DRAFT REMOVAL ACTION REPORT
FOR
PHYSICAL IMPROVEMENTS TO
LANAKILA PUBLIC HOUSING PROJECT
PHASE IIIb
HILO, HAWAII 96720

APPROX. 1.5 ACRE PORTION OF
TMK (3) 2-4-028:007, 29.3 ACRES

MNA PROJECT 2_1580-5

MAY 9, 2016

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DRAFT REMOVAL ACTION REPORT AND ENVIRONMENTAL HAZARD EVALUATION FOR PHYSICAL IMPROVEMENTS TO LANAKILA PUBLIC HOUSING PHASE IIIb HILO, HAWAII 96720

HPHA Job No. 95-003-104-F-IIIb

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TABLE OF ABBREVIATIONS

bgs	below ground surface
BF	Bio-accessible fraction
BMP	Best Management Practice
BTLT	Batch Test Leaching Model
COPC	Chemicals of Potential Concern
CWB	HDOH Clean Water Branch
DU	Decision Unit
EAL	Environmental Action Level
EHE	Environmental Hazard Evaluation
EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
HDOH	Hawaii Department of Health
HEER	HDOH Hazard Evaluation and Emergency Response office
HPHA	Hawaii Public Housing Authority
HRS	Hawaii Revised Statutes
ID	Identification
µm	micron
MIS	Multi-Increment Sampling
MNA	Myounghee Noh & Associates, LLC
MSL	Mean Sea Level
NFA	No Further Action
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NSF	Near-Surface
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
RAR	Removal Action Report
RCRA	Resource Conservation and Recovery Act
RSD	Relative Standard Deviation
SF	Surface
SBRC	Solubility Bioaccessibility Research Consortium
SMU	Soil Management Unit
SSF	Sub-surface
SSL	Soil Screening Level
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characteristic Leaching Procedure
TMK	Tax Map Key
UIC	Underground Injection Control

EXECUTIVE SUMMARY

Lanakila Homes is a public housing site, owned and operated by the Hawaii Public Housing Authority (HPHA), located at the 29.3-acre parcel, Tax Map Key (3) 2-4-007:028, bound by Kapiolani Street, Wailoa Street, and Ululani Street in the community of Hilo on the Island of Hawaii. HPHA is in the process of redeveloping the entire Lanakila Homes public housing site. The demolition of the seven existing, uninhabitable duplex structures (Buildings 56, 57, 58, 64, 65, 66, and 67) located in the southwest area of the parcel and bound by Kapiolani Street, Hema Street, and Akahi Street is the portion of the project designated as Phase IIIb. Four multi-unit housing structures will be constructed in this area.

In 2013, Myounghee Noh & Associates, L.L.C. (MNA), under an agreement with the HPHA, conducted a hazardous material survey of the structures on the entire property (i.e. both Phase IIIb and IV). Subsequently, MNA, under contract with INK Architects, LLC, completed a soil baseline survey based upon MNA's Soil Management Plan in 2014 and then completed site soil characterization with a supplemental soil survey in 2015. These soil surveys guide portions of this Draft Removal Action Report (Draft RAR) with respect to management of contaminated soil during both the construction phase of the project and the long-term.

The objectives of this Draft RAR and Environmental Hazard Evaluation (EHE) are to assess potential hazards and to present soil management alternatives as discussed by the design team. The alternatives that have been considered during this process are evaluated and the preferred alternative presented. Finally, recommendations for the long-term management of lead-, arsenic-, and pesticide-impacted soil are provided. This Draft RAR follows recommendations by the State of Hawaii Department of Health (HDOH) Office of Hazard Evaluation and Emergency Response's (HEER) Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan, Section 2.4.

The EHE assesses potential hazards for site chemicals of potential concern (COPC) utilizing the HEER Office Tier 1 Environmental Action Level (EAL) surfer tool. It was determined that there are potential risks associated with termiticides (pesticides), lead, and arsenic in soil, particularly with direct exposure and inhalation of dust.

In order to appropriately manage COPC, contaminated soil, and potentially contaminated soil during and after the demolition and construction phases of the project, remedial action alternatives were developed and evaluated. Evaluation criteria considered were effectiveness, feasibility, and cost. The following four alternatives were developed; the no action alternative, in-place encapsulation, excavation and landfill disposal of contaminated soil, and excavation and containment in a soil management unit on-site. The preferred strategy, management of contaminated soil on-site in a soil management unit, was determined through extensive discussions among the design team members, analysis of removal action objectives and options, and evaluation of options against the evaluation criteria - feasibility, effectiveness, and cost.

This preferred alternative will be presented to the public for informational purposes and to solicit public comments after HDOH acceptance of the Draft RAR.

1.0 INTRODUCTION

The project site is a portion of the Lanakila Public Homes, owned and operated by the HPHA, located on a portion of the 29.3-acre parcel with Tax Map Key (3) 2-4-007:028, Hilo, Island of Hawaii. HPHA is in the process of redeveloping the entire Lanakila Homes public housing site. The demolition of the seven existing, uninhabitable duplex structures (Buildings 56, 57, 58, 64, 65, 66, and 67) located in the southwest area of the parcel and bound by Kapiolani Street, Hema Street, and Akahi Street is the portion designated as Phase IIIb (Figure 1). Four multi-unit housing structures will be constructed in this area. Demolition of structures on both Phase IIIb and Phase IV portions of the project site commenced in July 2015 as part of a separate contract from the construction portion of the project, but building foundations were left in place.

In April 2015, Myounghee Noh & Associates, L.L.C. (MNA), coordinated with the Physical Improvements to Lanakila Public Housing Phase IIIb design team to discuss and evaluate alternatives associated with the management of contaminated and potentially contaminated soil during earthwork for construction. In 2013, MNA, under a separate contract with the Hawaii Public Housing Authority (HPHA), conducted a hazardous material survey of the structures on the entire property (i.e. both Phase IIIb and IV). Subsequently, MNA under contract with INK Architects, LLC, completed a soil baseline survey based upon MNA's Soil Management Plan, dated 1 August 2014. Phase IIIb soil characterization of the site was completed in 2015 with the Supplemental Soil Survey. These soil surveys guide portions of this Draft Removal Action Report (Draft RAR) with respect to proposed sampling and analysis of soil during construction.

The previous site assessments revealed that lead-, arsenic- and pesticide-impacted soils are present on-site that may be hazardous to human health and may have ecological impacts. This Draft RAR was prepared by MNA in coordination with the project design team to document the consideration of alternatives for management of lead-, arsenic- and pesticide-contaminated soil on the Lanakila HPHA Phase IIIb site, judged by the criteria of feasibility, effectiveness, and cost, and to present the evaluation of potential environmental hazards associated with the soil contamination.

The specific objectives of this Draft RAR are as follows:

- Present the results of previous site investigations that identified contaminants of potential concern (COPCs) and characterized their extent in soil.
- Evaluate potential environmental hazards or risks that are present due to impacted soil identified on-site.
- Present soil management alternatives that have been considered by the design team and discuss with the State of Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) Office.
- Present the preferred alternative that achieves project objectives including construction and minimization of identified hazards or risks to human health and the environment.

1.1 PROJECT OBJECTIVES

This Draft RAR represents the result of consultation between MNA and the project team including HPHA representatives, architect, engineers, HDOH HEER Office, and contractors involved in the project. The objective of these consultations was to arrive at a set of remedial choices that would achieve the project objective of construction of Phase IIIb while protecting human health and safety and ecological impacts, if any, within the constraints of public financing.

1.2 PROJECT BOUNDARY

Phase IIIb, approximately 1.5 acres, includes the demolition of the seven existing, uninhabitable duplex structures (Buildings 56, 57, 58, 64, 65, 66, and 67) located in the southwest area of the parcel and bound by Kapiolani Street, Hema Street, and Akahi Street. Four new multi-unit housing structures will be constructed in the same area. This Draft RAR pertains to the Phase IIIb project only (Figure 1).

1.3 DESIGN TEAM

The project team is composed of the following members:

- Project and Property Owner: Hawaii Public Housing Authority, State of Hawaii

- Prime Architect - Engineer: INK Architects, LLC
- Civil Engineer: Imata & Associates, Inc.
- Geotechnical Consultant: Hirata & Associates, Inc.
- Environmental Consultant: Myounghee Noh & Associates, L.L.C.

2.0 PROJECT BACKGROUND

Lanakila Homes sits on 29.3-acres of land located in Hilo, Island of Hawaii. The Tax Map Key of the site is (3) 2-4-028:007. Phase IIIb includes the demolition of seven structures (Buildings 56, 57, 58, 64, 65, 66, and 67) and construction of four multi-level residential structures, parking structures, sidewalks, and turf areas on approximately 1.5 acres. The existing concrete slabs of the seven buildings will be demolished. However, it is anticipated that this work will guide any soil characterization or remedial / mitigation action associated with subsequent Phase IV of the project.

2.1 SITE DESCRIPTION

The Lanakila Housing site in Hilo is located approximately 80-90 feet above mean sea level (MSL), on the east side of the intersection of Kapiolani Street and Wailoa Street. Phase IIIb of the project is bordered by Kapiolani Street, Hema Street, and Akahi Streets on the west, south, and east sides, respectively. The site slopes gradually to the east until near the eastern boundary, where it becomes more steeply sloping. As the project site was previously an HPHA residential housing area, the project site has been graded and has curb and gutter installed.

2.1.1 Climate

Located in Hilo, the project site vicinity has a wet, tropical climate with a small seasonal variance in temperature, about 150 inches of rainfall annually and high typical relative humidity of about 80 percent (%) (Juvik, S.P & Juvik, J.O., 1998).

2.1.2 Soils/Geology

The Island of Hawaii is of volcanic origin and was built by the Kohala, Mauna Kea, Mauna Loa, Kīlauea, and Hualālai Volcanoes. The island is comprised of numerous thin, extremely permeable tholeiitic basalt lava flows (Stearns, 1985).

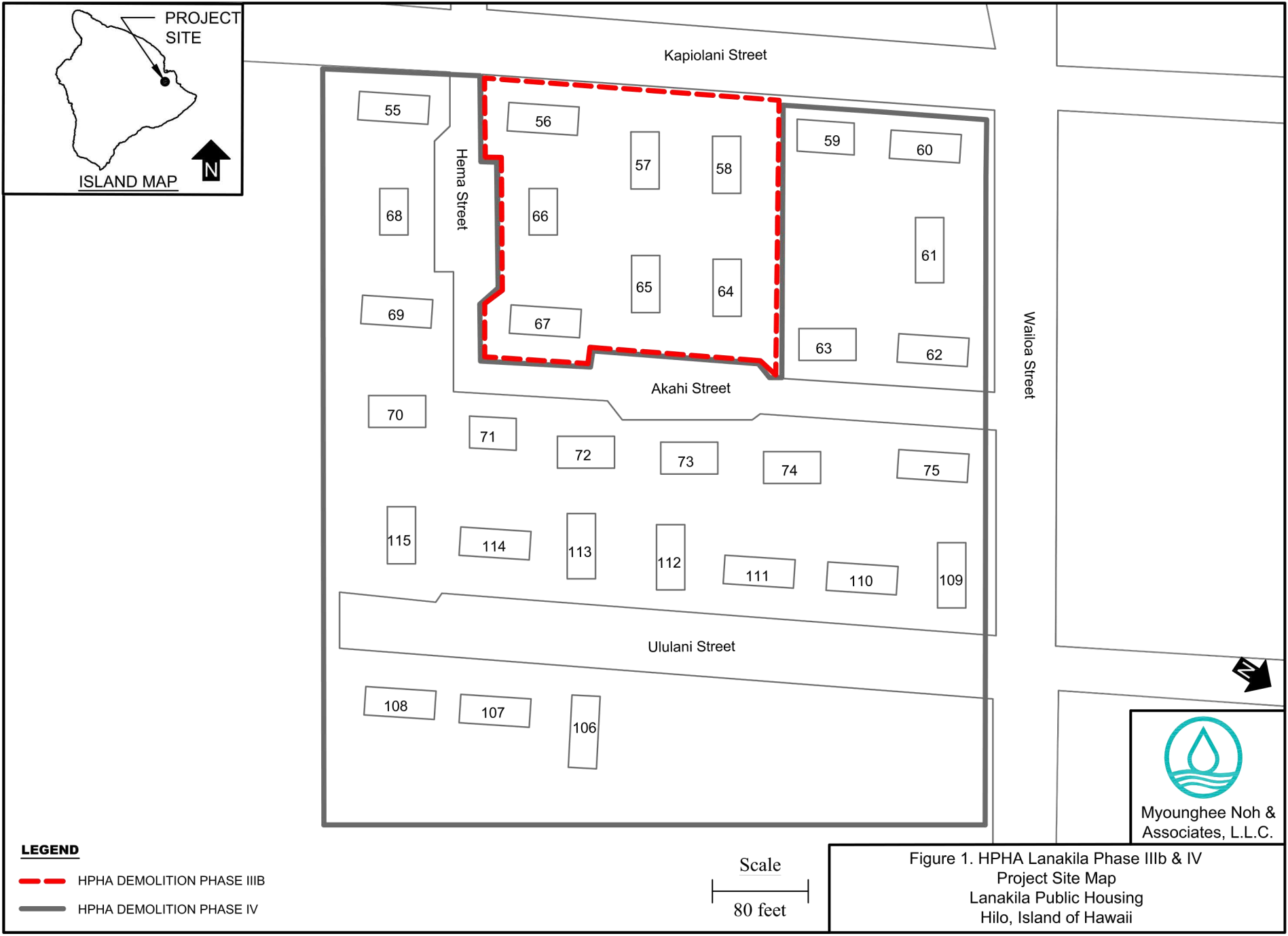


Figure 1. HPHA Lanakila Phase IIIb & IV
Project Site Map
Lanakila Public Housing
Hilo, Island of Hawaii

Hawaii, the youngest and largest Hawaiian Island, is larger than all the other Hawaiian Islands combined. In 1996, Hazlett and Hyndman described the island as follows:

> It sprawls over an area the size of Connecticut, spanning 90 miles from north to south and 80 miles from east to west. Five large volcanoes coalesce to make the visible part of the Big Island; a sixth lies buried beneath the surface. The southern part of the island is still volcanically active and building out along much of the coastline. To the north, volcanism is in the waning stages. Of all the Hawaiian Islands, the Big Island shows the greatest diversity of rocks and landscapes (Hazlett & Hyndman, 1996).

The subject property is located on the lower slope of the active Mauna Loa Volcano, the second youngest of the five Hawaiian volcanoes (Juvik & Juvik, 1998). The Mauna Loa Volcano is the largest volcano on the Island of Hawaii, making up 50.5% of the island's land area. Mauna Loa is a shield volcano and has a summit elevation of 13,777 feet (Morgan, 1996) and is composed of Kau Basalt (Mink, 1993).

In 1993, Mink described the geology in the vicinity of the subject property as follows:

> Virtually the entire region is covered with pre-historic lavas of the Kau Basalt, onto which long tongues of historic lavas from the northeast rift have flowed. Other than scanty recent alluvium, no sediments occur (Mink, 1993).

The U.S. Department of Agriculture Natural Resources Conservation Service classifies the soil at the subject property as Keaukaha Urban Land Complex (Series 439) with slopes of 2-10% and a depth to bedrock of 4-14 inches, composed of highly decomposed plant material over bedrock (United States Department of Agriculture, 2016).

A geotechnical investigation completed at the project site by Hirata & Associates, Inc., included four soil borings located within Phase IIIb that showed a soil horizon composed of clayey silt with depths varying from 1 to 5 feet underlain by gravel, with bedrock from 6-12 feet below ground surface. None of these soil borings reached ground water (Hirata & Associates, 2014).

2.1.3 Surface Water

The project site is located approximately 3/4 mile south of Hilo Bay. Waiakea Stream, a concrete-lined transient flood control channel in the vicinity of the project site, is located approximately 900 feet east from Phase IIIb.

2.1.4 Groundwater

The HDOH Safe Drinking Water Branch has established an Underground Injection Control (UIC) line to serve as a boundary between drinking water and non-drinking water portions of Hawaii's aquifers. In general, areas above (mountain side) the UIC line are within drinking water portions of the aquifer, while areas below (ocean side) the UIC are in the non-drinking water portions of the underlying aquifer. The subject property is located above the UIC line in a drinking water portion of the aquifer (Hawaii Department of Health Safe Drinking Water Branch, 2014).

Based on topography of the area, the regional groundwater flow is thought to be in the general easterly direction (i.e. toward the ocean). However, topography is not the only indication of

direction of groundwater flow. Groundwater flow is influenced naturally by zones of higher or lower permeability, and artificially by recharge or pumping. Therefore, groundwater flow direction can be different than what is dictated by the topography.

The hydraulic gradient of the basal groundwater within basaltic formations is generally from mountain areas to the shoreline. According to the Mink and Lau Technical Report #191, published by the University of Hawaii-Water Resources Research Center, the subject property is located above the Hilo aquifer. In 1993, Mink described the hydrogeology and aquifer as follows:

> Average annual rainfall starts at 120 inches at the coast, increases to a maximum of 300 inches, then decays to 20 inches on the upper slopes of Mauna Loa. Despite the extraordinary rainfall, perennial streams do not exist south of Wailuku River. Rain easily infiltrates into the permeable basalt.
>
> A voluminous basal lens extends at least 4 miles inland of the coast, beyond which high-level water has been encountered. Toward the rift zone dike-impounded high-level water probably occurs. Elsewhere the high-level water is likely to be perched. The flux of groundwater in the basal lens is enormous; the fresh water springs at Hilo-Waiakea have been measured at 150 million gallons per day. The gradient is about 5 feet per mile, and the permeability of the basalt is probably at least 5,000 feet.

Information for the Hilo aquifer is provided in Table 1 (Mink & Lau, 1993).

The geotechnical investigation completed by Hirata & Associates identified no groundwater or seepage to the extent of the borings (14.5 – 20 feet below ground surface). As groundwater is basal it can be expected to exist under the project site at a depth roughly corresponding to the site's elevation above sea level (i.e. 80-90 feet).

Table 1. Aquifer Classification System from Mink & Lau (1993)

Aquifer Code	**80401111**
Island Code	8 – Hawaii
Aquifer Sector	04 – Northeast Mauna Loa
Aquifer System	01 – Hilo
Aquifer Type, hydrogeology	1 – Basal
Aquifer Condition	1 – Unconfined
Aquifer Type, geology	1 – Flank, Horizontally extensive lavas
Status Code	**11111**
Development Stage	1 – Currently used
Utility	1 – Drinking
Salinity (in mg/L Cl^-)	1 – Fresh (<250)
Uniqueness	1 – Irreplaceable
Vulnerability to Contamination	1 – High

mg/L Cl^--milligrams per liter of chloride

2.2 HISTORY OF LAND USE

The existing residential structures on the Phase IIIb site were constructed in 1962 and renovated in 1999. A 1930 map entitled "Railroad and Flume Right of Ways Through Waiakea Homestead Lots & Government Land" shows that the project site was designated lot 1A and 2A of the

Waiakea Cane Lots, and railroad spurs traversed the area (Maly, 1996), suggesting that the vicinity was used for sugar cane cultivation. An aerial photograph from 1954 shows the site vegetated and vacant (United States Geological Survey, 2016).

2.3 PREVIOUS SITE INVESTIGATIONS

2.3.1 Hazardous Building Material and Lead in Surface Soil Survey (MNA 2013)

In 2013 MNA conducted a hazardous material survey of the Phase IIIb and Phase IV buildings under a separate HPHA contract (Myounghee Noh & Associates, L.L.C., 2013). The survey included visual inspection of each unit and sampling and analyses of potential asbestos- or arsenic-containing ceilings, lead in paint, and lead in soil. Two surface soil samples from each building were collected by multi-increment sample (MIS) method, with the first decision unit (DU) at the downspout discharge location at the front of each building and the second DU at the roof drip line at the front and back of the building. Total lead concentrations reported in these MIS samples ranged from 290 milligrams per kilogram (mg/kg) to 3,600 mg/kg, exceeding the HDOH Tier I EAL, 200 mg/kg.

2.3.2 Soil Baseline Survey (MNA 2014)

Introduction

During 15-18 September 2014 MNA performed soil sampling and analysis for arsenic, lead, and pesticides on the periphery of three of the Phase IIIb structures proposed for demolition (Myounghee Noh & Associates, L.L.C., 2014). This 2014 soil baseline survey was conducted prior to building demolition and site disturbance in an effort to determine the magnitude and extent of contamination by COPCs in areas surrounding building foundations.

Fieldwork

During the 2014 Soil Baseline Survey, soil samples were collected from the following three lateral DUs at each building (Buildings 56, 58, and 66):

- 0.0-1.0 foot (ft) from the foundation
- 1.0-5.0 ft from the foundation
- 5.0-10.0 ft from the foundation

To collect soil samples from surface [0-0.5 ft below ground surface (bgs)], near-surface (0.5-1.0 ft bgs), and sub-surface (1-1.5 ft bgs), MNA excavated trenches using a mini-excavator within the pre-determined lateral DUs. Each soil increment was collected from 50 points within each DU by using 10-gram Terra Core® samplers, with each increment collected at random locations within each vertical section. Individual increments were sampled from random locations within each vertical section.

To identify sampling precision and potential field sampling errors, triplicate samples (primary, duplicate, and triplicate) were collected. Three sets of triplicate samples were collected in order to verify that the incremental sample data accurately represents the DU. These were sampled from areas within the same trenches at different randomized locations.

Laboratory Analysis

A total of 33 samples, including replicate samples, were collected. The samples were analyzed as follows, with MIS processing by the laboratory:

- Lead, cadmium, and arsenic using Environmental Protection Agency (EPA) Method 6020 (33 samples)

- Organochlorine pesticides using EPA Method 8081 (33 samples)
- Heavy metals barium, chromium, mercury, selenium, and silver by EPA Methods 6020A/7471B to identify background heavy metal levels (3 samples)
- Bioaccessible arsenic using the Solubility Bioaccessibility Research Consortium (SBRC)-gastric preparation method, also known as physiologically based extraction test (6 samples). Two samples were submitted for this analysis from each building, and represented all vertical sections sampled. Samples were prepared by the laboratory by passing the samples through a 250 µm sieve.
- Toxicity Characteristic Leaching Procedure (TCLP) using EPA Method 1311 for Resource Conservation and Recovery Act (RCRA) 8 metals (lead, cadmium, arsenic, barium, chromium, selenium, silver, and mercury) to evaluate the acceptability by the local landfill if offsite disposal is required (1 sample).

Data Quality Review

MNA conducted an analytical data quality review to determine the usability of the data generated by performing a data check for sample preservation methods, technical sample holding times, method blanks, laboratory control sample/laboratory control sample duplicate (LCS/LCSD), matrix spike/matrix spike duplicate (MS/MSD), and surrogate recoveries. Additionally, field performance was reviewed by comparing the analytical results of triplicates of the MIS. All sample holding times were met. Blank results reported no presence of analytes. The LCS/LCSD, MS/MSD and surrogate recoveries were within acceptable ranges. Field performance review reported low variance as percent relative standard deviation.

Summary of Findings

Arsenic was detected in all samples exceeding the Soil Screening Level (SSL) of 24 mg/kg. Based on the bioaccessibility test for the six samples, the arsenic bioaccessible fraction (BF) ranged from 1.8% to 5.7% of total arsenic concentrations with a mean of 3.4%. The range of the total arsenic and estimated bioaccessible arsenic levels in each specific decision unit and depth interval are shown in Table 2.

Table 2. 2014 Range of Total Arsenic and Bioaccessible Arsenic

Distance from Foundation (feet) / Depth (ft. bgs)	Analyte	0.0'-1.0' (mg/kg)	1.0'-5.0' (mg/kg)	5.0'-10.0' (mg/kg)
0.0'-0.5'	**Total Arsenic**	**330-490**	**150-520**	**170-260**
	Bioaccessible Arsenic	14.7-21.8	6.7-**23.2**	7.6-11.6
0.5'-1.0'	**Total Arsenic**	**480-650**	**180-790**	**180-480**
	Bioaccessible Arsenic	21.4-**28.9**	8.0-**35.2**	8.0-21.4
1.0'-1.5'	**Total Arsenic**	**400-1100**	**190-1100**	**120-430**
	Bioaccessible Arsenic	17.8-**49.0**	8.5-**44.5**	5.3-19.1

Bold: Results exceeding the HDOH Tier 1 soil environmental action level for Residential Land Use, above a drinking water resource and more than 150 meters from surface water.
Total Arsenic EAL = 24 mg/kg, Bioaccessible Arsenic EAL = 23 mg/kg
Acronyms and Abbreviations: ft. bgs.: feet below ground surface mg/kg: milligrams per kilogram

The soils within a 5 foot lateral extension from the building foundations were classified as Category C, moderately impacted soil. Remedial or removal action for Category C soils is warranted (Hawaii Department of Health, 2012).

Lead concentrations were reported above the EAL of 200 mg/kg in four samples. Analytical results from the 2014 Soil Baseline Survey are shown in Tables 3-5. Three of these samples were located within one foot of foundations. The other sample with lead concentration above the Tier I HDOH EAL was reported within 1-5 feet from the foundation at 1-1.5 feet of depth. Lead was reported above detection limits in samples over all depths, ranging from 120-250 mg/kg, 40-380 mg/kg, and 12-170 mg/kg within 0-1 feet from foundations, 1-5 feet from foundations, and 5-10 feet from foundations, respectively.

The termiticides heptachlor epoxide and chlordane were reported above EALs in several samples. Heptachlor epoxide was reported above the EAL of 0.053 mg/kg in five samples, all located within one foot of foundations. Technical chlordane was reported above EALs in two samples, both located within one foot of foundations.

Table 3. Summary of Analytical Results – Building 56

Sample Location	Sample Analytical Results (mg/kg)											EAL (mg/kg)
	DU-A (0-1 ft from the foundation)					DU-B (1-5 ft from the foundation)			DU-C (5-10 ft from the foundation)			
Sample Depth (ft bgs)	Surface (0.0-0.5)	Surface (0.0-0.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	
Sample ID / Analyte	B56-DU-A-SF-S (Prime)	B56-DU-A-SF-D (Duplicate)	B56-DU-A-SF-R (Triplicate)	B56-DU-A-NSF-S	B56-DU-A-SSF-S	B56-DU-B-SF-S	B56-DU-B-NSF-S	B56-DU-B-SSF-S	B56-DU-C-SF-S	B56-DU-C-NSF-S	B56-DU-C-SSF-S	
Arsenic	**400***	**310***	**280***	**480***	**400***	**150***	**180***	**190***	**170***	**180***	**120***	24
Estimated bioaccessible arsenic	17.8	13.8	12.5	21.4	17.8	6.7	8.0	10.3†	57.6	8.0	5.3	23
Lead	**230**	**200**	180	170	180	170	110	86	170	12	42	200
Heptachlor epoxide	ND (<0.0085)	ND (<0.0085)	ND (<0.0085)	ND (<0.034)	**0.091***	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	0.053
Chlordane (Technical)	0.18	ND (<0.15)	0.2	1.6	7.8	0.038	0.031	ND (<0.03)	0.044	ND (<0.03)	ND (<0.03)	16

EAL: HDOH Tier 1 soil environmental action level with unrestricted (residential) land use above a drinking water resource and more than 150 meters from surface water.
Shade: Field quality control samples (primary sample, field duplicate sample, and field triplicate sample)
Estimated bioaccessible arsenic
Bold: Results exceeding the HDOH Tier 1 soil environmental action level for Residential Land Use
*: Results exceeding both the Residential *and* Commercial/Industrial land use EAL
†: Sample was analyzed for bioaccessible arsenic. Other samples used mean bioaccessible arsenic value of 3.4%.

Acronyms and Abbreviations:
ft bgs: feet below ground surface
mg/kg: milligrams per kilogram
ND (00): Not Detected (Reporting Limit)

Table 4. Summary of 2014 Analytical Results – Building 58

Sample Location	Sample Analytical Results (mg/kg)											EAL (mg/kg)
	DU-A (0-1 ft from the foundation)			DU-B (1-5 ft from the foundation)					DU-C (5-10 ft from the foundation)			
Sample Depth (ft bgs)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Near-surface (0.5-1.0)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	
Sample ID / Analyte	B58-DU-A-SF-S	B58-DU-A-NSF-S	B58-DU-A-SSF-S	B58-DU-B-SF-S	B58-DU-B-NSF-S (Prime)	B58-DU-B-NSF-D (Duplicate)	B58-DU-B-NSF-R (Triplicate)	B58-DU-B-SSF-S	B58-DU-C-SF-S	B58-DU-C-NSF-S	B58-DU-C-SSF-S	
Arsenic	**490***	**580***	**880***	**520***	**710***	**750***	**760***	**540***	**260***	**480***	**430***	24
Estimated bioaccessible arsenic	21.8	**25.8**	**39.2**	**12.2†**	20.5†	**33.4**	**33.8**	**24.0**	11.6	21.4	13.3	23
Lead	**230**	120	130	110	51	40	53	62	47	26	22	200
Heptachlor epoxide	**0.23***	**0.11**	**0.4***	ND (<0.0017)	0.0037	ND (<0.0017)	0.0046	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	0.053
Chlordane (Technical)	8.6	4.9	**25**	0.047	0.2	0.044	0.16	ND (<0.03)	ND (<0.03)	ND (<0.03)	ND (<0.03)	16

Bold: Results exceeding the HDOH Tier 1 soil environmental action level
EAL: HDOH Tier 1 soil environmental action level with unrestricted (residential) land use above a drinking water resource and more than 150 meters from surface water.
Shade: Field quality control samples (primary sample, field duplicate sample, and field triplicate sample)
Estimated bioaccessible arsenic
Bold: Results exceeding the HDOH Tier 1 soil environmental action level for Residential Land Use
*: Results exceeding both the Residential *and* Commercial/Industrial land use EAL
*: Sample was analyzed for bioaccessible arsenic. Other samples used mean bioaccessible arsenic value of 3.4%.
Acronyms and Abbreviations:
ft bgs: feet below ground surface
mg/kg: milligrams per kilogram
ND (00): Not Detected (Reporting Limit)

Table 5. Summary of 2014 Analytical Results – Building 66

Sample Location	Sample Analytical Results (mg/kg)											EAL (mg/kg)
	DU-A (0-1 ft from the foundation)			DU-B (1-5 ft from the foundation)			DU-C (5-10 ft from the foundation)					
Sample Depth (ft bgs)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	Surface (0.0-0.5)	Surface (0.0-0.5)	Surface (0.0-0.5)	Near-surface (0.5-1.0)	Sub-surface (1.0-1.5)	
Sample ID / Analytes	B66-DU-A-SF-S	B66-DU-A-NSF-S	B66-DU-A-SSF-S	B66-DU-BSF-S	B66-DU-B-NSF-S	B66-DU-B-SSF-S	B66-DU-C-SF-S (Prime)	B66-DU-C-SF-D (Duplicate)	B66-DU-C-SF-R (Triplicate)	B66-DU-C-NSF-S	B66-DU-C-SSF-S	
Arsenic	**470***	**650***	**1,100***	**490***	**790***	**1,000***	**170***	**170***	**170***	**190***	**350***	24
Estimated bioaccessible arsenic	20.9	**28.9**	**49.0**	21.8	**35.2**	**73.6†**	7.6	7.6	7.6	8.5	19.6†	23
Lead	120	**250**	140	130	120	**380**	52	48	63	48	35	200
Heptachlor epoxide	**0.18**	ND (<0.034)	**0.36***	ND (<0.034)	ND (<0.0084)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	ND (<0.0017)	0.053
Chlordane (Technical)	6.9	1.6	**31***	1.4	0.18	0.12	ND (<0.03)	ND (<0.03)	ND (<0.03)	ND (<0.03)	ND (<0.03)	16

EAL: HDOH Tier 1 soil environmental action level with unrestricted (residential) land use above a drinking water resource and more than 150 meters from surface water.
Shade: Field quality control samples (primary sample, field duplicate sample, and field triplicate sample)
Estimated bioaccessible arsenic
Bold: Results exceeding the HDOH Tier 1 soil environmental action level for Residential Land Use
*: Results exceeding both the Residential *and* Commercial/Industrial land use EAL
†: Sample was analyzed for bioaccessible arsenic. Other samples used mean bioaccessible arsenic value of 3.4%.
Acronyms and Abbreviations:
ft bgs: feet below ground surface
mg/kg: milligrams per kilogram
ND (00): Not Detected (Reporting Limit)

2.3.3 Soil Baseline Survey TCLP Testing

Any contaminated soil from the site that is disposed of at an approved sanitary landfill must undergo hazardous waste characterization. For waste characterization one soil sample (B56-DU-A-SF-S) was further tested using EPA Method 1311, TCLP. The extract was analyzed using Method 6010B/7471A for RCRA 8 Metals. The TCLP results for metals were compared to the Regulatory Limits for Toxicity Characteristics regulated by 40 Code of Federal Regulations (CFR) 261.24 to evaluate the acceptability by the local municipal landfill if offsite disposal is required. All results were below the TCLP regulatory limits (Table 6) and therefore it is acceptable for the soil to be disposed of as non-hazardous waste with respect to the COPCs arsenic and lead.

Table 6. TCLP Analytical Results for COPCs

Contaminants	Analytical Results (mg/L)	40 CFR 261.24 Regulatory Limit (mg/L)
Arsenic	ND (<0.05)	5.0
Lead	ND (<0.05)	5.0

Note: All other RCRA 8 metals were not detected above reporting limits.
CFR: Code of Federal Regulations mg/L: milligrams per liter
ND: Not Detected TCLP: Toxicity Characteristic Leaching Procedure

2.3.4 2015 Supplemental Soil Survey

This section describes the 2015 supplemental soil survey performed for the purpose of further characterizing the arsenic, lead, and pesticide distributions in soil of the Lanakila HPHA Phase IIIb site. This work was guided by the Phase IIIb Supplemental Soil Sampling and Analysis Plan/Quality Assurance Project Plan (Myounghee Noh & Associates LLC, 2015).

Fieldwork

Representative soil MIS were collected from five DUs and three vertical sections. The five DUs are presented in Figure 2 and are as follows:

Lateral Distinction

- DUA-01: Proposed parking lot area, excluding areas within two feet of former Buildings 57 and 65.
- DUA-02: Proposed turf pedestrian areas on southern portion of site, excluding areas previously sampled in and around former Buildings 56 and 66, and within two feet of former Building 67.
- DUA-03: Proposed turf pedestrian areas near the northern portion of Phase IIIb, excepting areas previously sampled in and around former Building 58 and within two feet of Building 64.
- DUA-04: Areas under the two proposed building footprints on the southern side of the Phase IIIb site.
- DUA-05: Areas under the two proposed building footprints on the northern side of the Phase IIIb site.

Vertical Distinction

At each lateral DU, surface, near-surface, and subsurface soils were assessed in the following vertical sections:

- Surface, DUA-0*-D1: Soil at 0.0-0.5 ft bgs

- Near-surface, DUA-0*-D2: Soil at 0.5-1.0 ft bgs
- Sub-surface, DUA-0*-D3: Soil at 1.0-2.0 ft bgs

Table 7 summarizes the boundaries of these decision units and the analyses performed.

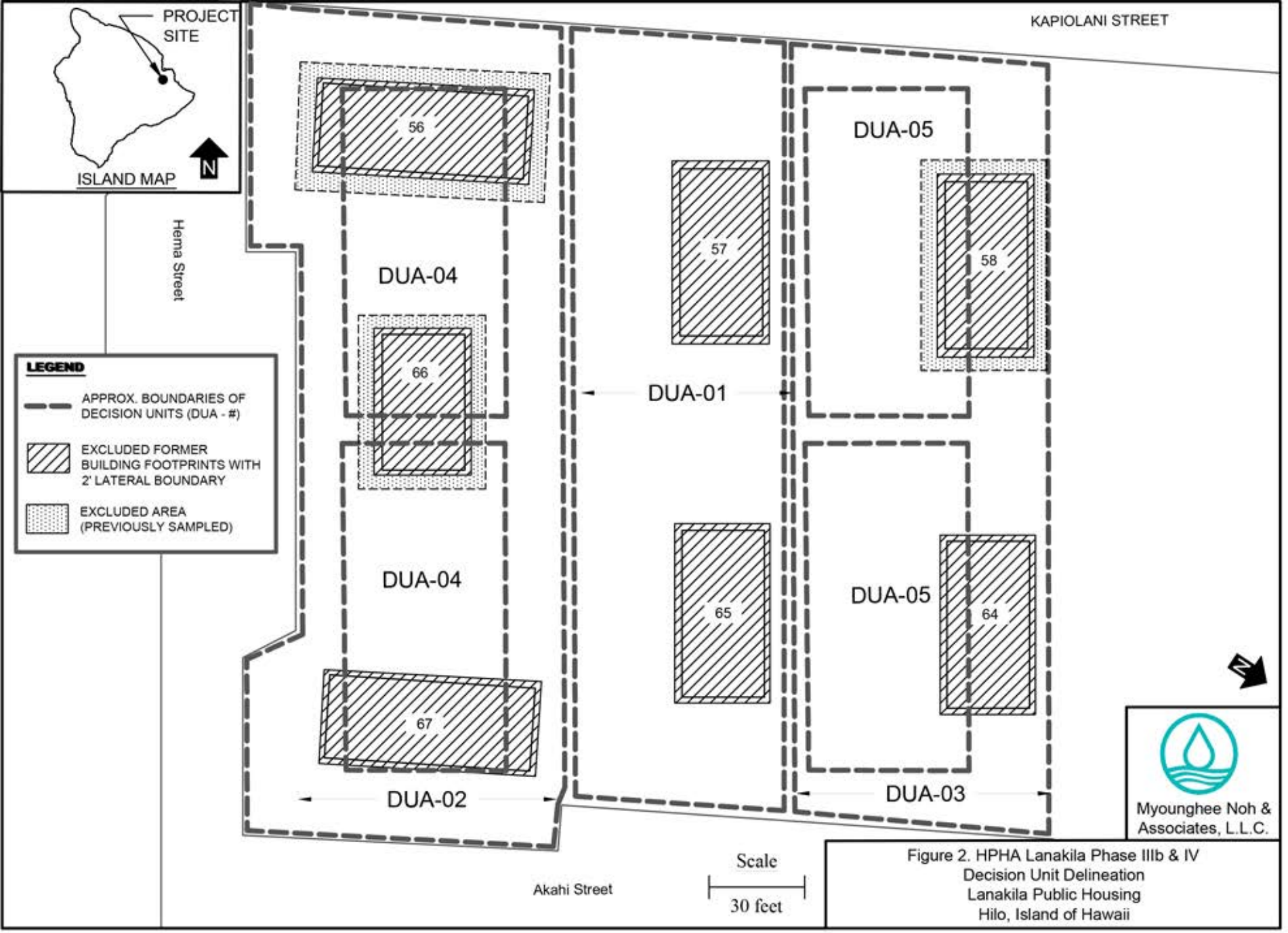


Figure 2. HPHA Lanakila Phase IIIb & IV
Decision Unit Delineation
Lanakila Public Housing
Hilo, Island of Hawaii

To identify sampling precision and potential field sampling errors, triplicate samples (primary, duplicate, and triplicate) were collected from one DU. These sample results were evaluated to verify that the incremental sample data accurately represents the DU. Although the size of the DU did not allow 90 separate trenches to be dug, sample of the prime, duplicate, and triplicate samples were collected as far apart from each other within each trench as possible. As each trench had approximate dimensions of 1.5' x 4' by 2' deep (minimum) the duplicate and triplicate samples were separated by about 4 feet. These sample results were evaluated to verify that the incremental sample data accurately represents the DU.

A total of 17 samples, including triplicate samples, were collected. The samples were analyzed as follows:

- Arsenic and lead using EPA Method 6020 (17 samples)
- Organochlorine pesticides including technical chlordane using EPA Method 8081 (3 samples)

Table 7. Summary of Soil Sampling and Analysis

Sample Identification (ID)	Sampling Location	Depth (feet below ground surface)	Analytical Group	
			Lead, & arsenic	Technical Chlordane/ Organochlorine Pesticides
DUA-01-D1	Proposed parking lot	0.0-0.5	X	
DUA-01-D2	Proposed parking lot	0.5-1.0	X	
DUA-01-D3	Proposed parking lot	1.0-2.0	X	
DUA-02-D1	Pedestrian/turf areas, S side of site	0.0-0.5	X	X
DUA-02-D2	Pedestrian/turf areas, S side of site	0.5-1.0	X	X
DUA-02-D3	Pedestrian/turf areas, S side of site	1.0-2.0	X	X
DUA-03-D1-1 (Prime)	Pedestrian/turf areas, N side of site	0.0-0.5	X	
DUA-03-D1-2 (Duplicate)	Pedestrian/turf areas, N side of site	0.0-0.5	X	
DUA-03-D1-3 (Triplicate)	Pedestrian/turf areas, N side of site	0.0-0.5	X	
DUA-03-D2	Pedestrian/turf areas, N side of site	0.5-1.0	X	
DUA-03-D3	Pedestrian/turf areas, N side of site	1.0-2.0	X	
DUA-04-D1	S two proposed bldg. footprints	0.0-0.5	X	
DUA-04-D2	S two proposed bldg. footprints	0.5-1.0	X	
DUA-04-D3	S two proposed bldg. footprints	1.0-2.0	X	
DUA-05-D1	N two proposed bldg. footprints	0.0-0.5	X	
DUA-05-D2	N two proposed bldg. footprints	0.5-1.0	X	
DUA-05-D3	N two proposed bldg. footprints	1.0-2.0	X	

Date of sampling: 10-16 November 2015

Data Quality Review

MNA conducted the analytical data quality review to determine the usability of the data generated by performing a data check for sample preservation methods, technical sample holding times, method blanks, LCS/LCSD, MS/MSD, and surrogate recoveries. The analytical laboratory noted that the samples were received in good condition with properly completed Chain-of-Custody forms. Technical holding times for metal and pesticide analyses were met. None of the pesticides or metals was found in the laboratory blank sample, which indicated that the analytical processes were free of contaminants.

The LCS/LCSD, MS/MSD, and surrogate recoveries were within the acceptable ranges with two exceptions. The serial dilution matrix spikes for arsenic and lead had high percent differences, 16% and 26%, respectively, in the serial dilution of sample DUA-03-D1-1, greater than the quality limits of 10%, indicating that analytical results of this sample may have suffered from matrix effects. These effects only appeared after serial dilutions. Based on a discussion with the laboratory analyst, a likely cause is due to viscosity of the sample extract, which reduces transport of the analytes. Upon dilution, the viscosity of the sample is reduced, enhancing mobility of the analytes; thus there may be a slight low bias for undiluted samples. MNA concluded that the analytical results are considered valid and useable.

MNA collected a set of triplicate surface soil samples from DUA-03 [pedestrian/turf areas, north side of site (Sample IDs: DUA-03-D1-1, DUA-03-D1-2, and DUA-03-D1-3)]. Field performance was reviewed by comparing the results of primary, duplicate, and triplicate samples. Standard deviation, average, and the percent relative standard deviation (RSD) between triplicates was evaluated (Table 8).

Arsenic was detected in the range of 69 mg/kg to 86 mg/kg with an average of 79 mg/kg. The RSD was 11.3%. Lead was detected in the range of 22 mg/kg to 30 mg/kg with an average of 26 mg/kg. The RSD for lead was 15.3%. The 11.3% RSD of arsenic and 15.3% RSD of lead were used to calculate the upper and lower range of analytes. These field performance review data are presented in Table 8.

Table 8. 2015 Field Performance Review Data

Analytes	Tier 1 EAL (mg/kg) Unrestricted (Residential)	Sample Results (mg/kg)			Field Performance Data		
		DUA-03-D1-1 (Primary)	DUA-03-D1-2 (Duplicate)	DUA-03-D1-3 (Triplicate)	Average (mg/kg)	Standard Deviation	Relative Standard Deviation (%)
Arsenic	24	**69**	**86**	**82**	**79**	8.9	11.3
Lead	200	27	22	30	26	4.0	15.3

Analytical Results

Arsenic, Lead, and Technical Chlordane

The summary of soil analytical results for arsenic and lead are presented in Table 9. Arsenic was detected in the range of 48 mg/kg to 160 mg/kg exceeding the Tier 1 EAL, 24 mg/kg. By using

the 11.3% RSD for arsenic, the upper and lower range values at one standard deviation were calculated as presented in Table 9.

Lead was detected in the range of 7.3 mg/kg to 89 mg/kg; the results were below the Tier 1 EAL, 200 mg/kg. By using the 15.3% RSD, the upper and lower range values at one standard deviation for lead were calculated. None of upper range results were found exceeding the Tier 1 EAL.

Technical chlordane was analyzed for the samples collected from DUA-02 but was not detected. No other organochlorine pesticides were detected above reporting limits.

Table 9. 2015 Summary of Soil Sampling and Analysis

Sample ID	Sample Depth (ft bgs)	Arsenic (mg/kg) [EAL unrestricted: 24] (RSD: 11.3)			Lead (mg/kg) [EAL unrestricted: 200] (RSD: 15.3)			Technical Chlordane (mg/kg) [EAL unrestricted: 16]
		Sample Result	Upper Range	Lower Range	Sample Result	Upper Range	Lower Range	Sample Result
DUA-01-D1	0.0-0.5	**51**	**57**	**45**	16	18	14	Not Analyzed
DUA-01-D2	0.5-1.0	**48**	**53**	**43**	10	12	8	Not Analyzed
DUA-01-D3	1.0-2.0	**160**	**178**	**142**	7.3	8	6	Not Analyzed
DUA-02-D1	0.0-0.5	**55**	**61**	**49**	17	20	14	ND (0.030)
DUA-02-D2	0.5-1.0	**150**	**167**	**133**	16	18	14	ND (0.059)
DUA-02-D3	1.0-2.0	**100**	**111**	**89**	8.2	9	7	ND (0.030)
DUA-03-D1*	0.0-0.5	**79**	**70**	**89**	26	22	31	Not Analyzed
DUA-03-D2	0.5-1.0	**85**	**95**	**75**	29	33	25	Not Analyzed
DUA-03-D3	1.0-2.0	**110**	**122**	**98**	8.7	10	7	Not Analyzed
DUA-04-D1	0.0-0.5	**81**	**90**	**72**	31	36	26	Not Analyzed
DUA-04-D2	0.5-1.0	**110**	**122**	**98**	16	18	14	Not Analyzed
DUA-04-D3	1.0-2.0	**130**	**145**	**115**	18	21	15	Not Analyzed
DUA-05-D1	0.0-0.5	**75**	**83**	**67**	39	45	33	Not Analyzed
DUA-05-D2	0.5-1.0	**95**	**106**	**84**	25	29	21	Not Analyzed
DUA-05-D3	1.0-2.0	**130**	**145**	**115**	89	103	75	Not Analyzed

Criteria: HDOH, Tier 1 Soil EAL with residential/unrestricted land use above a non-drinking water resource and more than 150 meters from surface water.
BOLD: The result exceeded the EAL.
Acronyms and Abbreviations:
ft bgs: feet below ground surface
ND (00): Not Detected (Reporting Limit)
*:result is average of prime, duplicate, and triplicate sample results
mg/kg: milligrams per kilogram
RSD: (percent) relative standard deviation

Bioaccessible Arsenic

To estimate the bioaccessible arsenic concentrations of the MIS samples, MNA utilized the bioaccessible fractions (BF) determined in the 2014 Soil Baseline Survey (Section 2.3.2) which ranged from 1.8% to 5.7%. MNA used the mean BF of 3.4% to calculate bioaccessible arsenic. The bioaccessible arsenic values estimated using this site specific BF are presented in Table 10.

Table 10. 2015 Estimated Bioaccessible Arsenic Concentrations

Decision Unit	Sample ID	Sample Depth (ft below ground surface)	Total Arsenic Sample Results (mg/kg)	Total Arsenic, Enrichment Factor Applied (mg/kg)	Assumed BF of Arsenic (%)	Estimated Bioaccessible Arsenic (mg/kg)	Exceed SSL of Bioaccessible Arsenic (>23 mg/kg)
DUA-01	DUA-01-D1	0.0-0.5	**51**	66	3.4%	2.3	No
	DUA-01-D2	0.5-1.0	**48**	62	3.4%	2.1	No
	DUA-01-D3	1.0-2.0	**160**	208	3.4%	7.1	No
DUA-02	DUA-02-D1	0.0-0.5	**55**	72	3.4%	2.4	No
	DUA-02-D2	0.5-1.0	**150**	195	3.4%	6.7	No
	DUA-02-D3	1.0-2.0	**100**	130	3.4%	4.5	No
DUA-03	DUA-03-D1*	0.0-0.5	**79**	103	3.4%	2.7	No
	DUA-03-D2	0.5-1.0	**85**	111	3.4%	3.8	No
	DUA-03-D3	1.0-2.0	**110**	143	3.4%	4.9	No
DUA-04	DUA-04-D1	0.0-0.5	**81**	105	3.4%	3.6	No
	DUA-04-D2	0.5-1.0	**110**	143	3.4%	4.9	No
	DUA-04-D3	1.0-2.0	**130**	169	3.4%	5.8	No
DUA-05	DUA-05-D1	0.0-0.5	**75**	98	3.4%	3.3	No
	DUA-05-D2	0.5-1.0	**95**	124	3.4%	4.2	No
	DUA-05-D3	1.0-2.0	**130**	169	3.4%	5.8	No

Notes: Total arsenic results analyzed by C&T Lab. Uses an average enrichment factor of 1.30
A site-specific 3.4% BF is applied to total arsenic values, as determined from the 2014 Soil Baseline Survey Data
Estimated Bioaccessible Arsenic = Total Arsenic x enrichment factor x BF
*:result is average of prime, duplicate, and triplicate sample results
Acronyms and Abbreviations:
BF: bioaccessible fraction mg/kg: milligrams per kilogram SSL: Soil Screening Level

Summary of 2015 Supplemental Soil Survey Findings

Arsenic: Arsenic was detected from all samples collected in the range of 48 mg/kg to 160 mg/kg exceeding the Tier 1 EAL, 24 mg/kg. To estimate the bioaccessible arsenic, MNA utilized the BF of 3.4% determined in the 2014 Soil Baseline Survey. The total arsenic values are reported for the fraction of samples that pass a 2mm sieve, but bioaccessible arsenic is reported for the fraction of samples that pass a 0.25mm sieve. As arsenic tends to adhere to smaller particles more, the total arsenic reported for the samples that were analyzed for bioaccessible arsenic by ALS Labs were higher than the values reported by C&T Lab by an average factor of 1.3. This factor is termed the "enrichment factor" and is then applied to the total arsenic values from C&T Lab before applying the BF in order to calculate the estimated bioaccessible arsenic shown in Table 10.

The estimated bioaccessible arsenic concentrations were in the range of 2.4 mg/kg to 8.0 mg/kg; the results were below the SSL for bioaccessible arsenic of 23 mg/kg. This places all decision units in the 2015 soil study within soil Category B (minimally impacted), "indicating probable anthropogenic impacts but at levels within acceptable health risks for long-term exposure,

Unrestricted Land Use ” (Hawaii Department of Health, 2012). Had the highest BF of 5.7% been used to calculate bioaccessible arsenic, the highest bioacacessible arsenic levels calculated would have been far short of the EAL. Soils within 5 feet of building pads fall under the arsenic criteria of Category C soils, requiring soil management to prevent exposure.

Lead: Lead was not reported in any samples at or above the screening level, 200 mg/kg. The highest reported concentration was 89 mg/kg in sample DUA-05-D3. The concentrations of lead reported in the remaining samples ranged from 7.3 – 39 mg/kg. As sampling did not take place within two feet of building foundations or within previously sampled areas these results suggest that building materials are the likely source of lead contamination.. All total lead levels exceeding HDOH EALs are limited to within 5 feet of the former building foundations.

Technical Chlordane: Technical chlordane was analyzed for in the three samples from DUA-02. This DU was selected to determine if technical chlordane reported over EALs within the periphery of two building foundations was also present away from the building foundations. Technical Chlordane was not reported above reporting limits of 0.030 to 0.059 mg/kg in DU-02. These values were well below the SSL of 16 mg/kg.

Pesticides: The 2014 Soil Baseline survey concluded that pesticide-impacted soils are present within 1 ft of the building foundations. The results herein appear to confirm that pesticide contamination is limited to the periphery of the building foundations and the possibility that pesticide treatment was also applied under the former building foundations remains.

Conclusions

This work, taken together with previous soil investigations, supports the picture that for the purposes of soil management the Phase IIIb site is seen as two distinct areas: areas within 5 feet of former buildings, and areas greater than 5 feet from the former buildings. Soil within 5 feet of former building foundations and down to an estimated 2 feet bgs will require management to minimize potential exposure to future residents on-site. Soil under slabs will be treated as per the results of characterization during demolition work.

3.0 ENVIRONMENTAL HAZARD EVALUATION

An Environmental Hazard Evaluation (EHE) is an evaluation of potential environmental concerns. This EHE evaluates potential environmental hazards for future site construction and site use conditions due to presence of arsenic-, lead-, and pesticide-impacted soil. In this section, MNA considers the manner in which the characteristics specific to each COPC may constitute hazards to human health. Based on the site investigations, arsenic, lead, heptachlor epoxide, and technical chlordane were identified as COPCs.

3.1 APPLICABLE ENVIRONMENTAL ACTION LEVELS

Land use at the site has been, and is expected to be, residential. The HDOH Tier 1 EAL for unrestricted (residential) land use above a drinking water resource and more than 150 meters from surface water was used to evaluate environmental hazards (Hawaii Department of Health, Fall 2011; revised Jan. 2012). Although distance is greater than 150 m to surface water features, the EALs for the COPCs are the same for both greater and less than 150 m from the nearest surface water feature. The Tier 1 EALs are conservative values considered adequate for

ensuring prevention of chemical hazards for residential housing, schools, medical facilities, day care centers, parks, and other sensitive uses. Applicable EALs for the COPCs are presented in Table 11.

Table 11. Applicable EALs for COPCs and Highest Concentrations Observed

Category	Chemical	Tier 1 Soil EAL (mg/kg) for Residential Use	Tier 1 Soil EAL (mg/kg) for Commercial/ Industrial Use	Highest Concentration from 2014 Soil Baseline Survey (mg/kg) (within 5 feet of building foundations)
Heavy metals	Arsenic	23	95	1,100
	Bioaccessible arsenic	24	(use bioaccessible arsenic)	66
	Lead	200	800	380
Pesticides	Heptachlor epoxide	0.053	0.19	0.40
	Chlordane (Technical)	16	29	31

mg/kg: milligrams per kilogram (parts per million)

3.2 CONCEPTUAL SITE MODEL

The conceptual site model considers the possible exposure pathways to human and ecological receptors. Routes to human or ecological exposure depend critically on the unique chemical characteristics of a particular compound. The potential hazards for the COPC were evaluated using the HDOH EAL "Surfer" tool (Hawaii Department of Health, Fall 2011 rev. Jan 2012). HDOH guidance recommends evaluating soil environmental hazards to include direct human contact (ingestion, dermal absorption, and inhalation), vapor emissions to indoor air, terrestrial ecotoxicity, gross contamination, and leaching (potential impact to ground water). Figures 3 through 6 provide the results of the EHE for the COPCs by showing the HEER "Surfer" tool output, which includes all potential hazard routes, with those specific to the compound in question marked with an "x". A conceptual site-specific conceptual site model is shown in Figure 7.

For the evaluation, MNA used the highest concentrations detected from the 2013, 2014, and 2015 soil studies. The summary of "Surfer" evaluations is provided in Table 12. The selected site scenario is as follows:

- Land use: Unrestricted
- Groundwater utility: Drinking water resource
- Distance to surface water: more than 150 meters.

Figure 3. Tier 1 EAL Surfer Evaluation - Arsenic

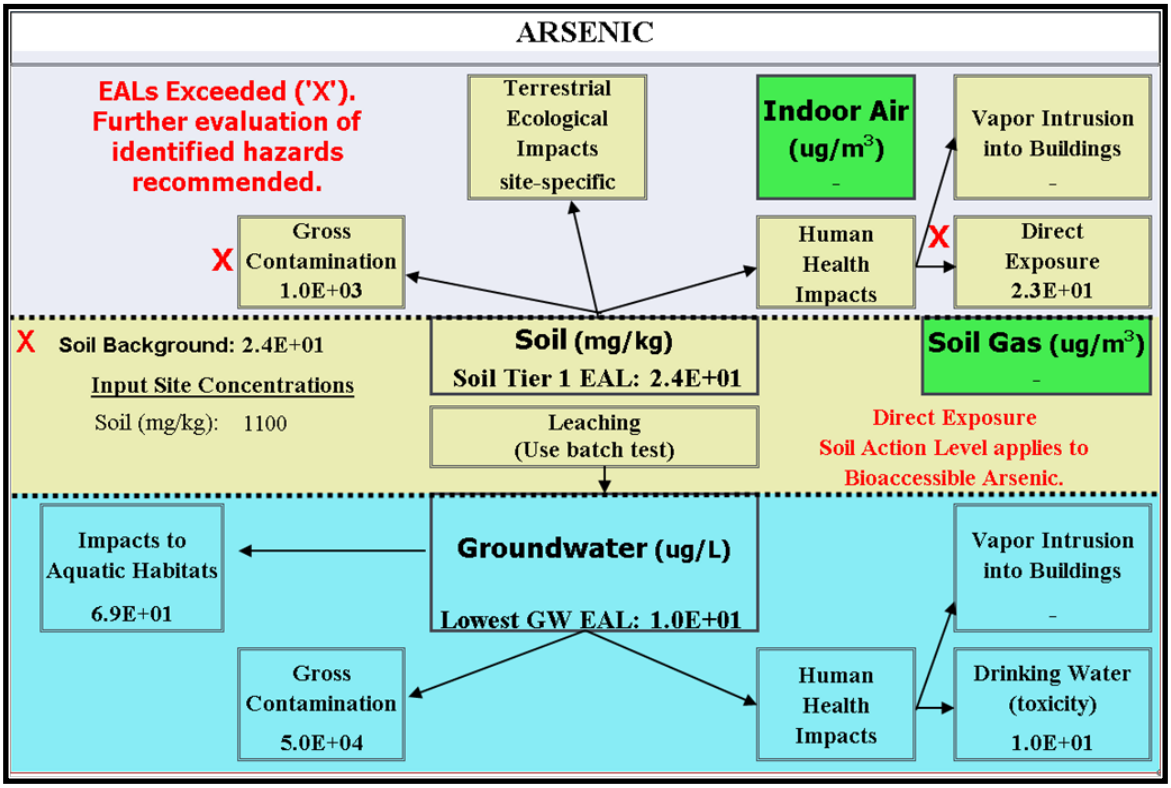


Figure 4. Tier 1 EAL Surfer Evaluation - Lead

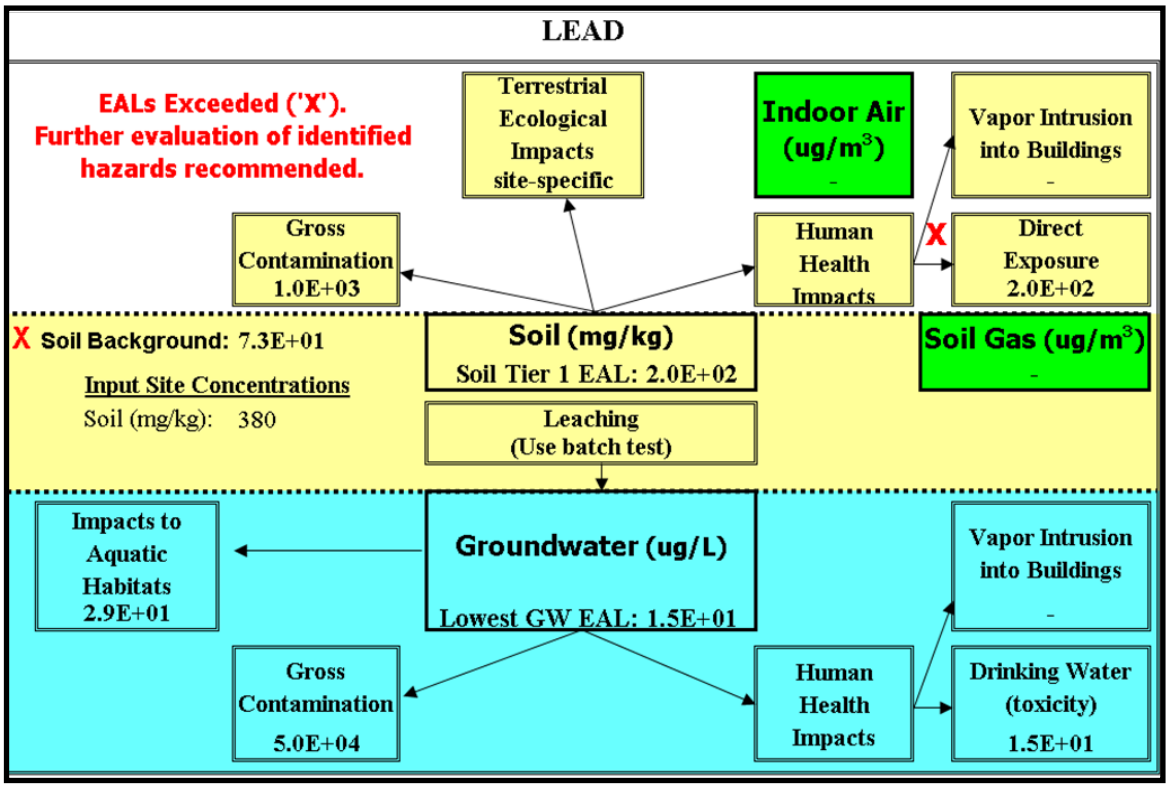


Figure 5. Tier 1 EAL Surfer Evaluation – Chlordane

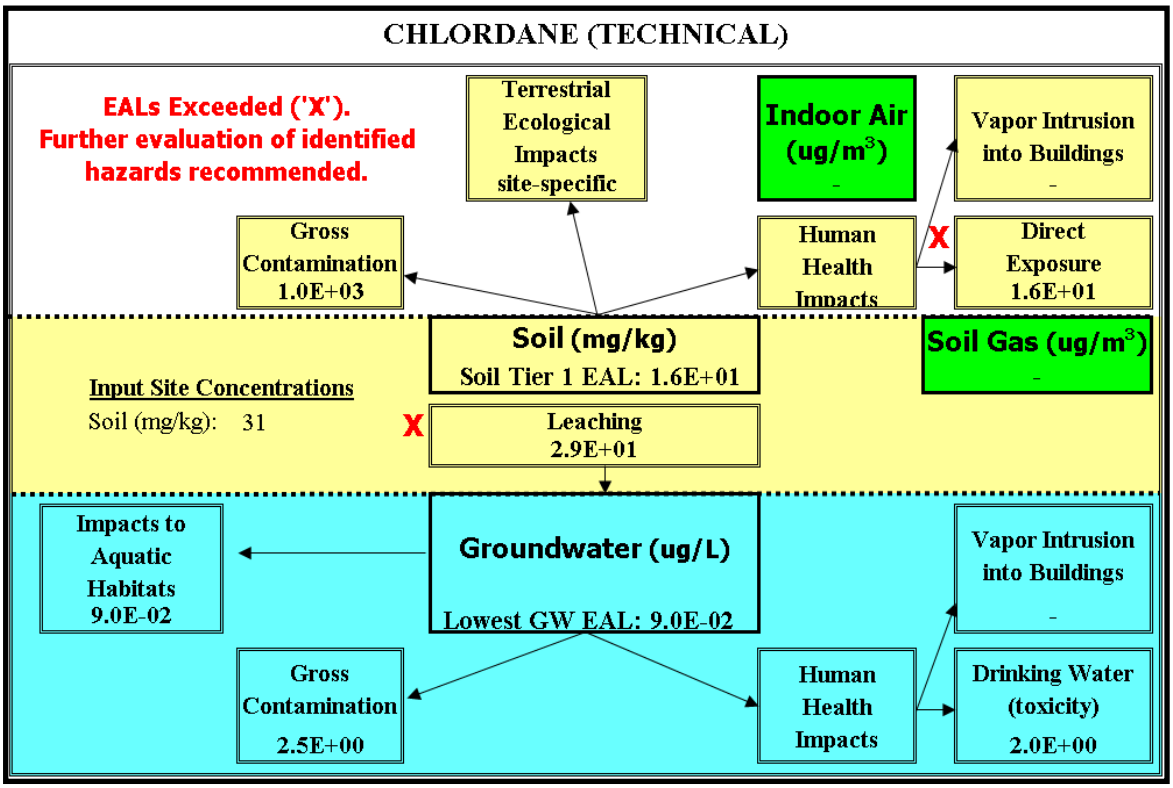
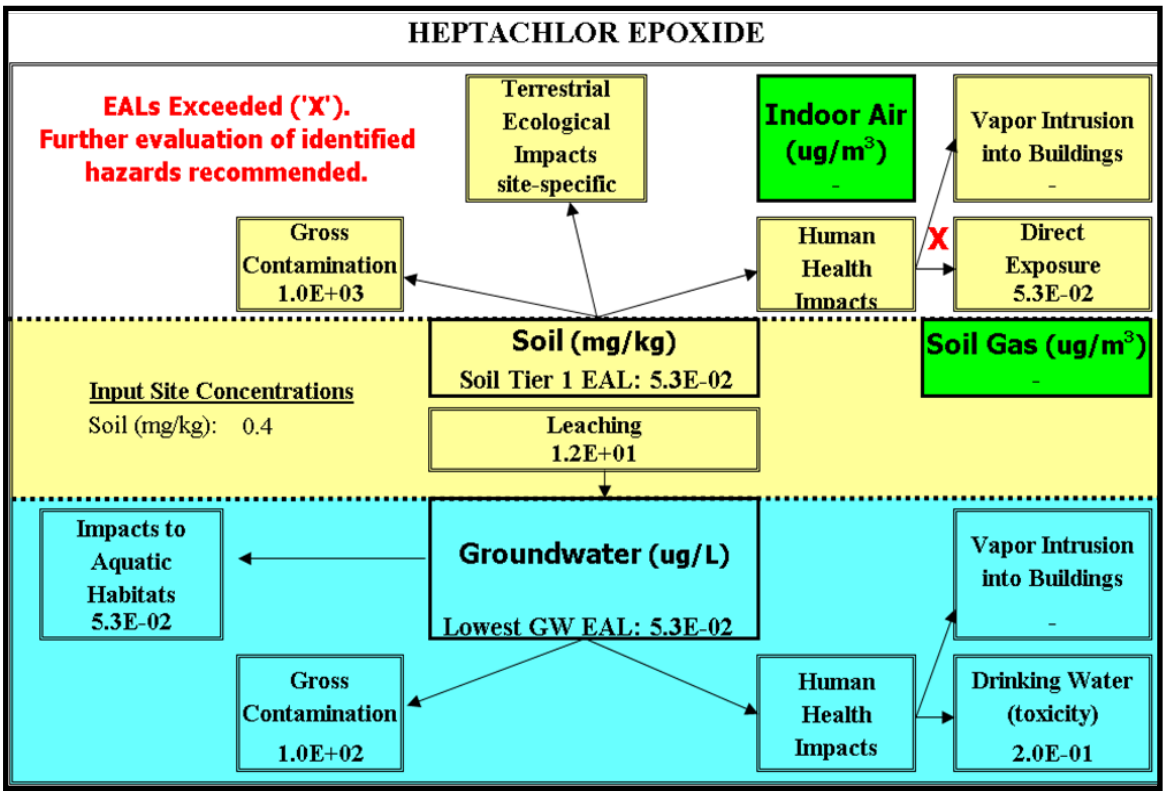
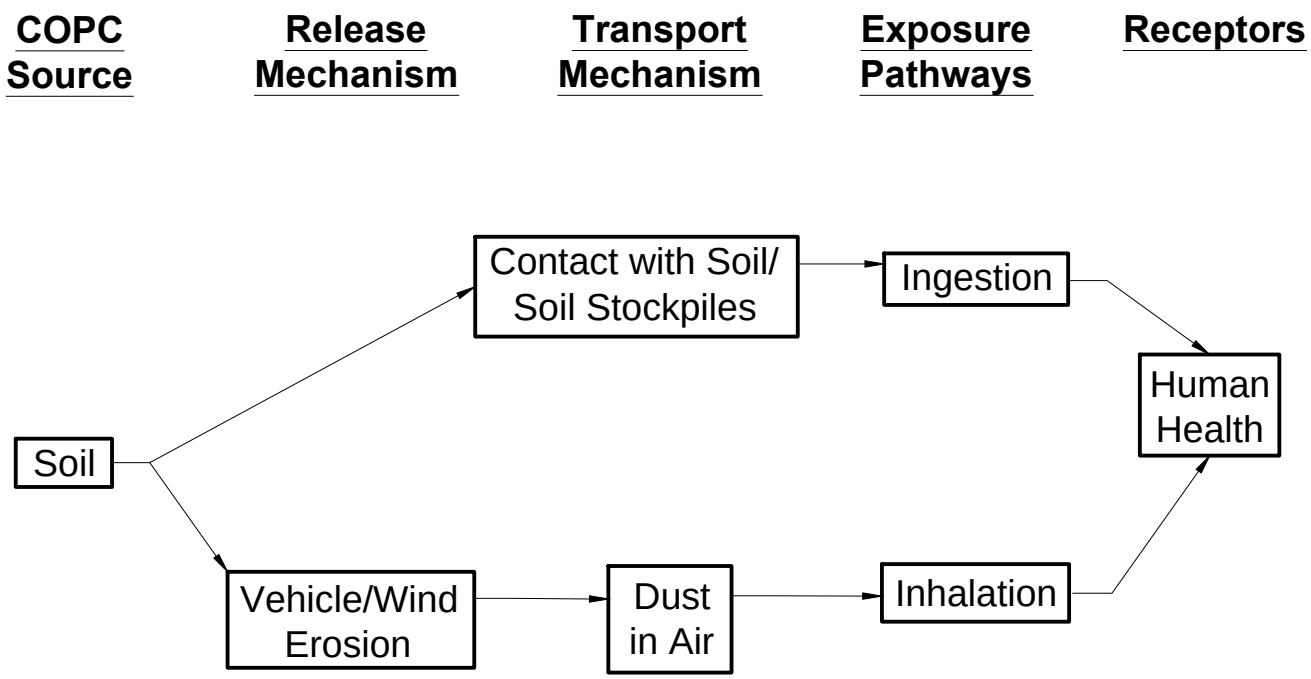


Figure 6. Tier 1 EAL Surfer Evaluation - Heptachlor Epoxide



Conceptual Site Model
COPC: Arsenic, Lead, and Termiticides in Soil



Legend and Notes:

COPC - Chemicals of Potential Concern

Figure 7. Conceptual Site Model
HPHA Lanakila Housing Phase IIIb EHE/RAR
Hilo, Island of Hawaii

March 2016

Table 12. Summary of Tier 1 EAL "Surfer" Preliminary Evaluation

Potential Hazard / COPC	Soil Environmental Hazards				
	Direct Exposure	**Vapor Emission to Indoor Air**	**Terrestrial Ecotoxicity**	**Gross Contamination**	**Leaching (threat to groundwater)**
Total Arsenic	**Yes**	No (non-volatile)	Site-specific	No	Use batch test*
Lead	**Yes**	No (non-volatile)	Site-specific	No	Use batch test*
Heptachlor Epoxide	**Yes**	No (non-volatile)	Site-specific	No	No
Total Chlordane	**Yes**	No (non-volatile)	Site-specific	No	**Yes**

Bold values indicated suspected hazards based on assumptions.
* - Use Synthetic Precipitation Leaching Procedure (SPLP) to assess leaching potential.

Based on the hazard evaluation, the potential hazards for COPC in soil at the subject site are direct exposure for all four contaminants. Total chlordane is marginally a leaching hazard while arsenic and lead are not mobile in soils and do not present leaching hazards. Due to the distance to groundwater of approximately 80-90 feet bgs, leaching potential is not expected to be significant; however, the leaching potential of chlordane will be further assessed during the demolitions/construction phase.

Impacts to terrestrial ecotoxicity are site-specific. Terrestrial ecotoxicity refers to the capability of a contaminant to damage an ecological population, ecological community, or ecosystem. Because of the nature of the site, habitat to support feeding and nesting of terrestrial ecological receptors is limited. In the future, once the site is redeveloped, areas of mowed turf grasses and landscape will provide the only terrestrial habitat. No endangered species or sensitive habitats are expected to be at or near the project area as it is located in an urban area. Consequently ecotoxicity hazards are not a significant concern for this site.

The potential for COPC-contaminated soil to be eroded or discharged to nearby surface water features could exist during the construction phase; however, erosion control measures will be implemented to eliminate this potential hazard. Construction will require implementation of National Pollution Discharge Elimination System (NPDES) General Permit requirements, which will require operational and engineering practices to minimize the potential for the release of soil from the site as dust or polluted stormwater runoff.

3.2.1 Environmental Hazard Evaluation - Arsenic

The source of arsenic in the site's soil is not specifically known, although arsenic was commonly used as an herbicide during sugar cane cultivation. The distribution of arsenic in soil on the site suggests an association with the buildings, and it may have been present in herbicide used on the periphery of buildings, was present in the structural fill used under the foundations, or originates from "canec" building materials. Arsenic also was used for rat control.

Arsenic is a potential hazard to human health through ingestion and/or inhalation of dust for construction workers, the public, and long-term residents. Arsenic in soil can also present a hazard to children who may be exposed by exhibiting so-called "pica" behavior or via out of doors play (Centers for Disease Control, 2011). Arsenic exposure could potentially happen through poor hygienic practices, such as eating with unwashed, soil-contaminated hands, or by having soil-contaminated clothing taken home, where it may contaminate household members. Arsenic is not a vapor inhalation hazard as it does not volatilize, nor is it a contact hazard as it is not absorbed significantly through skin. Exposure to arsenic by inhaling contaminated dust can occur by workers inadvertently breathing dust from weed-cutting activities during landscape maintenance. Dust exposure during planned construction activities can be minimized through the use of best practices designed to suppress dust where generated.

Assuming the highest arsenic concentration measured of 1,100 mg/kg, MNA used the HDOH EAL Surfer tool to assess hazards associated with arsenic. The HDOH EAL Surfer for total arsenic documents that there are potential arsenic hazards via direct exposure at this site. The graphical output of the HDOH HEER Office EAL Surfer tool for arsenic is shown in Figure 3.

Direct Exposure

Direct exposure hazards to human health and the environment involve direct contact with contaminated soil. Direct contact can be made via incidental ingestion of soil and inhalation of soil particulates by human receptors.

Leaching

Leaching refers to the movement of contaminants by dissolution in water and percolation through soil in the vadose zone and potentially into underlying groundwater. Leaching potential is governed by chemical-specific properties and site-specific soil characteristics. Chemicals that are highly soluble in water and do not sorb tightly to soils have the highest leaching potential (i.e. are considered "mobile") and chemicals with low water solubilities that bind tightly to soils have low leaching potential. The potential for arsenic to leach will be tested by the Synthetic Precipitation Leaching Procedure (SPLP) during RAR implementation (refer to Section 5.0). However, previous TCLP testing suggests that the potential for arsenic to leach on the site is negligible.

3.2.2 Environmental Hazard Evaluation - Lead

Lead was detected in relatively high levels near roof downspouts and drip lines, and hence may have leached from roofing materials and lead-based paint. Exposure to lead in soil is likely to be via direct exposure including ingestion and inhalation of dust. Lead is not volatile under normal conditions, and does not therefore present a vapor inhalation hazard. Nor is it absorbed through skin. MNA applied the HDOH EAL Surfer tool to assess hazard concentrations associated with this COPC assuming the highest lead concentration measured in the 2014 Soil Baseline Survey of 380 mg/kg. The graphical output of the HDOH HEER Office EAL Surfer tool is shown in Figure 4.

The result shows that there is potential hazard via direct exposure and further evaluation of the leaching hazard is recommended. Removal action would minimize the potential the hazards from lead to the future residents of this redevelopment.

Direct Exposure

Direct exposure hazards to human health and the environment involve direct contact with contaminated soil. Direct contact can be made via incidental ingestion of soil, dermal contact with soil, or inhalation of soil particulates in dust or polluted stormwater runoff by human and ecological receptors.

Leaching

Leaching potential is site-specific and therefore will be assessed using the Synthetic Potential Leaching Procedure (SPLP) test, as recommended by the EAL Surfer (Figure 3). This will be performed during the demolition/construction phase of the project prior to placement of contaminated soil in the Soil Management Unit (SMU). However, previous TCLP testing suggests that the potential for arsenic to leach on the site is negligible.

3.2.3 Environmental Hazard Evaluation - Heptachlor Epoxide and Chlordane

Heptachlor epoxide and chlordane were widely used as termiticides from 1948 to 1988, and their commercial products of each chemical contain 10%-20% of the other chemical (Centers for Disease Control and Prevention, 2013). Exposure to chlordane and related compounds (e.g., heptachlor epoxide) in soil is likely to be via direct exposure including ingestion and inhalation of dust. Heptachlor epoxide and chlordane have low vapor pressures (i.e. approximately 10^{-5} mm Hg); therefore, there is low potential of inhalation hazard of vapors or of skin absorption.

Assuming the highest heptachlor expoxide and chlordane concentrations measured in the 2014 Soil Baseline Survey of 0.4 mg/kg and 31 mg/kg, respectively, MNA used the HDOH EAL Surfer tool to assess hazard concentrations associated with these COPC. The result shows that there is potential hazard via direct exposure and leaching. The graphical output of the HDOH HEER EAL Surfer tool for heptachlor epoxide and chlordane are shown in Figures 5 and 6, respectively.

Direct Exposures

Direct exposure hazards to human health and the environment involve direct contact with contaminated soil. Direct contact can be made via incidental ingestion of soil, dermal contact with soil, and inhalation of soil particulates in dust.

Leaching

Leaching potential is site-specific and therefore will be assessed using the SPLP test during the demolition/construction phase and prior to placement of contaminated soil in the soil management unit.

3.3 SUMMARY OF ENVIRONMENTAL HAZARDS

Potential human health hazards exist at sites with arsenic-, lead-, and pesticide-impacted soil during demolition and construction phases and future site use.

Direct exposure is the most detrimental potential environmental hazard to human health for this project because the activities involve excavating impacted soil may disturb COPC present in soil

at the site. In the absence of institutional and/or engineering controls, individuals could be exposed to contaminated soil and dust.

As the COPC are non-volatile, there is negligible risk of exposure via vapor emissions. Hazards to terrestrial habitats and wildlife are unlikely as the site would not present suitable habitat. Erosion and polluted stormwater runoff must be controlled during the construction phase and the long-term. The leaching potential to aquatic and marine habitats is expected to be negligible but will be further evaluated during the demolition/construction phase by SPLP testing. TCLP testing previously performed suggests the potential for leaching from lead and arsenic is negligible.

There are both short-term (i.e. construction) and long-term (i.e. residential) potential exposure risks. Appropriate control of excavated soil is essential to reduce the risk of direct exposure or gross contamination. By implementing site controls, worker training, and best management practices, the direct exposure for the construction workers either through ingestion or inhalation of COPC-contaminated soil will be minimized during the excavation and transport of impacted soil. During site demolition and construction, the control of targeted environmental hazards must include erosion and dust control and air monitoring.

The direct exposure hazards to future residents must be mitigated. The alternatives considered and evaluated by the design team to achieve mitigation of potential exposure to future residents are discussed in Sections 4 and 5.

4.0 REMOVAL ACTION SUMMARY

Soils containing arsenic, lead, and pesticides at levels exceeding the HDOH EALs at the Lanakila Phase IIIb site present a potential direct exposure risk to construction workers, the public, and future residents of the redevelopment. Based on the hazard evaluation, either removal, disposal, or soil encapsulation on-site are appropriate solutions that will minimize long-term risk to human receptors. In order to determine the most appropriate removal action approach, an evaluation of alternatives was completed. The objective of this process was to screen and evaluate options that would be effective in mitigating hazards, would be feasible, and would be cost effective. This Section and Section 5 present the results of this alternative evaluation. Contaminants are located within five feet of foundations and are presumed to be building related. Conditions under former building foundations will be evaluated.

4.1 REMOVAL ACTION OBJECTIVES

The goals of this removal action are to address COPC-contaminated soils at the site in order to protect human and ecological health during and after the action taken. The removal action objectives are as follows:

- Remediate soil contaminated with COPCs for future residential use of the property.
- Prevent risk to human health or ecological receptors from exposure to COPC-contaminated soil, both during and after the removal action.
- Prevent migration of contaminants to surface waters or groundwater.

4.2 SUMMARY OF REMOVAL OPTIONS

Based on the soil baseline survey results, hazard evaluations of COPCs, and discussions among project stakeholders, the following alternatives were evaluated:

Alternative I. No action: This serves as a baseline against which to compare all other alternatives. This option involves no response action, and results in the unacceptable result of leaving identified soil hazards in place.

Alternative II. In-place encapsulation with slab demolition: This alternative involves covering of contaminated soil with clean soil cover, with a geotextile membrane and metallic warning tape separating contaminated soil and the clean soil cover. Long-term institutional controls would also be required to maintain the integrity of the solution.

Alternative III. Excavate and dispose of impacted soils in a sanitary landfill: This alternative involves excavation of all contaminated soils to a minimum of two feet bgs, disposal in a sanitary landfill, and backfilling with clean soil cover. If contaminated soils remain below two feet bgs these will be either excavated and disposed, or will be covered with clean soil cover, with geotextile membrane and metallic warning tape separating the two soil layers.

Alternative IV. Excavation and Soil Management Unit Containment: This alternative involves excavation of contaminated soil and containment in a Soil Management Unit (SMU) located at a suitable location on the project site, and covering any remaining contaminated soil with clean soil cover. All remaining contaminated soil would be covered with geotextile membrane, metallic warning tape, then surfaced with a minimum of two feet of clean soil cover.

Prior to the alternative evaluation, the design team considered how to manage the former building foundations. Demolition of the slabs is a significant expense, and leaving them in place would serve as an effective encapsulation of contaminants, although the presence of contamination under them is unknown and would remain so without sampling and analysis. However, leaving the slabs in place would present problematic engineering constraints; constructing proposed buildings over the slabs would require a more expensive foundation design, and would place portions of the site significantly above the surrounding areas. This would dictate that the remainder of the site be filled in order to achieve desired grade, requiring an additional expense (minimum of $150,000). Furthermore, HPHA considers leaving the slabs in place an undesirable option as it would serve as an additional cost to the public at some point in the future when redevelopment of the site is again desired. Therefore HPHA determined that the former building foundations would be demolished. Slab demolition is required for any particular alternative to be feasible and allow project completion.

An additional important consideration for the alternative analysis is placement of the concrete demolition waste and other excess soil produced from excavation for the proposed building foundations. Geotechnical soil borings show that the soils on the site are frequently more than 10 feet deep before bedrock is encountered, and with the type of structure planned structural and load-bearing soils are required. Thus there is a need to establish a location to receive the quantities of excess soil that will be produced. While off-site locations are certainly possible,

this would incur hauling and related costs. The design team decided that it would be more expedient to develop a simpler option, an on-site location that could receive contaminated soil, concrete waste, and excess soil from foundation excavation. The obvious place on this site is the eastern portion of the site, where a natural grade facilitates such a storage facility. This storage facility could also receive contaminated soil, should such a remedial alternative be selected.

4.3 REMOVAL ALTERNATIVES EVALUATION CRITERIA

The alternatives were assessed by the following three performance criteria:

- Effectiveness
- Feasibility
- Cost

Effectiveness is a measure of whether the action would achieve overall protection of human health and the environment over both the short-term and long-term. This requires regulatory compliance.

Feasibility involves a variety of issues including technical and administrative feasibility, suitability of land for future uses, complexity, time to implement, and the essential factor of whether the action would allow project construction to advance.

The *cost* criterion addresses overall and total cost to implement the action, including excavation, encapsulation or disposal costs, and long-term operations and maintenance (O&M) costs.

5.0 REMOVAL ALTERNATIVES EVALUATION

The alternatives evaluation is summarized in Table 13.

5.1 ALTERNATIVE I: NO ACTION ALTERNATIVE

The No Action Alternative, included as a comparative baseline, consists of no removal action and would leave the site in its current condition as much as possible. The No Action Alternative is considered to have no cost in remedial alternative analysis.

5.1.1 Effectiveness

The No Action Alternative would not be effective in achieving project objectives.

5.1.2 Feasibility

The No Action Alternative is feasible, but would be accomplished without completion of the project goals.

5.1.3 Cost

The No Action Alternative has zero cost.

5.2 ALTERNATIVE II: IN PLACE SOIL ENCAPSULATION

Contaminated soil within 5 feet of former building foundations would be covered with a minimum of two feet of clean soil cover, with geotextile and metallic warning tape separating the contaminated soil and the clean soil cover. After sampling and analysis of soil under the former building foundations this soil would be treated accordingly, either encapsulated in the same manner if contaminated, or left in place without cover. This alternative requires that the entire site be covered with a minimum of two feel of clean soil cover, and possibly as much as three feet.

5.2.1 Effectiveness

This method would be an effective alternative as it would eliminate the potential for direct human contact risks and the potential for exposure by inhalation of contaminated dust. Although the contaminated soil would not be removed, encapsulating contaminated soil would meet long-term effectiveness goals. This alternative is less effective in mitigating future risks than excavation and removal of contaminated soils as they would remain in place, in a number of locations on the project site. The potential for future release and exposure would also remain.

5.2.2 Feasibility

This alternative presents engineering difficulties that reduce its feasibility. Encapsulating only the former building foundation peripheries would produce mounds elevated above the surroundings. Therefore, the entire site would have to be raised by placing clean fill. This would also be undesirable as it would result in the Phase IIIb site being higher than surroundings, producing the potential for soil erosion, as well as being an undesirable engineering problem for the future Phase IV of the project. Therefore this alternative is considered to be of moderate feasibility.

5.2.3 Cost

Cost of this alternative includes clean soil cover, geotextile membrane and metallic warning tape, as well as environmental plans (i.e. EHMP, Removal Action Implementation Report) and signage, for a total of approximately $188,320 to $270,850. The cost of clean fill shown in Table 13 varies widely because considerably more fill would be required if soil under former building foundations is found to be contaminated.

5.3 ALTERNATIVE III: EXCAVATE AND LANDFILL CONTAMINATED SOILS

Remedial Alternative III involves hauling contaminated soils, and those sub-slab soils determined to be contaminated, offsite and disposed in an approved sanitary landfill. Appropriate soil profiling would be conducted to meet landfill requirements for disposal. Total soil volume for excavation of the 5 foot periphery of the seven former building foundations to 2 feet of depth is approximately 490 cubic yards. Total soil volume for the sub-slab soil, for seven former building foundations, is approximately 1,070 cubic yards, and concrete demolition waste approximately another 430 cubic yards (total ranges from 920 to 1,990 cubic yards, depending on whether sub-slab soil is contaminated). Additionally, if confirmation sampling of remaining soil after excavation shows COPCs below EALs, the geotextile barrier and warning tape would

not be required, alleviating this cost. If remaining soil is above EALs it may also be excavated and disposed or covered with a minimum of two feet of clean soil cover and barrier. Soil located under the former building foundations would also be disposed in a landfill if above EALs, or left in place or used as clean soil cover if uncontaminated.

5.3.1 Effectiveness

Excavation of contaminated soil and landfill disposal is an effective solution, negating related potential exposure. The long-term effectiveness of landfill disposal would have advantages in terms of the potential for resident exposure as no contaminated soil would remain on the site.

Short-term risk to construction workers would be relatively greater, as soil would be disturbed during excavation, loading and hauling. Risks to construction workers would be mitigated, in part, by use of appropriate worker PPE, air monitoring, and dust suppression methods.

5.3.2 Feasibility

Excavation of contaminated soil and landfill disposal is feasible in the respect that resources exist to accomplish it, and it would allow construction to advance. While landfill disposal is not a technically challenging solution, it would require about 94-139 gravel truck trips from the project site to the West Hawaii Sanitary Landfill, located approximately 70 miles from the project site. Communications with the County of Hawaii Department of Environmental Management Solid Waste Division indicate that this material would only be allowed at the West Hawaii Sanitary Landfill and would not be allowed at the much closer South Hilo Sanitary Landfill.

5.3.3 Cost

Assuming that the contaminated soil on the periphery of former building foundations and sub-slab soils are excavated to 2 feet bgs, and demolished concrete slabs are transported to a sanitary landfill (and are not characterized as hazardous wastes), total volume would range from 920 to 1,990 cubic yards. The estimated cost to haul excavated soil to the West Hawaii Sanitary Landfill was estimated at approximately $158,000 to $342,000. Additional costs would be incurred from excavation, soil fill cover, geotextile, warning tape, confirmation sampling, Removal Action Implementation Report and Environmental Hazard Management Plan (EHMP) preparation, and signage. Estimated total cost for this alternative is from $213,950 to $446,920.

If confirmation sampling of remaining soils, including sub-slab soils, shows COPCs to be below EALs, the barrier would not be necessary and this cost would be removed.

5.4 ALTERNATIVE IV: EXCAVATION AND CONTAINMENT IN SMU

This alternative involves excavation of all contaminated soil to a minimum of 2 feet bgs and placement within a soil management unit. An SMU is an engineered containment facility that is constructed ensure that contaminants, are free from disturbance and do not leave the site. The SMU would be located on the eastern side of the Phase IV project site. Leaching potential testing will help determine whether an impermeable cap is necessary for SMU design.

Sub-slab soil would be characterized and managed as described in Section 5.3. After characterization, excavated soil found above applicable EALs would be placed in the SMU.

Total soil volume for excavation of the 5 foot periphery of the seven former building foundations to 2 feet bgs is approximately 490 cubic yards. Total soil volume for the sub-slab soil to 2 feet depth, again for seven former building foundations, is about 1,070 cubic yards. The concrete slabs would contribute an additional approximate 430 cubic yards of material and would also be placed in the SMU.

If confirmation sampling demonstrates that some or all of the soil remaining after excavation has COPC concentrations below EALs, the geotextile and warning tape barrier would not be required, alleviating some or all of this cost. Management of soil remaining on the site, including the SMU, would require implementation of a Removal Action Implementation Report and an EHMP.

If SPLP testing shows that leaching of Technical Chlordane is an issue, the SMU will be constructed with an impermeable membrane to prevent infiltration of rainfall and production of contaminated leachate. The cost of this impermeable membrane is estimated at $30,000.

Excess soil generated by excavation for proposed building foundations would also be managed in the SMU.

5.4.1 Effectiveness

This method would mitigate long-term risks effectively, as it would remove the contaminated soil from the proximity of the residents of the housing project. Exposure hazards to construction workers would be mitigated through implementation of BMPs, training, and use of appropriate personal protective equipment (PPE). Further, this solution would allow achievement of project objectives.

5.4.2 Feasibility

This alternative is feasible, with consideration of several steps, including construction of SMU and placement of excavated soil in the SMU. This alternative is within the resources of HPHA in terms of cost and personnel and equipment. Approval of SMU design would be required by HDOH Solid and Hazardous Waste Branch.

5.4.3 Cost

This alternative would utilize the retaining wall structure for the SMU, and is therefore an efficient use of project resources. Costs included in this alternative include excavation costs, clean soil cover cover, geotextile, warning tape, confirmation sampling, Removal Action Implementation Report and EHMP preparation, and signage. Total cost for this alternative is estimated at $45,950 to $124,920.

5.5 COMPARISON OF ALTERNATIVES AND RECOMMENDATION

Table 13 provides a comparison of the removal/encapsulation alternatives presented herein. Ranges in costs are given due to the fact that soil under slabs has not been characterized for COPCs. Therefore, the range in costs given include soil management costs for only soils on the

perimeter of the former building foundations (minimum of range) and soil management costs for both the peripheral soils and those under the former building foundations (maximum of range).

Capping the contamination in place with clean soils at each of the former foundation pads (Alternative II) would require filling in the rest of the Phase IIIb area with clean fill to provide a uniform grade across the site. Effective management of capped soils over the long-term would be more difficult due to the number of former pad areas that would need to be kept track of across the site.

While removal of contaminated soil and disposal in a sanitary landfill may be ideal with respect to overall risk mitigation, this option does have higher potential short-term risks due to the substantial number of truckloads of soil and cement that would need to be hauled to the West Hawaii landfill. Disposing of soils in the West Hawaii landfill would also have the highest costs of the alternatives considered. Therefore, landfill disposal is an undesirable solution in terms of cost for the project.

Excavation of contaminated soil and management on-site is a relatively feasible and cost-effective solution that would achieve the project objectives and would effectively safeguard human health. This solution would also manage excess soil generated during excavation for proposed building foundations. Therefore, MNA recommends that contaminated soil be excavated to a minimum of two feet of depth and placed in an SMU on site, confirmation sampling performed, and excavations backfilled with clean soil cover soil after covering contaminated soil with a geotextile and ferro-metallic warning tape at regular spacing. Confirmation testing will occur (at the two foot depth) before clean fill is added, and if soils remain above the applicable Tier 1 EALs at that depth, a geotextile barrier with warning tape on top will be placed between the contaminated soil and the clean fill.

Table 13. Alternative Evaluation Matrix

Alternative	Effectiveness	Feasibility	Estimated Cost
I. **No Action**	Used as a baseline against which to compare other actions, this alternative would not achieve project objectives.	Achievable, but would not allow project completion.	No cost.
II. **In Place Encapsulation**	Moderate: Contaminated soils would remain in place. Cover soils would result in effective protection from exposure assuming long-term institutional controls are maintained. However, long-term management would be more difficult due to the multiple areas that would need to be tracked/managed across the site.	Moderate: Would require large quantities of fill soil to be added to the site.	Soil Fill Cover ……..$150,00 to $225,000 Geotextile…….....$2,660 to $7,290 Warning Tape……..……..…..…….$1,660 to $4,560 Confirmation Sampling……..…….……$12,000 Removal Action Work Plan ……..…….....…...$10,000 Implementation Report & EHMP…….…….$10,000 Signage…….…….....…$2,000 **Total……...…….…….……...$188,320 to $270,850**
III. **Excavate and Landfill Impacted Soils**	High: Contaminated soils within 2 feet of ground surface (around former foundation pads) would be removed from the site entirely. However, there would be a higher potential for short-term hazards due to trucking a large of amount of soil and concrete waste to the West Hawaii landfill.	High: Would allow project completion with institutional controls if contaminated soil remains on-site below 2 feet bgs.	Hauling & Landfill Disposal…...…….…$158,000 to $342,000 Excavation costs…..…….……$11,200 to $30,650 Clean soil Cover....……..……..$6,650 to $18,220 Geotextile……..……..…..……$0 to $7,290 Warning Tape…..……..…..…….$0 to $4,560 Confirmation Sampling…….…….…...$6,100 to $12,200 Removal Action Work Plan ……..…….....…...$10,000 Implementation Report & EHMP…….…….$10,000 Signage……...……..…….$2,000 **Total……..……..…….……$203,950 to$ 436,920**
IV. **Excavation and Containment in SMU**	Moderate-High: Contaminated soils within 2 feet of ground surface (around former foundation pads) would be removed to a soil management unit on site, but managed more effectively over the long-term in a single soil management unit.	High: Would allow project completion with institutional controls if contaminated soil remains on site below 2 feet. Costs would be much lower than hauling all contaminated soils to the landfill..	Excavation Costs…….…….$11,200 to $30,650 Clean soil Cover…….……...……....$6,650 to $18,220 Impermeable SMU membrane…….……..…..$0 to $30,000 Geotextile…….…….....….$0 to $7,290 Warning Tape……...……...……$0 to $4,560 Confirmation Sampling…….…….…...$6,100 to $12,200 Removal Action Work Plan ……..…….....…...$10,000 Implementation Report & EHMP…….…….$10,000 Signage…….…....…….…..……...$2,000 **Total…….…….….....…$45,950 to $124,920**

Notes: Large range in costs is due principally to unknown soil conditions under former building foundations. The geotextile and warning tape costs shown in alternatives II, III, and IV would be removed if confirmation testing confirms no additional contamination below the 2 foot depth. Impermeable membrane costs for Alternative IV would be removed if leaching tests confirm leaching is not a concern.

6.0 IMPLEMENTATION OF PREFERRED ALTERNATIVE (ALTERNATIVE IV)

Due to the feasibility and cost issues associated with other alternatives (e.g. landfill disposal), the alternative of contaminated soil containment in a SMU within the project site is preferred.

The SMU would be located on the eastern side of the site where a retaining wall will be constructed to accommodate concrete waste and excess soil produced from proposed building foundation excavation from both Phase IIIb and the future Phase IV of the project. A natural slope in this area lends itself to this use. The SMU would accommodate soils on the periphery of the former building foundations and sub-slab soil, if found to contain COPCs above EALs. The SMU would also be the endpoint for any other excavated soils determined to contain COPCs above soil screening levels, including spoils from excavation of building foundations.

In order to place concrete demolition waste (from the former building foundations) in the SMU concrete slabs must be processed to meet the inert fill requirement. According to Hawaii Revised Statutes (HRS) 342H-1, concrete demolition waste must have all paint removed, be crushed so that no pieces are larger than 8 inches in diameter, and have no exposed rebar.

In order to effectively implement this Draft RAR, the Contractor must conduct earthwork and manage the impacted soil in accordance with the 2014 Soil Management Plan (Myounghee Noh & Associates, L.L.C., 2014) and applicable portions of the most current Hawaii Department of Health's Technical Guidance Manual (Hawaii Department of Health, 2009), as well as the Removal Action Work Plan that will be developed to implement the Final RAR.

6.1 REMOVAL ACTION WORK PLAN FOR THE SELECTED REMOVAL ALTERNATIVE

Following HDOH approval of a removal alternative, a Removal Action Work Plan containing recommendations for demolition and construction phase implementation of the action will be prepared and submitted to HDOH for review, comment, and approval before commencing work. Worker training requirements, and health and safety plan requirements will be presented. Prior to commencement of work, a HASP incorporating a dust management and monitoring plan will be prepared by the contractor and reviewed by MNA.

The work plan will include (1) confirmation sampling of remaining soil after excavation of soil within 5 feet of former building foundations to 2 feet bgs, (2) confirmation sampling of remaining soil after excavation of sub-slab soil and (3) sampling and analysis of soil cuttings from proposed building foundation excavation. Analysis of this soil would include SPLP testing of Technical Chlordane to determine leaching potential. Characterization of soil under three of the former building foundations will be used to make assumptions regarding all of the sub-slab soil in Phase IIIb. The analytical results will be compared to the Tier 1 EALs. Soil with COPC in excess of an EAL for any of the three COPCs will be contained in the SMU. Soil with COPC concentrations below Tier 1 EALs will be used as clean soil cover cover on the site at the contractor's discretion.

Site control is currently maintained by a 10-foot tall chain link fence with two locked gates that encompasses the entire site (i.e. both Phase IIIb and Phase IV of the project). As the construction activities will occupy more than one acre, a NPDES permit for construction activities (Form CWB NOI-C) has been acquired and will be implemented. BMPs will include, but will not be limited to, erosion controls, good-housekeeping, stockpiling, hydro-mulching of bare soil areas, a stabilized construction area, and placement of silt fences around areas of disturbance.

6.2 PROJECT CLOSE OUT

After completing implementation of the removal action selected in the Final RAR, an Implementation Report will be submitted. It will describe the work performed, providing as-built drawings of the preferred alternative, and certify SMU containment of contaminated soil. Upon review and approval of the completion report, the HDOH HEER Office may issue a Letter of No Further Action (NFA) or a letter of No Further Action (NFA) With Restrictions, indicating that site cleanup goals have been achieved, but institutional controls are necessary to assure long-term management of any contaminated soils remaining on site. At this time the site would be available for construction and residential use. The NFA would include specific institutional controls to help ensure safe long-term management of contaminated soils left on-site. Additionally, use conditions would be attached to the property deed.

A long-term Environmental Hazard Management Plan (EHMP) will also be necessary to manage potential risks if the alternative selected leaves contaminated soil on site. The EHMP includes maps to scale showing the location of any contaminated soils remaining on site, as well as other actions that may be necessary to manage the soils long-term. These may include notice to property managers or others who are responsible for maintenance activities at the site, general notice to residents, signage that indicates the presence and nature of the hazard, and/or general prohibition on digging below a certain depth in some areas. Other institutional controls may include a prohibition of deep-rooting trees in areas where contaminated soil is managed.

7.0 PUBLIC REVIEW AND COMMENT PROCESS, DRAFT RAR

After the Draft RAR has been approved by the HEER Office, public notice will be conducted. A public notice will be published in the Hawaii Tribune Herald and on the HDOH HEER Office website along with the date, time, and location of a public meeting at which the removal alternatives will be presented and comments from the public invited. A Fact Sheet containing pertinent information on the project, hazards, and remedial alternatives, will also be distributed. The Public Notice and Fact Sheet will also be mailed to surrounding residents. The Final RAR will identify the final removal alternative selected by the HEER Office as well as summarize public comments received and provide responses to those comments.

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