PRELIMINARY DRAINAGE AND SOIL EROSION CONTROL STUDY

APPENDIX F

PRELIMINARY DRAINAGE & SOIL EROSION CONTROL STUDY

FOR

PROPOSED NEW QUARRY SITE

AT PULEHUNUI, WAILUKU, MAUI, HAWAII

TAX MAP KEY: (2) 3-8-04:01 (PORTION)

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JOB 05-065

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I. **INTRODUCTION**:

Hawaiian Cement plans to lease additional lands for quarrying purposes to replace its existing quarry sites which is anticipated to be completely mined out shortly.

The proposed quarry site (45.350 acres) is located about 2 miles east (mauka) of Mokulele Highway in Pulehunui, Wailuku, Maui, Hawaii. The site is part of Parcel 1 of Tax Map Key (2) 3-8-04. The land is presently a follow sugar cane field. The general location, vicinity and plat maps are shown on Figures 1, 2 and 3, respectively.

Quarrying is expected to be done incrementally at a maximum area of 15 acres in keeping with the requirements of Chapter 20.08 - Soil Erosion and Sedimentation Control, of the Maui County Code. After mining is completed for each increment, the exposed areas will be backfilled (using topsoil that was removed and stockpiled) and the area stabilized.

The existing crusher and batching plants and related accessories at the present quarry site will be used in conjunction with the proposed mining operations at the proposed new quarry site.

II. **PURPOSE**:

The purpose of this preliminary study are as follows:

A. to determine the effect of this project on drainage conditions;

B. to determine the 100-year discharge and inundation limits of Kolaloa Gulch that traverse along the proposed quarry site; and

C. to determine the requirements for grading and Best Management Practices (BMPs) to control soil erosion during quarry operations.

III. BASIS OF STUDY:

The Drainage Study is based on the design criteria as set forth by the "Rules of the Design of Storm Drainage Facilities" in the County of Maui [1] hereinafter referred to as "Maui County Drainage Standards". Soil erosion control measures to be instituted during mining operations of the project will be in accordance with the requirements of Chapter 20.08 of the Maui County Code (MCC) and Construction BMPs for the County of Maui [6].

IV. EXISTING ONSITE SOIL:

The predominant type of soil at the site belongs to Waiakoa, Pulehu and Alae Series [2]. Waiakoa Series includes extremely stony silty clay loam (WID2) on 3 to 25 percent slopes. Pulehu Series include Silt Loam (PpB) on 3 to 7 percent slopes and Cobbly Clary Loam (PtA) on 0 to 3 percent slopes. Alae Series include Cobbly Sandy Loam (AcA) on 0 to 3 percent slopes. All these types of soils are characterized by moderate to rapid permeability, slow runoff and slight to no more than slight erosion hazard. See Figure 4 for Soils Map.

V. ONSITE DRAINAGE:

A. Existing Conditions:

The proposed quarry site is presently fallow former sugar cane lands. This site has an average slope of about 3 percent. The ground elevation ranges from approximately 300 to 340 feet above mean sea level.

The proposed site lies to the north of Kolaloa Gulch. An existing drainageway lies to the north of the project site.

Runoff from the southern half of the proposed quarry site flows towards Kolaloa Gulch where it is blocked from directly entering the gulch by a dirt berm along the top bank of the gulch. The runoff flows along a dirt road to the Southwest corner of the new quarry area where it enters the gulch (Figure 5).

Runoff from the northern half of the site is directed to the northwest where it flows and ponds in a low area adjacent to the A.C. paved cane haul road.

Runoff from the fallow sugar cane fields above the project area are also directed to Kolaloa Gulch by existing diversionary ditches. Hence, runoff from these areas is not anticipated to affect the proposed new quarry site.

B. Onsite Runoff:

The proposed new quarry site encompassing 45.35 acres of leased land, will be mined in increments. Areas not in active quarrying will remain as fallow sugar cane fields. Therefore, for hydrologic analysis, a typical area of 15 acres with an overland flow of 800 feet long will be considered.

The rational method was used to determine runoff rate and volume for a 10-year and 50-year storm intensity, respectively. It was estimated that a typical 15-acre area in active quarry operations will increase the existing 10-year runoff rate by 15.2 c.f.s., from 13.3 c.f.s. to 28.5 c.f.s., while the increase of 50-year runoff volume is about 27,225 c.f. or 1,815 c.f. for each acre of grading area. The 50-year runoff volume increase will be the minimum volume to be retained onsite in order to attain a zero runoff increase during mining operations.

Drainage calculations are shown in the attached Preliminary Drainage Calculations.

VI. OFFSITE RUNOFF - KOLALOA GULCH DRAINAGE BASIN:

A. Drainage Basin:

The Kolaloa Gulch drainage basin (Figures 8 and 8A) is located on the northwesterly slope of Haleakala and extends from 300 feet elevation to the upper slopes at elevation 9,600 feet. It is about 75,400 feet long with an average slope of about 13 percent. The total drainage area including Hapapa Gulch watershed, is about 3,861 acres or 6.03 square miles.

Land uses varies throughout the drainage basin. The upper portion consist of poor range land and pasture land. The central portion consists of diversified agriculture and pasture lands. The lower portion consist of pasture lands and fallow cane fields in the vicinity of the quarry site.

Soils within the drainage basin are classified under hydrologic soil groups A, B and D as defined by U. S. Department of Agriculture Soil Conservation Services [2 and 5]. Group A soils have low runoff potential; Group B soils have moderately low runoff potential; Group D soils have high runoff potential. The predominant soils within the drainage basin are under hydrologic soil Group B.

B. Runoff Rate:

Kolaloa Gulch is anticipated to generate a 100-year, 24-hour storm flow of 2,480 c.f.s. This was determined by employing the NRCS (formerly SCS) Hydrograph Method. Calculations are given in the attached Preliminary Drainage Calculations.

C. Floodway Limits:

The inundation limits, were determined by using FEMA's Guide for Obtaining and Developing Base (100-Year) Flood Elevations [7]. Preliminary results show that the floodways will be confined within the stream banks. The average depth of flow is about 5.5 feet.

Cross-sections were taken along the existing stream. The approximate cross-sectional areas and the slopes were determined from an aerial topographic map of the site.

VII. PROPOSED DRAINAGE FACILITIES AND GRADING:

The proposed mining operations is anticipated to increase the storm runoff especially during active excavation when the ground is bare.

Increase in runoff volume (50-year, 1-hr. storm) due to mining operations will be retained onsite by means of retention ponds to be constructed at the downstream end of the grading area(s). In keeping with the requirements of the County Drainage Standards, the ponds will be sized to contain at least the 50 year, 1-hour runoff volume increase. Aside from keeping the runoff at pre-quarrying levels, the retention ponds will also have the effect of reducing or precluding the potential for sediment contained in the runoff from entering downstream properties and Kolaloa Gulch.

A typical cut section of the graded area is shown on Figure 7. Each incremental grading will be limited to 15 acres maximum.

When quarrying is completed on each increment, the exposed areas will be backfilled with two (2) feet of topsoil and replanted.

VIII. FLOODING HAZARD:

The proposed new quarry site is located within Zone X as plotted on Panel 1500030580F of the Flood Insurance Rate Map for the County of Maui. Zone X is designated as areas of minimal flooding. Refer to Figure 6.

Kolaloa Gulch runs adjacent to the proposed quarry site. The calculated stream flow, based on 100-year, 24-hour recurrence interval, is about 2,480 c.f.s. This flow is anticipated to be confined within the stream banks. There is no plan to disturb or alter the existing stream. Mining will be confined to areas outside of the stream. Under these conditions, the proposed quarry operations will not be affected.

IX. BEST MANAGEMENT PRACTICES:

Generally, the control of soil erosion and sediment will be in conformance with the applicable sections of the County of Maui Construction Best Management Practices [6].

The following are some of the measures to control soil erosion during quarrying operations.

A. Construct temporary drainage swales or berms to direct storm runoff away from mining area to natural drainageway or ground or to retention basins. Diverting runoff away from graded areas will minimize erosion of the bare soil especially over the cut slopes.

B. Construct drainage basin(s) at downstream end of mining areas. Grade in such manner that runoff from mining area will flow into the retention basin(s).

C. Mine area incrementally to extent possible. Exposed area at any given time should not be larger than 15 acres.

D. Areas where mining is completed should be stabilized or provided with top soil and replanted with suitable ground cover.

X. <u>CONCLUSION</u>:

Based on this preliminary study, the following conclusion and recommendations are:

A. The proposed mining operation will slightly increase the existing runoff quantities, however it is not anticipated to have adverse drainage effects on Kolaloa Gulch and downstream properties. The retention pond(s) to be constructed at the lower reaches of each incremental grading will keep or lower pre-quarrying runoff levels. The retention basin will also have the effect of reducing the potential for sediment contained in the runoff from entering neighboring properties or Kolaloa Gulch.

Further, after mining is completed in each increment, the area will be backfilled with two (2) feet of topsoil and be stabilized.

There will be no appreciable offsite runoff that will flow into the quarry area. Most of the offsite flows will be intercepted by several diversionary ditches, diverting the flow to either Kolaloa Gulch or to the drainageways that are running outside the quarry sites.

B. Kolaloa Gulch is anticipated to generate a 100-year storm flow of 2,480 c.f.s. which was determined by the SCS Hydrograph method in conformance with the Guidelines of the Maui County Drainage Standards. Preliminary analysis of the stream channel capacity, using method established by FEMA [7], showed that the 100-year flow will be confined within the stream banks.

Quarrying will be performed outside of the gulch area; therefore, as long as the stream banks are not disturbed, the 100-year flood is not expected to affect the quarry operations.

XI. REFERENCES:

1. Rules for the Design of Storm Drainage Facilities in the County of Maui, Title MC-15, Department of Public Works and Waste Management, County of Maui, Chapter 4.

2. Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii, prepared by U. S. Department of Agriculture, Soil Conservation Service, August 1972.

3. Flood Insurance Rate Maps for the County of Maui, September 19, 2012.

4. Rainfall-Frequency Atlas of the Hawaiian Islands, Technical Paper No. 43, U. S. Department of Commerce, Weather Bureau, 1962.

5. Erosion and Sediment Control Guide for Hawaii, prepared by U. S. Department of Agriculture, Soil Conservation Service, March 1981.

6. Construction Best Management Practices (BMPs) for the County of Maui, Dept. of Public Works and Waste Management, County of Maui, May 2001.

7. Guide for Obtaining and Developing Base (100-Year) Flood Elevations, prepared by Federal Emergency Management (FEMA), April, 1995.

PRELIMINARY DRAINAGE CALCULATIONS

I. Onsite

A. Reference: Rules for the Design of Storm Drainage Facilities in the County of Maui

B. Methodology: Rational Method

Recurrence Interval: 10-year, 1-hour rainfall (runoff rate)
50-year, 1-hour rainfall (runoff volume)

Drainage Area: 15 acres

Time of Concentration, Tc: Determined from Plate 1

Runoff Coefficient, C:

Existing Condition: C = 0.30 (unimproved)

New Condition: C = 0.50 (bare soil)

C. Runoff Rate

1. Existing Condition:

I_{10} = 2"

L = 800'

S = 3%

Tc = 26 min. (Plate 1)

i = 2.95 (Plate 2)

Q = CiA

= 0.30 x 2.95 x 15 = 13.3 c.f.s.

2. New Condition (During Quarrying):

I_{10} = 2"

L = 800'

S = 2%

Tc = 16 min. (Plate 1)

i = 3.8 (Plate 2)

Q = CiA

= 0.50 x 3.8 x 15 = 28.5 c.f.s.

3. Increase of Runoff Rate During Active Quarry Operations for Each Incremental Area of 15 Acres:

Increase = 28.5 - 13.3

= 15.2 c.f.s.

D. Runoff Volume:

1. Existing Conditions:

I_{50} = 2.5"

V = Rainfall x C x A

$$= \frac{2.5''}{12} \times 0.30 \times 15$$

= 0.9375 ac.-ft.

2. New Condition (During Quarrying):

$$V = \frac{2.5''}{12} \times 0.50 \times 15$$

= 1.5625 ac.-ft.

3. Increase in Volume:

= 1.5625 - 0.9375

= 0.625 ac.-ft.

= 27,225 cubic feet

$$\text{Increase/Acre} = \frac{27,225}{15}$$

$$= 1,815 \text{ c.f.}$$

4. Minimum Runoff Volume to be Retained Onsite

   = 1,815 c.f. For each acre of grading area

II. Kolaloa Gulch

A. Reference: Rules for the Design of Storm Drainage Facilities in the County of Maui

B. Methodology: SCS Hydrograph Method

C. Drainage Area: 3,861 Acres (Refer to Figure 9 & 9A)

D. Hydrologic Soil Group (HSG) and Curve Number (CN)
(Maps 106, 107, 116 and 117) [2]
(Tables 14, 25 and 26) [5]

Land Use	HSG	Acres	CN	CN x Acres
Range Land - Poor Condition	A	305	68	20,740
	B	99	79	7,821
	D	163	89	14,507
Range Land - Good Condition	B	2,878	61	175,558
Sugar Cane Field (Limited Cover)	A	93	65	6,045
	B	323	75	24,225
Total		3,861		248,896

$$CN = \frac{248,846}{3,861} = 64.5$$

Use CN = 65

E. Runoff Rate:

1. Rainfall (P): 100-year, 24-hour rainfall

   P = 10.0" (average)

2. Time of Concentration, Tc:

   Time of flow is based on velocities indicated on Table 4 [1]

   Tc_1 (300 ft. elev. to 4,200 ft. elev.):

   L = 54,100 ft.

$$S = \frac{4{,}200 - 280}{54{,}100} = 7.3\%$$

V = 4.0 fps (use for Natural Channel Flow)

$$Tc_1 = \frac{54{,}110}{4.0} \times \frac{1}{60} = 225 \text{ minutes}$$

Tc_2 (4,200 ft. elev. to 9,600 ft. elev.)

L = 21,300 ft.

$$S = \frac{9{,}600 - 4{,}200}{21{,}300} = 25\%$$

V = 4.5 fps (use for Overland Flow)

$$Tc_2 = \frac{21{,}300}{4.5} \times \frac{1}{60} = 79 \text{ minutes}$$

Total Tc = $Tc_1 + Tc_2$

= 225 + 79 = 304 minutes

3. Peak Discharge = 2,480 c.f.s.

(See attached Hydrologic Report)

F. Inundation Limits:

Approximate inundation limits were determined by computing the normal depth of the 100 year storm flow at few sections of the gulch using the programs developed by the Federal Emergency Management Agency (FEMA) [7]. The average depth of flow is estimated at 5.5 feet.

Table 1

GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS*

WATERSHED CHARACTERISTICS	EXTREME	HIGH	MODERATE	LOW
INFILTRATION	NEGLIGIBLE 0.20	SLOW 0.14	MEDIUM 0.07	HIGH 0.0
RELIEF	STEEP (> 25%) 0.08	HILLY (15 - 25%) 0.06	ROLLING (5 - 15%) 0.03	FLAT (0-5%) 0.0
VEGETAL COVER	NONE 0.07	POOR (< 10%) 0.05	GOOD (10 - 50%) 0.03	HIGH (50 - 90%) 0.0
DEVELOPMENT TYPE	INDUSTRIAL & BUSINESS 0.55	HOTEL - APARTMENT 0.45	RESIDENTIAL 0.40	AGRICULTURAL 0.15

**NOTE:* *The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.*

OFFSITE AREA - TABLE 1

Table 2

RUNOFF COEFFICIENTS

Type of Drainage Area	Runoff Coefficient C
Parks, cemeteries	0.25
Playgrounds	0.35
Railroad yard areas	0.40
Unimproved areas	0.30
Streets:	
Asphaltic	0.95
Concrete	0.95
Brick	0.85
Driveway and walks	0.85
Roofs	0.95
Lawns:	
Sandy soil, flat, 2%	0.10
Sandy soil, avg., 2-7%	0.15
Sandy soil, steep, 7%	0.20
Heavy soil, flat, 2%	0.17
Heavy soil, avg., 2-7%	0.22
Heavy soil, steep, 7%	0.35

Table 3

MINIMUM RUNOFF COEFFICIENTS FOR BUILT-UP AREAS

Residential areas	C=0.55
Hotel, apartment areas	C=0.70
Business areas	C=0.80
Industrial areas	C=0.80

The type of soil, the type of open space and ground cover and the slope of the ground shall be considered in arriving at reasonable and acceptable runoff coefficients.

Table 4

APPROXIMATE AVERAGE VELOCITIES OF RUNOFF FOR CALCULATING TIME OF CONCENTRATION

TYPE OF FLOW	VELOCITY IN FPS FOR SLOPES (in percent) INDICATED			
OVERLAND FLOW:	0–3%	4–7%	8–11%	12–15%
Woodlands	1.0	2.0	3.0	3.5
Pastures	1.5	3.0	4.0	4.5
Cultivated	2.0	4.0	5.0	6.0
Pavements	5.0	12.0	15.0	18.0
OPEN CHANNEL FLOW:				
Improved Channels	Determine Velocity by Manning's Formula			
Natural Channel* (not well defined)	1.0	3.0	5.0	8.0

**These values vary with the channel size and other conditions so that the ones given are the averages of a wide range. Where-ever possible, more accurate determinations should be made for particular conditions by Manning's formula.*

DRAINAGE — RUNOFF — 2

Q=Aci RATIONAL FORMULA (Logical approach).

Q = RUNOFF = Peak discharge of watershed in cubic feet per second (c.f.s.) due to maximum storm assumed. See Figs. A to F, Pg. 18-01 (Usually 10 – 25 years).
A = Area of watershed in acres.
C = Coefficient of runoff, Table B below (Measure of losses due to infiltration, etc.).
i = Intensity of rainfall in inches per hour based on concentration time. See Pg. 18-01.
Concentration time = time required for rain falling at most remote point to reach discharge point. Concentration time may include overland flow time, Fig. H, Pg. 18-01, and Channel flow time, Pg. 18-05, 18-06, 18-69 and 18-71.

TABLE A-COMPUTATION FORM FOR RATIONAL FORMULA.

LOCATION			A			TIME OF FLOW-MIN.					DESIGN					PROFILE				
STREET	FROM	TO	INCREMENT	TOTAL	C	TO INLET	IN CHANNEL	TIME OF CONC	L *	Q c.f.s.	CHANNEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPACITY FULL c.f.s.	V ft. per Sec.	LENGTH ft.	FALL ft.	OTHER LOSSES ft. †	INV. ELEV. UPPER END	INV. ELEV. LOWER END
FIRST ST.	A	B	1.8	1.8	.44	16.5	0.3	16.5	3.8	3.0	15"	.008	.015	4.6	3.9	60	0.48	0	82.00	81.52
MAIN RD.	B	C	1.9	3.7	.50		2.5	16.8	3.7	6.8	D-2	.011	.030	12.0	2.8	420	4.62	0	81.52	76.90
" "	C	D	2.0	5.7	.50		1.8	19.3	3.5	10.0	21"	.007	.015	11.1	4.5	480	3.36	2.20	74.70	70.34

* Note that the sequence of design as in example, Fig. J, Pg. 18-01 involves trial assumptions in determining i.
† Fall in manhole.

TABLE B – VALUES OF C = RUNOFF / RAINFALL

SURFACES			VALUE PROPOSED MIN.	VALUE PROPOSED MAX.	VALUE BY OTHER AUTHORITY MIN.	VALUE BY OTHER AUTHORITY MAX.	
ROOFS, slag to metal.			0.90	1.00	0.70	0.95	①
PAVEMENTS	Concrete or Asphalt.		0.90	1.00	0.95	1.00	③
	Bituminous Macadam, open and closed type.		0.70	0.90	0.70	0.90	③
	Gravel, from clean and loose to clayey and compact.		0.25	0.70	0.15	0.30	①
R.R. YARDS			0.10	0.30	0.10	0.30	①
EARTH SURFACES	SAND, from uniform grain size, no fines, to well graded, some clay or silt.	Bare	0.15	0.50	0.01	0.55	④
		Light Vegetation	0.10	0.40	0.01	0.55	④
		Dense Vegetation	0.05	0.30	0.01	0.55	④
	LOAM, from sandy or gravelly to → clayey.	Bare	0.20	0.60			
		Light Vegetation	0.10	0.45			
		Dense Vegetation	0.05	0.35			
	GRAVEL, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content.	Bare	0.25	0.65			
		Light Vegetation	0.15	0.50			
		Dense Vegetation	0.10	0.40			
	CLAY, from coarse sandy or silty to pure colloidal clays.	Bare	0.30	0.75	0.10	0.70	④
		Light Vegetation	0.20	0.60	0.10	0.70	④
		Dense Vegetation	0.15	0.50	0.10	0.70	④
COMPOSITE AREAS	City, business areas.		0.60	0.75	0.60	0.95	⑤
	City, dense residential areas, vary as to soil and vegetation.		0.50	0.65	0.30	0.60	⑤
	Suburban residential areas, " " "		0.35	0.55	0.25	0.40	⑤
	Rural Districts, " " "		0.10	0.25	0.10	0.25	②
	Parks, Golf Courses, etc., " " "		0.10	0.35	0.05	0.25	①

NOTE: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

① Bryant & Kuichling, Report, Back Bay Sewerage District, Boston, 1909.
② Metcalf and Eddy, American Sewerage Practice, 1928. Mc Graw-Hill.
③ Used by City of Boston, reported by Metcalf & Eddy.
④ Used by City of Detroit, reported by Metcalf & Eddy.
⑤ L.C. Urquhart, Civil Engineering Handbook, 1940. Mc Graw-Hill.

Table 25. Runoff curve numbers for selected agricultural, suburban, and urban land use

Land use description		Hydrologic soil group A	B	C	D
Cultivated land[1]					
without conservation treatment		72	81	88	91
with conservation treatment		62	71	78	81
Pasture or range land					
poor condition		68	79	86	89
good condition		39	61	74	80
Meadow					
good condition		30	58	71	78
Wood or Forest land					
thin stand, poor cover, no mulch		45	66	77	83
good cover[2]		25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.					
good condition					
grass cover on 75% or more of the area		39	61	74	80
fair condition					
grass cover on 50% to 75% of the area		49	69	79	84
Commercial and business areas (85% impervious)		89	92	94	95
Industrial districts (72% impervious).		81	88	91	93
Residential[3]					
Average lot size	Average % Impervious[4]				
⅛ acre or less	65	77	85	90	92
¼ acre	38	61	75	83	87
⅓ acre	30	57	72	81	86
½ acre	25	54	70	80	85
1 acre	20	51	68	79	84
Paved parking lots, roofs, driveways' etc.		95	95	95	95
Streets and roads					
paved with curbs and storm sewers		95	95	95	95
gravel		76	85	89	91
dirt		72	82	87	89

1. For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.
2. Good cover is protected from grazing and litter and brush cover soil.
3. Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.
4. The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

TABLE 26. **Runoff curve numbers for sugarcane in Hawaii**

Cover and Treatment	Hydrologic Soil Group A	B	C	D
Limited cover, straight row	67	78	85	89
Partial cover, straight row	49	69	79	84
Complete cover, straight row	39	61	74	80
Limited cover, contoured	65	75	82	86
Partial cover, contoured	25	59	75	83
Complete cover, contoured	6	35	70	79

NOTES:

Limited cover: Cane newly planted, or ratooned cane with a limited root system; canopy over less than ½ the field area.

Partial cover: Cane in the transition period between limited cover and complete cover; canopy over ½ to nearly the entire field area.

Complete cover: Cane from the stage of growth when full canopy is provided to the stage at harvest.

Straight-row planting is up and down hill or cross-slope on slopes greater than 2 percent. Contoured planting is the usual contouring or cross-slope planting on slopes less than 2 percent.

TABLE 27. **Runoff curve numbers for pineapple in Hawaii**

Cover and Treatment	Hydrologic Soil Group A	B	C	D
Partial cover, cross-sloped	67	78	85	89
Complete cover, cross-sloped	49	69	79	84
Partial cover, cross-sloped & terraced	65	75	82	86
Complete cover, cross-sloped & terraced	39	61	74	80
Partial cover, contoured & terraced	62	71	78	81
Complete cover, contoured & terraced	25	59	75	83

NOTES:

Partial cover: Stage of growth between time when crop is newly planted until initial closing in.

Complete cover: Stage of growth when crop is completely closed in, including ratoon crops.

1 HYDROLOGIC REPORT
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Kolaloa/Hapapa Gulches
100-Yr.,24-Hr.........
Discharge.............

Hyd. No. 1

Hydrograph type	= S.C.S. RUNOFF		Peak discharge	= 2480.18 cfs
Storm frequency	= 100 yr		Time interval	= 5 min
Basin area	= 3861 ac		Basin curve No.	= 65
Ave basin slope	= 13 %		Hydraulic len	= 75400 ft
Basin lag	= 182.4 min		Time of concen	=304.00 min
Total precip.	= 10.00 in		Distribution	= S.C.S. I

HYDROGRAPH DISCHARGE TABLE

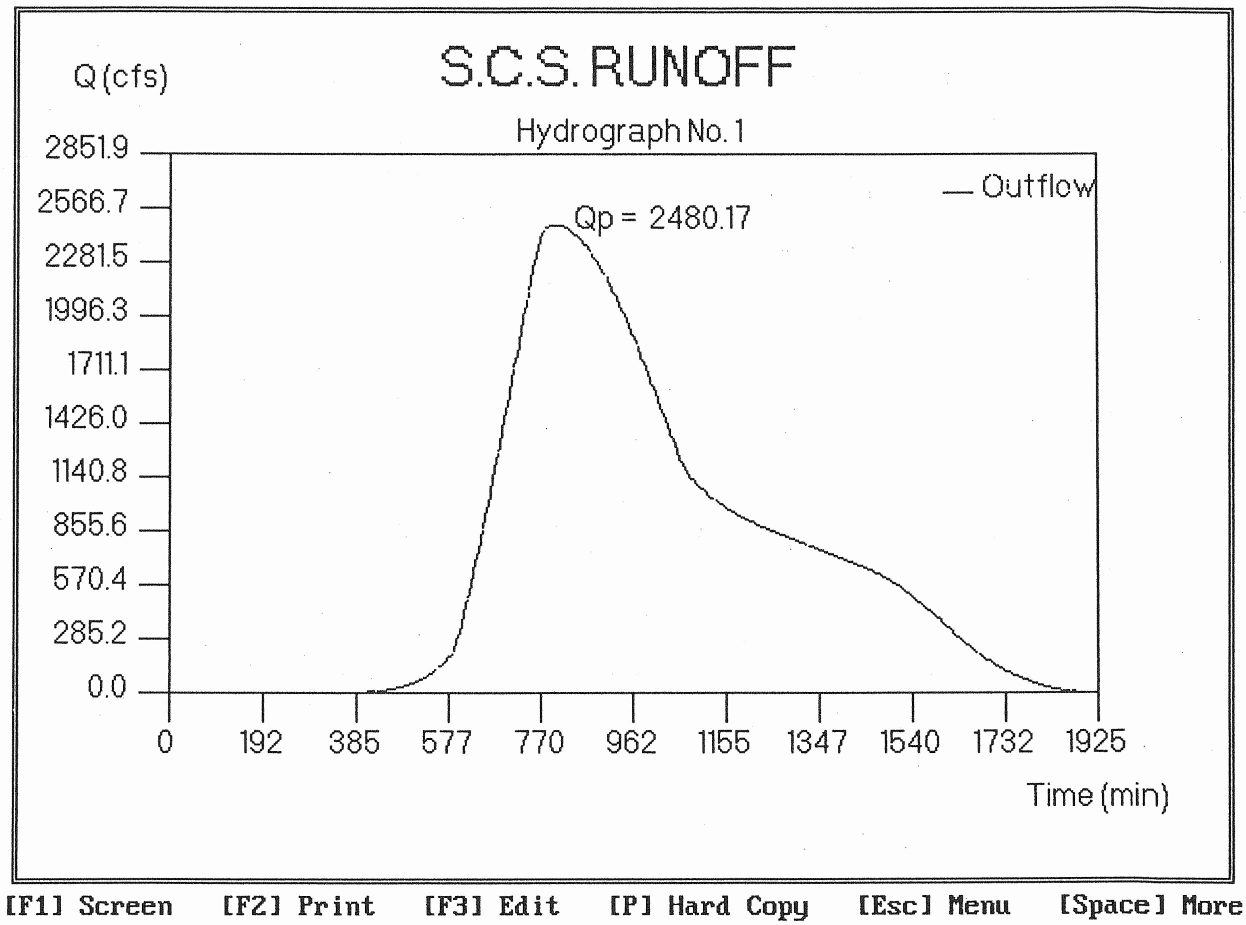
TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfS)
6.08	0.66	6.17	0.89	6.25	1.17	6.33	1.50
6.42	1.90	6.50	2.37	6.58	2.92	6.67	3.55
6.75	4.28	6.83	5.12	6.92	6.07	7.00	7.15
7.08	8.35	7.17	9.70	7.25	11.21	7.33	12.86
7.42	14.69	7.50	16.69	7.58	18.87	7.67	21.24
7.75	23.82	7.83	26.60	7.92	29.60	8.00	32.82
8.08	36.29	8.17	40.03	8.25	44.07	8.33	48.44
8.42	53.19	8.50	58.33	8.58	63.89	8.67	69.91
8.75	76.43	8.83	83.47	8.92	91.08	9.00	99.30
9.08	108.18	9.17	117.79	9.25	128.21	9.33	139.50
9.42	151.76	9.50	165.06	9.58	179.90	9.67	197.22
9.75	218.10	9.83	246.44	9.92	285.27	10.00	331.03
10.08	379.19	10.17	429.57	10.25	481.98	10.33	536.17
10.42	591.91	10.50	648.96	10.58	707.16	10.67	766.46
10.75	826.77	10.83	888.04	10.92	950.19	11.00	1013.16
11.08	1076.88	11.17	1141.29	11.25	1206.32	11.33	1271.89
11.42	1337.94	11.50	1404.38	11.58	1471.14	11.67	1538.12
11.75	1605.26	11.83	1672.45	11.92	1739.61	12.00	1806.64
12.08	1873.42	12.17	1939.82	12.25	2005.68	12.33	2070.87
12.42	2135.21	12.50	2198.54	12.58	2260.05	12.67	2318.19
12.75	2371.18	12.83	2412.78	12.92	2438.06	13.00	2452.72
13.08	2463.96	13.17	2472.00	13.25	2477.16	13.33	2479.77
13.42	2480.18	13.50	2478.73	13.58	2475.65	13.67	2471.00
13.75	2464.86	13.83	2457.31	13.92	2448.42	14.00	2438.27
14.08	2426.90	14.17	2414.37	14.25	2400.68	14.33	2385.88
14.42	2369.99	14.50	2353.06	14.58	2335.10	14.67	2316.17
14.75	2296.29	14.83	2275.49	14.92	2253.82	15.00	2231.30
15.08	2207.98	15.17	2183.87	15.25	2158.99	15.33	2133.36
15.42	2107.02	15.50	2079.98	15.58	2052.26	15.67	2023.89

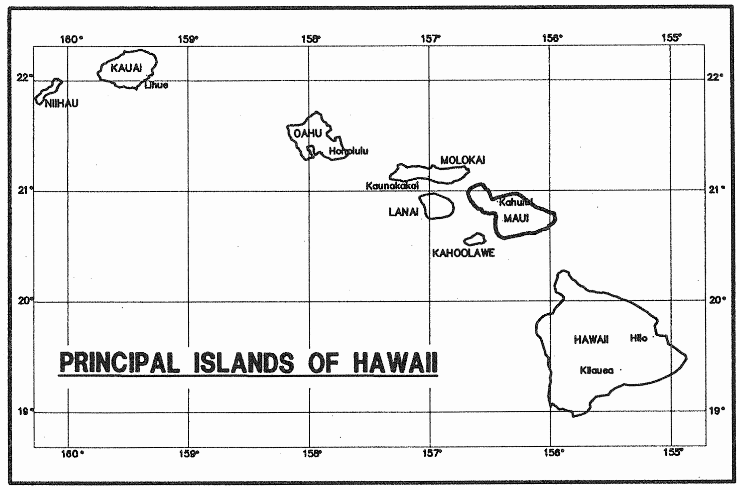
HYDROGRAPH DISCHARGE TABLE Cont'd

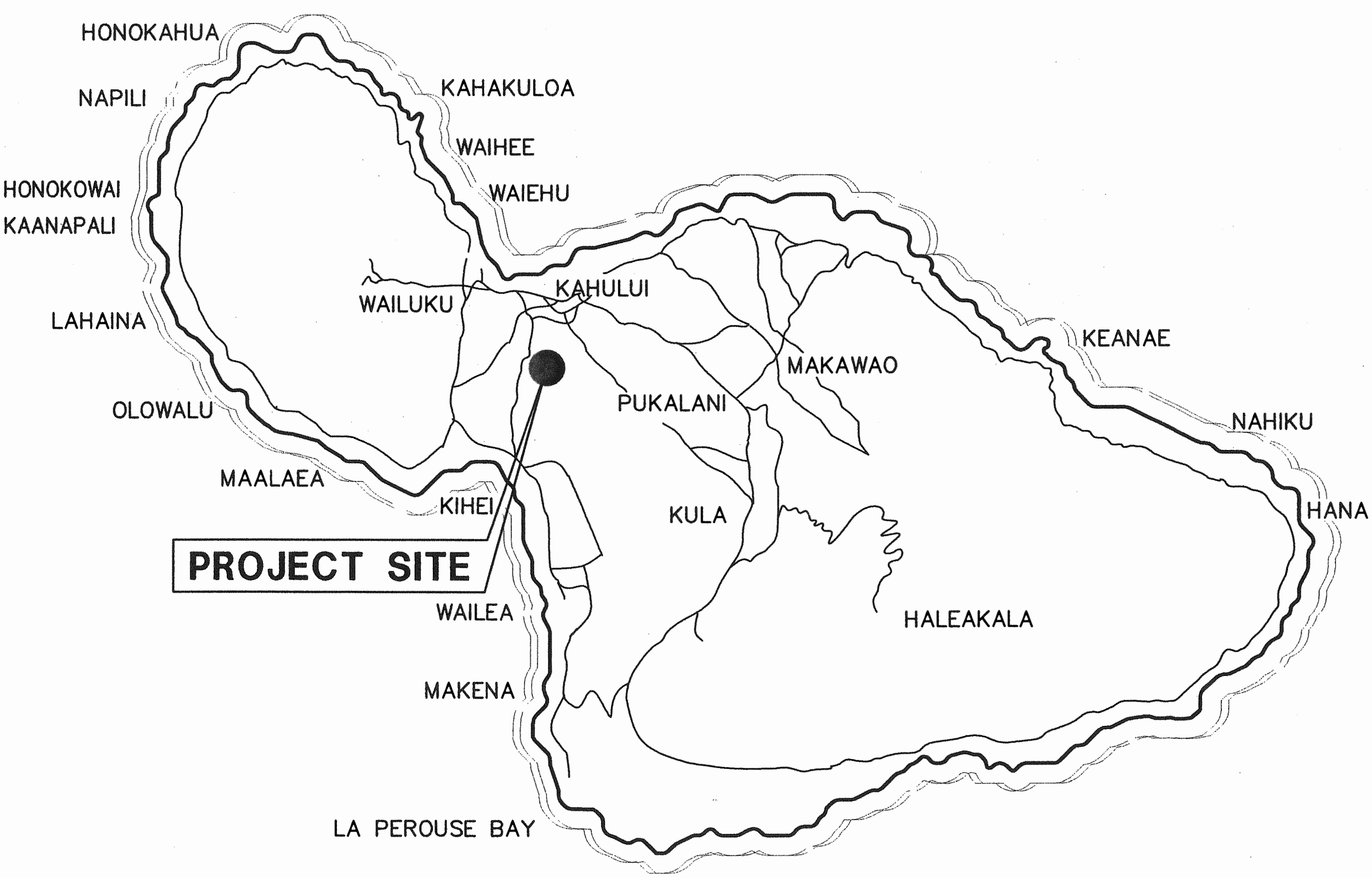
TIME (hrs	OUTFLOW cfs)	TIME (hrs	OUTFLOW cfs)	TIME (hrs	OUTFLOW cfs)	TIME (hrs	OUTFLOW cfS)
15.75	1994.89	15.83	1965.28	15.92	1935.10	16.00	1904.35
16.08	1873.08	16.17	1841.32	16.25	1809.10	16.33	1776.47
16.42	1743.47	16.50	1710.13	16.58	1676.50	16.67	1642.63
16.75	1608.55	16.83	1574.31	16.92	1539.97	17.00	1505.56
17.08	1471.14	17.17	1436.75	17.25	1402.45	17.33	1368.29
17.42	1334.32	17.50	1300.60	17.58	1267.44	17.67	1235.41
17.75	1205.18	17.83	1179.08	17.92	1158.95	18.00	1142.66
18.08	1127.49	18.17	1113.38	18.25	1100.18	18.33	1087.77
18.42	1076.03	18.50	1064.81	18.58	1054.03	18.67	1043.66
18.75	1033.67	18.83	1024.03	18.92	1014.71	19.00	1005.67
19.08	996.89	19.17	988.37	19.25	980.09	19.33	972.05
19.42	964.23	19.50	956.63	19.58	949.23	19.67	942.03
19.75	935.00	19.83	928.15	19.92	921.46	20.00	914.92
20.08	908.52	20.17	902.26	20.25	896.13	20.33	890.12
20.42	884.23	20.50	878.45	20.58	872.77	20.67	867.19
20.75	861.71	20.83	856.31	20.92	850.99	21.00	845.74
21.08	840.55	21.17	835.43	21.25	830.36	21.33	825.34
21.42	820.35	21.50	815.40	21.58	810.47	21.67	805.56
21.75	800.67	21.83	795.78	21.92	790.88	22.00	785.98
22.08	781.06	22.17	776.14	22.25	771.20	22.33	766.24
22.42	761.28	22.50	756.30	22.58	751.32	22.67	746.32
22.75	741.31	22.83	736.29	22.92	731.26	23.00	726.22
23.08	721.17	23.17	716.10	23.25	711.03	23.33	705.95
23.42	700.86	23.50	695.75	23.58	690.64	23.67	685.52
23.75	680.39	23.83	675.25	23.92	670.10	24.00	664.94
24.08	659.52	24.17	653.85	24.25	647.93	24.33	641.76
24.42	635.34	24.50	628.68	24.58	621.78	24.67	614.64
24.75	607.27	24.83	599.68	24.92	591.85	25.00	583.81
25.08	575.54	25.17	567.06	25.25	558.37	25.33	549.47
25.42	540.36	25.50	531.05	25.58	521.54	25.67	511.84
25.75	501.94	25.83	491.85	25.92	481.58	26.00	471.12
26.08	460.48	26.17	449.67	26.25	438.69	26.33	427.53
26.42	416.21	26.50	404.73	26.58	393.08	26.67	381.28
26.75	369.33	26.83	357.22	26.92	344.97	27.00	332.58
27.08	320.45	27.17	308.57	27.25	296.96	27.33	285.59
27.42	274.48	27.50	263.62	27.58	253.01	27.67	242.65
27.75	232.53	27.83	222.66	27.92	213.03	28.00	203.64
28.08	194.48	28.17	185.57	28.25	176.89	28.33	168.44
28.42	160.23	28.50	152.24	28.58	144.49	28.67	136.95
28.75	129.65	28.83	122.56	28.92	115.70	29.00	109.05
29.08	102.63	29.17	96.41	29.25	90.41	29.33	84.62
29.42	79.05	29.50	73.67	29.58	68.51	29.67	63.55
29.75	58.79	29.83	54.23	29.92	49.87	30.00	45.71
30.08	41.74	30.17	37.97	30.25	34.39	30.33	30.99
30.42	27.79	30.50	24.77	30.58	21.93	30.67	19.27
30.75	16.80	30.83	14.50	30.92	12.38	31.00	10.43

HYDROGRAPH DISCHARGE TABLE Cont'd

TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfs)	TIME--OUTFLOW (hrs	cfs)
31.08	8.66	31.17	7.06	31.25	5.62	31.33	4.36
31.42	3.25	31.50	2.31	31.58	1.54	31.67	0.92


S.C.S. RUNOFF
Hydrograph No. 1
Q (cfs)
Outflow
Qp = 2480.17
2851.9
2566.7
2281.5
1996.3
1711.1
1426.0
1140.8
855.6
570.4
285.2
0.0
0
192
385
577
770
962
1155
1347
1540
1732
1925
Time (min)
[F1] Screen
[F2] Print
[F3] Edit
[P] Hard Copy
[Esc] Menu
[Space] More





LOCATION MAP

ISLAND OF MAUI

(Layout1)
Z:\DRAW1\2005\05-065\PROP-QUARRY-SITE-ADDITION-LOCATIONMAP.dwg 22-OCT-2012 : Revised BY:Nancy

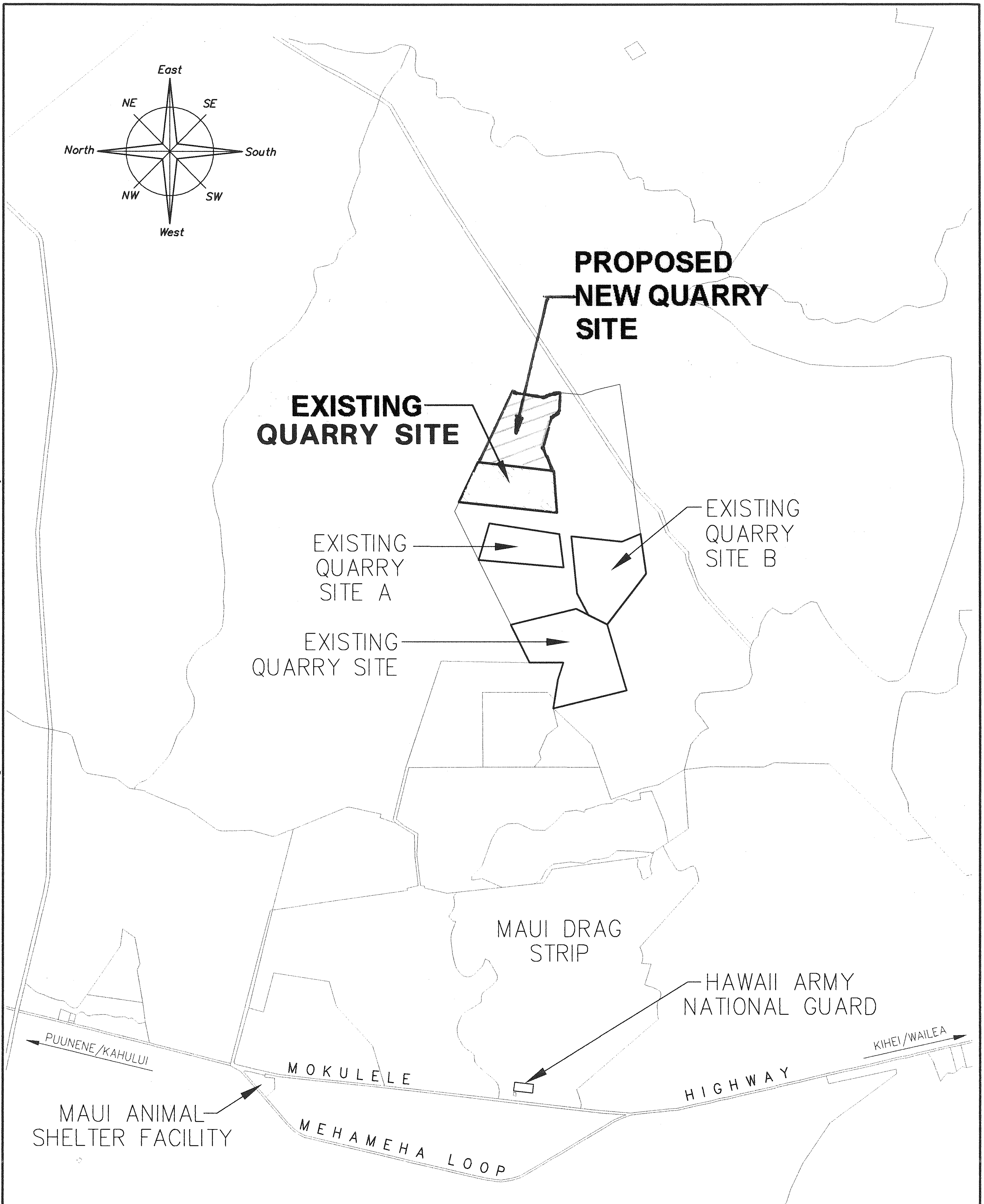
OCTOBER 2012

871 KOLU STREET, SUITE 201
WAILUKU, MAUI, HAWAII 96793

R. T. TANAKA ENGINEERS, INC.
LAND SURVEYORS - CIVIL & STRUCTURAL ENGINEERS

JOB NO. 05-065

FIGURE 1



VICINITY MAP

NOT TO SCALE

Tax Map Key (2) 3-8-04: 01 (Portion)

OCTOBER 2012

(Layout1)
Z:\DRAW1\2005\05-065\PROP-QUARRY-SITE-ADDITION-VICINITYMAP.dwg 05-OCT-2012 : Revised BY:Nancy

871 KOLU STREET, SUITE 201
WAILUKU, MAUI, HAWAII 96793

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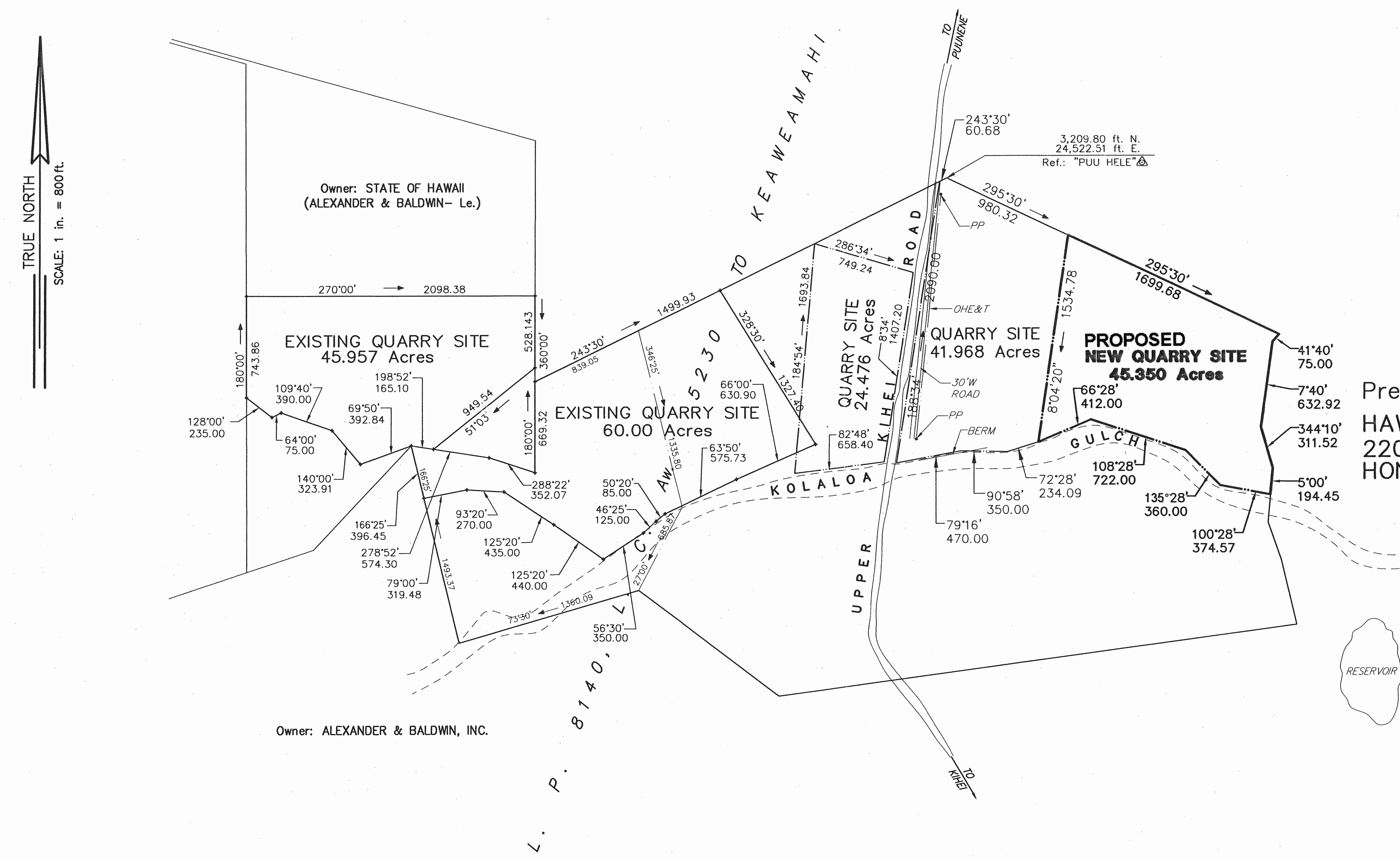
LAND SURVEYORS – CIVIL & STRUCTURAL ENGINEERS

JOB NO. 05-065

FIGURE 2



Prepared for:
HAWAIIAN CEMENT
220 SOUTH KING STREET
HONOLULU, HAWAII 96813

PLAN SHOWING NEW HAWAIIAN CEMENT QUARRY MINING SITE

AT PULEHUNUI, WAILUKU (KULA), MAUI, HAWAII

800 400 0 800 1600
GRAPHIC SCALE IN FEET

REVISED: MARCH 06, 2019
REVISED: OCTOBER 26, 2018
REVISED: JUNE 14, 2012
DECEMBER 10, 2007

Tax Map Key (2) 3-8-04: 01 (Portion)

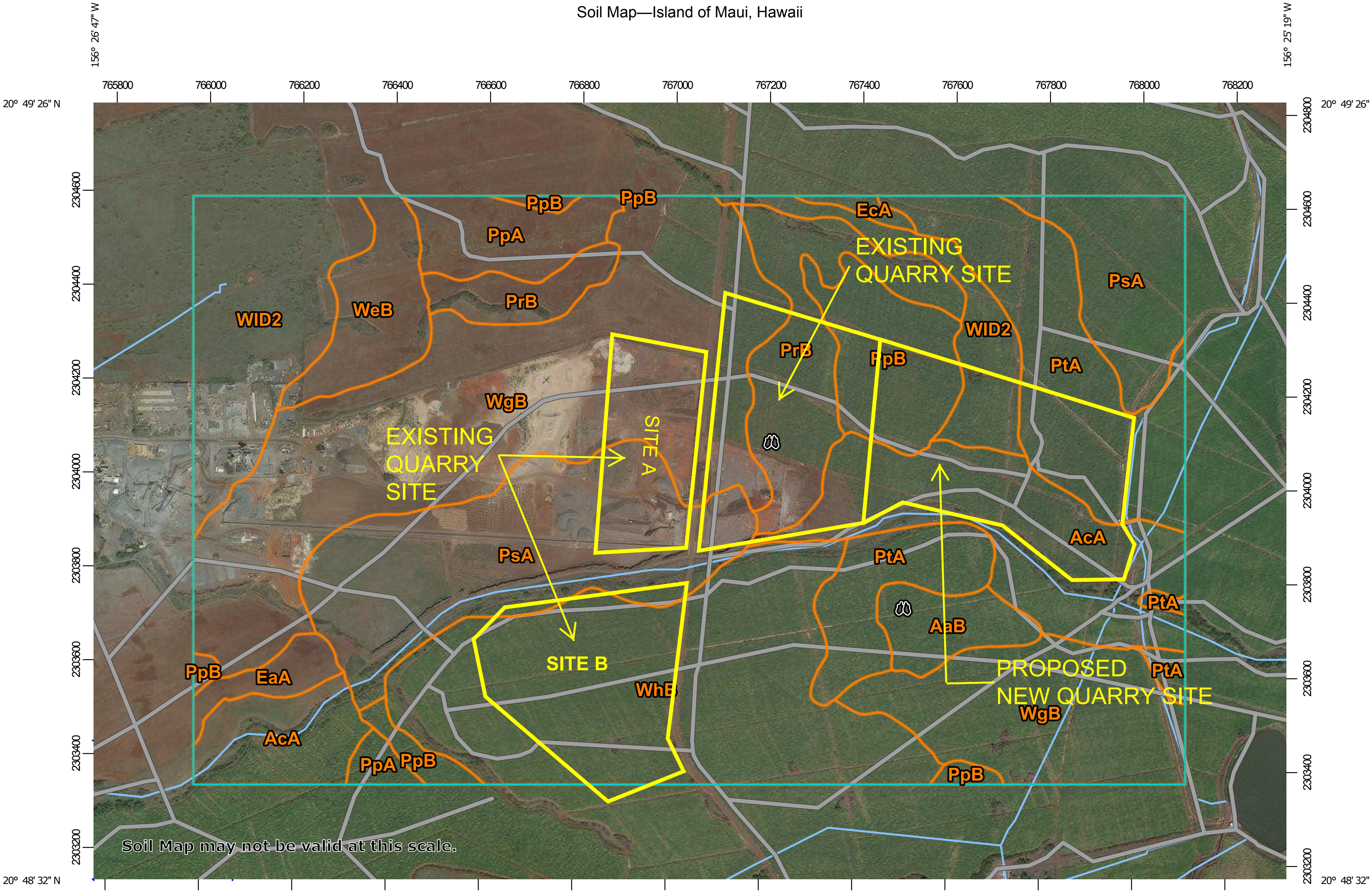
\\2015SERVERDELL\Users\Public\Documents\DRAW1\2005\05-065\6-5-12_HCMNT_QUARRY_SITE.dwg, Layout1, 3/6/2019 4:17:23 PM, Nancy

871 KOLU STREET, SUITE 201
WAILUKU, MAUI, HAWAII 96793

R. T. TANAKA ENGINEERS, INC.
LAND SURVEYORS – CIVIL & STRUCTURAL ENGINEERS

JOB NO. 05-065
FIGURE 3

Soil Map—Island of Maui, Hawaii



Map Scale: 1:11,700 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 4N WGS84

FIGURE 4

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 16, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Feb 14, 2017

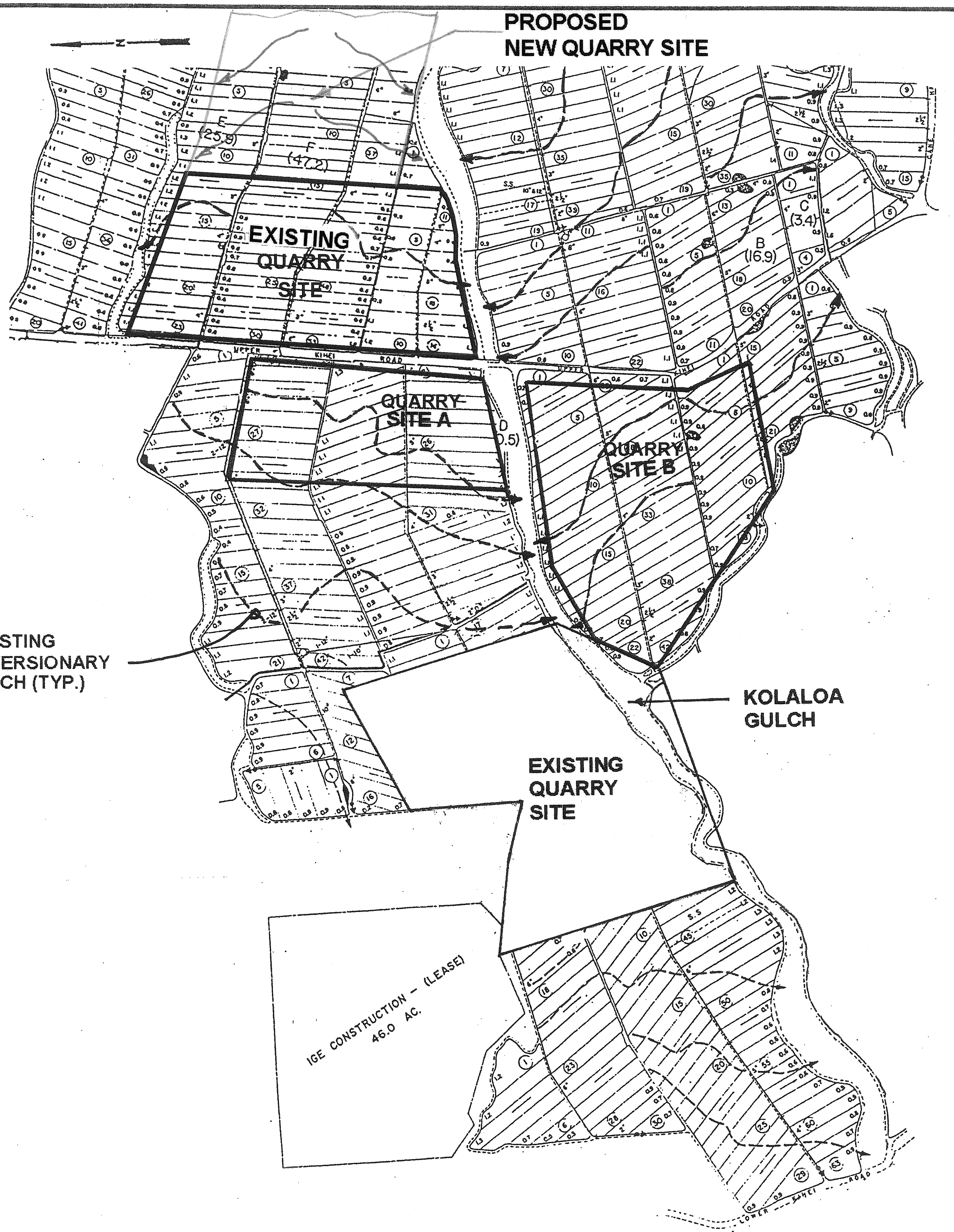
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

FIGURE 4

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AaB	Alae sandy loam, 3 to 7 percent slopes	10.9	1.7%
AcA	Alae cobbly sandy loam, 0 to 3 percent slopes	63.2	9.6%
EaA	Ewa silty clay loam, 0 to 3 percent slopes	6.2	0.9%
EcA	Ewa cobbly silty clay loam, 0 to 3 percent slopes	1.8	0.3%
PpA	Pulehu silt loam, 0 to 3 percent slopes	18.4	2.8%
PpB	Pulehu silt loam, 3 to 7 percent slopes	29.0	4.4%
PrB	Pulehu cobbly silt loam, 3 to 7 percent slopes	39.6	6.0%
PsA	Pulehu clay loam, 0 to 3 percent slopes , MLRA 163	89.6	13.6%
PtA	Pulehu cobbly clay loam, 0 to 3 percent slopes	64.3	9.7%
WeB	Waiakoa silty clay loam, 3 to 7 percent slopes	17.9	2.7%
WgB	Waiakoa very stony silty clay loam, 3 to 7 percent slopes	164.8	24.9%
WhB	Waiakoa extremely stony silty clay loam, 3 to 7 percent slopes, MLRA 157	97.7	14.8%
WID2	Waiakoa extremely stony silty clay loam, 3 to 25 percent slopes, eroded, MLRA 157	57.3	8.7%
Totals for Area of Interest		**660.7**	**100.0%**

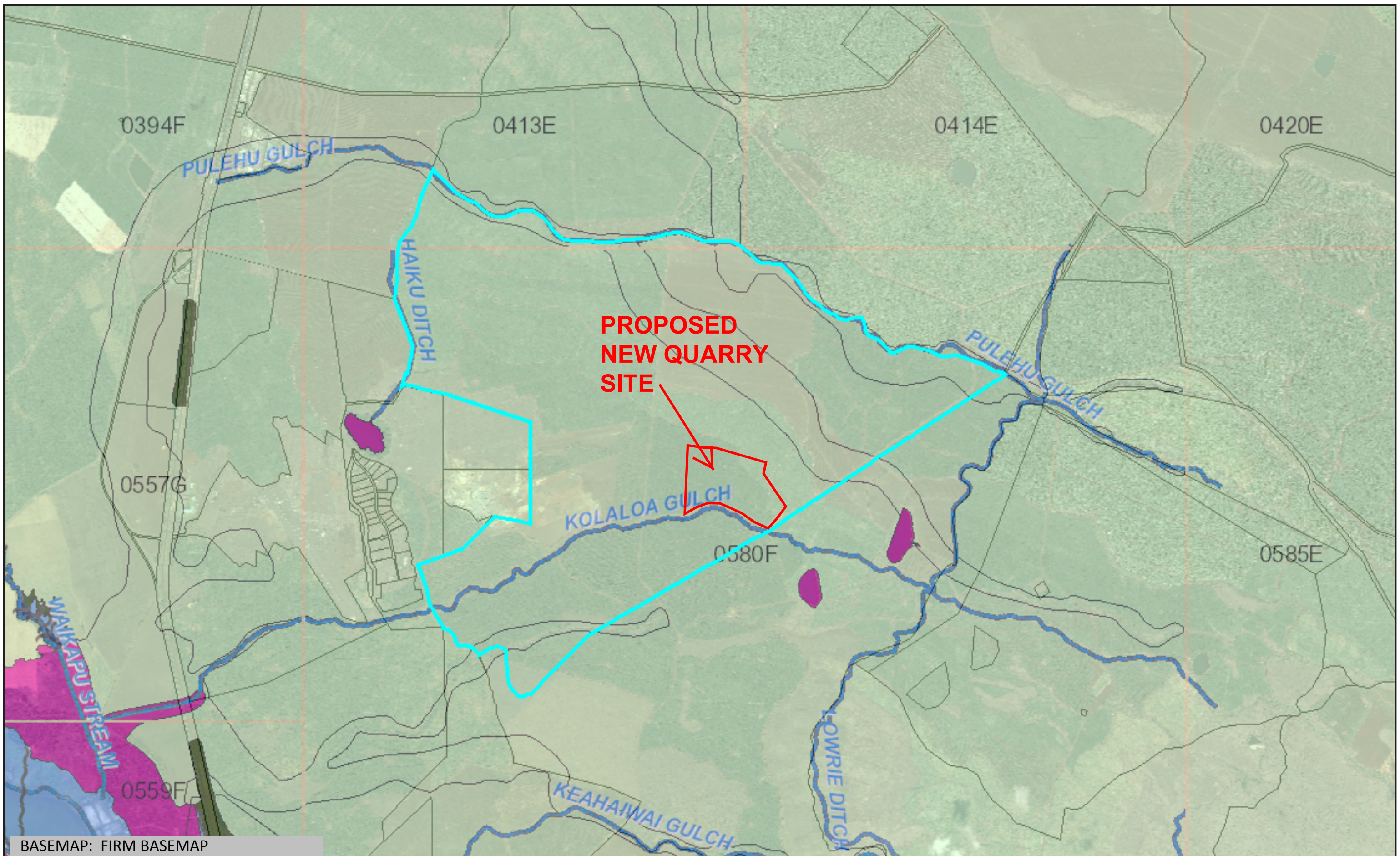
FIGURE 4



EXISTING ONSITE DRAINAGE PATTERN

Scale 1" = 800'

FIGURE 5



Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY: MAUI

TMK NO: (2) 3-8-004:001

WATERSHED: WAIKOA

PARCEL ADDRESS:

Notes:

Flood Hazard Information

FIRM INDEX DATE: NOVEMBER 04, 2015

LETTER OF MAP CHANGE(S): NONE

FEMA FIRM PANEL - EFFECTIVE DATE: 1500030413E - SEPTEMBER 25, 2009
1500030580F - SEPTEMBER 19, 2012

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: NO
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: YES (MA-0086; MA-0087)
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

N

0 0.60 1.20 mi

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

If this map has been identified as 'PRELIMINARY', please note that it is being provided for informational purposes and is not to be used for flood insurance rating. Contact your county floodplain manager for flood zone determinations to be used for compliance with local floodplain management regulations.

FLOOD HAZARD ASSESSMENT TOOL LAYER LEGEND
(*Note: legend does not correspond with NFHL)*

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD - The 1% annual chance flood (100-year), also know as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. SFHAs include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

Zone A: No BFE determined.

Zone AE: BFE determined.

Zone AH: Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.

Zone AO: Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.

Zone V: Coastal flood zone with velocity hazard (wave action); no BFE determined.

Zone VE: Coastal flood zone with velocity hazard (wave action); BFE determined.

Zone AEF: Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA - An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

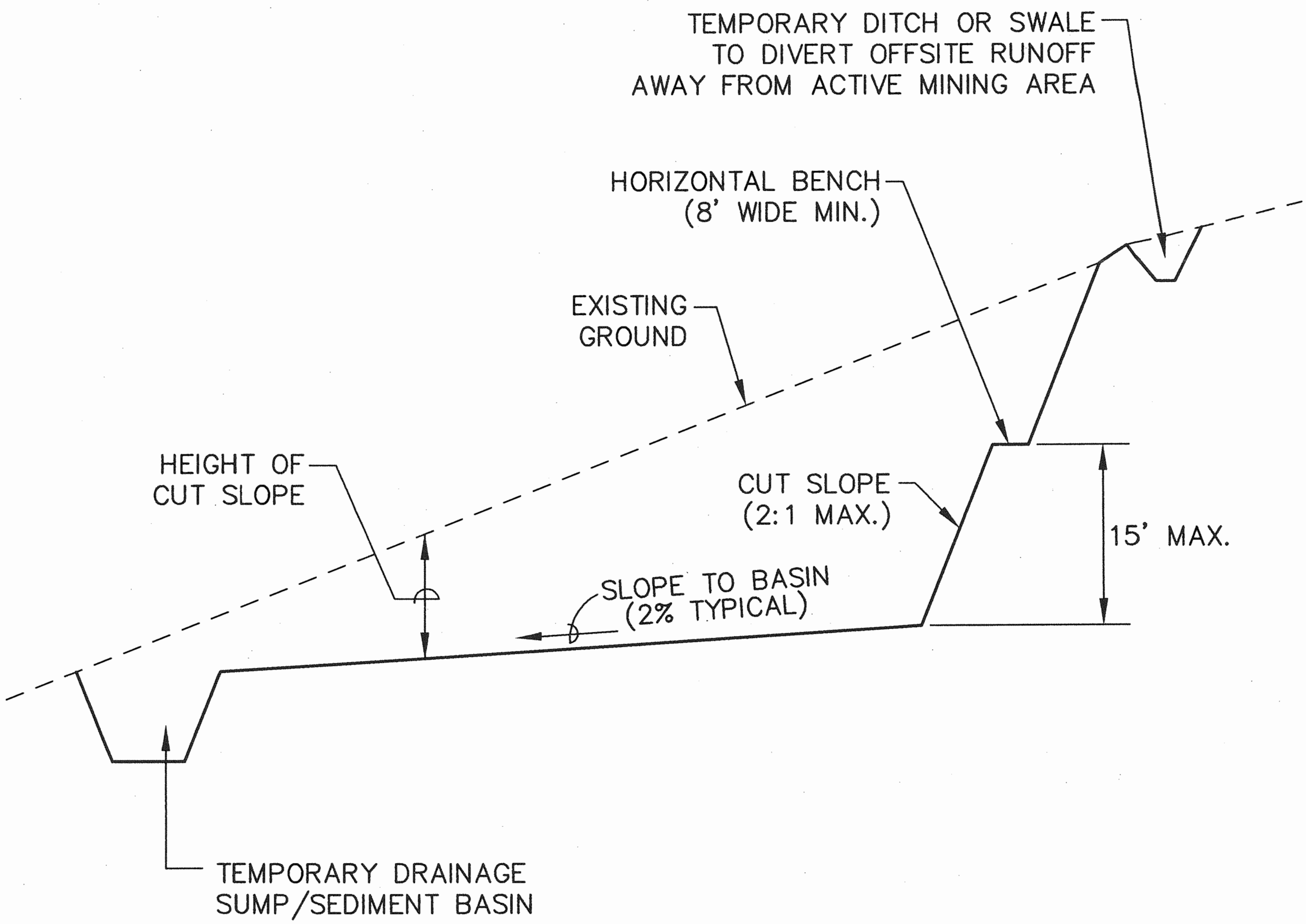
Zone XS (X shaded): Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

Zone X: Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

Zone D: Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase apply, but coverage is available in participating communities.

FIGURE 6



TYPICAL CUT SECTION

NOT TO SCALE

(Layout1) Z:\DRAW1\2005\05-065\PROP-QUARRY-SITE-ADDITION-CUTSECTION.dwg 05-OCT-2012 : Revised BY:Nancy

Tax Map Key (2) 3-8-04: 01 (Portion)

OCTOBER 2012

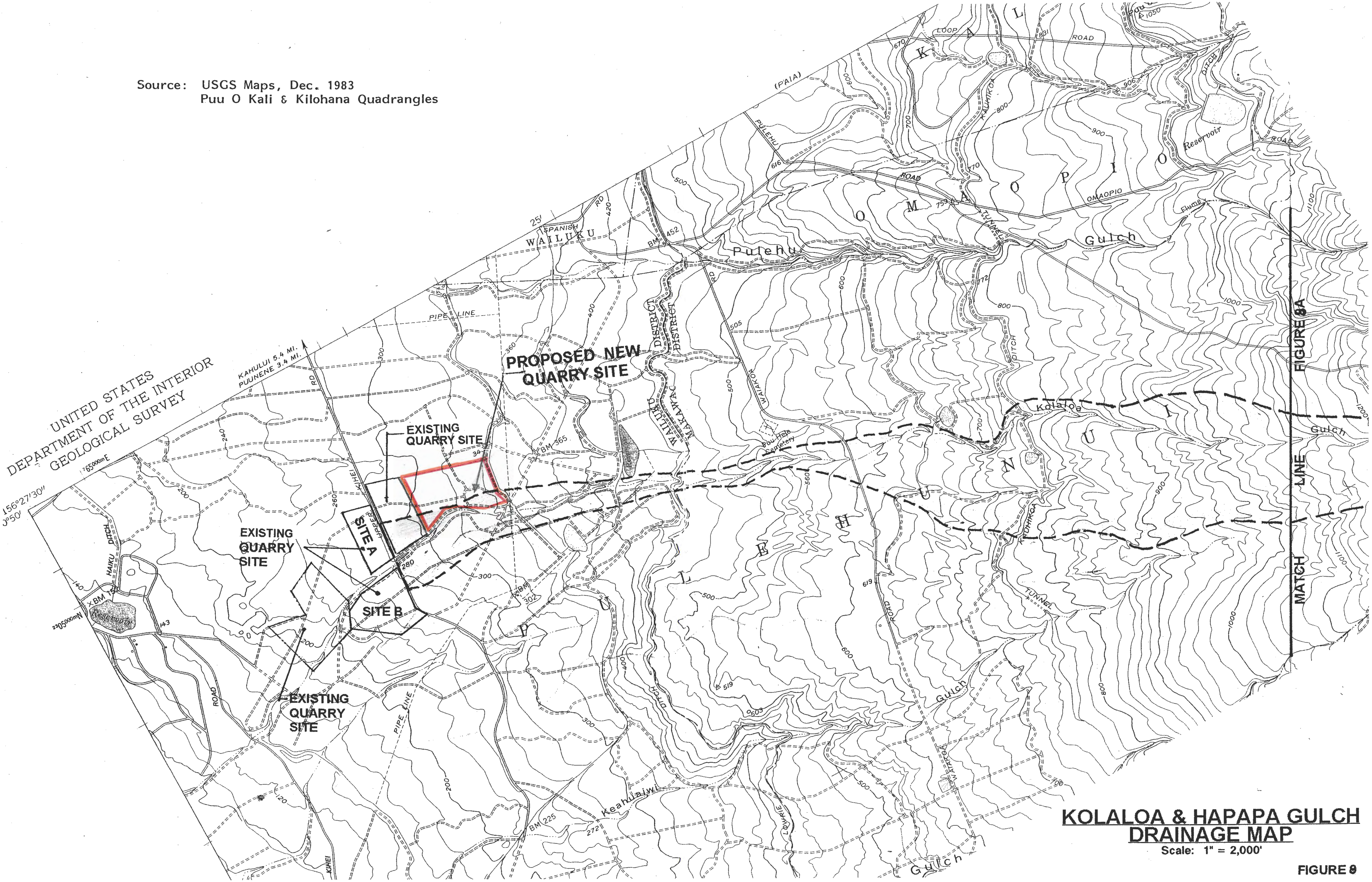
871 KOLU STREET, SUITE 201
WAILUKU, MAUI, HAWAII 96793

R. T. TANAKA ENGINEERS, INC.
LAND SURVEYORS - CIVIL & STRUCTURAL ENGINEERS

JOB NO. 05-065

FIGURE 7

Source: USGS Maps, Dec. 1983
Puu O Kali & Kilohana Quadrangles



KOLALOA & HAPAPA GULCH DRAINAGE MAP

Scale: 1" = 2,000'

FIGURE 9

FIGURE 8A

KOLALOA & HAPAPA GULCH DRAINAGE MAP

Scale: 1" = 2,000'

REF.: USGS MAP, DECEMBER 1983
PUU O KALI & KILOHANA QUADRANGLES