DAVID Y. IGE
GOVERNOR OF HAWAII

VIRGINIA PRESSLER, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:
15-458-SPM

July 17, 2015

Mr. Darrel Ing
Department of Hawaiian Homelands
91-5420 Kapolei Parkway
Kapolei, HI 96707

Facility/Site: East Kapolei Pesticide Mixing/Loading Site

Subject: No Further Action with Institutional Controls for East Kapolei Pesticide Mixing/Loading Site

Dear Mr. Ing:

The Hawaii Department of Health Hazard Evaluation and Emergency Response (HEER) Office has reviewed both the Remediation Verification Report, dated March 3, 2015 and the Environmental Hazard Management Plan, dated April 9, 2015 and has determined that the remedy outlined in the Response Action Memorandum has been completed and a No Further Action with Institutional Controls designation is appropriate for this site.

Should any of the conditions outlined in the EHMP be violated or not complied with to the satisfaction of the HEER Office, the No Further Action with ICs designation will be revoked immediately and a response action will be required. Long term management officially begins as of the date of this letter and the first quarterly inspection report will be due October 17th, 2015. Please submit this report to the HEER Office for review.

Should new information become available, the HEER Office may require a response action to be taken to address the situation. Should you have any questions concerning the above please feel free to contact Mr. Steven Mow at 586-7574.

Sincerely,

Fenix Grange
Supervisor, Site Discovery, Assessment, & Remediation Section
Hazard Evaluation and Emergency Response Office

c: Damon Hamura, EnviroServices

REMEDIATION VERIFICATION REPORT

EAST KAPOLEI II PESTICIDE MIXING AND LOADING SITE
TMK (1) 9-1-017: Parcel 110 (Portion)
Ewa, Oahu, Hawaii

Prepared For:
STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. Box 1879
Honolulu, Hawaii 96805

Prepared By:
ENVIROSERVICES & TRAINING CENTER, LLC
505 Ward Avenue, Suite 202
Honolulu, Hawaii 96814

Project No. 09-2012

December 2014

TABLE OF CONTENTS

1.0 CERTIFICATIONS AND LIMITATIONS 1

2.0 INTRODUCTION AND PURPOSE 2

3.0 BACKGROUND 3
3.1 SITE DESCRIPTION AND LAND AREA 3
3.2 SITE GEOLOGY 3
3.3 SITE HYDROGEOLOGY 4
3.4 HISTORICAL LAND USE 4
3.5 CURRENT AND FUTURE LAND USE 5
3.6 INVESTIGATION HISTORY 5
3.7 CONCEPTUAL SITE MODEL 6
3.7.1 Receptors of Concern 7
3.7.2 Exposure Pathway Analysis 8
3.8 NATURE AND EXTENT OF CONTAMINATION 9
3.8.1 Spill Areas 10
3.8.2 Investigation Areas 11
3.8.3 Outside PML Site 13
3.9 APPLICABLE REMEDIAL ACTION LEVELS 13

4.0 SUMMARY OF THE ENVIRONMENTAL HAZARD EVALUATION 14
4.1 CONTAMINANTS OF CONCERN 14
4.2 ENVIRONMENTAL HAZARD EVALUATION SUMMARY 15

5.0 REMEDIAL ACTION TASKS 17
5.1 DESCRIPTION OF THE SELECTED REMEDIAL ALTERNATIVE 18
5.1.1 Description of Selected Remedy 18
5.1.2 Benefits and Drawbacks 20
5.1.3 Environmental Hazard Evaluation – Post Implementation 21
5.2 PROJECT GOAL 22
5.3 REMEDIAL APPROACH 22
5.4 CONSTRUCTION DETAILS 25
5.5 FIELD OBSERVATIONS DURING REMEDIAL ACTION ACTIVITIES 25

6.0 CONFIRMATION SAMPLING ACTIVITIES 26
6.1 INITIAL CONFIRMATION SAMPLE COLLECTION 26
6.2 FOLLOW-UP CONFIRMATION SAMPLE COLLECTION 26
6.3 SAMPLE CONTROL PROCEDURES 27
6.4 DATA QUALITY 27
6.4.1 Field Quality Control Evaluation 27
6.4.2 Laboratory Quality Control Evaluation 28

7.0 CONFIRMATION SAMPLING ANALYTICAL RESULTS 29
7.1 CONFIRMATION SAMPLE DATA 29
7.2 FIELD REPLICATES EVALUATION 30

8.0 POST REMEDIATION ENVIRONMENTAL HAZARDS 32

9.0 ENVIRONMENTAL HAZARD MANAGEMENT 33
9.1 LONG-TERM MONITORING AND MAINTENANCE 33
9.2 MITIGATION MEASURES 33

10.0 CONCLUSIONS 35

11.0 REFERENCES 36

ATTACHMENTS

APPENDIX I:	Figures
APPENDIX II:	Conceptual Site Model Diagrams
APPENDIX III:	Photographic Documentation
APPENDIX IV:	Construction Plans and Specifications
APPENDIX V:	Groundwater Sampling and Monitoring Well Closure Report
APPENDIX VI:	Construction Permits
APPENDIX VII:	Confirmation Sample Data Tables and Laboratory Reports
APPENDIX VIII:	Construction Quality Assurance Report – Manthos Engineering, LLC
APPENDIX IX:	Work Completion Report – RHS Lee, Inc.
APPENDIX X:	Completion of Grading Letter – Hirata & Associates, Inc.
APPENDIX XI:	Inspection and Maintenance Report Forms

LIST OF ACRONYMS AND ABBREVIATIONS

As	arsenic
AST	aboveground storage tank
bgs	below ground surface
BMP	Best Management Practice
CLSM	Controlled Low Strength Material
COC	contaminant of concern
CSM	Conceptual Site Model
DBEDT	State of Hawaii Department of Business and Economic Development
DHHL	State of Hawaii Department of Hawaiian Home Lands
DOH	State of Hawaii Department of Health
EALs	Environmental Action Levels
EHE	Environmental Hazard Evaluation
ETC	EnviroServices & Training Center, LLC
GLCS	geomembrane liner cover system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high density polyethylene
HEER Office	Hazard Evaluation and Emergency Response Office
LCS/LCSD	laboratory control spike/laboratory control spike duplicate
mg/kg	milligrams per kilogram
MS/MSD	matrix spike/matrix spike duplicate
ng/kg	nanograms per kilogram
NPDES	National Pollutant Discharge Elimination System
PCP	pentachlorophenol
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
RVR	Remediation Verification Report
TA-H	TestAmerica-Honolulu
TEQ	toxicity equivalence
TLCG	The Limtiaco Consulting Group
TMK	Tax Map Key
US EPA	United States Environmental Protection Agency

1.0 CERTIFICATIONS AND LIMITATIONS

EnviroServices & Training Center (ETC), LLC has completed this Remediation Verification Report (RVR) for the project site. ETC's findings and conclusions presented in this report are professional opinions based solely upon visual observations of the project site, government regulations, and upon interpretation of the laboratory data and field measurements available at the time and location of the study.

This document is intended for the sole use of ETC's Client, exclusively for the project site indicated. The scope of services performed in execution of this project may not be appropriate for satisfying the needs of other users, and any use or reuse of this document or the findings and conclusions presented herein is unauthorized and at the sole risk of said user.

ETC makes no guarantee or warranty; either expressed or implied, except that our services are consistent with good commercial or customary practices designed to conform to acceptable industry standards and governmental regulations. No warranty or representation, expressed or implied, is included or intended in its proposal, contracts, or plan. Opinions stated in this plan apply only to the site as outlined and apply to the conditions present at the time of preparation. Moreover, these opinions do not apply to site changes that occur after the project has been completed.

Prepared By: ______________________________
Damon Hamura
Project Manager

Date: December 2014

2.0 INTRODUCTION AND PURPOSE

This Remediation Verification Report (RVR) was prepared to document remediation activities conducted at the East Kapolei II Pesticide Mixing and Loading (East Kapolei PML) site. The State of Hawaii Department of Hawaiian Home Lands (DHHL) retained RHS Lee, Inc. (RHS Lee) as the general contractor to perform site construction activities in accordance with the construction plans and specifications provided as part of Solicitation IFB-11-HNL-002. The construction plans and specifications were based on the October 2010 *Remedial Action Work Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)* prepared for DHHL by EnviroServices & Training Center, LLC (ETC).

DHHL retained ETC to provide environmental engineering services in support of the remedial action. These services included closure of existing monitoring wells, permit applications, review of contractor submittals, coordination and oversight of remedial actions, collection/analysis of confirmation samples, and preparation of this report. ETC retained the services of The Limtiaco Consulting Group (TLCG) for civil engineering design support, Hirata & Associates, Inc. (through TLCG) for geotechnical engineering support, and Manthos Engineering, LLC for quality assurance of the geomembrane liner system installation.

3.0 BACKGROUND

3.1 Site Description and Land Area

The project site is the former Oahu Sugar Company pesticide mixing and loading area located near Kualakai Parkway approximately 1.2 miles east of Kapolei and 2.0 miles southwest of Waipahu. A map illustrating the site location is included as Figure 1 in Appendix I. The site was previously occupied by two abandoned buildings and several elevated aboveground storage tanks. These structures were demolished (December 2009) and documentation of site demolition activities is provided in the January 2010 *Demolition and Disposal Report, East Kapolei II, Former Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii* prepared by ETC on behalf of DHHL.

The East Kapolei PML site consists of approximately 0.634-acres that are part of a larger 292-acre parcel owned by DHHL and identified as TMK (1) 9-1-017: Parcel 110, Ewa, Oahu, Hawaii. The property is located within the State Urban District and is zoned by the City and County of Honolulu for agricultural use.

The East Kapolei PML site has no street address and is accessible via cane haul roads from Palehua Road, an unimproved roadway. The property is centrally located within agricultural fields that either remain fallow or are currently under short-term lease to agricultural tenants, primarily Aloun Farms, for commercial cultivation of fruit and vegetables. Existing uses in the vicinity of the property include the Ewa Villages Golf Course to the south, the West Loch Golf Course to the east, and city of Kapolei to the west. The nearest existing residences to the East Kapolei PML site are located in the Ewa Villages community and in the DHHL's "Kanehili" (East Kapolei I) development, situated approximately 0.7 miles southeast and 0.7 miles to the southwest, respectively.

The East Kapolei PML site is situated at an elevation of approximately 100 feet above mean sea level (msl) and the topography suggests a slight surface gradient to the south. No drinking water wells are located within one mile of the property, and the nearest surface water body is the West Loch of Pearl Harbor, located approximately 1.6 miles to the east.

The East Kapolei PML site was formerly characterized by abandoned, derelict buildings and several elevated storage tanks surrounded by a chain-link fence. Ground cover within the fenced area consisted primarily of crushed coral covering native clay. A concrete-lined irrigation ditch runs adjacent to and through the fenced area.

3.2 Site Geology

The East Kapolei PML site is situated at an elevation of approximately 100 feet above msl. Soil at the property is classified by the U.S. Department of Agriculture (USDA) Soil Conservation Service as Honouliuli clay (HxA). The Honouliuli Series consists of well-drained soils on coastal plains in the Ewa area. These soils developed in alluvium derived from basic igneous rock. Honouliuli clay is dark reddish-brown, very sticky and very plastic clay, with 0 to 2 percent slopes underlain with coral reef limestone. Permeability is moderately slow, runoff is slow, and the erosion hazard is no more than slight. Workability is slightly difficult because of the very sticky and very plastic clay. The shrink-swell potential is high (USDA, 1972).

Observations made during previous subsurface investigations at the site indicated that existing site soils generally consist of a dark reddish-brown clay interspersed with relatively thin layers of coralline fill. Deeper soils exhibited a very plastic consistency, which impeded previous direct-push sampling efforts at greater depths, slowed hollow-stem auger drilling for monitoring well installation, and slowed groundwater recharge into boreholes. Recent investigations confirmed the geological descriptions above, with the exception of a larger fraction (and thicker layers) of coralline material in the near surface and shallow subsurface soils within the East Kapolei PML site boundaries.

3.3 Site Hydrogeology

According to Mink & Lau, 1990, the site is located above two aquifers within the Pearl Harbor Aquifer Sector, Waipahu Aquifer System. The upper aquifer is a basal, unconfined formation in sedimentary (nonvolcanic) lithology. Groundwater within this upper aquifer is a currently used, ecologically important, non-potable water source. This groundwater source is considered irreplaceable, with a low salinity and has a high vulnerability to contamination. The lower aquifer is a basal, confined aquifer in horizontally extensive lavas. The groundwater in this lower aquifer is a currently used, ecologically important, non-potable water source, and is further characterized as being an irreplaceable formation with a low salinity (between 250 and 1000 milligrams Cl^- per liter) and moderate vulnerability to contamination.

The depth to groundwater in the upper, unconfined aquifer in three monitoring wells previously installed within the site ranged from 79 to 85 feet below existing ground surface (approximately 15- to 20-feet above mean sea level). Data for older wells in the vicinity that apparently access the lower, confined aquifer indicate well depths of approximately 350- to 450-feet below mean sea level.

3.4 Historical Land Use

The East Kapolei PML site and surrounding lands were in sugarcane cultivation for over 100 years from approximately 1890 to 1994. Ewa Plantation Company operated the first sugar plantation in the area from 1890 to 1970, followed by Oahu Sugar Company, who leased the Project Site and surrounding lands from the Estate of James Campbell until 1994.

Ewa Plantation Company constructed the recently demolished buildings at the project site in 1953. The site was actively used for the storage, mixing, and loading of agricultural pesticides for approximately 40 years up to 1994. Pesticides were stored, mixed, and loaded onto trucks for distribution and dispersal in the plantation fields. In the 1950s, pentachlorophenol with diesel or kerosene was also mixed and applied. It is suspected that soils at the site became contaminated as a result of periodic chemical spills over the years. Such spills were typically not cleaned up by the plantation. Storm water runoff and truck movement from the site appear to have dispersed pesticides and contaminants outside the currently fenced area.

Activities on the East Kapolei PML site ceased when Oahu Sugar Company shut down operations in 1994. Through a condemnation proceeding, the State of Hawaii acquired the Project Site on August 22, 1994 by Land Court Document No. 2181717, recorded at the State of Hawaii Bureau of Conveyances on September 21, 1994. The site has not been utilized since plantation activities ceased.

3.5 Current and Future Land Use

Following completion of remediation activities, DHHL proposes the redevelopment of the East Kapolei PML site and surrounding lands as part of the agency's "East Kapolei II" community. DHHL's master plan for "East Kapolei II" shows the site as located within a five-acre lot. Although future use of the actual East Kapolei PML site has not yet been determined, no residential units will be located on the site itself.

3.6 Investigation History

A number of environmental investigations have been performed throughout the East Kapolei PML site and surrounding areas. These investigations were specifically detailed in the March 2010 *Site Investigation Report and Environmental Hazard Evaluation, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)* prepared by ETC on behalf of DHHL. Findings from these investigations indicated the presence of various pesticides and pesticide-related chemicals in site soils at elevated concentrations.

In general, data from these previous investigations indicated that the East Kapolei PML site has been impacted by arsenic, dioxins/furans, pentachlorophenol, and triazine pesticides. Patterns within the data suggest that the areas beneath the former elevated ASTs, beneath a former mixing tank built into the patio of the office/storage structure, and behind the former boiler building contain the highest contaminant concentrations (identified as the "Spill Areas" of the site). The March 2010 *Site Investigation Report and Environmental Hazard Evaluation* confirmed these patterns and also indicated the areas immediately adjacent to these Spill Areas (referred to as the "Investigation Areas" of the site) contained elevated concentrations of dioxins/furans and in certain instances, arsenic. The most recent data for samples collected from within the East Kapolei PML site boundaries were used to define both the magnitude and extent of contamination.

Historical investigations also suggested that there were contaminant impacts in soils outside of the existing East Kapolei PML site fence line. In particular, data obtained by ETC and documented in the August 2007 *Final Site Investigation and Preliminary Remedial Alternatives Analysis Report, East Kapolei – Brownfields, Former Oahu Sugar Company, Pesticide Mixing and Loading Areas, Kapolei, Oahu, Hawaii TMK (1)-9-1-017: Parcel 088* prepared for the State of Hawaii Department of Business, Economic Development and Tourism (DBEDT) indicated that dioxin impacts extended beyond the fence line, generally outside of the southwest gate, beyond Decision Units 8, 9, and 10 from the first "ring" of decision units, but limited to within the second "ring" of decision units.

An update to DOH action levels and corresponding guidance for dioxins/furans documented in the June 2010 technical memorandum *Update to Soil Action Levels for TEQ Dioxins and Recommended Soil Management Practices* prepared by the DOH HEER Office triggered the necessity for review of existing dioxin data. Specifically, the reduction of the soil action level for TEQ dioxins for unrestricted land use from 450 ng/kg presented in the Summer 2008 *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater* (EHE Guidance) to 240 ng/kg triggered the review.

Findings from this review indicated that the lateral extent of dioxin impacts were not completely characterized to the 240 ng/kg action level in two separate areas located outside of the East Kapolei PML site fence line. These areas included Decision Unit 19 (DU19) in the first "ring" of decision units sampled in 2006 and Decision Unit 12 (DU12) in the second "ring" of decision units sampled in 2006. Specifically, DU19 had reported and adjusted TEQ dioxin concentrations of 285.64 ng/kg and 347.97 ng/kg, respectively. DU12 had reported and adjusted TEQ dioxin concentrations of 353.37 ng/kg and 430.84 ng/kg, respectively. These were the only two areas affected by the reduction in the TEQ dioxin action level.

Discrete sample data collected by the US EPA in 2009 indicated that elevated arsenic concentrations exist in soil at depths of approximately 1 to 2 feet below ground surface (bgs) beyond the East Kapolei PML site fence line, generally outside of the southwest gate, and extending out to the south of the PML site, within the intersection of the coral/dirt roads.

Finally, limited data collected by the DOH/US EPA in the July 2000 *Site Inspection – Ewa Sugar Mill/Oahu Sugar Co. Pesticide Mixing and Loading Site, EPA Site ID Number HISFN0905536* indicated the presence of elevated dioxin TEQ concentrations in soil/sediment accumulated in the concrete-lined ditch adjacent to the East Kapolei PML site. Although the extent of dioxin impacts were not determined, DHHL and DOH decided that soil/sediment from sections of the concrete lined ditch located adjacent to and southwest (downgradient) of the East Kapolei PML site would be removed from the ditch during site remediation activities and addressed similar to other dioxin-impacted soil.

3.7 Conceptual Site Model

A conceptual site model (CSM) was prepared as part of the October 2010 *Remedial Action Work Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)*. A CSM provides a generalized framework regarding site-specific conditions relevant to potential contaminants, contaminant sources, migration pathways, routes of exposure, potential receptors, and environmental hazards (i.e., leaching to groundwater/discharge to surface waters, ecological toxicity) that may be affected by the contaminants. Establishment of this framework is essential for assessing environmental hazards associated with the contaminants, determining what receptors are at risk, determining appropriate remedial strategies, and addressing unacceptable hazards.

The following environmental hazards were initially considered:

- Direct exposure threats to human health;
- Intrusion of subsurface vapors into buildings;
- Leaching and subsequent threats to groundwater resources;
- Threats to terrestrial habitats; and
- Gross contamination and general resource degradation concerns.

Subsequent evaluation of environmental hazards based on the current and historical data concluded that the primary environmental hazard posed by arsenic, dioxins/furans, and pentachlorophenol at the site prior to remediation were direct exposure threats to human health and that the primary environmental hazard posed by pentachlorophenol and triazine pesticides prior to remediation were leaching and potential impacts to groundwater (see Appendix II). Note that direct exposure hazards associated with pentachlorophenol and certain triazine pesticides (as well as pentachlorophenol, arsenic, and dioxins) were also identified in suspect "Spill Areas" at the East Kapolei PML site.

3.7.1 Receptors of Concern

When identifying potential receptors, plausible exposure under both current and future land-use was evaluated. Accordingly, potential receptors were identified for both current and future use scenarios. For the purposes of this project, the following potential receptors were identified.

Future Site Users

Current land use plans identify residential development surrounding the existing East Kapolei PML site. The use of the area encompassing and including the current East Kapolei PML site has not been identified. Exposure pathways for future site users include:

- Inhalation of particulates from surface soil
- Dermal contact with soil
- Incidental ingestion of soil

Future Residents in Surrounding Areas

Future residents of surrounding dwellings may be exposed to contaminants stemming from the East Kapolei PML site. Exposure pathways for future residents in surrounding areas include:

- Inhalation of fugitive dust from site soil
- Dermal contact with soil and sediment from surface water runoff
- Incidental ingestion of soil and sediment from surface water runoff

Site Construction Worker

The future land use scenarios could include the development of the site. As a result, the construction worker would be present during development. It is assumed that construction workers could be exposed to contaminated soil. Specifically, the exposure pathways for a construction worker include:

- Inhalation of fugitive dust from soil
- Dermal contact with soil
- Incidental ingestion of soil

Aquatic Ecological Receptors

Although remote due to the site's distance to the nearest surface water body, aquatic ecological habitats may be impacted by contaminants through sediment runoff and dissolved chemicals that may enter the groundwater (and subsequently migrate to surface waters).

3.7.2 Exposure Pathway Analysis

Exposure is defined as the contact of an organism with a chemical or physical agent. An exposure pathway is defined as "the course a chemical or physical agent takes from a source to an exposed organism." It describes "a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site (US EPA, 1989)." In order for an exposure pathway to be considered potentially complete, four elements must exist: 1) a source or release from a source; 2) a transport/exposure media; 3) an exposure point (point of contact with the contaminated medium); and 4) an exposure route. The potential exposure pathways present at the property prior to remediation are described below.

A. Soil Exposure Pathway

Direct contact with soil may result in incidental oral ingestion and/or dermal absorption of contaminants of concern (COC). Although generally associated with surface soil, direct contact may also occur with subsurface soil during trenching and excavation work.

B. Air Exposure Pathway

Air exposure pathways become potential routes of exposure when COC enter the air via volatilization or via adsorption to fugitive dust particles. Volatilization occurs when COC partition to the air. Such volatilization may occur from surface soil, subsurface soil, and/or groundwater. When considering volatilization from subsurface soil or groundwater, transport of COC occurs through void spaces in unsaturated soils, asphalt, and concrete to the outdoor air or to future indoor air through foundation cracks. For this site and under current conditions, volatilization is not considered to be a concern due to the semi- to non-volatile nature of the COC.

Generation of fugitive dust may occur through disturbance of affected soil, such as wind or construction activities. Dust particles may be inhaled, may settle on human skin and be ingested (hand to mouth), and/or may settle on vegetation that may be ingested by humans.

C. Sediment Exposure Pathway

Receptors may be exposed to COC in sediment from the property as a result of surface runoff during storm events to nearby drainageways, which may eventually discharge to the ocean. Sediment may accumulate in the marine environment and be available for contact with various receptors. Recreational users of the marine environment (swimmers, surfers, fishermen) may come into direct contact with sediment and be exposed through oral ingestion and/or dermal absorption. Ecological receptors may live directly in the impacted sediment and may be exposed to COC through feeding within the sediment. As a secondary transport mechanism, COC may accumulate in ecological receptors (i.e., fish, shellfish), then be ingested by human receptors.

D. Groundwater Exposure Pathway

Groundwater beneath the site may have been impacted by surface spills through leaching from impacted soils, particularly associated with triazine pesticides. Receptors may be exposed to COC in the groundwater by direct contact or by inhaling volatile COC emitted from the groundwater to air. For this site, direct contact with groundwater is not anticipated since the aquifer is not considered to be usable as a drinking water resource and the depth to groundwater (approximately 80 feet below ground surface) makes direct human contact very unlikely. Inhalation of volatile COC is not anticipated under current site conditions due to the semi- to non-volatile nature of the COC. Although direct exposure to groundwater at the property is unlikely, the potential exists for contaminants that may leach into the groundwater to migrate or be drawn into downgradient wells.

Ecological receptors may also be affected in shallow marine environments within groundwater discharge zones. This is the primary concern associated with the groundwater exposure pathway. However, based on data obtained from on-site monitoring wells, groundwater beneath the site has not been impacted by COC.

3.8 Nature and Extent of Contamination

Based on review of current and historic data, the extent of COC impacts to soils at concentrations exceeding default DOH EALs within and adjacent to the East Kapolei PML site is shown in Figures 4 through 8 in Appendix I.

In general, the highest dioxins/furans TEQ concentrations were identified in the surface soil within the Spill Areas (decision units SA1 through SA3), with decreasing concentrations in the Investigation Areas (decision units IAT1 through IAT5 and IA1 through IA4) and the lowest concentrations out beyond the fence line. The dioxins/furans TEQ concentrations also appeared to decrease with depth, however the concentrations within the 5- to 10-foot depth layers of the Spill Area still contained elevated concentrations (e.g., vertical delineation of dioxins/furans contamination has not been completed). Elevated dioxin concentrations were also identified in surface soils outside the southwest gate, but were initially believed to be limited to within the second ring of decision units described in the August 2007 *Final Site Investigation and Preliminary Remedial Alternatives Analysis* report. A change in the EAL described in the DOH HEER Office's June 2010 technical memorandum *Update to Soil Action Levels for TEQ Dioxins and Recommended Soil Management Practices* triggered a revision to the lateral extent of dioxin impacts. This revision resulted in the inclusion of DU19 from the first "ring" of decision units and DU12 from the second "ring" of decision units to the areas beyond the East Kapolei PML site fence line that need to be addressed as dioxin-contaminated soil.

Arsenic concentrations were elevated within the Spill Areas, but concentrations generally decreased with depth and appeared to be limited to the top 2 feet of soil. Although elevated arsenic concentrations were not typically identified in the Investigation Areas, discrete sample data from outside of the fence line indicated elevated arsenic concentrations in the 1- to 2-foot layer of soil outside the southwest gate and within the intersection of the coral/dirt roadways.

Historic data indicated that elevated pentachlorophenol and triazine pesticide concentrations were generally limited to the Spill Areas of the East Kapolei PML site. Therefore, pentachlorophenol and triazine pesticides were only analyzed for soil samples within the Spill Areas. Data from the most current investigation indicated that elevated concentrations were generally limited to the surface soil layer (with the exception of decision unit area SA3, where elevated pentachlorophenol concentrations were found within the 5- to 10-foot soil layer). However, uncertainty in the data measured by the calculated standard deviation (and thus the adjusted concentrations) required that the assumption be made that pentachlorophenol and triazine pesticide contamination extend to 10 feet bgs.

Based on an overall evaluation of all available data compared to default DOH EALs, the following conclusions were made regarding the extent of contamination:

- Dioxin contamination exists within surface soils of all areas of the East Kapolei PML site (within the fence line) to depths of at least 10 feet bgs within the Spill Areas; to 5 feet in decision units IAT2, IAT4, and IAT5; to 2 feet bgs in decision units IAT1 and IAT3; and to 1 feet bgs in decision units IA1 through IA4. Discussions with DOH indicated that elevated contaminant concentrations located deeper than 10 feet bgs would constitute an incomplete direct exposure pathway since impacted soil would not be accessible to site users. However, the elevated COC may still trigger management requirements to ensure that the direct exposure pathway remains incomplete. It is also anticipated that dioxin contamination in soils outside of the fence line extend to a depth of 2 feet bgs and it is assumed that all soil and sediment in the concrete-lined ditch, from immediately adjacent to the PML site and downgradient (to Kualakai Parkway) is impacted with dioxins/furans at concentrations exceeding the default DOH EAL.

- Arsenic contamination exists in the top 2 feet of soil within the Spill Areas and within the top 2 feet of soil outside of the East Kapolei PML site fence line, within the coral/dirt roadways immediately adjacent to the southwest gate and within the roadway intersection.

- Pentachlorophenol and triazine pesticide contamination exists within the Spill Areas of the East Kapolei PML site down to 10 feet bgs.

The data indicated that while the lateral extent of contamination was generally delineated, the vertical extent of contamination was not delineated. Based on discussions with the DOH HEER Office, calculations of the total volume of soil impacted by COC should be estimated based on assumed depths through evaluation of the patterns in the data. Therefore, for the purposes of site remediation, the following areas and volumes of COC-impacted soil were targeted.

3.8.1 Spill Areas

For the Spill Areas, total volume of impacted soil was based on a depth of 10 feet bgs. Soil beneath 10 feet bgs was considered by the DOH to be unavailable for direct contact by surface receptors in unrestricted land use scenarios. Furthermore, the reported COC concentrations associated with leaching concerns at these depths were generally below their respective DOH EALs pertaining to soil leaching hazards. Total volumes of impacted soil in the Spill Areas with the associated environmental hazards are presented in Table 1, below.

Table 1: Impacted Soil Volumes, Spill Areas

Decision Unit	Depth Layer	Environmental Hazards	Total Volume (cy)
SA1	0' – 0.5'	Direct exposure, leaching to groundwater	47
	0.5' – 2'	Direct exposure, leaching to groundwater	142
	2' – 5'	Direct exposure, leaching to groundwater	284
	5' – 10'	Direct exposure, leaching to groundwater	474
SA2	0' – 0.5'	Direct exposure, leaching to groundwater	31
	0.5' – 2'	Direct exposure, leaching to groundwater	94
	2' – 5'	Direct exposure, leaching to groundwater	183
	5' – 10'	Direct exposure, leaching to groundwater	314
SA3	0' – 0.5'	Direct exposure, leaching to groundwater	19
	0.5' – 2'	Direct exposure, leaching to groundwater	58
	2' – 5'	Direct exposure, leaching to groundwater	117
	5' – 10'	Direct exposure, leaching to groundwater	194
		TOTAL	1,957

The total volume of soil impacted by COC in the Spill Areas was approximately 1,957 cubic yards (in-place, compacted). The environmental hazards associated with direct exposure and leaching to groundwater were identified for the entire volume. Dioxins/furans TEQ concentrations in the impacted soil from all decision units were well above the 1,000 ng/kg (1 part per billion) level.

Although terrestrial ecotoxicity hazards were initially identified to be associated with the elevated arsenic and pentachlorophenol concentrations, this hazard was not considered to be significant. There are no known terrestrial ecological habitats in the immediate vicinity of the site and the East Kapolei PML site is currently and has historically been located in an area used for commercial agricultural operations. Anticipated future use does not include plans that would be conducive to terrestrial ecological habitats and/or use by endangered species. Furthermore, the primary concern is human direct exposure and remedies to address this hazard would also address terrestrial ecotoxicity concerns (since the ecotoxicity EALs for arsenic and pentachlorophenol are equal to or higher than the direct exposure EALs). Therefore, the terrestrial ecotoxicity hazard was removed from consideration for the Spill Areas.

3.8.2 Investigation Areas

For the Investigation Areas, total volume of impacted soil was based on a depth of 5 feet bgs for decision units IAT1, IAT2, IAT4, and IAT5 (since dioxins and arsenic concentrations still exceeded their respective EALs at the 3-foot bgs depth limit of the trenches). For decision unit IAT3, the total volume of impacted soil was based on a depth of 2 feet bgs (since COC concentrations in the 2- to 3-foot bgs layer were below default DOH EALs). For decision units IA1 to IA4, the total volume of impacted soil was based on a depth of 2 feet bgs (since the dioxins concentrations in the 0- to 0.5-foot layer were close to the EAL and elevated concentrations were not anticipated to extend beyond the 2 foot depth). Total volumes of impacted soil in the Investigation Areas with the associated environmental hazards are presented in Table 2, below.

Table 2: Impacted Soil Volumes, Investigation Areas

Decision Unit	Depth Layer	Environmental Hazards	Total Volume (cy)
IA1	0 – 2’	Direct exposure	312
IA2	0 – 2’	Direct exposure	332
IA3	0 – 2’	Direct exposure	316
IA4	0 – 2’	Direct exposure	268
IAT1	0 – 0.5’	Direct exposure	87
	0.5’ – 2’	Direct exposure	262
	2’ – 3’	Direct exposure	174
	3’ – 5’	Direct exposure	349
IAT2	0 – 0.5’	Direct exposure	90
	0.5’ – 2’	Direct exposure	269
	2’ – 3’	Direct exposure	180
	3’ – 5’	Direct exposure	360
IAT3	0 – 0.5’	Direct exposure	53
	0.5’ – 2’	Direct exposure	160
IAT4	0 – 0.5’	Direct exposure	56
	0.5’ – 2’	Direct exposure	167
	2’ – 3’	Direct exposure	112
	3’ – 5’	Direct exposure	224
IAT5	0 – 0.5’	Direct exposure	46
	0.5’ – 2’	Direct exposure	137
	2’ – 3’	Direct exposure	92
	3’ – 5’	Direct exposure	184
		TOTAL	4,230

The total volume of soil impacted by COC (mostly dioxins, with arsenic in IAT1) in the Investigation Areas was approximately 4,230 cubic yards (in-place, compacted). The environmental hazards associated with direct exposure were identified for the entire volume. Adjusted dioxins/furans TEQ concentrations were well above the 1,000 ng/kg level in all impacted soils, with the exception of soil in decision unit IAT1 at depths of 2- to 5-feet bgs (approximately 523 cubic yards with dioxins/furans TEQ concentrations between 240 ng/kg and 1,000 ng/kg). Arsenic impacts were only identified for soil from decision unit IAT1 at depths of 2- to 5-feet bgs.

As discussed above, the terrestrial ecotoxicity hazard was removed from consideration, since addressing the direct exposure hazard associated with arsenic in the Investigation Areas would also address the terrestrial ecotoxicity hazard.

3.8.3 Outside PML Site

For areas outside of the East Kapolei PML site fence line, direct exposure hazards associated with elevated dioxin and arsenic concentrations were identified.

Direct exposure hazards associated with dioxin impacts exist in an estimated 2 feet of soil generally located between the fence line of the PML site and the second ring of decision units described in the August 2007 *Final Site Investigation and Preliminary Remedial Alternatives Analysis* report. Additional direct exposure hazards associated with dioxin impacts also existed within DU19 of the first ring of decision units and DU12 of the second ring of decision units based on the aforementioned change to the DOH EAL from 450 ng/kg to 240 ng/kg. Direct exposure concerns (terrestrial ecotoxicity hazard removed from consideration) associated with arsenic impacts also existed in these general areas in an estimated 3 feet of soil, and extend further out into the intersection of the three coral/dirt roads. A total volume of dioxin and arsenic impacted soil was estimated at approximately 3,065 cubic yards (in-place, compacted, 1,575 cubic yards dioxin impacts only, 1490 cubic yards dioxin and/or arsenic impacts). These areas are shown in Appendix I, Figure 7. Note that this volume also included soil located between the East Kapolei PML site fence line and the coral road to the east. Based on the data, the dioxins/furans TEQ concentrations in these soils were anticipated to be between 240 ng/kg and 1,000 ng/kg.

Direct exposure hazards associated with dioxin impacts also existed in the soil/sediment contained within the portions of the concrete-lined ditch adjacent to and downgradient from the East Kapolei PML site. The estimated thickness of soil/sediment in the ditch was approximately 3 feet. The ditch was approximately 3- to 4-feet wide and the total length was approximately 800 feet. The total volume of dioxin impacted soil was estimated at approximately 311 cubic yards (not compacted). Based on data from the July 3, 2000 *Site Investigation*, the anticipated dioxins/furans TEQ concentrations exceeded 1,000 ng/kg.

3.9 Applicable Remedial Action Levels

The action levels used for data comparison and evaluation were the unrestricted land use DOH EALs for sites where groundwater is not considered to be a current or potential drinking water source and where the nearest surface water body is greater than 150 meters. Specifically, the confirmation sample data were compared to the TEQ dioxins EAL of 240 ng/kg and the total arsenic EAL of 24 mg/kg associated with background concentrations in Hawaii soils.

4.0 SUMMARY OF THE ENVIRONMENTAL HAZARD EVALUATION

The Environmental Hazard Evaluation (EHE) process was developed by the Hawaii DOH to serve as a link between site investigation activities and the selected remedy to be implemented. The EHE is intended to identify potential environmental hazards associated with contaminant concentrations in site media through comparison with DOH EALs established for common environmental hazards. The March 2010 *Site Investigation Report and Environmental Hazard Evaluation* included a comparison of site data to DOH EALs for common environmental hazards associated with soil. These hazards included:

- Direct Exposure: exposure to contaminants via incidental ingestion, dermal absorption, and inhalation of vapors or dust in outdoor air
- Vapor Intrusion: emission of volatile contaminants from soil into overlying buildings
- Leaching: leaching of contamination from soil by infiltration of surface water (rainfall, irrigation, etc.) and downward migration of leachate into underlying groundwater
- Terrestrial ecotoxicity: toxicity to terrestrial flora and fauna
- Gross contamination: potentially mobile free product, odors, aesthetics, explosive hazards, and general resource degradation

4.1 Contaminants of Concern

Multiple lines of evidence, including data obtained from previous investigations at the site and descriptions of historic use, were used to identify the COC for the East Kapolei PML site. The suspected sources of contamination at the East Kapolei PML site included the bulk storage, mixing, and distribution of pesticides and herbicides during sugarcane cultivation operations. Specifically, COC included:

- Arsenic (metal associated with historic pesticides);
- Polychlorinated dibenzo-dioxins/polychlorinated dibenzo-furans (dioxins/furans, associated with pentachlorophenol);
- Pentachlorophenol (chlorinated herbicide); and
- Triazine pesticides (specifically ametryn, atrazine, simazine, and trifluralin).

Note that other chlorinated herbicides and organochlorine pesticides were excluded from the COC list based on historical data. Pentachlorophenol and triazine pesticides were included based on elevated concentrations (i.e., exceeding appropriate action levels) in recent samples and based on their common usage in the Hawaii sugar industry. The presence of these COC at elevated concentrations, particularly in the "Spill Areas" (decision units SA1 through SA3 shown in Figures 6 and 8 in Appendix I), was confirmed during the site investigation phase of work.

4.2 Environmental Hazard Evaluation Summary

Data from the most recent investigation were used to identify the extent and magnitude of existing environmental hazards within the fenced East Kapolei PML site. Historical data for areas outside of the East Kapolei PML site boundaries (i.e., outside of the fence line) were used to assess the lateral extent of COC impacts and identify existing environmental hazards. All DOH EALs used for comparison were based on unrestricted land use scenarios, based on reference documents that indicated groundwater beneath the site is not a current or potential drinking water source and the nearest surface water body is greater than 150 meters from the property.

A summary of the existing environmental hazards within the East Kapolei PML site is presented by decision unit in Table 3 below. These environmental hazards, as well as hazards outside of the East Kapolei PML site fence line, are shown in Appendix I, Figures 7 and 8.

Outside of the East Kapolei PML site fence line, direct exposure and terrestrial ecotoxicity hazards associated with elevated arsenic concentrations were identified in surface and near surface soil south and southwest of the PML, generally adjacent to the southwest gate and within the coral/dirt road intersection. Furthermore, direct exposure hazards associated with elevated dioxins/furans TEQ concentrations were identified in surface soil southwest of the site out to the second decision unit ring (and including DU12 of the second decision unit ring) identified in the August 2007 *Final Site Investigation and Preliminary Remedial Alternatives Analysis* report and within portions of the concrete-lined irrigation ditch adjacent to and southwest of the PML site. The estimated extent of direct exposure hazards and leaching to groundwater hazards are presented in Appendix I, Figures 7 and 8.

As previously discussed, although terrestrial ecotoxicity hazards were identified to be associated with the elevated arsenic and pentachlorophenol concentrations, this hazard was not considered to be significant. There are no known terrestrial ecological habitats in the immediate vicinity of the site and the East Kapolei PML site is currently and has historically been located in an area used for commercial agricultural operations. Anticipated future use does not include plans that would be conducive to terrestrial ecological habitats and/or use by endangered species. Furthermore, the primary concern is human direct exposure and remedies to address this hazard would also address terrestrial ecotoxicity concerns (since the ecotoxicity EALs for arsenic and pentachlorophenol were equal to or higher than the direct exposure EALs).

Table 3: Summary of Environmental Hazards

Decision Unit	Type/ Depth	Layer Vol. (cy)	Direct Exposure	Terrestrial Ecotoxicity	Leaching to Groundwater
SA1.A	0-0.5’	47.4	Dioxins, As, PCP, ametryn, atrazine	As, PCP	PCP, ametryn, simazine
SA1.B	0.5'-2'	142.2	Dioxins, As, PCP, atrazine	As, PCP	PCP, ametryn
SA1.C	2'-5'	284.4	Dioxins, PCP, atrazine	PCP	PCP, ametryn
SA1.D	5'-10'	474.1	Dioxins, PCP, atrazine	PCP	PCP, ametryn
SA2.A	0-0.5’	31.4	Dioxins, As, PCP, ametryn, atrazine	As, PCP	Dioxins, PCP, ametryn, atrazine, simazine
SA2.B	0.5'-2'	94.2	Dioxins, As, PCP, atrazine	As, PCP	PCP, ametryn
SA2.C	2'-5'	183.3	Dioxins, PCP, atrazine	PCP	PCP, ametryn
SA2.D	5'-10'	313.9	Dioxins, PCP, atrazine	PCP	PCP, ametryn
SA3.A	0-0.5’	19.4	Dioxins, As, PCP, atrazine, simazine	As, PCP	Dioxins, PCP, ametryn, atrazine, simazine
SA3.B	0.5'-2'	58.3	Dioxins, PCP, atrazine	PCP	PCP, ametryn
SA3.C	2'-5'	116.7	Dioxins, PCP, atrazine	PCP	Dioxins, PCP, ametryn
SA3.D	5'-10'	194.4	Dioxins, PCP, atrazine	PCP	PCP, ametryn
IA1	0-0.5’	78	Dioxins		
IA2	0-0.5’	83	Dioxins		
IA3	0-0.5’	78.8	Dioxins		
IA4	0-0.5’	66.9	Dioxins		
IAT1.A	0-0.5’	87.2	Dioxins		
IAT1.B	0.5'-2'	261.7	Dioxins		
IAT1.C	2'-3'	174.4	As	As	
IAT2.A	0-0.5’	89.8	Dioxins		
IAT2.B	0.5'-2'	269.4	Dioxins		
IAT2.C	2'-3'	179.6	Dioxins		
IAT3.A	0-0.5’	53.4	Dioxins		
IAT3.B	0.5'-2'	160.3	Dioxins		
IAT3.C	2'-3'	106.9			
IAT4.A	0-0.5’	55.6	Dioxins		
IAT4.B	0.5'-2'	166.7	Dioxins		
IAT4.C	2'-3'	111.1	Dioxins		
IAT5.A	0-0.5’	45.6	Dioxins		
IAT5.B	0.5'-2'	136.7	Dioxins		
IAT5.C	2'-3'	91.1	Dioxins		

5.0 REMEDIAL ACTION TASKS

The May 2010 *Remedial Alternatives Analysis Report, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)* (referred to as the RAA) was prepared to provide a comparative evaluation of potential remedial strategies that may be appropriate for addressing the environmental hazards identified at the site. The principal considerations that the remedial alternatives were weighed against included:

- Overall protection of human health and the environment;
- Compliance with applicable regulations;
- Reduction of contaminant toxicity/mobility/volume;
- Long-term effectiveness;
- Short-term effects;
- Technical feasibility;
- Administrative feasibility; and
- Overall cost.

The various alternatives considered included:

- Alternative 1: No action;
- Alternative 2: Geomembrane liner cover system;
- Alternative 3: Limited excavation and placement of soil cover;
- Alternative 4: Thermal desorption and placement of soil cover; and
- Alternative 5: Excavation and off-site treatment/disposal.

Each alternative was given a score of 1 to 5 for each criterion in relation to the other alternatives. The alternative with the highest ranking for a specific criterion was given a score of 5 and the alternative with the lowest ranking for a specific criterion was given a score of 1. Based on the comparison of alternatives, the geomembrane liner cover system was selected as the highest ranking remedial alternative and identified as the preferred alternative. The overall rankings are shown in Table 4, below.

Table 4: Ranking of Remedial Alternatives

Criteria	Alternative				
	1	2	3	4	5
Effectiveness: Overall protection of human health & the environment	1	4	3.5	3.5	5
Effectiveness: Compliance with ARARs	1	5	4	3	2
Effectiveness: Reduction of toxicity, mobility, and volume	1	2	3	4	5
Effectiveness: Long-term effectiveness	1	4	2	3	5
Effectiveness: Short-term effects	5	4	2	3	1
Implementability: Technical feasibility	5	4	3	1	2
Implementability: Administrative feasibility	1	4	2	3	5
Overall Costs	5	4	3	2	1
Composite Score	20	31	22.5	22.5	26

The August 2010 *Final Response Action Memorandum, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)* (referred to as the Final RAM) was prepared to summarize pertinent site information, provide a concise summary of environmental investigation data and the associated environmental hazards, document the basis for remediation, and describe the rationale for selection of the preferred remedial alternative. Based on review of submitted comments during the public comment period, a final remedy was selected for the site.

5.1 Description of the Selected Remedial Alternative

Based on the comparative analysis of remedial alternatives using the specified screening criteria and submitted comments during the public comment period, the geomembrane liner cover system (GLCS) was selected as the final remedy to address environmental hazards at the East Kapolei PML site.

5.1.1 Description of Selected Remedy

The GLCS alternative utilizes engineering controls and institutional controls to address the environmental hazards identified at the East Kapolei PML site. Engineering controls include placement of a visual indicator barrier (such as orange construction fencing) over the contaminated soil to warn against further excavation, subgrade preparation, a geotextile protection layer, a 60-mil high density polyethylene (HDPE) geomembrane layer, placement of a metallic barrier tape grid detectable via electromagnetic or ground penetrating radar instrumentation, a compacted soil cover layer, and a top soil layer with vegetation.

Institutional controls may include:

- Limitations on the future land use maintained in perpetuity (such as a Uniform Environmental Covenant that gets filed with the property deed) to avoid activities that may compromise the integrity of the engineering controls (e.g., excavation or drilling through the soil cap and geomembrane liner).

- Preparation and implementation of an Environmental Hazard Management Plan to describe, at a minimum, appropriate cap maintenance/reporting requirements, prohibited activities that may compromise the integrity of the engineering controls, appropriate soil handling and worker/area protection requirements should disturbance of the contaminated soils be unavoidable, and appropriate mitigation measures if a portion of the soil cap and/or geomembrane liner is breached.

Prior to system installation, off-site areas of contamination (i.e., areas located outside of the East Kapolei PML site fence line as shown in Appendix I, Figure 9) would be excavated and transported to the site. Residual contaminant levels would be verified in these excavations by way of multi-incremental samples. Clean fill material would then be utilized to replace the excavated material.

The COC-impacted soils relocated onto the site would then be graded and compacted to provide a relatively firm and even surface. Thereafter, the visual barrier would be placed over the contaminated soil. Clean, low permeability soil would then be imported onto the site; placed on top of the visual barrier and over the Spill Areas (areas where leaching to groundwater environmental hazards were identified), and compacted to form an approximate 24-inch thick layer. This layer would provide the uniformly firm and smooth surface needed to minimize/prevent differential settlement and potential damage to the HDPE liner. A layer of non-woven geotextile fabric would then be installed immediately above the subgrade.

The 60-mil geomembrane liner would then be placed above the geotextile fabric. Liner seams will need to be welded by personnel with experience in these types of installation and the contractor installing the liner will need to perform its own quality control. To ensure proper installation, independent quality assurance checks should be performed by experienced and knowledgeable personnel. Care should be taken to minimize the liner's solar exposure to minimize material degradation.

Following installation of the liner, similar low-permeability soil would be placed and compacted in the remaining areas of the site (i.e., Investigation Areas) to match the elevation of the area covered with the liner. A metallic barrier tape grid would then be placed across the filled areas of the East Kapolei PML site. The grid of metallic tape can be detected using geophysical means (i.e., when toning to identify underground utility lines prior to excavation) and will serve as a mechanism to warn of the contaminated soil. Upon completion of the barrier tape grid layout, a low-permeability soil cover layer would be placed and compacted to an approximate 24-inch thickness. This layer should be constructed of the same material as the subgrade, inclusive of a 6-inch layer of top soil at the surface. The top soil should be seeded or vegetated following placement, but the final ground cover would be dependent upon future land use plans. This cap system will isolate soils with contaminant concentrations that exceed field area background levels due to historic pesticide mixing/loading operations from potential human receptors.

The layering system described above would create multiple barriers between contaminated soils and potential receptors, therefore mitigating the direct exposure hazard associated with contaminant concentrations in site soils. The 60-mil HDPE (or equivalent) liner would provide the primary barrier against storm water infiltration through the contaminated soil, therefore preventing migration of contaminants via soil leaching. The visual barrier and the metallic barrier tape grid would provide a warning system to minimize the potential for future disturbance of the contaminated soils. A conceptual plan view drawing of the geomembrane liner cover system is presented in Appendix I, Figure 9 and a conceptual cross section drawing of the liner system is presented in Appendix I, Figure 10.

Various geomembrane industry sources have suggested that, with good periodic maintenance practices, the life expectancy of a HDPE geomembrane liner in buried applications can be up to 200 years. After completion, the GLCS and soil cap should be inspected on a quarterly basis to detect damage, stress, or any other detrimental conditions.

5.1.2 Benefits and Drawbacks

The primary benefits of the GLCS alternative include the following:

- Adequately addresses the two environmental hazards identified at the site – human direct exposure and contaminant leaching from soil – through use of engineering controls and institutional controls.

- Provides reliable, long-term protection of overall human health by isolating soils with contaminant concentrations that exceed field area background levels due to historic pesticide mixing/loading operations from human contact.

- The 60-mil HDPE (or equivalent) liner will prevent infiltration of surface water through the pesticide-contaminated soil, therefore minimizing and/or eliminating the potential generation of contaminated leachate that may migrate to the underlying groundwater.

- Minimal potential for migration of contaminants during implementation (e.g., no vapors generated, minimal soil handling, no transportation of wastes off-site).

- The visual indicator barrier and the metallic barrier tape grid will provide a physical warning system to minimize the potential for disturbance of contaminated soil through future excavation work.

- Implementation of the remedy is well understood since this type of installation has been performed for other sites within the State for various purposes, including the encapsulation and isolation of waste.

- Cost of implementation is anticipated to be relatively low, therefore the remedy would have a lesser effect on DHHL's operations and other projects/programs funded using the Hawaiian Home Lands trust funds as compared to other remedial alternatives.

- Cost savings during site development may be realized since less soil would need to be imported to fill the site (e.g., no soil removal planned as part of the remedy).

The primary drawbacks of this remedial alternative include the following:

- This alternative will not reduce the toxicity or volume of the contaminants, it will only isolate and immobilize the contaminated media. Natural degradation of certain contaminants may occur over time, however arsenic and dioxins/furans concentrations are anticipated to remain constant.

- Specialized equipment, material, and personnel will be needed to implement this remedy.

- Institutional controls will need to be put into place to avoid damage to the geomembrane liner cover system and prevent disturbance of the underlying contaminated soil.

- There will be limitations on future land development (e.g., construction activities that require excavation for the installation of underground utilities, structural foundations, etc.) directly atop the geomembrane liner and in a surrounding setback no less than 50 feet.

- Regular monitoring of the surface soil layers and the vegetation will be needed, as well as maintenance of the soil and vegetation to avoid compromising the geomembrane liner.

5.1.3 Environmental Hazard Evaluation – Post Implementation

The data obtained from historic investigation activities and the more recent site investigation identified direct exposure and leaching as the two significant environmental hazards associated with existing conditions at the site. An appropriate remedial alternative would need to address both these existing hazards in order to be considered an effective and viable solution to protect human health and the environment. The remaining three hazards (vapor intrusion, gross contamination, and terrestrial ecotoxicity) were considered to be insignificant in comparison and/or would be mitigated if direct exposure and leaching hazards were addressed.

The preferred GLCS remedial alternative addresses both direct exposure and leaching hazards through the use of engineering and institutional controls. Placement of the compacted soil sub-base, 60-mil HDPE (or equivalent) geomembrane liner, the compacted soil layer above the liner, and vegetated topsoil layer (or other type of groundcover, which may include asphalt or concrete pavement, etc.) provides an effective mechanism to break exposure pathways between anticipated receptors of concern (future site users, future residents in surrounding areas, future site construction workers, and aquatic ecological receptors) and the COC-impacted soil. The physical presence of the soil layers and the geomembrane liner will prevent direct exposure to human receptors and the presence of the impermeable geomembrane liner will mitigate concerns associated with surface water infiltration through the COC-impacted soil and the creation of contaminated leachate that may migrate to the underlying groundwater. The presence of the visual indicator barrier and the metallic barrier tape grid provides a physical warning system to indicate the presence of the contaminated soil and to minimize/prevent the occurrence of contaminated soil disturbance through future excavation activities. A Conceptual Site Model diagram depicting the conditions at the site after implementation of the preferred alternative has been included in Appendix II.

In order to maintain the integrity of the engineering controls, institutional controls would need to be implemented to avoid re-establishment of exposure pathways.

5.2 Project Goal

The primary goal of the remedial action is to mitigate direct exposure and leaching hazards by breaking the exposure pathways. This goal has been accomplished by consolidating contaminated soil within the boundaries of the former East Kapolei PML site and placing both a soil and geomembrane liner cap on top of the soil to isolate the contaminants from future site users, as well as preventing percolation of surface water through the contaminated soil. Long-term exposures will be mitigated through use of institutional controls, such as deed restrictions or a Uniform Environmental Covenant to be enforced in perpetuity and the preparation of/compliance with an Environmental Hazard Management Plan (included as Section 9.0 in this report).

5.3 Remedial Approach

The general work items performed by ETC and DHHL's selected contractor, RHS Lee, to implement the remedial action included the following tasks:

- Closed the three existing groundwater monitoring wells located adjacent to and within the East Kapolei PML site (see Appendix V for June 8, 2011 *Groundwater Sampling and Monitoring Well Closure Report*).

- Obtained a National Pollutant Discharge Elimination System (NPDES) permit through DOH Clean Water Branch (see Appendix VI for copy of the Notice of General Permit Coverage).

- Obtained a Grading Permit through the City & County of Honolulu, Department of Planning and Permitting (see Appendix VI for copy of the Erosion Control Plan and Grading Permit).

- Mobilized heavy equipment and 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) certified personnel to the project site.

- Delineated the work area and established appropriate site security measures.

- Implemented best management practices (BMPs) to address potential dust, erosion, and/or sediment runoff issues. Maintained BMPs throughout all stages of work.

- Identified and demarcated excavation areas outside of the East Kapolei PML site fence line.

- Excavated arsenic-impacted soil outside of the PML site fence line to a depth of 3 feet below existing surface grade.

- Excavated dioxin-impacted soil outside of the PML site fence line to a depth of 2 feet below existing surface grade.

- Excavated suspect dioxin-impacted soil within the adjacent irrigation ditch.

- Following excavation of soil and sediment in the concrete irrigation ditch, the integrity of the ditch was inspected. There were no significant cracks or deterioration observed within the concrete floor of the irrigation ditch.

- Demolished and removed the subsurface culvert portions of the irrigation ditch beneath the field roads.

- Backfilled the portion of the irrigation ditch fronting the PML site with Controlled Low-Strength Material (CLSM, a self-compacted cementitious material).

- Transported the arsenic- and dioxin-impacted soil onto the PML site (i.e., within the existing fence line).

- Collected confirmation soil samples from the base of the excavated areas and analyzed the samples for total arsenic and/or dioxins/furans.

- Excavated an additional 2 feet of arsenic- and dioxin-impacted soil from select areas due to elevated arsenic and dioxin concentrations in the initial round of confirmation samples.

- Transported the arsenic- and dioxin-impacted soil onto the PML site (i.e., within the existing fence line).

- Collected a second round of confirmation soil samples from the base of the excavated areas and analyzed the samples for total arsenic and/or dioxins/furans.

- Graded arsenic- and dioxin-impacted soil within the PML site to create a flat surface grade. Compacted the soil using maximum loose lift thicknesses of 8 inches to the specified 90% +/- 2% of maximum dry density and confirmed compaction through testing by a geotechnical engineer (Hirata & Associates, Inc.).

- Since the second round of confirmation sampling indicated that remaining soil within the excavations outside of the PML site fence line had arsenic and dioxins/furans concentrations below project action levels, the RHS Lee backfilled and compacted the excavations with clean fill material that had been generated during previous development by DHHL in close proximity to the PML site. This fill material originated from areas previously evaluated by the DOH during an investigation of the East Kapolei development area documented in the December 12, 2007 *Final Site Assessment Report, East Kapolei Affordable Housing Project, Kapolei, Oahu, Hawaii* prepared by Tetra Tech EM Inc. for the DOH HEER Office. This clean fill material also met project specifications for use as low permeability soil, as well as top soil following on-site screening of the material.

- Decontaminated all heavy equipment used to excavate, haul, grade, and compact contaminated soil using dry methods within the PML site.
- Placed orange construction fencing to serve as a visual indicator barrier on top of compacted, contaminated soil within the PML site boundaries.
- Transported fill material from the borrow site for use in creating the first 24-inch thick layer of the soil cap.
- Placed fill material in 8-inch loose lifts, moistened the soil using a water truck, and compacted the lifts to 90 percent (+/- 2 percent) of maximum dry density.
- Placed 16-ounce, polypropylene geotextile fabric and 60-mil HDPE geomembrane liner over specified areas (i.e., Spill Areas of the site). The geotextile fabric and geomembrane liner extended a minimum of 5 feet beyond the identified boundaries of the Spill Areas.
- Welded the geomembrane liner seams to create a contiguous barrier completely impervious to surface water infiltration.
- Performed appropriate quality assurance/quality control (QA/QC) inspections and testing of the geomembrane liner to ensure that installation met or exceeded appropriate industry standards. A report documenting QA/QC on the geomembrane liner and liner installation was prepared by Manthos Engineering and is included in Appendix VIII.
- Placed a second layer of 16-ounce, polypropylene geotextile fabric on top of the geomembrane liner.
- Placed and anchored a grid of 6-inch wide, 5-mil thick metallic barrier tape, spaced at 10-feet apart, on top of the second layer of geotextile fabric. The marking tape was imprinted with the warning message: “Caution! Stop Digging! Arsenic and Dioxin Contaminated Soil Below, Contact Hawaii Department of Health.”
- Transported fill material from the borrow site for use in creating the second 24-inch thick layer of soil cap.
- Screened soil within the borrow site to meet project specifications for top soil.
- Placed fill material in 8-inch loose lifts, moistened the soil using a water truck, and compacted the lifts to 90 percent (+/- 2 percent) of maximum dry density.
- Installed concrete filled pipe bollards around the perimeter of the capped area to provide a visual indication of the contaminated soil location.

- Seeded and established vegetation at the new ground surface.
- Removed BMPs and demobilized heavy equipment.

5.4 Construction Details

Construction activities were performed in accordance with the plan drawings and project specifications that were made available for bid by qualified contractors. The project specifications and updated plan drawings are provided in Appendix IV.

The project specifications required the contractor to prepare a summary report following completion of site activities. The summary report was prepared by Quinn Consultants, Inc. on behalf of RHS Lee, Inc. This report is included in Appendix IX. In addition to the report, RHS Lee, Inc. provided copies of all air monitoring laboratory reports. A summary of the air monitoring data is also included in Appendix IX.

The project specifications detailed requirements for compaction of contaminated soil within the PML site, as well as compaction requirements for the subsequent layers of low permeability soil. A summary report, documenting the completion of grading activities, was prepared by Hirata & Associates, Inc. for submittal to the City & County of Honolulu, Department of Planning & Permitting to close out the site grading permit. This summary letter has been included in Appendix X.

The liner system was installed by RHS Lee's subcontractor, Northwest Liners. In order to ensure proper installation of the liner system, the contractor was required to provide quality control testing and DHHL's liner consultant, Manthos Engineering, LLC performed quality assurance testing on the liner system components and installation. The Construction Quality Assurance Report prepared by Manthos Engineering, LLC has been included in Appendix VIII.

5.5 Field Observations during Remedial Action Activities

Field observations made throughout the remediation project indicated that RHS Lee personnel were following project specifications. An unforeseen circumstance that was encountered during construction was the presence of a live, PVC water line used for agricultural purposes running through soil excavation areas. This water line initially created problems associated with excavating to the specified depths, however these problems were mitigated and soil excavation depths were achieved. No other problems or issues were encountered during site remediation activities.

6.0 CONFIRMATION SAMPLING ACTIVITIES

The primary purpose of the confirmation sampling activities performed as part of the remedial action was to ensure that soil with elevated arsenic and dioxin concentrations located outside of the planned cap area was sufficiently removed. Sufficient removal and relocation of impacted soil ensured that the remedial action effectively addressed exposure pathways for future users of the site and surrounding areas.

6.1 Initial Confirmation Sample Collection

Confirmation soil sample collection was initially planned for areas outside of the East Kapolei PML site boundaries following excavation and relocation of impacted soils. A total of thirteen decision units were initially established within the excavated areas based on data from previous investigations. Flags were used to indicate physical boundaries in areas where boundaries were not readily evident (i.e., no excavation "wall" to indicate decision unit boundary). These initial decision units are shown in Appendix I, Figure 11.

In March and April 2012, multi-incremental confirmation samples were collected in a systematic, random manner (i.e., collected soil increments from random locations within the decision unit, but ensuring that each portion of the decision unit was represented) from the surface of each decision unit (excavation floors). Each increment was collected with a stainless steel scoop and placed into a one-gallon resealable polyethylene bag. The same tool was used to collect all soil increments from a particular decision unit. Once the entire multi-incremental sample was collected, the sampling tool was discarded and disposed as solid waste. A total of fifty soil increments were collected from each decision unit.

A total of thirteen primary samples were collected from the thirteen decision units. In addition, two field replicate multi-incremental samples were collected from DU1 and two field replicate multi-incremental samples were collected from DU8 for quality control purposes. A total of seventeen multi-incremental soil samples were collected.

6.2 Follow-Up Confirmation Sample Collection

Analytical data received in April 2012 from the initial confirmation sampling activities indicated that residual arsenic and dioxin concentrations remained above unrestricted land use EALs in nine of the thirteen decision units. Therefore, DHHL instructed RHS Lee to excavate an additional 2 feet of soil from decision units DU1 through DU5, DU7 through DU9, and DU11. The additional excavated soil was placed within the former PML site and addressed in the same manner as previously excavated soils.

In December 2013 and January 2014, additional multi-incremental confirmation samples were collected in a systematic, random manner from the surface of nine decision units (Appendix I, Figure 12). The samples were collected in the same manner as the initial confirmation soil samples described in Section 6.1.

A total of nine primary samples were collected from the nine decision units. In addition, two field replicate multi-incremental samples were collected from DU1 for quality control purposes. A total of eleven multi-incremental soil samples were collected.

6.3 Sample Control Procedures

All sample containers (re-sealable polyethylene bags) were labeled with the project name, sample identification number, date/time of sample collection, sampler's initials, and the requested analyses. The samples were kept in a sample cooler pending delivery to TestAmerica – Honolulu (TA-H) in Aiea, Hawaii for processing and analysis.

Personnel collecting the soil samples donned a new pair of disposable nitrile gloves at each decision unit. Only new or pre-cleaned sampling tools and/or containers were used to collect soil samples.

The sample labeling, or sample naming, procedure for samples collected and analyzed during this field investigation used the following format.

C*x*-DU*y* where:

x	=	round of confirmation sampling (C1 or C2)
y	=	numeric decision unit identification

Field replicate samples were labeled in a similar manner as described above using fictitious depth layer designations such that the samples are indistinguishable from primary samples.

Soil samples remained in the possession of ETC personnel and were hand-delivered to TA-H with completed chain-of-custody documentation for multi-incremental subsample processing in accordance with the DOH HEER Office's Interim Final *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan* (DOH HEER TGM), which includes air-drying, sieving, and obtaining representative subsamples using either an appropriate mechanical splitter or through multi-increment sampling protocols. TA-H was instructed to analyze the processed samples for total arsenic via EPA Method 6010B and/or dioxins/furans via EPA Method 8290.

6.4 Data Quality

Quality control (QC) check samples used for this project included field replicate soil samples and laboratory QC samples specified in the applicable EPA methodologies.

6.4.1 Field Quality Control Evaluation

ETC collected one primary multi-incremental sample and two field replicate multi-incremental samples (i.e., field triplicate samples) at a frequency of one set of field triplicate samples for every ten primary multi-incremental samples (10%) for quality control purposes. The primary sample and the two field replicate samples were collected in the same manner, as if three separate multi-incremental samples were being collected from the same decision unit.

In the initial round of confirmation sample collection, two sets of field triplicates were collected, one set from decision unit DU1 and one set from decision unit DU8. In the second, follow-up round of confirmation sample collection, one set of field triplicates was collected from decision unit DU1.

Since data from multi-incremental samples theoretically provides estimates of the mean concentrations in the particular decision unit being assessed, a measure of the variation from the mean and the effects of sampling error is needed to evaluate how that variation affects the decision making process. In an effort to conservatively account for variance in the data, the relative standard deviation (RSD) was calculated for each set of triplicate samples and the RSDs were applied to the reported concentrations for each multi-incremental sample. The resulting "adjusted" concentrations were used to make decisions regarding the adequacy of soil excavation.

6.4.2 Laboratory Quality Control Evaluation

Review of laboratory QC data was completed by TA-H prior to delivery to ETC. Upon receipt of the analytical results, ETC performed additional review of QC data to determine whether analytical data is acceptable for use in the context of this field investigation. ETC's evaluation included an assessment of laboratory QC data, such as surrogate recoveries, MS/MSD percent recoveries and RPDs, and LCS/LCSD percent recoveries and RPDs. Although the laboratory reported data with qualifier flags, review indicated that data quality was satisfactory for use in determining whether arsenic and/or dioxin contaminated soils were sufficiently removed from areas outside of the PML site.

7.0 CONFIRMATION SAMPLING ANALYTICAL RESULTS

The results of confirmation sampling activities are provided below.

7.1 Confirmation Sample Data

A summary of confirmation sampling data from the initial round of sample collection are presented in Table 5 below. Tables summarizing dioxin TEQ calculations and the actual laboratory reports are presented in Appendix VII.

Table 5: Analytical Data – Initial Confirmation Samples

Sample ID	Dioxin TEQ (ng/kg)	Adjusted Dioxin TEQ (ng/kg	Arsenic (mg/kg)	Adjusted Arsenic (mg/kg)
C1-DU1	220	**626**	11.6	11.8
C1-DU1-12	**668**		9.9	
C1-DU1-24	224		11.3	
C1-DU2	280	**473**	11	11.9
C1-DU3	61	103	**44**	**47.5**
C1-DU4	--	--	**43**	**46.4**
C1-DU5	--	--	**59.3**	**64.0**
C1-DU6	108	183	--	--
C1-DU7	221	**373**	--	--
C1-DU8	**310**	**385**	--	--
C1-DU8-12	233		--	--
C1-DU8-24	140		--	--
C1-DU9	142	**240**	--	--
C1-DU10	75	127	--	--
C1-DU11	**393**	**538**	--	--
C1-DU12	118	199	--	--
C1-DU13	138	233	--	--
DOH EALs	**240**		**24**	

Dioxin TEQs calculated based on 2005 World Health Organization Toxicity Equivalence Factors.
Dioxin TEQ concentrations reported as nanograms per kilogram.
Arsenic concentrations reported as milligrams per kilogram.
Adjusted values = reported concentration plus highest relative standard deviation (RSD)
For triplicate samples (DU1 and DU8), the mean of the three reported values were used to calculate adjusted value.
Highest calculated RSD of 69% used to obtain adjusted dioxin TEQ values.
Calculated RSD of 8% used to obtain adjusted arsenic values.
Boldfaced, shaded values exceed DOH EAL
-- = not analyzed
DOH EAL = DOH EAL for unrestricted land use

Based on the data from the initial round of confirmation sampling, an additional 2 feet of soil was excavated from decision units DU1 through DU5, DU7 through DU9, and DU11. Following additional excavation, a second round of confirmation sampling was performed. A summary of confirmation sampling data from the follow-up round of sample collection are presented in Table 6 below. Tables summarizing dioxin TEQ calculations and the actual laboratory reports are presented in Appendix VII.

Table 6: Analytical Data – Follow-Up Confirmation Samples

Sample ID	Dioxin TEQ (ng/kg)	Adjusted Dioxin TEQ (ng/kg	Arsenic (mg/kg)	Adjusted Arsenic (mg/kg)
C2-DU1	31	56	9.5	9.4
C2-DU1-12	55		8.0	
C2-DU1-24	46		8.4	
C2-DU2	32	41	3.0 J	3.3
C2-DU3	31	40	2.9 J	3.2
C2-DU4	--	--	14	15.3
C2-DU5	--	--	7.6	8.3
C2-DU7	22	28	--	--
C2-DU8	43	55	--	--
C2-DU9	182	233	--	--
C2-DU11	132	169	--	--
DOH EALs	**240**		**24**	

Dioxin TEQs calculated based on 2005 World Health Organization TEFs.
Dioxin TEQ concentrations reported as nanograms per kilogram.
Arsenic concentrations reported as milligrams per kilogram.
Adjusted values = reported concentration plus highest relative standard deviation (RSD)
For triplicate samples (DU1), the mean of the three reported values were used to calculate adjusted value.
Calculated RSD of 28% used to obtain adjusted dioxin TEQ values.
Calculated RSD of 9% used to obtain adjusted arsenic values.
-- = not analyzed
DOH EAL = DOH EAL for unrestricted land use

7.2 Field Replicates Evaluation

For the initial round of confirmation sampling, two sets of field replicates were collected, one set from decision unit DU1 (analyzed for arsenic and dioxins) and one set from decision unit DU8 (analyzed for dioxins only). The resulting RSD for arsenic was 8% (DU1) and the resulting RSDs for dioxin TEQ were 69% (DU1) and 37% (DU8). The arsenic RSD (8%) and the highest dioxin TEQ RSD (69%) were used to calculate the "adjusted" arsenic and dioxin TEQ concentrations using the formula:

Concentration + (Concentration x %RSD) = Adjusted Concentration

The adjusted concentrations were then compared to DOH EALs and used to determine whether additional excavation was needed. This evaluation resulted in the decision to excavate an additional 2 feet of soil within decision units DU1 – DU5, DU7 – DU9, and DU11.

For the follow-up round of confirmation sampling, one set of field replicates was collected from decision unit DU1. The resulting RSD for arsenic was 9% and the resulting RSD for dioxin TEQ was 28%. The RSDs were used to calculate the adjusted dioxin TEQ and arsenic concentrations. Comparison of the conservative adjusted concentrations to DOH EALs indicated that arsenic and dioxin TEQ concentrations were below DOH EALs and therefore no further excavation was required.

8.0 POST REMEDIATION ENVIRONMENTAL HAZARDS

The data obtained from previous site investigations identified direct exposure and leaching as the two significant environmental hazards associated with the site. The vapor intrusion, gross contamination, and terrestrial ecotoxicity hazards were considered to be insignificant in comparison and/or would be mitigated if direct exposure and leaching hazards were addressed.

The selected remedial alternative, excavation of contaminated soils outside of the PML area and consolidating the excavated soils within the PML area beneath a geomembrane liner system and a cap of clean, imported soil, addressed both direct exposure and leaching hazards through the use of engineering controls. A Conceptual Site Model diagram depicting the conditions at the site after implementation of the preferred alternative has been included in Appendix II.

9.0 ENVIRONMENTAL HAZARD MANAGEMENT

In order to maintain the integrity of the engineering controls, institutional controls should be implemented to avoid re-establishment of exposure pathways. Such controls should include placing limitations on the future use of the capped area to avoid activities that may compromise the integrity of the engineering controls (e.g., excavation or drilling through the soil cap and geomembrane liner system) and conducting regular maintenance and monitoring of the soil cap. At no time should this area be used for residential purposes.

9.1 Long-Term Monitoring and Maintenance

The condition of the vegetation and soil cap should be inspected and the inspection should be documented in an inspection report on a quarterly basis. Specifically, the inspector should visually inspect the entire cap area within the pipe bollards to identify:

- Signs of potential erosion or other potential degradation/breach of the soil cap.
- Cracks in the soil that may lead to solar exposure of the geomembrane liner.
- Areas of water ponding.
- Any large shrubs or trees that may be growing within the soil cap.

If maintenance items are identified, the current property operator should immediately take steps to mitigate any potential breach. For areas where erosion or cracks in the soil are noted, clean soil should be brought on-site to fill the void left by erosion and the area should be re-vegetated. Water ponding situations should be remedied by adding soil to depressions. Any large shrubs or trees should be immediately removed to prevent the root system from penetrating through the liner system and/or into the underlying contaminated soil.

Example inspection and maintenance report forms have been included in Appendix XI for use by the property owner and/or operator.

9.2 Mitigation Measures

Should a situation arise where the soil cap is breached down to the underlying contaminated soil (e.g., excavation/drilling through the geomembrane liner, excavation/drilling through the visual indicator barrier), the owner/operator of the property should immediately contact the DOH HEER Office at (808) 586-4249 to report the breach. Any excavated soil from beneath the visual indicator barrier should be segregated, temporarily placed on 10-mil polyethylene sheeting or similar material, then covered with 10-mil polyethylene sheeting or similar. This contaminated soil will then need to be characterized for off-site disposal or placed back into the excavation beneath a soil cap of similar thickness described in this report.

Repairs should be implemented immediately to prevent further exposure to contaminated soil and to prevent migration of surface water through contaminated soils beneath the geomembrane liner. If the geomembrane liner has been penetrated, then the soil surrounding the breach will need to be excavated and the geomembrane liner will need to be patched by welding pieces of 60-mil HDPE liner. The geotextile fabric will similarly need to be repaired and the excavation will need to be backfilled in a similar manner described in this report.

If the breach does not impact contaminated soils beneath the visual indicator barrier, then low permeability soil should be placed/compacted within the excavation to restore the soil cap and the surface should be re-vegetated to prevent future erosion of the soil cap.

10.0 CONCLUSIONS

The selected remedial alternative was implemented at the East Kapolei PML site in accordance with the construction plans/specifications and the October 2010 *Remedial Action Work Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)*. Activities included the removal and closure of three existing groundwater monitoring wells, excavation of arsenic and dioxin/furan contaminated soils from the irrigation ditch and adjacent haul road/field area, placement of the excavated soil within the PML site, collection of two rounds of confirmation soil samples following excavation, placement and compaction of clean soil (low permeability, granular, and top soil) from a nearby import site, installation of the geomembrane liner cover system, and installing vegetation as ground cover.

The geomembrane liner cover system and the constructed soil cap currently serve to isolate contaminated soils from direct human contact and prevent surface water infiltration through soils that have the potential to leach contaminants. Exposure pathways are currently mitigated and long-term monitoring and maintenance of the geomembrane liner cover system at the East Kapolei PML site will ensure that environmental hazards remain isolated from exposure.

Future use of the PML site should be restricted to non-residential uses that do not require drilling, excavation, and/or grading to depths greater than 18 inches below existing ground surface in order to maintain the integrity of the geomembrane liner and constructed soil cap. Such land use restriction should be permanently attached the property deed to ensure that the integrity of the liner and soil cap is maintained in perpetuity.

11.0 REFERENCES

- EnviroServices & Training Center, LLC. 2007. *Final Site Investigation and Preliminary Remedial Alternatives Analysis Report, East Kapolei – Brownfields, Former Oahu Sugar Company, Pesticide Mixing and Loading Areas, Kapolei, Oahu, Hawaii TMK (1)-9-1-017: Parcel 088*. Prepared for the State of Hawaii DBEDT. August.

- EnviroServices & Training Center, LLC. 2009. *Site Safety & Health Plan, Site Demolition and Remedial Investigation, East Kapolei Pesticide Mixing and Loading (PML) Area, Kapolei, Oahu, Hawaii*. September.

- EnviroServices & Training Center, LLC. 2009. *Community Involvement Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii*. Prepared for the State of Hawaii DHHL. October.

- EnviroServices & Training Center, LLC. 2009. *Site Demolition and Hazardous Materials Disposal Plan, East Kapolei II, Former Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii*. Prepared for the State of Hawaii DHHL. November.

- EnviroServices & Training Center, LLC. 2009. *Site Investigation Work Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)*. Prepared for State of Hawaii DHHL. December.

- EnviroServices & Training Center, LLC. 2010. *Demolition and Disposal Report, East Kapolei II, Former Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii*. Prepared for the State of Hawaii DHHL. January.

- EnviroServices & Training Center, LLC. 2010. *Site Investigation Report and Environmental Hazard Evaluation, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)*. Prepared for the State of Hawaii DHHL. March.

- EnviroServices & Training Center, LLC. 2010. *Remedial Alternatives Analysis Report, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii TMK (1) 9-1-017: Parcel 93 (Portion)*. Prepared for the State of Hawaii DHHL. May.

- EnviroServices & Training Center, LLC. 2010. *Draft Response Action Memorandum, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii, TMK (1) 9-1-017: Parcel 93 (Portion)*. Prepared for Hawaii Department of Health Hazard Evaluation and Emergency Response Office. June.

- EnviroServices & Training Center, LLC. 2010. *Final Response Action Memorandum, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii, TMK (1) 9-1-017: Parcel 93 (Portion)*. Prepared for Hawaii Department of Health Hazard Evaluation and Emergency Response Office. August.

- EnviroServices & Training Center, LLC. 2010. *Remedial Action Work Plan, East Kapolei II Pesticide Mixing and Loading Site, Ewa, Oahu, Hawaii, TMK (1) 9-1-017: Parcel 110 (Portion)*. Prepared for State of Hawaii DHHL. October.

- Hawaii State Department of Health. 2011 (Revised January 2012). *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Fall.

- Hawaii State Department of Health. 2008. *Technical Guidance Manual for Implementation of the Hawaii State Contingency Plan, Interim Final*. November.

- Hawaii State Department of Health. 2010. *Update to Soil Action Levels for TEQ Dioxins and Recommended Soil Management Practices*. June.

- Hawaii State Department of Health / U.S. EPA. 2000. *Site Inspection – Ewa Sugar Mill/Oahu Sugar Co. Pesticide Mixing and Loading Site, EPA Site ID Number HISFN0905536*. July.

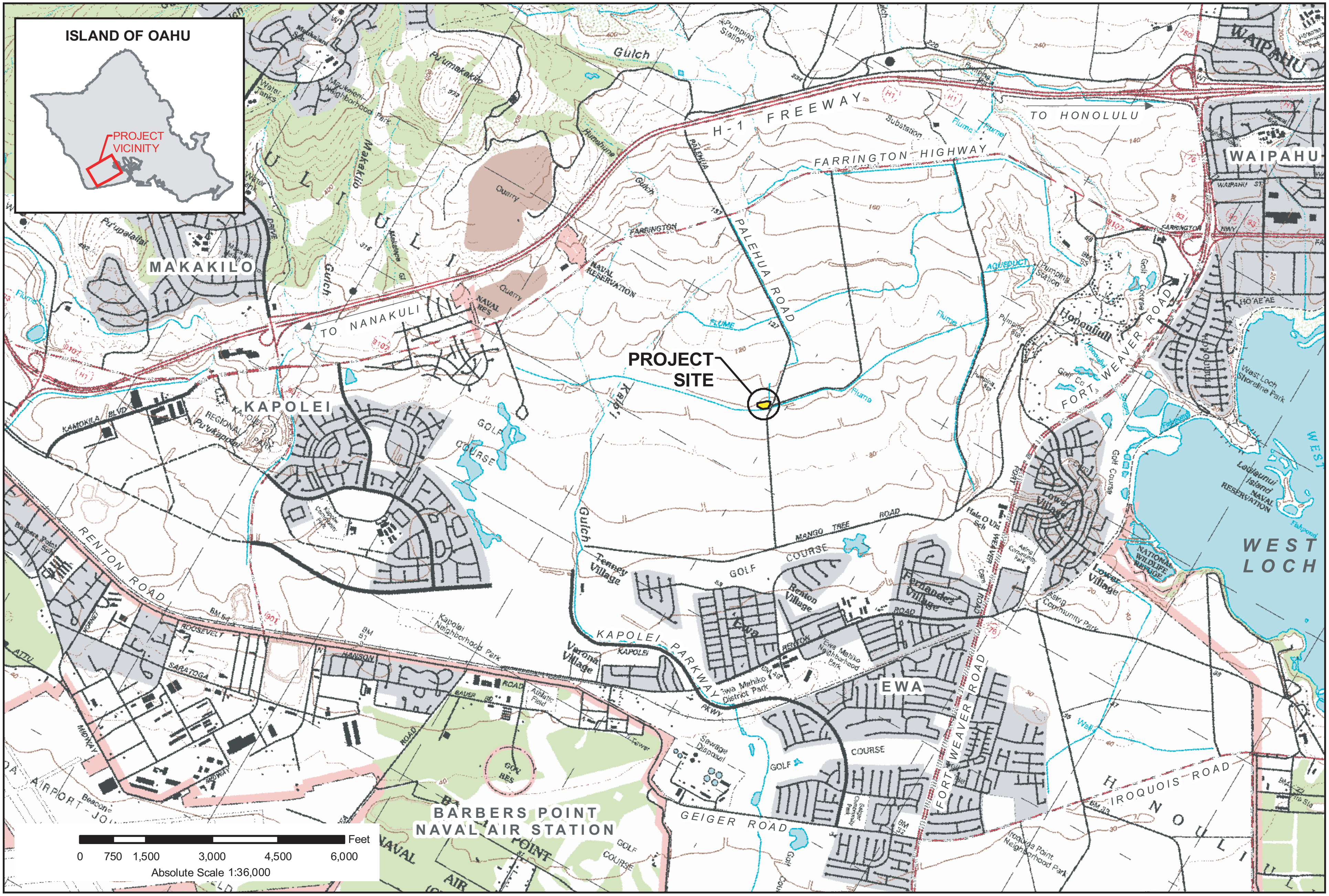
- Macdonald, G.A., Abbot, A.T. and Peterson, F.L. 1983. *Volcanoes and the Sea*. University of Hawaii Press.

- Mink, John F. and Stephen L. Lau. 1990. *Aquifer Identification and Classification for Oahu: Groundwater Protection Strategy for Hawaii*. Technical Report No. 179. Water Resources Research Center, University of Hawaii at Manoa. February.

- Tetra Tech EM Inc. 2007. *Final Site Assessment Report, East Kapolei Affordable Housing Project, Kapolei, Oahu, Hawaii*. Prepared for the State of Hawaii DOH HEER Office. December 12.

- U.S. Department of Agriculture Soil Conservation Service. 1972. *Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*.

- U.S. EPA. 1989. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final*. EPA/540/1-89/002. December.



Project No. 09-2012

December 2014

Figure 1 - Location Map
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii

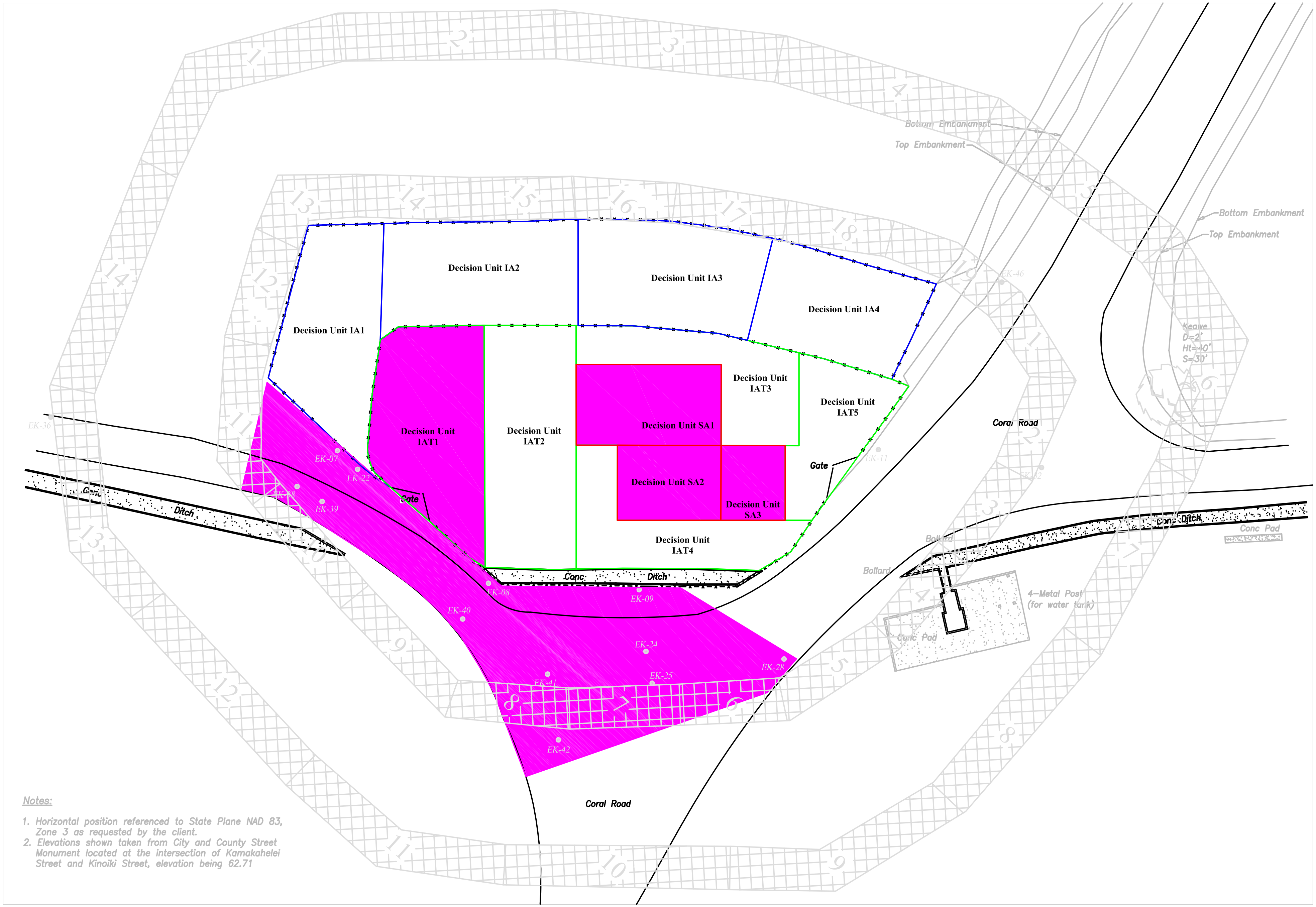
enviro SERVICES & TRAINING CENTER, LLC

Project No. 09-2012	**Figure 2 - Aerial Site Vicinity**
	Remediation Verification Report
December 2014	East Kapolei II PML Site Ewa, Oahu, Hawaii

Project No. 09-2012

December 2014

Figure 3
Aerial Photograph Prior to Remediation
Remediation Verification Report
East Kapolei II PML Site



Notes:

1. Horizontal position referenced to State Plane NAD 83, Zone 3 as requested by the client.
2. Elevations shown taken from City and County Street Monument located at the intersection of Kamakahelei Street and Kinoiki Street, elevation being 62.71

30' 0' 30' 60'

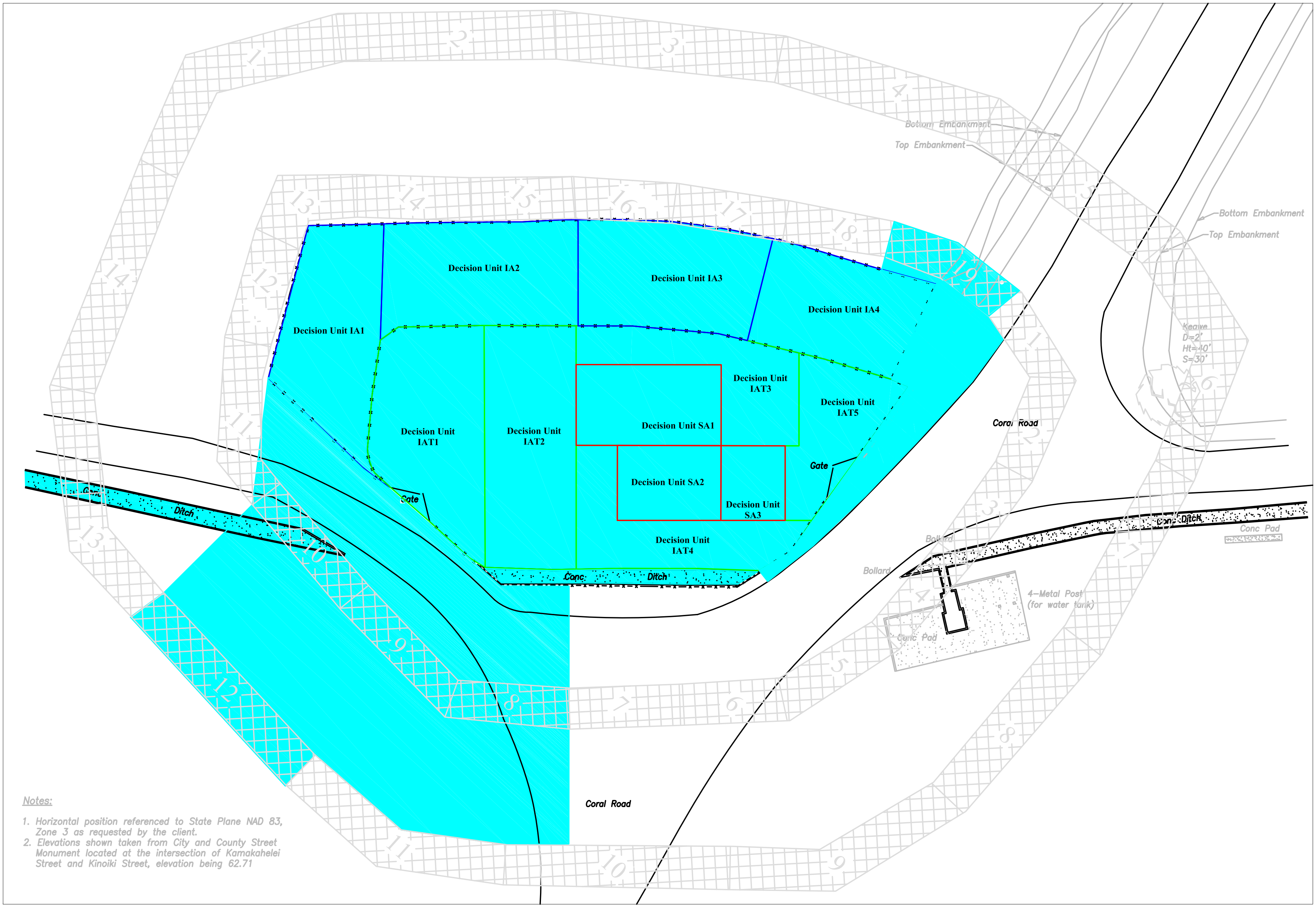
Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 4 - Extent of Arsenic Impacts
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



Notes:

1. Horizontal position referenced to State Plane NAD 83, Zone 3 as requested by the client.
2. Elevations shown taken from City and County Street Monument located at the intersection of Kamakahelei Street and Kinoiki Street, elevation being 62.71

30' 0' 30' 60'

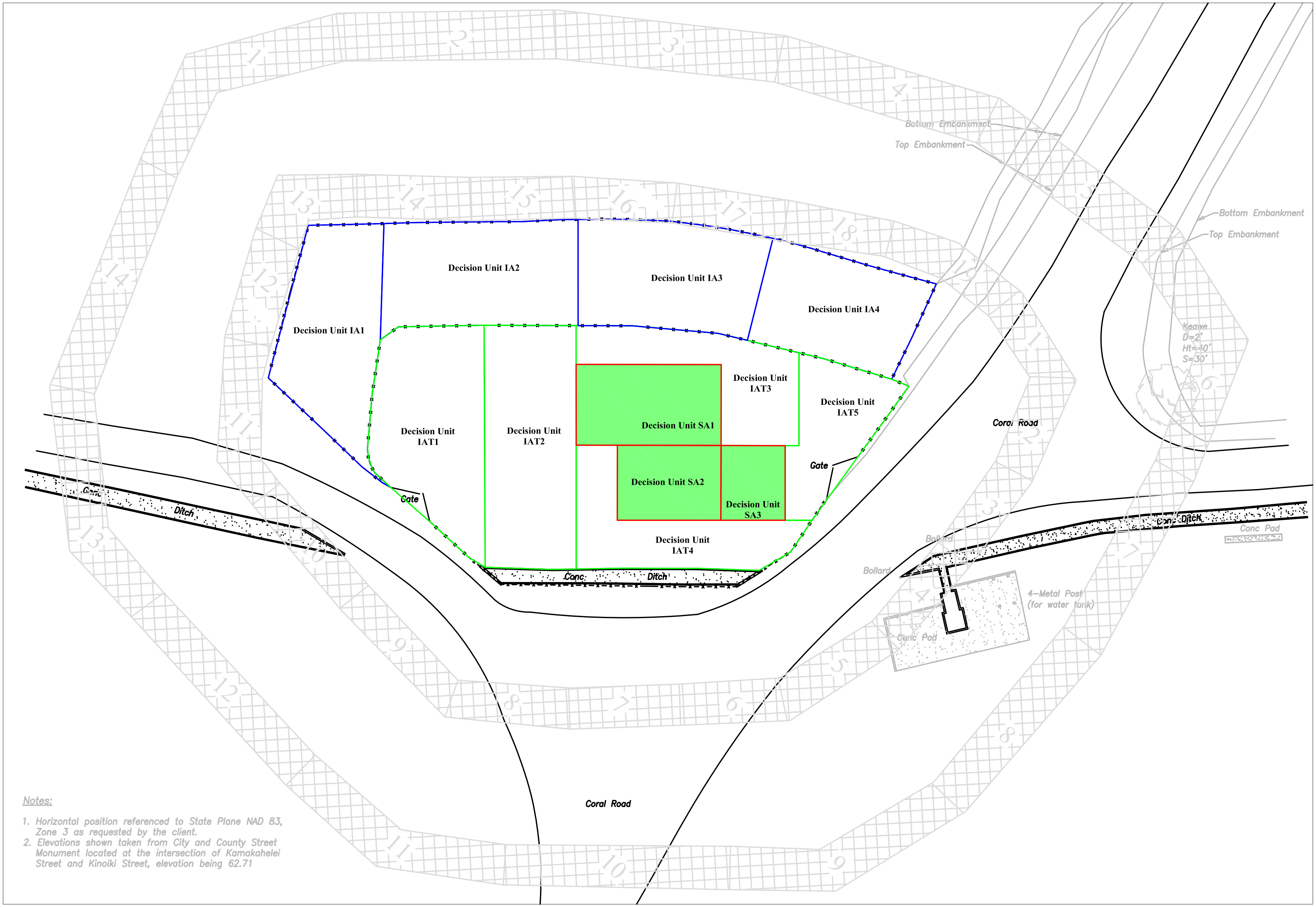
Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 5 - Extent of Dioxin Impacts
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



Notes:

1. Horizontal position referenced to State Plane NAD 83, Zone 3 as requested by the client.
2. Elevations shown taken from City and County Street Monument located at the intersection of Kamakahelei Street and Kinoiki Street, elevation being 62.71

30' 0' 30' 60'

Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 6 - Extent of PCP/Triazine Impacts
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii

Notes:

1. Horizontal position referenced to State Plane NAD 83, Zone 3 as requested by the client.
2. Elevations shown taken from City and County Street Monument located at the intersection of Kamakahelei Street and Kinoiki Street, elevation being 62.71

30' 0' 30' 60'

Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

Direct exposure hazards associated with dioxins/furans only

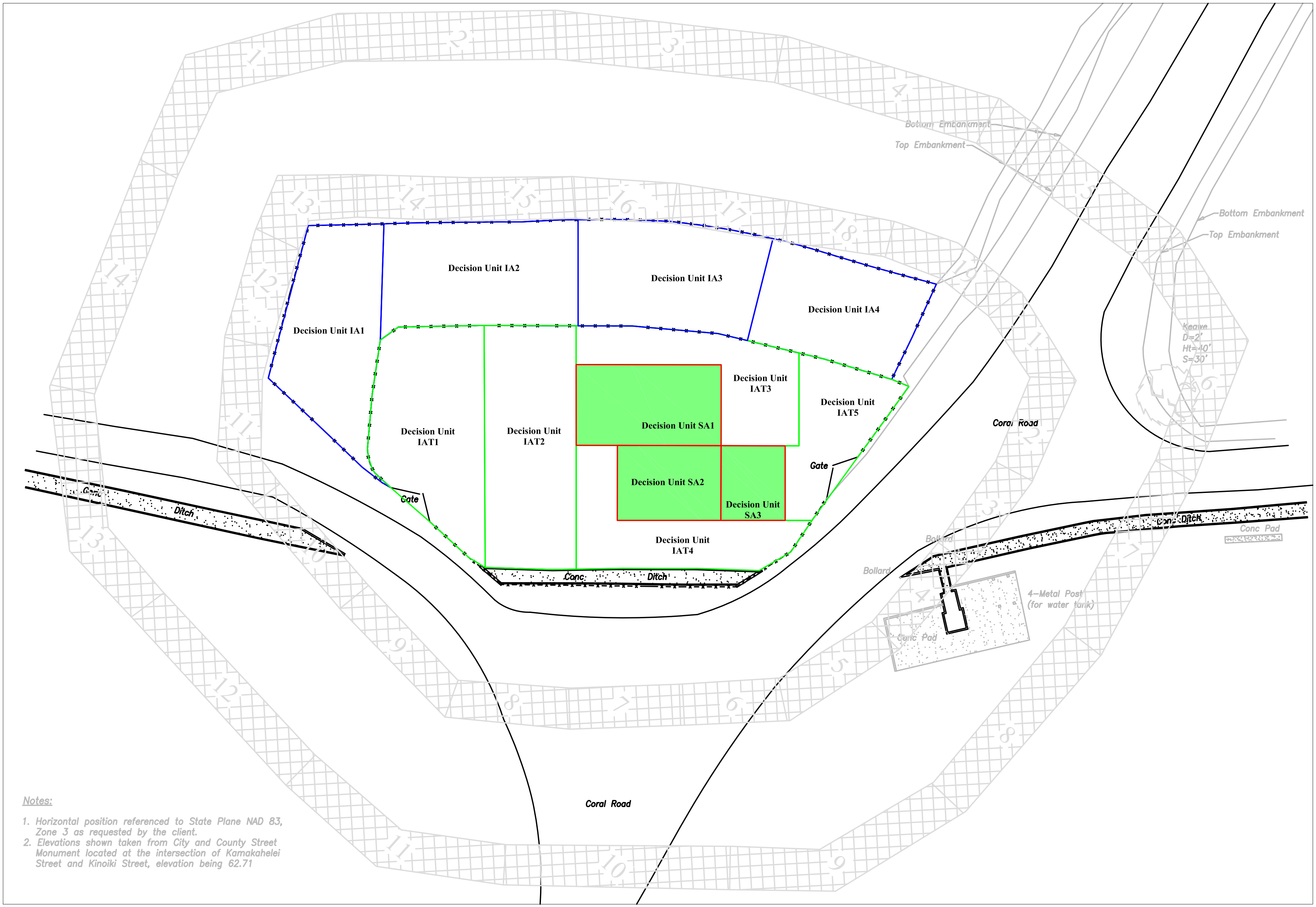
Direct exposure hazards associated with arsenic, dioxins/furans, PCP, and/or triazine pesticides

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 7 - Direct Exposure Hazards
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



Notes:

1. Horizontal position referenced to State Plane NAD 83, Zone 3 as requested by the client.
2. Elevations shown taken from City and County Street Monument located at the intersection of Kamakahelei Street and Kinoiki Street, elevation being 62.71

30' 0' 30' 60'

Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

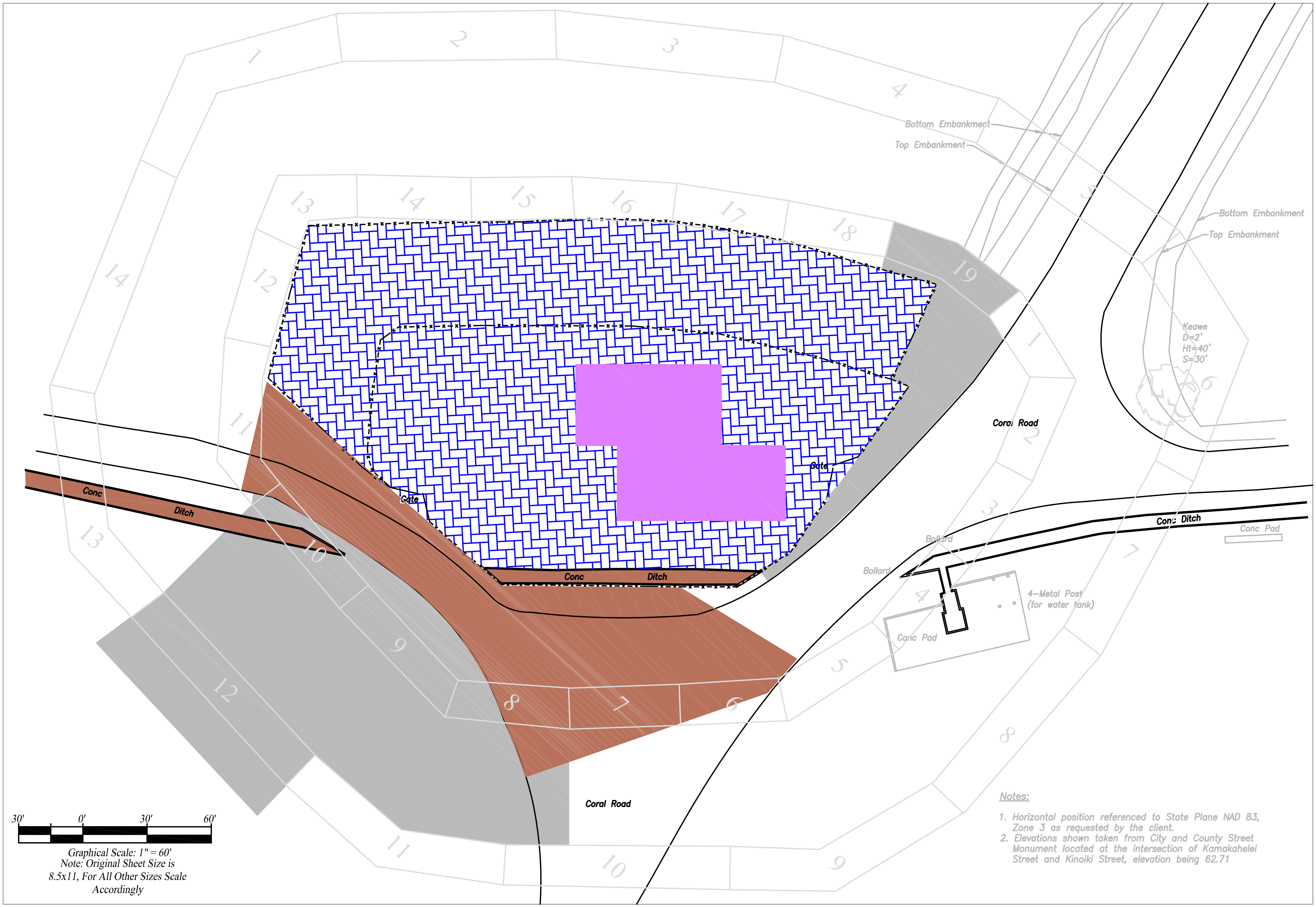
Leaching hazards associated with dioxins/furans, PCP, and/or triazine pesticides

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 8 - Leaching to Groundwater Hazards
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



Conceptual extent of geomembrane liner

Conceptual extent of clean, compacted soil cap

Extent of 2-foot soil excavation for relocation onto PML site

Extent of 3-foot soil excavation for relocation onto PML site

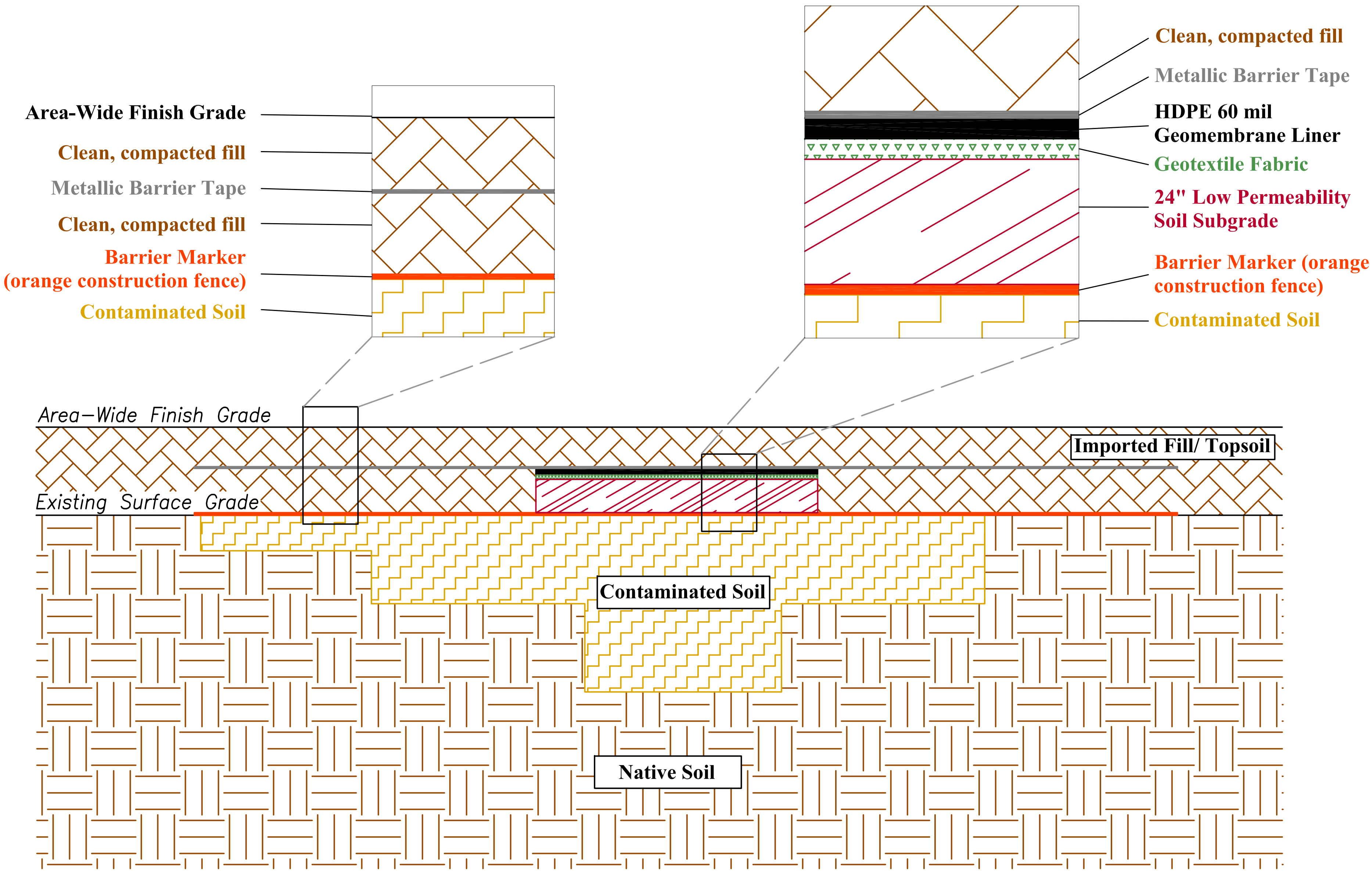
enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

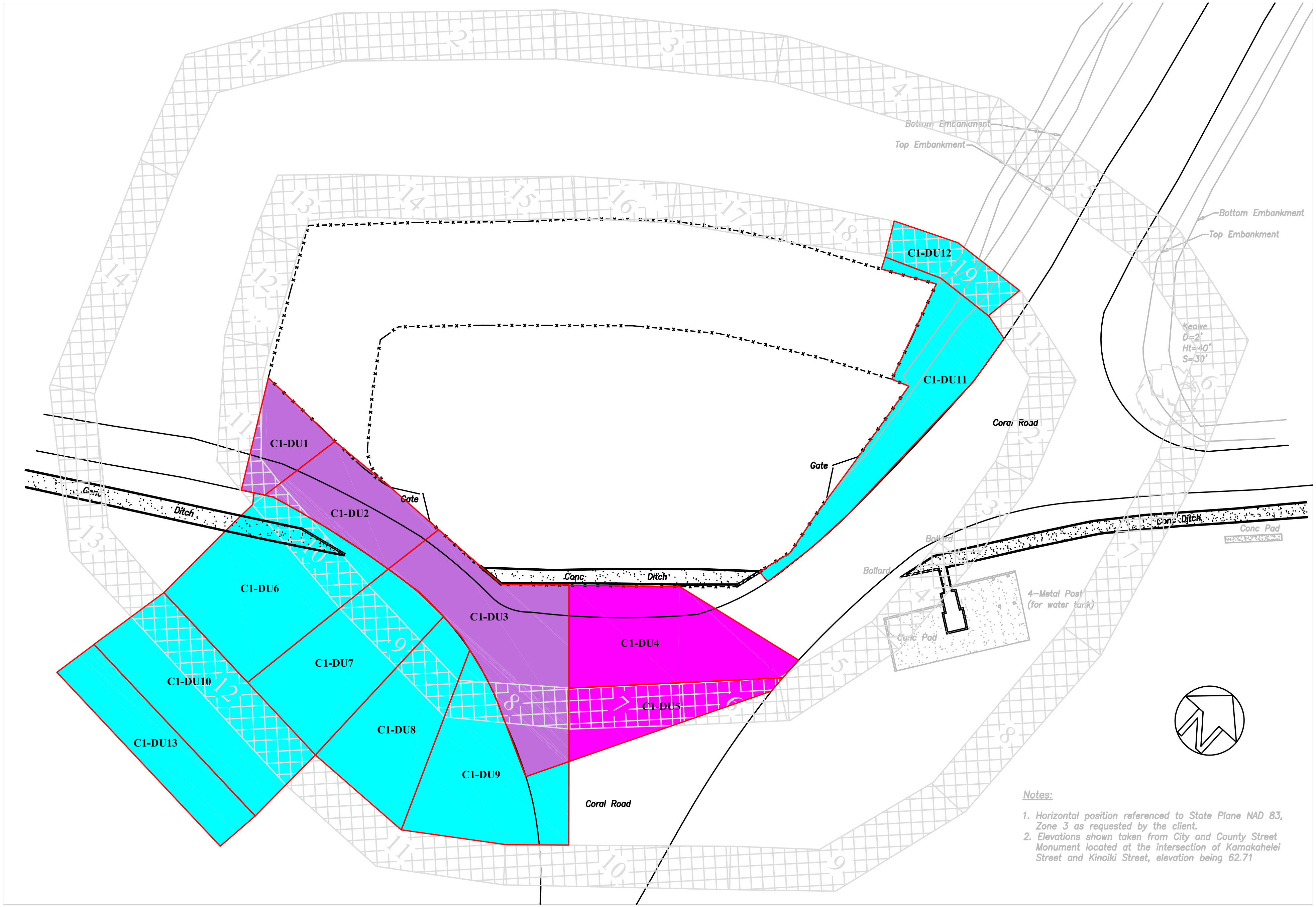
December 2014

Figure 9 - Conceptual Plan View of Selected Remedial Alternative

Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



Project 09-2012	**Figure 10 - Conceptual Cross-Section of the Selected Remedial Alternative** Remediation Verification Report East Kapolei II PML Site Ewa, Oahu, Hawaii
December 2014	



30' 0' 30' 60'

Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

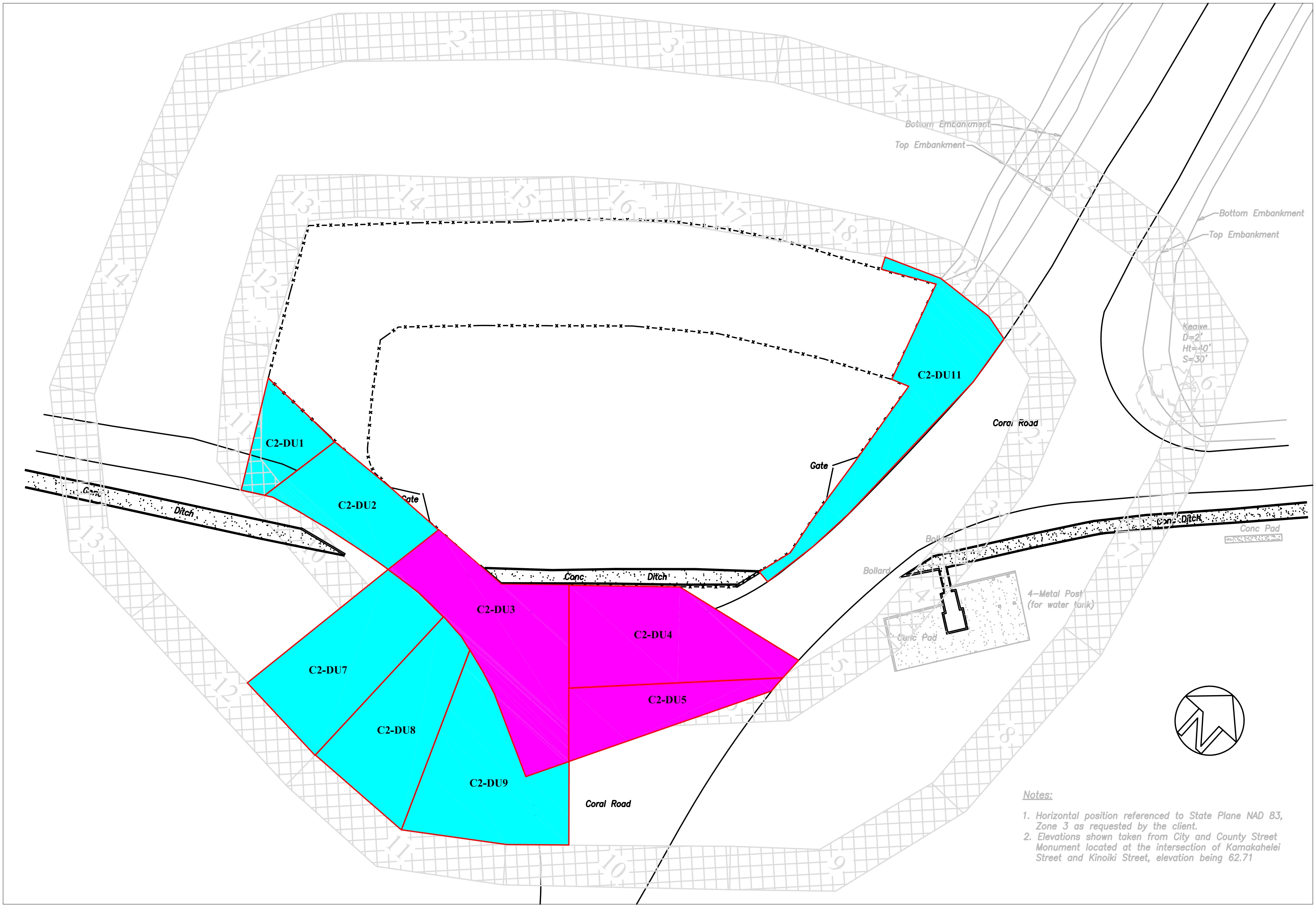
- Confirmation samples analyzed for arsenic
- Confirmation samples analyzed for dioxins
- Confirmation samples analyzed for arsenic & dioxins

enviro SERVICES & TRAINING CENTER, LLC

Project 09-2012

December 2014

Figure 11
Initial Confirmation Sample DUs
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii



30' 0' 30' 60'

Graphical Scale: 1" = 60'
Note: Original Sheet Size is 8.5x11, For All Other Sizes Scale Accordingly

Confirmation samples analyzed for arsenic

Confirmation samples analyzed for dioxins

enviro SERVICES & TRAINING CENTER, LLC

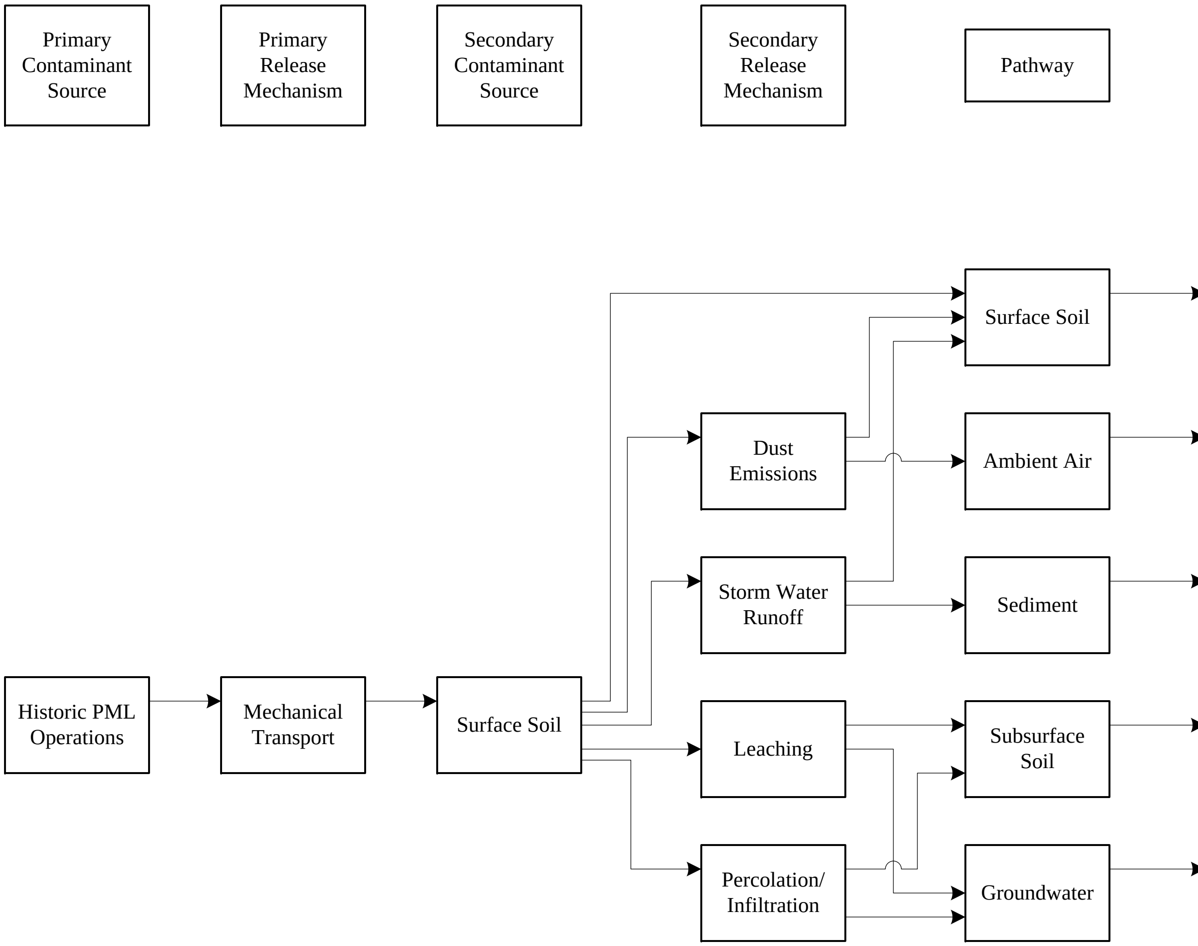
Project 09-2012

December 2014

Figure 12
Secondary Confirmation Sample DUs
Remediation Verification Report
East Kapolei II PML Site
Ewa, Oahu, Hawaii

CONCEPTUAL SITE MODEL DIAGRAM – PRIOR TO REMEDIATION

EAST KAPOLEI PML SITE

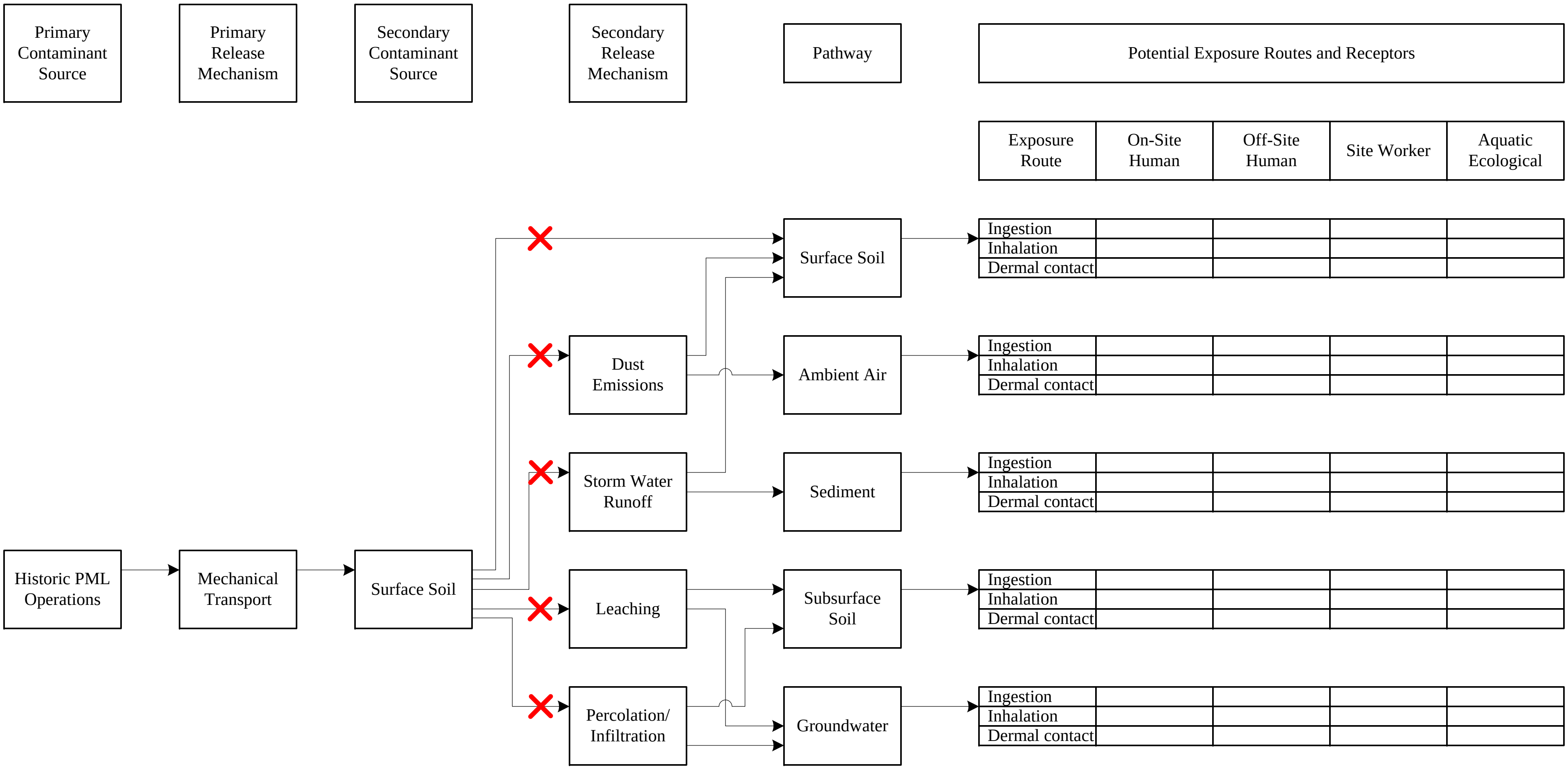


Potential Exposure Routes and Receptors

Pathway	Exposure Route	On-Site Human	Off-Site Human	Site Worker	Aquatic Ecological
Surface Soil	Ingestion	X		X	
	Inhalation	X		X	
	Dermal contact	X		X	
Ambient Air	Ingestion	X	X	X	
	Inhalation	X	X	X	
	Dermal contact	X	X	X	
Sediment	Ingestion		X		X
	Inhalation		X		X
	Dermal contact		X		X
Subsurface Soil	Ingestion			X	
	Inhalation			X	
	Dermal contact			X	
Groundwater	Ingestion		X	X	X
	Inhalation				X
	Dermal contact		X	X	X

CONCEPTUAL SITE MODEL DIAGRAM – AFTER REMEDIATION

EAST KAPOLEI PML SITE



Photograph 1: Silt fence and other storm water BMPs installed prior to start of construction.

Photograph 2: RHS Lee clearing vegetation.

Photograph 3: Start of soil excavation outside of PML boundary.

Photograph 4: Soil from concrete-lined irrigation ditch removed and placed within PML site. No breaks in concrete-lined ditch observed.

Photograph 5: Soil removed from section of concrete-lined irrigation ditch adjacent to PML site.

Photograph 6: View of typical pump and media used for air monitoring at project boundaries.

Photograph 7: CLSM used to fill irrigation ditch after demolition of concrete culverts beneath haul roads.

Photograph 8: View of excavation area outside of PML boundary, south of irrigation ditch.

Photograph 9: View of excavation area outside of PML boundary.

Photograph 10: View of excavation area north of PML boundary.

Photograph 11: Excavation area south of PML boundary partially backfilled.

Photograph 12: Compacting low permeability soil prior to placement of geotextile fabric and geomembrane liner.

Photograph 13: Hirata & Associates checking soil compaction prior to placement of fabric and liner.

Photograph 14: Placement of geomembrane liner.

Photograph 15: Welding and securing geomembrane liner.

Photograph 16: View of geomembrane liner, welded and anchored in placed.

Photograph 17: Excavation area north of PML boundary partially backfilled.

Photograph 18: View of fill area with geomembrane liner and orange construction fence visual indicator.

Photograph 19: Backfilling excavation area outside of PML boundary.

Photograph 20: View of fill area with geomembrane liner.

Photograph 21: Orange construction fence used as visual indicator barrier.

Photograph 22: Backfilling and compacting excavation area adjacent to PML fill area.

Photograph 23: View of geomembrane liner and visual indicator barrier.

Photograph 24: Placement of metallic tape using 10-foot grid spacing.

Photograph 25: View of metallic tape placed above contaminated soil (thin layer of soil between orange construction fencing and metallic tape).

Photograph 26: View of metallic tape grid.

Photograph 27: View of backfill material near haul road prior to placement of imported granular fill.

Photograph 28: Placement of top soil in preparation for hydroseeding.

Photograph 29: Screening soil at borrow site to meet specifications for top soil.

Photograph 30: View of pipe bollards prior to filling with concrete, installed along the perimeter of the capped area.

Photograph 31: View of concrete-filled pipe bollards. Hydroseeding complete, irrigation system installed.

Photograph 32: View of former excavation area and haul road. Hydroseeding complete, granular material used to fill haul road.

Photograph 33: View along haul road following backfilling and hydroseeding.

Photograph 34: View of site after completion of backfilling and hydroseeding.

Photograph 35: View of irrigation system installed after hydroseeding.

Photograph 33: View of granular fill used to re-establish haul road.