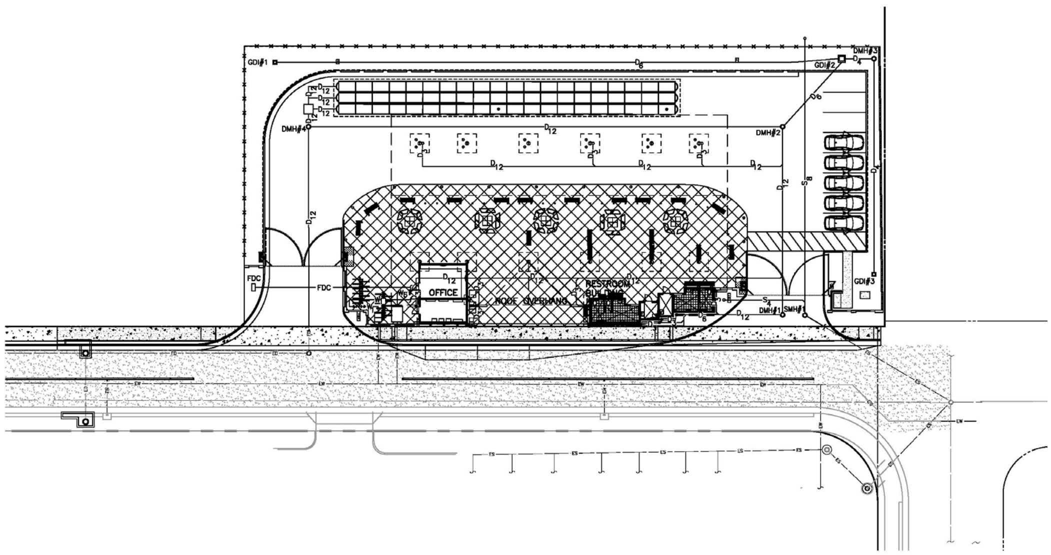
DRAINAGE REPORT
For Transit Hub

Kahului, Maui, Hawaii
Tax Map Key (2) 3-7-004:003 (Portion)



Project:

Transit Hub
Kahului, Maui, Hawaii

Date: May 7, 2020

Client:

Department of Transportation
County of Maui
2145 Kaohu Street
Wailuku, Hawaii 96793
Phone: (808) 270-7511

Consultant:

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E-Mail: office@maui.com

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I. PURPOSE

The purpose of this report is to present storm design information and to comply with the following standards and requirements: (1) Chapter 20.08, Soil Erosion and Sedimentation Control, of the Maui County Code to obtain a grubbing and grading permit, and (2) Title MC-15, Chapter 111, Rules for the Design of Storm Water Treatment Best Management Practices.

II. PROJECT DESCRIPTION

A. General Location

The project involves relocating the Maui Bus transit hub currently located at Queen Kaahumanu Center to a portion of a lot in Kahului that is owned by the State of Hawaii, Department of Education identified as Tax Map Key (2) 3-7-004:003. The 5.572–acre parcel is bounded by Kaahumanu Avenue to the north, Kane Street to the west, Vevau Street to the South, and a gas station and residential condominiums to the east. On the lot, there exists one office building, several abandoned structures, asphalt and concrete pavement, and a large open grass field. The office building is actively occupied by the McKinley Community School for Adults. See Figure 1 – Location Map (USGS), page 6; Figure 2 – Vicinity Map (Tax Map), page 7.

The portion of the lot to be occupied by the new transit hub will be approximately 0.73 acre and located along Vevau Street approximately 300 feet east of the intersection of Vevau Street and Kane Street. The construction grading limits will encompass approximately 0.81 acre. The additional area will allow connection to existing surfaces to the northerly and westerly sides of the transit hub site.

B. Project Components

The relocation of the transit hub involves construction of an office and ticket booth, a restroom building, and a roof structure covering the passenger waiting area and 6 bus bays. Site improvements will include vehicle and pedestrian pavements, site furnishings, plantings, site lighting, and utility services including water, sewer, electric, communications, and drainage.

III. DRAINAGE SYSTEM

A. Topography

The project site sits on partially developed land consisting of asphalt pavement and overgrown landscaping. Generally, the site slopes down from South to North and West to East along Vevau Street. Elevations range from 8 feet to 10 feet above mean sea level. Slopes range from 0 to 2 percent. (See Figure 5 – Topographic Map, page 10.)

B. Soil

According to the Soil Conservation Service, the on-site soils include Puuone sand, 7 to 30 percent slopes (PZUE). The Puuone series consists of somewhat excessively drained soils on low uplands on the island of Maui. The survey characterizes the soil as grayish-brown, calcareous sand about 20 inches think and underlain by grayish-brown, cemented sand, moderately alkaline, permeability rapid above the cemented layer, and runoff is slow. The soil is generally used for pasture and home sites. (See Figure 3 – Soil Map, page 8.)

C. Flood and Tsunami Hazard

The flood insurance rate map of the area shows there are no flood hazard areas on the site. The flood insurance rate map designates the site as Zone X, an area subject to minimal flooding. (See Figure 4 - Flood Insurance Rate Map, page 9.)

D. Existing Drainage Improvements

There are no existing drainage improvements within the project site. Runoff from the project site sheet flows from the property line fronting Vevau Street in a northeasterly direction toward the open grass field. From the grass field, runoff ponds or overflows to catch basins located in Kaahumanu Avenue. The catch basins discharge to a 36" drainline within Kaahumanu Avenue. (See Figure 6 – Existing Drainage Map, page 11)

E. Planned Drainage Improvements

There is a planned Kahului Lani affordable senior housing community development that will be constructed across Vevau Street from the project site. The development will also include roadway and drainage improvements along Vevau Street. The roadway and drainage improvements done by the development will include curb and gutters, catch basins, and new drain lines. There will be lateral stubouts installed for the drainage from the transit hub project site to tie into.

F. Proposed Drainage Improvements

The proposed drainage improvements for the transit hub include drain inlets, manholes, drain pipes, a stormwater filtration unit (hydrodynamic separator), and a subsurface retention basin to mitigate the increase in runoff volume and flowrate due to the project.

The County drainage standards require the use of a 50-year, 1-hour rainfall for computing volumes and rates of flow.

Drainage improvements that involve transmission of storm flows will conform to the "Rules for the Design of Storm Drainage Facilities in the County of Maui." The rules will be applied to the sizing of drain lines and the retention basin. Based on the County rules, the drainage systems will be designed to handle a storm with a recurrence interval of 50 years since the drainage area is less than 100 acres.

The following is a summary of hydrologic design data for the proposed project (see Appendix A for drainage calculations). The transit hub's area of 0.73 acre is used for the drainage calculations.

Item	Undeveloped	Developed
Drainage Area	0.73 acres	0.73 acre
50-year, 1-hour Rainfall	2.53 inches	2.53 inches
50-year, 1-hour Peak Flow	1.17 cfs	3.87 cfs

The Grading and Drainage Plan shows the proposed grading and drainage improvements. See Figure 7 – Grading and Drainage Plan, page 12. The plan involves grading for the driveway pavement, building pads, pedestrian waiting areas and walkways, landscaping, and parking areas.

Design concepts incorporated in the plan include maintaining existing drainage patterns and mitigating increases in runoff volume and runoff flow rate. Measures for mitigating increases in runoff will be accomplished with a subsurface retention basin. Runoff from two portions of the project site will not discharge to the retention basin (see Area A and Area B on Figure 7 – Grading and Drainage Plan). The increase in runoff volume from these two areas will flow to the catch basins along Vevau Street. The retention basin will retain one hundred percent of the collected runoff to mitigate the total volume of runoff during the design storm. The retention basin consists of infiltration chambers in a gravel bed, drain pipe, and manholes. The diverter manhole, equipped with a sump, channels the initial flows to an isolator row of chambers that collects suspended solids in the stormwater. After the stormwater fills half of the depth of the isolator row, it overtops a weir in the diverter manhole and flows through a manifold to the remaining chambers until it reaches its maximum level at the top of the gravel layer above the chambers. Stormwater volumes in excess of the required water quality design volume (WQDV) and the retention volume will be released into the drainage system along Vevau Street installed by Kahului Lani Development. The collected runoff percolates into the surrounding soil. Maintenance procedures including vacuuming the pre-treatment manhole and diverter manhole, and jetting the isolator row to remove sediments.

The following is a summary of the design data for the retention basin. See Appendix A for drainage information.

Water Quality Design Volume	1,288 cubic feet
Required Retention Volume	3,868 cubic feet
Provided Retention Volume	3,952 cubic feet

G. Water Quality Improvements

The County has established rules for post-construction storm water BMP requirements as part of the building code for new structures and developments. The rules are defined in Title MC-15, Chapter 11 "Rules for the Design of Storm Water Treatment Best Management Practices" and under these rules, projects with a disturbed area of more than one acre are required to meet the specific criteria for sizing of storm water quality facilities. Although, this project is less than one acre in disturbed area, the project will conform to the criteria as defined.

In order to address storm water quality, storm water runoff generated onsite will be directed to a stormwater filtration unit (hydrodynamic separator). The hydrodynamic separator in conjunction with the retention basin will remove TSS, debris, and other pollutants before discharging to existing storm drains.

The rules that define the required flow-rate for a flow-through system, such as a hydrodynamic separator and volume for the combination system are presented in Appendix A.

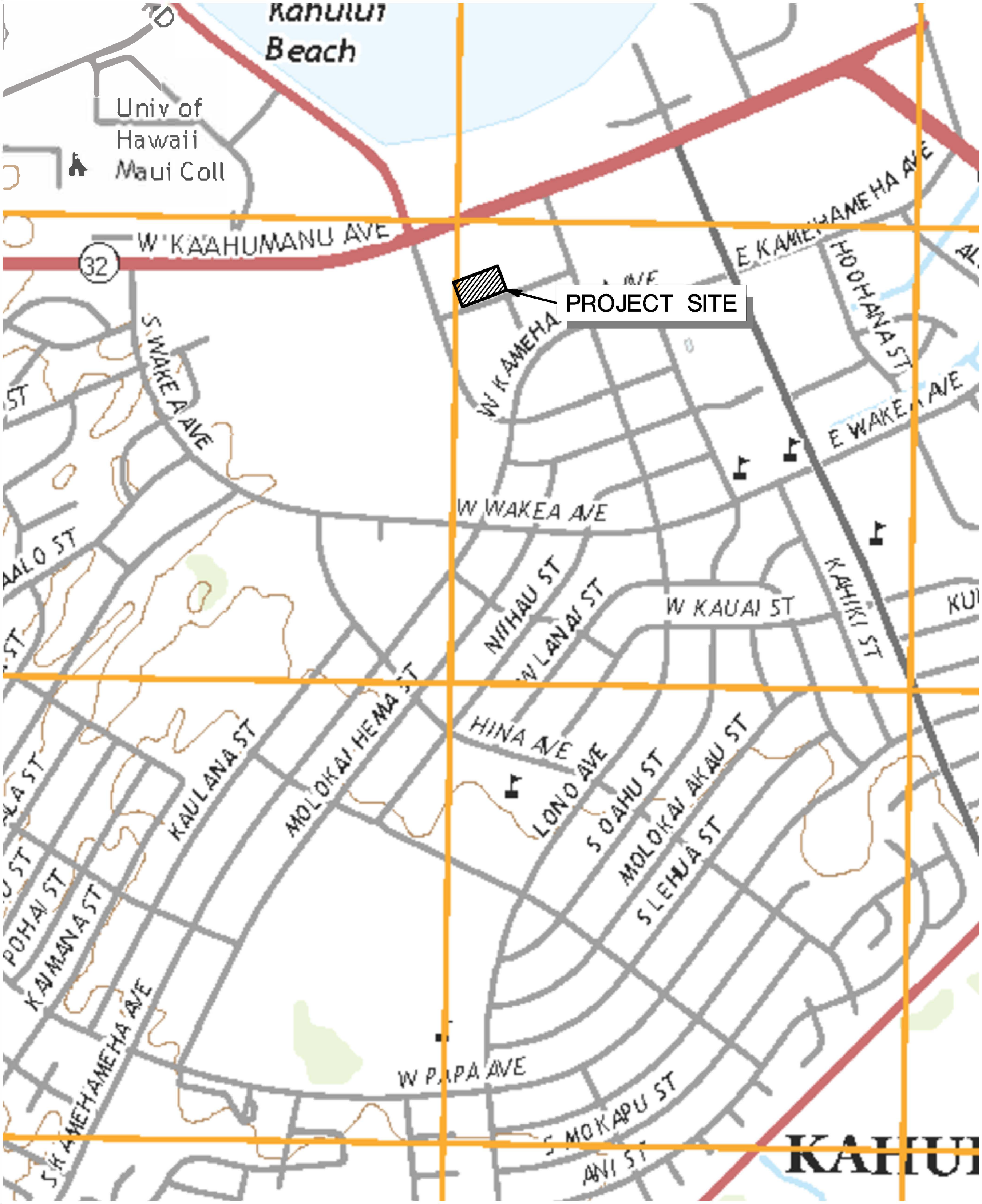
Based on the required flow rate, the project will utilize a Contech CDS Unit, Model #2015 or a similar product for stormwater treatment. The project owner, the County of Maui Department of Transportation, will be responsible for properly operating and maintaining the hydrodynamic separator.

H. Conclusion

There will be no adverse effects on the adjacent or downstream properties due to this project. This conclusion is based on maintaining peak discharge rates and volumes at pre-development level as well as removing total suspended solids, debris, and other pollutants.

IV. REFERENCES

1. City and County of Honolulu, Department of Public Works, Division of Engineering, *Storm Drainage Standards*, Honolulu, Hawaii, May 1988.
2. County of Maui, "Title MC-15, Department of Public Works and Waste Management, Chapter 4, Rules for the Design of Storm Drainage Facilities in the County of Maui," Wailuku, Hawaii, November 1995.
3. County of Maui, "Title MC-15, Chapter 111 Rules for Design of Storm Water Treatment Best management Practices," Wailuku, Hawaii, November 2012
4. Federal Emergency Management Agency, Federal Insurance Administration, *Flood Insurance Study, Maui County, Hawaii*, December 1, 1980.
5. Maidment, David R., *Handbook of Hydrology*, McGraw-Hill, Inc., New York, New York, 1993
6. R. M. Towill Corporation, *Drainage Master Plan for the County of Maui*, Honolulu, Hawaii, October 1971.
7. State of Hawaii, "Title 11, Hawaii Administrative Rules Department of Health, Chapter 62, Wastewater Systems," Honolulu, Hawaii, January 14, 2004.
8. U. S. Department of Agriculture, Soil Conservation Service, *Erosion and Sediment Control Guide for Hawaii*, Honolulu, Hawaii, March 1981.
9. U. S. Department of Agriculture, Soil Conservation Service, *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*, Washington, D.C., August 1972.
10. U. S. Department of Agriculture, Soil Conservation Service, *Urban Hydrology for Small Watersheds*, Technical Release 55, Second Edition, Washington, D.C., June 1986.
11. U. S. Department of Commerce, Weather Bureau, *Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years*, Technical Paper No. 43, Washington, D.C., 1962.



LOCATION MAP (USGS Map)

SCALE IN FEET

0 1000 2000 4000 6000

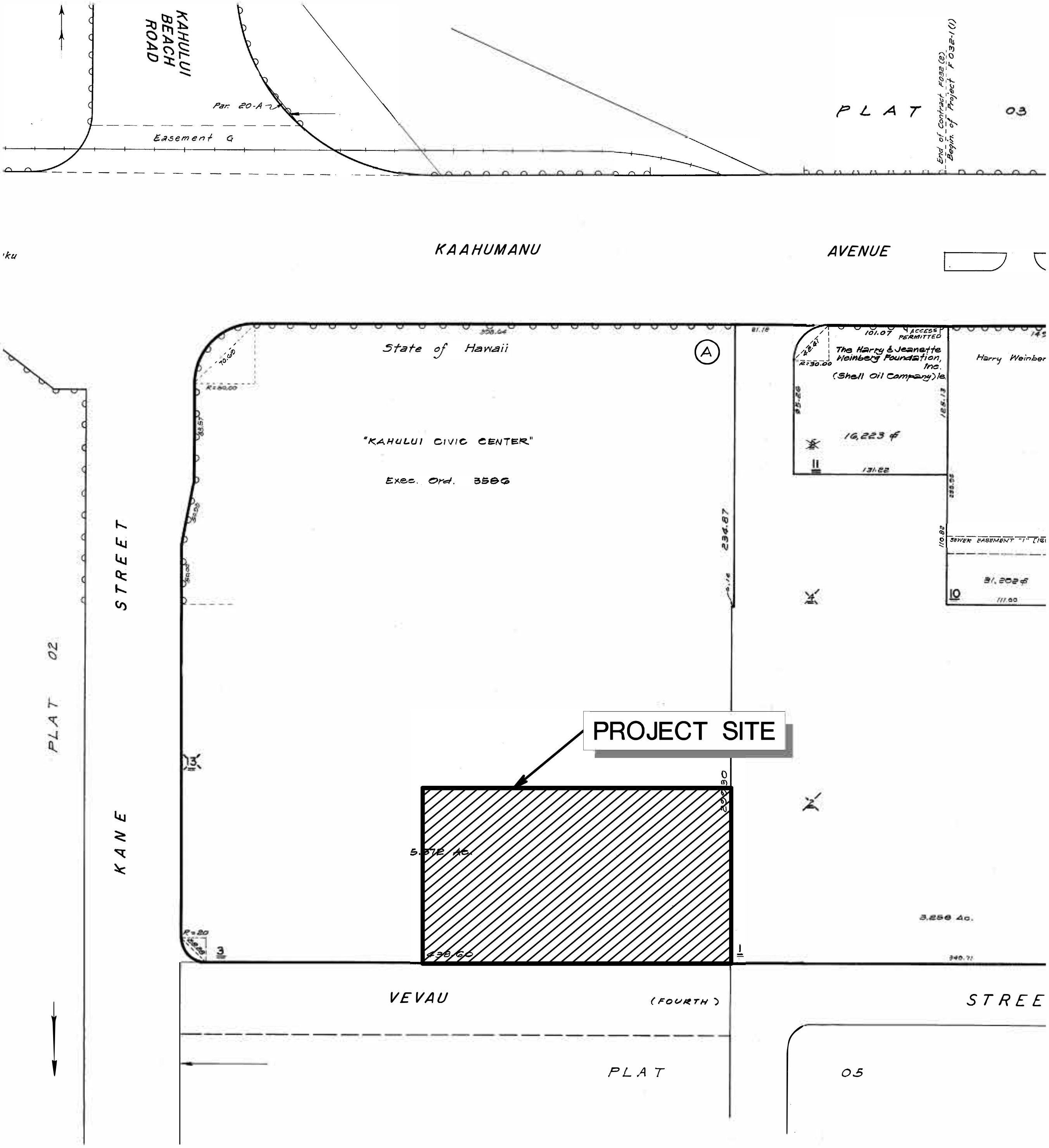
NORTH

Figure 1

SOURCE: USGS WAILUKU QUADRANGLE MAP

PREPARED FOR: COUNTY OF MAUI, DEPARTMENT OF TRANSPORTATION

PREPARED BY: FUKUMOTO ENGINEERING, INC.



VICINITY MAP (Tax Map)

SCALE IN FEET

0 250 500 1000 1500

NORTH

Figure 2

SOURCE: TAX MAP KEY (2) 3-7-004:003

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Custom Soil Resource Report
Soil Map

NORTH

SOIL MAP

SCALE IN FEET

0 250 500 1000 1500

Figure 3

SOURCE: SOIL SURVEY

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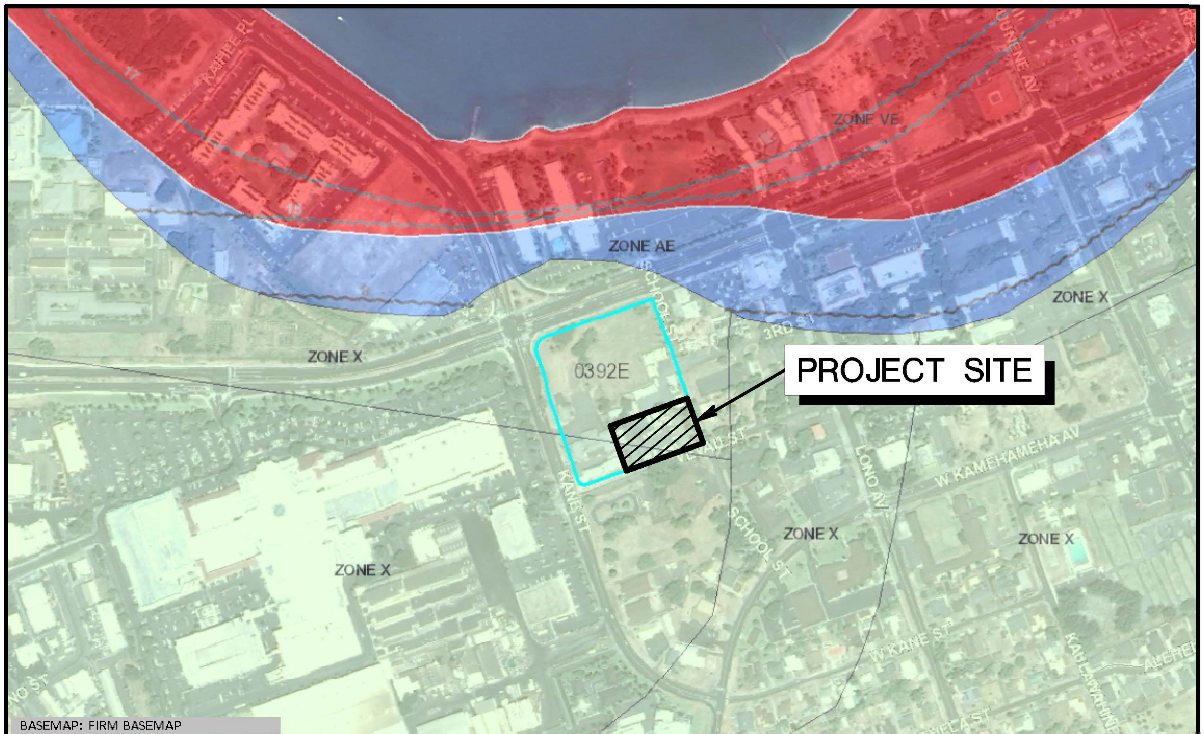

Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY: MAUI

TMK NO: (2) 3-7-004:003

WATERSHED: IAO

PARCEL ADDRESS: 153 W KAAHUMANU AVE, KAHULUI, HI 96732

Notes:

Flood Hazard Information

FIRM INDEX DATE: NOVEMBER 04, 2015

LETTER OF MAP CHANGE(S): NONE

FEMA FIRM PANEL: 1500030392E

PANEL EFFECTIVE DATE: SEPTEMBER 25, 2009

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: YES
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: YES (MA-0083; MA-0084; MA-0085; MA-0141; MA-0150; MA-0151)
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

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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:

(magenta)	**Zone A:** No BFE determined.
(light blue)	**Zone AE:** BFE determined.
(purple)	**Zone AH:** Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
(peach)	**Zone AO:** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
(red)	**Zone V:** Coastal flood zone with velocity hazard (wave action); no BFE determined.
(red)	**Zone VE:** Coastal flood zone with velocity hazard (wave action); BFE determined.
(dark blue)	**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.

(dark green)	**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.
(light green)	**Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

(olive)	**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.

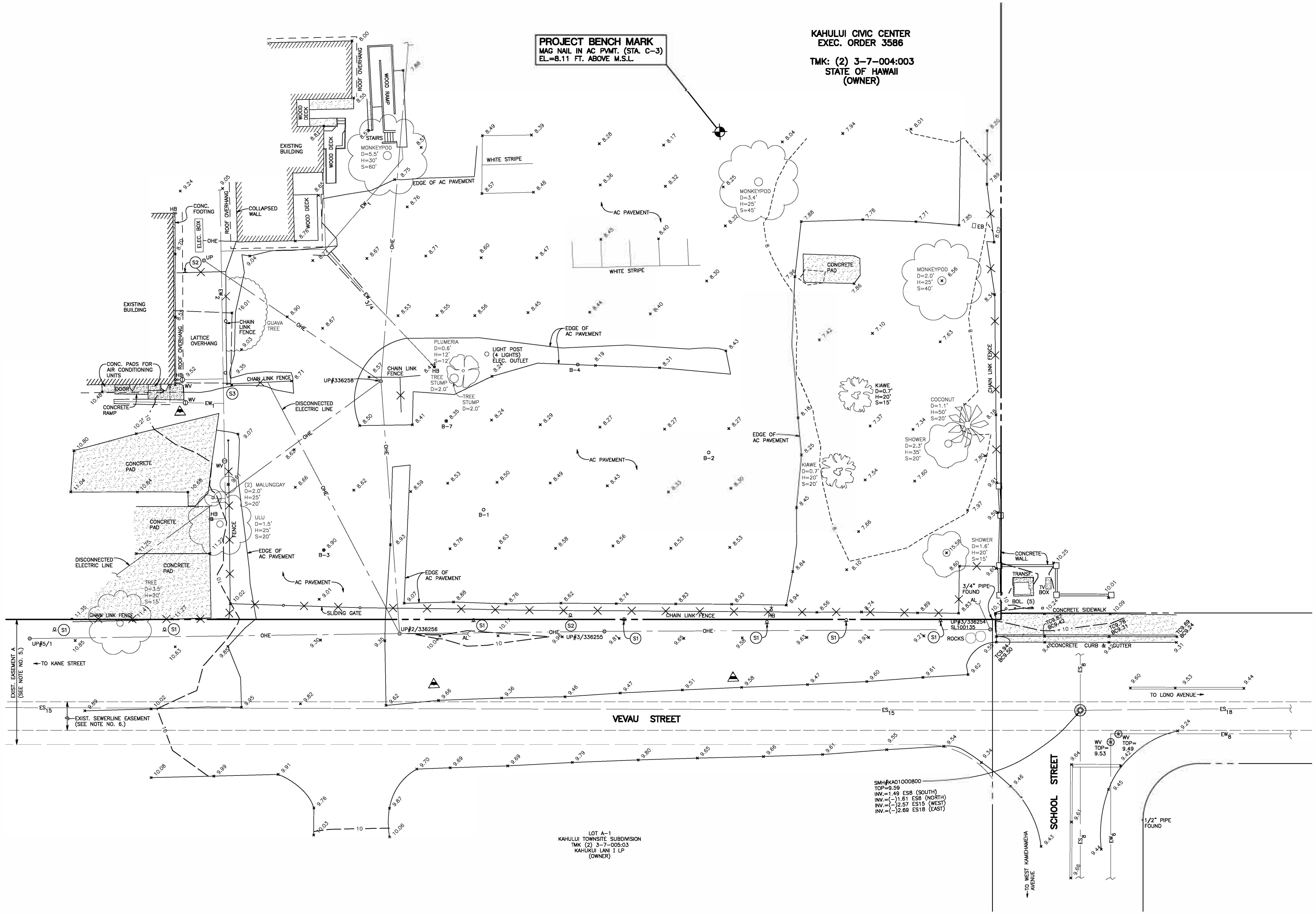
FLOOD HAZARD ASSESSMENT REPORT

NOT TO SCALE

NORTH

Figure 4

SOURCE: FLOOD HAZARD ASSESSMENT TOOL



TOPOGRAPHIC MAP

SCALE IN FEET

0 20 40 80 120

NORTH

Figure 5

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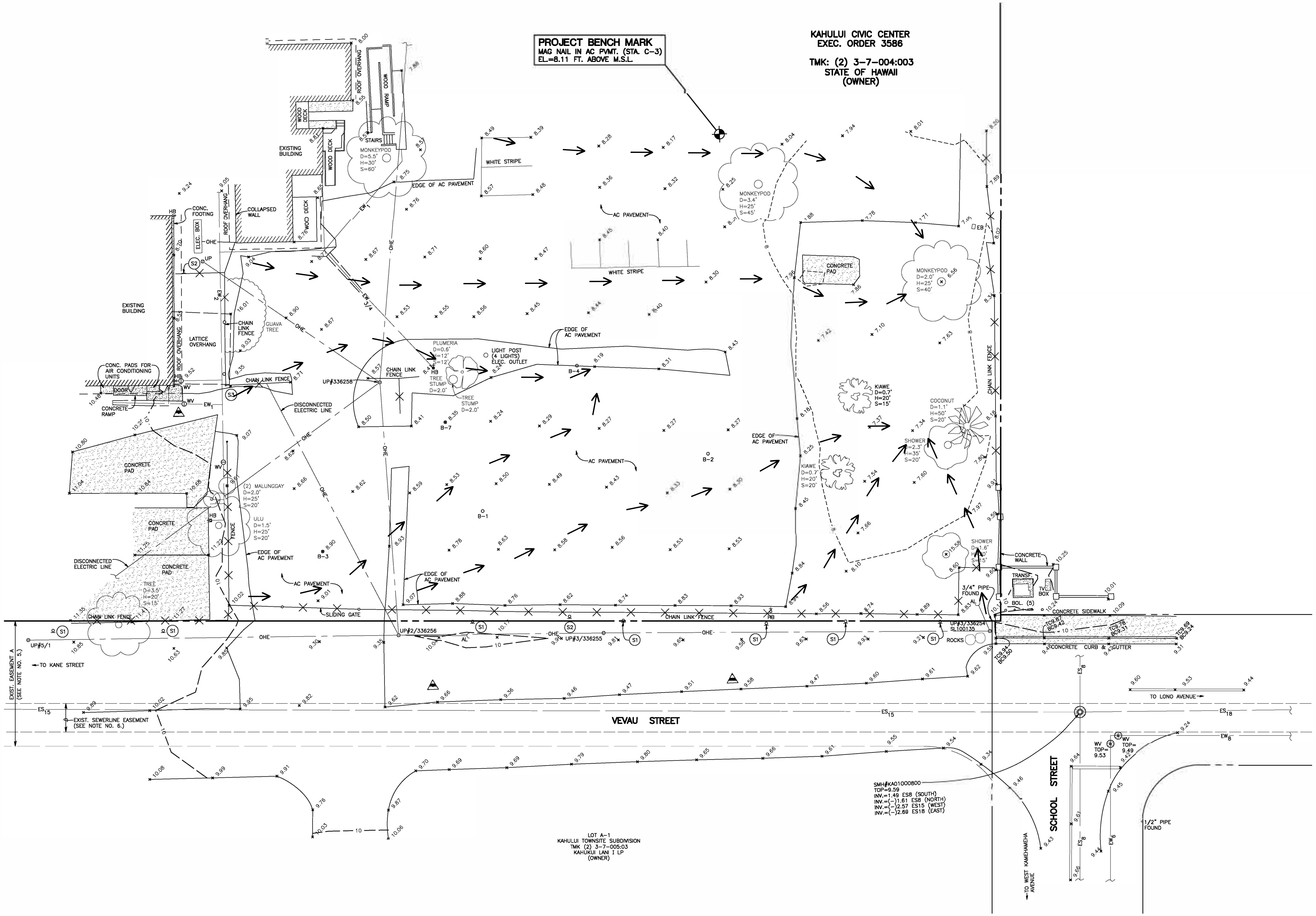

EXISTING DRAINAGE MAP

Figure 6

SCALE IN FEET

0 20 40 80 120

NORTH

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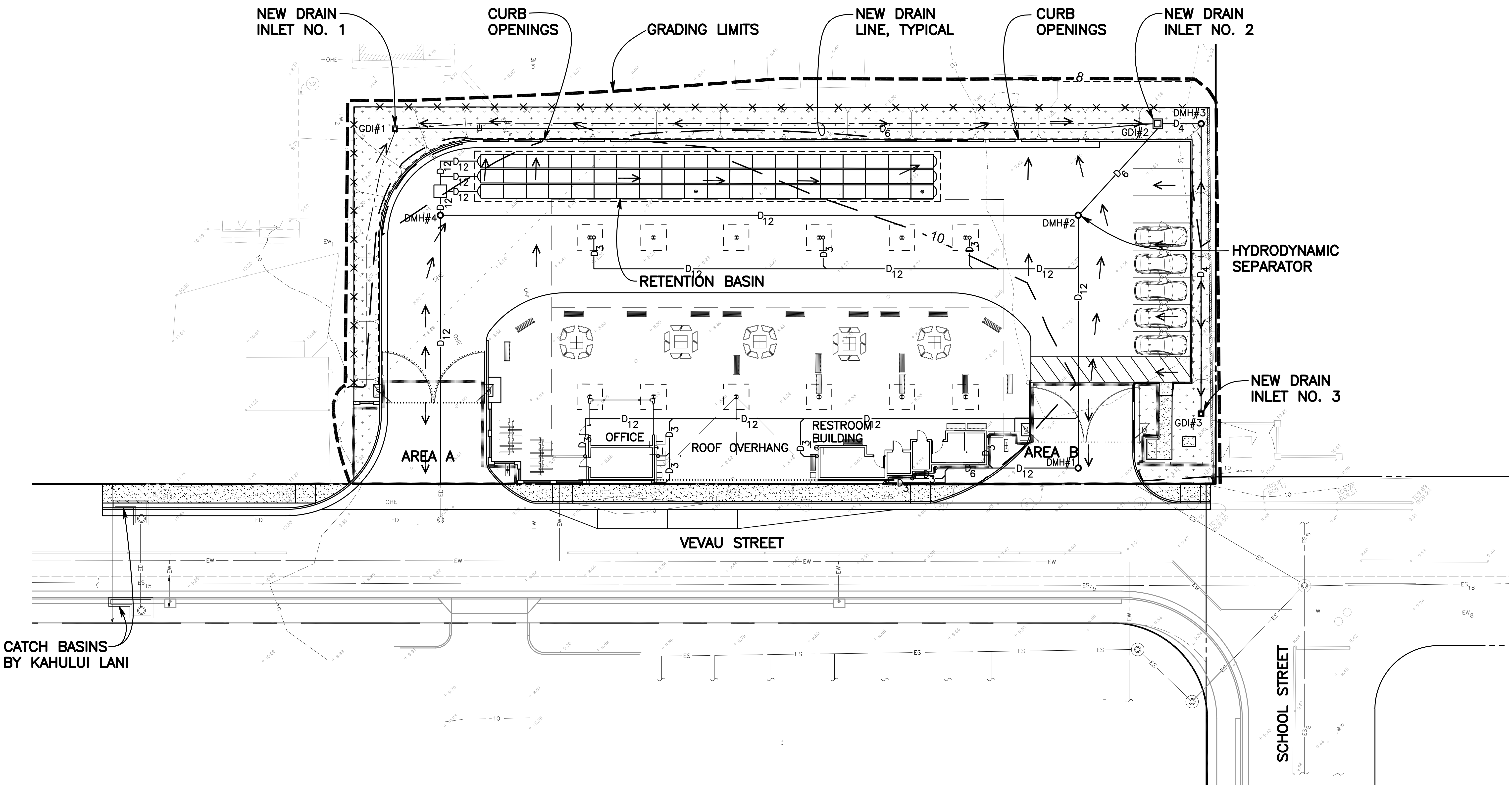

GRADING AND DRAINAGE PLAN

SCALE IN FEET: 0, 15, 30, 60, 90

NORTH

Figure 7

DRAINAGE INFORMATION

A. FLOW RATE (RATIONAL METHOD)
1. RUNOFF COEFFICIENT
a. Existing Conditions
i. On-site Unimproved Area — Area = 0.73 acre — C = 0.30

b. Developed Conditions
i. On-site Developed Area

Landscaping	Area = 0.11 acre	C = 0.10
Building/Roadways/Walkways	Area = 0.62 acre	C = 0.95
Total	Area = 0.73 acre	

$C_{COMPOSITE} = [(0.11 \times 0.10) + (0.62 \times 0.95)]/0.73 = 0.82$

The runoff coefficients were determined from the "*Title MC-15 Rules for the Design of Storm Drainage Facilities In the County of Maui*" Table 2. The coefficient used for the developed conditions in the following calculations was calculated using a weighted average of the developed landscaping and building/roadway/walkway areas.

2. RECURRENCE INTERVAL & RAINFALL
a. Recurrence interval T_m = 50 years
b. One-hour rainfall I_{50} = 2.53 inches

3. TIME OF CONCENTRATION
a. Existing On-site Conditions T_c = 9 minutes
b. Developed On-site Conditions T_c = 5 minutes

4. EXISTING RUNOFF (Rational Method)
a. Existing Conditions
$C = 0.30$
$I_{50} = 2.53 \times 2.1025 = 5.32$ inches/hour
$a = 0.73$ acres
$Q = Cia = 0.30 \times 5.32 \times 0.73 = 1.17$ cfs

5. DEVELOPED RUNOFF (Rational Method)
a. Developed Conditions
$C = 0.82$
$I_{50} = 2.53 \times 2.5575 = 6.47$ inches/hour
$a = 0.73$ acre
$Q = Cia = 0.82 \times 6.47 \times 0.73 = 3.87$ cfs

6. INCREASE DUE TO DEVELOPMENT (Rational Method)
a. On-site Area
$\Delta Q = 3.87 - 1.17 = 2.7$ cfs

7. DEVELOPED RUNOFF RELEASED FROM DRIVEWAYS AT AREA A & AREA B
   a. Area A
      C = 0.95 (Building/Roadways/Walkways)
      I_{50} = 2.53 x 2.5575 = 6.47 inches/hour
      a = 0.032 acre
      Q_A = Cia = 0.95 x 6.47 x 0.032 = 0.20 cfs
   b. Area B
      C = 0.95 (Building/Roadways/Walkways)
      I_{50} = 2.53 x 2.5575 = 6.47 inches/hour
      a = 0.04 acre
      Q_B = Cia = 0.95 x 6.47 x 0.04 = 0.25 cfs

8. LIMIT OF FLOW RATE RELEASE FROM DRAINAGE SYSTEM
   a. 1.17 cfs – Q_A – Q_B = 1.17 – 0.20 – 0.25 = 0.72 cfs

B. RETENTION VOLUME (TR-55 METHOD)
1. AREA
   On-Site Existing and Developed Conditions Area = 0.73 acre

2. RAINFALL DATA
   50-year, 1-hour: P=2.53 inches

3. CURVE NUMBER
   Soil: PZUE
   Hydrologic Soil Group A

   a. Existing Conditions

Open Space – Fair Condition	Area = 0.73 acre	CN = 49

   b. Developed Conditions

Open Space – Good Condition	Area = 0.11 acre	CN = 39
Building, Parking, & Walkways	Area = 0.62 acre	CN = 98
	Total Area = 0.73 acre	

$CN_{WEIGHTED}$ = [(0.12 x 39) + (0.62 x 98) / 0.73] = 88.67

4. RETENTION VOLUME
   a. Existing
      S = (1000/CN)-10 = (1000/49) - 10 = 10.41
      Q = $(P - 0.2S)^2/(P + 0.8S) = (2.53 - 0.2 \times 10.41)^2/(2.53 + 0.8 \times 10.41)$ = 0.02 inches
      Volume = (Q/12) x A x 43560 = (0.02/12) x 0.73 x 43560 = 49 cu. ft.

   b. Developed
      S = (1000/CN)-10 = (1000/88.67) - 10 = 1.28
      Q = $(P - 0.2S)^2/(P + 0.8S) = (2.53 - 0.2 \times 1.28)^2/(2.53 + 0.8 \times 1.28)$ = 1.46 inches
      Volume = (Q/12) x A x 43560 = (1.46/12) x 0.73 x 43560 = 3,868 cu. ft.

C. DRAINLINE SIZING

Determine pipe size based on Manning's Formula:

$Q = AV = 1.486\ (A/P)^{2/3}\ S^{1/2}\ A\ /\ n$

where A = Area of cross section (square foot)
V = Velocity (foot per second)
n = Manning's roughness coefficient
P = Wetted Perimeter (feet)
S = Slope of the energy gradient (foot/foot)

Upstream	Downstream	Cummulative Q50 [cfs]	Slope	n	Min. Pipe Diameter [in.]	Pipe Diameter [in.]
GDI #1	GDI #2	0.24	0.5%	0.013	4.97	6
GDI #3	DMH #3	0.03	0.5%	0.013	2.33	4
DMH #3	GDI #2	0.03	0.5%	0.013	2.33	4
GDI #2	DMH #2	0.27	0.5%	0.013	5.21	6
Westerly Roof	DMH #1	0.68	0.5%	0.013	7.33	12
Easterly Roof	Drainline Connection	1.00	0.5%	0.013	8.46	12
DMH #1	Drainline Connection	0.68	0.5%	0.013	7.33	12
Drainline Connection	DMH #2	1.68	0.5%	0.013	10.28	12
DMH #2	DMH #4	1.96	0.5%	0.013	10.88	12

D. DRAIN INLETS

1. Inlet Capacities

a. Grated Drain Inlet Capacity

The capacities of grated drain inlets shall be determined by the weir formula with a factor of safety (FS) of 2 for clogging. $Q = CPd^{1.5} / FS$ in cubic feet per second where C is 3.0, P is the available perimeter in feet, and d is the allowable ponding depth in feet.

(1) 1'x1' GDI: (3" depth) $Q = 3 \times 4 \times 0.25^{1.5}/2 = 0.75$ cfs

(2) 2'x2' GDI: (3" depth) $Q = 3 \times 8 \times 0.25^{1.5}/2 = 1.5$ cfs

(3) 4'x4' Diverter Manhole Drainage Inlet: (3" depth) $Q = 3 \times 16 \times 0.25^{1.5}/2 = 3.0$ cfs

The following table shows peak flows to the inlets and confirms that the inlets have adequate capacities.

Structure	Type	Planted [acres]	Hard [acres]	Total [acres]	C	Tc	cf	i [in/hr]	Q50 [cfs]	Capacity [cfs]
GDI 1	1’x1’	0.06	0.02	0.08	0.45	5	2.56	6.48	0.23	0.75
GDI 2	2’x2’	0.04	0.16	0.20	0.77	5	2.56	6.48	1.01	1.5
GDI 3	1’x1’	0.01	0.00	0.01	0.39	5	2.56	6.48	0.03	0.75
DMH 4	4’x4’	0.00	0.09	0.09	0.9	5	2.56	6.48	0.53	3

b. Drain Inlet No. 1
a = 0.08 acre
i = 6.48 in/hr
C = 0.45
Q = Cia = 0.45 x 6.48 x 0.08 = 0.23 cfs ≤ 0.75 cfs therefore 1’x1’ GDI O.K.

c. Drain Inlet No. 2
a = 0.20 acre
i = 6.48 in/hr
C = 0.77
Q = Cia = 0.77 x 6.48 x 0.20 = 1.01 cfs ≤ 1.5 cfs therefore 2’x2’ GDI O.K.

d. Drain Inlet No. 3
a = 0.01 acre
i = 6.48 in/hr
C = 0.39
Q = Cia = 0.39 x 6.48 x 0.01 = 0.03 cfs ≤ 0.75 cfs therefore 1’x1’ GDI O.K.

e. Diverter Manhole DMH #4
a = 0.091 acre
i = 6.47 in/hr
C = 0.9
Q = Cia = 0.9 x 6.48 x 0.091 = 0.53 cfs ≤ 3.0 cfs therefore 4’x4’ GDI O.K.

E. RETENTION BASIN SIZING

The drainage basin will consist of a drainage system such as StormTech SC-740 chambers or approved equal in a gravel bed of filter rock. The basin will hold the runoff volume from a 50-year, 1-hour storm. The following are the sizing computations.

Elevation	Total Volume (cubic feet)	Gravel Bed (cubic feet)	StormTech Volume (cubic Feet)	Comment
7.00	3952	1195	2757	Top of Gravel
6.50	3693	936	2757	Top of StormTech
6.00	3301	715	2586	
5.50	2676	562	2114	
5.00	1936	442	1494	
4.50	1122	344	778	
4.00	259	259	0	Bottom of StormTech
3.50	0	0	0	Bottom Of Bed

	Volume (cubic ft/ft)	Bed Width (ft)	Bed Length (ft)	Void Factor	Safety Factor
Gravel Bed Volume per foot of depth	519	15.75	146.37	0.45	0.5

F. Water Quality Calculations

Detention Based Control for a Combination System

WQDV	=	C x 0.6” x A x 3630
WQDV	=	Water Quality Design Volume in cubic feet
IMP	=	Impervious Area expressed as a percentage
C	=	0.05 + 0.009 x IMP
A	=	Area of the site in acres

Applying that formula with the project specific data

IMP	=	0.62 / 0.73	=	84.2%
C	=	0.05 + 0.009 x 84.2	=	0.81
WQDV	=	0.81 x 0.6” x 0.73 x 3630		
WQDV	=	1,288 cubic feet		

Flow-Through Based Control for a Combination System

WQFR	=	C x 0.2” x A
WQFR	=	Water Quality Flow rate in cubic feet per second
C	=	Runoff coefficient
A	=	Area of the site in acres

Applying that formula with the project specific data

WQFR	=	0.81 x 0.2 x 0.73
WQFR	=	0.12 cubic feet per second