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October 28, 2014

County of Maui
Department of Environmental Management
Solid Waste Division
2200 Main Street, Suite 225
Wailuku, Hawaii 96793

Attention: Mr. Michael Kehano

Subject: Phase I of Post Closure Services for Closed Olowalu Landfill
Olowalu, Maui, Hawaii

Dear Mr. Kehano:

Element Environmental, LLC (E2) is pleased to submit this letter report documenting Phase 1 of post-closure services for Olowalu Landfill. E2 along with A-Mehr Inc. has been retained by the County of Maui (hereafter referred to as the County), Department of Environmental Management to facilitate post-closure planning services for the closed Olowalu Landfill on the Island of Maui, Hawaii (Figure 1).

1.0 INTRODUCTION

The purpose of Phase 1 of the post-closure services was to achieve the following:

- **Obtain and review available documents and information, including, but not limited to closure/post-closure plans, construction reports, monitoring plans/data, correspondence, aerial photographs, etc.** Documents were obtained through the County Department of Environmental Management and through the State of Hawaii Department of Health (HDOH). A complete list of documents reviewed is provided in the Bibliography in Attachment A. Scanned documents are included on an attached CD for your records.

- **Interview current and former County of Maui employees and knowledge of the landfill.** Elaine Baker and Tia Stupplebeen were interviewed on August 13, 2013 and again on January 15, 2014. They were able to locate site features such as groundwater monitoring wells, gas wells, provide historical documents and verify site information.

- **Conduct site investigations to locate/map and inspect the status and conditions of gas and groundwater monitoring wells, drainage systems, cover, roads, security, etc. Document existing post-closure uses.** Two site investigations were conducted; One on August 13, 2013 and another on January 14, 2014. Existing site features were documented with a GPS unit and are shown on the attached Figure 2.

- **Provide a brief list of findings and recommendations based on completion of the above tasks.** Findings and recommendations were based on historical documents reviewed, site information obtained via site walks and information obtained from the County of Maui. Recommendations are provided in Section 3.

- **Identify options for interim and final post-closure uses and evaluate relative to County objectives.** Uses were identified based on records reviewed and are summarized in Section 3.

- **Identify and quantify, to extent possible, County resources and costs to implement Phases 2 and 3.** County resources are summarized in Section 4 and were based on the recommendations provided through research and assessment of the closed landfill.

2.0 SITE INFORMATION

General Background Information

The landfill occupies approximately 38 acres and is located approximately three miles south of Lahaina along the Honoapiilani Highway, mauka of the Olowalu Convenience and Recycling Center at TMK 4080003:039, Island of Maui, Hawaii (Figure 1). The property is surrounded by sloping range land to the north, an intermittent drainage gulch to the northeast, a cinder borrow pit owned by the State of Hawaii to the southeast, and the Honoapiilani Highway to the south. A transfer station is currently located at the base of the closed landfill.

The County of Maui is responsible for post-closure activities. Executive Order 2972 was issued by the Governor of Hawaii in 1979 granting the County of Maui operation and control of the land and permitted use as a landfill. The Executive Order contained terms in conditions including using interim and final cover (State of Hawaii, 1979).

The landfill began accepting waste in 1969 and was closed in 1992. The landfill accepted approximately 250 tons per day in the late 1980's. Approximately 150 tons were construction and demolition, earth/ash fill, rubber, metallic and automobiles and the other 100 tons were municipal solid waste, yard waste/trees, paper and cardboard (Parametrix, 1993). A series of 21 former sludge drying ponds are located on about seven acres of the landfill site (Parametrix, 1992). A site map showing current and historical landfill features is shown in Figure 2.

The interim cover material typically used at the landfill was cinder from the adjacent cinder cone borrow site. The material was porous and contributed to the landfill subsurface fires. During site reconnaissance, E2 noted that vegetation was sparse and the top of the landfill is mostly devoid of vegetation. Due to the dry climate on the leeward side of the island, vegetation is typically sparse year around. Site photos are shown in Attachment B.

The steeper slopes at the landfill occur along the north side along the gulch, and the south side adjacent to Honoapiilani Highway. Based on the topographic survey conducted by E2 (Figure 2), the south facing slope has the approximate slope of 4.5 horizontal to 1 vertical (4.5H:1V). The northern slope near the gulch is approximately 3H:1V. The site plateaus to a nearly flat surface then gradually steepens to a 10H:1V slope in the vicinity of the former sludge ponds.

The calculated landfill volume was based on historical documents and used an average of 100 tons/day for 5.5 days per week over 22 years with the compaction rate of 800 pounds per

cubic yard. The landfill volume was calculated to be about 1,452,000 cubic yards. The calculated volume does not account for variability in compaction rates, quantities of waste received, or landfill settling/decomposition since the landfill was closed.

To confirm the calculated volume of the Landfill, E2 used a Trimble® GPS unit to conduct a topographic survey during the January 2014 site visit. The topographic points were compared to the historical 1955/1956 United States Geological Survey (USGS) topo map of the site area. According to the topographic survey, the current total volume of the landfill was calculated to be approximately 1,277,911 cubic yards. The accuracy of the calculated volume may depend on the accuracy of the 1955/56 USGS topographic map used to evaluate the native land surface. The surveyed volume determined by E2 was used to evaluate landfill gas generation. Figure 2 shows the surveyed topography of the site.

The landfill currently has restricted access and the site is not in use other than the adjacent transfer station. The transfer station is not situated on refuse, however it is located on the County's property and operated by the County. The end use described in the Post-Closure Plan stated that the site would be open space with restricted access and that the landfill and cover must be maintained (Parametrix, 1992).

Final Cover System and Storm Water Drainage

According to the Olowalu Landfill Post Closure Maintenance Manual, the cover system at the landfill consists of a low permeable cover soil, top soil and cover vegetation (Parametrix Inc., 1993). Cover material observed during site reconnaissance appeared to consist of high permeability soil. A flexible membrane liner is located in the vicinity of the former sludge pits.

During site reconnaissance, E2 noted that vegetation was sparse and the top of the landfill is mostly devoid of vegetation. Due to the dry climate on the leeward side of the island, vegetation is typically sparse year around. Storm events typically only happen a few times a year and tend to be larger storm events with heavy rainfall. Site photos are shown in Attachment B.

The storm water drainage system onsite consists of the landfill collector and perimeter ditches, the landfill collector ditch/access road, culverts, and perimeter channel, and drainage swales. The drainage system was evaluated during the site reconnaissance. The system appeared to be in good condition and well maintained. The lined drainage swale located along the southern boundary of the former landfill had been recently cleared of accumulated sediment and vegetation during the August 2013 site visit. The sediment that was removed from the drainage swale was placed in a pile at the bottom of the landfill, near the transfer station.

Sediment accumulates in the drainage swales largely due to the lack of vegetation for erosion control and the episodic heavy nature of the storm events. The lack of vegetation coupled with the infrequent heavy storm events erodes the cover material.

Groundwater

Olowalu Landfill is located within the Ukumehame Aquifer System of the Lahaina Aquifer Sector (Mink and Lau, 1990). One distinct aquifer underlies the site. The aquifer is basal where fresh water is in contact with seawater, unconfined, and located in a dike (aquifer in dike

compartments). The aquifer has low salinity with a chloride content between 250 milligrams per liter (mg/l) and 1,000 mg/l; however is not considered fresh or potable (i.e.<250 mg/l). This aquifer is considered replaceable and has a high vulnerability to contamination (Mink and Lau, 1990).

Depth to groundwater below the landfill varies across the site. The elevation of the landfill closest to the Honoapiilani Highway is approximately 35 feet above groundwater. The northern most portion of the landfill that extends uphill in the vicinity of the former sludge ponds is approximately 300 feet above the groundwater table (Parametrix, 1991). Groundwater in the vicinity of the landfill generally flows toward the ocean in a southwesterly direction (perpendicular to the shoreline) (Parametrix, Inc. 1994). Figure 2 shows the general groundwater flow direction.

A total of four (4) groundwater monitoring wells remain at the site along the downhill, western boundary of the landfill. All four groundwater monitoring wells were encountered during site reconnaissance in January 2014. The wells were surveyed using a Trimble® GPS unit. Table 1 shows the coordinates and top of casing elevations. Monitoring well locations are shown in Figure 2.

A hydrogeologic assessment was conducted as part of the Closure/Post-Closure Plan. The assessment included an evaluation of the soils and geology, a slug test, a tidal investigation, and groundwater monitoring. This assessment stated that the impact of Olowalu Landfill on groundwater resources is low (Parametrix Inc., 1992). Groundwater monitoring was also conducted in MW-2 through MW-5 in July of 1991. Groundwater was analyzed for metals, alkalinity, NO_2+NO_3, ammonia, chloride sulfate, total dissolved solids (TDS), total organic carbon (TOC), chemical oxygen demand (COD), cyanide (CN), pH, specific conductivity, and volatile organic compounds (VOCs). The groundwater monitoring event was well documented and had appropriate quality assurance/quality control measures. Results of groundwater monitoring indicated that the landfill had no apparent impacts on groundwater (Parametrix Inc., 1992).

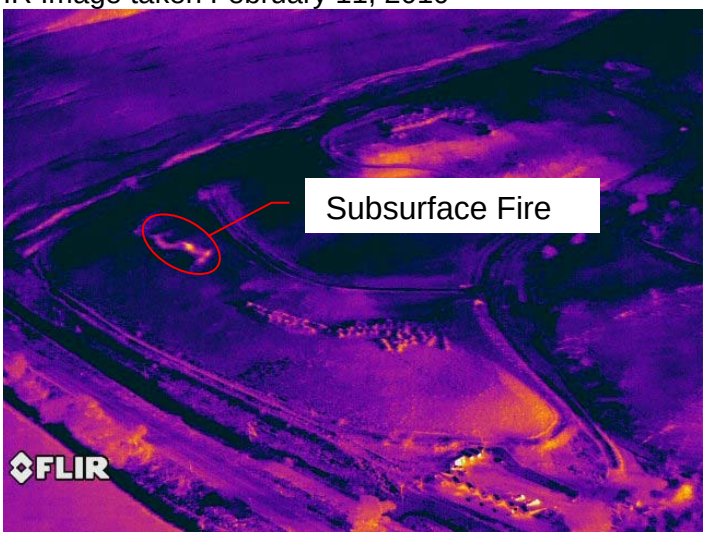
Subsurface Landfill Fire Monitoring and Carbon Dioxide Injection

Olowalu Landfill has a history of surface and subsurface landfill fires. The porous cover material, relatively dry conditions, and winds have contributed to the subsurface fire conditions. Information obtained from HDOH and the County referencing subsurface fires date back to 1982 (HDOH, 1982). In 1998, landfill subsurface fires were observed on the southern side of the landfill and on the west slope of the landfill. Injection probes were used to inject CO_2 into the landfill. A surface fire swept across the southern portion of the landfill in mid-November 1998. Historically, subsurface fire conditions were evaluated typically using temperatures, dragger tubes to detect carbon monoxide (CO), and observations. Landfill fires were mitigated by filling sinkholes, repairing cover material, wetting the areas of concern, and injecting CO_2 into the landfill (County of Maui, 1998; County of Maui, 2005).

An infrared (IR) survey was conducted at Olowalu Landfill in conjunction with a survey at Central Maui Landfill on February 11, 2010. The purpose of the survey was to see if hot spots

were present at the landfill that might indicate that active subsurface landfill fires were present. Photos were taken after the sun had risen. The warmth from the sun had begun to heat the surface of the landfill in some areas making it difficult to identify warmer areas indicative of landfill fires. However, the known subsurface fire area is clearly shown on the south-facing slope of the landfill in the IR survey photo below.

IR Image taken February 11, 2010



During the site investigation the GEM 2000 Plus landfill gas meter was used to monitor the perimeter gas probes (GP-1 through GP-6, both shallow and deep) and Landfill gas system ports (ES-01 through 13 and ES-16 through 18). Gas measurements did not indicate that subsurface fire conditions were present because CO was not detected in any of the gas probes or the landfill gas system ports. Furthermore, there were no indications of active subsurface fire issues (i.e. sinkholes, fissures, smoke, stressed vegetation) at the landfill. Table 2 shows the results of landfill gas monitoring and the condition of the perimeter gas probes and gas system monitoring ports.

Oxygen (O_2) was high in almost all probes indicating that sufficient oxygen is available for fires to ignite if high temperatures and fuel are available. The only area where O_2 was low was at ES-07 where methane (CH_4) was above the lower explosive limit (LEL) of five (5) percent by volume. Explosive or ignitable conditions are present when the LEL is above five (5) percent by volume and (O_2) is above four (4) percent by volume. These conditions were not observed at any of the monitoring ports.

Landfill Gas

The landfill gas venting system consists of below ground horizontal trenches, above ground collection manifolds, wellhead connections, and a flare facility. The landfill also has both

shallow and deep perimeter gas monitoring probes to monitor for landfill gas migration. The perimeter gas monitoring probes and the gas system monitoring ports were located and surveyed during the January 15, 2014 site visit. Portions of the landfill gas system have been removed as shown in the site photographs (Attachment B). Figure 2 shows the perimeter gas monitoring probes and surveyed ports.

E2 used the GEM™ 2000 Plus gas monitor to collect gas readings. CH_4 concentrations measured in probes and in the gas system were low. ES-7 was the only gas probe that measured above the LEL at 8.1% percent by volume. All other CH_4 concentrations were between 0 and 2.2 % by volume. CH_4 measurements indicate that gas generation at the landfill is low, likely due to the age and the dry climate on the leeward side of the island. Gas system monitoring ports where CH_4 was elevated were located in the last areas to be filled in 1992. Table 2 shows the landfill gas measurements and also the condition of each of the probes and ports.

A-Mehr, Inc. used the USEPA LandGem (Landfill Gas Emissions Model) computer program to compute the landfill gas emissions. LandGem uses a series of assumed waste composition, moisture and climate characteristics developed for typical landfills to estimate landfill gas generation. The memorandum describing the results of the model is provided in Attachment C.

Results of the model analysis indicate that average emission rate of landfill gas for 2014 is 78 standard cubic feet per minute (scfm). By comparison, the landfill gas collection and control system at Central Maui Landfill typically handles 600 to 800 scfm. If emitted uniformly from the surface of the landfill, the methane volume of 39 scfm projected by the model for 2014 would be equivalent to approximately 2.4×10^{-5} scfm per square foot of landfill surface, or to a concentration of 24 parts per million by volume (ppmv) of methane mixed in a one cubic foot volume of air above the surface. USEPA rules for gas collection and control systems in large landfills (40 CFR 60.755) require landfill surface emissions to be less than 500 ppmv methane.

Based on current landfill gas monitoring data collected from the perimeter gas probes and the LandGem, it is reasonable to conclude that the potential landfill gas emissions at the closed Olowalu Landfill are well below the threshold at which control would be feasible. It is also reasonable to conclude there is no danger of landfill gas migration.

Maintenance Activities

The landfill is currently visually inspected, roughly, on a quarterly basis by County Solid Waste staff. If cracks on the landfill are observed, the cover is typically filled with sediment that is periodically removed from the perimeter drainage swales and stored onsite.

3.0 RECOMMENDATIONS

The main goal of this study is to either demonstrate that the County has fulfilled their post-closure duties or to determine where additional post-closure duties are required. The elements of demonstration are as follows:

- Post-closure use: Current uses are compatible with the closure plan and uses meet all legal requirements.
- Final cover: Intact to an acceptable depth, the permeability is 1X10E^{-6} cm/sec, adequate drainage, and vegetation.
- Landfill Gas: No subsurface migration and minimal surface emissions;
- Leachate: Little generation and/or no evidence of groundwater impacts;
- Groundwater: No evidence of contamination;

The recommendations provided in this section will require consultation with HDOH. The recommended elements of demonstration may require modification after consultation.

POST-CLOSURE USE/POST-CLOSURE PLAN

Existing conditions: Site is secured and is not being used, which is in conformance with the post-closure use (open space) stated in the Closure Plan.

Recommendations: The following should be conducted in accordance with the Post-Closure Plan.

- The Post-Closure Plan should be revised, updated and approved by the HDOH. The revised Post-Closure plan will contain the remedial design improvements.
- A topographic survey should be conducted to prepare the remedial design.
- The perimeter fence should be replaced.

FINAL COVER

The following are known about the final cover system:

- The site generally slopes at minimum 5% to 3:1.
- The closure plan specified minimum 30 inches of final cover soil.
- The site was initially vegetated with grass, which remained in good condition until at least 1995.

- HDOH photos in May 1999 and August 2001 shows large areas of the site mostly bare, with loss likely due at least in part to landfill fires. During the August 2013 site visit, the site was observed to be bare. Aerial photos (Google Earth) from 2000 to 2013 show the site and all surrounding properties to be more or less bare.

- Excessive sediment collects in the drainage system from erosion of cover material.

- The perimeter concrete/rock drainage channel has been recently cleaned and appears in good condition.

Recommendations:

Leaving the site bare without maintenance for the long term risks future erosion and washout of refuse. There are several alternatives for a more permanent final cover system that will work in the arid climate of the landfill. The following describe the alternatives:

Option 1- Vegetative Cover

- Pothole cover to verify cover soil depth.

- Inspect closely for erosion and repair as needed.

- If cover thickness is substantially less than 30", add soil.

- Revegetation would likely require some soil amendment like mixing in compost or adequate topsoil. It would also require six to nine months of trucking in water for irrigation.

Option 2- Rock Armoring the Landfill Surface

- Pothole cover to verify cover soil depth.

- Inspect closely for erosion and repair as needed.

- If cover thickness is substantially less than 30 inches, add soil.

- Add a geotextile membrane to prevent soil erosion and undermining of rock armoring from storm events.

- Armor the surface of the Landfill using several different sizes of rock for stabilization.

Option 3-Armoring and Vegetative Cover

- Pothole cover to verify cover soil depth.

- Inspect closely for erosion and repair as needed.

- If cover thickness is substantially less than 30", add soil.

- Revegetation would likely require some soil amendment like mixing in compost or adequate topsoil. It would also require six to nine months of trucking in water for irrigation.

- Armor the surface of the Landfill using several different sizes of rock for stabilization.

EXPOLOSIVE LANDFILL GAS

A gas collection system and six (6) perimeter gas monitoring probes were installed during closure in 1993. Based on current landfill gas monitoring data and the LandGem, it is reasonable to conclude that the potential landfill gas emissions at the closed Olowalu Landfill are well below the threshold at which control would be feasible. It is also reasonable to conclude there is no danger of landfill gas migration. According to the LandGem, the landfill does not present a threat to human health or the environment.

Recommendations:

There are no further recommendations pertaining to explosive landfill gas production or migration.

LANDFILL FIRE HAZARD

The landfill experienced subsurface fires before closure and subsequently at least as late as 2010. The IR survey was conducted clearly showed the known subsurface landfill fire area on the south-facing slope of the landfill. Gas measurements taken during site reconnaissance did not indicate that subsurface fire conditions were present because CO was not detected in any of the gas probes or the landfill gas system ports. Furthermore, there were no indications of active subsurface fire issues (i.e. sinkholes, fissures, smoke, stressed vegetation) at the landfill.

Recommendations:

We recommend the following tasks be completed to demonstrate that landfill subsurface fires are no longer present at the site and to prevent future subsurface landfill gas fires:

- An IR survey should be conducted to see if there are indications of subsurface landfill fires. If subsurface landfill fires exist, the landfill should be visually monitored at least quarterly to check for indications of ongoing subsurface landfill fire conditions. Sinkholes and fissures should be covered and compacted with low permeability cover material.

- The landfill gas system should be decommissioned because methane gas is no longer being produced in quantities that warrant a landfill gas system according both the landfill

gas measurements taken at the site and to the conceptual landfill gas model and emissions estimates contained in Appendix C. If the system becomes dilapidated, it could be a conduit for oxygen which could fuel future subsurface fires.

LEACHATE

There is currently no leachate collection system in place at the landfill, therefore there is no way to measure or monitor leachate collection or generation.

GROUNDWATER

Four groundwater monitoring wells were installed down gradient of the landfill during the landfill's active years. The wells were located and surveyed during site reconnaissance in January 2014. The wells appeared to be good condition. With respect to groundwater, the following conditions exist:

- According to the Closure Plan, post-closure groundwater monitoring is not required due to the site's closure prior to October 1993 (Subtitle D operative date).
- The Closure plan contained a hydrogeological assessment that indicated that the impact of the landfill on groundwater resources is low.
- Groundwater monitoring was conducted in July 1991 and indicated the landfill had no apparent impacts to groundwater.

Recommendations:

We do not recommend further groundwater monitoring at the site due to the following conditions:

- The site has had an extensive and thorough hydrogeologic assessment. Results of the assessment concluded that the groundwater had a low vulnerability to impacts from the landfill.
- Groundwater monitoring in 1991 did not indicate impacts to down gradient groundwater.
- Post-closure groundwater monitoring is not required because the landfill was closed prior to the Subtitle D operative date of October 1993.

We do not recommend closure of the groundwater monitoring wells at the site at this time. Due to the close proximity to the ocean, there may be a need in the future to demonstrate that the landfill is not adversely impacting groundwater.

4.0 COST ANALYSIS

The following cost analysis was established as a starting point to estimate future post-closure expenditures for the County. The actual cost of the recommendations will depend on the final remedial design plans and acceptance by the HDOH.

Task	Approximate Quantity	Unit	Unit Price	Amount
Remedial Design and Revised Closure/Post-Closure Plan				
Topographic Survey	1	allow	$15,000	$15,000
HDOH Approved Post-Closure Plan with Design	1	allow	$50,000	$50,000
Replace Perimeter Fence	1,200	linear feet	$35.00	$42,000
Final Cover				
Regrade for Drainage and erosion repairs	1	allow	$60,000	$60,000
Armor Rock	3,143	tons	$200	$628,500
Compost/Topsoil	30,000	cubic yards	$50	$1,500,000
Hydroseed and Maintain Nine Months	32	acres	$13,000	$416,000
Improve Drainage Facilities	1	allow	$100,000	$100,000
Landfill Fire Evaluation/Mitigation				
Infrared Survey	1	allow	$15,000	$15,000
Decommission/Remove Gas Collection System	1	allow	$90,000	$90,000
Contingency		base cost	20%	$583,300
			Subtotal	**$3,499,800**

We appreciate the opportunity to prepare this letter report for you. Please call me on my mobile phone at (231) 709-5033 or at the office at (808) 488-1200, if you have any questions.

Sincerely,

Lindsay B. Mason, P.E.
Environmental Engineer
Element Environmental, LLC

Figures:
Figure 1: Site Vicinity and Location Map
Figure 2: Site Plan

Tables:
Table 1- Groundwater Monitoring Well Information
Table 2- Landfill Gas Monitoring Results

Attachments:
Attachment A: Bibliography and CD Containing Documents Reviewed
Attachment B: Site Photographs
Attachment C: A-MEHR, Inc. Memorandum, Conceptual Landfill Gas Model and Emission Estimates

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Figures

Figure 1: Site Vicinity and Location Map
Figure 2: Site Plan

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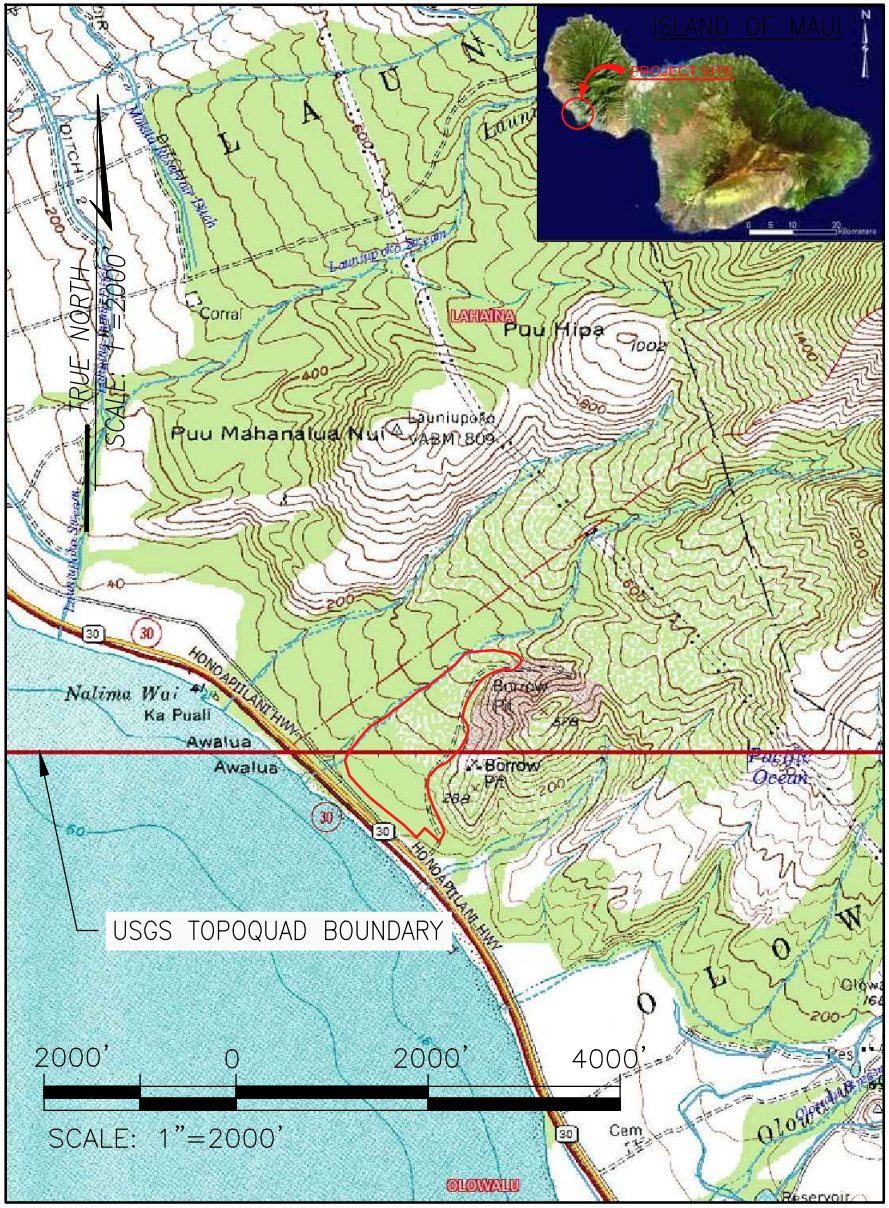
www.e2hi.com



250' 0 250' 500'

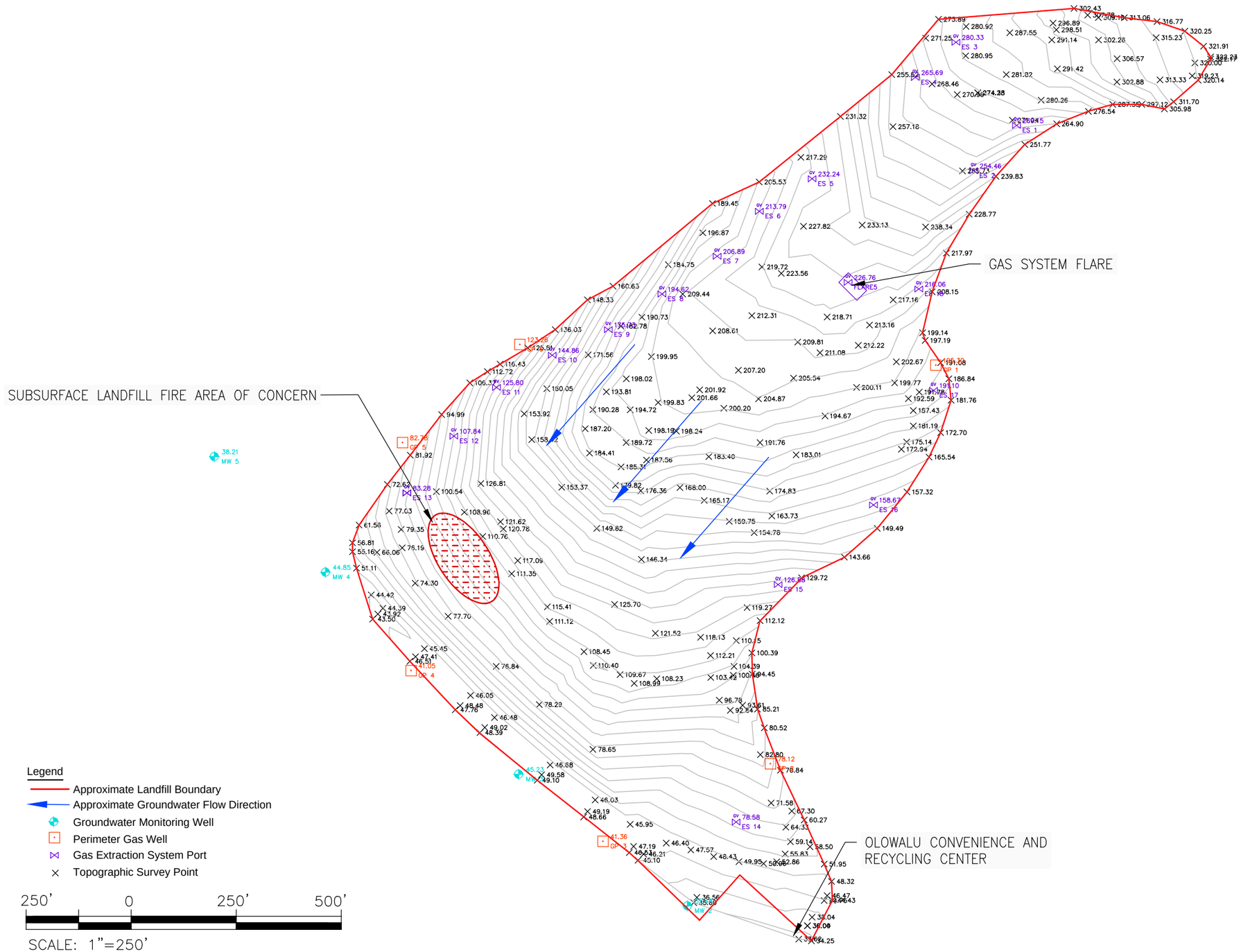
SCALE: 1"=250'

Legend

Approximate Landfill Boundary

References:
Google, 2013; www.aaccessmaps.com, 2013; and DeLorme, 2005.

	DATE: OCT 2014	PROJECT TITLE: PHASE 1 OF POST CLOSURE SERVICES CLOSED OLOWALU LANDFILL OLOWALU, ISLAND OF MAUI, HAWAII
	FIGURE TITLE: SITE VICINITY AND LOCATION MAP	FIGURE NO.: 1



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PROJECT TITLE:
PHASE 1 OF POST CLOSURE SERVICES
CLOSED OLOWALU LANDFILL
OLOWALU, ISLAND OF MAUI, HAWAII

FIGURE TITLE:
SITE MAP AND TOPOGRAPHIC SURVEY

DATE:
OCTOBER 2014

FIGURE NO.:
2

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Tables

Table 1: Groundwater Monitoring Well Information
Table 2: Landfill Gas Monitoring Results

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Table 1: Groundwater Monitoring Well Information

Monitoring Wells	Northing	Easting	Elevation (ft msl)
MW-2	1651748.277	179485.1081	35.48
MW-3	1651346.875	179798.2901	45.23
MW-4	1650887.153	180278.735	44.85
MW-5	1650622.481	180553.7373	38.21

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Table 2: Landfill Gas Monitoring Results

Gas Probe ID/ Extr. System Outlet	Probe/Outlet Condition and Notes	Date/Time Units:	CH4 %	CO2 %	O2 %	Balance %	%LEL %	Adj. Gas Temp. °F	CO ppm	H2S ppm	H2 ppm
GP-3	Good	1/15/2014 11:14	0	0.9	22.4	76.7	0	93	0	0	LOW
GP-4 Shallow	Vault cover is rusted and has holes, valve fittings are burned and melted.	1/15/2014 11:25	0	0.8	22	77.2	0	91	0	1	LOW
GP-4 Deep		1/15/2014 11:29	0	0	22.6	77.4	0	90	0	1	LOW
GP-5 Shallow	Good	1/15/2014 11:47	0	0.5	22.1	77.4	0	91	0	0	LOW
GP-5 Deep	Good	1/15/2014 11:50	0	0.1	22.5	77.4	0	92	0	0	LOW
GP-6 Shallow	Good	1/15/2014 11:59	0	0.2	22.5	77.3	0	89	0	0	LOW
GP-6 Deep	Good	1/15/2014 12:03	0	0	22.6	77.4	0	99	0	0	LOW
GP-2 Shallow	Good	1/15/2014 12:30	0	0	22.5	77.5	0	88	0	0	LOW
GP-2 Deep	Good	1/15/2014 12:35	0	0	22.2	77.8	0	87	0	0	LOW
GP-1 Shallow	Good	1/15/2014 13:06	0.1	0	22.1	77.8	2	89	0	0	LOW
GP-1 Deep	Good	1/15/2014 13:08	0.1	0	22.3	77.6	2	91	0	0	LOW
ES-01	Standpipe Intact	1/15/2014 15:09	0	0.1	22.5	77.4	0	85	0	0	LOW
ES-02	Standpipe Intact	1/15/2014 15:14	0.1	0.1	22.6	77.2	2	86	0	0	LOW
ES-03	Standpipe Intact	1/15/2014 15:18	0.1	0.6	22.1	77.2	2	87	0	0	LOW
ES-04	Standpipe Intact	1/15/2014 15:22	0.1	0	18.8	81.1	2	86	0	0	LOW
ES-05	Standpipe Intact	1/15/2014 15:28	0.1	3.9	17.6	78.4	2	92	0	0	LOW
ES-06	Outlet is flush mounted	1/15/2014 15:33	0.1	4.9	15.4	79.6	2	89	0	0	LOW
ES-07	Outlet is flush mounted	1/15/2014 15:38	8.1	22.1	0	69.8	>>>>	89	0	20	LOW
ES-08	Outlet is flush mounted	1/15/2014 15:45	2.2	13.3	5.3	79.2	44	89	0	1	LOW
ES-09	Outlet is flush mounted	1/15/2014 15:50	0.1	10.7	8.4	80.8	2	86	0	0	LOW
ES-10	Outlet is flush mounted	1/15/2014 15:53	0.1	0.2	22.8	76.9	2	87	0	0	LOW
ES-11	Outlet is flush mounted	1/15/2014 15:57	0.1	0.3	22.8	76.8	2	84	0	0	LOW
ES-12	Outlet is flush	1/15/2014 15:59	0.1	0.2	18.8	80.9	2	83	0	0	LOW

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Gas Probe ID/ Extr. System Outlet	Probe/Outlet Condition and Notes	Date/Time Units:	CH4 %	CO2 %	O2 %	Balance %	%LEL %	Adj. Gas Temp. °F	CO ppm	H2S ppm	H2 ppm
	mounted										
ES-13	Outlet is flush mounted	1/15/2014 16:02	0.1	0.6	22.6	76.7	2	84	0	0	LOW
ES-18	Standpipe Intact	1/15/2014 16:19	0.1	0.5	22.8	76.6	2	82	0	0	LOW
ES-17	Outlet is flush mounted	1/15/2014 16:25	0	0.1	19	80.9	0	86	0	0	LOW
ES-16	Outlet is flush mounted	1/15/2014 16:29	0	1	22.4	76.6	0	86	0	0	LOW
ES-15	Outlet is flush mounted	1/15/2014 16:33	0	1	21.9	77.1	0	88	0	0	LOW
ES-14	Outlet is flush mounted	1/15/2014 16:38	0	1.4	21.5	77.1	0	92	0	0	LOW

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Attachment A: Bibliography and CD Containing Documents Reviewed

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Attachment B: Site Photographs

ATTACHMENT B

Photo 1: Landfill Gas System Port

Photo 2: Excavated Gas Collection System

Photo 3: Landfill Drainage Swale

Photo 4: Landfill Drainage Swale

Photo 5: Groundwater Monitoring Well

Photo 6: Perimeter Gas Monitoring Well

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Attachment C: A-MEHR, Inc. Memorandum, Conceptual Landfill Gas Model and Emission Estimates

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A-MEHR, INC.
Memorandum

June 4, 2014

TO: File, Olowalu Closed Landfill

FROM: Glen Odell

RE: Conceptual Landfill Gas Model and Emission Estimates

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1. In order to provide an estimate of potential landfill gas emissions from the closed Olowalu Landfill we developed a conceptual model of landfill gas generation using the USEPA LandGem (Landfill Gas Emissions Model) computer program. The model computes LFG emissions using a time record of site-specific waste disposal volumes combined with a series of assumed waste composition, moisture and climate characteristics developed for typical landfills.

2. In the absence of historical records of annual waste disposal volumes, we developed a synthetic disposal record based on:

   - Total volume of waste disposed - 1,277,900 cubic yards based on topographic analysis by Element Environmental;
   - Average in-place density of waste - 1,000 lb/cubic yard, a conservative estimate for low to medium tonnage sites operating in the 1970's and 1980's. This results in an estimated total waste tonnage in place of 639,000 tons.
   - Active life from 1969 to 1982 (23 years)
   - Uniform annual tonnage intake (information indicates tonnage of 250 tons/day in 1987, 13 tons/day in 1991; no basis for any particular trend).

3. Conventional LandGem default model parameters were used as follows:

   - Potential methane generation capacity (L_o) - 100 m^3/Mg
   - Methane generation rate (k) - 0.05 $year^{-1}$
   - Methane content - 50% by volume

4. The resulting model output demonstrates a typical LFG curve with a methane generation rate that increases annually through the end of the landfill operational life, and then decreases at an exponential rate. Results of the model analysis are summarized in Table 1 below. The projected average emission rate of LFG for 2014 is 78 standard cubic feet per minute (scfm) from the 38-acre landfill. By comparison, the LFG collection and control system at Central Maui Landfill typically handles 600 to 800 scfm.

5. If emitted uniformly from the surface of the landfill, the methane volume of 39 scfm projected by the model for 2014 would be equivalent to approximately 2.4×10^{-5} scfm per square foot of landfill surface, or to a concentration of 24 ppmv of methane mixed in a one cubic foot volume of air above the surface. USEPA rules for gas collection and control systems in large landfills (40 CFR 60.755) require landfill surface emissions to be less than 500 ppmv methane.

6. Olowalu Landfill is equipped with a passive gas collection and venting system consisting of buried perforated pipes leading to a series of standpipes and flush-mounted surface outlets. Element Environmental personnel tested for methane in this system on January 15, 2014 and produced the results summarized in Table 2. Methane concentrations of 0.1% (1,000 ppmv) or less were measured in 16 of the 18 outlets sampled, with the other two indicating 2.2% and 8.1% methane by volume. Significantly, the two outlets with higher concentrations are in the area containing the most recently disposed refuse (late 1980's, early 1990's).

7. Element Environmental may recommend that the passive gas vent system be abandoned in order to reduce potential infiltration of oxygen into the refuse mass with resulting potential for creating landfill fires. If this is done, the existing point discharges of LFG would be replaced by dispersed emissions from the final cover surface as estimated in paragraph (5) above. Given the shallow depth and wide spacing (150 feet) of the collection trenches, it is unlikely that overall surface emissions from the landfill surface would significantly increase after abandonment of the passive vent system.

TABLE 1
OLOWALU LANDFILL
CONCEPTUAL LANDFILL GAS GENERATION
BY USEPA LANDGEM COMPUTER MODEL

YEAR	ANNUAL LFG (METRIC TONS / YEAR)	AVERAGE LFG (SCFM)	AVERAGE METHANE (SCFM)
1990	4,118	222	111
2000	2,901	156	78
2010	1,760	95	47
2014	1,441	78	39
2020	1,067	57	29
2030	647	35	17
2040	393	21	11
2050	238	13	6.5

TABLE 2
OLOWALU LANDFILL PASSIVE GAS COLLECTION SYSTEM
OUTLET GAS CONCENTRATIONS, 15 JANUARY 2014

Location	Probe/Outlet Condition and Notes	CH4	CO2	O2	Balance
		%	%	%	%
ES-01	Standpipe Intact	0	0.1	22.5	77.4
ES-02	Standpipe Intact	0.1	0.1	22.6	77.2
ES-03	Standpipe Intact	0.1	0.6	22.1	77.2
ES-04	Standpipe Intact	0.1	0	18.8	81.1
ES-05	Standpipe Intact	0.1	3.9	17.6	78.4
ES-06	No Standpipe, gas outlet is flush mounted	0.1	4.9	15.4	79.6
ES-07	No Standpipe, gas outlet is flush mounted	8.1	22.1	0	69.8
ES-08	No Standpipe, gas outlet is flush mounted	2.2	13.3	5.3	79.2
ES-09	No Standpipe, gas outlet is flush mounted	0.1	10.7	8.4	80.8
ES-10	No Standpipe, gas outlet is flush mounted	0.1	0.2	22.8	76.9
ES-11	No Standpipe, gas outlet is flush mounted	0.1	0.3	22.8	76.8
ES-12	No Standpipe, gas outlet is flush mounted	0.1	0.2	18.8	80.9
ES-13	No Standpipe, gas outlet is flush mounted	0.1	0.6	22.6	76.7
ES-14	No Standpipe, gas outlet is flush mounted	0	1.4	21.5	77.1
ES-15	No Standpipe, gas outlet is flush mounted	0	1	21.9	77.1
ES-16	No Standpipe, gas outlet is flush mounted	0	1	22.4	76.6
ES-17	No Standpipe, gas outlet is flush mounted	0	0.1	19	80.9
ES-18	Standpipe Intact	0.1	0.5	22.8	76.6