Attachment A – 3: Quantity of Storm Water Discharge Calculations

KAIPAPAU STREAM BRIDGE REPLACEMENT (PROJECT NO. BR-083-1(48))
KAMEHAMEHA HIGHWAY, STATE ROUTE 83

Storm Event: 10-year, 1-Hr. rainfall recurrence interval

Hydrologic Criteria: The hydrologic criteria established in the City and County of Honolulu, Department of Planning and Permitting, Storm Drainage Standards (2000), will be utilized in calculating design flows.

Method of Determining Existing Design Flows

Design flows for the developed areas will be based on the Rational Method (for drainage areas less than 100 acres):

Q	=	Flow rate (cfs), where
C	=	Runoff coefficient
I	=	Rainfall intensity in inches per hour for a duration equal to the time of concentration (inches/hr)
A	=	Drainage area in acres

Hydrologic Calculations

Rational Method (Drainage Areas Less Than 100 Acres):

Runoff Coefficient, C

C = 0.90 for flat paved areas

Average Rainfall Intensity, I

I = 2.2 in/hr (Plate 1: Intensity of 10-year, 1-Hr. Rainfall)

Time of Concentration, Tc

Tc = 7.5 min. (Plate 3: Overland Flow Chart)

Correction Factor, F

F = 2.50 (Plate 4: Correction Factor)

Drainage Area, A

A = 1.6 acres

Q = (0.90)(2.2 in/hr)(2.50)(1.6 acres) = 7.92 cfs

REFERENCES

Rules Relating to Storm Drainage Standards, Department of Planning and Permitting, City & County of Honolulu, January 2000.

Table 2

MINIMUM RUNOFF COEFFICIENTS FOR BUILT-UP AREAS

RESIDENTIAL AREAS:	C = 0.55 to 0.70
HOTEL-APARTMENT AREAS:	C = 0.70 to 0.90
BUSINESS AREAS:	C = 0.80 to 0.90
INDUSTRIAL AREAS:	C = 0.80 to 0.90

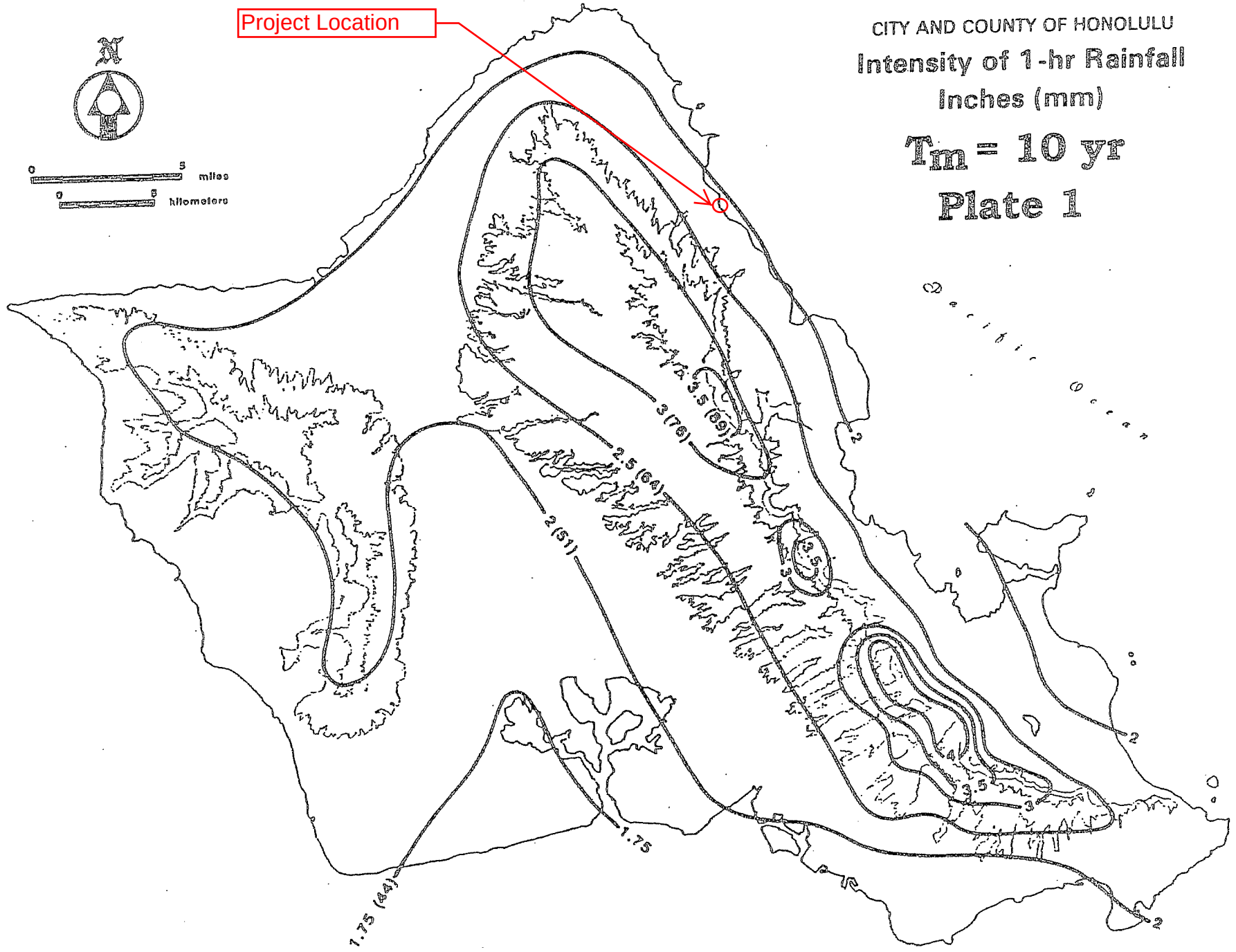
The type of soil, the type of open space, and ground cover and the slope of the ground shall be considered in arriving at reasonable and acceptable runoff coefficients.

Table 3

APPROXIMATE AVERAGE VELOCITIES OF RUNOFF FOR CALCULATING TIME OF CONCENTRATION

TYPE OF FLOW	VELOCITY IN fps FOR SLOPES (in percent) INDICATED			
	0-3%	4-7%	8-11%	12-15%
OVERLAND FLOW:				
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 Formula			
Natural Channel*	1.0	3.0	5.0	8.0
(not well defined)				

* *These values vary with the channel size and other conditions so that the ones given are averages of a wide range. Wherever possible, more accurate determinations should be made for particular conditions by Manning Formula or from Plate 5.*



SOURCE: DEPARTMENT OF LAND AND NATURAL RESOURCES STATE OF HAWAII

Plate 3

Overland Flow Chart

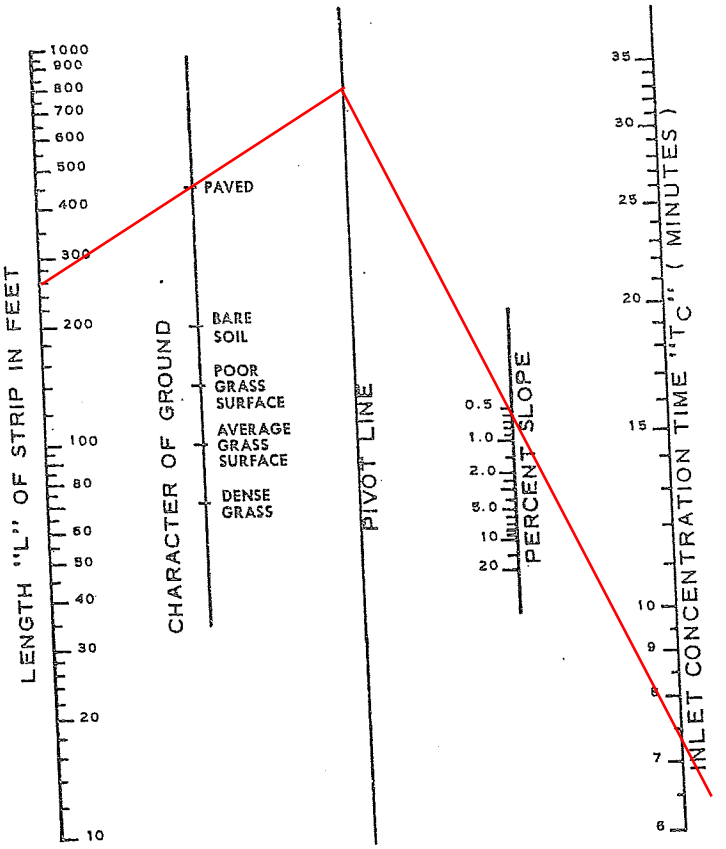
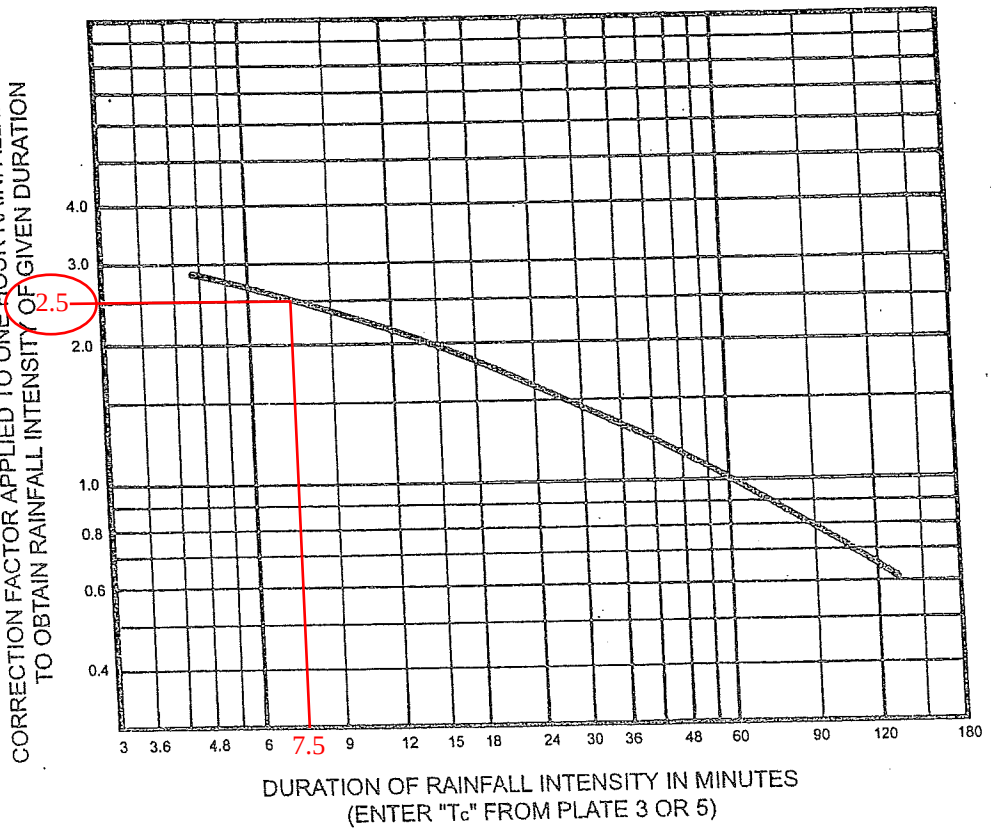


Plate 4



CORRECTION FACTOR

FOR CONVERTING 1 HR. RAINFALL TO RAINFALL INTENSITY OF VARIOUS DURATIONS

TO BE USED FOR AREA LESS THAN 100 ACRES

(See Plate 6 for area more than 100 acres)