under this alternative, no engineering features or institutional controls (signage, deed notices, etc.) are employed to prevent potential human or ecological risks from exposure to arsenic-impacted soils.

#### **5.1.1 Effectiveness**

The No Action alternative would not achieve RAOs and, most importantly, would not protect against incidental human direct contact with arsenic or dioxin contaminated soil.

#### **5.1.2 Implementability**

There are no issues of implementability for the No Action alternative, since by definition no action is planned.

#### **5.1.3 Cost**

There is no cost associated with the No Action alternative.

### **5.2 ALTERNATIVE 2 – LANDFILL DISPOSAL**

Excavation and landfill disposal of arsenic- and dioxin-contaminated soils exceeding the RALs constitutes the second remedial alternative for evaluation. The general tasks under this option include site preparation, soil excavating and loading, transporting and disposal of soil at a landfill, and site restoration. Alternatives 2a and 2b consider soil disposal either at an on-island landfill (West Hawaii Sanitary Landfill in lower Pu‘uanahulu) or at a mainland landfill, respectively. This alternative consists of tasks including post-excavation confirmation sampling, backfilling excavations with clean soil, and restoring the site with vegetative ground cover. This alternative is based on the assumption that all excavated soils meet regulatory levels and are not considered a hazardous waste requiring potential treatment and/or disposal in a hazardous waste (mainland, Subtitle C landfill).

Based on prior sampling and analysis by HDOH and Weston, and supplemental waste characterization sampling and analysis performed by Integral/ACSI (Section 2.4), arsenic and dioxin contaminated soil potentially excavated from the site would be considered non-hazardous solid waste. The only solid waste landfill on the Island of Hawaii that is permitted to accept contaminated soil is the West Hawaii Sanitary Landfill in lower Pu'uanahulu, managed by Waste Management Solutions, Inc. This facility is located approximately 30 miles from the subject site. Discussions with Waste Management staff indicate that site soils would be accepted for disposal at the West Hawaii Sanitary Landfill.

Soils exceeding the unrestricted land use RAL (arsenic and dioxin Category C and D soils) are shown as orange and red shaded areas on Figures 7 and 8. Approximately 1,300 cy of soil is estimated to require removal and disposal under this alternative. Considering 1.6 tons of soil per in-place cubic yard, some 2,000 tons would require excavation and disposal. Further details on scope elements for this alternative are provided in Tables 6 and 7.

### **5.2.1 Effectiveness**

Excavation and offsite disposal of soils exceeding the unrestricted land use RAL would be an effective long-term remedy to meet RAOs. It would eliminate the potential for human direct contact risks associated with arsenic- and dioxin-contaminated soils and minimize risk to potential environmental receptors at the site. This alternative would remove arsenic and dioxin to acceptable RALs, thereby, reducing the toxicity, mobility, and volume of contamination at the property; however, the impacted soil would still need to be disposed at a permitted landfill facility. Short-term effectiveness, during and immediately after the removal action, is only moderate since there is potential exposure to site workers and the community during implementation of the soil excavation, transport, and disposal. Short-term effectiveness can be improved by strong engineering and management controls, such as personal protective equipment (PPE) for workers and air monitoring and mitigations for dust suppression, dust barriers, etc. This alternative would be in compliance with regulatory requirements.

### **5.2.2 Implementability**

The excavation and offsite disposal of soil can be implemented using traditional construction techniques. This alternative is simple in approach, i.e., "dig and haul." Dust control and soil erosion control measures must be implemented during excavation and loading activities to ensure community and worker health and safety. Approximately 2,000 tons (or one hundred 20-ton loads) of contaminated soil would have to be transported by truck over local roadways, resulting in increased truck traffic and potential neighborhood disturbances. Local permitting is expected to be required in order to perform soil excavation work. This would include stormwater and grading/grubbing permits.

### 5.2.3 Cost

The total estimated cost for Alternative 2a - On-Island Landfill Disposal alternative is estimated at \$484,000. The cost of Alternative 2b – Mainland Landfill Disposal is estimated at \$1,774,000. Details are provided in Tables 6 and 7.

## 5.3 ALTERNATIVE 3 – ONSITE CAPPING

Onsite containment and capping of contaminated soils is a proven removal technology designed to improve the condition of targeted property and eliminate direct contact hazards associated with a contaminated soil or waste material. Under Alternative 3, soils exceeding the unrestricted land use RALs for arsenic and dioxin will be contained in place and capped with either clean soil (Alternative 3a) or a concrete cap (Alternative 3B). The contaminated soil containment area, after capping, would not be used for future residential redevelopment.

The areas of arsenic and dioxin contaminated soils exceeding RALs (Category C and D soils) are shown on Figures 7 and 8. The footprint of dioxin contaminated soils is greater than that for arsenic, and it is this larger footprint that would define the capping area. It includes DU-1, DU-2, DU-3, DU-4, DU-7, DU-8, and DU-10 (orange and red areas on Figure 8). The remedy would consist of constructing a concrete stem wall at the property boundaries along the south and east perimeters of the impacted area. This wall will support the onsite cap, and will function to prevent migration of contaminated soil onto the remediated area from adjacent, unmitigated properties (Harbottle and Westrum properties). Additionally, the stem wall will retain and direct stormwater within the HICDC property boundary.

For the soil cap alternative (2a), the cap system will consist of a demarcation barrier (e.g., geomembrane) and labeled warning tape placed above the contaminated soil, covered by at least 2 ft of clean cover soil. Stanchions would be placed at the corners of the containment area, with signage indicating that arsenic- and dioxin-contaminated soils are present beneath the soil cap. For the concrete cap alternative (2b), geotextile fabric and crushed stone subbase would be placed above the contaminated soil, followed by a 6 in. thick concrete surface layer.

Institutional controls, to include deed notice and environmental covenant, with land use restrictions, and an Environmental Hazard Management Plan (EHMP), would be implemented as a final component of this removal action alternative. Long-term inspection and maintenance of the soil or concrete cap would be required in perpetuity.

### 5.3.1 Effectiveness

Storage within an onsite capped containment area is an effective remedy to eliminate the potential for human and ecological direct contact with exposed arsenic- and dioxin-contaminated soils. The soils that present a direct contact hazard (Category C and D soils) are

placed under a soil or concrete cap, providing a physical barrier eliminating the potential for exposure. This remedy effectively mitigates human health and environmental hazards. This scenario is not considered a permanent solution, since the contaminated soil has not been completely eliminated, but it does meet long-term effectiveness goals. Overall this alternative would protect human health and the environment. Storage in an onsite capped containment area would not reduce the toxicity or volume of the contaminated soil, but the engineered cap would prevent direct contact risks and significantly decrease contaminant mobility potential.

Long-term effectiveness of the cover system can be increased by engineering and institutional controls to prevent unwanted intrusive activities. Engineering controls include visible subsurface barriers (geotextile fabric, buried warning tape) for the soil cap alternative, and a physical surface barrier under the concrete cap for that alternative. Both capping alternatives will include perimeter stanchions with signage indicating that contaminated soils are located within the perimeter of the stanchions. Institutional controls, such as land use and/or deed restrictions, will ensure that the location and engineering features of the containment cell are known and documented to ensure long-term safety. Long-term effectiveness of the concrete cap is expected to be greater than for the soil cap. The soil cap will require ongoing maintenance to limit the establishment of deep rooting plants, which may breach the soil cap and compromise the cap's structural integrity, and surface repairs for any soil erosion that may occur.

Short-term effectiveness of the capping alternatives is lessened by potential contaminant exposure to workers and the community during implementation of the grading, geotextile placement, and capping work. This exposure risk can be overcome by proper worker PPE, air monitoring, and mitigations such as dust suppression, dust barriers, etc. This alternative would be in compliance with regulatory requirements.

### **5.3.2 Implementability**

This alternative is technically feasible and avoids transporting contaminated soil over public roadways, and will not consume valuable landfill space. An engineering design and construction plans would be described in a removal action work plan that would be prepared in advance of work to ensure proper implementation. All engineering and construction components of this remedy are readily implemented using standard environmental remediation and civil construction techniques. Dust control and soil erosion control measures will be implemented during soil excavation, relocation, and grading activities to prevent nuisance and contaminant migration.

Local permitting is expected to be required in order to perform soil excavation work and build an onsite soil or concrete cap. This would include stormwater and grading/grubbing permits. Land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP, will be recorded for the area of the property where the soil or concrete cap is placed.

### 5.3.3 Cost

The total estimated cost for the On-site Capping remedy for Category C and D Soils alternatives are \$365,000 for the soil capping alternative (3a) and \$364,000 for the concrete capping alternative (3b). Costs include construction costs to implement the remedy and long-term O&M costs to maintain the remedy in perpetuity. In order to fully account for the long-term cost of ownership of a capping remedy, the net present value of anticipated O&M costs are included in cost estimates for alternatives 3a and 3b. Details are provided in Tables 8 and 9.

## 5.4 COMPARISON OF ALTERNATIVES AND RECOMMENDATION

Table 10 provides a comparison of the removal action alternatives presented herein. Of the five removal action alternatives presented, Alternative 1 (No Action) does not meet the minimum requirements of protecting human health and the environment, since RAOs are not achieved and, in particular, because hazards posed by soils containing arsenic and dioxin above the RALs are not addressed.

Comparison of Alternative 2a (on-island landfill disposal), Alternatives 2b (mainland landfill disposal), Alternative 3a (soil cap) and Alternative 3b (concrete cap) on the basis of effectiveness, implementability, and cost, provides some noticeable contrasts.

In terms of effectiveness, all four remedies are generally effective at preventing human direct contact exposure with contaminated soils. Since arsenic in soil cannot be eliminated, and dioxin can only be destroyed using very expensive thermal technologies, a key differentiator is the location where the material will reside for the long term. Alternatives 2a/2b provide the greatest long-term effectiveness since the contaminated soil is moved to a permitted landfill facility designed and managed for the purpose of long-term storage of solid waste materials. After implementing the remedy, the site is available for future use without future constraints. There is no difference in effectiveness between Alternatives 2a and 2b, only a difference in whether the receiving landfill is in Hawaii or the mainland. Alternatives 3a and 3b provide somewhat less effectiveness than Alternatives 2a/2b, since the contaminated soils will remain on the site and will have to be managed in that location for the foreseeable future. Alternative 3a (soil cap) will be less effective than Alternative 3b (concrete cap), as the potential for accidental intrusion beneath the cap and contact with contaminated soils is higher. The concrete cap provides both a more visible indication that the site should not be disturbed, as well as a more difficult and unlikely situation for accidental (or intentional) intrusive activities.

From a technical and construction perspective, all alternatives can be readily implemented. Alternative 2 (offsite landfill disposal), involves significant truck traffic through the local community and across county roads, which increases traffic safety risk and nuisance issues, whereas with Alternative 3 (capping), construction activities are confined to the site. The onsite

capping alternatives will require land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP.

Alternative 2 (excavation and offsite landfill disposal) provides the least restrictions on future use and redevelopment at the property, in that no areas are subject to land use restrictions designed to prevent intrusion through the impounded soil capping system. The landfill alternative also permanently removes the contaminated soil from the site, leaving a clean site behind for future use. This remedy would alleviate the potential for community stigma related to having a contaminated site (albeit capped) located in a residential community for perpetuity.

The cost of Alternative 2b (Mainland Landfill Disposal) is the highest of all alternatives at \$1,774,000. Alternative 2a, On-Island Landfill Disposal, is the next highest cost at \$484,000. The onsite capping remedies have slightly lower cost, with the soil cap alternative estimated to cost \$365,000, and the concrete cap alternative estimated at \$364,000.

Based on comparison of the remedial alternatives, Alternative 2a (On-Island Landfill Disposal) provides the best balance of effectiveness, implementability, and cost. In addition, this remedy results in a clean site, with no loss of land use, no need to manage long-term O&M, and no potential community stigma of having a closed contaminated site in the neighborhood. Based on thoughtful comparison of the alternatives, On-Island Landfill Disposal is recommended for selection by HDOH as the approved removal action alternative.



## 6 CONCEPTUAL DESIGN AND IMPLEMENTATION

This section provides a description of the conceptual design for implementation of Alternative 2a, consisting of excavation and on-island landfill disposal of arsenic and TEQ dioxin Category C and D soil.

### 6.1 REMOVAL ACTION WORK PLAN

Following HDOH approval of the recommended remedy, a removal action work plan containing construction specifications and implementation plans will be prepared and submitted to HDOH for review, comment and approval before commencing work. Health and safety protocols, including specialized training requirements for workers, will be presented in an environmental health and safety plan for activities performed during implementation of the contaminated soil remediation. The environmental health and safety plan will include special precautions for handling and respiratory protection, as well as prevention of cross contamination between the HICDC property and adjacent properties.

### 6.2 SITE PREPARATION ACTIVITIES

Preparatory work to facilitate remedy implementation will include the following activities: 1) clearing of vegetation and fencing; 2) installation of a construction access road; 3) removal of one large banyan tree, and; 4) disassembly and removal of four steel ASTs. Vegetation within the impacted area consists of dense shrubs and trees. To facilitate survey work and delineation of cap extent, grubbing work shall bring vegetation to ground level. Existing fencing surrounding the impacted area, and ranch fencing along the northern perimeter of the site, will be removed to provide vehicle access from Kumakua Street. Silt fencing will be installed along property boundaries to prevent cross-property migration of contaminated soil.

No access road exists at the subject site; heavy duty vehicles necessary for remedy construction will require installation of a gravel access road. Integrated within the western (upper) CRM wall, as depicted in Figure 4, is a large banyan tree. Above-ground vegetation and root systems of the banyan tree must be removed prior to implementing the recommended remedy. West of the CRM wall are four ASTs. Two vertical tanks measure approximately 10 ft in height and 8 ft in diameter, and two horizontal tanks measure approximately 20 ft long and 6 ft in diameter. All ASTs are empty and rinsate testing (Weston 2011) indicated that residual contents are non-hazardous. Prior to implementing the recommended remedy, each tank shall be disassembled and either recycled or disposed according to state and federal requirements.

Planned excavation limits will be marked to facilitate soil excavation. Site work perimeters will be established, and soil loading and equipment decontamination areas will be constructed.

### **6.3 SOIL EXCAVATION AND DISPOSAL**

Soil within the DUs containing arsenic and TEQ dioxins exceeding RALs will be excavated and loaded into dump trucks for transport and disposal at the West Hawaii Landfill. The depth of initial soil excavation will be based on prior sampling and analysis work (see estimated soil contamination depths on Table 5). A portable X-ray fluorescence (XRF) instrument, capable of measuring total arsenic levels, will be used to confirm that soil excavation depths are adequate.

During soil excavation and truck loading, water spray will be used as necessary to prevent generation of dust. A site health & safety manager will be on site during all soil handling periods to ensure compliance with the project-specific Health & Safety Plan, including dust control measures. Soils will be transported from the site to the landfill by a licensed trucking firm in dump trucks with tarp covers to prevent soil release during transport. Soil will be dumped at the landfill under the direction of Waste Management personnel.

Rock and cement from the existing retaining walls, and roots associated with the banyon tree and other vegetation, are anticipated to be generated during excavation work along with soils. This larger debris material will be managed as waste material and will be landfill disposed. No attempt to “clean” and reuse the debris will be made.

### **6.4 POST-EXCAVATION CONFIRMATORY SAMPLING AND ANALYSIS**

Once soils have been removed to design limits and as further required by real-time XRF analysis, a comprehensive post-excavation confirmation sampling and analysis program will be implemented. The sampling and analysis will consist of MI sampling of soils on the excavation bottom and sidewalls, in accordance with a sampling design described in the HDOH-approved removal action work plan. If samples are determined to meet the RALs, then the excavation work will be deemed complete, and site restoration work will commence. If soils within certain confirmation DUs do not meet RALs, then further excavation and additional confirmation sampling will be undertaken – until RALs are achieved across the project site.

### **6.5 SITE RESTORATION**

Upon attainment of RALs, as demonstrated by post-excavation sampling and analysis, the excavation will be backfilled with clean soil and graded to conform with the surrounding topography. Nearby clean soils from HICDC property are anticipated to be used for backfill. Once placed and compacted, soils will be re-vegetated with grasses to prevent soil erosion and allow for future use.

## **6.6 PROJECT CLOSE-OUT**

Upon completion of the removal action work, a removal action completion report will be submitted describing the work performed, providing as-built drawings of the engineered remedy and certifying attainment of the RALs. Upon review and approval of the completion report, HDOH will issue a No Further Action letter, indicating that site cleanup has been achieved. After such time, the site should be available for unrestricted use.

## 7 CONCLUSIONS AND RECOMMENDATIONS

This removal action report addresses the need for remedial action of arsenic- and dioxin-impacted soils at the subject property. Based on soil investigations at the site, it has been determined that these contaminants are present at concentrations requiring a response action. RAOs have been developed as follows:

1. Remediate portions of the property anticipated for future unrestricted (residential) land use to appropriate bioaccessible arsenic and TEQ dioxin soil concentrations (RALs )
2. Prevent migration of contaminants to surface or groundwater
3. Minimize potential risk to human health or ecological receptors from exposure to arsenic- and dioxin-impacted soil, during and after the removal action.

RALs are defined to be consistent with the lower limits of Category C soils, consisting of 23 mg/kg bioaccessible arsenic and 240 ng/kg TEQ dioxins. All soils above the RALs (Category C and D soils) shall be addressed by the removal action. Other chemicals of concern will be remediated to Tier 1 direct exposure EAL concentrations.

Four removal action alternatives (plus the No Action alternative) were evaluated in term of effectiveness, implementability, and cost. Alternative 2a, On-Island Landfill Disposal, was determined to provide the best balance of human health and environmental protectiveness at a reasonable cost.

Upon approval of the recommended removal action alternative by HDOH, a removal action work plan will be prepared to provide design specifications and guidance in implementing the proposed remedy.

## 8 REFERENCES

- Brattin, W., J. Drexler, Y. Lowney, S. Griffin, G. Diamond, and L. Woodbury. 2013. An In Vitro Method for Estimation of Arsenic Relative Bioavailability in Soil. *J. Toxicol. Environ. Health.* 76(7), 458–478.
- Drexler, J.W., and W.J. Brattin. 2007. An In Vitro Procedure for Estimation of Lead Bioavailability: With Validation. *Hum. Ecol. Risk Assess.* 13:383–401.
- HDOH. 2010. Update to Soil Action Levels for TEQ Dioxins and Recommended Soil Management Practices. EHA/HEER Office memo 2010-389-RB. Hawaii Department of Health. June 2010.
- HDOH. 2011. Screening for Environmental Hazards at Sites with Contaminated Soil and Groundwater, Fall 2011 Updates. EHA/HEER Office memo 2011-716-RB. Hawaii Department of Health. December 2011.
- HDOH. 2012a. Tier 1 Environmental Action Levels Surfer. <http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/environmental-hazard-evaluation-and-environmental-action-levels>. Hawaii Department of Health. January 2012.
- HDOH. 2012b. Update to Soil Action Levels for Inorganic Arsenic and Recommended Soil Management Practices. EHA/HEER Office memo 2011-690-RB. Hawaii Department of Health. September 2012.
- HDOH. 2013. Unpublished drawing of decision unit boundaries. (E-mail to W. Cutler, Integral Consulting Inc., Louisville, CO, from L. Peard, HDOH HEER Office.) Hawaii Department of Health.
- Weston. 2011. Phase I/II Investigation Targeted Brownfields Assessment, Kohala Sugar Plantation, Pesticide Mixing Site, Kohala, Hawaii. Prepared for U.S. Environmental Protection Agency, Region 9. Weston Solutions, Inc. April 2011.