APPENDIX E

Stormwater Control Plan Report

WorleyParsons
resources & energy

WorleyParsons Job Number: 52011702

STORMWATER CONTROL PLAN REPORT

For The

ANAEROBIC DIGESTION FACILITY PHASE I - III

Prepared for:

Zero Waste Energy Development Company

Prepared by:

WorleyParsons Group, Inc.

2330 E. Bidwell Suite 150

Folsom, California 95630 USA

PRELIMINARY ISSUE

NOTICE

The information presented in this document was compiled and interpreted exclusively for the purposes stated in the document introduction. WorleyParsons provided this report for Pacific Gas and Electric (PG&E) Company solely for the purpose noted above.

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Prepared By:

3/5/2010

Jonas Dahlgren Date

Reviewed By:

Rolando C. Saylo, California Registered Professional Engineer, as an employee of WorleyParsons, with expertise in civil engineering, has reviewed the report with the title "Stormwater Control Plan Report for Anaerobic Digestion Facility Phase I-III". His signature and stamp appear below.

REGISTERED PROFESSIONAL ENGINEER
ROLANDO C. SAYLO
No. C70098
Exp. 9-30-2010
CIVIL
STATE OF CALIFORNIA

3-5-2010

Rolando C. Saylo, PE Date

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APPENDIX

1. INTRODUCTION

Zero Waste Energy Development Company is proposing a 150,000 ton per year dry fermentation Anaerobic Digestion Facility to process and recover energy from the organic portion of municipal solid waste generated by the City of San Jose and surrounding communities. The proposed project will be developed in three phases with each phase capable of processing approximately 50,000 tons per year of organic materials.

The facility is located on the former Nine Par Landfill (Nine Par Site) at 2100 Los Esteros Road, San Jose, California (refer to **Figure 1**). It is adjacent to the Zanker Road Resource Recovery Operation and Landfill (ZRRROL) and the Zanker Material Processing Facility (ZMPF).

The topographic survey with the lease boundary for this site is shown on **Figure 2**. The survey drawing shows the existing swamps and overflow lands on the north side of the property. There are existing trees on the south side of the property parallel with Los Esteros Road and future 20 feet right of way take. There are existing channels on the westerly side of the while there is existing 50 feet ingress and egress easement on the east side.

The top elevations of the existing grades vary with almost twin peaks sloping down on all the sides of the property.

2. PURPOSE

The aim of this study is to evaluate existing grading and drainage patterns associated with predevelopment conditions and the future post development grading requirements and drainage flows through and around the project site. The objective of the study is to ensure the development minimizes its overall impact within the Site and on the downstream properties and drainage system. This report includes the stormwater control measures and engineering analysis and design of BMP and drainage structures.

The project site is located in a flood zone at Flood Plain El. 12.00 based on FEMA flood zone Map Number 006085C0062H and Map Number 06085C0055H dated May 18, 2009 (refer to **Figure 4**)

The existing landfill soil cover consists of a non-uniform mix of silty clay, sandy clay, gravelly clay, clayey sand, silty sand and gravelly silt materials.

The groundwater elevation is approximately at Elevation 0'-0". The hydrologic soil group is D.

3. DRAINAGE AREAS

The total drainage area is approximately 28.3 acres. The finish grade elevations vary to minimize excavations on existing landfill. The vertical profile of the post-developed area resembles a series of terrace type shapes. The whole area is subdivided into sub-areas as small basins with appropriate mark number, slope and area. Perimeter vegetated water quality swales are provided to capture sheet flows in all directions. The swales are marked as Swale A, B, C, D, E and F. Watershed area marked as basin 1 drains to swale A. Basin 2 drains to Swale B. Basin 11 drains to Swale C and connected to Swale B. Basin 12 drains to Swale D. Basin 17 drains to Swale E. Basin 10 drains to Swale F. Interior basins 3, 4, 5, 6, 7, 8, 9, 13, 14 and 15 drain to storm drainage pipes. The end of the storm drainage pipe terminates at Forebay 3. This forebay is connected downstream with vegetated water quality swale A which in turn release a controlled fllow rate at the existing catch basin (west side of the property).

4. STORMWATER CONTROL MEASURES

Water quality treatment train is provided for the whole site. The primary treatment BMP is the use of settling basin called "forebay" at the upstream of each vegetated swale. The function of forebay is to trap all sediments and other pollutants prior to discharging to the downstream flow-based BMP. The secondary treatment is the use of vegetated water quality swale connected in series with the forebay. The tertiary treatment is the existing receiving water or the wetlands. The outflow rate discharging to existing water or wetland is limited flow, thus, not exceeding the prevailing pre-developed flow.

The forebay provides a location for sedimentation of larger particles that has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay volume is between 5 to 10 percent of the volume of the BMP serving the area. The side slope of the forebay is 3:1. The outlet pipe from the forebay to the flow-based BMP (vegetated water quality swale) is provided with headwall and by-pass weir for flow in excess of water quality treatment level. Forebays are a lot cheaper to maintain and provide easy access anytime.

Vegetated water quality swale is a wide, shallow densely vegetated channel that treats stormwater runoff as it is slowly conveyed into a downstream system. These swales have very shallow slopes in order to allow maximum contact time with the vegetation. The depth of water of the design flow is about 4 inches maximum. Contact with vegetation improves water quality by plant uptake of pollutants, removal of sediment and increase in infiltration. These swales are used in combination with forebays.

5. HYDROLOGIC CALCULATIONS

The Santa Clara Drainage Manual adopted on August 14, 2007, Santa Clara Valley Urban Runoff Pollution Prevention Program, C.3 Stormwater Handbook dated May 2004 and Post-Construction Urban Runoff Management Policy Number 6-29, City of San Jose, California, August 15, 2006 were used as basis for the project site drainage and stormwater control design.

As the project site is less than 50 acres, the rational method is the selected hydrology analysis method for sizing the storm drainage pipes for 10-year storm capacity. The storm drainage pipes are located in the interior portion of the site. The flows from these pipes drain into the forebay 3. These basins called "forebays" serve a primary runoff water quality treatment. The function of these forebays is to trap incoming sediments prior to discharging into a flow-based or volume-based BMP. The forebays shall be sized at least 10% BMP volume serving the area. See Appendix 1 for sizing of the forebays.

5.1 MODIFIED RATIONAL METHOD METHODOLOGY

The rational method equation for design discharge is:

$Q_T = k\, C \times I_T \times A$ **(Equation 3-1, SCCDM)**

Where:

Q_T = design discharge in cubic feet per second (cfs)

T = recurrence interval (years)

C = runoff coefficient (unitless)

I_T = rainfall intensity in inches per hour (in/hr)

A = drainage area in acres (ac)

5.1.1 WATERSHED BOUNDARY

To determine the quantity of stormwater run off entering the Site, the watershed was determined using the topography maps, local survey and field investigation.

Figure 5 outlines the pre-developed watershed boundary and **Figure 6** outlines the post-developed watershed boundary. Vegetated water quality swales are provided around the site and drain into the forebays and discharge back to the flow-based BMP (vegetated water quality swales). Storm sewer pipes have been provided in the interior portion of the site to drain the area and connected to Forebay 3 for runoff treatment prior to discharging into the flow-based BMP (vegetated water quality swale).

5.1.2 RUNOFF COEFFICIENT

The runoff coefficient is estimated by land type, using the values presented in Table 3-1, Santa Clara County Drainage Manual 2007.

5.1.3 RAINFALL INTENSITY

The rainfall intensity is dependant on the time of concentration, which is the time required for surface runoff from the most remote part of the drainage area to reach the design point. The time of concentration has three factors; overland flow, gutter/channel flow and pipe flow. Under pre-developed conditions, the time of concentration is based on overland flow only, however under post developed conditions; there is overland flow and channel flow.

The equation to calculate concentration time is shown below.

$T_c = 0.0078\ (L^2/S)^{0.385} + 10$ (**Equation 3-2, SCCDM)**

The Mean Annual Precipitation Map (MAP) for Santa Clara County is obtained from Figure A-2 of SCCDM.

Rainfall intensity is calculated by:

The TDS Regional Equation is given by:

$X_{T,D} = A_{T,D} + (B_{T,D}MAP)$ **(Equation 3-3, SCCDM)**

The precipitation intensity, $i_{T,D}$ is given by :

$I_{T,D} = X_{T,D}/D$ **(Equation 3-4, SCCDM)**

Intensity-Duration-Frequency (IDF) curves for Mean Annual Precipitation (MAP) values are shown in Appendix B of SCCDM.

5.2 MODIFIED RATIONAL METHOD RESULTS

The drainage calculation results are provided in **Appendix 1.**

The pre-developed flow rate at the west and north end of the project site in a 100 year storm event is estimated as 1.60 feet per second (cfs) and 8.17 cubic feet per second (cfs) respectively. The pre-developed flow rate at east end of the site where Forebay 4 and swale E drain in a 100 year storm event is 1.17 cubic feet per second (cfs).

The post-development watershed area for the vegetated water quality swales and storm drainage pipes are shown in Figure 6.

6. BMP SIZING

6.1 Water Quality Vegetated Swales

Vegetated swales are sized in accordance with Santa Clara Valley Urban Runoff Pollution Prevention Program and Post-Construction Urban Runoff Management Policy Number 6-29, City of San Jose, California. These water quality vegetated swales are sized to treat the following:

- Method 1 - Ten percent (10%) of the 50-year peak flow rate (**Factored Flood Flow Approach**); or,
- Method 2 - The flow of runoff produced by a rain event equal to or at least two (2) times the 85th percentile hourly rainfall intensity for the applicable area, based on historical records of hourly rainfall depths (**CA Storm BMP Handbook Flow Approach**); or
- Method 3 - The flow of runoff from a rain event equal to at least 0.2 inches per hour intensity (**Uniform Intensity Approach**).

Design Criteria – Water Quality Vegetated Swales:

- Flow-based BMP (Method A, B or C as above)
- Longitudinal slope – velocity based
- Optimum grass height = 6 inches
- Manning's n = 0.25 (WQ)
- Manning's n = 0.022 (Flood conveyance)
- Length = 100 ft (minimum)
- Hydraulic Residence Time = 10 minutes (7 min is ok)
- Flow velocity < 1 ft/sec
- Bottom Width : 2 ft minimum
- Maximum slope = 5 %
- Side slope: 2:1 max
- Flow depth: 4" max

Table 1 : Water Quality Vegetated Swale – Flow Rates

Swale	Method 1	Method 2	Method 3
A	0.108 cfs	0.142 cfs	**0.167 cfs**
B	0.168 cfs	0.237 cfs	**0.279 cfs**
C	0.136 cfs	0.165 cfs	**0.194 cfs**
D	0.109 cfs	0.143 cfs	**0.168 cfs**
E	0.202 cfs	0.229 cfs	**0.270 cfs**
F	0.338 cfs	0.442 cfs	**0.520 cfs**

6.2 Forebays

Forebays shall be sized in accordance with Santa Clara Valley Urban Runofff Pollution Prevention Program . These forebays are used to trap incoming sediments and other pollutants. The BMP volume serving the area shall be designed to treat storm water runoff equal to:

- Method 1 – The maximum stormwater quality capture volume for the area, based on historical rainfall records, determined using the formula and volume capture coefficients set forth in *Urban Runoff Quality Management WEF Manual of Practice No. 23 and ASCE Manual of Practice No. 87, (1998*), pages 175-178 (**URQM Approach**); or
- Method 2 – The volume of annual runoff required to achieve eighty percent (80%) or more capture, determined in accordance with the methodology set forth in Appendix D of the *California Stormwater Best Management Practices Handbook, (1993*) using local rainfall data. (**CA Stormwater BMP Handbook Volume Approach**).

Design Criteria – Forebays:

- Design volume = 5% to 10% (BMP Volume)
- Side slope: 3:1
- Hardened floor and side slopes to facilitate mechanical maintenance during removal of pollutants, sediments and debris.

Table 2- Forebay Design Volumes and Dimensions

Mark	BMP Vol	10%(BMP Vol)	Width	Length	Depth
FB-1	.232 acre-ft	.023 acre-ft	15 ft	30 ft	3 ft
FB-2	.044 acre-ft	.004 acre-ft	8 ft	16 ft	3 ft
FB-3	.472 acre-ft	.047 acre-ft	20 ft	40 ft	3 ft
FB-4	0.057 acre-ft	.005 acre-ft	8 ft	16 ft	3 ft

7. STORAGE FACILITIES

The vegetated swales and forebays are oversized such that both can handle 100 year storm. The forebays are provided with headwalls and by-pass weirs to sustain higher flows.

8. REFERENCES

A. RUGGERI-JENSEN-AZAR, Topographic Survey with Lease Area Boundary Nine Par Site, January 15, 2010.

B. Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), C.3 Stormwater Handbook, May 2004.

C. Santa Clara County Drainage Manual (SCCDM) 2007.

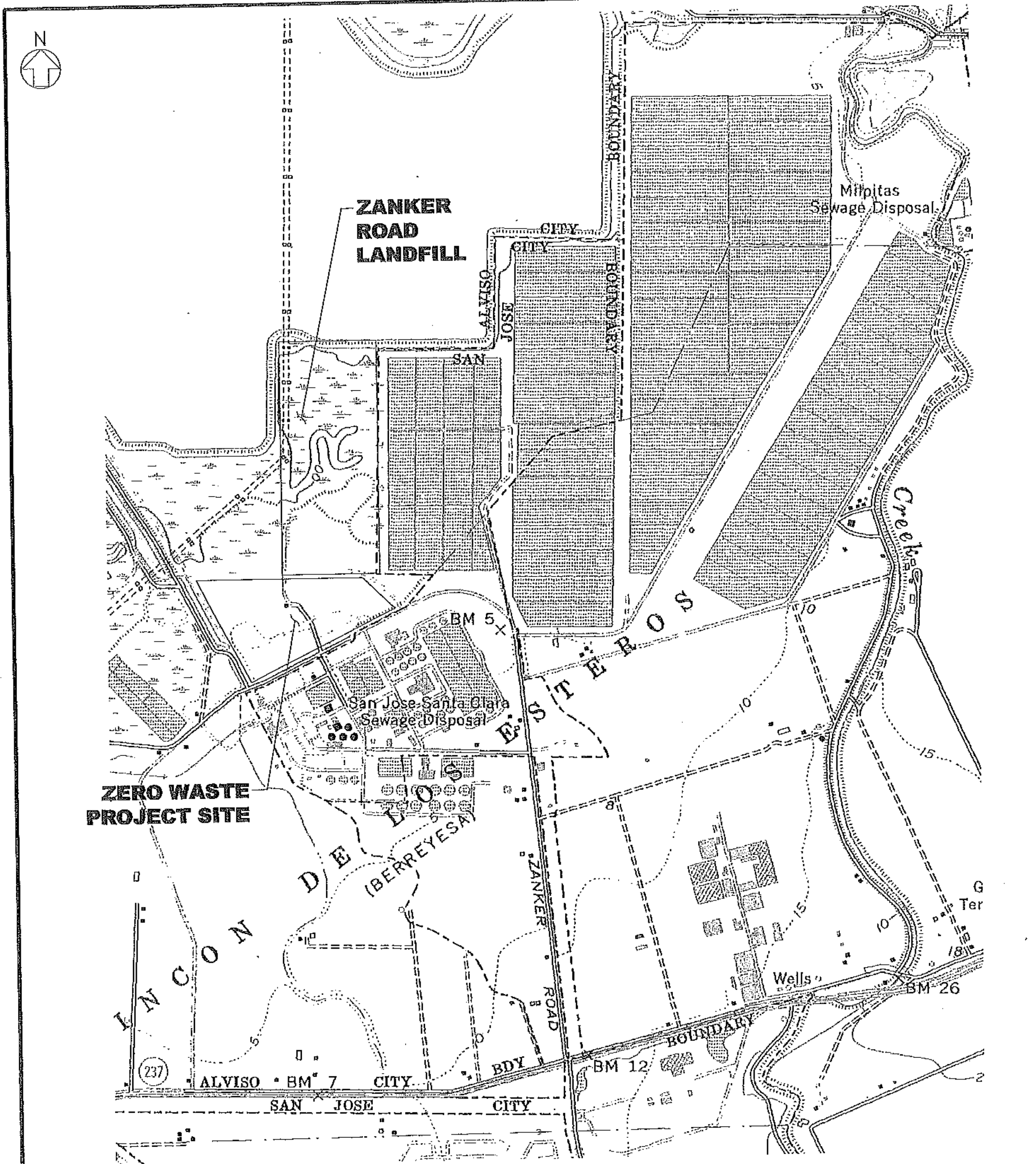
D. Post-construction Urban Runoff Management Policy Number 6-29, City of San Jose, California dated August 15, 2006.

E. California Stormwater Best Management Practices (BMP) Handbook – Construction, California Stormwater Quality Association, January 2003.

F. California Stormwater Best Management Practices (BMP) Handbook – New Development and Redevelopment, California Stormwater Quality Association, January 2003.

G. California Stormwater Best Management Practices (BMP) Handbook – Industrial and Commercial, California Stormwater Quality Association, January 2003.

LIST OF FIGURES



Adapted from USGS Map, California 7.5 Minute Series, Milpitas, CA

Zero Harm — Leadership, No Incidents, Safe Behavior

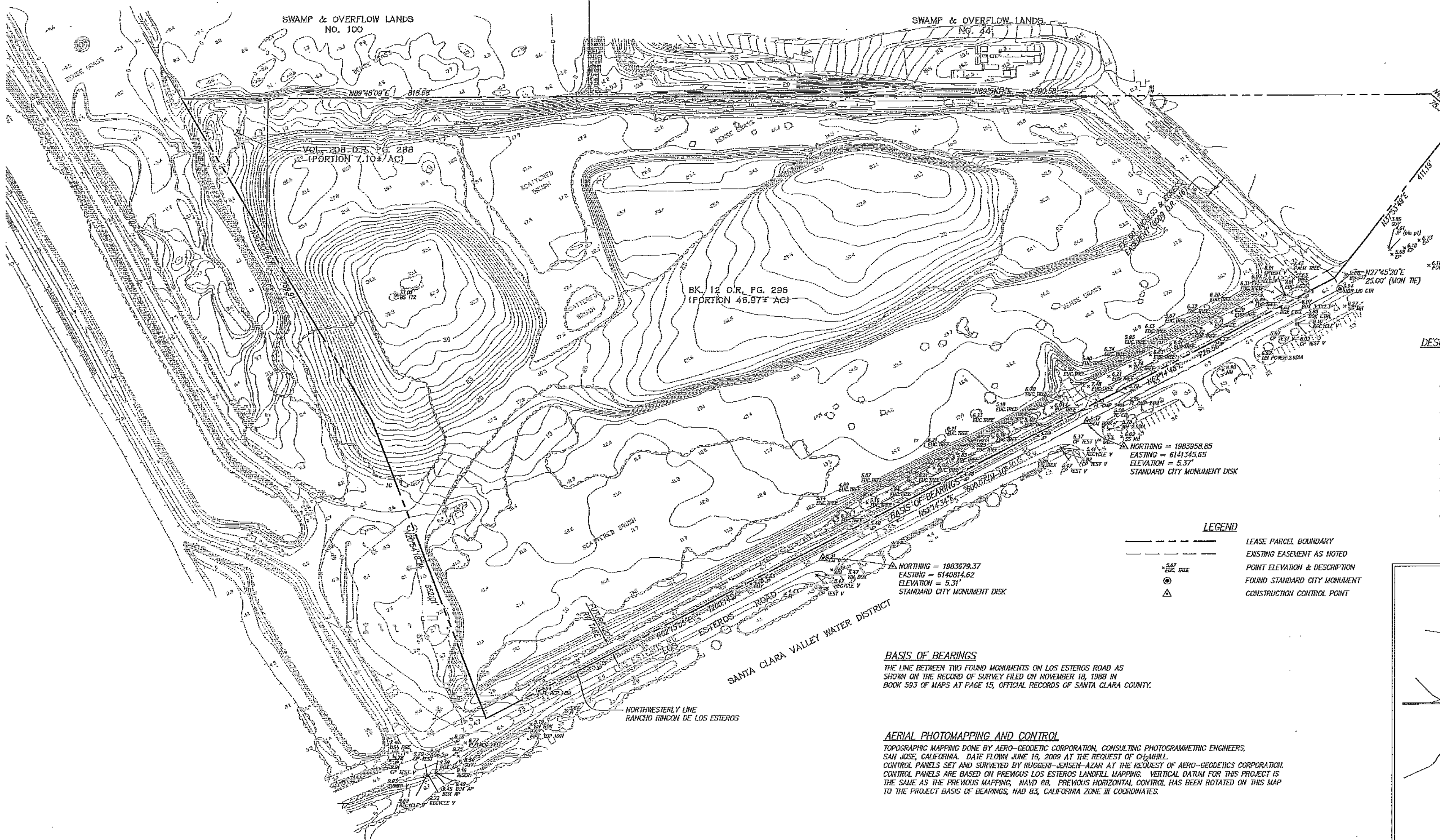
WorleyParsons resources & energy

FIGURE 1

ZeroWaste™ ENERGY DEVELOPMENT COMPANY

SITE LOCATION
SAN JOSE, CA

DRAWN BY: A. PRATT	SCALE: NOT TO SCALE
DATE: 2-5-2010	



LEGEND

——— — — — ———	LEASE PARCEL BOUNDARY
—— —— —— ——	EXISTING EASEMENT AS NOTED
× 5.67 EUC. TREE	POINT ELEVATION & DESCRIPTION
◉	FOUND STANDARD CITY MONUMENT
△	CONSTRUCTION CONTROL POINT

DESCRIPTOR KEY FOR SUPPLEMENTAL TOPO POINTS

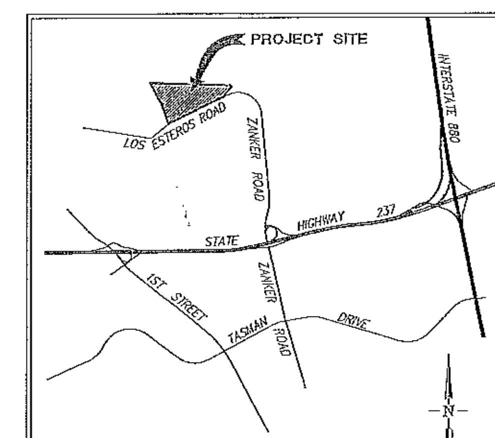
BOX AP	BOX ANGLE POINT/COVER
CP TEST V	CATHODE PROTECTION TEST STATION VALVE
JP	CENTERLINE OF JOINT POLE
CMP	CORRUGATED METAL PIPE
EUC TREE	EXISTING EUCALYPTUS TREE
FI	FIELD INLET
MH	MANHOLE
GUY	POLE GUY ANCHOR
RECYCLE V	RECLAIMED WATER VALVE
RCP	REINFORCED CONCRETE PIPE
SVWRP V	SANTA CLARA VALLEY WATER VALVE
TC CB	TOP OF CURB AT CENTER OF CATCH BASIN
USA	UTILITY SERVICE ALERT MARKING
WM BOX	WATER METER BOX

BASIS OF BEARINGS

THE LINE BETWEEN TWO FOUND MONUMENTS ON LOS ESTEROS ROAD AS SHOWN ON THE RECORD OF SURVEY FILED ON NOVEMBER 18, 1988 IN BOOK 593 OF MAPS AT PAGE 15, OFFICIAL RECORDS OF SANTA CLARA COUNTY.

AERIAL PHOTOMAPPING AND CONTROL

TOPOGRAPHIC MAPPING DONE BY AERO-GEODETIC CORPORATION, CONSULTING PHOTOGRAMMETRIC ENGINEERS, SAN JOSE, CALIFORNIA. DATE FLOWN JUNE 16, 2009 AT THE REQUEST OF CH_2MHILL. CONTROL PANELS SET AND SURVEYED BY RUGGERI-JENSEN-AZAR AT THE REQUEST OF AERO-GEODETICS CORPORATION. CONTROL PANELS ARE BASED ON PREVIOUS LOS ESTEROS LANDFILL MAPPING. VERTICAL DATUM FOR THIS PROJECT IS THE SAME AS THE PREVIOUS MAPPING, NAVD 88. PREVIOUS HORIZONTAL CONTROL HAS BEEN ROTATED ON THIS MAP TO THE PROJECT BASIS OF BEARINGS, NAD 83, CALIFORNIA ZONE III COORDINATES.



VICINITY MAP
NOT TO SCALE

TOPOGRAPHIC SURVEY WITH LEASE AREA BOUNDARY

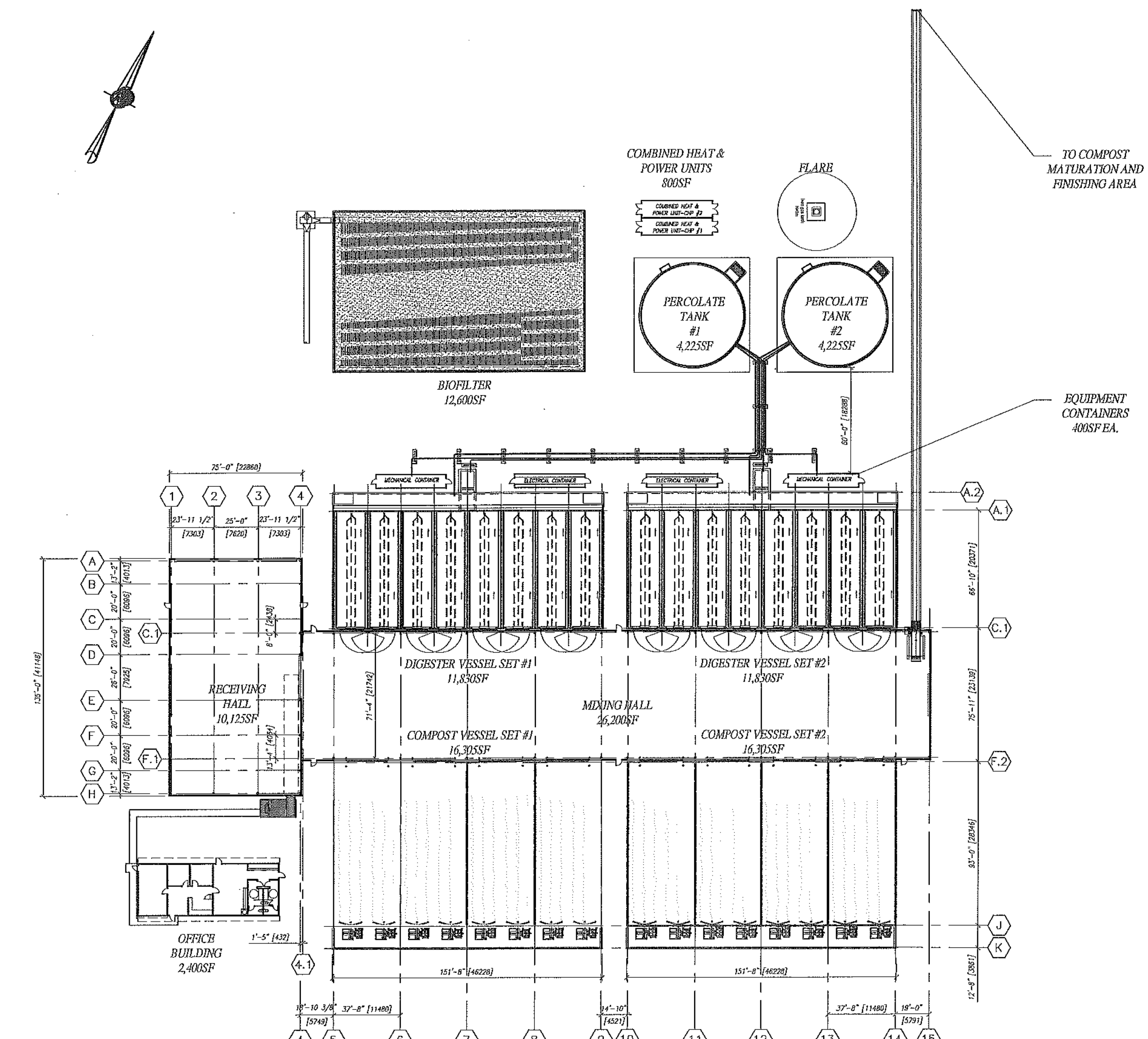
NINE PAR SITE - ZANKER ROAD/LOS ESTEROS ROAD

CITY OF SAN JOSE, SANTA CLARA COUNTY, CALIFORNIA

FIGURE 2

RJA
RUGGERI-JENSEN-AZAR
ENGINEERS • PLANNERS • SURVEYORS
4580 CHABOT DRIVE, SUITE 200 PLEASANTON, CA 94588
PHONE: (925) 227-9100 FAX: (925) 227-9300

DATE: JANUARY 15, 2010 JOB NO. 091091 SHEET 1 OF 1



REV	DESCRIPTION	DRN	DATE	CKD	DATE	APD	DATE
1	REFERENCE ONLY	RRM	01-14-10	.	.	.	.

ZeroWaste ENERGY DEVELOPMENT COMPANY

Eggersmann Anlagenbau
32549 Bad Oeynhausen
Germany

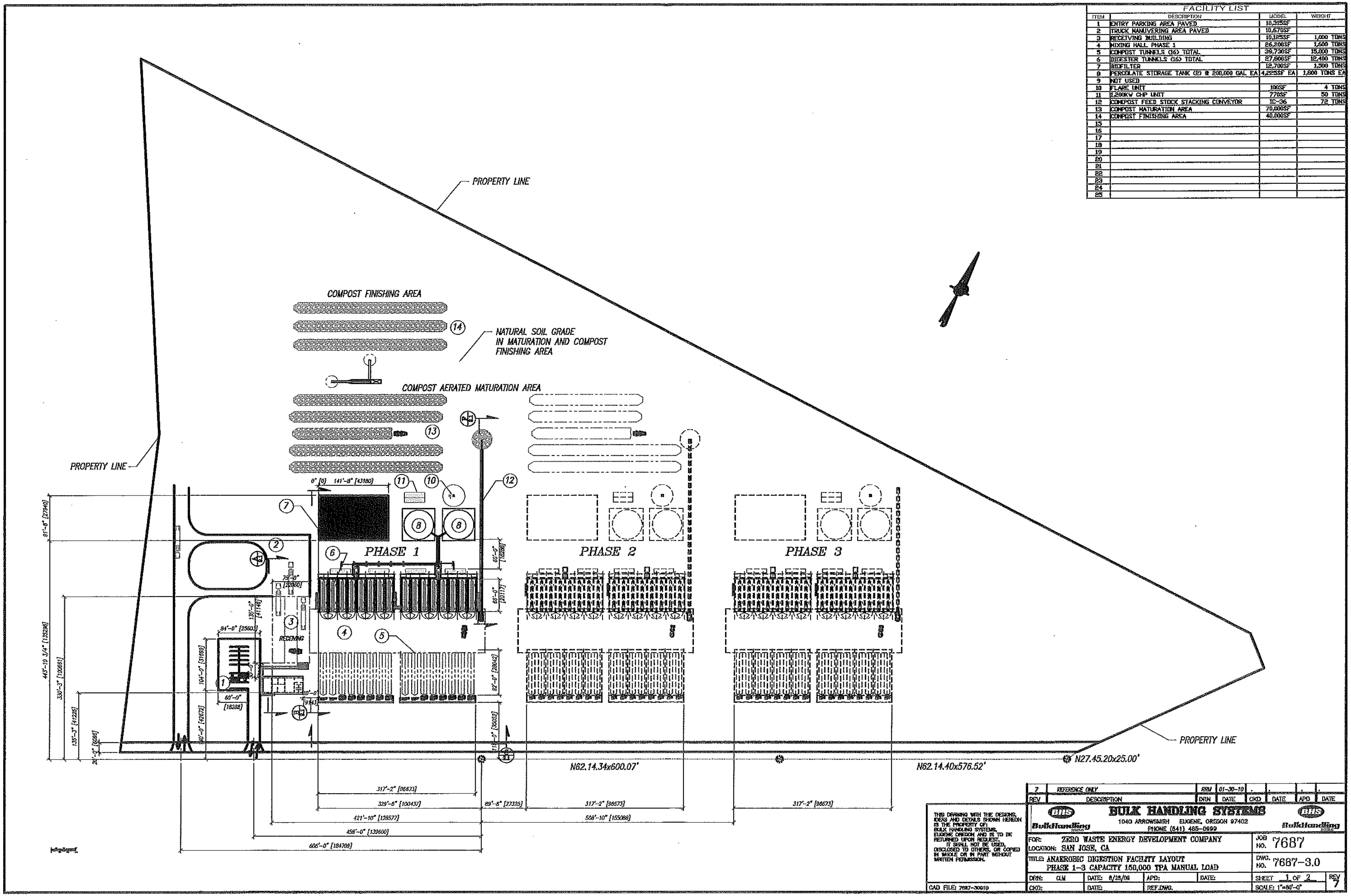
CAD FILE: 7687-40A10

BULK HANDLING SYSTEMS
1040 ARROWSMITH EUGENE, OREGON 97402
PHONE (541) 485-0999

FOR: ZERO WASTE ENERGY DEVELOPMENT COMPANY
LOCATION: SAN JOSE, CA
TITLE: ANAEROBIC DIGESTION FACILITY LAYOUT PHASE 1 CAPACITY 50,000 TPA

JOB NO. 7687
DWG. NO. 7687-4.0
DRN: RRM DATE: 01-14-10 APD: DATE:
CKD: DATE: REF.DWG.
SHEET 1 OF 9 REV 1
SCALE: 1"=30'-0"

FIGURE 3 (SHT 1 OF 2



FACILITY LIST			
ITEM	DESCRIPTION	MODEL	WEIGHT
1	ENTRY PARKING AREA PAVED	10,315SF	
2	TRUCK MANUVERING AREA PAVED	10,670SF	
3	RECEIVING BUILDING	10,125SF	1,000 TONS
4	MIXING HALL PHASE 1	26,200SF	1,500 TONS
5	COMPOST TUNNELS (16) TOTAL	39,730SF	15,000 TONS
6	DIGESTER TUNNELS (16) TOTAL	27,800SF	12,400 TONS
7	BIOFILTER	12,700SF	1,500 TONS
8	PERCOLATE STORAGE TANK (2) @ 200,000 GAL EA	4,225SF EA	1,600 TONS EA
9	NOT USED		
10	FLARE UNIT	100SF	4 TONS
11	1,200KW CHP UNIT	770SF	50 TONS
12	COMPOST FEED STOCK STACKING CONVEYOR	IC-36	72 TONS
13	COMPOST MATURATION AREA	70,000SF	
14	COMPOST FINISHING AREA	40,000SF	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

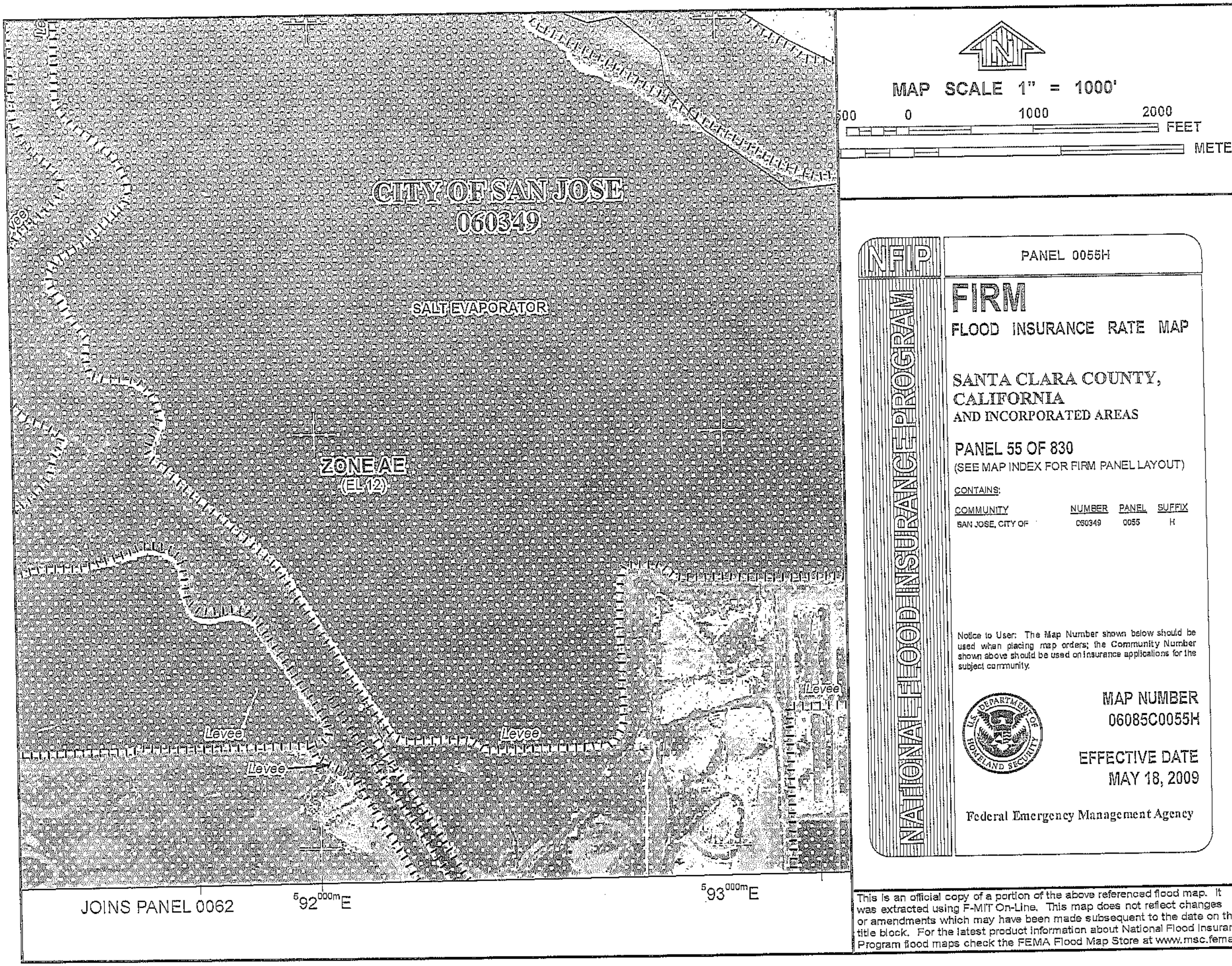
REV	DESCRIPTION	DRN	DATE	CKD	DATE	APD	DATE
7	REFERENCE ONLY	RRM	01-30-10	.	.	.	.

CAD FILE: 7687-30010

BULK HANDLING SYSTEMS
1040 ARROWSMITH EUGENE, OREGON 97402
PHONE (541) 485-0999

FOR: ZERO WASTE ENERGY DEVELOPMENT COMPANY
LOCATION: SAN JOSE, CA
JOB NO. 7687
TITLE: ANAEROBIC DIGESTION FACILITY LAYOUT PHASE 1-3 CAPACITY 150,000 TPA MANUAL LOAD
DWG. NO. 7687-3.0
DRN: CLM DATE: 8/28/09 APD: DATE:
CKD: DATE: REF.DWG.
SHEET 1 OF 2 REV 7
SCALE: 1"=80'-0"

FIGURE 3 (SHT 2 OF 2)



NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0055H

FIRM

FLOOD INSURANCE RATE MAP

SANTA CLARA COUNTY,
CALIFORNIA
AND INCORPORATED AREAS

PANEL 55 OF 830
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SAN JOSE, CITY OF	060349	0055	H

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

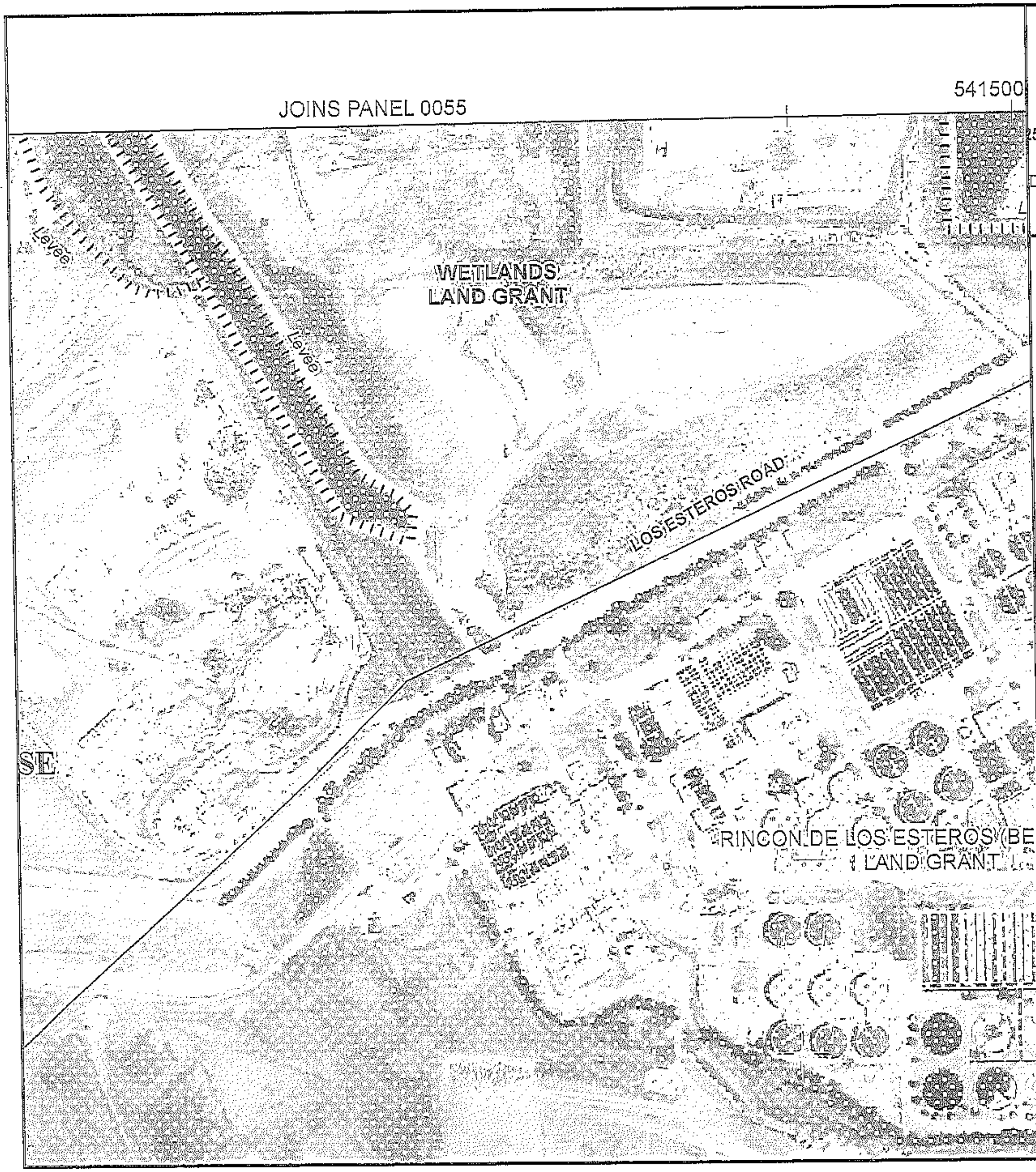
MAP NUMBER
06085C0055H

EFFECTIVE DATE
MAY 18, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FIGURE 4 (2 OF 2)



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METER

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0062H

FIRM

FLOOD INSURANCE RATE MAP

SANTA CLARA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 62 OF 830

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SAN JOSE, CITY OF	060349	0062	H
SANTA CLARA, CITY OF	060350	0062	H

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
06085C0062H

EFFECTIVE DATE
MAY 18, 2009

Federal Emergency Management Agency

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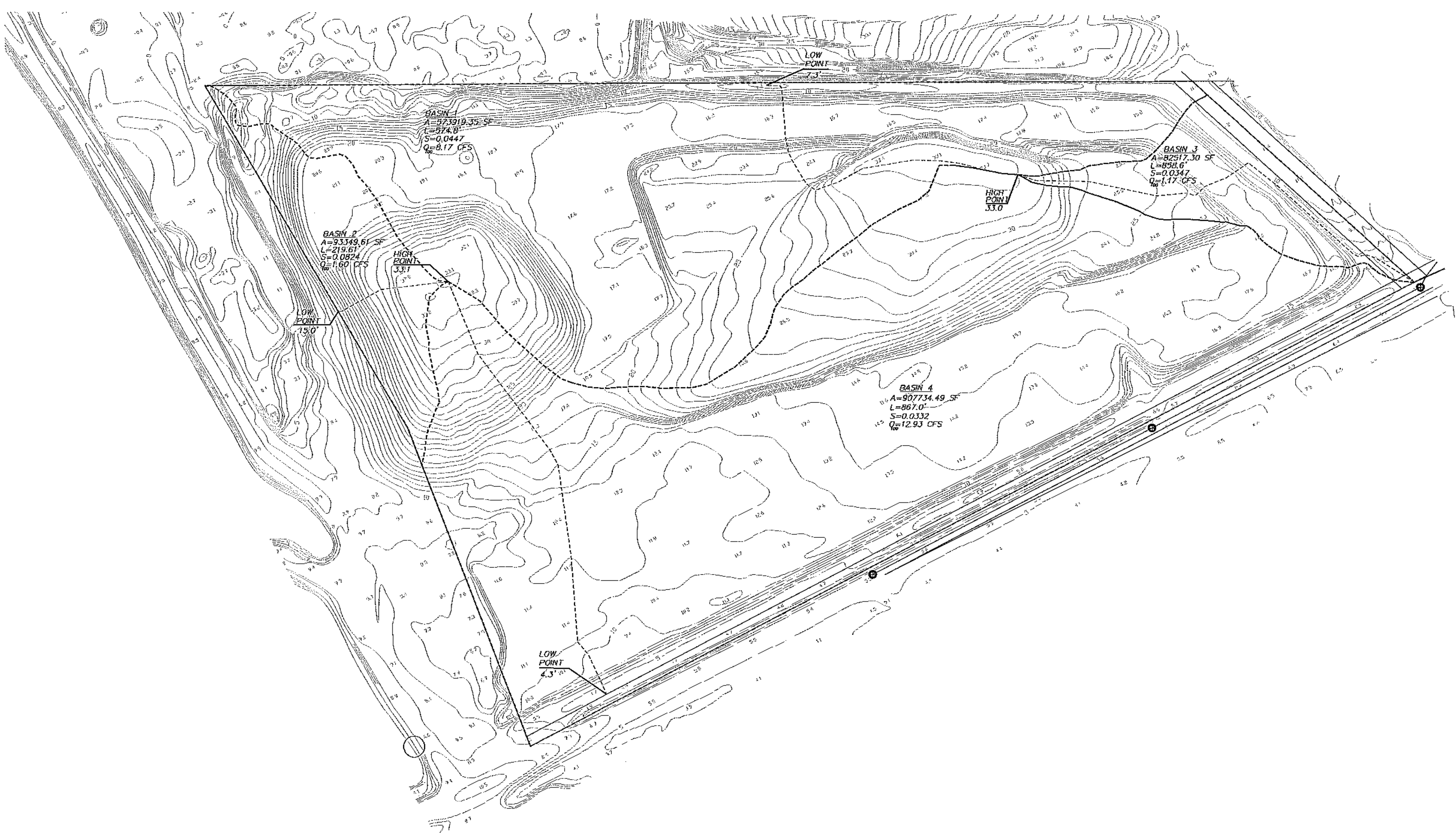
FIGURE 4 (1 OF 2)



NOTES

1. FOR NOTES SEE ZWES-1-DW-111-717-001.
2. FOR COMPLETE LEGEND SEE ZWES-1-DW-111-717-001.

LEGEND

- EXISTING WATER COURSES WITHIN BASIN AREA
- BASIN WATERSHED BOUNDARY
- LEASE PROPERTY BOUNDARY
- EXISTING CONTOUR

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH SPEC	LEAD ENGINEER	PROJ ENG MANAGER	PROJECT MANAGER
A	03/04/10	ISSUED FOR PERMITTING	AP	RCS	JD	RCS	RH	AH	AH

PRELIMINARY STATUS — DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

APPROVED STATUS — DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

ORIGINATING PERSONNEL

DRAWN BY: A. PRATT
CHECKED BY: R. C. SAYLO
LEAD DESIGNER: J. DAHLGREN
ENGINEER/TECH SPECIALIST: R. C. SAYLO
PROJECT ENGINEERING MANAGER: R. HILL
PROJECT MANAGER: A. HALL

PROFESSIONAL ENGINEER'S SEAL

Zero Harm — Leadership, No Incidents, Safe Behavior

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF PE: ROLANDO C. SAYLO STATE: CA LIC. NO.: C76858 DATE:

WorleyParsons resources & energy

ZeroWaste ENERGY DEVELOPMENT COMPANY

CLIENT/PROJECT TITLE

ANAEROBIC DIGESTION FACILITY
SAN JOSE, CA

PHASE I - III
STORM WATER CONTROL PLAN
PRE-CONSTRUCTION
WATER SHED

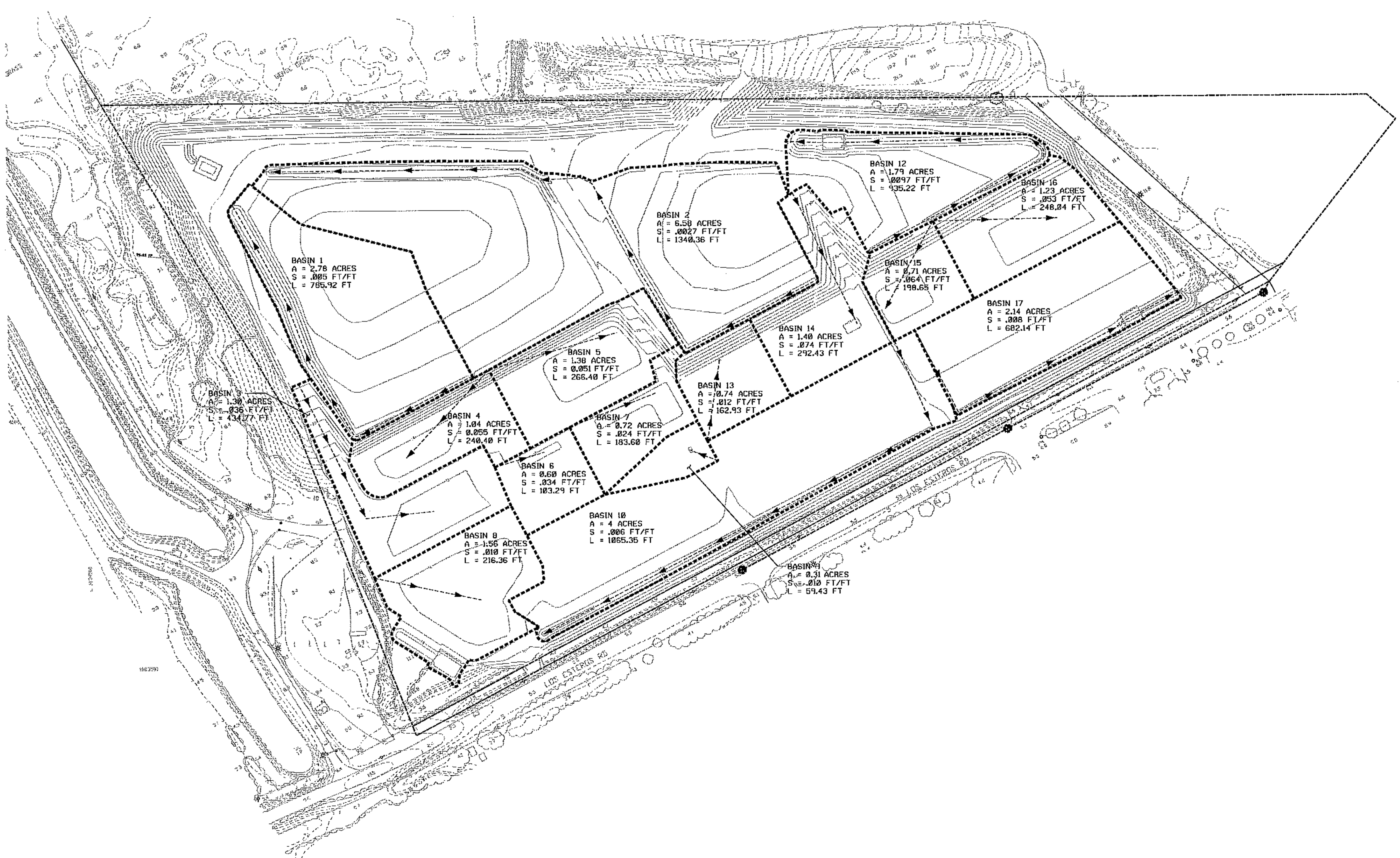
SCALE: 1"=100'
DRAWING SIZE: ARCH D (36" x 24")
WORLEYPARSONS DWG. NO.: FIGURE 5
REV: A

PRELIMINARY
NOT FOR CONSTRUCTION

$$DESIGN-FILE-NAME$$ $$$DATE$$$ $$$TIME$$$$

10 9 8 7 6 5 4 3 2 1
A B C D E F G H

..\ZWES-1-DW-112-720-015_Figure 5.dgn 3/15/2010 9:23:03 AM



LEGEND

- LONGEST WATER COURSE WITHIN SUB-BASIN AREA
- SUB-BASIN WATERSHED BOUNDARY
- LEASE PARCEL BOUNDARY
- PROPOSED CONTOUR
- ROAD CENTERLINE
- EXISTING CONTOUR

N

0 100 200 300 400
1" = 100 FT

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH. SPEC.	LEAD DISC ENGINEER	PROJ ENGR MANAGER	PROJECT MANAGER
A	02 16 10	ISSUED FOR PERMITTING	AP	RCS	JD	RCS	RH	AH	AH

PRELIMINARY STATUS DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.
LOE

APPROVED STATUS DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.
LOE

ORIGINATING PERSONNEL	PROFESSIONAL ENGINEER'S SEAL
DRAWN BY A. PRATT	
CHECKED BY R. SAYLO	
LEAD DESIGNER J. DAHLGREN	
ENGINEER/TECH SPECIALIST R. SAYLO	
PROJECT ENGINEERING MANAGER R. HILL	
PROJECT MANAGER A. HALL	

Zero Harm — Leadership, No Incidents, Safe Behavior

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF PE: ROLANDO C. SAYLO STATE: CA LIC. NO.: C70098 DATE:

WorleyParsons
resources & energy

ZeroWaste ENERGY DEVELOPMENT COMPANY

CLIENT/PROJECT TITLE

ANAEROBIC DIGESTION FACILITY
SAN JOSE, CA

PHASE I - III
STORM WATER CONTROL PLAN
POST-CONSTRUCTION
WATER SHED

SCALE 1"=100' | DRAWING SIZE ARCH D (36" x 24")

WORLEYPARSONS DWG. NO. FIGURE 6 | REV A

THIS STORM WATER CONTROL PLAN CONFORMS TO CITY OF SAN JOSE POLICY NO. 6-29

PRELIMINARY
NOT FOR CONSTRUCTION

DESIGN-FILE-NAME **DATE** **TIME**

..\ZWES-1-DW-112-720-016_Figure 6.dgn 3/16/2010 2:35:20 PM

APPENDIX 1

WorleyParsons
resources & energy

Customer	Zero Waste Energy Development Company	**Project No.**	52011702
Project Title	Anaerobic Digestion Facility I-III	**Calc No.**	ZWES-1-DC-024-CE-0001
Calculation Title	Storm Drain System	**Phase/CTR**	
Elec File Location			
Project File Location		**Page**	1 of 6

Calculation Objective

Design the storm drainage system including the stormwater control measures for the ZWED site. Calculation will determine size of storm drain pipe, culverts, vegetative swales and forebays.

Calculation Method

Methods are used:

1) Rational Method, for a 10-yr storm and 100-yr storm
2) 25-yr storm for culvert size and 100-yr storm

Software Used

Title	Version	Validated (Yes/No/NA)

Assumptions

1) Mean Annual Precipitation (MAP) at the site is 14 inches, per Figure A-2 of the Santa Clara County Drainage Manual

Professional Engineer Seal

References

1) Santa Clara Valley Urban Runoff Pollution Prevention Program, C.3 Stormwater Handbook
2) Santa Clara County Drainage Manual, 2007
3) Post-Construction Urban Runoff Management Policy Number 6-29, City of San Jose, California, August 15, 2006

Conclusions

See attached spreadsheets for Calculation results

Rev	Date	Description	By	Checked	Approved
A	3-04-10	Issued for Permitting	JG	RS	

WorleyParsons
resources & energy

Customer	Zero Waste Energy Development Company	**Project No.**	52011702		
Project Title	Anaerobic Digestion Facility I-III	**Calc No.**	ZWES-1-DC-024-CE-0001		
Calculation Title	Storm Drain System	**Phase/CTR**			
Elec File Location					
Project File Location		**Page**	2	of	6

Please check boxes for all applicable items checked or delete if not appropriate:

Calculations:

- ☐ Calculation number assigned and registered (refer to project numbering system or Document Numbering System EPP-0040 for format).
- ☐ Project title shown.
- ☐ Calculation title shown.
- ☐ Revision history box complete and signed.
- ☐ Index.
- ☐ Appropriate stamp for preliminary issues.
- ☐ Calculation objectives (aims) stated.
- ☐ Calculation method defined or described (including formulae if relevant).
- ☐ Reference made to text, standard or code. Check version/edition with that required for project.
- ☐ Source of input data stated (with revision number and date if relevant).
- ☐ Assumptions stated.
- ☐ Summary of results or conclusions.
- ☐ For software based calculations, reference to software validation if available.
- ☐ Approach used is appropriate for problem being solved.
- ☐ Method clear and easy to follow.
- ☐ Input data correct.
- ☐ Calculation is arithmetically correct OR software previously verified and reference to verification checked.
- ☐ Calculation result within expected limits.
- ☐ Calculation tolerances stated if significant.
- ☐ Units used as required by customer.
- ☐ Abbreviations correct.
- ☐ Appropriate cross-references.
- ☐ Sketches included and clearly labeled, where required.
- ☐ Attachments included and referenced, as required.
- ☐ Considered design reviews, Hazop actions, client input, safety and environmental issues, etc.

Checking records:

- ☐ Checked and annotated copy of calculation filed (use "Check Print" stamp).
- ☐ Corrections made as required and calculation dated and signed on cover sheet by checker.

Revisions:

- ☐ Changes clouded.
- ☐ Revision history block updated.
- ☐ Calculation re-checked if required.

A	3-04-10	Issued for Permitting	JG	RS	
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

WorleyParsons
resources & energy

Customer	Zero Waste Energy Development Company	Project No.	52011702
Project Title	Anaerobic Digestion Facility I-III	Calc No.	ZWES-1-DC-024-CE-0001
Calculation Title	Storm Drain System	Phase/CTR	
Elec File Location			
Project File Location		Page	3 of 6

Table of Contents

Customer	Zero Waste Energy Development Company	**Project No.**	52011702		
Project Title	Anaerobic Digestion Facility I-III	**Calc No.**	ZWES-1-DC-024-CE-0001		
Calculation Title	Storm Drain System	**Phase/CTR**			
Elec File Location					
Project File Location		**Page**	4	of	6

1.0 Description
This Calculation will analyze the storm drain network and determine the size and slopes of the drainage pipes and culverts.

2.0 Background

3.0 Method of Analysis
a) Rational Method for 10 year storm
b) Mannings equations for open channel flow
c) 25-yr storm for Culvert sizing

4.0 Assumption
a) Mean Annual Precipitation is 14 inches
b) Minimum Pipe size for Main line storm drain 15 inches diameter

5.0 Calculations
5.1 Storm Drain: Using the rational method for 10-yr storm, determine the peak flow. The following is an example for one drainage area:

a) Find the drainage area to CB#3, use the attached post-development map;
Drainage area, A= 1.30 ac
Impervious A= 0.67 acres and Pervious A=0.0.628 ac

b) Next determine the composite or weighted C value,
C= 0.85 for Paved area (impervious)
C= 0.30 for Unpaved area (pervious)

Weighted C= [(0.85)(0.67) + (0.30)(0.628)] / (1.3)
C= 0.58

c) Determine time of concentration, Tc, using eq:

Tc= 0.0078 [(L^2)/S]^3.85 +10
where, L= furthest distance to drain (ft),
S= slope
For CB 3, L= 437', S= 0.036
Tc= 13.03 min

d) Find rainfall intensity, I, using the IDF curve for MAP14 (10-yr curve)
at Tc=13.03 min, I = 1.75 in/hr

e) Now determine peak flow, Q
Q= CiA = (0.58)*(1.75)*(1.30)= 1.33 cfs

See the attached Spreadsheet, ZWED for the remaining area flow calculations.

5.2 Use the attached pipe flow chart to determine pipe diameter from CB12.

a) For area 3, try Pipe flow chart for 12" dia.
Slope, s =0.002, and mannings number n= 0.013 for concrete pipe,
Velocity of flow = 3.6 fps
3.6 fps ≥ 2.6 fps Okay

b) Now determine Tc at downstream of pipe,
Tc= Initial Time + pipe flow time

Initial Tc= 13.03 min (overland) (from 5.1c)

With pipe Length 200'
Tc =200/3.6/60= 0.926 min

Total Tc= 13.03 min + 0.926 min = 13.96 min

See attached spreadsheet for remaining pipe sizes calculation.

5.3 Culvert size
Culvert is sized for 25 year storm and then checked for 100 yr storm for both inlet and outlet control.

a) Culvert 1, use Nomograph Headwater depth for concrete pipe culvert with inlet control.
Dia.= 12"
Q= 1.33 cfs (for 25-yr storm)
Hw/D= 0.65
Since Hw/D < 1, 12" pipe is okay

b) Now check for 100 year storm, inlet and outlet control
@ 100-yr storm, Q= 1.58 cfs

c) Now check for 100 year storm, inlet control

With Hw/D= 0.976
Culvert size 12" pipe okay.

d) Now check for 100 year, outlet control
Using Nomograph Head for concrete pipe culverts flowing full @ Q= 1.58 cfs,

L(pipe)= 85'
Ke= 0.2 (by Storm Drain design manual for concrete pipe)
Hw < 0.4

Use 12" minimum diameter pipe.

5.4 Pre-developed 100-yr Discharges -- See Attachment 7.9

5.5 Vegetative Water Quality Swales -- See Attachment 7.10

5.6 Forebay Calculations -- See Attachment 7.11

5.7 Open Channel Flow Calculator -- See Attachment 7.12

6. Conclusions

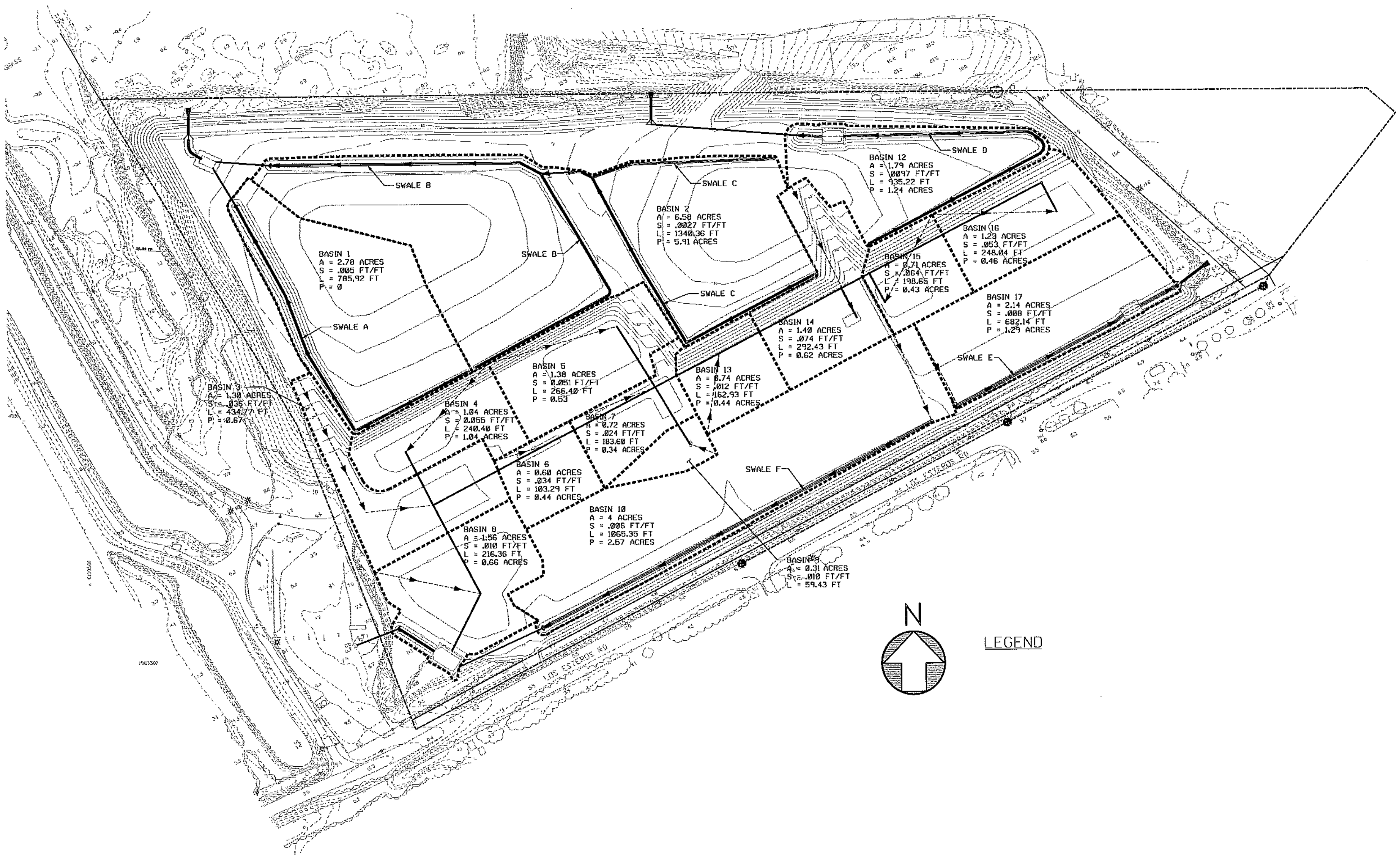
See all attachments.

NOTES

1. FOR NOTES SEE ZWES-1-DW-111-717-001.
2. FOR COMPLETE LEGEND SEE ZWES-1-DW-111-717-001.

LEGEND

Symbol	Description
————	EXISTING WATER COURSES WITHIN BASIN AREA
-------	BASIN WATERSHED BOUNDARY
– – – –	LEASE PROPERTY BOUNDARY
—492—	EXISTING CONTOUR
A	AREA
S	SLOPE
L	LENGTH
P	PERVIOUS



N

0 100 200 300 400
1" = 100 FT

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/ TECH SPEC	LEAD DISC ENGINEER	PROJ ENGR MANAGER	PROJECT MANAGER
A	03 04 10	ISSUED FOR PERMITTING	AP	RCS	JD	RCS	RH	AH	AH

PRELIMINARY STATUS — DATE — LOE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

APPROVED STATUS — DATE — LOE — REPRESENTS REVIEWED AND APPROVED DESIGN, ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

ORIGINATING PERSONNEL	
DRAWN BY	A. PRATT
CHECKED BY	R. C. SAYLO
LEAD DESIGNER	J. DAHLGREN
ENGINEER/TECH SPECIALIST	R. C. SAYLO
PROJECT ENGINEERING MANAGER	R. HILL
PROJECT MANAGER	A. HALL

PROFESSIONAL ENGINEER'S SEAL

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF PE: ROLANDO C. SAYLO STATE: CA LIC. NO.: C70098 DATE:

Zero Harm — Leadership, No Incidents, Safe Behavior

WorleyParsons resources & energy

ZeroWaste ENERGY DEVELOPMENT COMPANY

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SAN JOSE, CA

PHASE I - III
STORM WATER CONTROL PLAN
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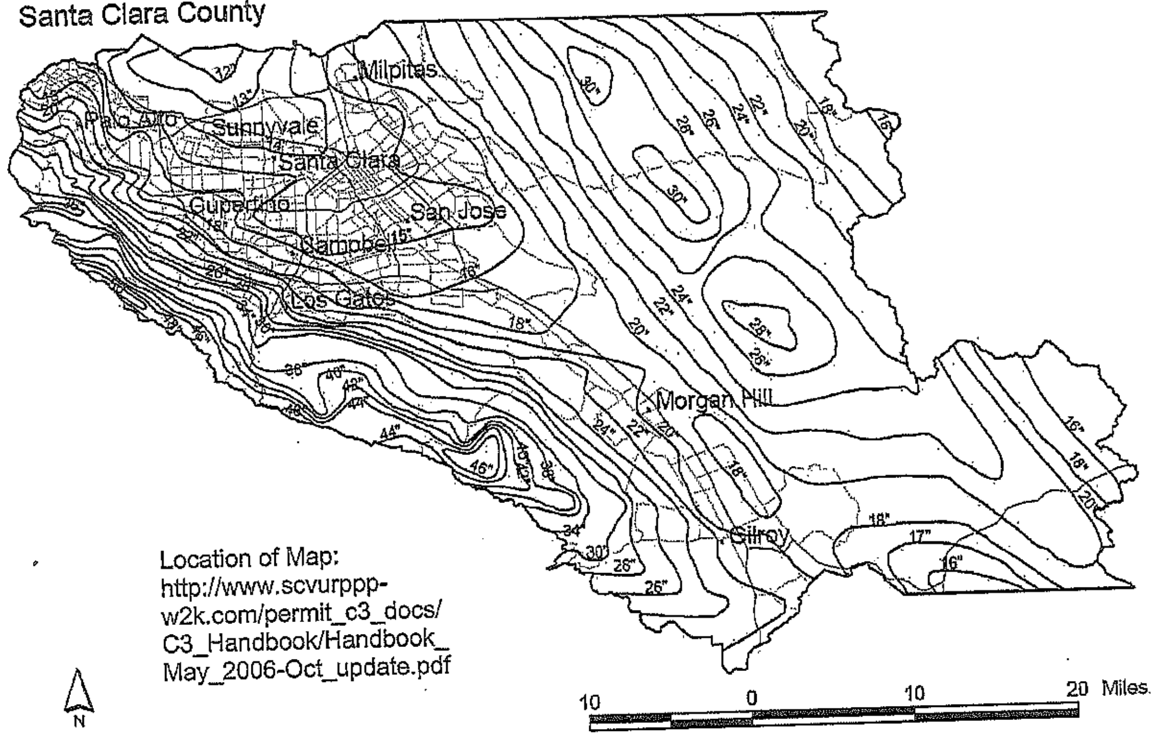
SCALE: 1"=100' — DRAWING SIZE: ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.: ATTACHMENT 7.1 — REV: A

PRELIMINARY
NOT FOR CONSTRUCTION

A TACHMENT 7.2

Figure A-2
Mean Annual Precipitation Map
Santa Clara County



SOURCE: Santa Clara Valley Water District, Mean Annual Precipitation Map, San Francisco & Monterey Bay Region, 1998

Figure A-2: Mean Annual Precipitation, Santa Clara County

ATTACHMENT 7.3

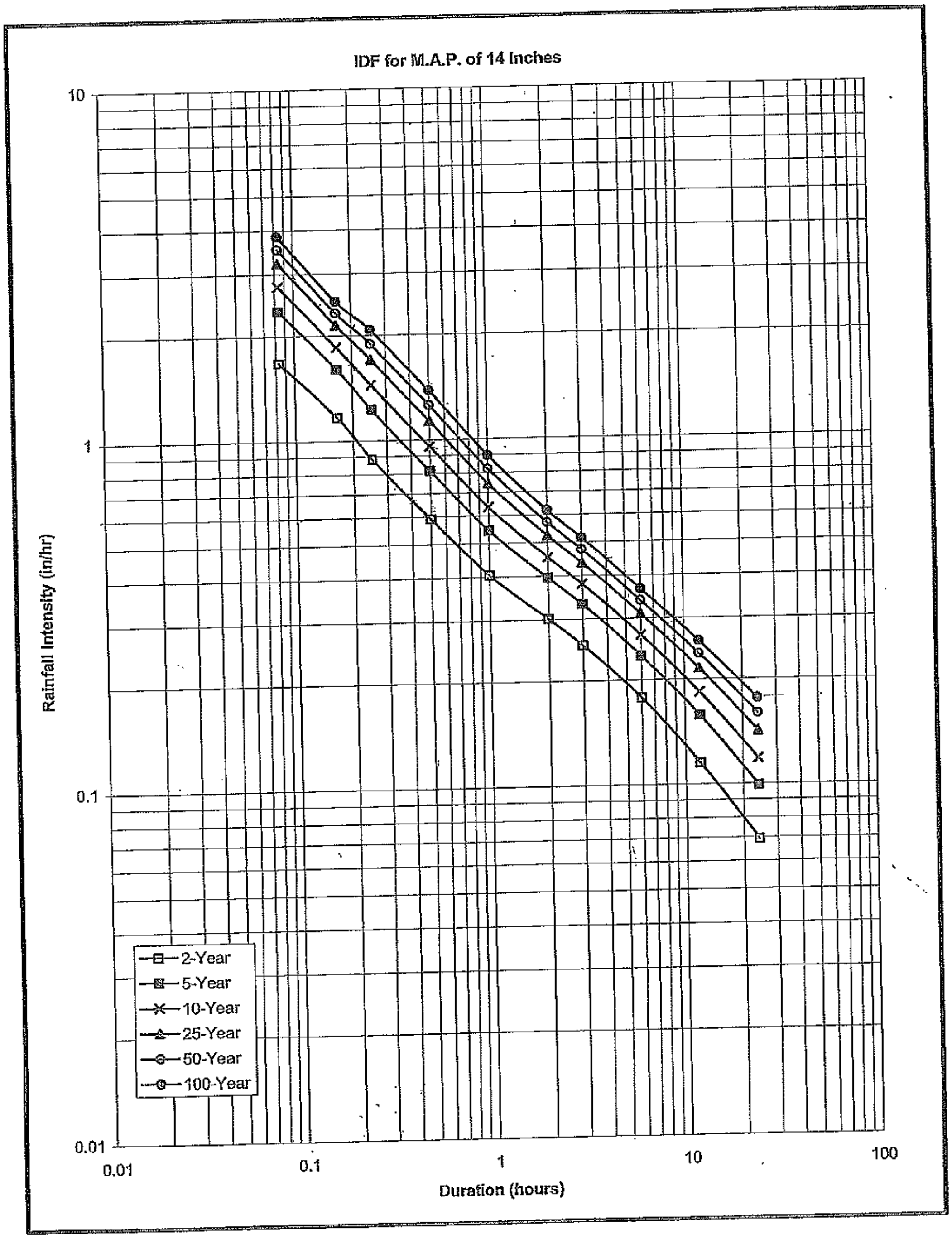


Figure B-2: IDF for M.A. P. of 14 Inches

ATTACHMENT 7.4

ZWES-1-DC-024-CE-0001

ZWED Q cumulative for 2/10/25/50/100 year

Area	C
Paved Area	0.85
Unpaved Shrub Area	0.3

Area	Catch Basin	Area in SQFT Paved	Area in SQFT Unpaved	Total	Composite Ave. C	Area (acres)	Length to inlet	slope	**(Tc) Flow Time (min)	2yr *I (in/hr)	2yr Q (cfs)	10-yr *I (in/hr)	10-yr Q (cfs)	25-yr *I (in/hr)	25-yr Q (cfs)	50-yr *I (in/hr)	50-yr Q (cfs)	100-yr *I (in/hr)	100-yr Q (cfs)
1	swale A	0	120869	120869	0.30	2.78	785	0.005	20.16	0.79	0.66	1.40	1.17	1.60	1.33	1.80	1.50	1.9	1.58
2	swale B/C	29226	256861	286087	0.36	6.58	1340	0.0027	29.45	0.60	1.41	0.80	1.87	1.15	2.70	1.30	3.05	1.45	3.40
	Forebay 1												**3.04**						**4.98**
3	3	29226	27295	56521	0.58	1.30	437	0.036	13.03	1.00	0.76	1.75	1.33	1.95	1.48	2.10	1.60	2.25	1.71
4	4	6495	38722	45217	0.38	1.04	240	0.055	11.62	1.10	0.43	1.80	0.71	1.95	0.77	2.12	0.84	2.33	0.92
5	5	22982	62174	60000	0.51	1.38	266	0.051	11.81	1.10	0.78	1.80	1.27	1.95	1.37	2.15	1.52	2.30	1.62
6	6	19130	6957	26087	0.70	0.60	103	0.034	11.02	1.15	0.49	1.82	0.77	1.97	0.83	2.15	0.91	2.35	0.99
7	7	14673	16631	31304	0.56	0.72	184	0.024	11.82	1.10	0.44	1.80	0.72	1.95	0.78	2.15	0.86	2.3	0.92
8	8	29651	38175	67826	0.54	1.56	216	0.010	12.88	0.95	0.80	1.68	1.42	1.90	1.60	2.05	1.73	2.1	1.77
9	9	10434	3044	13478	0.73	0.31	59	0.010	11.06	1.15	0.26	1.82	0.41	1.97	0.44	2.15	0.48	2.35	0.53
10	swale F	112143	61770	173913	0.65	4.00	1065	0.006	21.98	0.70	1.83	1.30	3.40	1.50	3.93	1.60	4.19	1.75	4.58
13	13	19275	12898	32173	0.63	0.74	163	0.012	12.16	1.02	0.48	1.70	0.79	1.95	0.91	2.15	1.00	2.4	1.12
14	14	27112	33757	60869	0.54	1.40	197	0.012	12.50	1.00	0.76	1.68	1.28	1.93	1.47	2.12	1.62	2.33	1.78
15	15	18629	12240	30869	0.63	0.71	198	0.064	11.32	1.11	0.50	1.82	0.82	1.96	0.88	2.15	0.96	2.33	1.05
16	16	20213	33265	53478	0.51	1.23	248	0.053	11.69	1.10	0.69	1.80	1.12	1.95	1.22	2.12	1.32	2.3	1.44
	Forebay 3												**14.04**						**18.42**
12	swale D	23926	53900	77826	0.47	1.79	935	0.010	19.01	0.82	0.69	0.85	0.71	1.62	1.36	1.74	1.90	1.88	1.58
	Forebay 2												**0.71**						**1.58**
17	swale E	56005	37038	93043	0.63	2.14	682	0.008	17.61	0.68	0.92	1.10	1.49	1.45	1.96	1.6	2.16	1.7	2.30
	Forebay 4												**1.49**						**2.30**
	Total sqft:	439120	815596	1229560							**11.88**		**19.28**		**23.04**		**25.64**		**27.28**
	Total Ac.	10.10	18.76	28.28															

*From IDF for M.A.P of 14 inches

** Tc per Santa Clara County Storm Drain Manual, 2007

ATTACHMENT 7.5

ZWES-1-DC-024-CE-0001

ZWED Storm Drain Network- 10yr storm

Confluence Analysis

* For Q1 < Q2

Case 1: T1=T2   Qp = Q1+Q2

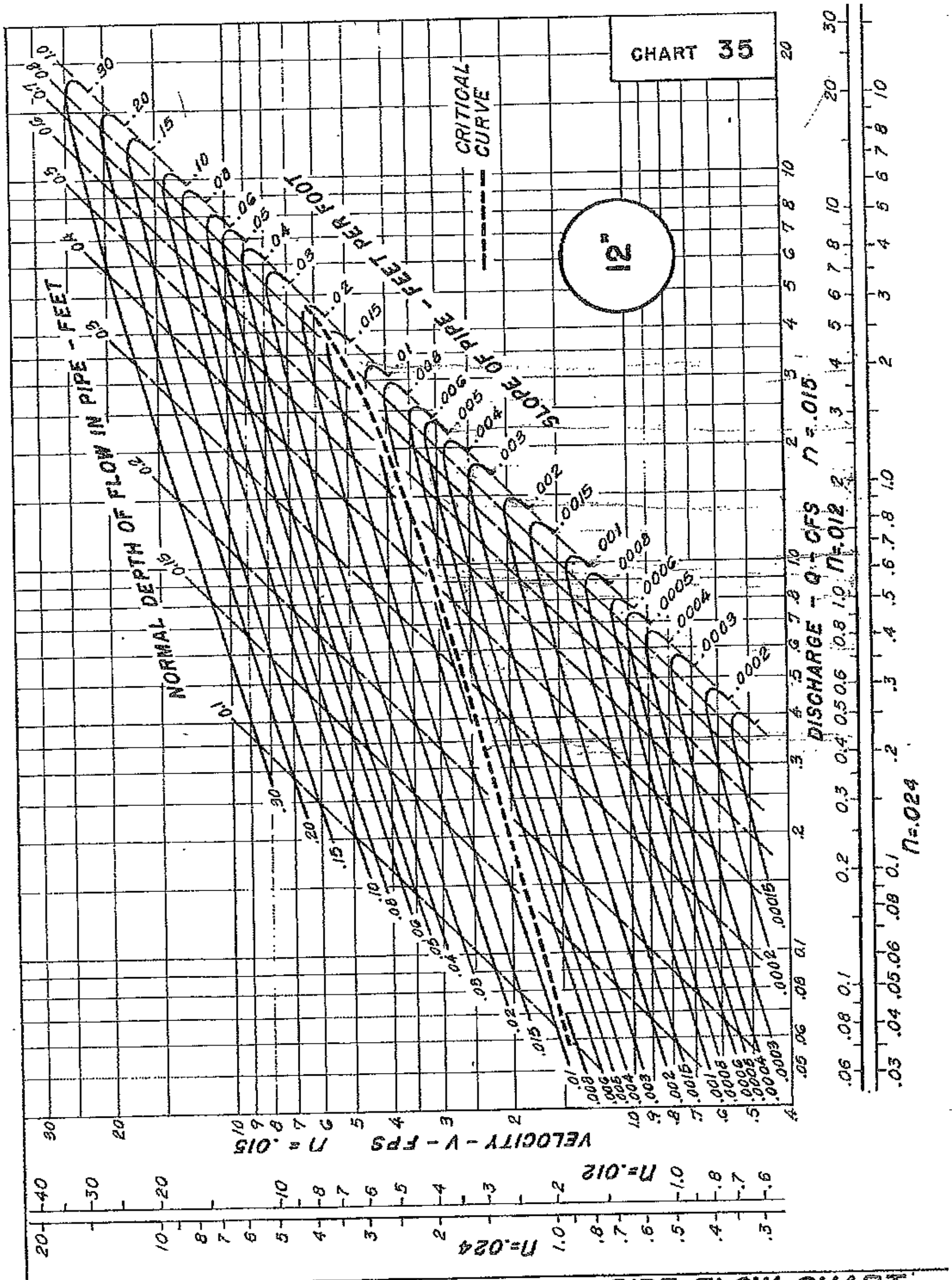
Case 2: T1<T2   Qp = Q2+(I2/I1)Q1   big Q, big T

Case 3: T1>T2   Qp = Q2+(I2/I1)(T2/T1)Q1   big Q, small T

Structure	Acres	Weight Ave. C	I (in/hr)	Q (cfs)	Sum QT (cfs)	slope	Pipe	Pipe Size Dia (in)	V (fps)	Length (ft)	T (min)	Sum Tc	I at sum Tc	Invert in	Invert out
CB 16	1.23	0.505	1.8	1.12								11.69			
					1.12	0.005	P1	12	3.3	66	0.33	12.02		10.9	10.57
MH 1															
					1.12	0.005	P2	12	3.3	387	1.95	13.98	1.72	10.47	8.54
CB 15	0.71	0.63	1.82	0.81								11.32			
					0.81	0.008	P10	12	4.1	65	0.26	11.58		9.16	8.64
MH 2															
					1.79	0.002	P3	15	2.8	63	0.38	14.35	1.7	8.44	8.31
CB 14	1.4	0.54	1.685	1.27								12.50			
					1.27	0.003	P11	12	2.8	66	0.39	12.89		8.61	8.41
MH 3															
					2.87	0.002	P4	15	2.8	276	1.64	16.00	1.5	8.21	7.66
CB 13	0.74	0.63	1.7	0.79								12.16			
					3.27	0.0015	P5	18	2.8	144	0.86	16.85	1.48	7.56	7.34
CB 5	1.38	0.51	1.8	1.27								11.82			
					1.25	0.008	P13	12	3.5	140	0.67	12.49		8.56	7.44
CB 9	0.31	0.73	1.82	0.41								11.06			
					0.41	0.008	P12	12	2.8	133	0.79	11.85		8.51	7.44
CB 7	0.72	0.56	1.8	0.73								11.82			
					4.85	0.002	P6	21	3.2	250	1.30	18.15	1.35	7.24	6.74
CB 6	0.7	0.6	1.82	0.76								11.02			
					5.10	0.001	P7	21	3.2	250	1.30	19.46	1.35	6.64	6.39
CB 4	1.04	0.38	1.8	0.71								11.62			
					0.75	0.008	P14	12	3.2	120	0.63	12.25		7.45	6.49
CB 3	1.31	0.58	1.75	1.33								13.03			
					7.18	0.002	P8	24	3.6	200	0.93	20.38	1.3	6.29	5.89
CB 8	1.56	0.54	1.68	1.42								12.88			
					8.60	0.002	P9	24	3.9	128	0.55	20.93		5.79	5.54
outlet															

Culvert	Length (ft)	Slope (ft/ft)	Q-25 yr (cfs)	Hw/D Inlet 25yr	Q-100yr (cfs)	Hw Inlet 100yr	Hw outlet 100yr	dia (in)
1	85	0.001	1.33	0.65	1.58	0.76	<0.4	12
2	109	0.014	2.70	0.75	3.40	0.84	<0.4	15
3	36	0.003	0.87	<0.6	1.13	0.70	<0.4	12
4	298	0.001	1.36	0.65	1.58	0.75	<0.4	12
5	184	0.004	3.93	0.70	4.58	0.77	0.9	18
6	90	0.01	15.69	0.75	18.42	0.88	0.4	30

ATTACHMENT 7.6



PIPE FLOW CHART
12-INCH DIAMETER

FIGURE A-4. (CHART 35) Pipe charts for the solution of Manning's equation. *(Courtesy of U.S. Department of Commerce, Bureau of Public Roads, Design Charts for Open-Channel Flow.)*

ATTACHMENT 7.7

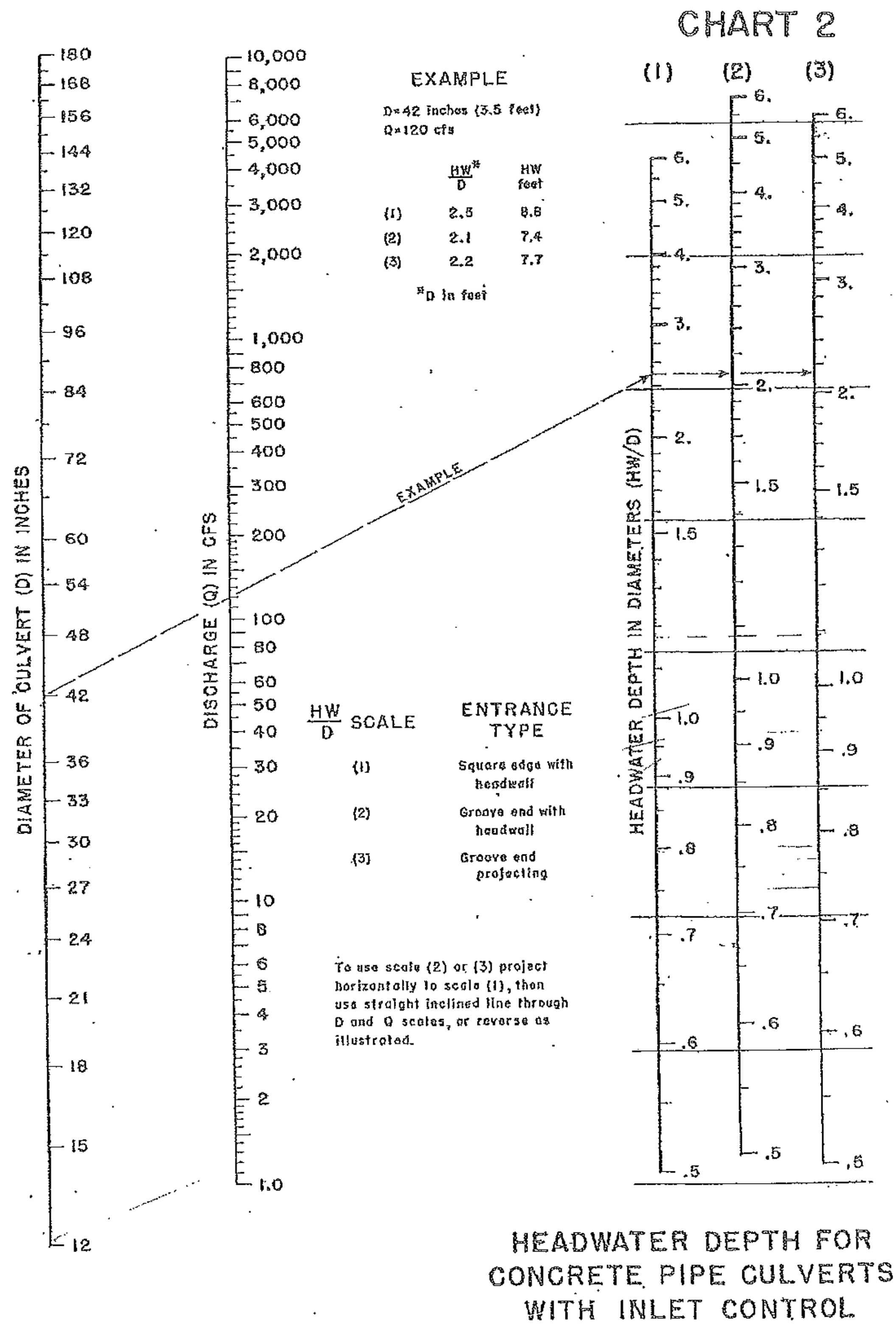
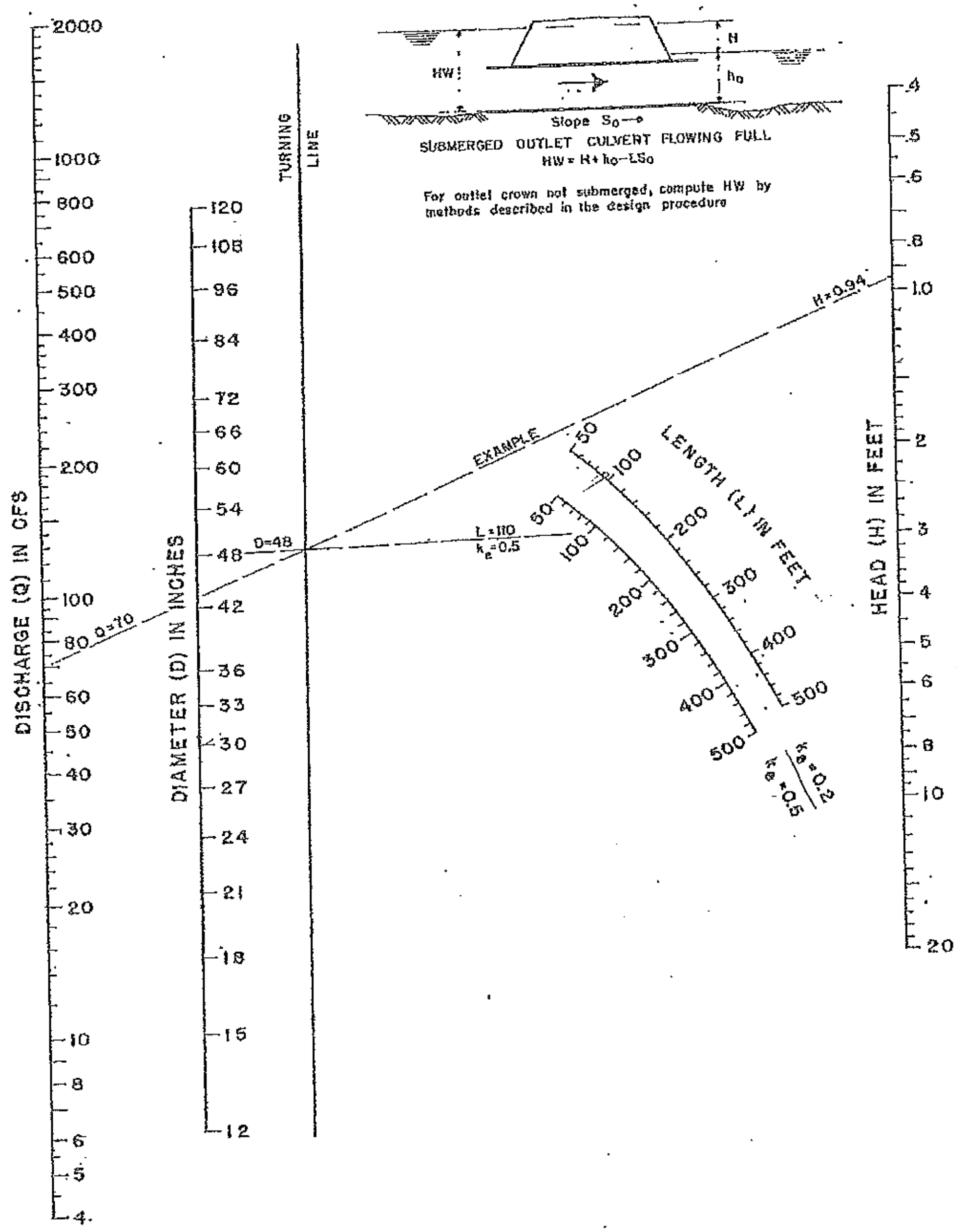


FIGURE B-1. (CHART 2) Culverts with inlet control. *(Courtesy of U.S. Department of Transportation, Federal Highway Administration, Hydraulic Charts for the Selection of Highway Culverts.)*

ATTACHMENT 7.8

CHART 9



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

FIGURE B-2. (CHART 9) Culverts with outlet control. *(Courtesy of U.S. Department of Transportation, Federal Highway Administration, Hydraulic Charts for the Selection of Highway Culverts.)*

ATTACHMENT 7.9 (SHT 1 OF 4)

WorleyParsons
resources & energy

Calculation Sheet

Customer	Proj No
Project Title Zero Waste Energy	Calc No
Calculation Title Calc's based on Santa Clara County Drainage Manual Modified Rational Method Guidelines	Phase/CTR
Elec File Location C:\Documents and Settings\erica.carlson\My Documents\[CalculationShtFormec.xls]Calculation Cover Sheet	
Project File Location	Page of

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
	3/4/10	Jonas D.									

Basin 1:

C = 0.30 L = 574.8'
A = 13.17 acres S = 0.0447

$t_c = 0.0078\left(\frac{L^2}{S}\right)^{0.385} + 10$

$t_c = 0.0078\left(\frac{(574.8)^2}{0.0447}\right)^{0.385} + 10$

$t_c = 13.43$ mins.

15-min → 100 yr return period

$X_{T,D} = (0.421360) + (0.006957)(14)$

$X_{T,D} = 0.518758$

$i_{T,D} = \frac{X_{T,D}}{D} = \frac{0.518758}{0.25} = 2.07$

$Q = CiA$
$Q = (0.30)(2.07)(13.17)$

$Q_1 = 8.17$ cfs

Basin 2:

C = 0.30 L = 219.61'
A = 2.14 acres S = 0.0824

$t_c = 0.0078\left(\frac{(219.61)^2}{0.0824}\right)^{.385} + 9$

$t_c = 11.29$ mins.

10 min → 100 yr return period

$X_{T,D} = (0.315263) + (0.007312)(14)$

$X_{T,D} = 0.417631$

$i_{T,D} = \frac{0.417631}{0.16667} = 2.50$

$Q = CiA$
$Q = (0.30)(2.50)(2.14)$

$Q_2 = 1.60$ cfs

WorleyParsons
resources & energy

Calculation Sheet

Customer	Proj No
Project Title	Calc No
Calculation Title	Phase/CTR
Elec File Location	

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Project File Location — Page of

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
	3/4/10	Jonas D.									

Basin 3:

$L = 858.6'$ $C = 0.3$

$S = 0.0347$ $A = 1.89$ acres

$$t_c = 0.0078\left(\frac{(858.6)^2}{0.0347}\right)^{.385} + 10$$

$t_c = 15.16$ mins

15 min → 100 yr return period

$X_{T,D} = (0.421360) + (0.006957)(14)$

$X_{T,D} = 0.518758$

$$i_{T,D} = \frac{X_{T,D}}{D} = \frac{0.518758}{0.25} = 2.07$$

$Q = CiA$

$Q = (0.30)(2.07)(1.89)$

$Q_3 = 1.17$ cfs

Basin 4:

$L = 867'$ $C = 0.3$

$S = 0.0332$ $A = 20.83$ acres

$$t_c = 0.0078\left(\frac{(867)^2}{0.0332}\right)^{.385} + 10$$

$t_c = 15.29$ mins.

15 min → 100 yr return period

$X_{T,D} = (0.421360) + (0.006957)(14)$

$X_{T,D} = 0.518758$

$$i_{T,D} = \frac{X_{T,D}}{D} = \frac{0.518758}{0.25} = 2.07$$

$Q = CiA$

$Q = (0.30)(2.07)(20.83)$

$Q_4 = 12.93$ cfs

ATTACHMENT 7.9 (SHT 3 OF 4)

WorleyParsons
resources & energy

Calculation Sheet

Customer		Proj No	
Project Title	Zero Waste Energy	Calc No	
Calculation Title	Calc's based on Santa Clara County	Phase/CTR	
Elec File Location	Drainage Manual Guidelines for Modified Rational Method		
	C:\Documents and Settings\erica.carlson\My Documents\[CalculationShtFormec.xls]Calculation Cover Sheet		
Project File Location		Page	of

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
	3/4/10	Jonas D.									

Existing Catch Basin Q sizing for existing flows:

A = 4.97 acres S = 0.034 ft/ft
L = 775.04' C = 0.30

$$t_c = 0.0078\left(\frac{L^2}{S}\right)^{.385} + 10$$

$$t_c = 0.0078\left(\frac{(775.04)^2}{0.034}\right)^{0.385} + 10$$

$$t_c = 14.81 \text{ mins.}$$

15 min → 100 yr return period:

$$X_{T,D} = (0.421360) + (0.006957)(14)$$

$$X_{T,D} = 0.518758$$

$$i_{T,D} = \frac{X_{T,D}}{D} = \frac{0.518758}{0.25} = 2.07$$

$$Q = CiA$$

$$Q = (0.30)(2.07)(4.97)$$

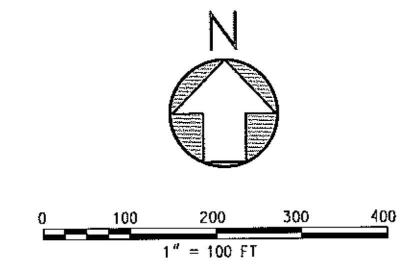
$$\boxed{Q_{CB} = 3.08 \text{ cfs}}$$

NOTES

1. FOR NOTES SEE ZWES-1-DW-111-717-001.
2. FOR COMPLETE LEGEND SEE ZWES-1-DW-111-717-001.

LEGEND

- EXISTING WATER COURSES WITHIN BASIN AREA
- BASIN WATERSHED BOUNDARY
- LEASE PROPERTY BOUNDARY
- EXISTING CONTOUR



REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH SPECIALIST	PROJECT ENGINEERING MANAGER	PROJECT MANAGER	
A	03/04/10	ISSUED FOR PERMITTING	AP	RCS	JD	RCS	RH	AH	AH

PRELIMINARY STATUS — DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.
LOE

APPROVED STATUS — DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.
LOE

ORIGINATING PERSONNEL | PROFESSIONAL ENGINEER'S SEAL

DRAWN BY: A. PRATT
CHECKED BY: R. C. SAYLO
LEAD DESIGNER: J. DAHLGREN
ENGINEER/TECH SPECIALIST: R. C. SAYLO
PROJECT ENGINEERING MANAGER: R. HILL
PROJECT MANAGER: A. HALL

Zero Harm — Leadership, No incidents, Safe Behavior

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF PE: ROLANDO C. SAYLO STATE: CA LIC. NO.: C78696 DATE:

WorleyParsons resources & energy

ZeroWaste

CLIENT/PROJECT TITLE

ANAEROBIC DIGESTION FACILITY
SAN JOSE, CA

PHASE I - III
STORM WATER CONTROL PLAN
PRE-CONSTRUCTION
WATER SHED

SCALE: 1"=100' | DRAWING SIZE: ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.: ATTACHMENT 7.9 | REV: A

PRELIMINARY
NOT FOR CONSTRUCTION

SWALE A

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

Q=CIA

Where:
- Q is the design flow in cubic feet per second (cfs),
- C is the drainage area runoff coefficient,
- I is the design intensity (in/hr), and
- A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.78 acres

Step 2 Determine the runoff coefficient, C = .30

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: .34 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.30 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = 0.13 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.108 *cfs*[5] (SWALE A)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
- Q = the design flow in cubic feet per second (cfs),
- C = the drainage area runoff coefficient,
- I = the design intensity (in/hr), and
- A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.78 acres

Step 2 Determine the runoff coefficient, C = .30

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} /MAP_{gage} = (**Step 3**)/(**Step 4**)

Correction Factor = 1.01

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6 Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

   Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

   Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

$$Q = C*I*A$$

$$Q = (\text{Step 2}) * (\text{Step 7}) * (\text{Step 1})$$

Q = ______ acres-in

Q = 0.142 cfs[6] (SWALE A)

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.78 acres

Step 2 Determine the runoff coefficient, C = .30

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = (**Step 2**) * (0.2 in/hr) * (**Step 1**)

Q = ______ acres-in/hr

Design Flow, Q = 0.167 cfs[7] (SWALE A)

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

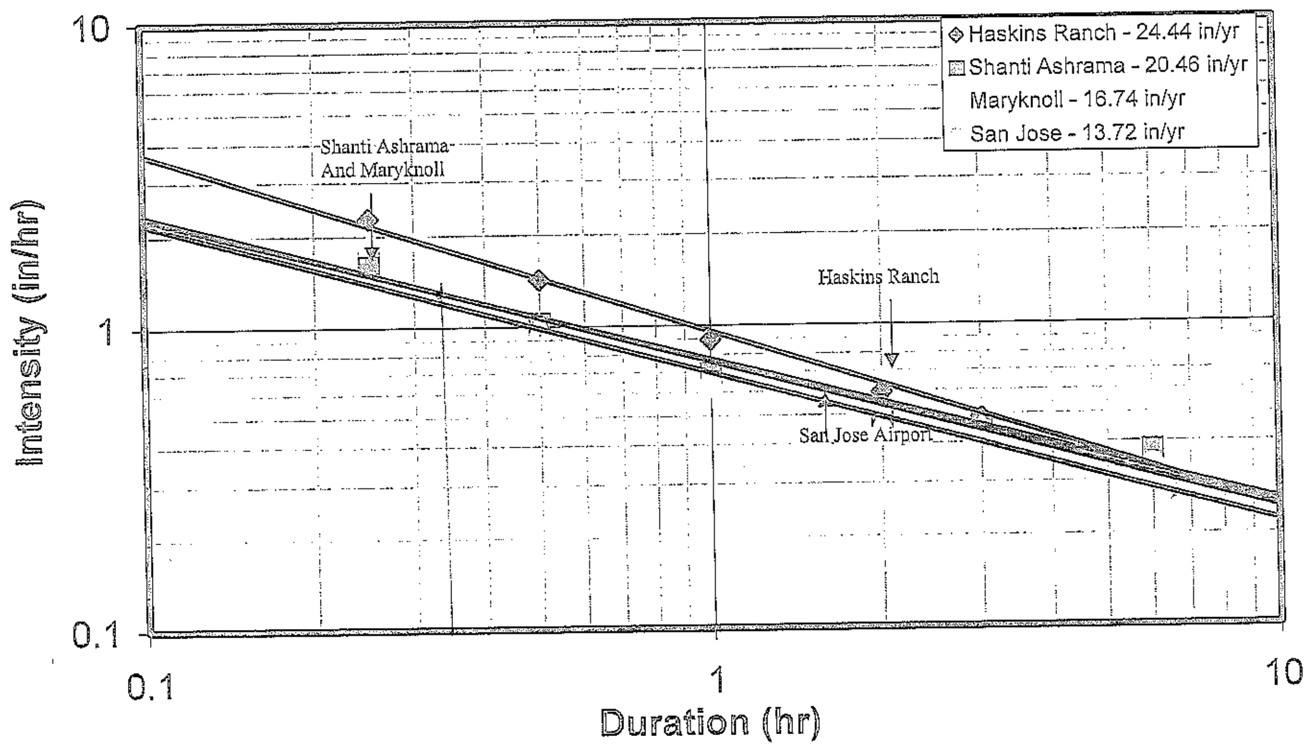


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
- Q is the design flow in cubic feet per second (cfs),
- C is the drainage area runoff coefficient,
- I is the design intensity (in/hr), and
- A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 3.88 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: 0.46 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.2 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = 0.12 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.168 *cfs*[5] (SWALE B)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
Q = the design flow in cubic feet per second (cfs),
C = the drainage area runoff coefficient,
I = the design intensity (in/hr), and
A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 3.88 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} /MAP_{gage} = (Step 3)/(Step 4)

Correction Factor = 1.01

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6   Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

   Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

   Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

$$Q = C*I*A$$

$$Q = (\text{Step 2}) * (\text{Step 7}) * (\text{Step 1})$$

Q = ______ acres-in

Q = 0.237 cfs[6] (SWALE B)

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 3.88 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = (Step 2) * (0.2 in/hr) * (Step 1)

Q = ______ acres-in/hr

Design Flow, Q = 0.279 cfs[7] (SWALE B)

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft³/ sec or cfs.

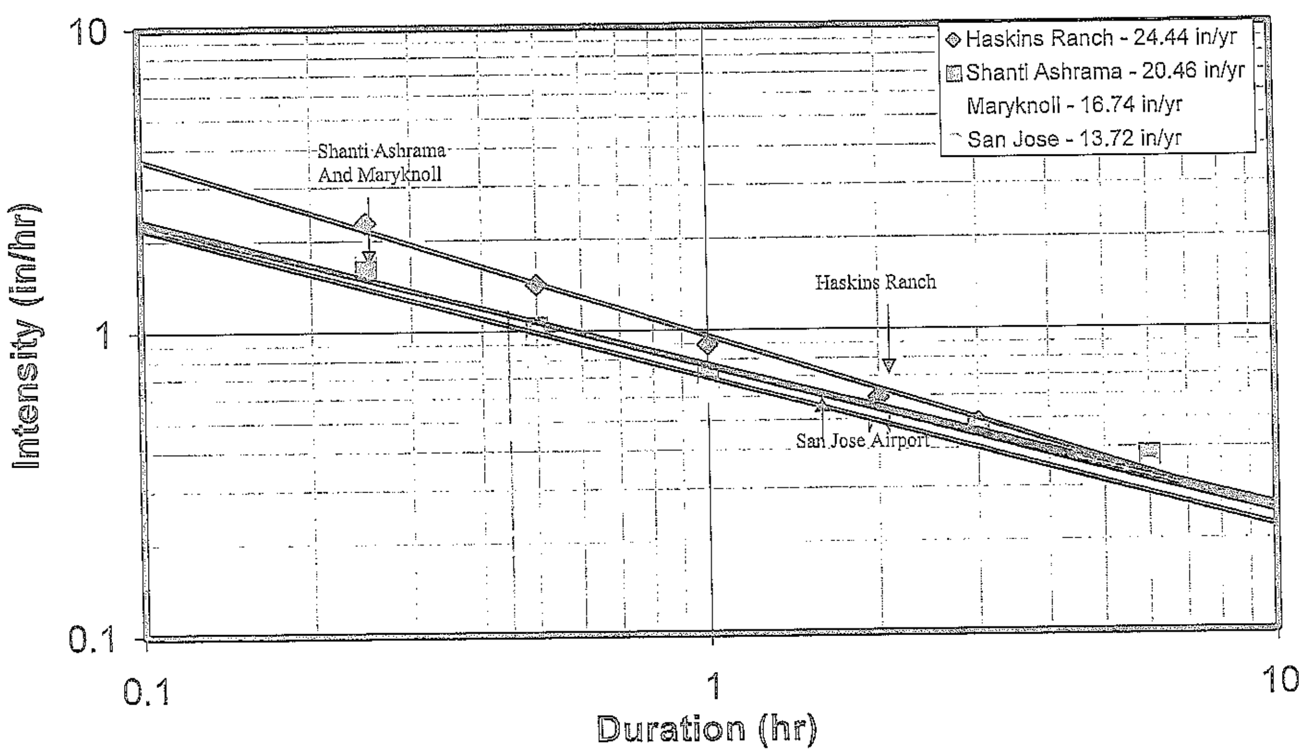


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
- Q is the design flow in cubic feet per second (cfs),
- C is the drainage area runoff coefficient,
- I is the design intensity (in/hr), and
- A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.70 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: 0.35 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.4 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = .14 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.136 *cfs*[5] (SWALE C)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
Q = the design flow in cubic feet per second (cfs),
C = the drainage area runoff coefficient,
I = the design intensity (in/hr), and
A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.70 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from Step 3 and Step 4.

Correction Factor = MAP_{site} /MAP_{gage} = (Step 3)/(Step 4)

Correction Factor = 1.01

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6 Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

   Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

   Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

$$Q = C*I*A$$

$$Q = (\text{Step 2}) * (\text{Step 7}) * (\text{Step 1})$$

Q = ______ acres-in

Q = 0.165 cfs[6] (SWALE C)

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft³/ sec or cfs.

Attachment IV-1
Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.70 acres

Step 2 Determine the runoff coefficient, C = .36

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = (**Step 2**) * (0.2 in/hr) * (**Step 1**)

Q = ______ acres-in/hr

Design Flow, Q = 0.194 cfs[7] (SWALE C)

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

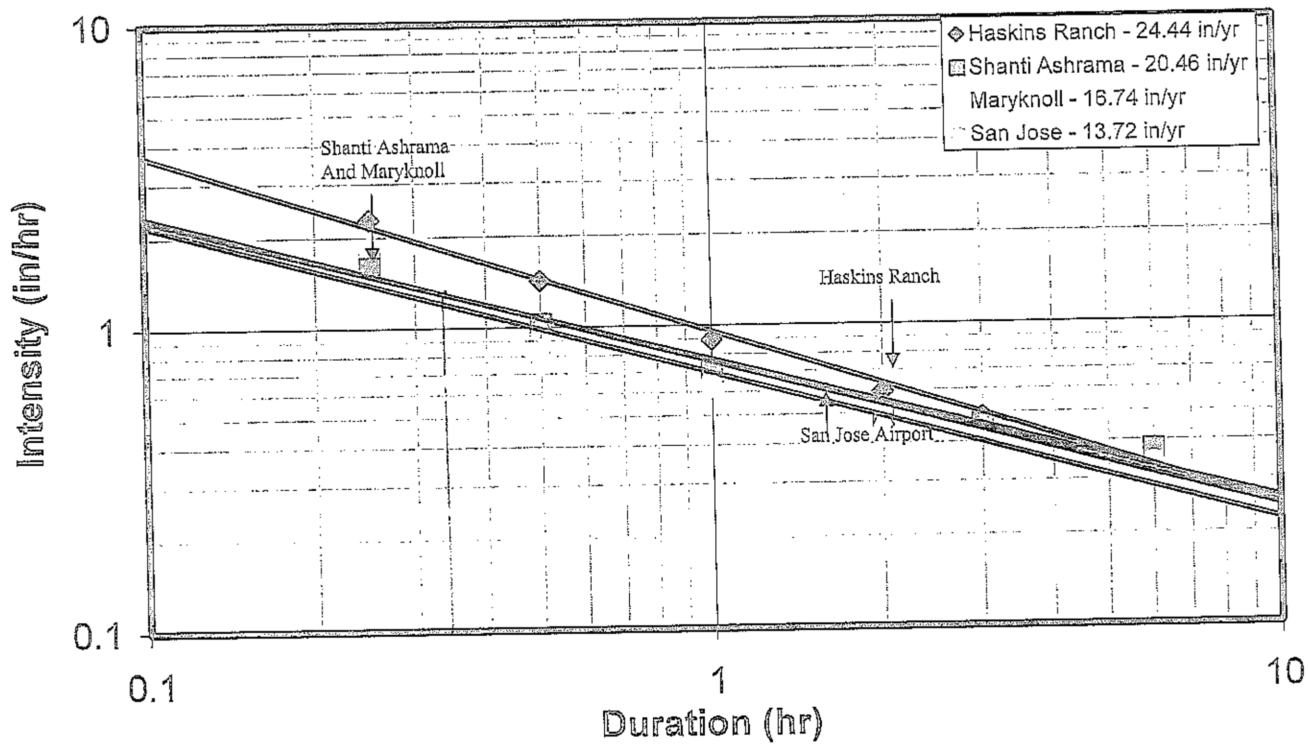


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

SWALE D

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

Q=CIA

Where:
- Q is the design flow in cubic feet per second (cfs),
- C is the drainage area runoff coefficient,
- I is the design intensity (in/hr), and
- A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 1.79 acres

Step 2 Determine the runoff coefficient, C = 0.47

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: 0.32 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.30 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = .13 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.109 *cfs*[5] (SWALE D)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft³/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
Q = the design flow in cubic feet per second (cfs),
C = the drainage area runoff coefficient,
I = the design intensity (in/hr), and
A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 1.79 acres

Step 2 Determine the runoff coefficient, C = 0.47

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} /MAP_{gage} = (Step 3)/(Step 4)

Correction Factor = 1.01

Attachment IV-1
Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6 Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

   Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

   Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

$$Q = C*I*A$$

$$Q = (\text{Step 2}) * (\text{Step 7}) * (\text{Step 1})$$

Q = ______ acres-in

Q = 0.143 cfs[6]

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 1.79 acres

Step 2 Determine the runoff coefficient, C = 0.47

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = **(Step 2)** * (0.2 in/hr) * **(Step 1)**

Q = ______ acres-in/hr

Design Flow, Q = 0.168 cfs[7]

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

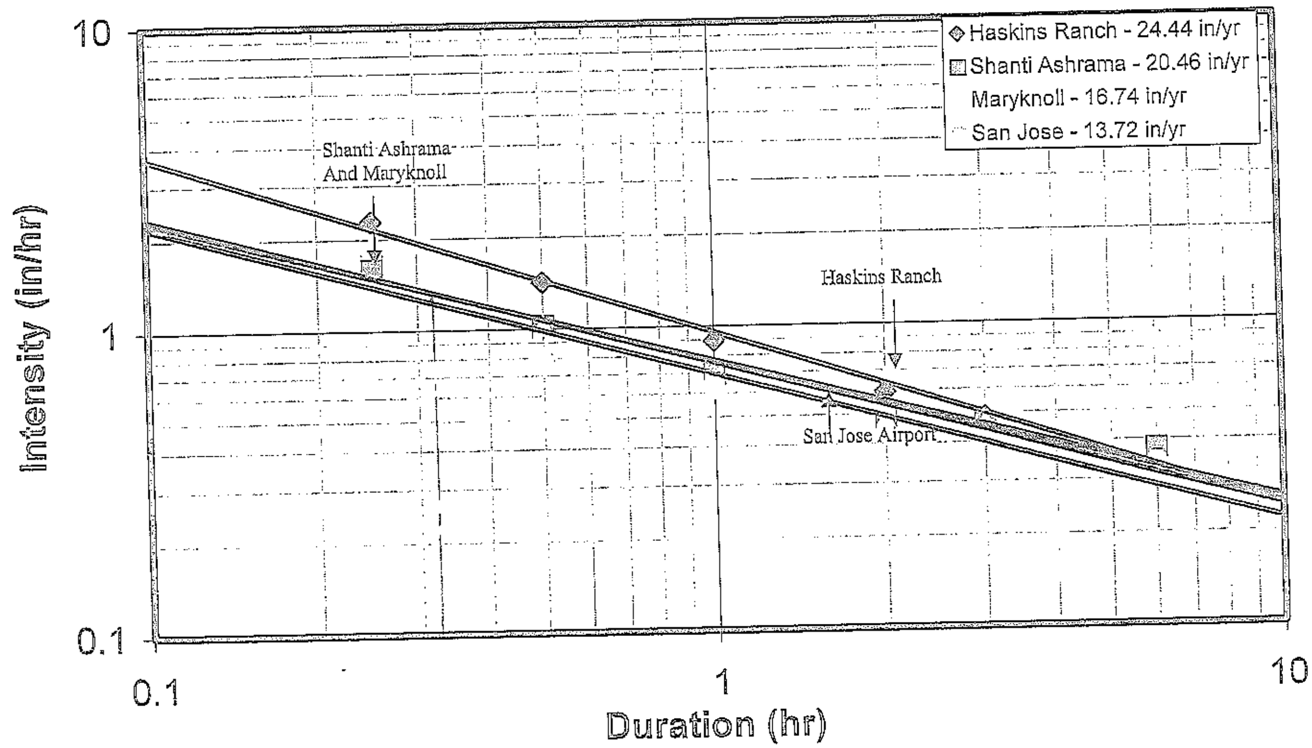


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.14 acres

Step 2 Determine the runoff coefficient, C = 0.63

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: 0.29 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.5 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = .15 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.202 *cfs*[5] (SWALE E)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
Q = the design flow in cubic feet per second (cfs),
C = the drainage area runoff coefficient,
I = the design intensity (in/hr), and
A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.14 acres

Step 2 Determine the runoff coefficient, C = 0.63

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from Step 3 and Step 4.

Correction Factor = MAP_{site} /MAP_{gage} = (Step 3)/(Step 4)

Correction Factor = 1.01

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6 Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

   Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

   Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

$$Q = C*I*A$$

$$Q = (\text{Step 2}) * (\text{Step 7}) * (\text{Step 1})$$

Q = ______ acres-in

Q = 0.229 cfs[6] (SWALE E)

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1
Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 2.14 acres

Step 2 Determine the runoff coefficient, C = .63

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = (**Step 2**) * (0.2 in/hr) * (**Step 1**)

Q = ______ acres-in/hr

Design Flow, Q = 0.270 cfs[7] (SWALE E)

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

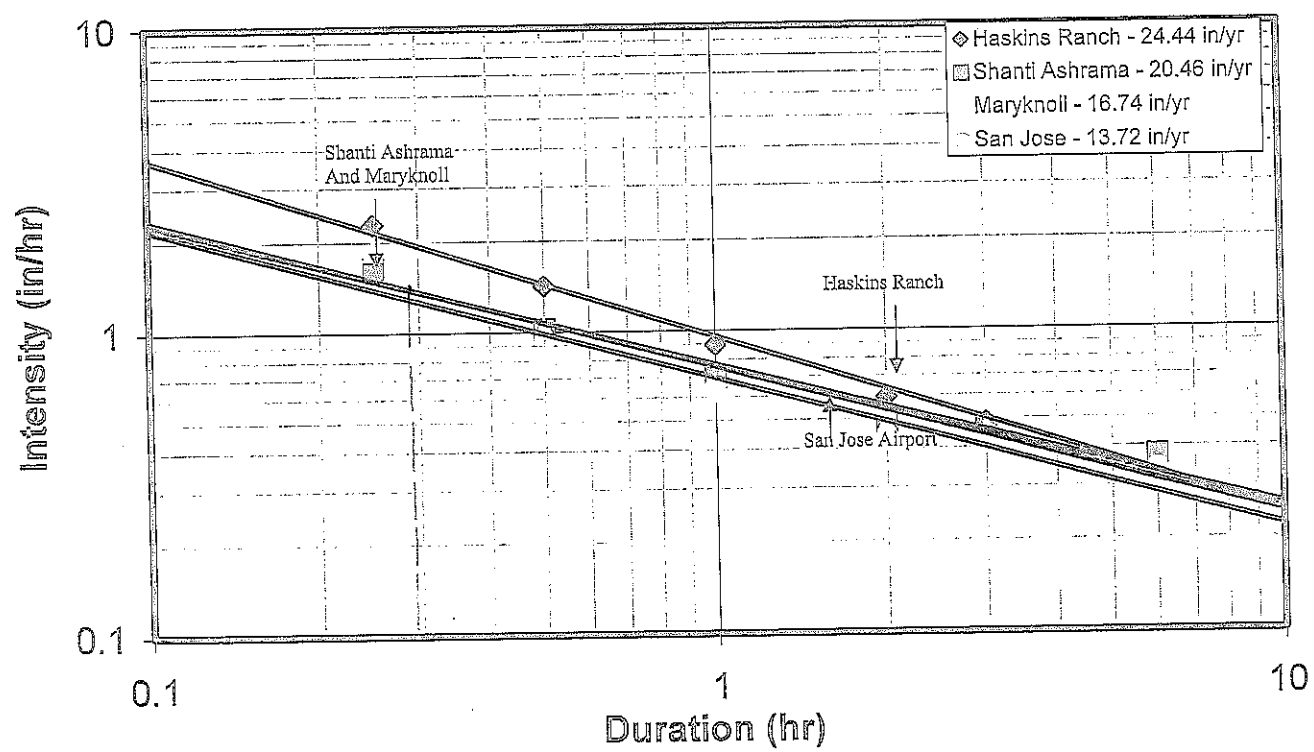


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

Section A — Sizing Flow-Based Treatment Controls based on the Factored Flood Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:
- Q is the design flow in cubic feet per second (cfs),
- C is the drainage area runoff coefficient,
- I is the design intensity (in/hr), and
- A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 4.0 acres

Step 2 Determine the runoff coefficient, C = 0.65

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Find the time of concentration (t_c) for the site (i.e. the travel time from the most remote portion of the BMP drainage area to the BMP). (Check with local agency's Engineering Department for standard or accepted methods of computing t_c).

t_c = Time of overland flow + time in drainage pipe: 0.37 hrs

Step 4 Using the time of concentration as the duration, use Figure 4 to determine the intensity for the 50-year storm (IDF curve) (in/hr). ______

intensity for the 50-year storm = 1.3 in/hr

Step 5 The design intensity (I) will be 10% of the intensity obtained from the IDF curve (intensity for the 50-year storm).

I = (Step 4 * 0.10) = = .13 in/hr

Step 6 Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A
Q = (Step 2)(Step 5) * (Step 1)*
Q = ______ acres-in/hr

Design Flow, Q = 0.338 *cfs*[5] (SWALE F)

[5] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 s.f/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1

Sizing for Flow-Based Treatment Controls

Section B—Sizing Flow-Based Treatment Controls based on the California Stormwater BMP Handbook Flow Approach

This method uses the Rational Method equation to determine the design flow, using a design intensity that is 10 % of the intensity for the 50-year return period found on the local intensity-duration-frequency (IDF) curve:

$$Q=CIA$$

Where:

Q = the design flow in cubic feet per second (cfs),
C = the drainage area runoff coefficient,
I = the design intensity (in/hr), and
A = the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 4.0 acres

Step 2 Determine the runoff coefficient, C = 0.65

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} /MAP_{gage} = (**Step 3**)/(**Step 4**)

Correction Factor = 1.01

Attachment IV-1
Sizing for Flow-Based Treatment Controls

Section B—California Stormwater BMP Handbook Flow Approach (continued)

Step 6 Select the design intensity, I, for the reference gage closest to the site from the following list:

I, Design Rainfall Intensity = 0.17 *in/hour*

Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (I) (in/hr)
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Gilroy	0.11	0.21
Morgan Hill	0.12	0.24

The design intensity is twice the 85th percentile Hourly Rainfall Intensity.

7. Determine the corrected design rainfall intensity (I) for the site:

Design intensity (site) = Correction factor * Design rainfall intensity for closest rain gage

Design intensity (site) = (Step 5) * (Step 6) = 0.17

9. Determine the design flow (Q) using the Rational Method equation:

Q = C*I*A

Q = (Step 2) * (Step 7) * (Step 1)

Q = ______ acres-in

Q = 0.442 cfs[6] (SWALE F)

[6] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

Attachment IV-1
Sizing for Flow-Based Treatment Controls

Section C.—Sizing Flow-Based Treatment Controls based on the Uniform Intensity Approach

This method uses the Rational Method equation:

$$Q=CIA$$

Where:

Q is the design flow in cubic feet per second (cfs),
C is the drainage area runoff coefficient,
I is the design intensity (in/hr), and
A is the drainage area for the BMP (acres)

Step 1. Determine the drainage area for the BMP, A = 4.0 acres

Step 2 Determine the runoff coefficient, C = .65

It is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area (Table 3a), if possible, than to assume a composite "C-factor" such as those in Table 3b, especially for small drainage areas.

Step 3 Use a design intensity of **0.2 in/hr** for "I" in the Q=CIA equation.

I = 0.2 in/hour

Step 4 Determine the design flow (Q) using Q = CIA

Q = C*I*A

Q = (Step 2) * (0.2 in/hr) * (Step 1)

Q = ______ acres-in/hr

Design Flow, Q = 0.520 cfs[7]

[7] No conversion factor for correct units is needed for the rational formula because (1 acre-in/hr) * (43,560 sq.ft/acre) * (1ft/12 in) * (1hr/3600 sec) ≈ 1 ft^3/ sec or cfs.

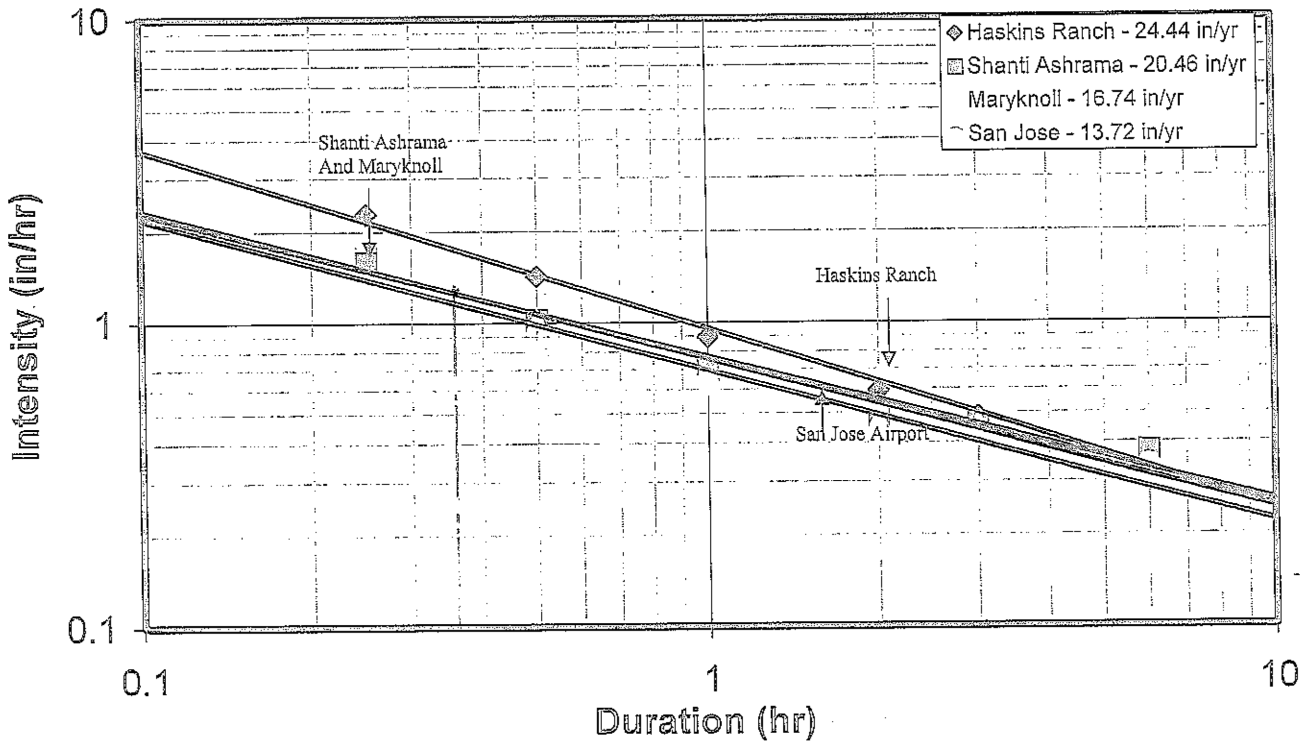


Figure 4 Intensity-Frequency-Duration Curves for a 50-Year Return Period for Haskins Ranch, Shanti Ashrama, Maryknoll, and San Jose Airport Rain Gages

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Calculation Sheet

Customer	ZERO WASTE ENERGY DEVELOPMENT COMPANY							Proj No			
Project Title	ANAEROBIC DIGESTION FACILITY							Calc No	ZWES-1-DC-024		
Calculation Title								Phase/CTR	-CE-0001		
Elec File Location											
Project File Location								Page		of	
Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
A	3-5-10	RS									

CALCULATE TIME OF CONCENTRATION

1. SWALE A

$L = 785.92$

$S = .005$

$t_c = 0.0078\left(\frac{L^2}{S}\right)^{0.385} + 10$

$t_c = 0.0078\left(\frac{785.92^2}{.005}\right)^{0.385} + 10$

$t_c = 20.2$ MIN $= 0.34$ HR

2. SWALE B

$L = 1126.24$

$S = .0024$

$t_c = 0.0078\left(\frac{1126.24^2}{.0024}\right)^{.385} + 10$

$t_c = 27.8$ MIN $= 0.46$ HR

3. SWALE C

$L = 725.98$

$S = .0034$

$t_c = 0.0078\left(\frac{725.98^2}{.0034}\right)^{.385} + 10$

$t_c = 21.10 = 0.35$ HR

WorleyParsons
resources & energy

Calculation Sheet

Customer	ZERO WASTE ENERGY DEVELOPMENT COMPANY								Proj No		
Project Title	ANAEROBIC DIGESTION FACILITY								Calc No	ZWES-1-DC-024	
Calculation Title									Phase/CTR	CE-0001	
Elec File Location											
Project File Location									Page		of
Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
A	3-5-10	RS									

4. SWALE D

$L = 935.22$

$S = .0097$

$$t_c = 0.0078\left(\frac{935.22^2}{.0097}\right)^{.385} + 10$$

$t_c = 19.01$ MIN $= 0.32$ HR

5. SWALE E

$L = 682.14$

$S = .008$

$$t_c = 0.0078\left(\frac{682.14^2}{.008}\right)^{.385} + 10$$

$t_c = 17.61$ MIN $= 0.29$ HR

6. SWALE F

$L = 1065.35$

$S = .006$

$$t_c = 0.0078\left(\frac{1065.35^2}{.006}\right)^{.385} + 10$$

$t_c = 21.98$ MIN $= 0.37$

ZWED Q cumulative for 2/10/25/50/100 year

ZWES-1-DC-024-CE-0001

Area	C
Paved Area	0.85
Unpaved Shrub Area	0.3

Area	Catch Basin	Area in SQFT Paved	Unpaved	Total	Composite Ave. C	Area (acres)	Length to inlet	slope	**(Tc) Flow Time (min)	2yr *I (in/hr)	2yr Q (cfs)	10-yr *I (in/hr)	10-yr Q (cfs)	25-yr *I (in/hr)	25-yr Q (cfs)	50-yr *I (in/hr)	50-yr Q (cfs)	100-yr *I (in/hr)	100-yr Q (cfs)
1	swale A	0	120869	120869	0.30	2.78	785	0.005	20.16	0.79	0.66	1.40	1.17	1.60	1.33	1.80	1.50	1.9	1.58
2	swale B	29226	256861	286087	0.36	6.58	1340	0.0027	29.45	0.60	1.41	0.80	1.87	1.15	2.70	1.30	3.05	1.45	3.40
	Forebay 1												**3.04**						**4.98**
3	3	29226	27295	56521	0.58	1.30	437	0.036	13.03	1.00	0.76	1.75	1.33	1.95	1.48	2.10	1.60	2.25	1.71
4	4	6495	38722	45217	0.38	1.04	240	0.055	11.62	1.10	0.43	1.80	0.71	1.95	0.77	2.12	0.84	2.33	0.92
5	5	22982	62174	60000	0.51	1.38	266	0.051	11.81	1.10	0.78	1.80	1.27	1.95	1.37	2.15	1.52	2.30	1.62
6	6	19130	6957	26087	0.70	0.60	103	0.034	11.02	1.15	0.49	1.82	0.77	1.97	0.83	2.15	0.91	2.35	0.99
7	7	14673	16631	31304	0.56	0.72	184	0.024	11.82	1.10	0.44	1.80	0.72	1.95	0.78	2.15	0.86	2.3	0.92
8	8	29651	38175	67826	0.54	1.56	216	0.010	12.88	0.95	0.80	1.68	1.42	1.90	1.60	2.05	1.73	2.1	1.77
9	9	10434	3044	13478	0.73	0.31	59	0.010	11.06	1.15	0.26	1.82	0.41	1.97	0.44	2.15	0.48	2.35	0.53
10	swale F	112143	61770	173913	0.65	4.00	1065	0.006	21.98	0.70	1.83	1.30	3.40	1.50	3.93	1.60	4.19	1.75	4.58
13	13	19275	12898	32173	0.63	0.74	163	0.012	12.16	1.02	0.48	1.70	0.79	1.95	0.91	2.15	1.00	2.4	1.12
14	14	27112	33757	60869	0.54	1.40	197	0.012	12.50	1.00	0.76	1.68	1.28	1.93	1.47	2.12	1.62	2.33	1.78
15	15	18629	12240	30869	0.63	0.71	198	0.064	11.32	1.11	0.50	1.82	0.82	1.96	0.88	2.15	0.96	2.33	1.05
16	16	20213	33265	53478	0.51	1.23	248	0.053	11.69	1.10	0.69	1.80	1.12	1.95	1.22	2.12	1.32	2.3	1.44
	Forebay 3												**14.04**						**18.42**
12	swale D	23926	53900	77826	0.47	1.79	935	0.010	19.01	0.82	0.69	0.85	0.71	1.62	1.36	1.74	1.90	1.88	1.58
	Forebay 2												**0.71**						**1.58**
17	swale E	56005	37038	93043	0.63	2.14	682	0.008	17.61	0.68	0.92	1.10	1.49	1.45	1.96	1.6	2.16	1.7	2.30
	Forebay 4												**1.49**						**2.30**
	Total sqft:	439120	815596	1229560							**11.88**		**19.28**		**23.04**		**25.64**		**27.28**
	Total Ac.	10.10	18.76	28.28															

*From IDF for M.A.P of 14 inches

** Tc per Santa Clara County Storm Drain Manual, 2007

Attachment IV-1
Sizing for Volume-Based Treatment Controls

II. Sizing for Volume-Based Treatment Controls

The SCVURPPP Permit Provision C.3.d allows two methods for sizing volume-based controls—the Urban Runoff Quality Management method (URQM Method) or the California Stormwater Best Management Practice[1] (BMP) Handbook Volume Method. Steps for applying these methods are presented in Sections A and B below.

Section A.— Sizing Volume-Based Treatment Controls based on the Urban Runoff Quality Management[1], Approach (URQM Approach)

The equations used in this method are:

$$P_o=(a*C_w)*P_6$$

$$C_w=0.858i^3-0.78i^2+0.774i+0.04$$

Where:

P_o = maximized detention storage volume (inches over the drainage area to the BMP)
a = regression constant (unitless)
C_w = watershed runoff coefficient (unitless)[2]
P_6 = mean storm event precipitation depth (inches);
i = watershed impervious ratio (range: 0-1)

Step 1. Determine the drainage area for the BMP, A = 9.36 acres

Step 2. Determine the watershed impervious ratio, "i", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a. Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = 0.133 acres

b. Calculate the watershed impervious ratio, i:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = (Step 2.a.)/(Step 1) = .014 (range: 0-1)

Percent impervious area= i/100 = 1.4 %

[1] For the purpose of this worksheet, a stormwater best management practice, or BMP, is the same as a stormwater treatment measure or device.

[2] For the purpose of this worksheet, the watershed runoff coefficient is notated as "C_w" to avoid confusion with the runoff coefficient "C" used in the Rational Method.

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 3. Determine the watershed runoff coefficient, "C_w", using the following equation:

$C_w = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$, using "$i$" from **Step 2.b.**

C_w = 0.051

Step 4. Find the mean annual precipitation at the site (MAP_{site}). To do so, estimate where the site is on Figure 1and estimate the mean annual precipitation in inches from the rain line (isopleth) nearest to the project site.[3],

Mean annual precipitation at the site, MAP_{site} = 14

(Each line on the figure, called a rainfall isopleth, indicates locations where the same amount of rainfall falls on average each year (e.g., the isopleth marked 14 indicates that areas crossed by this line average 14 inches of rainfall per year). If the project location is between two lines, estimate the mean annual rainfall depending on the location of the site.)

Step 5. Identify the reference rain gage closest to the project site from the following list.

Table 2: Precipitation Data for Four Reference Gages

Gages	Mean Annual Precipitation (MAP_{gage}) (in)	Mean Storm Event Precipitation $(P_6)_{gage}$ (in)
San Jose Airport	13.9	0.512
Palo Alto	13.7	0.522
Gilroy	18.2	0.684
Morgan Hill	19.5	0.760

Select the MAP_{gage} and the mean storm precipitation $(P_6)_{gage}$ for the reference gage, and use them to determine $(P_6)_{site}$ for the project site in Step 6.

MAP_{gage} = 13.9

$(P_6)_{gage}$ = 0.512

[3] Check with the local municipality to determine if more detailed maps are available for locating the site and estimating MAP.

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 6. Calculate the mean storm event precipitation depth at the project site, called $(P6)_{site}$. Multiply the mean storm event precipitation depth for the rain gage chosen by a correction factor, which is the ratio of the mean annual precipitation at the site (MAP_{site}) to the mean annual precipitation at the rain gage (MAP_{gage}).

$$(P_6)_{site} = (P_6)_{gage} * (MAP_{site}) / (MAP_{gage}).$$

$$(P_6)_{site} = \text{Mean Event Precipitation } (P_6)_{gage} \text{ (Step5)} * (MAP_{site}) \text{ (Step4)} / (MAP_{gage}) \text{(Step5)}.$$

$P_{6\ site}$ = 0.516 inches

Step 7 Find "a", the regression constant (unitless)[4]:

a = 1.963 for a 48-hour drain time
a = 1.582 for a 24-hour drain time
a = 1.312 for a 12-hour drain time

a = 1.963

Recommendation: Use a 48-hour drain time for detention basins and 24-hour drain time for pervious paving.

Step 8 Determine the maximized detention storage volume P_o:

$$P_o = (a * C_w) * P_6$$

$$P_o = (\text{Step 7} * \text{Step 3}) * (\text{Step 6})$$

P_o = 0.052 inches

Step 9 Determine the volume of the runoff to be treated from the drainage area to the BMP (i.e., the BMP design volume):

Design volume = P_o * A = (Step 8) * (Step 1) * 1 foot/12 inches

Design Volume = 0.040 acre-feet

[4] *WEF Manual of Practice No. 23 and the ASCE Manual of Practice No. 87 (1998), pages 175-178.*

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B — Sizing Volume-Based Treatment Controls based on the Adapted California Stormwater BMP Handbook Approach

The equation that will be used to size the BMP is:

BMP Volume = (Correction Factor) X (Unit Storage) X (Drainage Area to the BMP)

Step 1. Determine the drainage area for the BMP, A = 9.76 acres

Step 2. Determine the watershed impervious ratio, "i", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a) Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = 0.133 acres

b) Calculate the watershed impervious ratio, i:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = (Step 2.a.)/(Step 1) = .014 (range: 0-1)

Percent impervious area= i/100 = 1.40 %

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} (**Step 3**)/MAP_{gage} (**Step 4**)

Correction Factor = 1.01

Step 6. Identify representative soil type for the BMP drainage area.

a) Identify from Figure 1, the soil type that is representative of the pervious portion of the project shown here in order of increasing infiltration capability:

✓ Clay ____ Sandy Clay ____ Clay Loam

____ Silt Loam ____ Loam

b) Does the site planning allow for protection of natural areas and associated vegetation and soils so that the soils outside the building footprint are not graded/compacted? [ ]

If your answer is no, and the soil will be compacted during site preparation and grading, the soil's infiltration ability will be decreased. Modify your answer to a soil with a lower infiltration rate (e.g., Silt Loam to Clay Loam or Clay).

Modified soil type: [ ]

7. Determine the average slope for the drainage area for the BMP: 3 %

8. Determine the unit basin storage volume from sizing curves.

a) Slope ≤ 1%,

Use the figure entitled "Unit Basin Volume for 80% Capture, 1% Slope" corresponding to the nearest rain gage: Figure 2-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.

Unit Basin Storage $(UBS)_{1\%}$ = 0.29 (inches)

b) Slope ≥ 15%

*Use the figure entitled "Unit Basin Volume for 80% Capture, 15% Slope" corresponding to the nearest rain gage: Figure 3-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.*

Unit Basin Storage $UBS_{15\%}$ = 0.32 (inches)

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

c) *Slope > 1% and < 15%*

*Find the unit basin volumes for 1% and 15% using the techniques in **Steps 8a** and **8b** and interpolate by appling a slope correction factor per the following formula:*

$UBS_{x=}$ Unit Basin Storage of intermediate slope, x

UBS_x = $UBS_{1\%}$ + ($UBS_{15\%}$ - UBS_1)*(x-1) / (15% -1%)
= (**Step 8a**) + (**Step 8b- Step 8a**) * (x-1)/15%-1%)

Unit Basin Storage volume = 0.294 (inches)
(corrected for slope of site)

9. Size the BMP, using the following equation:

BMP Volume = Rain Gage Correction Factor * Unit Basin Storage Volume * Drainage Area

BMP Volume = (**Step 5**) * (**Step 8** unit storage) * (**Step 1** Drainage area) * 1 foot/12 in.

BMP Volume = .232 acre-feet

FOREBAY 1

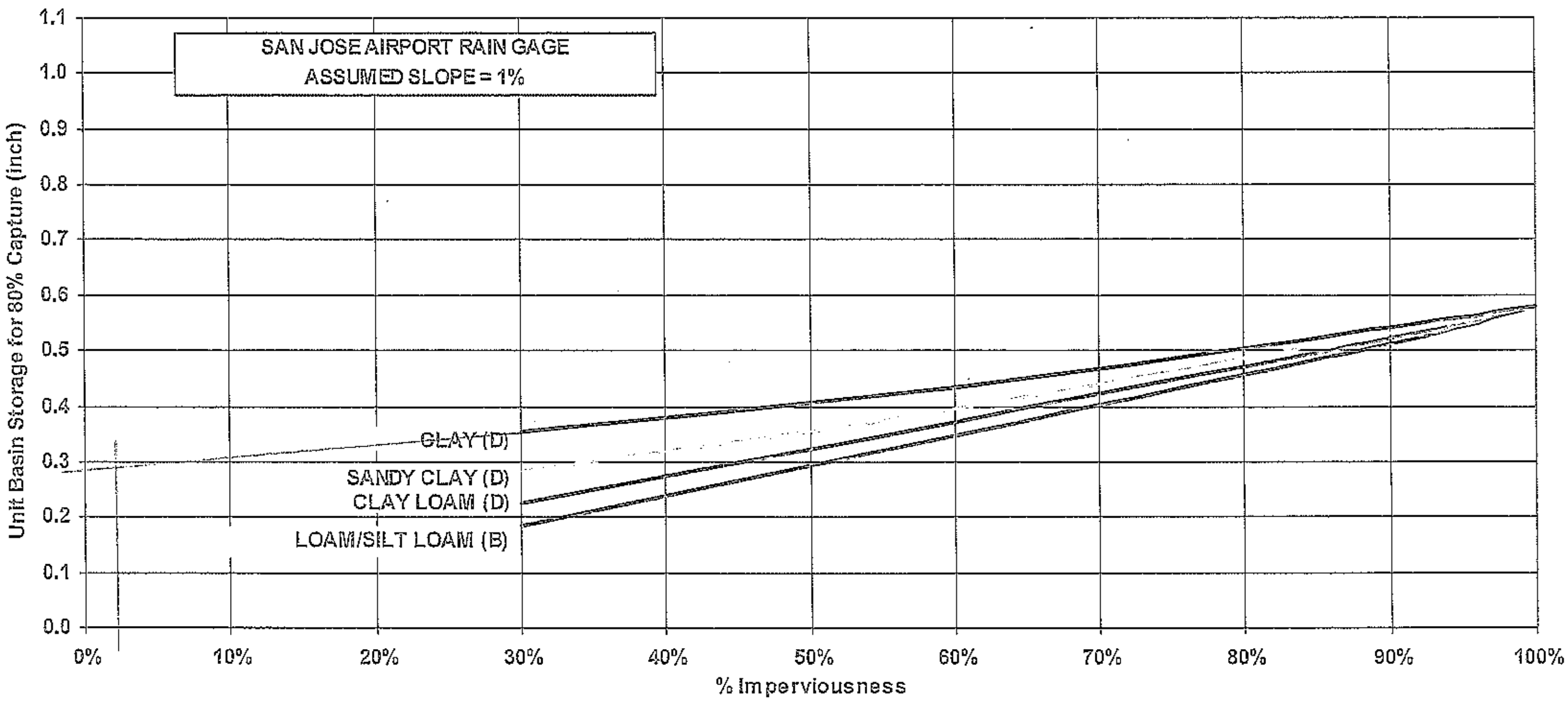

Figure 2-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

FOREBAY 1

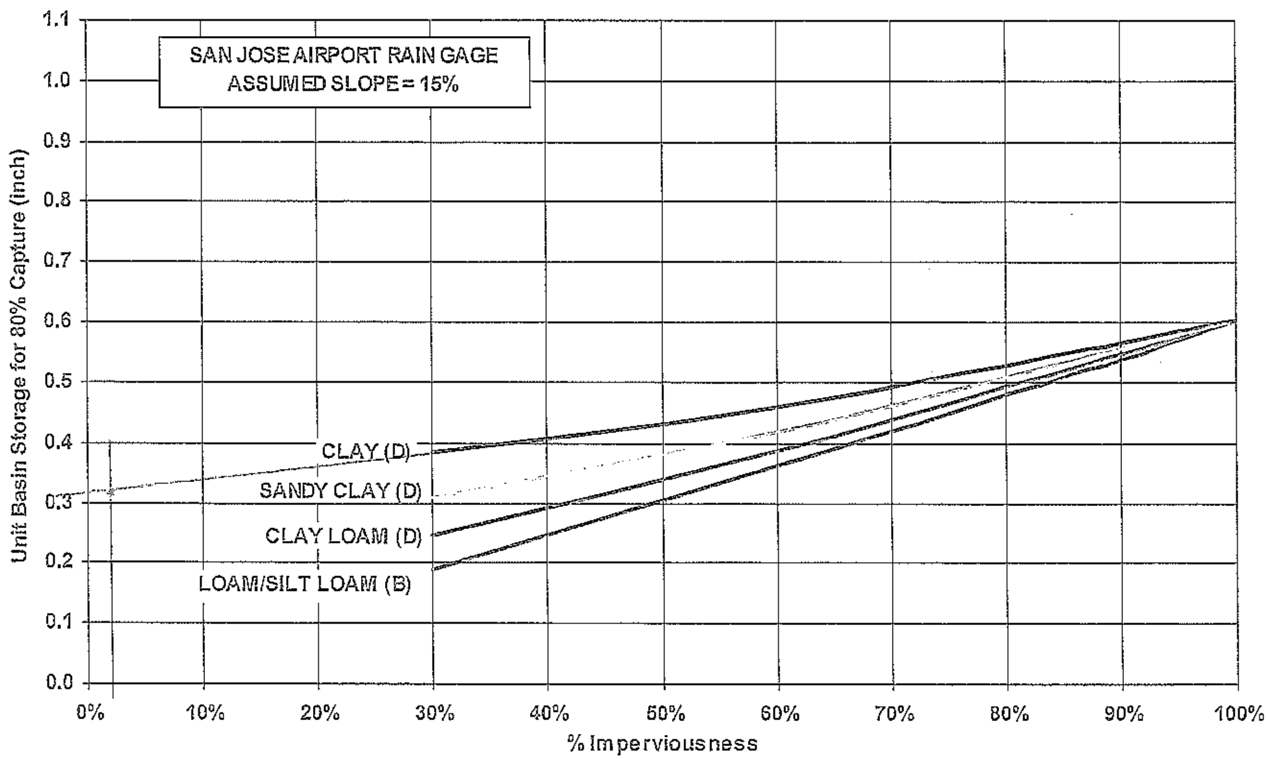

Figure 3-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

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Calculation Sheet

Customer ZERO WASTE ENERGY DEVELOPMENT COMPANY
Project Title ANAEROBIC DIGESTION FACILITY I-III
Calculation Title STORM DRAINAGE SYSTEM
Elec File Location

Proj No 52011703
Calc No ZWES-1-DC-024-CE-0001
Phase/CTR

Project File Location

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FOREBAY 1

BMP VOL = .232 AC-FT

FOREBAY VOL = 10% (BMP VOL)

= .10(.232)

= 0.023 AC-FT

= 1010.59 FT^3

ASSUME h = 3 FT $A = \frac{1010.59}{3} = 336.86\ FT^2$

A = L × W   L = 2W

$A = (2W)(W) = 2W^2$

$2W^2 = 336.86$

W = 12.97' ~ SAY 15' ⟶ L = 30'

USE 15' × 30' × 3'-0" DEEP

FOREBAY 2

ATTACHMENT 11 (SHT 10 OF 36)

Attachment IV-1

Sizing for Volume-Based Treatment Controls

II. Sizing for Volume-Based Treatment Controls

The SCVURPPP Permit Provision C.3.d allows two methods for sizing volume-based controls—the Urban Runoff Quality Management method (URQM Method) or the California Stormwater Best Management Practice[1] (BMP) Handbook Volume Method. Steps for applying these methods are presented in Sections A and B below.

Section A.— Sizing Volume-Based Treatment Controls based on the Urban Runoff Quality Management[1], Approach (URQM Approach)

The equations used in this method are:

$$P_o = (a * C_w) * P_6$$

$$C_w = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$$

Where:

- P_o = maximized detention storage volume (inches over the drainage area to the BMP)
- a = regression constant (unitless)
- C_w = watershed runoff coefficient (unitless)[2]
- P_6 = mean storm event precipitation depth (inches);
- i = watershed impervious ratio (range: 0-1)

Step 1. Determine the drainage area for the BMP, A = [1.79] acres

Step 2. Determine the watershed impervious ratio, "*i*", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a. Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = [.0265] acres

b. Calculate the watershed impervious ratio, *i*:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = **(Step 2.a.)/(Step 1)** = [0.015] (range: 0-1)

Percent impervious area= *i*/100 = [1.50] %

[1] For the purpose of this worksheet, a stormwater best management practice, or BMP, is the same as a stormwater treatment measure or device.

[2] For the purpose of this worksheet, the watershed runoff coefficient is notated as "C_w" to avoid confusion with the runoff coefficient "C" used in the Rational Method.

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 3. Determine the watershed runoff coefficient, "C_w", using the following equation:

$C_w = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$, using "$i$" from **Step 2.b.**

C_w = 0.051

Step 4. Find the mean annual precipitation at the site (MAP_{site}). To do so, estimate where the site is on Figure 1and estimate the mean annual precipitation in inches from the rain line (isopleth) nearest to the project site.[3],

Mean annual precipitation at the site, MAP_{site} = 14.0

(Each line on the figure, called a rainfall isopleth, indicates locations where the same amount of rainfall falls on average each year (e.g., the isopleth marked 14 indicates that areas crossed by this line average 14 inches of rainfall per year). If the project location is between two lines, estimate the mean annual rainfall depending on the location of the site.)

Step 5. Identify the reference rain gage closest to the project site from the following list.

Table 2: Precipitation Data for Four Reference Gages

Gages	Mean Annual Precipitation (MAP_{gage}) (in)	Mean Storm Event Precipitation $(P_6)_{gage}$ (in)
San Jose Airport	13.9	0.512
Palo Alto	13.7	0.522
Gilroy	18.2	0.684
Morgan Hill	19.5	0.760

Select the MAP_{gage} and the mean storm precipitation $(P_6)_{gage}$ for the reference gage, and use them to determine $(P_6)_{site}$ for the project site in Step 6.

MAP_{gage} = 13.9

$(P_6)_{gage}$ = 0.512

[3] Check with the local municipality to determine if more detailed maps are available for locating the site and estimating MAP.

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 6. Calculate the mean storm event precipitation depth at the project site, called $(P6)_{site}$. Multiply the mean storm event precipitation depth for the rain gage chosen by a correction factor, which is the ratio of the mean annual precipitation at the site (MAP_{site}) to the mean annual precipitation at the rain gage (MAP_{gage}).

$$(P_6)_{site} = (P_6)_{gage} * (MAP_{site}) / (MAP_{gage}).$$

$(P_6)_{site}$ = Mean Event Precipitation $(P_6)_{gage}$ (Step5) * (MAP_{site}) (Step4) / (MAP_{gage})(Step5).

$P_{6\ site}$ = 0.516 inches

Step 7 Find "a", the regression constant (unitless)[4]:

a = 1.963 for a 48-hour drain time
a = 1.582 for a 24-hour drain time
a = 1.312 for a 12-hour drain time

a = 1.963

Recommendation: Use a 48-hour drain time for detention basins and 24-hour drain time for pervious paving.

Step 8 Determine the maximized detention storage volume P_o:

$$P_o = (a*C_w) * P_6$$

P_o = **(Step 7 * Step 3) * (Step 6)**

P_o = 0.052 inches

Step 9 Determine the volume of the runoff to be treated from the drainage area to the BMP (i.e., the BMP design volume):

Design volume = P_o * A = **(Step 8) * (Step 1)** * 1 foot/12 inches

Design Volume = 0.006 acre-feet

[4] *WEF Manual of Practice No. 23 and the ASCE Manual of Practice No. 87 (1998), pages 175-178.*

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B — Sizing Volume-Based Treatment Controls based on the Adapted California Stormwater BMP Handbook Approach

The equation that will be used to size the BMP is:

BMP Volume = (Correction Factor) X (Unit Storage) X (Drainage Area to the BMP)

Step 1. Determine the drainage area for the BMP, A = 1.79 acres

Step 2. Determine the watershed impervious ratio, "i", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a) Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = .0265 acres

b) Calculate the watershed impervious ratio, i:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = **(Step 2.a.)/(Step 1)** = 0.015 (range: 0-1)

Percent impervious area= i/100 = 1.5 %

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4.**

Correction Factor = MAP_{site} (**Step 3**)/MAP_{gage} (**Step 4**)

Correction Factor = 1.01

Step 6. Identify representative soil type for the BMP drainage area.

a) Identify from Figure 1, the soil type that is representative of the pervious portion of the project shown here in order of increasing infiltration capability:

✓ Clay   ____ Sandy Clay   ____ Clay Loam

____ Silt Loam   ____ Loam

b) Does the site planning allow for protection of natural areas and associated vegetation and soils so that the soils outside the building footprint are not graded/compacted? [ ]

If your answer is no, and the soil will be compacted during site preparation and grading, the soil's infiltration ability will be decreased. Modify your answer to a soil with a lower infiltration rate (e.g., Silt Loam to Clay Loam or Clay).

Modified soil type: [ ]

7. Determine the average slope for the drainage area for the BMP: 3 %

8. Determine the unit basin storage volume from sizing curves.

a) Slope ≤ 1%,

Use the figure entitled "Unit Basin Volume for 80% Capture, 1% Slope" corresponding to the nearest rain gage: Figure 2-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.

Unit Basin Storage $(UBS)_{1\%}$ = .29 (inches)

b) Slope ≥ 15%

Use the figure entitled "Unit Basin Volume for 80% Capture, 15% Slope" corresponding to the nearest rain gage: Figure 3-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to ***Step 2****, above) on the x-axis. From there, find the line corresponding to the soil type (from* ***Step 6****), and obtain the unit basin storage on the y-axis.*

Unit Basin Storage $UBS_{15\%}$ = .31 (inches)

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

c) *Slope > 1% and < 15%*

Find the unit basin volumes for 1% and 15% using the techniques in ***Steps 8a*** *and* ***8b*** *and interpolate by appling a slope correction factor per the following formula:*

$UBS_{x=}$ Unit Basin Storage of intermediate slope, x

$$UBS_x = UBS_{1\%} + (UBS_{15\%} - UBS_1)*(x-1) / (15\% - 1\%)$$
$$= \textbf{(Step 8a)} + \textbf{(Step 8b- Step 8a)} * (x-1)/15\%-1\%)$$

Unit Basin Storage volume = 0.293 (inches)
(corrected for slope of site)

9. Size the BMP, using the following equation:

BMP Volume = Rain Gage Correction Factor * Unit Basin Storage Volume * Drainage Area

BMP Volume = **(Step 5)** * **(Step 8** unit storage) * **(Step 1** Drainage area) * 1 foot/12 in.

BMP Volume = .044 acre-feet

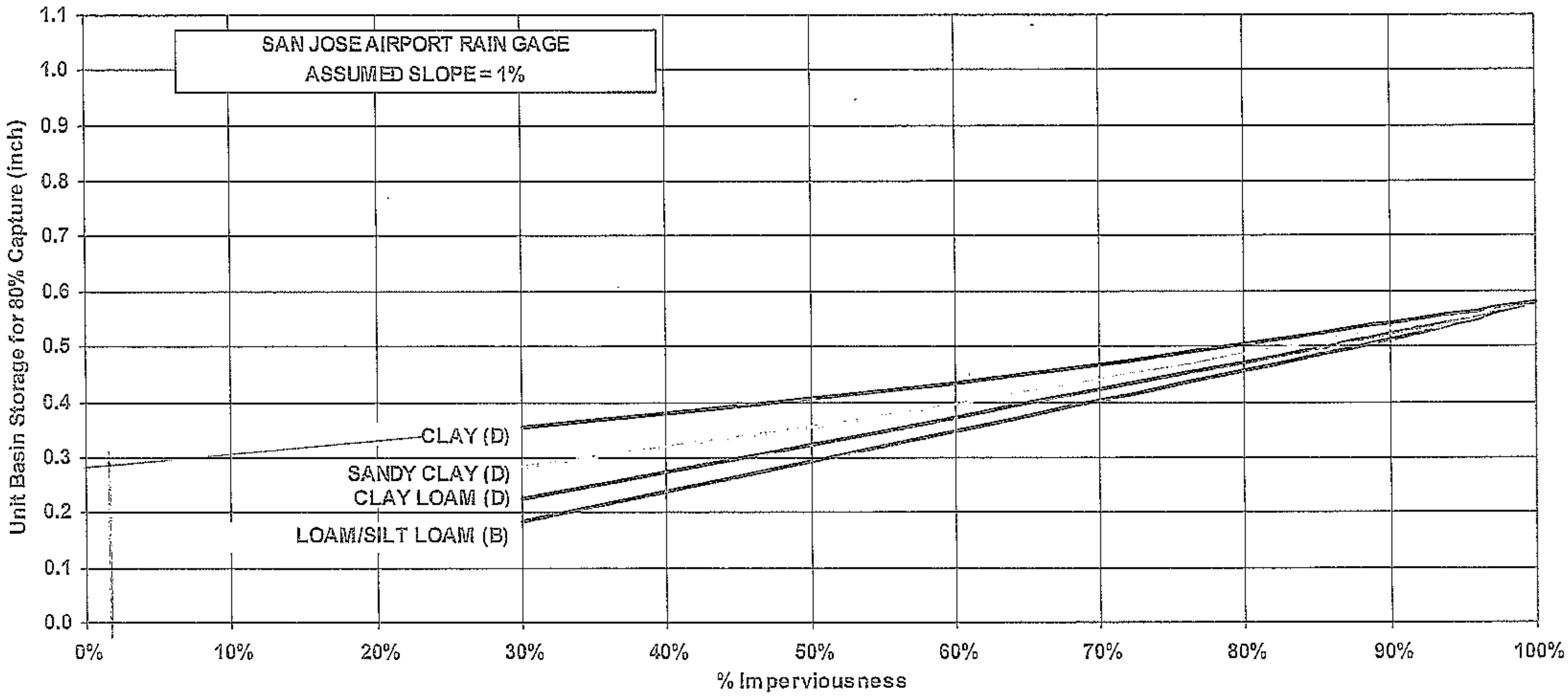

Figure 2-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

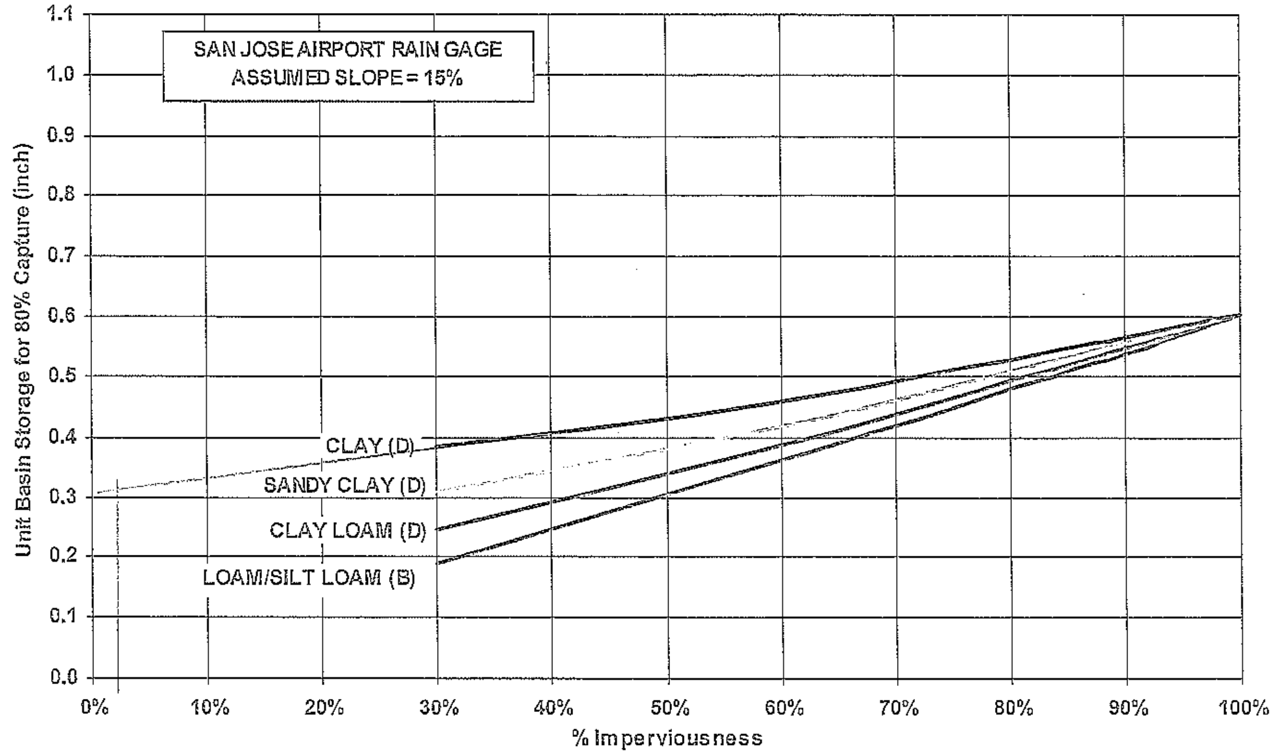

Figure 3-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

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Calculation Sheet

Customer ZERO WASTE ENERGY DEVELOPMENT COMPANY | Proj No 52011702
Project Title ANAEROBIC DIGESTION FACILITY I-III | Calc No ZWES-1-DC-024-CE-0001
Calculation Title STORM DRAINAGE SYSTEM | Phase/CTR
Elec File Location

Project File Location | Page | of

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A	3-5-10	RS									

FOREBAY 2

BMP VOL = .044 AC-FT

FOREBAY VOL = 10% (BMP VOL)

= 0.10(.044)

= .004 AC-FT

$= 191.7\ FT^3$

ASSUME h = 3' ⟶ $A = \frac{191.7}{3} = 63.9\ FT^2$

A = LW L = 2W ∴ $A = 2W^2$

$W^2 = \frac{63.9}{2}$

W = 5.65 ∼ 8' ⟶ L = 16

USE 8' × 16' × 3'-0"

Attachment IV-1
Sizing for Volume-Based Treatment Controls

II. Sizing for Volume-Based Treatment Controls

The SCVURPPP Permit Provision C.3.d allows two methods for sizing volume-based controls—the Urban Runoff Quality Management method (URQM Method) or the California Stormwater Best Management Practice[1] (BMP) Handbook Volume Method. Steps for applying these methods are presented in Sections A and B below.

Section A.— Sizing Volume-Based Treatment Controls based on the Urban Runoff Quality Management[1], Approach (URQM Approach)

The equations used in this method are:

$$P_o=(a*C_w)*P_6$$

$$C_w=0.858i^3-0.78i^2+0.774i+0.04$$

Where:

- P_o = maximized detention storage volume (inches over the drainage area to the BMP)
- a = regression constant (unitless)
- C_w = watershed runoff coefficient (unitless)[2]
- P_6 = mean storm event precipitation depth (inches);
- i = watershed impervious ratio (range: 0-1)

Step 1. Determine the drainage area for the BMP, A = 14.97 acres

Step 2. Determine the watershed impervious ratio, "*i*", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a. Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = 5.60 acres

b. Calculate the watershed impervious ratio, *i*:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = **(Step 2.a.)/(Step 1)** = 0.374 (range: 0-1)

Percent impervious area= *i*/100 = 37.4 %

---

[1] For the purpose of this worksheet, a stormwater best management practice, or BMP, is the same as a stormwater treatment measure or device.

[2] For the purpose of this worksheet, the watershed runoff coefficient is notated as "C_w" to avoid confusion with the runoff coefficient "C" used in the Rational Method.

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 3. Determine the watershed runoff coefficient, "C_w", using the following equation:

$C_w = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$, using "*i*" from **Step 2.b.**

C_w = 0.265

Step 4. Find the mean annual precipitation at the site (MAP_{site}). To do so, estimate where the site is on Figure 1and estimate the mean annual precipitation in inches from the rain line (isopleth) nearest to the project site.[3],

Mean annual precipitation at the site, MAP_{site} = 14

(Each line on the figure, called a rainfall isopleth, indicates locations where the same amount of rainfall falls on average each year (e.g., the isopleth marked 14 indicates that areas crossed by this line average 14 inches of rainfall per year). If the project location is between two lines, estimate the mean annual rainfall depending on the location of the site.)

Step 5. Identify the reference rain gage closest to the project site from the following list.

Table 2: Precipitation Data for Four Reference Gages

Gages	Mean Annual Precipitation (MAP_{gage}) (in)	Mean Storm Event Precipitation $(P_6)_{gage}$ (in)
San Jose Airport	13.9	0.512
Palo Alto	13.7	0.522
Gilroy	18.2	0.684
Morgan Hill	19.5	0.760

Select the MAP_{gage} and the mean storm precipitation $(P_6)_{gage}$ for the reference gage, and use them to determine $(P_6)_{site}$ for the project site in Step 6.

MAP_{gage} = 13.90

$(P_6)_{gage}$ = 0.512

[3] Check with the local municipality to determine if more detailed maps are available for locating the site and estimating MAP.

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section A.— URQM Approach (continued)

Step 6. Calculate the mean storm event precipitation depth at the project site, called $(P6)_{site}$. Multiply the mean storm event precipitation depth for the rain gage chosen by a correction factor, which is the ratio of the mean annual precipitation at the site (MAP_{site}) to the mean annual precipitation at the rain gage (MAP_{gage}).

$$(P_6)_{site} = (P_6)_{gage} * (MAP_{site}) / (MAP_{gage}).$$

$(P_6)_{site}$ = Mean Event Precipitation $(P_6)_{gage}$ (Step5) * (MAP_{site}) (Step4) / (MAP_{gage})(Step5).

$P_{6\ site}$ = 0.516 inches

Step 7 Find "a", the regression constant (unitless)[4]:

a = 1.963 for a 48-hour drain time
a = 1.582 for a 24-hour drain time
a = 1.312 for a 12-hour drain time

a = 1.963

Recommendation: Use a 48-hour drain time for detention basins and 24-hour drain time for pervious paving.

Step 8 Determine the maximized detention storage volume P_o:

$$P_o = (a*C_w) * P_6$$

$$P_o = (\text{Step 7 * Step 3}) * (\text{Step 6})$$

P_o = 0.268 inches

Step 9 Determine the volume of the runoff to be treated from the drainage area to the BMP (i.e., the BMP design volume):

Design volume = P_o * A = **(Step 8)** * **(Step 1)** * 1 foot/12 inches

Design Volume = 0.335 acre-feet

[4] *WEF Manual of Practice No. 23 and the ASCE Manual of Practice No. 87 (1998), pages 175-178.*

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section B — Sizing Volume-Based Treatment Controls based on the Adapted California Stormwater BMP Handbook Approach

The equation that will be used to size the BMP is:

BMP Volume = (Correction Factor) X (Unit Storage) X (Drainage Area to the BMP)

Step 1. Determine the drainage area for the BMP, A = 14.97 acres

Step 2. Determine the watershed impervious ratio, "*i*", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a) Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = 5.60 acres

b) Calculate the watershed impervious ratio, *i*:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = **(Step 2.a.)/(Step 1)** = 0.374 (range: 0-1)

Percent impervious area= i/100 = 37.4 %

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} (Step 3)/MAP_{gage} (Step 4)

Correction Factor = 1.01

Step 6. Identify representative soil type for the BMP drainage area.

a) Identify from Figure 1, the soil type that is representative of the pervious portion of the project shown here in order of increasing infiltration capability:

✓ Clay ____ Sandy Clay ____ Clay Loam

____ Silt Loam ____ Loam

b) Does the site planning allow for protection of natural areas and associated vegetation and soils so that the soils outside the building footprint are not graded/compacted? [ ]

If your answer is no, and the soil will be compacted during site preparation and grading, the soil's infiltration ability will be decreased. Modify your answer to a soil with a lower infiltration rate (e.g., Silt Loam to Clay Loam or Clay).

Modified soil type: [ ]

7. Determine the average slope for the drainage area for the BMP: 3 %

8. Determine the unit basin storage volume from sizing curves.

a) Slope ≤ 1%,

Use the figure entitled "Unit Basin Volume for 80% Capture, 1% Slope" corresponding to the nearest rain gage: Figure 2-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.

Unit Basin Storage (UBS) $_{1\%}$ = 0.37 (inches)

b) Slope ≥ 15%

Use the figure entitled "Unit Basin Volume for 80% Capture, 15% Slope" corresponding to the nearest rain gage: Figure 3-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to ***Step 2****, above) on the x-axis. From there, find the line corresponding to the soil type (from* ***Step 6****), and obtain the unit basin storage on the y-axis.*

Unit Basin Storage UBS $_{15\%}$ = 0.40 (inches)

Attachment IV-1
Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

c) *Slope > 1% and < 15%*

*Find the unit basin volumes for 1% and 15% using the techniques in **Steps 8a** and **8b** and interpolate by appling a slope correction factor per the following formula:*

$UBS_{x=}$ Unit Basin Storage of intermediate slope, x

UBS_x = $UBS_{1\%}$ + ($UBS_{15\%}$ - UBS_1)*(x-1) / (15% -1%)
= (**Step 8a**) + (**Step 8b**- **Step 8a**) * (x-1)/15%-1%)

Unit Basin Storage volume = 0.374 (inches)
(corrected for slope of site)

9. Size the BMP, using the following equation:

BMP Volume = Rain Gage Correction Factor * Unit Basin Storage Volume * Drainage Area

BMP Volume = (**Step 5**) * (**Step 8** unit storage) * (**Step 1** Drainage area) * 1 foot/12 in.

BMP Volume = .472 acre-feet

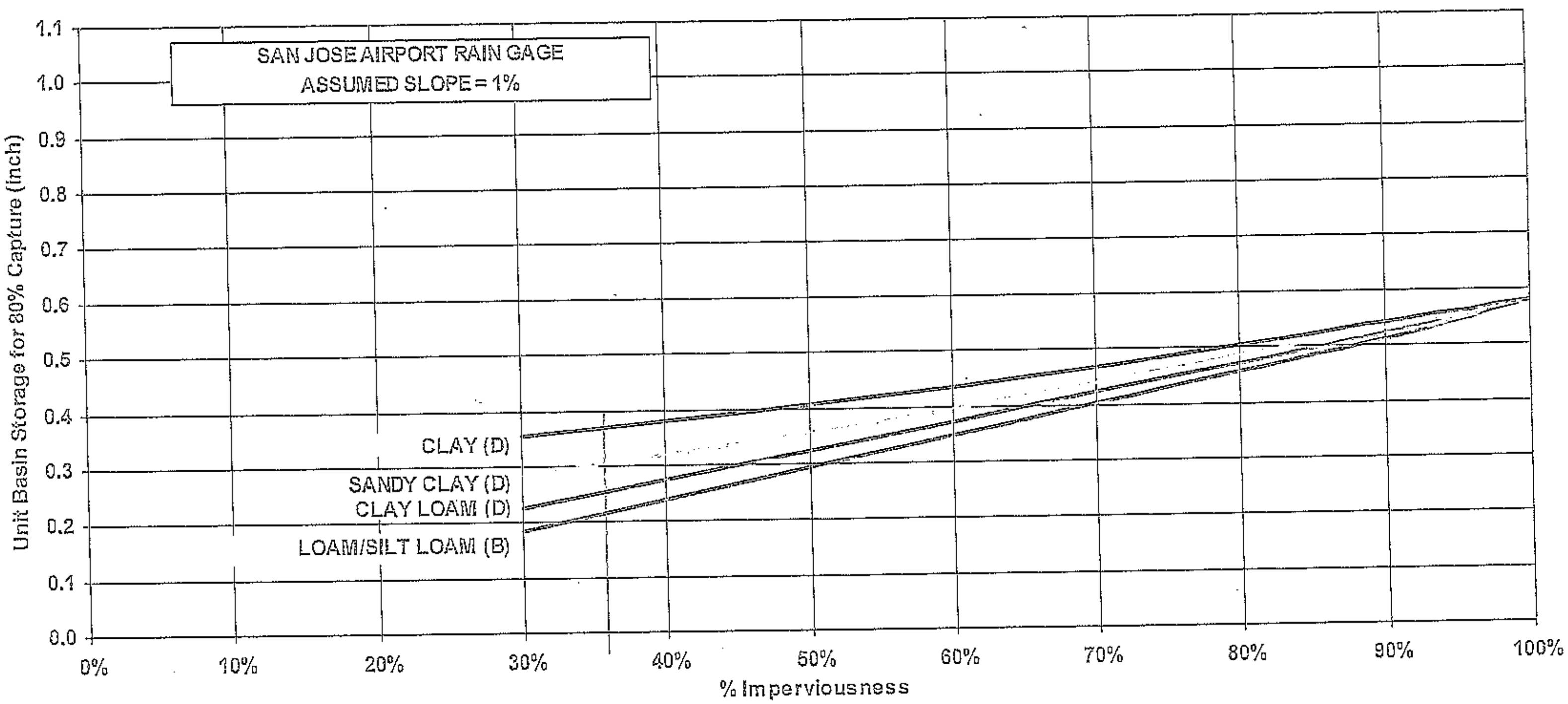

Figure 2-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

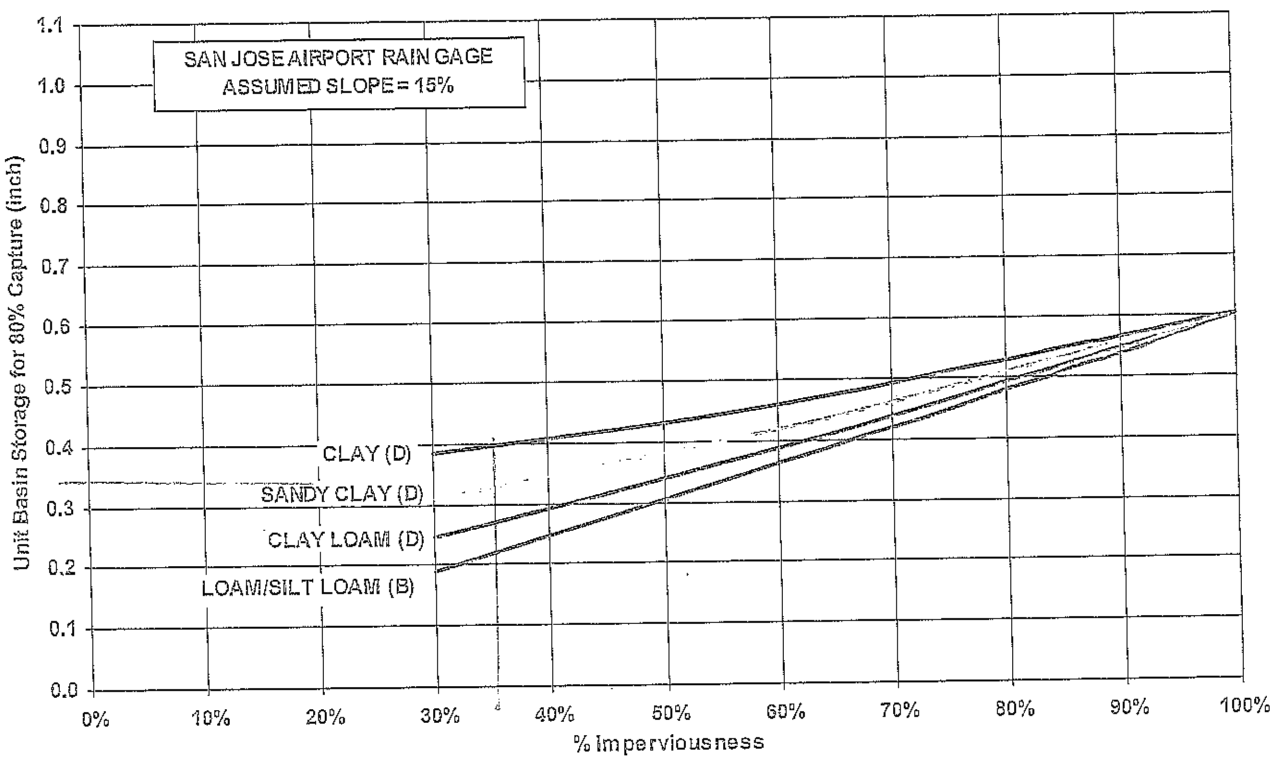

Figure 3-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

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Calculation Sheet

Customer	ZERO WASTE ENERGY DEVELOPMENT COMPANY							Proj No	52011702		
Project Title	ANAEROBIC DIGESTION FACILITY							Calc No	ZWES-1-DC-024		
Calculation Title	STORM DRAINAGE SYSTEM							Phase/CTR	-CE-0001		
Elec File Location											
Project File Location								Page		of	
Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
A	3-5-10	RS									

FOREBAY 3

BMP VOL = 0.472 AC-FT

FOREBAY VOL = 10% (BMP VOL)

= .10 (0.472)

= 0.047 AC-FT

= 2056.03 FT^3

ASSUME h = 3 ⟶ $A = \frac{2056.03}{3} = 685.34\ FT^2$

A = L x W   L = 2W

$A = 2W^2 = 685.34$

$W^2 = 342.67$

W = 18.5' ~ SAY 20'   L = 40

USE 20' WIDE x 40' LONG x 3'-0" DEEP

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B — Sizing Volume-Based Treatment Controls based on the Adapted California Stormwater BMP Handbook Approach

The equation that will be used to size the BMP is:

BMP Volume = (Correction Factor) X (Unit Storage) X (Drainage Area to the BMP)

Step 1. Determine the drainage area for the BMP, A = 2.14 acres

Step 2. Determine the watershed impervious ratio, "*i*", which is the amount of impervious area in the drainage area to the BMP divided by the drainage area, or the percent of impervious area in the drainage area divided by 100.

a) Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP = 0.28 acres

b) Calculate the watershed impervious ratio, *i*:

i = amount of impervious area (acres)/drainage area for the BMP (acres)

i = **(Step 2.a.)/(Step 1)** = 0.131 (range: 0-1)

Percent impervious area= i/100 = 13.1 %

Step 3. Determine from Figure 1 the mean annual precipitation (MAP_{site}) at the project site location: (see Section II. Step 4 for more explanation.)

MAP_{site} = 14 inches

Step 4 Identify the reference rain gage closest to the project site from the following list and record the MAP_{gage}:

MAP_{gage} = 13.9 inches

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Gilroy	18.2
Morgan Hill	19.5

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4.**

Correction Factor = MAP_{site} (**Step 3**)/MAP_{gage} (**Step 4**)

Correction Factor = 1.01

Step 6. Identify representative soil type for the BMP drainage area.

a) Identify from Figure 1, the soil type that is representative of the pervious portion of the project shown here in order of increasing infiltration capability:

✓ Clay ____ Sandy Clay ____ Clay Loam

____ Silt Loam ____ Loam

b) Does the site planning allow for protection of natural areas and associated vegetation and soils so that the soils outside the building footprint are not graded/compacted? ☐

If your answer is no, and the soil will be compacted during site preparation and grading, the soil's infiltration ability will be decreased. Modify your answer to a soil with a lower infiltration rate (e.g., Silt Loam to Clay Loam or Clay).

Modified soil type: ☐

7. Determine the average slope for the drainage area for the BMP: 3 %

8. Determine the unit basin storage volume from sizing curves.

a) Slope ≤ 1%,

Use the figure entitled "Unit Basin Volume for 80% Capture, 1% Slope" corresponding to the nearest rain gage: Figure 2-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.

Unit Basin Storage $(UBS)_{1\%}$ = 0.31 (inches)

b) Slope ≥ 15%

*Use the figure entitled "Unit Basin Volume for 80% Capture, 15% Slope" corresponding to the nearest rain gage: Figure 3-A, B, C, or D for San Jose, Palo Alto, Gilroy and Morgan Hill, respectively. Find the percent imperviousness of the drainage area (see answer to **Step 2**, above) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage on the y-axis.*

Unit Basin Storage $UBS_{15\%}$ = 0.35 (inches)

FOREBAY 4

ATTACHMENT 7.11 (SHT 33 OF 36)

Attachment IV-1

Sizing for Volume-Based Treatment Controls

Section B —Adapted California Stormwater BMP Handbook Approach (continued)

c) *Slope > 1% and < 15%*

*Find the unit basin volumes for 1% and 15% using the techniques in **Steps 8a** and 8b and interpolate by appling a slope correction factor per the following formula:*

$UBS_{x=}$ Unit Basin Storage of intermediate slope, x

UBS_x = $UBS_{1\%}$ + ($UBS_{15\%}$ - UBS_1)*(x-1) / (15% -1%)
= **(Step 8a)** + **(Step 8b- Step 8a)** * (x-1)/15%-1%)

Unit Basin Storage volume = 0.316 (inches)
(corrected for slope of site)

9. Size the BMP, using the following equation:

BMP Volume = Rain Gage Correction Factor * Unit Basin Storage Volume * Drainage Area

BMP Volume = **(Step 5)** * (**Step 8** unit storage) * (**Step 1** Drainage area) * 1 foot/12 in.

BMP Volume = .057 acre-feet

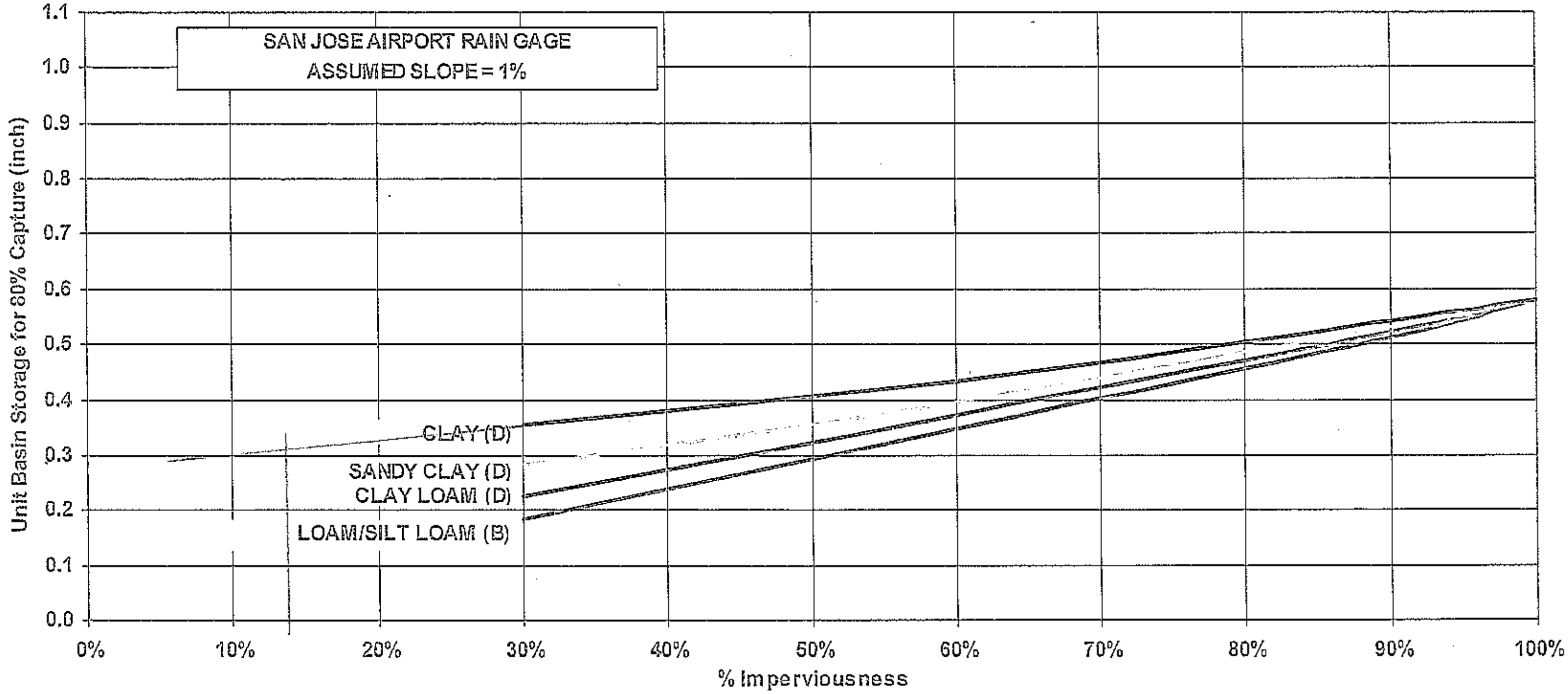

Figure 2-A Unit Basin Volume for 80% Capture - San Jose Airport Rain Gage

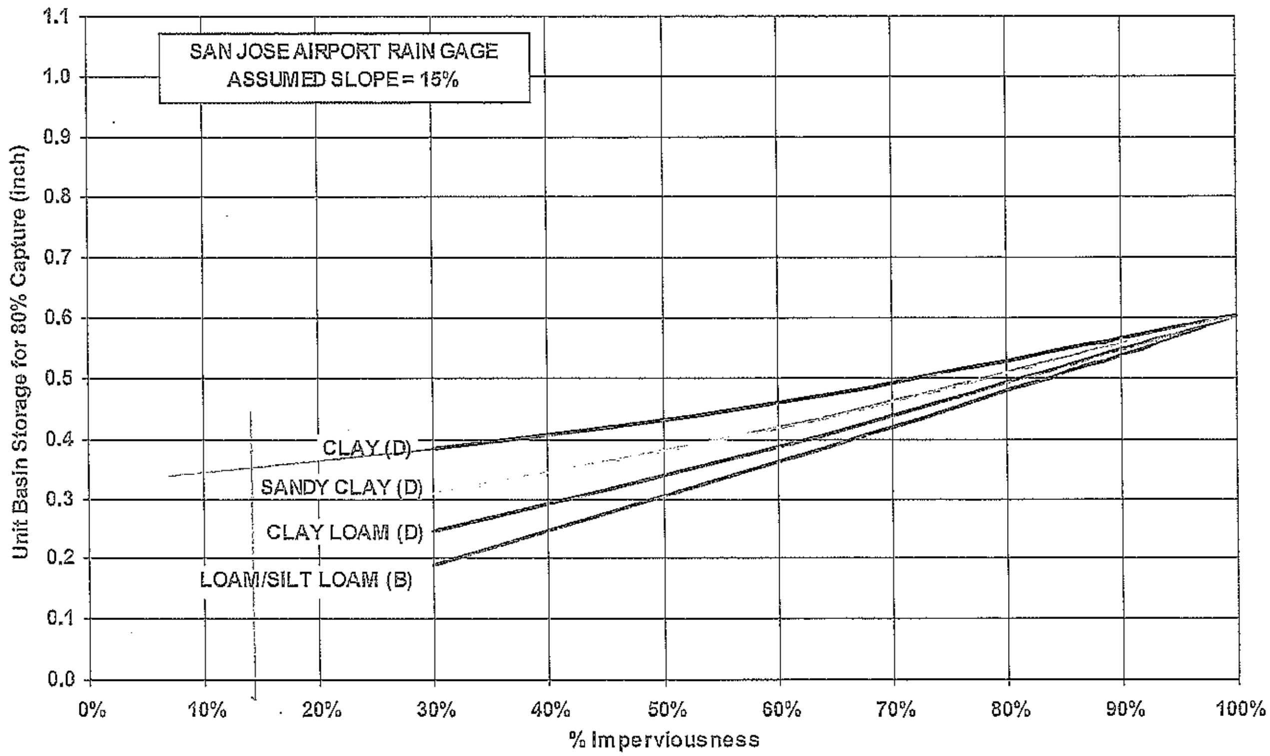

Figure 3-A Unit Basin Volume for 80% Capture - <u>San Jose Airport Rain Gage</u>

WorleyParsons
resources & energy

Calculation Sheet

Customer ZERO WASTE ENERGY DEVELOPMENT COMPANY								Proj No 52011702			
Project Title ANAEROBIC DIGESTION FACILITY I-III								Calc No ZWEB-1-DC-024			
Calculation Title STORM DRAINAGE SYSTEM								Phase/CTR -CE-0001			
Elec File Location											
Project File Location								Page		of	
Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked

FOREBAY 4

BMP VOL = 0.057 AC-FT

FOREBAY VOL = 10% (BMP VOL)

= .10 (0.057)

= 0.005 AC-FT

$= 224.39 \text{ FT}^3$

ASSUME h = 3' ⟶ $A = \frac{224.39}{3} = 74.79 \text{ FT}^2$

A = LW   L = 2W

$A = (2W)(W) = 2W^2 = 74.79$

$W^2 = 37.40$

W = 6.11' ∼ 8'   L = 16'

USE 8' WIDE × 16'-0" × 3'-0" DEEP

FlowSizer.com

ATTACHMENT 7.12 (SHT 1 OF 1)

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

( ) Circular (•) Trapezoidal ( ) Rectangular ( ) Triangular

$$Q = \frac{1.486}{n} AR^{2/3}\sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	4
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.005
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	0.1768
Wetted Perimeter	ft	6.108
Wetted Area	sq.ft	1.667
Hydraulic Radius	ft	0.2729
Calculated Flow	cfs	0.2947

SI. Units	Units	Values
Velocity	m/s	0.05389
Wetted Perimeter	m	1.862
Wetted Area	sq. m	0.1549
Hydraulic Radius	m	0.08318
Calculated Flow	cu-m/s	0.00834

Bookmark/Search this post with:

Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE A – WATER QUALITY CAPACITY

ATTACHMENT 7.12 (SHT 2 OF 12

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular • Trapezoidal Rectangular Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	5
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.0024
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	0.1390
Wetted Perimeter	ft	6.635
Wetted Area	sq.ft	2.188
Hydraulic Radius	ft	0.3298
Calculated Flow	cfs	0.3041

SI. Units	Units	Values
Velocity	m/s	0.04237
Wetted Perimeter	m	2.022
Wetted Area	sq. m	0.2033
Hydraulic Radius	m	0.1005
Calculated Flow	cu-m/s	0.00861

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Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically
calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically
calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE B — WATER QUALITY CAPACITY

ATTACHMENT 7.12 (SHT 3 OF 12)

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

( ) Circular (•) Trapezoidal ( ) Rectangular ( ) Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	5
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.0034
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	0.1654
Wetted Perimeter	ft	6.635
Wetted Area	sq.ft	2.188
Hydraulic Radius	ft	0.3298
Calculated Flow	cfs	0.3619

SI. Units	Units	Values
Velocity	m/s	0.05041
Wetted Perimeter	m	2.022
Wetted Area	sq. m	0.2033
Hydraulic Radius	m	0.1005
Calculated Flow	cu-m/s	0.01025

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Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE C – WATER QUALITY CAPACITY

ATTACHMENT 7.12 (SHT 4 OF 12)

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular | Trapezoidal (selected) | Rectangular | Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	4
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.0097
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	0.2463
Wetted Perimeter	ft	6.108
Wetted Area	sq.ft	1.667
Hydraulic Radius	ft	0.2729
Calculated Flow	cfs	0.4106

SI. Units	Units	Values
Velocity	m/s	0.07507
Wetted Perimeter	m	1.862
Wetted Area	sq. m	0.1549
Hydraulic Radius	m	0.08318
Calculated Flow	cu-m/s	0.01163

Bookmark/Search this post with:

Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE D – WATER QUALITY CAPACITY

FlowSizer.com

ATTACHMENT 7.12 (SHT 5 OF 12

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

( ) Circular (•) Trapezoidal ( ) Rectangular ( ) Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	4
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.008
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	5

Eng. Units	Units	Values
Velocity	ft/s	0.2283
Wetted Perimeter	ft	7.108
Wetted Area	sq.ft	2.000
Hydraulic Radius	ft	0.2814
Calculated Flow	cfs	0.4566

SI. Units	Units	Values
Velocity	m/s	0.06959
Wetted Perimeter	m	2.167
Wetted Area	sq. m	0.1858
Hydraulic Radius	m	0.08577
Calculated Flow	cu-m/s	0.01293

Bookmark/Search this post with:

Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE E - WATER QUALITY CAPACITY

ATTACHMENT 7.12 (SHT 6 OF 1

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular (•) Trapezoidal Rectangular Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	5
Manning's N - n(unitless)	0.25
Longitudinal Slope - S(ft/ft)	0.006
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	5

Eng. Units	Units	Values
Velocity	ft/s	0.2248
Wetted Perimeter	ft	7.635
Wetted Area	sq.ft	2.604
Hydraulic Radius	ft	0.3411
Calculated Flow	cfs	0.5854

SI. Units	Units	Values
Velocity	m/s	0.06852
Wetted Perimeter	m	2.327
Wetted Area	sq. m	0.2419
Hydraulic Radius	m	0.1040
Calculated Flow	cu-m/s	0.01658

Bookmark/Search this post with:

Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically
calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically
calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE F - WATER QUALITY CAPACITY

ATTACHMENT 7.12 (SHT 7 OF 12

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular (•) Trapezoidal Rectangular Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.005
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	3.687
Wetted Perimeter	ft	10.32
Wetted Area	sq.ft	7.000
Hydraulic Radius	ft	0.6783
Calculated Flow	cfs	25.81

SI. Units	Units	Values
Velocity	m/s	1.124
Wetted Perimeter	m	3.146
Wetted Area	sq. m	0.6503
Hydraulic Radius	m	0.2067
Calculated Flow	cu-m/s	0.7309

Bookmark/Search this post with:

Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE A - FLOOD CONVEYANCE CAPACITY

ATTACHMENT 7.2 (SHT 8 OF 12

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

◯ Circular ◉ Trapezoidal ◯ Rectangular ◯ Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.0024
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	2.555
Wetted Perimeter	ft	10.32
Wetted Area	sq.ft	7.000
Hydraulic Radius	ft	0.6783
Calculated Flow	cfs	17.89

SI. Units	Units	Values
Velocity	m/s	0.7788
Wetted Perimeter	m	3.146
Wetted Area	sq. m	0.6503
Hydraulic Radius	m	0.2067
Calculated Flow	cu-m/s	0.5066

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Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE B – FLOOD CONVEYANCE CAPACITY

ATTACHMENT 7.12 (SHT 9 OF 12)

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular · Trapezoidal · Rectangular · Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.0034
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	3.041
Wetted Perimeter	ft	10.32
Wetted Area	sq.ft	7.000
Hydraulic Radius	ft	0.6783
Calculated Flow	cfs	21.29

SI. Units	Units	Values
Velocity	m/s	0.9269
Wetted Perimeter	m	3.146
Wetted Area	sq. m	0.6503
Hydraulic Radius	m	0.2067
Calculated Flow	cu-m/s	0.6029

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Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

SWALE C- FLOOD CONVEYANCE CAPACITY

ATTACHMENT 7.12 (SHT 10 OF

FlowSizer.com

Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

( ) Circular (•) Trapezoidal ( ) Rectangular ( ) Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.0097
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	4

Eng. Units	Units	Values
Velocity	ft/s	5.136
Wetted Perimeter	ft	10.32
Wetted Area	sq.ft	7.000
Hydraulic Radius	ft	0.6783
Calculated Flow	cfs	35.95

SI. Units	Units	Values
Velocity	m/s	1.565
Wetted Perimeter	m	3.146
Wetted Area	sq. m	0.6503
Hydraulic Radius	m	0.2067
Calculated Flow	cu-m/s	1.018

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Open Channel Flow Calculator Variables

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Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

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ATTACHMENT 7.12 (SHT 11 of 12)

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Updated Open Channel Flow Calculator

Open Channel | Pipes | Weir

Select Channel Shape

( ) Circular (•) Trapezoidal ( ) Rectangular ( ) Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.008
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	5

Eng. Units	Units	Values
Velocity	ft/s	4.793
Wetted Perimeter	ft	11.32
Wetted Area	sq.ft	8.000
Hydraulic Radius	ft	0.7067
Calculated Flow	cfs	38.34

SI. Units	Units	Values
Velocity	m/s	1.461
Wetted Perimeter	m	3.450
Wetted Area	sq. m	0.7432
Hydraulic Radius	m	0.2154
Calculated Flow	cu-m/s	1.086

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Open Channel Flow Calculator Variables

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Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

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ATTACHMENT 7.12 (SHT 12 OF 1..

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Updated Open Channel Flow Calculator

Open Channel

Select Channel Shape

Circular (•) Trapezoidal Rectangular Triangular

$$Q = \frac{1.486}{n} A R^{2/3} \sqrt{S}$$

Provide Trapezoidal Chan. Variables

Flow Depth - d(in)	12
Manning's N - n(unitless)	0.022
Longitudinal Slope - S(ft/ft)	0.006
Side Slope - Z(ft/ft)	3
Bottom Width - W(ft)	5

Eng. Units	Units	Values
Velocity	ft/s	4.151
Wetted Perimeter	ft	11.32
Wetted Area	sq.ft	8.000
Hydraulic Radius	ft	0.7067
Calculated Flow	cfs	33.21

SI. Units	Units	Values
Velocity	m/s	1.265
Wetted Perimeter	m	3.450
Wetted Area	sq. m	0.7432
Hydraulic Radius	m	0.2154
Calculated Flow	cu-m/s	0.9404

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Open Channel Flow Calculator Variables

Access the Open Channel Flow and Mannings Calculator here

Flow Depth

This open channel flow calculator variable represents the depth of flow in the channel and should be entered in inches. Simply enter a new depth (e.g. 48 - to represent 48 inches or 4 ft) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid. If a depth that exceeds the channel diameter is entered for circular channels, an error occurs and the grid shows "NAN" (not a number).

Manning's N

This open channel flow calculator variable represents the Manning's roughness coefficient. Even though the Manning's coefficient actually varies with the flow depth, this variation is often ignored in open channel calculations and is therefore not considered in our calculations. Simply enter a new Manning's n (e.g. 0.013 for concrete channels) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Slope

This open channel flow calculator variable represents the longitudinal slope of the channel and should be entered as a ratio of the vertical rise per unit length. Simply enter a new slope (e.g. 0.2 to represent a 2 ft rise for every 100 ft horizontal distance) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Side Slope

This open channel flow calculator variable represents the slopes of the sides or banks of the channel and should be entered as a ratio of the vertical rise of the channel sides or banks per unit length. Simply enter a new side slope (e.g. 3 to represent 3H: 1V) and the open channel flow, flow velocity, wetted perimeter, hydraulic radius, and Froude number are automatically calculated and shown in the grid.

Diameter

This open channel flow calculator variable is used only with circular pipes and channels and represents the diameter of the channel entered in inches. Simply

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