APPENDIX 2A

Stormwater Management Plan

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CALCULATION COVER SHEET

CLIENT	Calpine
PROJECT	Russell City Energy Center, Alameda County, California
SUBJECT	Stormwater Management
JOB NUMBER	53794801
WBS NUMBER	024
CALCULATION NO.:	RCEC-024-DC-0001
PAGE 1 OF	15

DESCRIPTION/PURPOSE

Design stormwater system to collect site runoff and convey the runoff to an existing drainage channel (Line E) located west of the project site. The stormwater system will consist of inlet and pipe systems and open channels and will be designed in accordance with the requirements of the Alameda County, California, the Alameda County Flood Control and Water Conservation District Hydrology and Hydraulics Criteria Summary Manual and Alameda Countywide Clean Water Program (ACCWP), Provision C.3 Stormwater Technical Guidance.

METHOD OF ANALYSIS

Use the Modified Rational Method as implemented by the ACFC&WCD Hydrology Manual to estimate peak runoff for the collection system design. Use Haestad methods, "StormCAD", "Culvertmaster", and "Flowmaster" to design the storm drain and culvert system.

CODES AND STANDARDS

None applicable.

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INFORMATION SOURCES

1. Federal Emergency Management Agency (FEMA), National Flood Insurance Program, Flood Boundary and Floodway Map, Flood Insurance Rate Maps (FIRM), Panels 10 and 18 of 29, February 9, 2000.
2. Federal Emergency Management Agency (FEMA), National Flood Insurance Program, Flood Boundary and Floodway Map, Map Index, Community Panel Numbers 065033 0001-0029 February 9, 2000.
3. Federal Emergency Management Agency (FEMA), National Flood Insurance Program, Flood Insurance Study, City of Hayward, California, Alameda County, February 9, 2000.
4. City of Hayward, Hayward Municipal Code, 2006.
5. Alameda County General Ordinance Code, Matthew Bender & Company, Inc., 2006.
6. Alameda County Flood Control and Water Conservation District, Alameda County Hydrology and Hydraulics Criteria Summary Manual, 1989.
7. Alameda Countywide Clean Water Program (ACCWP), Provision C.3 Stormwater Technical Guidance.
8. MK-GEN-DB-003, Mankato Energy Center, Project Design Guidelines for Combined Cycle Plant with a 1x1x1 Configuration.
9. USDA, Soil Conservation Service, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx "Soil Survey of Western Alameda Area, California," 2006.
10. McCuen, Richard, "Hydrologic Analysis and Design", 2nd Edition.
11. Bentley Systems, "Flowmaster", Service Pack 3.
12. FHWA, HEC-15, April 1983, pgs. 17, 36 and 37.
13. Bentley Systems, "Culvertmaster", Service Pack 1.
14. Bentley Systems, "StormCAD", Service Pack 2.
15. National Stone Association (NSA), Suggested Riprap Stone Sizes.
16. Commonwealth of Pennsylvania, Department of Environmental Protection, Erosion and Sediment Control Manual, 2000.

ASSUMPTIONS

Contained in body of calculation.

CONCLUSIONS AND RESULTS

The storm water management system for the site meets the requirements of Alameda County Flood Control and Water Conservation District Hydrology Manual and the Alameda Countywide Clean Water Program (ACCWP), Provision C.3 Stormwater Technical Guidance.

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A. Final Site Grading and Drainage Plan (RC-GEN-DE-C1-0001)
B. Documents Received from Alameda County
C. Surfacing Plan (RC-GEN-DE-C1-0002)
D. Site Soils Map
E. Tributary Drainage Areas
F. Runoff Coefficient C Calculation
G. Peak Flow Q Calculation by the Modified Rational Method
H. StormCAD Summary Reports
I. Storm Drainage System Catch Basin and Pipe Schedule
J. Mitigation of Excess Runoff
K. Permanent Channel Design Calculations
L. Culvert Design Calculation Reports
M. East Bay Dischargers Association Easement Information
N. Riprap Outlet Protection Calculations

PROJECT DESIGN CRITERIA FOR STORM WATER MANAGEMENT

1. Flood Control:

   A. According to the FIRM maps, (Reference 1), the southwest portion of the site falls within a flood zone, Zone A1. The base flood elevation (also called the 100-yr flood) is seven (7) feet above mean sea level (MSL) in the vicinity of the project site. From Reference 4, Chapter 9, Article 4, Flood Plain Management, Section 9.-4.110, for Zone A, the lowest floor shall be elevated to a level at or above the base flood elevation. From Reference 5, Article III, Permit Standards for Floodplain Management, the lowest floor shall be at least one foot above the base flood elevation.

   The finished floor for all structures shall be set at elevation +10.0 ft. and the site will be graded at a minimum slope of 0.5%, where appropriate.

2. Storm Water Management:

   A. The storm water drainage system for the Russell City Energy Center will be designed consistent with the requirements of Alameda County, California, the Alameda County Hydrology and Hydraulics Manual (Reference 6). All the runoff from the project site will drain to the Hayward Outfall Channel (Line E) mainly by the proposed stormwater facilities (Attachment B, District Drawing H-12). This is a primary facility as designated by the District located in Zone 4 (Attachment B).

   For primary facilities, the following guidelines for the design storm shall be followed as required by the District (Reference 6):

   - No outflow: All zones. All lines subject to tidal backwater effects and covered by the FEMA study.
   - 5-Year Storm: All zones. All lines near the bay subject to tidal backwater effects.
   - 15-Year Storm: All zones except zone 12. For all drainage areas up to ten square miles.
   - FEMA 100-Year Storm: All zones. For all reached of the flood control system covered by the FEMA flood insurance study. The flows to be used in design are found in the Flood Insurance Study for the particular line.

   B. The 'Modified Rational Method', as implemented by the District, is the recommended method for determining peak discharge from drainage areas of less than 640 acres.

   C. A detention facility may be required to limit the augmented discharge from the project site. The discharge shall be controlled by the outlet works such that the predetermined discharge rate (pre-existing conditions) from the detention facility and the peak flow in the receiving facility are not exceeded. Several types of detention facilities are acceptable to the District for controlling on-site augmented storm discharge such as parking lot detention, conduit storage, channel storage, and multi-purpose facilities. Due to the lack of space to construct a detention pond for the Russell City site, the excess post-development stormwater discharge will be controlled by conduit and channel storage.

   D. Culverts/Channels:

- Minimum velocities:

  Earth Channels: 2.0 ft/sec
  Concrete Lined Channels: 2.0 ft/sec
  Closed Conduits: 3.0 ft/sec

- Maximum Velocities:

  Earth Channels: 6.0 ft/sec
  Concrete Lined Channels: 14.0 ft/sec
  Closed Conduits: 14.0 ft/sec

- Minimum Slope:

  Earth Channels: 0.0007 ft/ft
  Concrete Lined Channels: 0.0007 ft/ft
  Closed Conduits: 0.0007 ft/ft

- Minimum pipe size shall be 12 inches in diameter.
- Minimum bottom width for open channels and boxes shall be four (4) feet for earth sections and six feet for concrete sections whenever possible.
- Maximum EGL elevation shall be below the top of bank in channels and below ground in closed conduit systems wherever possible.
- Manhole spacing for underground conduits shall not exceed 400 feet on center.
- The ratio of side slope for earth channels shall be no steeper than two and one half (2 1/2) horizontal units to one (1) vertical unit.

F. Freeboard Requirements:

Facility	Freeboard	From Design HGL up to:
Closed Conduits	1.25 ft	Top of Curb
Non-Leveed Channels		
District Design Storm	1.00 ft	Top of Bank
FEMA Q(100)	0.00 ft	Top of Bank
Retention/Detention Pond	1.00 ft	Top of Ground

G. From Reference 6, a modified runoff coefficient, C' is to be used in the design of the project site.

H. Time of concentration (Tc) is calculated using methods from Reference 6 based on the length and slope of the flow path and the land cover of the area. The time of concentration will be calculated using Equation 1-2 for *undeveloped watersheds* given in Reference 6.

$Tc = L / 60 V$ where,

Tc = Time of concentration in minutes

L = Overland flow length in feet

V = Overland flow velocity in feet per second, from Figure 4, page 28 (Ref. 6).

A five (5) minute minimum time of concentration is used.

The urbanized watershed figures will not be used to calculate the Tc since this does not apply to the project site.

STORMWATER DRAINAGE CALCULATION

1. Location

   The site for the proposed Russell City Energy Center is located in Alameda County, California, north of State Highway 92 between Depot Road and Enterprise Road on various parcels. The proposed plant facilities will envelop approximately 15.5 acres. A general arrangement of the proposed plant area is shown in Attachment A.

2. General Approach

   Design the site grading to have a minimum slope of 0.5% in the paved areas and a minimum slope of 1% in the unpaved areas in accordance with Reference 4, Section 10-8.33e(3). The Calpine design guidelines (Reference 8) state that site grading will comply with applicable land development regulations. Using the grading as shown on Attachment A, determine the tributary area to each inlet. The tributary areas are shown on Attachment E. Design the storm sewer to have a minimum pipe slope of 0.0007 ft/ft (Reference 6) to minimize the trench depth.

3. Site Soils

   According to Soil Survey of Western Alameda County, California, (Reference 9), the soils within the limits of the project property are described as Reyes Clay (Map Unit Symbol 139) and the hydrologic soil group (HSG) as given in Reference 9 for this soil series is classified as HSG D. A site soils map and the hydrologic group table are given in Attachment D.

4. Drainage Areas

   Measure drainage area tributary to individual storm drain system components (see Attachment E).

5. Modified Rational Runoff Coefficients, C'

   In Reference 6, a formula is given for the calculation of runoff coefficients, which incorporates the slope and the rainfall intensity factor. However, the modified C' will never exceed 0.80 when calculations are based on land use rather than type of surface. Therefore, runoff coefficients for the project site were taken from Reference 10, Table 7-10. This table is given in Attachment F.

   <u>Impervious (pavement, roof, and concrete):</u> C = 0.95
   Table 7-10, upper end of Pavement

   <u>Gravel:</u> C = 0.65
   Table 7-10, average for Industrial – Light

Grass: C = 0.20
Table 7-10, upper end for Lawns

The composite runoff coefficient for each tributary area is calculated and presented in Attachment F.

6. Time of Concentration

A minimum Time of Concentration, Tc = 5 minutes, is used for all sub-areas for all drainage structures except for catch basin # 19, the diversion channel(s) and Channel A. The time of concentration is 11.35 minutes, 29 minutes, and 47 minutes for catch basin # 19, the diversion channel(s), and Channel A, respectively.

7. Rainfall Intensity

The 15- and 100-year Intensity-Duration-Frequency curves from Reference 6 were entered in StormCAD as shown in Attachment H.

The average mean annual precipitation (MAP) is 17 inches for the watershed from the isohyetal map (Reference 6).

Example, for Tc = 5 minutes:

$Ix = I_{15} = 0.15\ h^{-1}$ (from Reference 6, Unit Frequency-Duration Curves)

$Ix = I_{100} = 0.20\ h^{-1}$ (from Reference 6, Unit Frequency-Duration Curves)

$i_{15} = I_{15} \times MAP = 0.15 \times 17\ in = 2.55\ in$

$i_{100} = I_{100} \times MAP = 0.20 \times 17\ in = 3.40\ in$

8. Peak Runoff Rate

Utilize the Modified Rational formula to compute peak storm runoff rate, where

$$Q_p = C'IA$$

The peak flows, which are collected into catch basins in the sub-drainage areas, are calculated and shown in Attachment G.

STORM DRAIN SYSTEM CALCULATION

1. Storm Drain System

Haestad Methods "StormCAD" (Reference 11) is used to calculate pipe capacities. StormCAD Summary Reports and profiles for the storm drainage pipes are presented in Attachment H, which provides additional pertinent computed hydraulic data. The average velocities in the pipes at design flow are less than 14 feet per second for the 15-year and 100-yr design storm. The head difference between the site grades and the base flood elevation is very low; therefore, the average velocities are less than the preferred 3 ft/s. More maintenance will be required if the sediment builds up in the pipes over time.

The capacity of the storm drain system is adequate for both the design storm (15-year) and check storm (100-year) peak flows given in Attachment H. The pipe and catch basin schedule is given in Attachment I.

Using information received from the Alameda County Public Works department (Attachment B), the flow for the 15-yr discharge in the Hayward Outfall Channel is 100 cfs at the end of Line E-3 (end of Enterprise Road) and 112 cfs at the end of Line E-2 (end of Depot Road). By interpolation, a flow of 107 cfs is assumed in calculating the tailwater for the stormwater system. The normal depth in this channel is calculated as 2.35 ft assuming a channel slope of 0.01 ft/ft and a roughness coefficient of 0.05 assuming vegetative growth. Using the gradually varied flow method, the tailwater elevation for the storm water system is 4.70' by adding the depth calculated at the upstream end of Channel A of 1.70' and the contour interval of 3'. (Attachment H). The same process is used for the 100-yr analysis and the tailwater elevation is 4.85'.

The Alameda County Flood Control and Water Conservation District also requires that the augmented storm runoff has to be mitigated if the development associated with a higher runoff coefficient is proposed.

Composite C (pre) = 0.60 (Attachment B)

Composite C (post) = 0.70 (Attachment J)

100-yr 24 hour storm, Px = P_{100} = 0.24 (from Reference 6, Figure 11)

0.24 x 17 in = 4.08 in

Volume(pre) = 4.08 in x 1 ft/12 in x 0.60 x 15.5 acres = 3.16 acre-ft

Volume(post) = 4.08 in x 1 ft/12 in x 0.70 x 15.5 acres = 3.69 acre-ft

Retain the post: Difference = post – pre = 3.69 – 3.16 acre-ft = 0.53 acre-ft = 23,087 ft^3

Volume in pipes = 7,931 ft^3 (Attachment J)

Volume stored in channel (Channel A):

Bottom width = 10'

Top width = 28' (3H:1V side slopes and a height of 3')

10'+28' / 2 = 19' x 3' = 57 ft^2

SAY Length = 321' 57 ft^2 x 321' = 18,297 ft^3

Length is measured from the east boundary of the EBDA easement and the junction of Diversion Channel C and Channel A.

Total Volume = 18,297 ft^3 + 7,931 ft^3 = 26,228 ft^3

There is sufficient volume in the storm system and the open channel to contain the 100-yr, 24-hr storm.

2. Permanent Channel Design

All channels are designed using Flowmaster (Reference 12) and the calculations are given in Attachments K.

In accordance with Reference 6, all channels should be designed to carry the peak flow from the 15-yr and the 100-yr storm. For the 15-yr, the freeboard required is one (1) foot and for the 100-yr storm it is zero feet from the design hydraulic grade line (HGL) up to the bank. The design velocities for channels should not exceed the permissible velocity and the permissible unit shear stress for the type of lining used. According to Reference 6, the Manning's "n" for all earth (smooth geometric) channels is 0.030 minimum. Erosion-control blankets (such as jute matting) will be required to protect new-growth vegetation so it will not be removed by storm flows before the vegetation can become established. From Reference 6, the Manning "n" for these linings will be determined according to manufacturer's specifications, however, they are taken directly from the material library in the Flowmaster software. The permissible unit shear stress is taken from Reference 12 and is also given in Attachment K.

A. Diversion Channels

Diversion Channel (A)

A channel will be required to divert the existing run-on onto the project site. After reviewing the adjacent topography, a watershed area of approximately 35 acres is draining to the project site. The total runoff is calculated using a time of concentration of 29 minutes and a rational runoff coefficient of 0.8 (heavy industrial). The designated watershed map is given in Attachment K.

Time of Concentration Calculation:

Tc = L/60V

Tc =Time of Concentration in minutes	28.3
L = Overland Flow Length in feet	2461
V =Overland Flow Velocity in feet per second, Reference 6, Figure 4, page 28	1.45

SAY 29 minutes

Additionally, part of the project site will also drain to this channel. The watershed area is approximately 1.20 and 0.39 acres for the north and south channel, respectively, with the sub-areas as following:

	North	South
Impervious, C = 0.95:	0.140	0.155 acres
Gravel, C = 0.65:	0 acres	0.235 acres
Grass, C = 0.20:	1.06 acres	0 acres
Watershed, C = 0.80:	35 acres	35 acres
Composite C:	0.78	0.80

Peak Flow (T_C = 29 minutes)

$I_{15} = 0.065h^{-1}$ Q_{15}: 31.2 cfs **31.3 cfs**

$I_{100} = 0.085h^{-1}$ Q_{100}: 40.8 cfs **40.9 cfs**

Since the peak flows for the north and south sections are very close in value, use the maximum flows for simplicity.

Assume a trapezoidal shape:

Slope:	0.004 ft/ft
Side slopes:	2.5H:1V
Bottom Width (min):	4.0 feet
Lining:	grass cover with jute matting (n = 0.022)
Manning "n":	0.03, normal depth(15) = 1.41 ft normal depth (100) = 1.61 ft
	0.05, normal depth(15) = 1.81 ft normal depth (100) = 2.06 ft
Freeboard Required:	15-yr storm – 1 ft 100-yr storm – 0 ft

Design as a grass-lined trapezoidal channel with b = 4', d = 3' and 2.5:1 slopes. Use jute net for the temporary lining.

Diversion Channel (B)

The diversion channel will run along the eastern and northern boundary of the project site and the channel cross-section will be consistent throughout. However, for a small channel run for about 100 feet along the eastern boundary of the "Eash" parcel, the channel section width is reduced two feet and the side slopes are 2H:1V due to limitation on the space in this area.

Assume a trapezoidal shape:

Slope:	0.004 ft/ft
Side slopes:	2H:1V
Bottom Width (min):	2.0 feet
Lining:	grass cover with jute matting (n = 0.022)
Manning "n":	0.03, normal depth(15) = 1.79 ft normal depth (100) = 2.02 ft
	0.05, normal depth(15) = 2.25 ft normal depth (100) = 2.53 ft
Freeboard Required:	15-yr storm – 1 ft 100-yr storm – 0 ft

Design as a grass-lined trapezoidal channel with b = 2', d = 3.5' and 2:1 slopes. Use jute net for the temporary lining.

Diversion Channel (C)

The diversion channel will continue along northern boundary of the project site into Channel B. The slope for this part of the channel will be the minimum required 0.0007 ft/ft due to invert

constraints. The minimum velocity requirement is not met and maintenance will be needed to provide adequate depth for the channel. Due to the low velocities, a temporary lining will not be required, however it is recommended to use a lining before vegetation is established.

Assume a trapezoidal shape:

Slope:	0.0007 ft/ft
Side slopes:	2.5H:1V
Bottom Width (min):	4.0 feet
Lining:	grass cover with jute matting (n = 0.022)
Manning "n":	0.03, normal depth(15) = 2.15 ft normal depth (100) = 2.43 ft
	0.05, normal depth(15) = 2.72 ft normal depth (100) = 3.07 ft
Freeboard Required:	15-yr storm – 1 ft 100-yr storm – 0 ft

Design as a grass-lined trapezoidal channel with b = 4', d = 3.7' and 2.5:1 slopes. Use jute net for the temporary lining.

B. Channel A

A channel will be located on the northern end of the RCEC site. This channel will drain all the water from the entire site, including the flow from the stormwater system and the flow from the diversion channels into the Hayward Outfall Channel.

The total area that the channel will drain is:

Watershed, C = 0.80:	35 acres
Site, C = 0.70:	15.5 acres (see Attachment J, Post-Development)
Composite C:	0.77

Time of Concentration Calculation:

The time of concentration is 29 minutes for the diversion channels. Additionally, the time to get around the channel system is calculated as follows:

Tc = L/60V

Tc =Time of Concentration in minutes	17.9	Say 18 minutes
L = Overland Flow Length in feet	1131	
V =Overland Flow Velocity in feet per second, Grassed Waterway, Reference 6, Figure 4, page 28	1.05	

Total Tc = 29 + 18 = <u>47 minutes</u>

Peak Flow (T_C = 47 min)

$Ix = I_{15} = 0.049\ h^{-1}$ (from Reference 6, Unit Frequency-Duration Curves)

$Ix = I_{100} = 0.065\ h^{-1}$ (from Reference 6, Unit Frequency-Duration Curves)

$i_{15} = I_{15} \times MAP = 0.049\ h^{-1} \times 17\ in = 0.84\ in/hr$

$i_{100} = I_{100} \times MAP = 0.065\ h^{-1} \times 17\ in = 1.11\ in/hr$

Q_{15} = 50.5 acres x 0.84 in/hr x 0.77 = **32.67 cfs**

Q_{100} = 50.5 acres x 1.11 in/hr x 0.77 = **43.17 cfs**

This channel is designed as a vegetated swale according to the requirements of the ACCWP Section 6.1 (Reference 7). This channel is designed to treat the runoff through sedimentation filtering by the vegetation in the channel, filtering through a subsoil matrix, or infiltration into the underlying soils as approved by the ACCWP. The runoff from the impervious area of the site is required to be treated.

In the requirements, it is stated that a single swale cannot treat areas greater than 10 acres. The total area that is draining to the diversion channels is about 36.6 acres; however the diversion channel will have vegetation, which will treat the runoff before it reaches Channel A. The total area from the site (excluding the off-site run-on) draining to Channel A is about 13.9 acres. Although, the maximum area of 10 acres is exceeded, part of the water will travel over gravel and grass surfaced areas before reaching the catch basins and will also be treated.

The swale is to have a treatment size of at least 4% of the impervious surface area of the site. The impervious site area is 6.03 acres (see Attachment J, Post-Development) and 4% of this is equal to 0.24 ac (10,507 ft^2). The area of the channel at the maximum water treatment depth of 4" is approximately 3,210 ft^2.

However, during the plant operation, the day-to-day activities will be managed by the operational SWPPP. The vehicular traffic on the site will be minimal and the oil leaked from cars will be minimal (see limited parking spaces shown in Attachment A). There will be containment for oil onsite. Additionally, each inlet will have a drain insert to reduce any trash or sediment from traveling through the storm water system. The site does not have high oil and grease concentrations as other sites may have. Therefore, maximizing the treatment size to accommodate the entire impervious area may be unnecessary.

Slope:	0.0025 ft/ft
Side slopes:	3H:1V
Bottom Width (min):	10.0 feet
Lining:	grass cover with jute matting (n = 0.022)
Manning "n":	0.03, normal depth(15) = 1.10 ft normal depth (100) = 1.28 ft
	0.05, normal depth(15) = 1.45 ft normal depth (100) = 1.68 ft
Freeboard Required:	15-yr storm – 1 ft 100-yr storm – 0 ft

Design as a grass-lined trapezoidal channel with b = 10', d = 3' and 3:1 slopes. Use jute net for the temporary lining.

There is an easement for a 60" Force Main that runs through the project site, which is controlled by the East Bay Dischargers Authority. Channel A will intersect this easement at the north-west end of the site where it discharges into the Hayward Outfall Channel. From Drawing 5, 'Force Main between Hayward and Alvarado', the top of the pipe is at approximate elevation 100'. This elevation is based on mean sea level datum 1929 (adj.) plus 100 feet. According to Reference 6, Figure 12, the mean sea level is 0.00 (Attachment M). The invert of the channel is at least 3' above the pipe and therefore is not a design concern.

3. Culvert Design

Culverts will be required to carry the flow from the diversion channels to Channel A. Haestad Methods "Culvertmaster" (Reference 14) Calculation Reports are presented in Attachment L, which give additional pertinent computed hydraulic data. Based on the culvert analysis, the headwater elevations are less than maximum allowable elevations, hence the proposed culverts have adequate capacities to discharge the design flows without overtopping the roadways. The velocities at the design flows for the culverts exceed 3 fps. See Table 1 for dimensions.

Table 1 – Culvert Data (15-yr)

Culvert	Size (in)	# of Sections	Material	Upstream Invert (ft)	Downstream Invert (ft)	Length (ft)	Allowable HW (ft)	Computed HW (ft)	Discharge (cfs)	Velocity (fps)
C-1	36	1	SLPE	3.79	3.70	100	9.0	7.35	31.3	4.43
C-2	36	1	SLPE	3.70	3.63	70	8.0	6.71	31.3	5.50
C-3	36	1	SLPE	3.26	3.23	30	8.0	6.50	31.3	4.65

4. Riprap Outlet Protection

Riprap outlet protection will be required at the downstream end of pipe P-21 (outfall into Channel A) and the downstream ends of culverts C-2 and C-3. The required stone size and thickness are given in Table 2 below. The riprap stone sizes are taken from Reference 15 (Attachment N) and the thickness is calculated as 1.5 times the maximum rock diameter. The dimensions of the apron are determined from Reference 16, Figure 22 (Attachment N). All pipe diameters (d_0) are 36 inches (3 ft).

Table 2

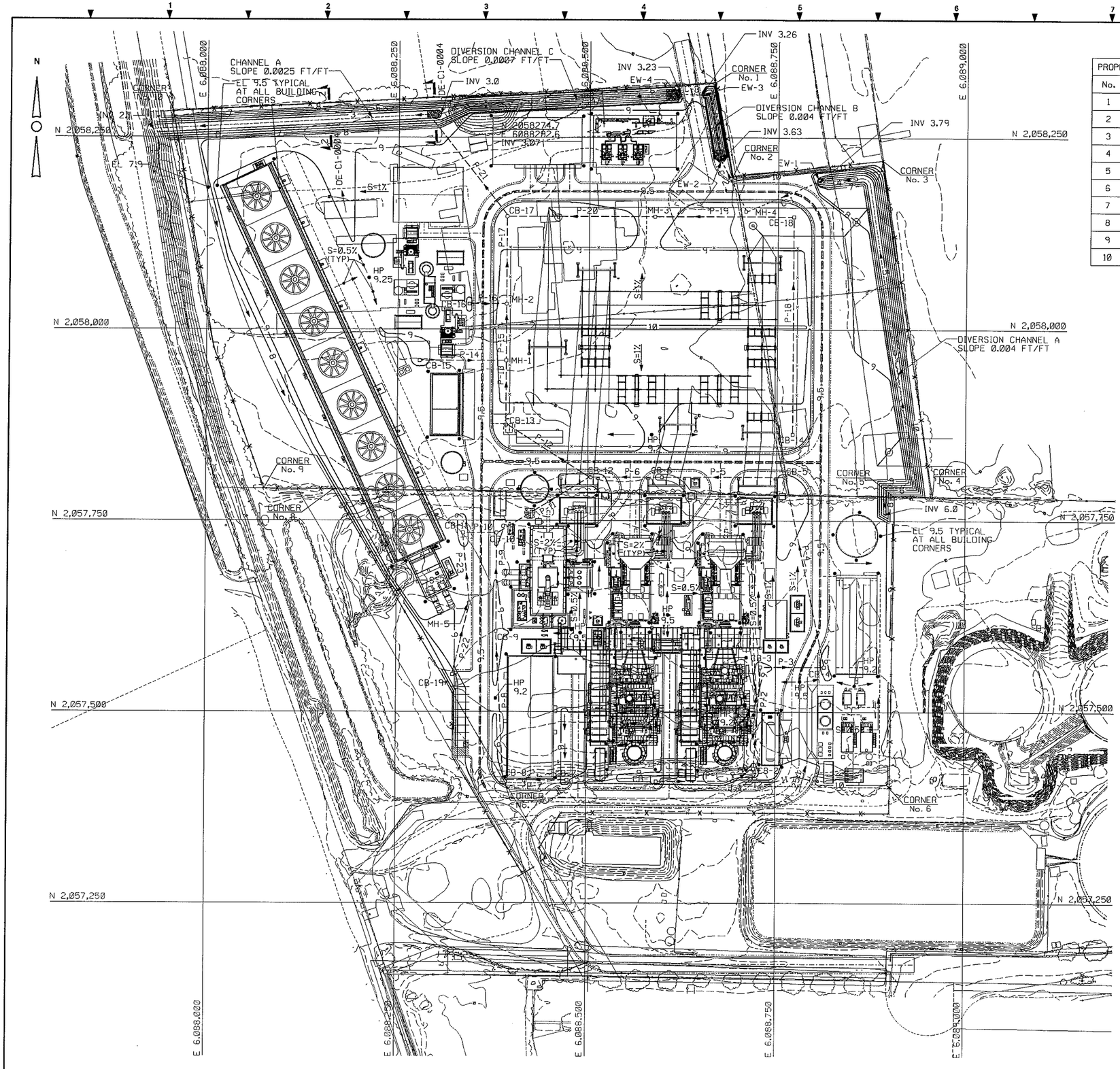
Culvert / Pipe	Discharge 15-yr (cfs)	Velocity 15-yr (fps)	Width (ft)	*Length (La) (ft)	Required Riprap Stone (NSA No.)	Thickness (in)
P-21	15.11	4.39	14.2	13'	R-3	9
C-2	31.3	5.50	14.2	13'	R-3	9
C-3	31.3	4.65	14.2	13'	R-3	9

*Apron Length is based on discharge (see Attachment N)

CONCLUSIONS AND RESULTS

The storm water management system for the site meets the requirements of Alameda County Flood Control and Water Conservation District Hydrology Manual and the Alameda Countywide Clean Water Program (ACCWP), Provision C.3 Stormwater Technical Guidance.

ATTACHMENT A



PROPERTY CORNER COORDINATE SCHEDULE		
No.	NORTH	EAST
1	2058321.5	6088667.5
2	2058199.4	6088690.1
3	2058220.4	6088888.1
4	2057781.1	6088956.2
5	2057781.8	6088905.8
6	2057401.0	6088901.2
7	2057407.2	6088394.3
8	2057790.8	6088166.8
9	2057791.9	6088076.5
10	2058283.4	6087954.3

LEGEND

- EXISTING GRADE CONTOUR
- FINAL GRADE CONTOUR
- 9.5 FINAL GRADE SPOT ELEVATION
- PROPOSED FENCE
- PROPOSED STORM DRAIN
- PROPOSED CULVERT
- PROPOSED STORM CATCH BASIN
- PROPOSED ENDWALL
- PROPOSED DRAINAGE CHANNEL
- DIRECTION OF FLOW

NOTES:

1. COORDINATES LISTED ARE STATE PLANE NAD83, CALIFORNIA ZONE 3.
2. DRAIN INSERTS SHALL BE USED FOR ALL CATH BASINS AND SHALL BE ACCORDING TO ULTRA DRAIN GUARD, OIL AND SEDIMENT MODEL, PART # 9225, OR EQUAL.

REFERENCES:

DC-G1-0001	GENERAL ARRANGEMENT SITE PLAN
DE-C1-0002	SITE SURFACING PLAN
DE-C1-0004	GRADING DETAILS
DE-C2-0002	DRAINAGE STRUCTURES
DE-C2-0001	CATCH BASIN AND PIPE SCHEDULE

60 0 60 120 180
SCALE IN FEET

REV	DATE	DESCRIPTION	DRAWN	CHECKED	ENGINEER	PROJECT ENGINEER	PROJECT MANAGER
A	11- -06	ISSUED FOR CLIENT REVIEW	GU	AM	DS	PK	DE

DRAWN BY GJU DATE 11- -06
CHECKED BY ALM DATE 11- -06
ENGINEER D SHETH DATE 11- -06
PROJECT ENGINEER P KHAN DATE 11- -06
PROJECT MANAGER DR ERALI DATE 11- -06

PROFESSIONAL ENGINEER STAMP

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF CALIFORNIA.

PRINT NAME PRADIP KHAN
SIGNATURE
DATE
LICENSE # 54262

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
PE#
LIC. NO.:
STATE:
DATE:

WorleyParsons

CALPINE

RUSSELL CITY ENERGY CENTER
HAYWARD, CALIFORNIA

CIVIL
GEN-GENERAL
FINAL SITE GRADING
AND DRAINAGE PLAN

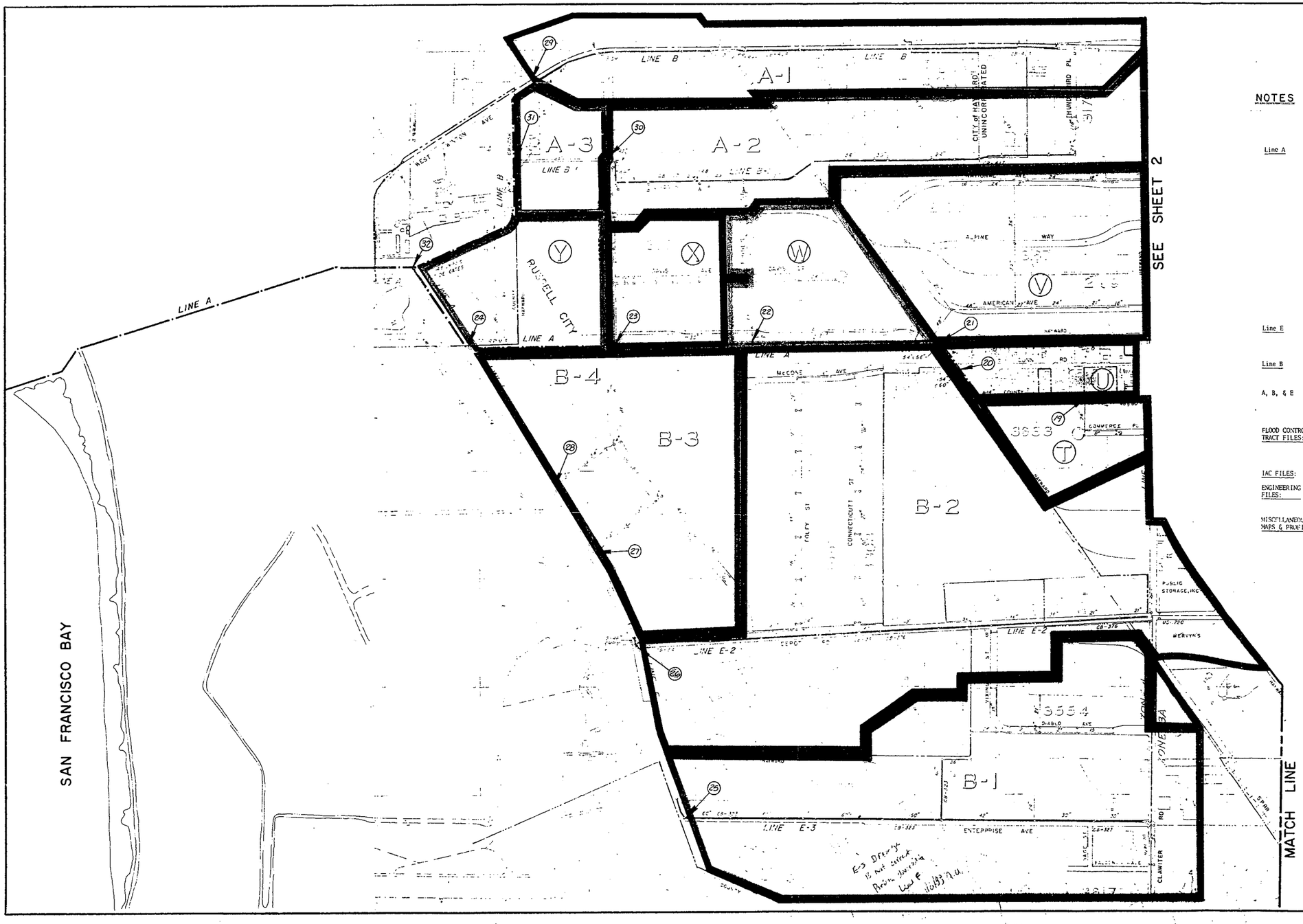
SCALE 1"=60'

DWG. NO. RC-GEN-DE-C1-0001 SHEET NO. 01 REVISION A

RCEC-024-DC-0001
A-1

FILE NAME:
PATH:
SERVER:
DWG-FILE: rc-gen-de-c1-0001.dgn
DWG-DATE: 01-Nov-06 10:38

ATTACHMENT B



NOTES

	Pt. of Conc.	C-Factor	Acres	Acres
Line A	1	.6	32.9	32.9
	2	.6	19.5	53.4
	3	.6	10.2	53.6
	4	.8	22.0	75.6
	5	.6	15.0	90.6
	6	.4	19.9	110.5
	7	.4	32.3	142.8
	8	.8	23.4	166.2
	9	.8	15.8	182.0
	10	.6	182.3	364.4
	11	.6	71.1	435.5
	12	.4	8.7	444.2
	13	.6	112.2	556.4
	14	.6	8.1	564.5
	15	.6	11.5	576.0
	16	.6	82.9	658.9
	17	.7	20.6	679.5
	18	.6	108.7	788.2
	19	.7	24.7	812.9
	20	.7	20.9	833.8
	21	.7	93.8	927.6
	22	.7	43.6	971.2
	23	.7	31.3	1002.5
	24	.7	40.3	1042.8
Line E	25	.6	196.3	196.3
	26	.6	285.5	481.8
	27	.6	77.3	559.1
	28	.6	25.0	584.1
Line B	29	.6	94.4	94.4
	30	.6	99.3	193.7
	31	.6	21.1	214.8
A, B, & E	32			1841.7

REFRENCES

	LINE A	LINE B	LINE E
FLOOD CONTROL TRACT FILES:	1407 2109 3110 3633 3640	3414	3308 3633
IAC FILES:	Chabot College		
ENGINEERING FILES:	E4-A.2 E4-A.3 E4-C.2	E4-B.2	
MISCELLANEOUS MAPS & PROFILES:	MB 250 MC 211, 231 MC 130 MC 80 P 382, 447, 503, 620, 507	P 462, 472	MC 211, 231 P 411 MC 1611

ALAMEDA COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

ZONE NO. 4 PROJECT

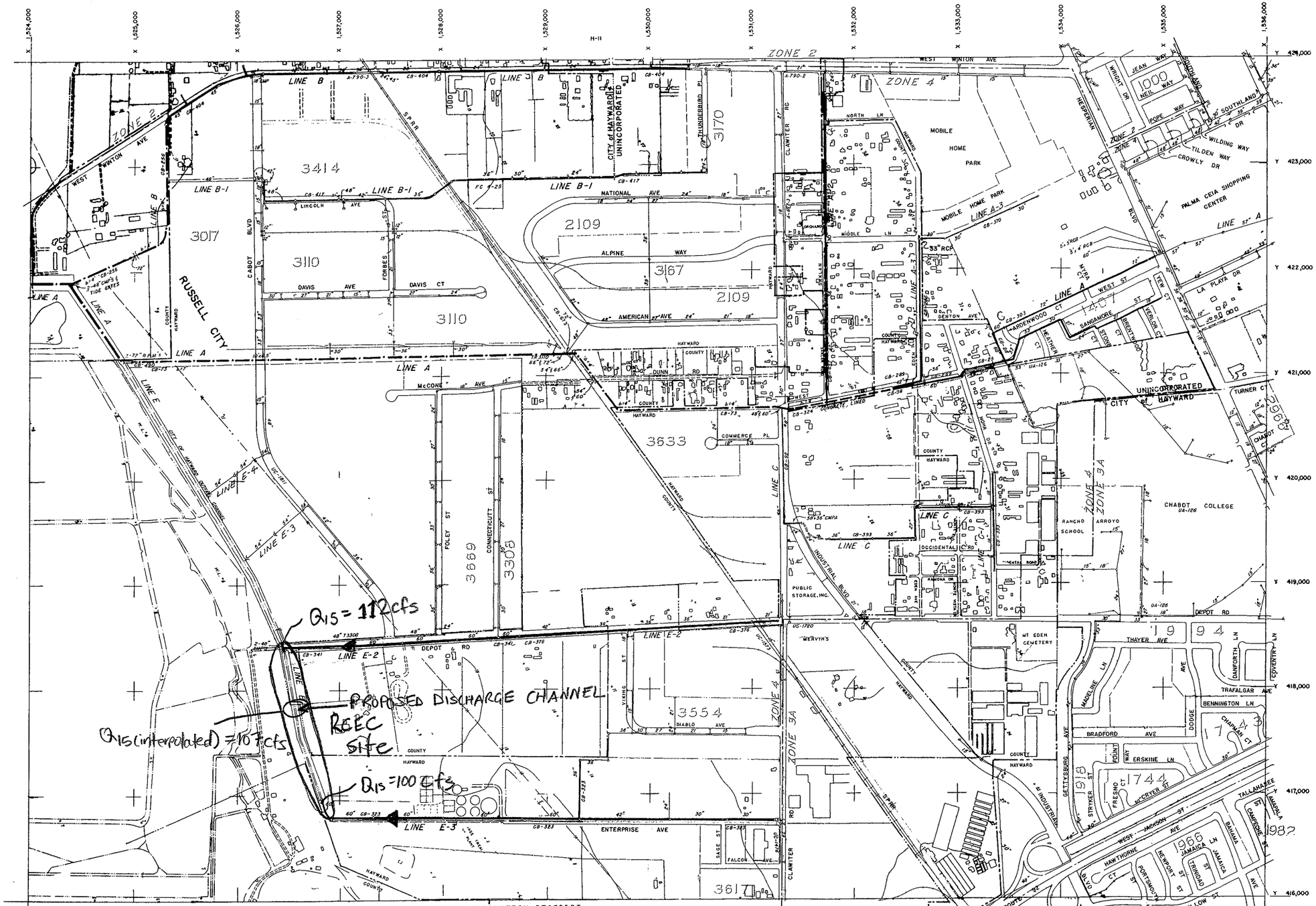
LINES A, B & E

DRAINAGE AREA MAP

DRAWN	DESIGNED	DATE	MARCH 1984
CHECKED		SCALE	1" = 400'
APVL. REC.		FILE NO.	MB-263
APPROVED		SHEET NO.	1 OF 2

RCEC-024-DC-0001

B-1



ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

This map has been prepared to show the general locations of various storm drainage and flood control facilities. The information shown on this drawing is compiled from limited data and this District assumes no responsibility or liability for the accuracy or completeness of the information shown hereon nor does this District assume responsibility for any use which is made of this map.

DISTRICT
- Conduit
- Open Conc Chan
- Open Earth Chan

OTHERS
- Conduit
- Open Conc Chan
- Open Earth Chan

RCEC-024-DC-0007
B-2

Dipti,

Thank you for your follow-up e-mail and thank you for your patience as well.

After our review of the contents of the Engineering file folder **FC4-18,** we did not find any drainage information that will be particularly useful and specifically relevant to your project site. Upon further research however, we would like to inform you that an Alameda County Flood Control District drainage area map drawing **MB-263** dated March 1984, were located that showed an adjusted runoff coefficient C-factor of 0.60 assigned to your project site.

In addition to the District **P-436** drawing dated January 1971, that was previously transmitted to you, which shows a 15-year design discharge of **112 CFS** for Line E-2 at the end of Depot Road, we would also like to inform you that as per District drawing **P-411** dated May 1969, a 15-year design discharge of **100 CFS** for Line E-3 at the end of Enterprise Avenue was calculated.

We trust that the above-mentioned hydrology information that were provided will be helpful in the storm drainage analysis and design of your project site. Please be reminded that if development associated with a higher runoff coefficient is to be proposed, the augmented storm runoff will have to be mitigated .

Should you have any questions or require any further clarification, you can either call or e-mail me.

Fernando B. Gonzales, P.E.
Associate Civil Engineer
Development Services Department
Alameda County Public Works Agency
Tel No. 510.670.5267
Fax No. 510.670.5269

From: Sheth, Dipti (Reading) [mailto:Dipti.Sheth@worleyparsons.com]
Sent: Wednesday, October 04, 2006 2:45 PM
To: Gonzales, Fernando
Subject: RE: Stormwater Management Information

Fernando,

Have you had any luck locating the FC4-18 record? Thanks.

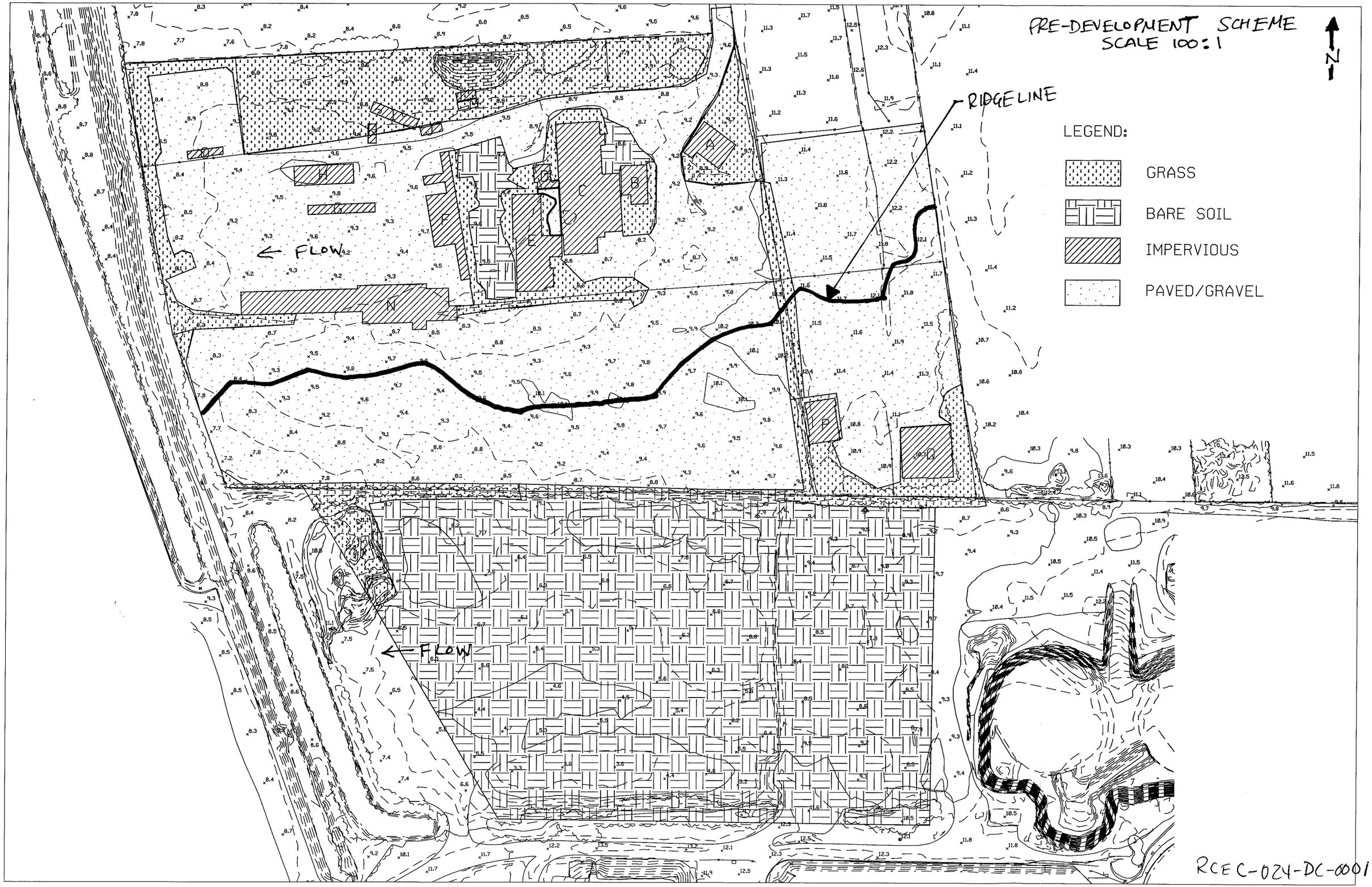
Dipti J. Sheth, E.I.T
Civil/Geotechnical Engineering
2675 Morgantown Road
Reading, PA 19607
Phone: 610-855-2781
Fax: 610-855-2727
Dipti.Sheth@WorleyParsons.com

From: Gonzales, Fernando [mailto:fernando@acpwa.org]
Sent: Monday, September 25, 2006 8:49 PM
To: Sheth, Dipti (Reading)
Cc: Aguiar, Gloria
Subject: RE: Stormwater Management Information

RCEC-024-DC-0001
B-3

Hi Dipti,

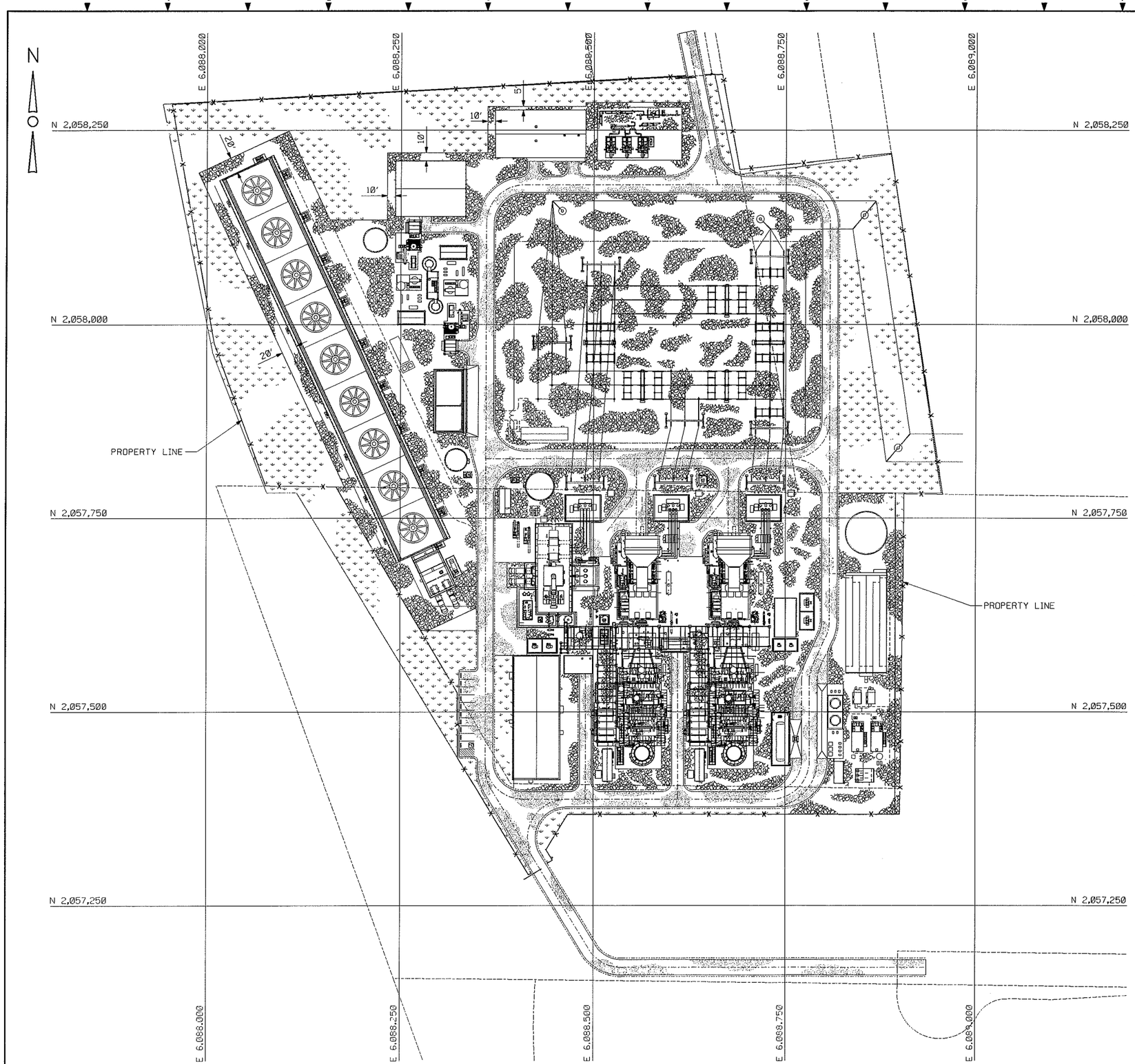
Enclosed please find for your information and reference, copy of the storm drainage **Base Map H-12** that shows the sizes and



RCEC-024-DC-0001

B-4

ATTACHMENT C



LEGEND

- AGGREGATE SURFACING
- CONCRETE SLAB
- BITUMINOUS PAVING
- GRASS

NOTES:

1. SURFACING IS BASED ON REVISION E OF THE GENERAL ARRANGEMENT DRAWING RC-GEN-DC-G1-0001.

REFERENCES:

DC-G1-0001	GENERAL ARRANGEMENT - SITE PLAN
DE-C1-0005	ROADWAY AND FENCE LOCATION - PLAN

60 0 60 120 180
SCALE IN FEET

REV	DATE	DESCRIPTION	DRAWN	CHECKED	ENGINEER	PROJECT ENGINEER	PROJECT MANAGER
A	11- -06	ISSUED FOR CLIENT REVIEW	GU	AM	DS	PK	DE

DRAWN BY GJU	DATE 11- -06
CHECKED BY ALM	DATE 11- -06
ENGINEER D SHETH	DATE 11- -06
PROJECT ENGINEER P KHAN	DATE 11- -06
PROJECT MANAGER DR ERALI	DATE 11- -06

PROFESSIONAL ENGINEER STAMP

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PRINT NAME PRADIP KHAN
SIGNATURE
DATE
LICENSE # 54262

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
PE: STATE:
LIC. NO.: DATE:

WorleyParsons

CALPINE

RUSSELL CITY ENERGY CENTER
HAYWARD, CALIFORNIA

CIVIL
GEN-GENERAL
SITE SURFACING PLAN

SCALE 1"=60'

DWG. NO.	SHEET NO.	REVISION
RC-GEN-DE-C1-0002	01	A

FILE NAME:
PATH:
SERVER:

DWG-FILE: rc-gen-de-c1-0002.dgn
DWG-DATE: 01-Nov-06 07:10

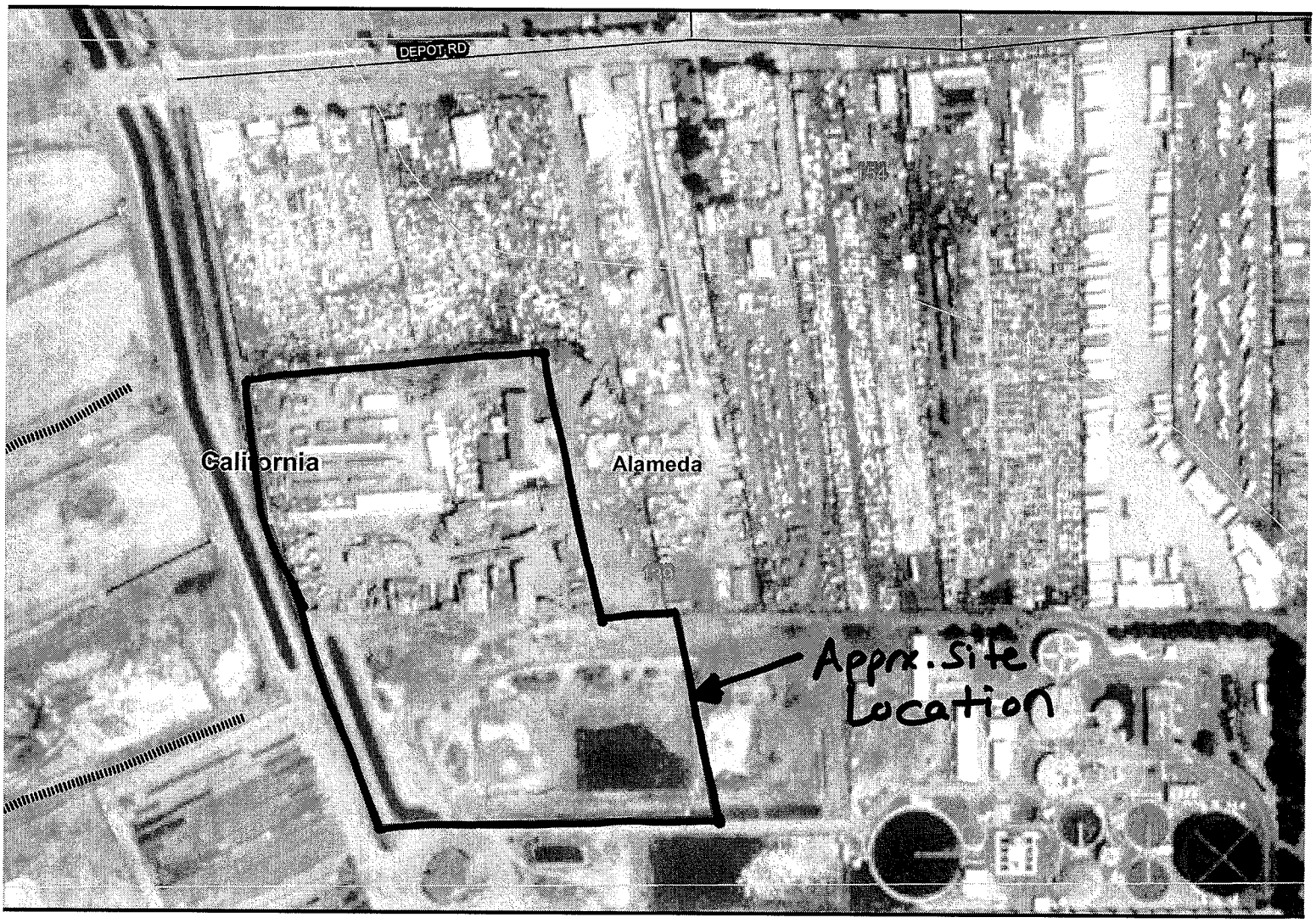
RCEC-024-DC-0001
C-1

VHL: Thu Jun 09 14:23:05 2005

ATTACHMENT D

SOIL SURVEY OF ALAMEDA COUNTY, CALIFORNIA, WESTERN PART

close-up russel city



Meters
0 40 80 160

Feet
0 100 200 400 600 800

Resources
tion Service

Web Soil Survey 1.1
National Cooperative Soil Survey

RCEC-024-DC-0001
D-1

SOIL SURVEY OF ALAMEDA COUNTY, CALIFORNIA, WESTERN PART

close-up russel city

MAP LEGEND

- Soil Map Units
- Cities
- Detailed Counties
- Detailed States
- Interstate Highways
- Roads
- Rails
- Water
- Hydrography
- Oceans
- Escarpment, bedrock
- Escarpment, non-bedrock
- Gulley
- Levee
- Slope
- Blowout
- Borrow Pit
- Clay Spot
- Depression, closed
- Eroded Spot
- Gravel Pit
- Gravelly Spot
- Gulley
- Lava Flow
- Landfill
- Marsh or Swamp
- Miscellaneous Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Slide or Slip
- Sinkhole
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Perennial Water
- Wet Spot

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 10

Soil Survey Area: Alameda County, California, Western Part
Spatial Version of Data: 1
Soil Map Compilation Scale: 1:24000

Map comprised of aerial images photographed on these dates:
7/10/1993

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

RCEC-024-DC-0001
D-2

Map Unit Legend Summary

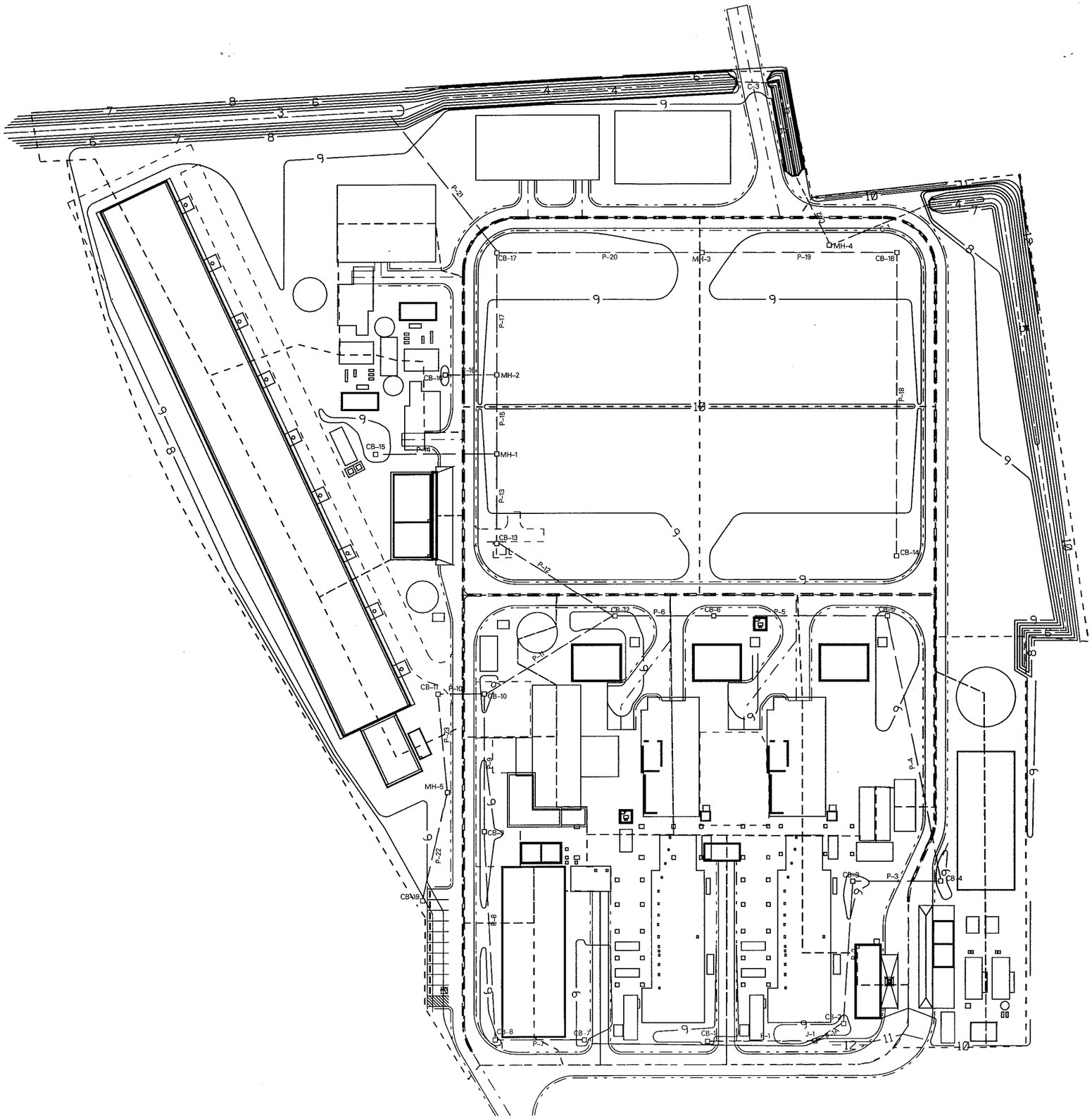
Alameda County, California, Western Part

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
139	Reyes clay, drained	74.0	76.1
154	Willows clay, drained	23.2	23.9

RCEC-024-DC-0001
D-3

ATTACHMENT E

TRIBUTARY AREAS
SCALE 100:1



RCEC-024-DC-0001
E-1

ATTACHMENT F

TABLE 7–10 Runoff Coefficients for the Rational Method

Description of Area	Range of Runoff Coefficients	Recommenc Value*
Business		
Downtown	0.70–0.95	0.85
Neighborhood	0.50–0.70	0.60
Residential		
Single-family	0.30–0.50	0.40
Multiunits, detached	0.40–0.60	0.50
Multiunits, attached	0.60–0.75	0.70
Residential (suburban)	0.25–0.40	0.35
Apartment	0.50–0.70	0.60
Industrial		
Light	0.50–0.80	0.65
Heavy	0.60–0.90	0.75
Parks, cemeteries	0.10–0.25	0.20
Playgrounds	0.20–0.35	0.30
Railroad yard	0.20–0.35	0.30
Unimproved	0.10–0.30	0.20

It is often desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. This procedure often is applied to typical "sample" block as a guide to selection of reasonable values of the coefficient for an entire area. Coefficients with respect to surface type currently in use are listed below.

Character of Surface	Range of Runoff Coefficients	Recommended Value*
Pavement		
Asphaltic and Concrete	0.70–0.95	0.85
Brick	0.75–0.85	0.80
Roofs	0.75–0.95	0.85
Lawns, sandy soil		
Flat, 2%	0.05–0.10	0.08
Average, 2 to 7%	0.10–0.15	0.13
Steep, 7%	0.15–0.20	0.18
Lawns, heavy soil		
Flat, 2%	0.13–0.17	0.15
Average, 2 to 7%	0.18–0.22	0.20
Steep, 7%	0.25–0.35	0.30

The coefficients in these two tabulations are applicable for storms of 5- to 10-year frequencies. Less frequent, higher intensity storms will require the use of higher coefficients because infiltration and other losses have a proportionally smaller effect on runoff. The coefficients are based on the assumption that the design storm does not occur when the ground surface is frozen.

*Recommended value not included in original source.

Source: Design and Construction of Sanitary and Storm Sewers, American Society of Civil Engineers, New York, p. 332, 1969.

RCEC-024-DC-0001
F-1

Project Russell City Energy Center
Job No. 53794801
Design Storm Frequency: 5-yr, 15-yr, and 100-yr

Date 10/17/2006
Computed DS
Reviewed KG

Runoff Coefficient C Calculation

Rational Runoff Coefficient (C) per the site cover condition:

Grass:	0.20
Gravel:	0.65
Impervious (Pavement, Roofs)	0.95

Sub-drainage No.	Areas							Composite C
	Total	Subtracted	Drainage		Impervious	Gravel	Grass	
	(SF)	(SF)	(SF)	(AC)	(SF)	(SF)	(SF)	
CB-1	26,010	0	26,010	0.597	15,233	10,778	0	0.83
CB-2	23,751	0	23,751	0.545	13,140	10,611	0	0.82
CB-3	14,679	0	14,679	0.337	8,708	5,972	0	0.83
CB-4	21,136	0	21,136	0.485	8,962	12,174	0	0.78
CB-5	26,883	0	26,883	0.617	10,599	16,285	0	0.77
CB-6	27,680	0	27,680	0.635	20,671	7,009	0	0.87
CB-7	10,417	0	10,417	0.239	6,680	3,737	0	0.84
CB-8	9,061	0	9,061	0.208	5,852	605	2,604	0.71
CB-9	16,794	0	16,794	0.386	13,094	3,700	0	0.88
CB-10	10,276	0	10,276	0.236	7,810	2,466	0	0.88
CB-11	18,488	0	18,488	0.424	10,150	8,338	0	0.81
CB-12	25,236	0	25,236	0.579	13,769	11,467	0	0.81
CB-13	38,916	0	38,916	0.893	5,448	33,468	0	0.69
CB-14	38,916	0	38,916	0.893	4,433	34,483	0	0.68
CB-15	35,696	0	35,696	0.819	18,857	16,839	0	0.81
CB-16	16,198	0	16,198	0.372	10,587	5,610	0	0.85
CB-17	38,916	0	38,916	0.893	4,433	34,483	0	0.68
CB-18	38,916	0	38,916	0.893	4,433	34,483	0	0.68
CB-19	68,609	0	68,609	1.575	27,209	23,584	17,816	0.65
SUM (A)			506,579	11.63	210,066	276,093	20,420	

RCEC-024-DC-0001
F-2

ATTACHMENT G

Project	Russell City Energy Center	Date	10/17/2006
Job No.	53794801	Computed	DS
Design Storm Frequency: 5, 15, 100-yr.		Reviewed	KG

Peak Flow Calculation by Rational Method

5 Minute Duration Rainfall Intensity per Storm Frequency:

Frequency	5-yr	15-yr	100-yr
Intensity	1.96	2.55	3.40

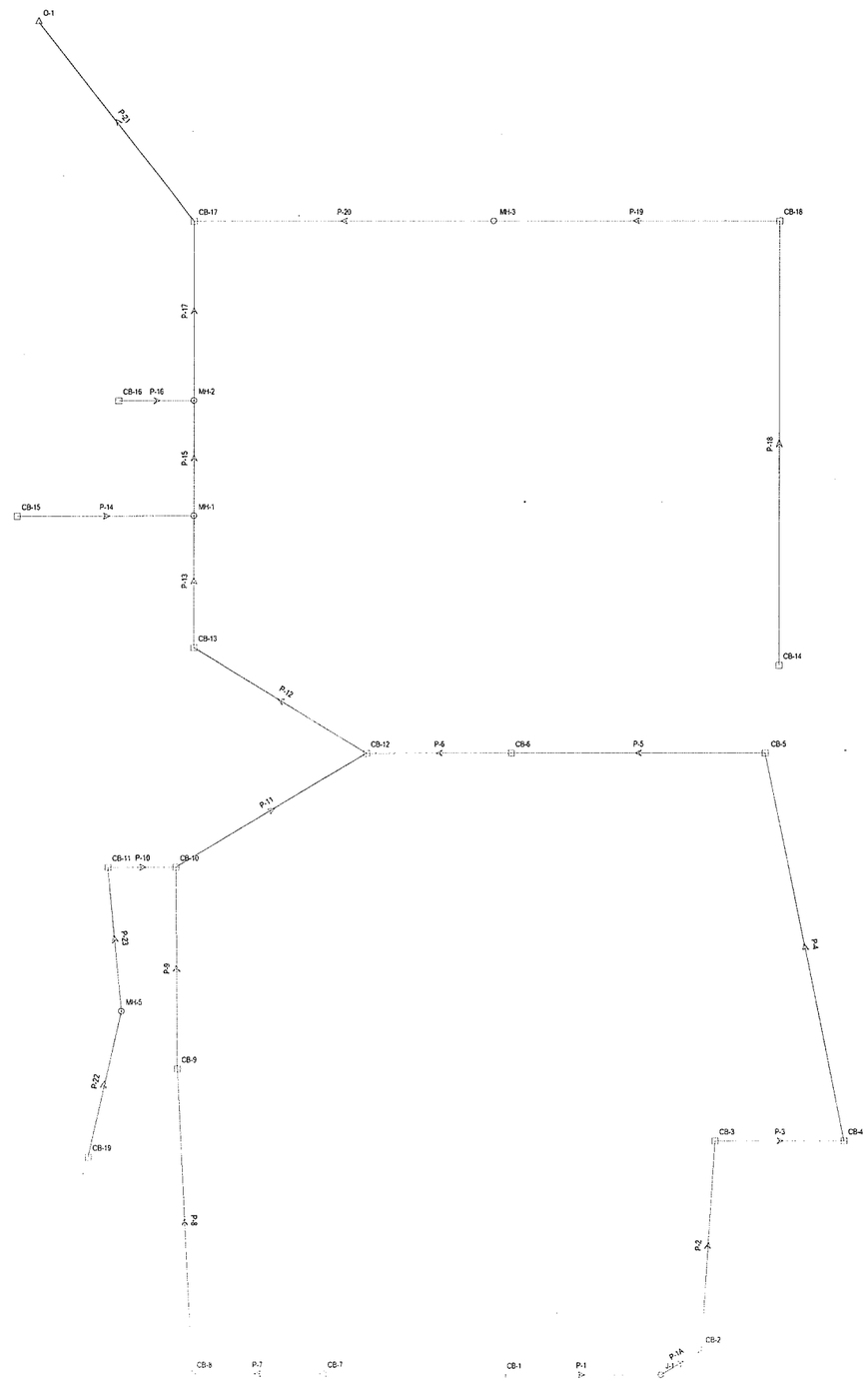
Sub-Area No.	Drainage Area	Composite C	Peak Flow			
			5-yr	15-yr	100-yr	
	(AC)		(CFS)	(CFS)	(CFS)	
CB-1	0.597	0.83	0.96	1.26	1.68	
CB-2	0.545	0.82	0.87	1.13	1.51	
CB-3	0.337	0.83	0.55	0.71	0.95	
CB-4	0.485	0.78	0.74	0.96	1.28	
CB-5	0.617	0.77	0.93	1.21	1.61	
CB-6	0.635	0.87	1.09	1.42	1.89	
CB-7	0.239	0.84	0.39	0.51	0.68	
CB-8	0.208	0.71	0.29	0.38	0.51	
CB-9	0.386	0.88	0.67	0.87	1.16	
CB-10	0.236	0.88	0.40	0.53	0.70	
CB-11	0.424	0.81	0.68	0.88	1.18	
CB-12	0.579	0.81	0.92	1.20	1.60	
CB-13	0.893	0.69	1.21	1.58	2.10	
CB-14	0.893	0.68	1.19	1.56	2.08	
CB-15	0.819	0.81	1.30	1.69	2.25	
CB-16	0.372	0.85	0.62	0.80	1.07	
CB-17	0.893	0.68	1.19	1.56	2.08	
CB-18	0.893	0.68	1.19	1.56	2.08	
*CB-19	1.575	0.65	1.40	1.75	2.44	Tc = 11.35 min

Note:
1) For CB-19, the minimum time of concentration is 11.35 minutes.

RCEC-024-DC-0001
9-1

ATTACHMENT H

Scenario: Base



RCEC-024-DC-0001
H-1

Title: Russell City Energy Center
r:\...\stormcad\stormsystem-15.stm
11/09/06 02:13:10 PM

© Bentley Systems, Inc. Haestad Methods Solution Center Watertown, CT 06795 USA +1-203-755-1666

Project Engineer: Dipti Sheth
StormCAD v5.6 [05.06.012.00]

Rainfall Table

Return Periods			
Durations	5 year	15 year	100 year
5 min	1.96	2.55	3.40
10 min	1.39	1.96	2.55
30 min	0.80	1.05	1.45
60 min	0.56	0.75	1.02

Rainfall Intensities are in (in/hr)

RCEC-024-DC-0001
H-2

Calculation Results Summary

15-YR

==========
Scenario: Base

>>>> Info: Subsurface Network Rooted by: O-1
>>>> Info: Subsurface Analysis iterations: 2
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
CB-17	Generic Inlet	Generic Default 100%	1.56	0.00	100.0	0.00	0.00
CB-18	Generic Inlet	Generic Default 100%	1.56	0.00	100.0	0.00	0.00
CB-14	Generic Inlet	Generic Default 100%	1.56	0.00	100.0	0.00	0.00
CB-13	Generic Inlet	Generic Default 100%	1.58	0.00	100.0	0.00	0.00
CB-2	Generic Inlet	Generic Default 100%	1.15	0.00	100.0	0.00	0.00
CB-3	Generic Inlet	Generic Default 100%	0.72	0.00	100.0	0.00	0.00
CB-4	Generic Inlet	Generic Default 100%	0.97	0.00	100.0	0.00	0.00
CB-5	Generic Inlet	Generic Default 100%	1.22	0.00	100.0	0.00	0.00
CB-6	Generic Inlet	Generic Default 100%	1.42	0.00	100.0	0.00	0.00
CB-12	Generic Inlet	Generic Default 100%	1.21	0.00	100.0	0.00	0.00
CB-1	Generic Inlet	Generic Default 100%	1.27	0.00	100.0	0.00	0.00
CB-10	Generic Inlet	Generic Default 100%	0.53	0.00	100.0	0.00	0.00
CB-9	Generic Inlet	Generic Default 100%	0.87	0.00	100.0	0.00	0.00
CB-8	Generic Inlet	Generic Default 100%	0.38	0.00	100.0	0.00	0.00
CB-11	Generic Inlet	Generic Default 100%	0.88	0.00	100.0	0.00	0.00
CB-7	Generic Inlet	Generic Default 100%	0.52	0.00	100.0	0.00	0.00
CB-16	Generic Inlet	Generic Default 100%	0.81	0.00	100.0	0.00	0.00
CB-15	Generic Inlet	Generic Default 100%	1.71	0.00	100.0	0.00	0.00
CB-19	Generic Inlet	Generic Default 100%	1.95	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-21	1	36 inch	Circular	162.00	15.17	4.39	4.90	4.70
P-20	1	24 inch	Circular	194.00	2.70	2.89	5.74	5.25
P-17	1	36 inch	Circular	114.00	12.16	4.25	5.11	5.04
P-19	1	24 inch	Circular	184.00	2.85	2.93	6.13	5.81
P-16	1	12 inch	Circular	49.00	0.81	2.16	6.47	6.28
P-15	1	30 inch	Circular	74.00	11.70	4.21	5.28	5.20
P-18	1	15 inch	Circular	284.00	1.56	2.55	6.62	6.19
P-14	1	15 inch	Circular	114.00	1.71	2.60	6.65	6.29
P-13	1	30 inch	Circular	84.00	10.62	4.12	5.45	5.39
P-12	1	30 inch	Circular	131.00	9.68	3.50	5.64	5.54
P-11	1	18 inch	Circular	143.00	4.14	4.29	5.86	5.71
P-6	1	24 inch	Circular	94.00	5.38	4.03	5.75	5.71
P-9	1	15 inch	Circular	129.00	1.63	3.33	5.98	5.92
P-10	1	18 inch	Circular	44.00	2.52	3.01	5.94	5.92
P-5	1	24 inch	Circular	164.00	4.45	3.31	5.88	5.80
P-8	1	15 inch	Circular	195.00	0.87	2.80	6.54	6.04
P-23	1	18 inch	Circular	93.00	1.92	2.13	5.99	5.96
P-4	1	18 inch	Circular	254.00	3.69	3.14	6.28	5.94
P-7	1	12 inch	Circular	84.00	0.52	2.46	6.81	6.60

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H-3

Calculation Results Summary

P-22	1	18 inch	Circular	96.00	1.95	2.11	6.04	6.01
P-3	1	18 inch	Circular	84.00	2.89	2.97	6.42	6.35
P-2	1	18 inch	Circular	133.00	2.32	2.81	6.56	6.47
P-1A	1	15 inch	Circular	31.00	1.23	2.40	6.61	6.60
P-1	1	12 inch	Circular	103.00	1.27	2.40	6.74	6.63

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	14.92	9.00	4.70	4.70
CB-17	15.17	8.50	5.04	4.90
MH-3	2.70	9.00	5.81	5.74
MH-2	12.16	9.70	5.20	5.11
CB-18	2.85	8.50	6.19	6.13
CB-16	0.81	8.50	6.51	6.47
MH-1	11.70	9.60	5.39	5.28
CB-14	1.56	8.50	6.67	6.62
CB-15	1.71	8.50	6.71	6.65
CB-13	10.62	8.50	5.54	5.45
CB-12	9.68	8.50	5.71	5.64
CB-10	4.14	8.50	5.92	5.86
CB-6	5.38	8.50	5.80	5.75
CB-9	1.63	8.50	6.04	5.98
CB-11	2.52	8.50	5.96	5.94
CB-5	4.45	8.50	5.94	5.88
CB-8	0.87	8.50	6.60	6.54
MH-5	1.92	9.00	6.01	5.99
CB-4	3.69	8.50	6.35	6.28
CB-7	0.52	8.60	6.86	6.81
CB-19	1.95	7.00	6.06	6.04
CB-3	2.89	8.50	6.47	6.42
CB-2	2.32	8.50	6.60	6.56
J-1	1.23	8.90	6.63	6.61
CB-1	1.27	8.50	6.77	6.74

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H-4

Calculation Results Summary

100-YR

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Scenario: Base

>>>> Info: Subsurface Network Rooted by: O-1
>>>> Info: Subsurface Analysis iterations: 3
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
CB-17	Generic Inlet	Generic Default 100%	2.08	0.00	100.0	0.00	0.00
CB-18	Generic Inlet	Generic Default 100%	2.08	0.00	100.0	0.00	0.00
CB-14	Generic Inlet	Generic Default 100%	2.08	0.00	100.0	0.00	0.00
CB-13	Generic Inlet	Generic Default 100%	2.11	0.00	100.0	0.00	0.00
CB-2	Generic Inlet	Generic Default 100%	1.53	0.00	100.0	0.00	0.00
CB-3	Generic Inlet	Generic Default 100%	0.96	0.00	100.0	0.00	0.00
CB-4	Generic Inlet	Generic Default 100%	1.30	0.00	100.0	0.00	0.00
CB-5	Generic Inlet	Generic Default 100%	1.63	0.00	100.0	0.00	0.00
CB-6	Generic Inlet	Generic Default 100%	1.89	0.00	100.0	0.00	0.00
CB-12	Generic Inlet	Generic Default 100%	1.61	0.00	100.0	0.00	0.00
CB-1	Generic Inlet	Generic Default 100%	1.70	0.00	100.0	0.00	0.00
CB-10	Generic Inlet	Generic Default 100%	0.71	0.00	100.0	0.00	0.00
CB-9	Generic Inlet	Generic Default 100%	1.16	0.00	100.0	0.00	0.00
CB-8	Generic Inlet	Generic Default 100%	0.51	0.00	100.0	0.00	0.00
CB-11	Generic Inlet	Generic Default 100%	1.18	0.00	100.0	0.00	0.00
CB-7	Generic Inlet	Generic Default 100%	0.69	0.00	100.0	0.00	0.00
CB-16	Generic Inlet	Generic Default 100%	1.08	0.00	100.0	0.00	0.00
CB-15	Generic Inlet	Generic Default 100%	2.27	0.00	100.0	0.00	0.00
CB-19	Generic Inlet	Generic Default 100%	2.55	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-21	1	36 inch	Circular	162.00	19.45	4.67	5.11	4.85
P-20	1	24 inch	Circular	194.00	3.60	3.13	5.85	5.34
P-17	1	36 inch	Circular	114.00	15.58	4.53	5.35	5.28
P-19	1	24 inch	Circular	184.00	3.80	3.17	6.25	5.93
P-16	1	12 inch	Circular	49.00	1.08	2.32	6.55	6.34
P-15	1	30 inch	Circular	74.00	14.97	4.45	5.55	5.46
P-18	1	15 inch	Circular	284.00	2.08	2.73	6.75	6.32
P-14	1	15 inch	Circular	114.00	2.27	2.78	6.77	6.37
P-13	1	30 inch	Circular	84.00	13.58	4.36	5.75	5.67
P-12	1	30 inch	Circular	131.00	12.36	3.70	5.95	5.84
P-11	1	18 inch	Circular	143.00	5.32	3.01	6.34	6.03
P-6	1	24 inch	Circular	94.00	7.10	4.32	6.08	6.03
P-9	1	15 inch	Circular	129.00	2.17	3.59	6.53	6.41
P-10	1	18 inch	Circular	44.00	3.24	1.84	6.45	6.41
P-5	1	24 inch	Circular	164.00	5.88	3.55	6.22	6.14
P-8	1	15 inch	Circular	195.00	1.16	3.04	6.62	6.56
P-23	1	18 inch	Circular	93.00	2.49	1.41	6.52	6.47
P-4	1	18 inch	Circular	254.00	4.89	3.28	6.68	6.27
P-7	1	12 inch	Circular	84.00	0.69	2.67	6.86	6.69

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H-5

Calculation Results Summary

P-22	1	18 inch	Circular	96.00	2.55	1.45	6.58	6.53
P-3	1	18 inch	Circular	84.00	3.83	3.16	6.82	6.74
P-2	1	18 inch	Circular	133.00	3.07	3.01	6.94	6.86
P-1A	1	15 inch	Circular	31.00	1.63	2.58	6.98	6.97
P-1	1	12 inch	Circular	103.00	1.70	2.16	7.20	7.00

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	19.17	9.00	4.85	4.85
CB-17	19.45	8.50	5.28	5.11
MH-3	3.60	9.00	5.93	5.85
MH-2	15.58	9.70	5.46	5.35
CB-18	3.80	8.50	6.32	6.25
CB-16	1.08	8.50	6.60	6.55
MH-1	14.97	9.60	5.67	5.55
CB-14	2.08	8.50	6.81	6.75
CB-15	2.27	8.50	6.84	6.77
CB-13	13.58	8.50	5.84	5.75
CB-12	12.36	8.50	6.03	5.95
CB-10	5.32	8.50	6.41	6.34
CB-6	7.10	8.50	6.14	6.08
CB-9	2.17	8.50	6.56	6.53
CB-11	3.24	8.50	6.47	6.45
CB-5	5.88	8.50	6.27	6.22
CB-8	1.16	8.50	6.69	6.62
MH-5	2.49	9.00	6.53	6.52
CB-4	4.89	8.50	6.74	6.68
CB-7	0.69	8.60	6.92	6.86
CB-19	2.55	7.00	6.60	6.58
CB-3	3.83	8.50	6.86	6.82
CB-2	3.07	8.50	6.97	6.94
J-1	1.63	8.90	7.00	6.98
CB-1	1.70	8.50	7.23	7.20

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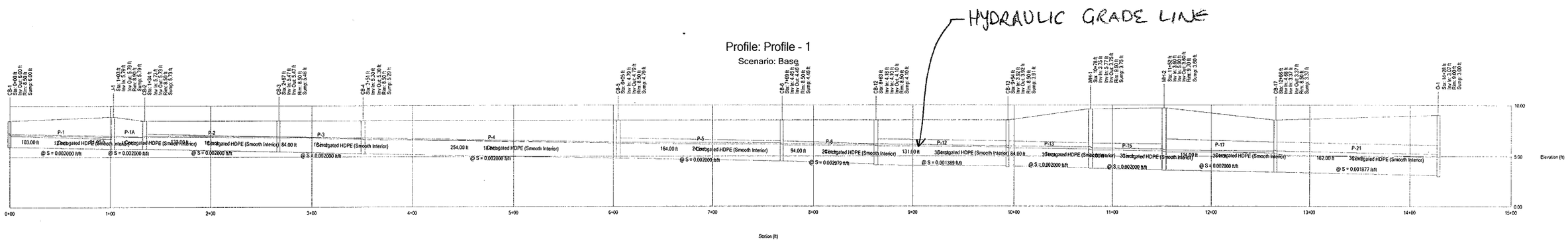
H-6

Profile
Scenario: Base

100-YR

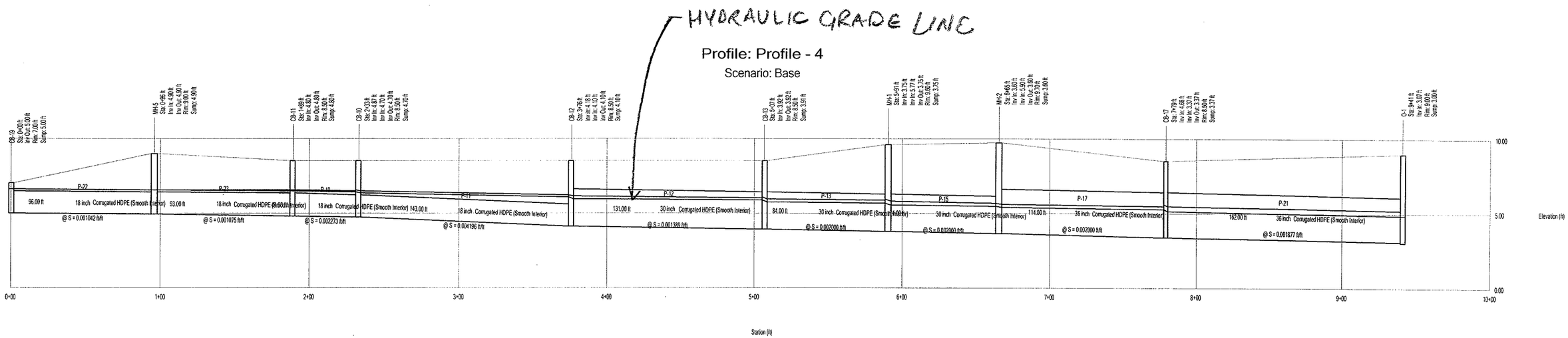
CB-1 TO O-1



RCEC-024-DC-0001
H-7

Profile
Scenario: Base

100-YR
CB-19 TO O-1



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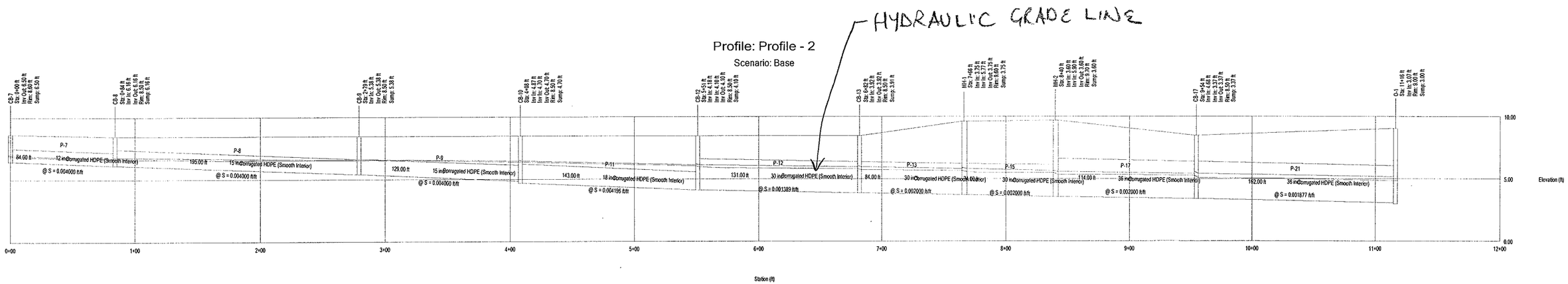
H-9

Profile
Scenario: Base

100-YR

CB-7 TO O-1



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H-8

Worksheet for Hayward Outfall Channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050		→ assumed Rough channel w/ grass
Channel Slope	0.01000	ft/ft	→ see sketch
Left Side Slope	3.00	ft/ft (H:V)	Scaled off topography See sketch
Right Side Slope	3.00	ft/ft (H:V)	
Bottom Width	5.00	ft	
Discharge	107.00	ft³/s	→ 15-YR Flow (interpolated)

Results

Normal Depth	2.35	ft
Flow Area	28.39	ft²
Wetted Perimeter	19.89	ft
Top Width	19.12	ft
Critical Depth	1.73	ft
Critical Slope	0.03652	ft/ft
Velocity	3.77	ft/s
Velocity Head	0.22	ft
Specific Energy	2.57	ft
Froude Number	0.55	
Flow Type	Subcritical	

Used to calculate tailwater for storm system outlet

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.35	ft
Critical Depth	1.73	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.03652	ft/ft

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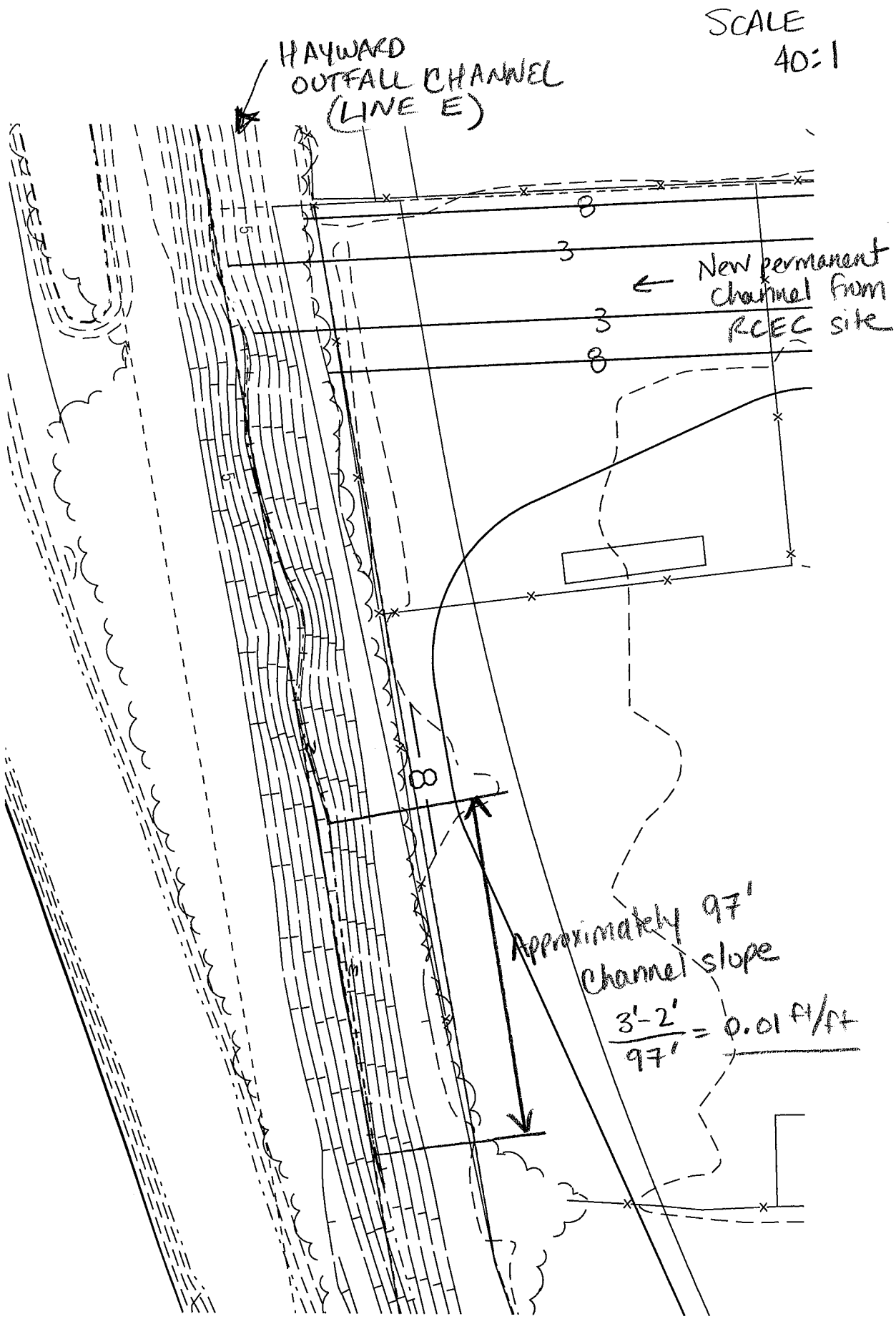
H-10



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H-11

Channel A

Worksheet for 15-yr - 0.0025 ft/ft (Grass 0.05) - GVF

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	32.67	ft^3/s ← 15-YR DISCHARGE

Results

Normal Depth	1.45	ft
Flow Area	20.81	ft^2
Wetted Perimeter	19.17	ft
Top Width	18.70	ft
Critical Depth	0.65	ft
Critical Slope	0.04519	ft/ft
Velocity	1.57	ft/s
Velocity Head	0.04	ft
Specific Energy	1.49	ft
Froude Number	0.26	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	2.35	ft ← DEPTH TAKEN FROM HAYWARD OUTFALL CHANNEL
Length	377.00	ft
Number Of Steps	10	

GVF Output Data

Upstream Depth	1.70	ft ← Calculated upstream depth used in Storm system calculation.
Profile Description	M1	
Profile Headloss	0.29	ft
Downstream Velocity	0.82	ft/s
Upstream Velocity	1.27	ft/s
Normal Depth	1.45	ft
Critical Depth	0.65	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.04519	ft/ft

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H-12

CHANNEL A

Worksheet for 100-yr - 0.0025 ft/ft (Grass 0.05) - GVF

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	43.17	ft^3/s ← 100-YR Discharge

Results

Normal Depth	1.68	ft
Flow Area	25.34	ft^2
Wetted Perimeter	20.65	ft
Top Width	20.10	ft
Critical Depth	0.77	ft
Critical Slope	0.04307	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.05	ft
Specific Energy	1.73	ft
Froude Number	0.27	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	2.35	ft ← Depth taken from Hayward outfall Channel
Length	377.00	ft
Number Of Steps	10	

GVF Output Data

Upstream Depth	1.85	ft ← Calculated upstream depth used in storm system Calculation
Profile Description	M1	
Profile Headloss	0.44	ft
Downstream Velocity	1.08	ft/s
Upstream Velocity	1.51	ft/s
Normal Depth	1.68	ft
Critical Depth	0.77	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.04307	ft/ft

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H-13

ATTACHMENT I

Scenario: Base

Inlet Report

Label	Northing (ft)	Easting (ft)	Ground Elevation (ft)	Set Rim Equal to Ground Elevation?	Rim Elevation (ft)	Sump Elevation (ft)	Area (acres)	Inlet C	Inlet CA (acres)	Time of Concentration (min)	External CA (acres)	External Time of Concentration (min)	Known Flow (cfs)	Inlet	Inlet Location	Local Rational Flow (cfs)	Intercepted Tc (min)
CB-1	,057,409.04	,088,591.83	8.50	true	8.50	6.00	0.60	0.83	0.50	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.27	5.00
CB-8	,057,410.55	,088,391.23	8.50	true	8.50	6.16	0.21	0.71	0.15	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.38	5.00
CB-7	,057,410.55	,088,475.23	8.60	true	8.60	6.50	0.24	0.84	0.20	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.52	5.00
CB-2	,057,425.37	,088,721.00	8.50	true	8.50	5.73	0.55	0.82	0.45	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.15	5.00
CB-19	,057,548.74	,088,324.05	7.00	true	7.00	5.00	1.57	0.65	1.02	11.35	0.00	0.00	0.00	Generic Default 1(	In Sag	1.95	11.35
CB-3	,057,558.58	,088,729.47	8.50	true	8.50	5.46	0.34	0.83	0.28	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.72	5.00
CB-4	,057,558.65	,088,813.46	8.50	true	8.50	5.29	0.49	0.78	0.38	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.97	5.00
CB-9	,057,605.08	,088,381.18	8.50	true	8.50	5.38	0.39	0.88	0.34	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.87	5.00
CB-11	,057,734.27	,088,337.00	8.50	true	8.50	4.80	0.42	0.81	0.34	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.88	5.00
CB-10	,057,734.39	,088,380.83	8.50	true	8.50	4.70	0.24	0.88	0.21	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.53	5.00
CB-12	,057,807.09	,088,504.10	8.50	true	8.50	4.10	0.58	0.81	0.47	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.21	5.00
CB-5	,057,807.09	,088,762.10	8.50	true	8.50	4.79	0.62	0.77	0.48	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.22	5.00
CB-6	,057,807.09	,088,598.10	8.50	true	8.50	4.46	0.64	0.87	0.55	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.42	5.00
CB-14	,057,863.31	,088,770.60	8.50	true	8.50	6.00	0.89	0.68	0.61	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.56	5.00
CB-13	,057,875.31	,088,392.60	8.50	true	8.50	3.91	0.89	0.69	0.62	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.58	5.00
CB-15	,057,959.31	,088,278.60	8.50	true	8.50	6.00	0.82	0.81	0.66	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.71	5.00
CB-16	,058,033.31	,088,343.60	8.50	true	8.50	6.00	0.37	0.85	0.32	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	0.81	5.00
CB-17	,058,147.31	,088,392.60	8.50	true	8.50	3.37	0.89	0.68	0.61	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.56	5.00
CB-18	,058,147.31	,088,770.60	8.50	true	8.50	5.43	0.89	0.68	0.61	5.00	0.00	0.00	0.00	Generic Default 1(	In Sag	1.56	5.00

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I-1

Scenario: Base

Pipe Report

Label	Downstream Node	Upstream Node	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-18	CB-18	CB-14	0.61	0.61	1.56	284.00	0.002000	15 inch	0.012	3.13	6.00	5.43	1.25	1.82	6.62	6.19
P-19	MH-3	CB-18	0.61	1.21	2.85	184.00	0.002000	24 inch	0.012	10.96	5.43	5.06	1.07	1.94	6.13	5.81
P-20	CB-17	MH-3	N/A	1.21	2.70	194.00	0.002000	24 inch	0.012	10.96	5.06	4.68	1.94	1.82	5.74	5.25
P-21	O-1	CB-17	0.61	8.78	15.17	162.00	0.001877	36 inch	0.012	31.30	3.37	3.07	2.13	2.93	4.90	4.70
P-6	CB-12	CB-6	0.55	2.63	5.38	94.00	0.002979	24 inch	0.012	13.37	4.46	4.18	2.04	2.32	5.75	5.71
P-5	CB-6	CB-5	0.48	2.08	4.45	164.00	0.002000	24 inch	0.012	10.96	4.79	4.46	1.71	2.04	5.88	5.80
P-4	CB-5	CB-4	0.38	1.60	3.69	254.00	0.002000	18 inch	0.012	5.09	5.30	4.79	1.70	2.21	6.28	5.94
P-3	CB-4	CB-3	0.28	1.22	2.89	84.00	0.002000	18 inch	0.012	5.09	5.47	5.30	1.53	1.70	6.42	6.35
P-2	CB-3	CB-2	0.45	0.94	2.32	133.00	0.002000	18 inch	0.012	5.09	5.73	5.47	1.27	1.53	6.56	6.47
P-1	J-1	CB-1	0.50	0.50	1.27	103.00	0.002000	12 inch	0.012	1.73	6.00	5.79	1.50	2.11	6.74	6.63
P-1A	CB-2	J-1	N/A	0.50	1.23	31.00	0.002000	15 inch	0.012	3.13	5.79	5.73	1.86	1.52	6.61	6.60
P-8	CB-9	CB-8	0.15	0.35	0.87	195.00	0.004000	15 inch	0.012	4.43	6.16	5.38	1.09	1.87	6.54	6.04
P-9	CB-10	CB-9	0.34	0.69	1.63	129.00	0.004000	15 inch	0.012	4.43	5.38	4.87	1.87	2.38	5.98	5.92
P-10	CB-10	CB-11	0.34	1.37	2.52	44.00	0.002273	18 inch	0.012	5.42	4.80	4.70	2.20	2.30	5.94	5.92
P-7	CB-8	CB-7	0.20	0.20	0.52	84.00	0.004000	12 inch	0.012	2.44	6.50	6.16	1.10	1.34	6.81	6.60
P-11	CB-12	CB-10	0.21	2.26	4.14	143.00	0.004196	18 inch	0.012	7.37	4.70	4.10	2.30	2.90	5.86	5.71
P-12	CB-13	CB-12	0.47	5.36	9.68	131.00	0.001389	30 inch	0.012	16.56	4.10	3.92	1.90	2.08	5.64	5.54
P-13	MH-1	CB-13	0.62	5.98	10.62	84.00	0.002000	30 inch	0.012	19.87	3.92	3.75	2.08	3.35	5.45	5.39
P-15	MH-2	MH-1	N/A	6.64	11.70	74.00	0.002000	30 inch	0.012	19.87	3.75	3.60	3.35	3.60	5.28	5.20
P-16	MH-2	CB-16	0.32	0.32	0.81	49.00	0.002000	12 inch	0.012	1.73	6.00	5.90	1.50	2.80	6.47	6.28
P-14	MH-1	CB-15	0.66	0.66	1.71	114.00	0.002000	15 inch	0.012	3.13	6.00	5.77	1.25	2.58	6.65	6.29
P-17	CB-17	MH-2	N/A	6.96	12.16	114.00	0.002000	36 inch	0.012	32.31	3.60	3.37	3.10	2.13	5.11	5.04
P-22	MH-5	CB-19	1.02	1.02	1.95	96.00	0.001042	18 inch	0.012	3.67	5.00	4.90	0.50	2.60	6.04	6.01
P-23	CB-11	MH-5	N/A	1.02	1.92	93.00	0.001075	18 inch	0.012	3.73	4.90	4.80	2.60	2.20	5.99	5.96

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I-2

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ATTACHMENT J

RCEC - Quantity of Flow for the Post-development Condition

Project:	Russell City Energy Center	**By:**	D. Sheth	**Date:**	11/1/2006
Location:	Hayward City, CA	**Checked:**	K. Giffin	**Date:**	11/3/2006

Post-development

Composite Runoff Coefficient Calculation

Total Area 672,661 sq.ft
15.44 acres

Land Use Sub Areas

	HSG	Cover Type	A (sq. ft)	A (acres)	C	C x A
Plant Site Area						
1	D	Aggregate Surfacing	305,978	7.024	0.65	4.57
2	D	Bituminous Paving	99,257	2.279	0.95	2.16
3	D	Concrete Slab		3.747	0.95	3.56
		Cooling Tower	45,722			
		ZLD and other	37,178			
		Power Block	30,174			
		Power Block	34,684			
		Title 22 Area	15,481			
4	D	Grass	104,188	2.392	0.20	0.48
		Sum:	672,661	15.44		10.77

C (composite) = 0.70

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J-1

Label	Length (ft)	Section Size (in.)	Volume
P-1	103	12	81
P-1A	31	15	38
P-2	133	18	235
P-3	84	18	148
P-4	254	18	449
P-5	164	24	515
P-6	94	24	295
P-7	84	12	66
P-8	195	15	239
P-9	129	15	158
P-10	44	12	35
P-11	143	18	253
P-12	131	30	643
P-13	84	30	412
P-14	114	15	140
P-15	74	30	363
P-16	49	12	38
P-17	114	36	806
P-18	284	15	349
P-19	184	24	578
P-20	194	24	609
P-21	162	36	1145
P-22	96	18	170
P-23	93	18	164
		Total =	**7931**

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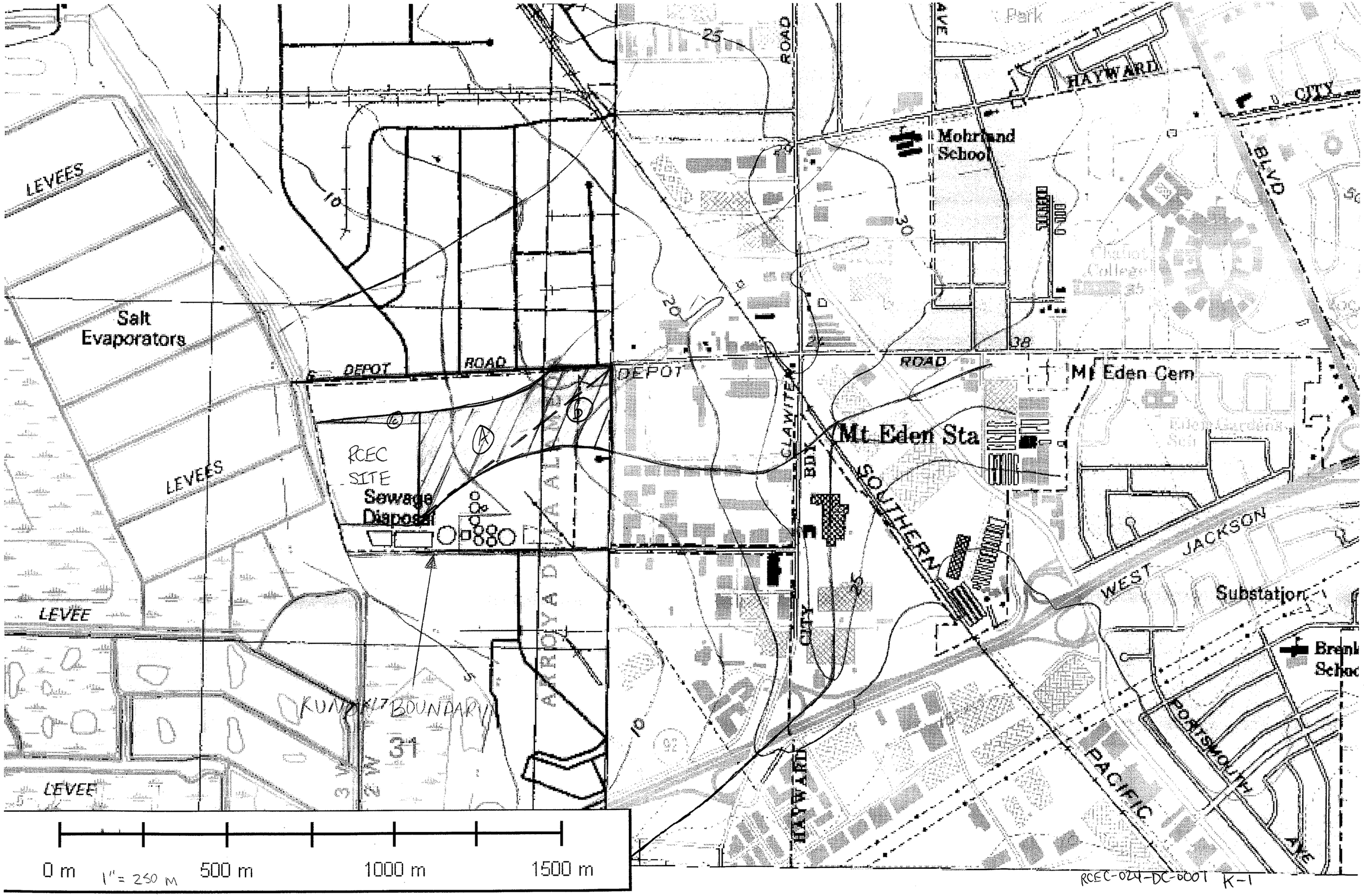
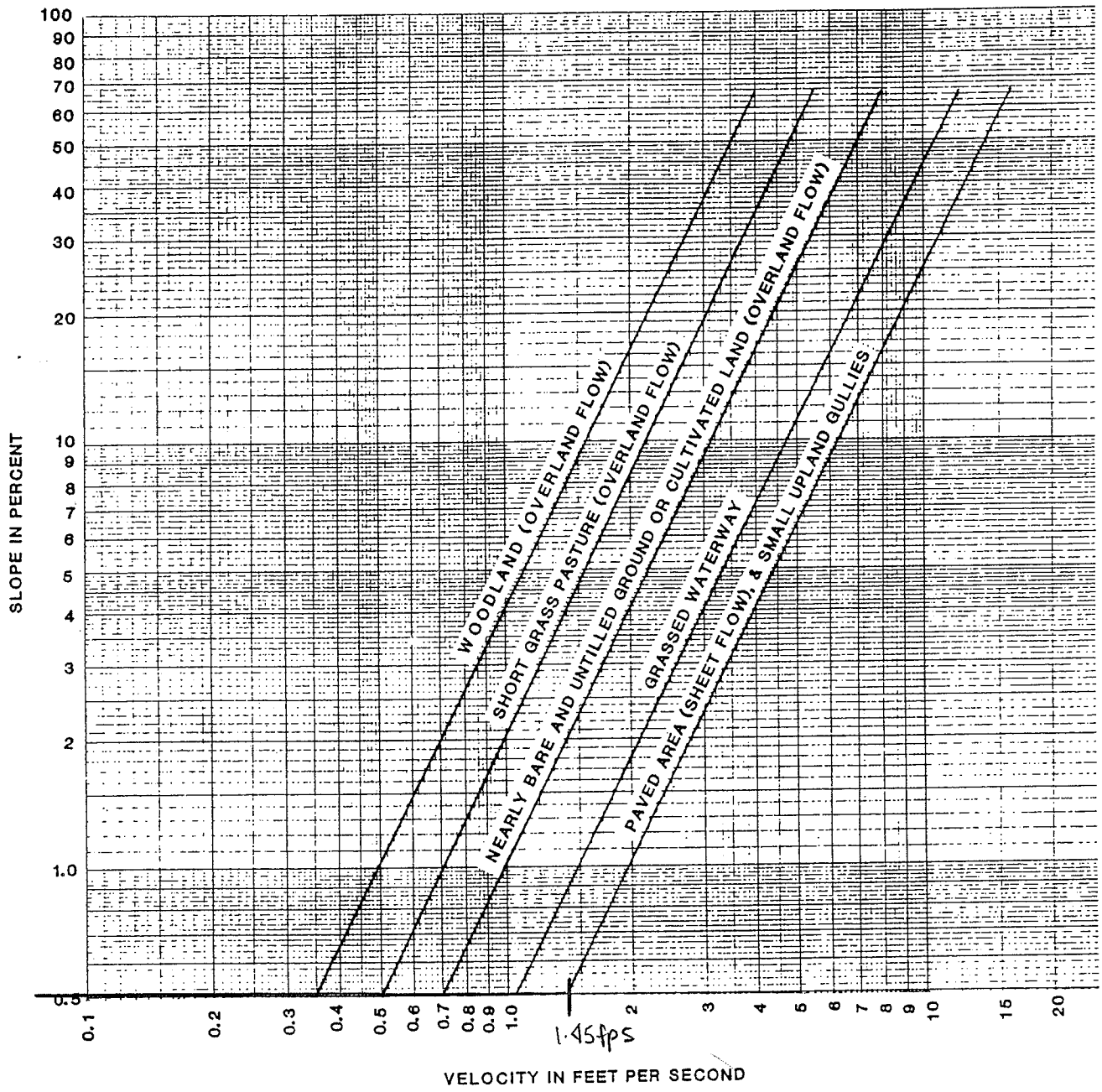
J-2

ATTACHMENT K



RCEC-024-DC-0001 K-1

Flow due to RUNON
Use this V in the Initial Time of Concentration



ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT	**OVERLAND FLOW VELOCITY CHART**	DATE: FEBRUARY 1987 **FIGURE 4**

RCEC-024-DC-0001 K-2

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

Lining Category	Permissible Unit Shear Stress, T_d Lining Type	(lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} **Stone Size** (inches)	
Gravel Riprap	1	0.33
	2	0.67
Rock Riprap	6	2.00
	9	3.00
	12	4.00
	15	5.00
	18	6.00
	21	7.80
	24	8.00

Adapted From: FHWA, HEC-15, April 1983, pgs. 17 & 37.

Design Procedure-Temporary Liners

The following is a step-by-step procedure for designing a temporary liner for a channel. Because temporary liners have a short period of service, the design Q may be reduced. For liners that are needed for six months or less, the 2-yr frequency storm is recommended.

Step 1. Select a liner material suitable for site conditions and application. Determine roughness coefficient from manufacturer's specifications or Table 8.05e, pg. 8.05.10.

Step 2. Calculate the normal flow depth using Manning's equation (Figure 8.05d). Check to see that depth is consistent with that assumed for selection of Manning's *n* in Figure 8.05d, pg. 8.05.11. For smaller runoffs Figure 8.05d is not as clearly defined. Recommended solutions can be determined by using the Manning equation.

Step 3. Calculate shear stress at normal depth.

Step 4. Compare computed shear stress with the permissible shear stress for the liner.

Step 5. If computed shear is greater than permissible shear, adjust channel dimensions to reduce shear or select a more resistant lining and repeat steps 1 through 4.

Design of a channel with temporary lining is illustrated in Sample Problem 8.05b, pg. 8.05.14.

RCEC-024-DC-0001
K-3

Diversion Channel - A
Worksheet for 15-yr - 0.004 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	1.41	ft
Flow Area	10.61	ft^2
Wetted Perimeter	11.59	ft
Top Width	11.05	ft
Critical Depth	1.00	ft
Critical Slope	0.01546	ft/ft
Velocity	2.95	ft/s
Velocity Head	0.14	ft
Specific Energy	1.54	ft
Froude Number	0.53	
Flow Type	Subcritical	

>2 ft/s - Assumed permissible velocity for bare soil
Use temporary lining until grass is established.

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.41	ft
Critical Depth	1.00	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01546	ft/ft

RCEC-024-DC-0001
K-4

Diversion Channel - A
Worksheet for 15-yr - 0.004 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	1.81	ft
Flow Area	15.42	ft^2
Wetted Perimeter	13.74	ft
Top Width	13.05	ft
Critical Depth	1.00	ft
Critical Slope	0.04294	ft/ft
Velocity	2.03	ft/s > 2 ft/s ... OK
Velocity Head	0.06	ft
Specific Energy	1.87	ft
Froude Number	0.33	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.81	ft
Critical Depth	1.00	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.04294	ft/ft

RCEC-024-DC-0001
K-5

Diversion Channels - A
Worksheet for 15-yr - 0.004 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	— From Flow master Library
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	1.21	ft
Flow Area	8.46	ft^2
Wetted Perimeter	10.49	ft
Top Width	10.03	ft
Critical Depth	1.00	ft
Critical Slope	0.00831	ft/ft
Velocity	3.70	ft/s
Velocity Head	0.21	ft
Specific Energy	1.42	ft
Froude Number	0.71	
Flow Type	Subcritical	

Check permissible shear stress (T_d):

Jute Net T_d = 0.45 psf

T_d = 1.21 ft × 0.004 ft/ft × 62.4 pcf = 0.30 psf

OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.21	ft
Critical Depth	1.00	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00831	ft/ft

RCEC-024-DC-0001
K-6

Diversion Channel - A
Worksheet for 100-yr - 0.004 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	1.61	ft
Flow Area	12.90	ft^2
Wetted Perimeter	12.66	ft
Top Width	12.04	ft
Critical Depth	1.16	ft
Critical Slope	0.01490	ft/ft
Velocity	3.17	ft/s
Velocity Head	0.16	ft
Specific Energy	1.76	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.61	ft
Critical Depth	1.16	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01490	ft/ft

RCEC-024-DC-0001
K-7

Diversion Channel - A
Worksheet for 100-yr - 0.004 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	2.06	ft
Flow Area	18.79	ft^2
Wetted Perimeter	15.07	ft
Top Width	14.28	ft
Critical Depth	1.16	ft
Critical Slope	0.04138	ft/ft
Velocity	2.18	ft/s > 2 ft/s ... OK
Velocity Head	0.07	ft
Specific Energy	2.13	ft
Froude Number	0.33	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.06	ft
Critical Depth	1.16	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.04138	ft/ft

RCEC-024-DC-0001
K-8

Diversion Channel - A
Worksheet for 100-yr - 0.004 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	1.38	ft
Flow Area	10.28	ft^2
Wetted Perimeter	11.43	ft
Top Width	10.90	ft
Critical Depth	1.16	ft
Critical Slope	0.00801	ft/ft
Velocity	3.98	ft/s
Velocity Head	0.25	ft
Specific Energy	1.63	ft
Froude Number	0.72	
Flow Type	Subcritical	

Check permissible shear stress: Jute Net Td = 0.45 psf

1.38 ft × 0.004 ft/ft × 62.4 pcf =

0.34 psf OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.38	ft
Critical Depth	1.16	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00801	ft/ft

RCEC-024-DC-0001
K-9

Diversion Channel – B
Worksheet for 15-yr - 0.004 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	1.79	ft
Flow Area	10.00	ft^2
Wetted Perimeter	10.01	ft
Top Width	9.16	ft
Critical Depth	1.31	ft
Critical Slope	0.01553	ft/ft
Velocity	3.13	ft/s
Velocity Head	0.15	ft
Specific Energy	1.94	ft
Froude Number	0.53	
Flow Type	Subcritical	

> 2 ft/s Assumed permissible velocity for bare soil
Use temporary lining until grass is established.

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.79	ft
Critical Depth	1.31	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01553	ft/ft

RCEC-024-DC-0001
K-10

Diversion Channel – B
Worksheet for 15-yr - 0.004 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	2.25	ft
Flow Area	14.64	ft^2
Wetted Perimeter	12.07	ft
Top Width	11.01	ft
Critical Depth	1.31	ft
Critical Slope	0.04315	ft/ft
Velocity	2.14	ft/s >2 ft/s ... OK
Velocity Head	0.07	ft
Specific Energy	2.32	ft
Froude Number	0.33	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.25	ft
Critical Depth	1.31	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.04315	ft/ft

RCEC-024-DC-0001
K-11

Diversion Channel – B
Worksheet for 15-yr - 0.004 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	→ From Flowmaster Library
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	31.30	ft³/s

Results

Normal Depth	1.55	ft
Flow Area	7.94	ft²
Wetted Perimeter	8.95	ft
Top Width	8.22	ft
Critical Depth	1.31	ft
Critical Slope	0.00835	ft/ft
Velocity	3.94	ft/s
Velocity Head	0.24	ft
Specific Energy	1.80	ft
Froude Number	0.71	
Flow Type	Subcritical	

Check permissible shear stress (τ_d):

Jute Net $\tau_d = 0.45$ psf

$\tau_d = 1.55$ ft $\times 0.004$ ft/ft $\times$ 62.4 pcf $= 0.39$ psf

OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.55	ft
Critical Depth	1.31	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00835	ft/ft

RCEC-024-DC-0001
K-12

Diversion Channel – B
Worksheet for 100-yr - 0.004 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	2.02	ft
Flow Area	12.21	ft^2
Wetted Perimeter	11.04	ft
Top Width	10.08	ft
Critical Depth	1.49	ft
Critical Slope	0.01502	ft/ft
Velocity	3.35	ft/s
Velocity Head	0.17	ft
Specific Energy	2.20	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.02	ft
Critical Depth	1.49	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01502	ft/ft

RCEC-024-DC-0001
K-13

Diversion Channel – B
Worksheet for 100-yr - 0.004 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	2.53	ft
Flow Area	17.88	ft^2
Wetted Perimeter	13.32	ft
Top Width	12.13	ft
Critical Depth	1.49	ft
Critical Slope	0.04172	ft/ft
Velocity	2.29	ft/s > 2ft/s..ok
Velocity Head	0.08	ft
Specific Energy	2.61	ft
Froude Number	0.33	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.53	ft
Critical Depth	1.49	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.04172	ft/ft

RCEC-024-DC-0001
K-14

Diversion Channel – B
Worksheet for 100-yr - 0.004 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	⇒ From flowmaster library
Channel Slope	0.00400	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	40.90	ft³/s

Results

Normal Depth	1.76	ft
Flow Area	9.69	ft²
Wetted Perimeter	9.86	ft
Top Width	9.03	ft
Critical Depth	1.49	ft
Critical Slope	0.00808	ft/ft
Velocity	4.22	ft/s
Velocity Head	0.28	ft
Specific Energy	2.03	ft
Froude Number	0.72	
Flow Type	Subcritical	

Check permissible shear stress:

Jute net = 0.45 psf

$T_d = 1.76\ ft \times 0.004\ ft/ft \times 62.4\ pcf = 0.44\ psf$

OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.76	ft
Critical Depth	1.49	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00808	ft/ft

RCEC-024-DC-0001
K-15

Diversion Channel – C
Worksheet for 15-yr - 0.0007 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	2.15	ft
Flow Area	20.13	ft^2
Wetted Perimeter	15.57	ft
Top Width	14.74	ft
Critical Depth	1.00	ft
Critical Slope	0.01546	ft/ft
Velocity	1.56	ft/s
Velocity Head	0.04	ft
Specific Energy	2.19	ft
Froude Number	0.23	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.15	ft
Critical Depth	1.00	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.01546	ft/ft

RCEC-024-DC-0001
K-16

Diversion Channel – C
Worksheet for 15-yr - 0.0007 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	2.72	ft
Flow Area	29.40	ft^2
Wetted Perimeter	18.65	ft
Top Width	17.61	ft
Critical Depth	1.00	ft
Critical Slope	0.04294	ft/ft
Velocity	1.06	ft/s
Velocity Head	0.02	ft
Specific Energy	2.74	ft
Froude Number	0.15	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.72	ft
Critical Depth	1.00	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.04294	ft/ft

RCEC-024-DC-0001
K-17

Diversion Channel – C
Worksheet for 15-yr - 0.0007 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	31.30	ft^3/s

Results

Normal Depth	1.85	ft
Flow Area	16.01	ft^2
Wetted Perimeter	13.98	ft
Top Width	13.27	ft
Critical Depth	1.00	ft
Critical Slope	0.00831	ft/ft
Velocity	1.96	ft/s
Velocity Head	0.06	ft
Specific Energy	1.91	ft
Froude Number	0.31	
Flow Type	Subcritical	

Check permissible Shear Stress:
Jute Wet Td = 0.45 psf
1.85 ft × 0.0007 × 62.4 pcf = 0.08 psf OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.85	ft
Critical Depth	1.00	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.00831	ft/ft

RCEC-024-DC-0001
K-18

Diversion Channel – C
Worksheet for 100-yr - 0.0007 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	2.43	ft
Flow Area	24.53	ft^2
Wetted Perimeter	17.10	ft
Top Width	16.17	ft
Critical Depth	1.16	ft
Critical Slope	0.01490	ft/ft
Velocity	1.67	ft/s
Velocity Head	0.04	ft
Specific Energy	2.48	ft
Froude Number	0.24	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.43	ft
Critical Depth	1.16	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.01490	ft/ft

RCEC-OLY-DC-0001
K-19

Diversion Channel – C
Worksheet for 100-yr - 0.0007 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	3.07	ft
Flow Area	35.87	ft^2
Wetted Perimeter	20.54	ft
Top Width	19.36	ft
Critical Depth	1.16	ft
Critical Slope	0.04138	ft/ft
Velocity	1.14	ft/s
Velocity Head	0.02	ft
Specific Energy	3.09	ft
Froude Number	0.15	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.07	ft
Critical Depth	1.16	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.04138	ft/ft

RCEC-024-DC-0001
K-20

Diversion Channel – C
Worksheet for 100-yr - 0.0007 ft/ft (ECB)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00070	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	40.90	ft^3/s

Results

Normal Depth	2.11	ft
Flow Area	19.50	ft^2
Wetted Perimeter	15.34	ft
Top Width	14.53	ft
Critical Depth	1.16	ft
Critical Slope	0.00801	ft/ft
Velocity	2.10	ft/s
Velocity Head	0.07	ft
Specific Energy	2.17	ft
Froude Number	0.32	
Flow Type	Subcritical	

Check permissible shear stress:

2.11 ft × 0.0007 ft/ft × 62.4 pcf = 0.09 psf

OK

Juk Net (Td) = 0.45 psf

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.11	ft
Critical Depth	1.16	ft
Channel Slope	0.00070	ft/ft
Critical Slope	0.00801	ft/ft

RCEC-024-DC-0001
K-21

Channel A
Worksheet for 15-yr - 0.0025 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	32.67	ft^3/s

Results

Normal Depth	1.10	ft
Flow Area	14.58	ft^2
Wetted Perimeter	16.94	ft
Top Width	16.58	ft
Critical Depth	0.65	ft
Critical Slope	0.01627	ft/ft
Velocity	2.24	ft/s >2 ft/s → Need temp. lining
Velocity Head	0.08	ft
Specific Energy	1.18	ft
Froude Number	0.42	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.10	ft
Critical Depth	0.65	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.01627	ft/ft

RCEC-024-DC-0001
K-22

Channel A
Worksheet for 15-yr - 0.0025 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	32.67	ft^3/s

Results

Normal Depth	1.45	ft
Flow Area	20.81	ft^2
Wetted Perimeter	19.17	ft
Top Width	18.70	ft
Critical Depth	0.65	ft
Critical Slope	0.04519	ft/ft
Velocity	1.57	ft/s
Velocity Head	0.04	ft
Specific Energy	1.49	ft
Froude Number	0.26	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.45	ft
Critical Depth	0.65	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.04519	ft/ft

RCEC-024-DC-0001
K-23

Channel A
Worksheet for 15-yr - 0.0025 ft/ft (ECB 0.022)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	32.67	ft^3/s

Results

Normal Depth	0.92	ft
Flow Area	11.79	ft^2
Wetted Perimeter	15.84	ft
Top Width	15.54	ft
Critical Depth	0.65	ft
Critical Slope	0.00875	ft/ft
Velocity	2.77	ft/s
Velocity Head	0.12	ft
Specific Energy	1.04	ft
Froude Number	0.56	
Flow Type	Subcritical	

permissible shear stress

Jute Net : 0.45 psf

0.92 ft X 0.0025 ft/ft X 62.4 pcf = 0.14 psf

OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.92	ft
Critical Depth	0.65	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.00875	ft/ft

RCEC-024-DC-0001

K-24

Channel A
Worksheet for 100-yr - 0.0025 ft/ft (Earth 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	43.17	ft^3/s

Results

Normal Depth	1.28	ft	
Flow Area	17.69	ft^2	
Wetted Perimeter	18.09	ft	
Top Width	17.67	ft	
Critical Depth	0.77	ft	
Critical Slope	0.01551	ft/ft	
Velocity	2.44	ft/s	>2 ft/s - Need temp. lining
Velocity Head	0.09	ft	
Specific Energy	1.37	ft	
Froude Number	0.43		
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.28	ft
Critical Depth	0.77	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.01551	ft/ft

RCEC-024-DC-0001
K-25

Channel A
Worksheet for 100-yr - 0.0025 ft/ft (Grass 0.05)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	43.17	ft^3/s

Results

Normal Depth	1.68	ft
Flow Area	25.34	ft^2
Wetted Perimeter	20.65	ft
Top Width	20.10	ft
Critical Depth	0.77	ft
Critical Slope	0.04307	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.05	ft
Specific Energy	1.73	ft
Froude Number	0.27	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.68	ft
Critical Depth	0.77	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.04307	ft/ft

RCEC-024-DC-0001
K-26

Channel A
Worksheet for 100-yr - 0.0025 ft/ft (ECB 0.03)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00250	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	43.17	ft^3/s

Results

Normal Depth	1.08	ft
Flow Area	14.26	ft^2
Wetted Perimeter	16.82	ft
Top Width	16.47	ft
Critical Depth	0.77	ft
Critical Slope	0.00834	ft/ft
Velocity	3.03	ft/s
Velocity Head	0.14	ft
Specific Energy	1.22	ft
Froude Number	0.57	
Flow Type	Subcritical	

Jute Net: 0.45 psf

1.08 ft x 0.0025 ft/ft x 62.4 pcf = 0.17 psf

OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.08	ft
Critical Depth	0.77	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.00834	ft/ft

RCEC-024-DC-0001
K-27

ATTACHMENT L

Culvert Calculator Report
C-1-15-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	9.00	ft	Headwater Depth/Height	1.19	
Computed Headwater Elevation	7.35	ft	Discharge	31.30	cfs
Inlet Control HW Elev.	6.71	ft	Tailwater Elevation	6.71	ft → Computed HW from C-2(15-yr)
Outlet Control HW Elev.	7.35	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	3.79	ft	Downstream Invert	3.70	ft
Length	100.00	ft	Constructed Slope	0.000900	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.01	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.81	ft
Velocity Downstream	4.43	ft/s	Critical Slope	0.004058	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	7.35	ft	Upstream Velocity Head	0.30	ft
Ke	0.50		Entrance Loss	0.15	ft

Inlet Control Properties					
Inlet Control HW Elev.	6.71	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

RCEC-024-DC-0001
L-1

Culvert Calculator Report
C-1-100-yr

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	9.00 ft	Headwater Depth/Height	1.53
Computed Headwater Elevation	8.39 ft	Discharge	40.90 cfs
Inlet Control HW Elev.	7.29 ft	Tailwater Elevation	7.29 ft ← Computed HW from C-2 (100-yr)
Outlet Control HW Elev.	8.39 ft	Control Type	Outlet Control

Grades			
Upstream Invert	3.79 ft	Downstream Invert	3.70 ft
Length	100.00 ft	Constructed Slope	0.000900 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	3.59 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.08 ft
Velocity Downstream	5.79 ft/s	Critical Slope	0.004670 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	Corrugated HDPE (Smooth Interior)	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	8.39 ft	Upstream Velocity Head	0.52 ft
Ke	0.50	Entrance Loss	0.26 ft

Inlet Control Properties			
Inlet Control HW Elev.	7.29 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

RCEC-024-DC-0001
L-2

Culvert Calculator Report
C-2-15-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	6.71	ft	Discharge	31.30	cfs
Inlet Control HW Elev.	6.47	ft	Tailwater Elevation	5.88	ft → 3.63' + 2.25'
Outlet Control HW Elev.	6.71	ft	Control Type	Outlet Control	

↑ INV. ↑ 15-yr depth for Diversion Channel B (0.05)

Grades					
Upstream Invert	3.70	ft	Downstream Invert	3.63	ft
Length	70.00	ft	Constructed Slope	0.001000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	2.25	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.81	ft
Velocity Downstream	5.50	ft/s	Critical Slope	0.004058	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	6.71	ft	Upstream Velocity Head	0.42	ft
Ke	0.50		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	6.47	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

RCEC-024-DC-0001
L-3

Culvert Calculator Report
C-2-100-yr

Solve For: Headwater Elevation

Culvert Summary				
Allowable HW Elevation	8.00 ft	Headwater Depth/Height	1.20	
Computed Headwater Elevation	7.29 ft	Discharge	40.90 cfs	
Inlet Control HW Elev.	7.06 ft	Tailwater Elevation	6.16 ft	→ 3.63' + 2.53'
Outlet Control HW Elev.	7.29 ft	Control Type	Outlet Control	INV. ↑

100-YR Depth for Diversion Channel B (0.05)

Grades			
Upstream Invert	3.70 ft	Downstream Invert	3.63 ft
Length	70.00 ft	Constructed Slope	0.001000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	2.53 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	2.08 ft
Velocity Downstream	6.43 ft/s	Critical Slope	0.004670 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	Corrugated HDPE (Smooth Interior)	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	7.29 ft	Upstream Velocity Head	0.57 ft
Ke	0.50	Entrance Loss	0.28 ft

Inlet Control Properties			
Inlet Control HW Elev.	7.06 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

RCEC-024-DC-0001
L-4

Culvert Calculator Report
C-3-15-yr

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	8.00 ft	Headwater Depth/Height	1.08
Computed Headwater Elevation	6.50 ft	Discharge	31.30 cfs
Inlet Control HW Elev.	6.03 ft	Tailwater Elevation	5.95 ft → 3.23' + 2.72'
Outlet Control HW Elev.	6.50 ft	Control Type	Outlet Control

INV.

15-yr depth for Diversion Channel C (0.05)

Grades			
Upstream Invert	3.26 ft	Downstream Invert	3.23 ft
Length	30.00 ft	Constructed Slope	0.001000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	2.72 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.81 ft
Velocity Downstream	4.65 ft/s	Critical Slope	0.004058 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	Corrugated HDPE (Smooth Interior)	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	6.50 ft	Upstream Velocity Head	0.33 ft
Ke	0.50	Entrance Loss	0.17 ft

Inlet Control Properties			
Inlet Control HW Elev.	6.03 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

RCEC-024-DC-0001
L-5

Culvert Calculator Report
C-3-100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8.00	ft	Headwater Depth/Height	1.31	
Computed Headwater Elevation	7.18	ft	Discharge	40.90	cfs
Inlet Control HW Elev.	6.62	ft	Tailwater Elevation	6.30	ft
Outlet Control HW Elev.	7.18	ft	Control Type	Outlet Control	

→ 3.23' + 3.07'

Inv.

100-yr depth for Diversion Channel C (0.05)

Grades					
Upstream Invert	3.26	ft	Downstream Invert	3.23	ft
Length	30.00	ft	Constructed Slope	0.001000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.07	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	2.08	ft
Velocity Downstream	5.79	ft/s	Critical Slope	0.004670	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

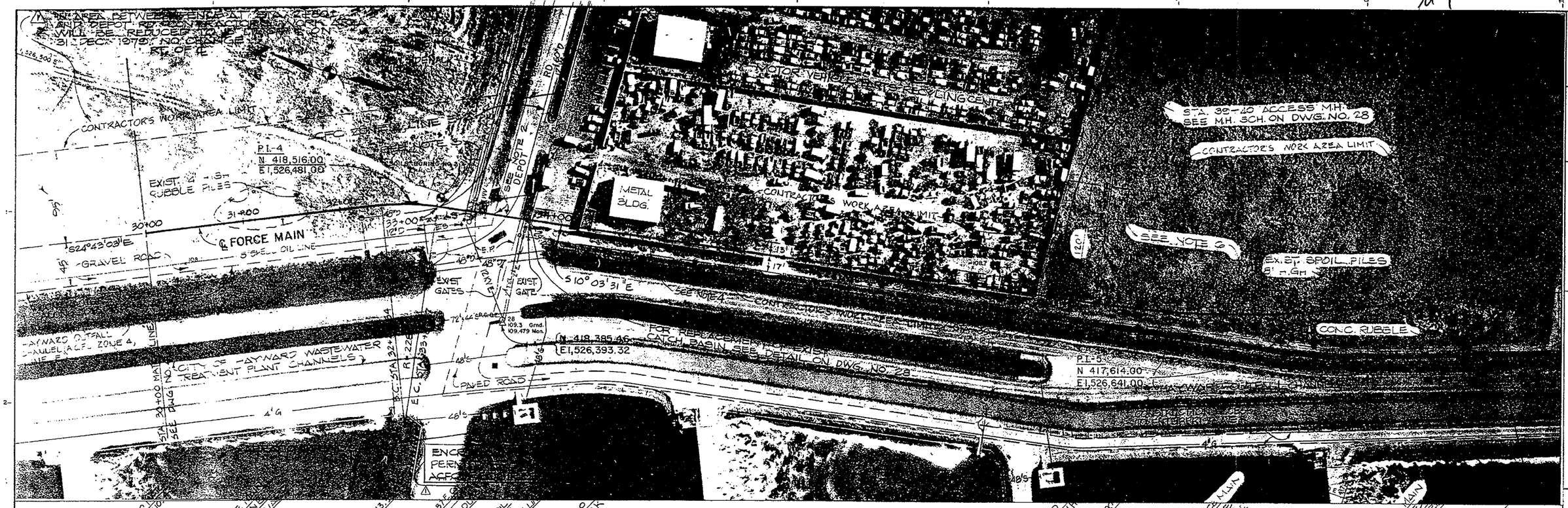
Outlet Control Properties					
Outlet Control HW Elev.	7.18	ft	Upstream Velocity Head	0.52	ft
Ke	0.50		Entrance Loss	0.26	ft

Inlet Control Properties					
Inlet Control HW Elev.	6.62	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

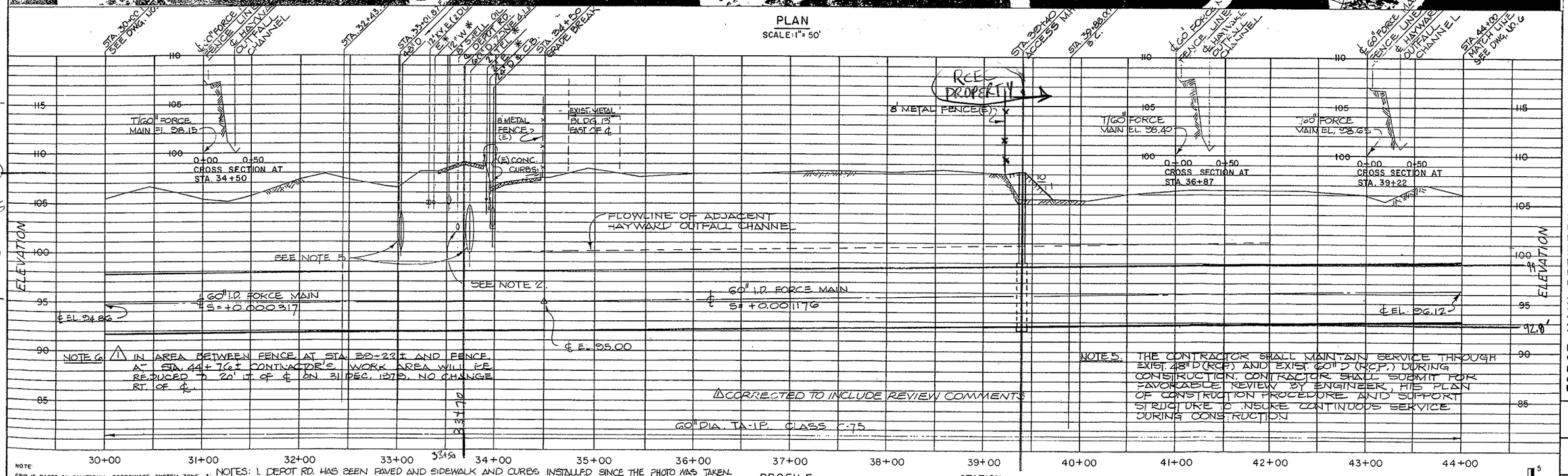
RCEC-024-DC-0001
L-6

ATTACHMENT M

RCEC-624-DC-0001
M-1



PLAN
SCALE: 1" = 50'



PROFILE
HORIZ. SCALE: 1" = 50'
VERT. SCALE: 1" = 5'

NOTE:
GRID IS BASED ON CALIFORNIA COORDINATE SYSTEM, ZONE 3.
FIELD SURVEY CONTROL BY TOWILL INC.
ELEVATIONS ARE BASED ON MEAN SEA LEVEL DATUM 1929 ADJ.
PLUS 100 FEET.
DATE OF PHOTOGRAPHY - 1975
ORTHOPHOTO MAP BY TOWILL, INC.

NOTES:
1. DEPOT RD. HAS BEEN PAVED AND SIDEWALK AND CURBS INSTALLED SINCE THE PHOTO WAS TAKEN.
2. THE CONTRACTOR SHALL CALL MR. WENDELL WILLIAMS, SHELL MAINTENANCE FOREMAN, (228-4285) 48 HOURS PRIOR TO EXCAVATING NEAR THE 8" SHELL OIL LINE.
3. THE THREE CROSS SECTIONS SHOWN ON THIS SHEET ARE CUT LOOKING SOUTHERLY.
4. BETWEEN STA. 34+48± AND STA. 39-22 ± THE CONTRACTOR SHALL CONSTRUCT A TEMPORARY 6'-0" HIGH CHAIN LINK FENCE W/3 STRANDS OF BARBED WIRE ON TOP, SLANTED OUT. THE EXIST. 8'-0" HIGH METAL FENCE (METAL POSTS SET IN 12" SQ. CONCRETE FOOTINGS 8'-0" CC.) SHALL BE REMOVED, STORED & REPLACED AFTER CONSTRUCTION BY CONTRACTOR. CONTRACTOR SHALL REMOVE TEMPORARY FENCE AFTER METAL FENCE IS REPLACED. AUTOS AND AUTO PARTS WILL BE REMOVED & REPLACED BY OTHERS. THERE ARE FOUR TELEPHONE AND ONE SPEAKER SYSTEM WIRES RUNNING ALONG THE TOP OF THE EXIST. METAL FENCE. THE CONTRACTOR SHALL TEMPORARILY SUPPORT THESE WIRES ON TOP OF THE CHAIN LINK FENCE AND REPLACE THEM AFTER THE METAL FENCE IS REPLACED. THERE IS A 1½" PLASTIC WATER PIPE RUNNING ALONG THE BOTTOM OF THE EXISTING METAL FENCE. THE CONTRACTOR SHALL INSTALL A TEMPORARY WATER SERVICE ALONG CHAIN LINK FENCE TO A POINT 30 FT. SOUTH OF EXIST. METAL BUILDING. CONTRACTOR SHALL RESTORE PLASTIC WATER PIPE TO ITS ORIGINAL CONDITION ALONG BOTTOM OF METAL FENCE AFTER METAL FENCE IS REPLACED.

GRAPHIC SCALES: 1" = 50' (0, 50, 100); 1" = 5' (0, 1, 2, 3, 4, 5)

THIS PRINT REDUCED HALF SCALE

DESIGN	CHECKED	DATE
SS		
DRAWN		
M. Eng		2 Aug 77

EAST BAY DISCHARGERS AUTHORITY
ALAMEDA COUNTY, CALIFORNIA
WATER QUALITY MANAGEMENT PROGRAM - PHASE I

FORCE MAIN BETWEEN HAYWARD AND ALVARADO

PLAN AND PROFILE

JOB N 6127

SCAL AS SHO

DWG. 5

RCEC-024-PC-0001
M-2

DATUM PLANES

ON THESE DATUM PLANES 0.00 IS ABOVE MEAN SEA LEVEL THE NUMBER OF FEET INDICATED.

8.616	City of San Francisco (City Engineer 12/10/64)
5.730	* Highest Tide at Pt. San Quentin Estimated (State Chart 11/19/51)
5.470	* Highest Tide at Pt. Richmond Estimated (State Chart 11/19/51)
5.200	* Highest Tide at Presidio 12/24/40 (State Chart 11/19/51)
3.410	City of Alameda (City Engineer 1/7/65)
3.26	Emeryville
3.17	Berkeley
3.00	City of Oakland (City Engineer 12/10/64)
2.87	* M.H.H.W. at Pt. Richmond (State Chart 11/19/51)
2.80	San Leandro (Prior to 1960)
2.65	* S.P.R.R. Coast Division (2.61 M.H.H.W. at Presidio State Chart 11/19/51)
2.03	* M.H.H.W. at Presidio (State Chart 11/19/51)
VARIES	EBMUD Mokelumne Aqueduct (Varies - See Published Lists)

0.00 USC&GS Mean Sea Level Datum of 1929:

- Alameda County
- Alameda County Flood Control & Conservation District
- Albany
- Bay Area Rapid Transit District (Verified by R.M. Towill Inc.)
- California Division of Highways Dist. IV (Since 1956)
- Central Contra Costa Sanitary District
- Concord
- Contra Costa County
- Contra Costa County Flood Control
- E.B.M.U.D.
- El Cerrito (Ord. #7100)
- Hayward
- Richmond
- Richmond - San Rafael Bridge
- San Leandro (Since 1960)
- San Pablo
- Webster St. Tube

ON THESE DATUM PLANES 0.00 IS BELOW MEAN SEA LEVEL THE NUMBER OF FEET INDICATED.

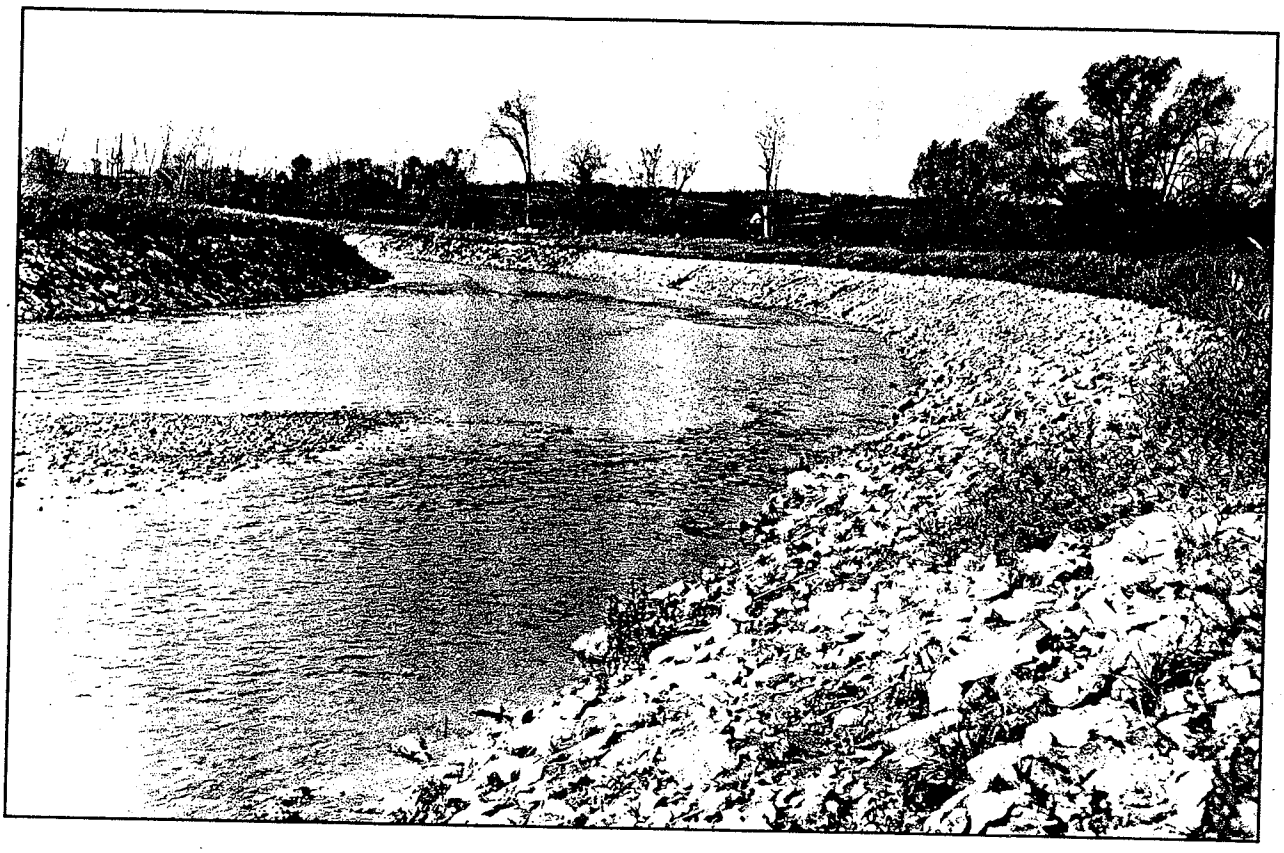
-1.44	San Pablo Reservoir (At San Pablo Dam)
-1.51	San Pablo Reservoir (At San Pablo Filter Plant)
-2.171	Richmond (Prior to 1962)
-2.77	* M.L.L.W. Pt. San Quentin (State Chart 11/19/51)
-2.83	* M.L.L.W. Pt. San Pablo (State Chart 11/19/51)
-3.03	* M.L.L.W. Pt. Richmond (State Chart 11/19/51)
-3.10	* S.F.O.B.B. & Parallel Bridge, M.L.L.W. at Presidio (State Chart 11/19/51)
-3.20	Port of Oakland (Since 1959)
-3.817	* C.P. Ry. (Western Div. - East Bay) (State Chart 11/19/51)
-4.25	* State Hwy. #1, S.F.O.B.B. East Bay Approaches (State Chart 11/19/51)
-5.50	* Lowest Tide Presidio (State & E.B.M.U.D.)
-8.600	* Bottom Presidio Staff Gage (State Charts)
-97.011	* Posey Tube Datum
-100.00	E.B.M.U.D. Water Pollution Control Div.

NOTES:

1. An elevation based on a special datum may be converted to an elevation based on USC&GS mean sea level datum by adding the indicated difference.
2. All elevations are vertical distances above or below a level surface. This surface or level datum is assumed to remain at a fixed elevation whereas the record elevation of bench marks may vary due to discrepancies, movement of marks, and readjustment of level lines. For these reasons a conversion chart is limited as to accuracy and on any project where a dependable relationship of level data is required a field check should be made.
3. * Information obtained in 1959 or earlier and not verified for this edition.

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT	**BAY AREA DATUM PLANES**	DATE: FEBRUARY 1987 **FIGURE 12**

ATTACHMENT N



SUGGESTED SIZES

Depending on the factors involved in the final decision and the stone products generally available, the following is offered:

Table 1

Flow Velocity (ft./sec.)	GRADED RIPRAP STONE Size Inches (sq. openings) NSA No.	Max.	Avg.	Min.	Filter Stone NSA No.
2.5	R-1	1½	¾	No. 8	FS-1
4.5	R-2	3	1½	1	FS-1
6.5	R-3	6	3	2	FS-1
9.0	R-4	12	6	3	FS-2
11.5	R-5	18	9	5	FS-2
13.0	R-6	24	12	7	FS-3
14.5	R-7	30	15	12	FS-3

Notes:
- See appendix for more complete information on riprap sizes and filter stone requirements.
- Flow velocities measured at mid-stream or 10 ft. from eroding bank, whichever is closest to bank.
- Stone sizes could be reduced about 30 percent for side slopes of 6 to 1.

REFERENCES RECOMMENDED: 2, 4, 8, 15, 16 (See page 30.)

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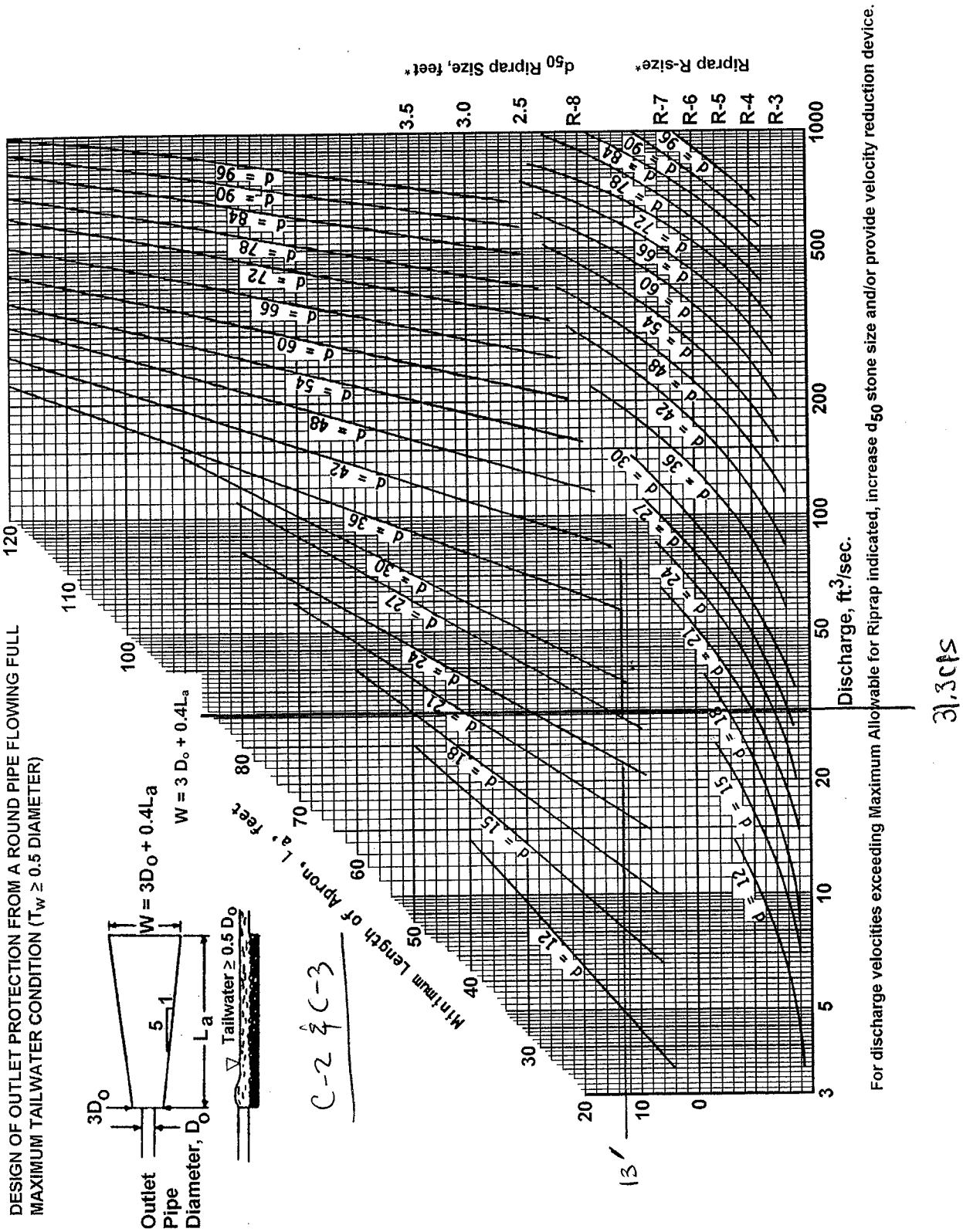
FIGURE 22
Riprap Apron Design, Maximum Tailwater Condition



C-2 & C-3

13'

31.3 cfs

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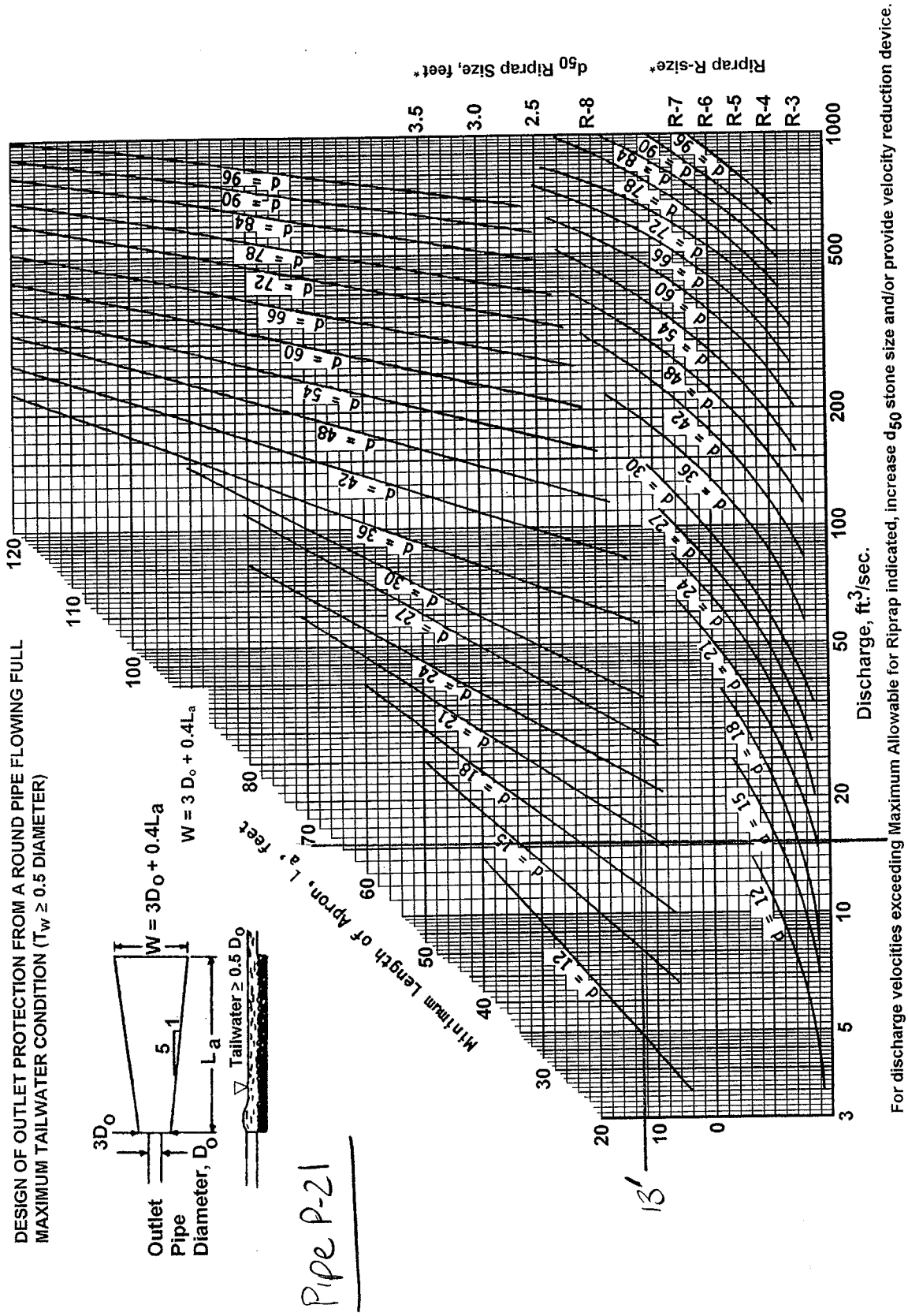
FIGURE 22
Riprap Apron Design, Maximum Tailwater Condition



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