

## **FINAL** PALAUEA CULTURAL RESERVE

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Palauea, Kīhei, Maui, Hawai'i  
Tax Map Key: (2) 2-1-023:034

# DRAINAGE INSPECTION REPORT

**Prepared for:**

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This work was prepared by me or under my supervision. To the best of my knowledge, the information submitted is true, accurate and complete.

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## **ATTACHMENT**

- FEMA Floodway Data and Flood Profile
- OHA Palauea Drainageway Maintenance Plan and Inspection Form

## 1. Inspection Report Purpose

Group 70 International, Inc. dba G70 was contracted by the Office of Hawaiian Affairs (OHA) to perform a drainage inspection and provide a maintenance checklist for the northern-most drainageway on the OHA Cultural Reserve. This inspection report will evaluate the physical conditions of the drainageway on OHA property and provide recommendations for site improvements and/or maintenance measures.

## 2. Background Information

The project area is located within a 20.8-acre undeveloped cultural preserve located on the island of Maui in the Palauea ahupua'a between Kihei and Makena, near the Fairmont Kea Lani Resort. The project property is designated as Tax Map Key (2) 2-1-023: 034 and is bounded by Kaukahi Street to the north, Makena Alanui Drive to the east, the Keauhou at Makena Subdivision to the south, and Ualei Place to the west. The property wraps around the One Palauea Bay Subdivision. The area of interest is the drainage channel that runs along Kaukahi Street, between the Palauea Subdivision and the Fairmount Kea Lani Resort as shown in Figure 1.

Two drainage studies have been completed for the Palauea Subdivision and the cultural reserve: "Grading and Drainage Report for Palauea Subdivision" by Austin, Tsutsumi & Associates, Inc. dated July 1999, and revised in July 12, 2002 (referred herein as the ATA report) and "Drainage Study for the Cultural Preserve at the Palauea Subdivision" by Otomo Engineering dated August 2012 (referred herein as the Otomo report).

## 3. Existing Topography and Drainage Conditions

The existing drainage channel conveys runoff from a 1,706 acre drainage basin from mauka to makai in a westerly direction to the Pacific Ocean. The drainage channel is identified by the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) as Kihei Gulch 4. It is an unlined natural drainage channel which appears to be in its same historic alignment through the project area. The existing channel is normally dry and only receives flow during larger storm events.

The development along the coastline and the properties surrounding the project area has impacted the drainage channel due to encroachment, storm drain outlets, and roadway crossings resulting in an increase in the peak flow rates and runoff volumes through the project area.

According to the ATA report, there are three (3) drainage culverts that discharge runoff into the drainage channel along Kaukahi Street including a 24-inch culvert and two (2) 18-inch culverts as shown on Figure 2. Along the drainage channel there are three roadway crossings with culverts and a concrete ford. There are two (2) 120-inch culverts at the Makena Alanui Drive crossing, four (4) 90-inch culverts at the Ualei Place crossing, and a concrete ford at Makena Road as shown on Photo 1 and Figure 2. A red painted bollard with signage provides warning to motorists and pedestrians not to cross the ford if runoff is flowing across the road.



Figure 1: Project Location



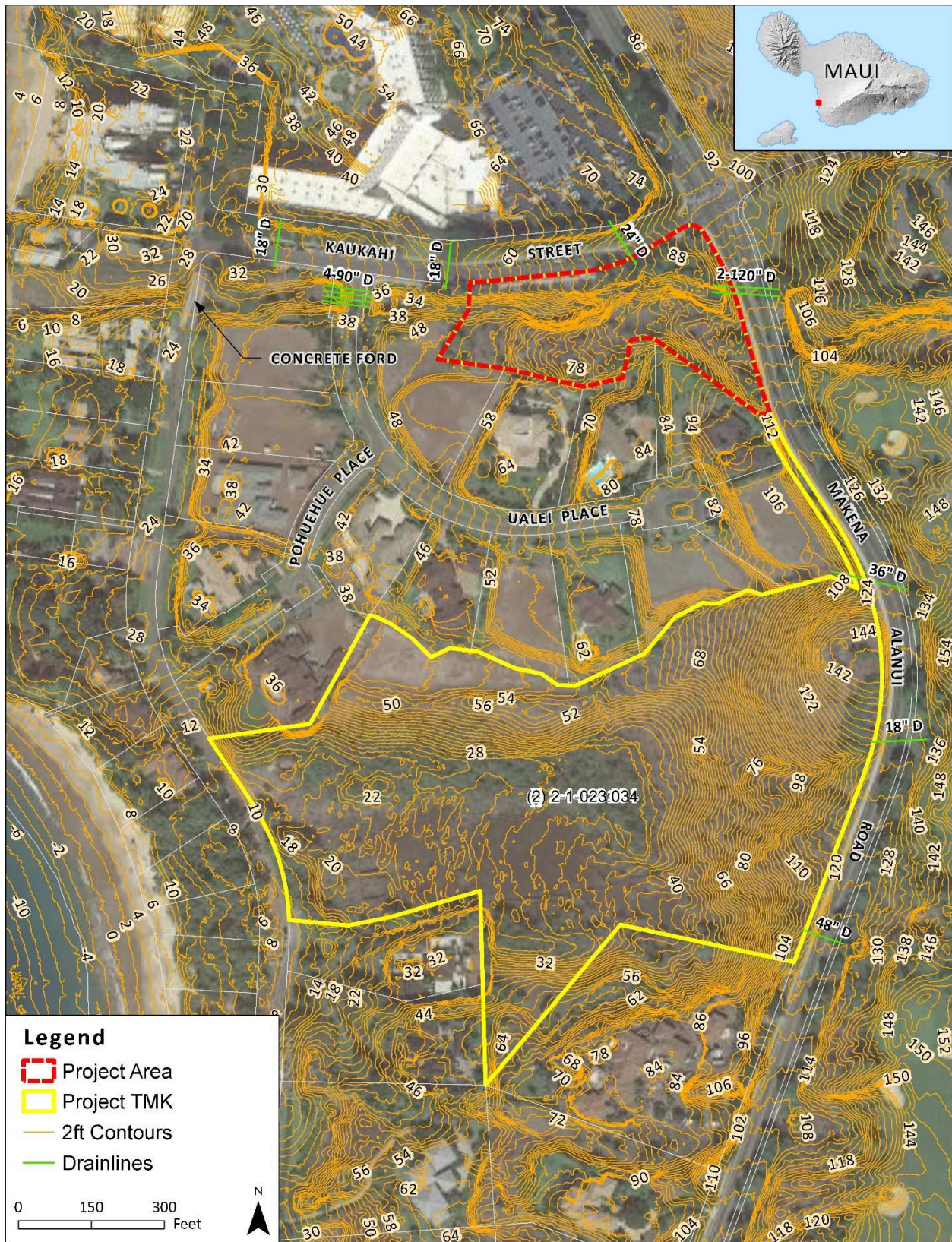


Figure 2: Existing Topography and Drain Culvert Locations

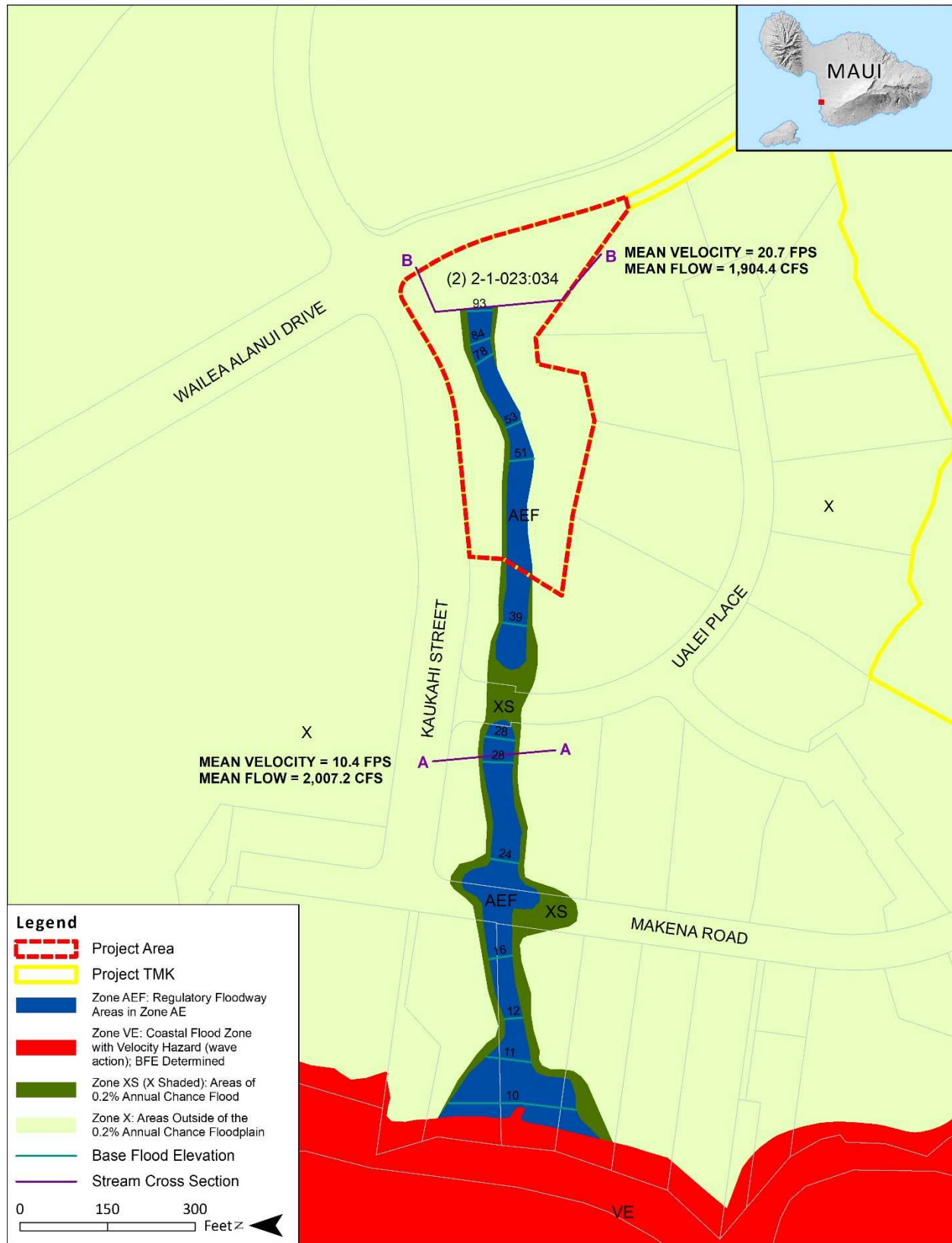




**Photo 1: Concrete ford along Makena Road, facing south.**

According to the Flood Insurance Rate Map, Panel Number 1500030678F, dated November 4, 2015, the project area is located in Flood Zones XS and AEF. Flood Zone XS means the area has a 0.2% annual chance of flooding, which is a low-to-moderate risk flood zone. Flood Zone AEF means the area is a floodway and is subject to inundation by the 1-percent-annual chance flood event. Figure 3 identifies the project area and the limits for each flood zone. Floodway data including peak flow rates, flow velocities, and the channel profile for Kihei Gulch 4 is excerpted from the FIS and is attached to this report and also depicted on Figure 3.

The FIS identifies two (2) cross sections in Kihei Gulch 4. One is located at the top of the project area just below Makena Alanui Road (Section B-B), and the second section is located just downstream of the four 90-inch culverts that cross Ualei Place (Section A-A). The study identifies Section B-B of the channel to have a 33-foot wide channel bottom with a 100-year rainfall event mean flow of 1,904.4 cubic feet per second (cfs) and a mean velocity of 20.7 feet per second (fps). This is consistent with the Otomo report. At Section A-A, the channel widens to an 88-foot wide channel bottom with a 100-year rainfall event mean flow of 2,007.2 cfs and a mean velocity of 10.4 fps. Based on the base flood elevations, the 100-year storm appears to be contained within the channel with an average depth of 2 to 3 feet.





## 4. Physical Drainage Inspection

A site inspection was conducted by a G70 Engineer, Steven Doo, on August 22, 2017 to observe the physical condition of the drainageway. The investigation started upstream at the two 120-inch culverts at Makena Alanui Road and continued past the project area to the concrete ford at Makena Road. This physical drainage inspection evaluated the drainageway for erosion and sedimentation and flow conveyance.

### Upstream of the Project Area

At the time of the inspection, the two 120-inch culverts appeared to have minimal debris at the upstream mouth of the culverts. However, a fallen tree from the adjacent golf course was observed at the top of the concrete apron. This may act as a blockage during large storm events and may impede runoff upstream of the culverts, contributing to localized flooding. Photo 2 depicts the current upstream condition of the project area. The fallen tree, as shown in Photo 2, should be removed by the golf course owner to prevent future drainage issues and possible liability issues.



**Photo 2: Looking downstream at the two 120-inch culverts with fallen tree in the foreground.**

### Project Area

The majority of the project area is overgrown with brush, weeds, kiawe trees, and other various trees that cover the slopes and bottom of the existing drainage channel. Portions of the drainageway were inaccessible due to heavy brush and overgrowth, as shown in Photo 3. Specifically, the 24-inch and two 18-inch drain outlets between Makena Alanui Road and Makena Road could not be accessed due to the heavy brush and vegetation.



The channel width (33-feet) appears to be consistent with the FIS at the upstream section A-A. However, the channel appeared to narrow to approximately 10-feet towards the middle and bottom of the project area. The narrower channel bottom in these areas may constrict flow conveyance and yield higher water levels during storm events.



**Photo 3: Looking upstream from Ualei Place towards the bottom of the Project Area**

During the inspection, there were no areas of concentrated erosion or sedimentation observed along the channel, but erosion and sedimentation was observed sporadically throughout the project area. There were two areas of erosion observed during the inspection. Loose rocks were observed near the top of the project area along the Palauea Subdivision property (near Lot 3). The rocks appear to have broken off from the side of the channel and may be an area of concern for future erosion. Photos 4 and 5 highlight the areas of erosion. Additionally, an area near the bottom of the project area showed early signs of erosion, Photo 6. Figure 4 is a photo map to identify the photo direction and area of interest.

In the areas observed, sedimentation and erosion appeared to reach up to 2 to 3 feet along the channel's sides/slopes and is consistent with the FIS. Due to the overgrowth in the lower third of the project area, the presence of erosion and sedimentation could not be determined.





**Photo 4: Looking towards the Palauea Subdivision for potential future slope erosion**



**Photo 5: A close-up image of the area of interest**





**Photo 6: Signs of erosion at the invert of the drainageway near the bottom of the project area**

While the natural vegetation within the channel helps to slow the velocity of the runoff, trees or large objects (e.g. boulders, abandoned refuse, etc.) that become dislodged and fall into the drainageway, may impede the flow of storm runoff and contribute to flooding upstream.

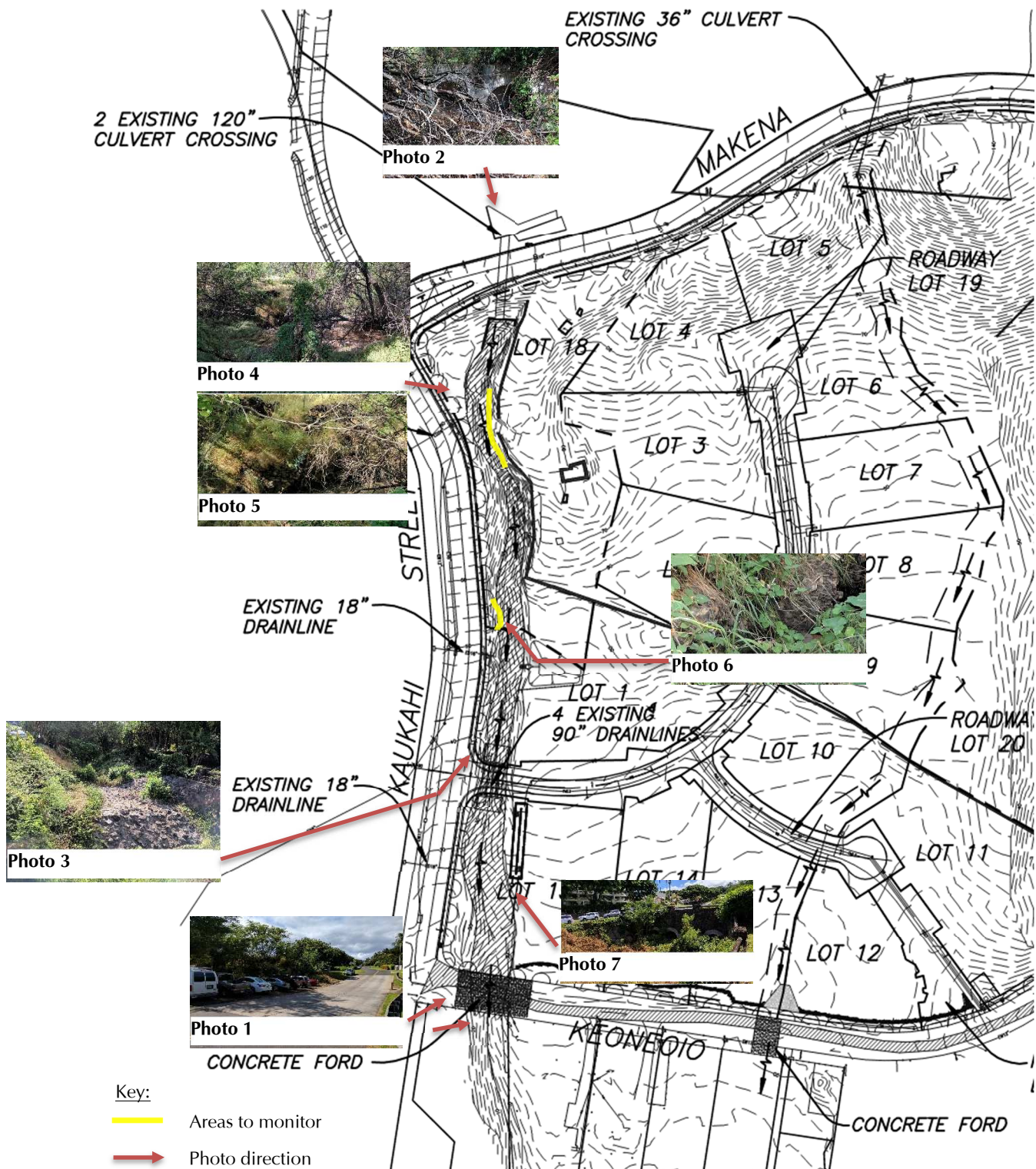
### Downstream of the Project Area

The drainage channel continues from OHA's property into the Palaeua Subdivision. The project area and boundary of the property ends approximately 100' upstream from the grouted rip rap lined channel (see Photo 3). The inlet and outlet surrounding the four 90-inch culverts are lined with grouted rip rap. The bottom of the channel opens up to 88-feet wide downstream of the four culverts and is overgrown with vegetation to the concrete ford, as shown in Photo 7. The concrete ford at the Makena Road crossing does not appear to have any physical issues. However, parked vehicles were observed where the channel meets the concrete ford (see Photo 2). There should not be vehicles parked in the area before or during a storm event. In addition, a sign is posted on both ends of the concrete ford, "Do not cross when water level touches red on posts." Any objects within the concrete ford may get washed downstream and impact the downstream properties.



**Photo 7: Looking upstream toward the four 90" drain lines crossing under Ualei Place**

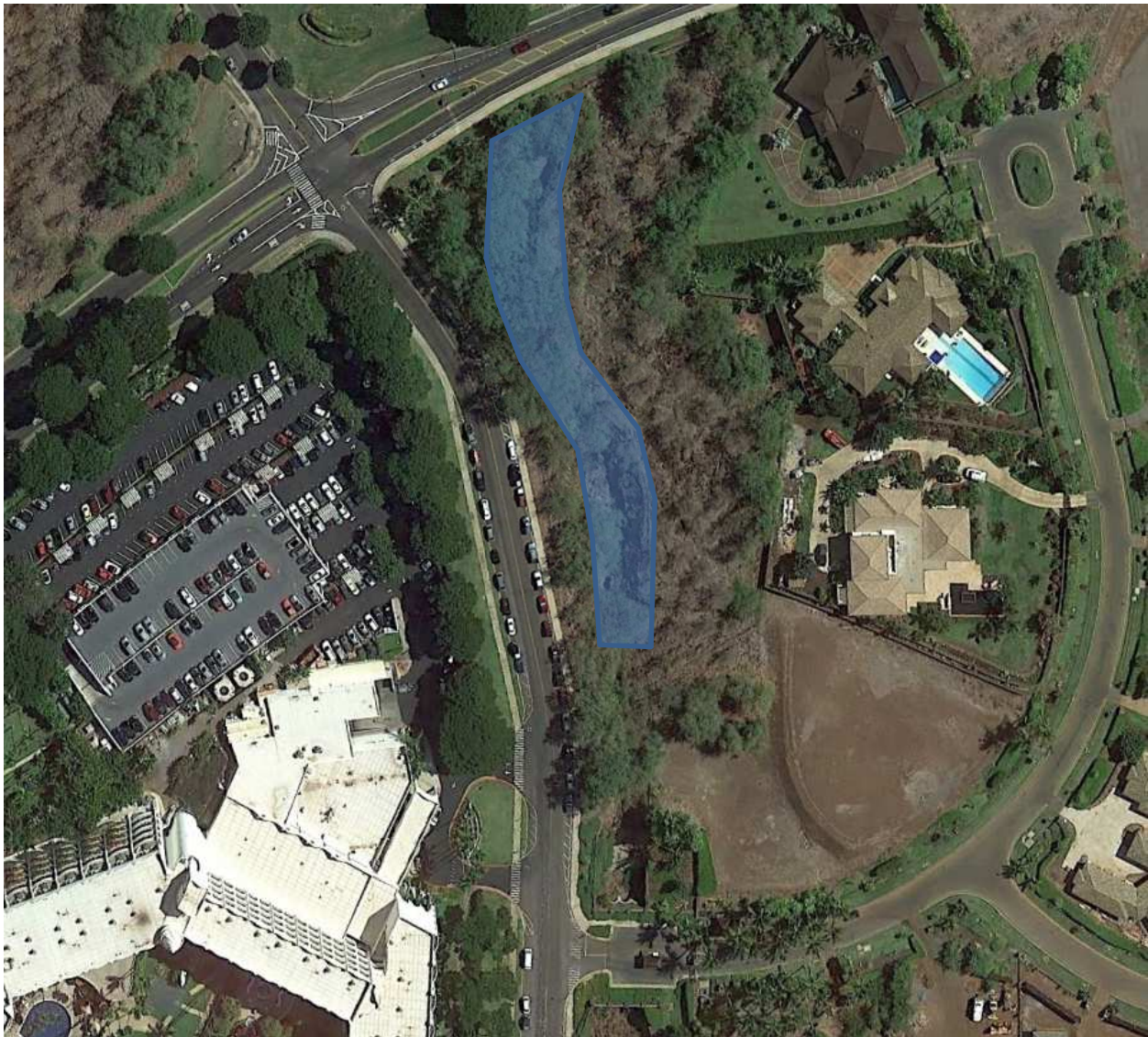






## 5. Recommendations

Based on the drainage inspection conducted on August 22, 2017, the drainage channel doesn't appear to require immediate maintenance. However, we recommend clearing the vegetation (e.g. cut grass to 4" to 9" height and remove clippings; remove dead vegetation, dead trees, loose debris, etc.) to conduct a follow up inspection to verify the location and condition of the existing drain outlets along Kaukahi Street and reinspection of the drainageway to identify additional areas of concern. When clearing, do not grub or destroy vegetation and roots holding soil and channel together. Doing so may compromise the integrity of the channel. Figure 5 highlights the area to be cleared for further inspection.



**Figure 5: Area to be Cleared**

In addition, we recommend doing one of the two following options to minimize the frequency and scale of future remediation projects. These recommendations are based on both erosion and sedimentation and flow conveyance of the drainageway:



- 1) Continue monitoring the drainage channel and performing maintenance, as necessary. Action steps are listed below:

- Remove all large loose objects that may impede the natural flow of storm runoff (e.g. boulders, abandoned refuse, etc.).
- Remove any dead vegetation, dead trees, and other vegetative debris.
- Remove or prune any trees and plants that could create hazardous conditions or impede conveyance of storm water runoff (e.g. large trees in the middle of the channel, tree that may fall over, etc.).
- Restore vegetative cover and fix any eroded areas.
- Visually inspect eroded slopes. Action should be taken if the conditions worsen.

A drainageway maintenance plan and inspection form is attached for regular inspections. At a minimum, inspections should occur annually AND within 24 hours before and after any large storm events (i.e. tropical storms, hurricanes, etc.). Additional inspections shall occur if the condition of the drainage easement warrants additional repair work, remedial action, or maintenance.

Further action may include obtaining engineering consultation to evaluate erosion conditions and/or implementing erosion control measures such as geotextile matting, energy dissipaters upstream of erosion, riprap revetment, and lining of the natural drainage channel to mitigate further erosion.

- 2) Line the drainage channel now to prevent a large storm event from washing out the channel and causing future erosion. At this time, lining of the channel is not required and is intended to be a preventative measure to minimize future remediation projects.

Table 1 provides a Rough Order of Magnitude costs for various preventative and remediation measures:

Table 1: Rough Order of Magnitude Costs	
Type	Range
<b>Option 1</b>	
Vegetation and Tree Maintenance	\$5,000 – \$30,000
Erosion Control (per event)	\$6,000 – \$50,000
<b>Option 2</b>	
Grouted Rip Rap	\$400,000 – \$690,000
Concrete Lined Channel	\$950,000 – \$1,500,000

In general, the drainage channel is an unlined natural drainageway. Based on the mean flows and velocities identified in the FIS, current drainage standards dictate the channel to be lined. However, since the flow appears to be contained within the channel and there is no imminent threat to life and safety or flooding concerns to the neighboring properties, the channel can continue to be monitored for channel stability. If remediation is necessary, cost effective erosion control BMPs can be applied to stabilize the channel.

# **ATTACHMENTS**



FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET LOCAL TIDAL DATUM)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
<b>KIHEI GULCH 2</b>								
A	990	34	134	24.1	31.7	31.7	31.7	0.0
B	1,500	104	306	11.4	82.2	82.2	82.2	0.0
<b>KIHEI GULCH 3</b>								
A	960	51	208	13.4	49.2	49.2	49.2	0.0
B	1,620	134	209	13.4	93.8	93.8	93.8	0.0
<b>KIHEI GULCH 4</b>								
A	700 <sup>1</sup>	88	193	10.4	35.8	35.8	35.8	0.0
B	1,550 <sup>1</sup>	33	92	20.7	90.5	90.5	90.5	0.0
<b>KOPE GULCH</b>								
A	1,667 <sup>1</sup>	98	397	7.2	46.6	46.6	46.8	0.2
B	2,756 <sup>1</sup>	103	268	9.4	74.5	74.5	74.5	0.0
C	3,568 <sup>1</sup>	89	251	9.7	97.1	97.1	97.2	0.1
D	4,300 <sup>1</sup>	126	274	8.4	131.5	131.5	131.5	0.0
<b>LIILIOHOLO GULCH</b>								
A	810 <sup>1</sup>	49	171	17.5	21.8	21.8	21.8	0.0
B	1,550 <sup>1</sup>	56	161	18.7	51.6	51.6	51.6	0.0

<sup>1</sup> Stream distance in feet above confluence with Pacific Ocean

**TABLE 10**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**MAUI COUNTY, HI**

## FLOODWAY DATA

**KIHEI GULCH 2 – KIHEI GULCH 3 – KIHEI GULCH 4  
– KOPE GULCH – LIILIOHOLO GULCH**







## OHA Palaukea Drainage Easement Maintenance Plan and Inspection Form

Inspection Date: \_\_\_\_\_ Inspection Time: \_\_\_\_\_

Inspected By: \_\_\_\_\_

Name: \_\_\_\_\_

Organization: \_\_\_\_\_

Address: \_\_\_\_\_ Phone number: \_\_\_\_\_

Approximate Date/Time of Last Rainfall: \_\_\_\_\_

Inspection Frequency: At a minimum, inspections should occur annually AND within 24 hours before and after any large storm events (i.e. tropical storms, hurricanes, etc.). Additional inspections shall occur if the condition of the drainage easement warrants additional repair work, remedial action, or maintenance.

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### Water Quality

- Observe and record water levels and note locations on map.
- Observe and record water quality characteristics including oil sheen, smell, turbidity, etc. and note locations on map.
- Note all corrective actions taken.

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### Sediment and Debris

- Remove all trash and debris from the drainageway.
- Observe and measure depth of accumulated sediment at the invert of the natural drainage channel and note locations on map.
- Observe and measure erosion along channel and at culvert inlet and outlets and note on map; include photographs of eroded areas
- Remove and dispose of any accumulated sediment and debris.

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## **OHA Palaukea Drainage Easement Maintenance Plan and Inspection Form**

### **Vegetation**

- Observe and note condition of vegetation, including height, health and density.
- Remove any dead vegetation, dead trees, fallen leaves and other vegetative debris.  
DO NOT REMOVE ROOTS OR EXPOSE SOIL TO POTENTIAL EROSION
- Remove or prune any hazardous trees, restore vegetative cover.
- Remove any vegetation that interferes with the hydraulic operation of the facility.
- Cut grass to a 4" - 9" height and remove clippings.
- Restore vegetative cover to prevent erosion

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### **Structural**

- Inspect all drainage structures and piping including inlets, outlets, flow control structure and spillway:
  - Clear all debris and sediment
  - Structural deficiencies should be observed, noted and corrected immediately.
  - Any undermining of the spillway should be stabilized and repaired immediately.
- Inspect rock berms, filter berms and low flow channel.
  - Berms and channels should adequately direct or filter runoff.
  - Deficiencies should be observed, noted and corrected immediately.
- Stabilize and repair erosion of side slopes or embankments.
- Significant settlements in berms or embankments should be investigated immediately and corrective and/or mitigative measures should be taken. A licensed civil or geotechnical engineer should be consulted if settlement is significant.
- Inspect signage and fencing.
  - Any damaged or inoperable signage or fencing shall be repaired or replaced.
- Note all corrective actions taken for any structural maintenance performed.

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### **Safety Hazards**

- Identify any safety hazards.
- Note all corrective actions taken.

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