SHERWOOD
DESIGN ENGINEERS

58 MAIDEN LANE, 3RD FLOOR, SAN FRANCISCO, CA 94108
(415) 677-7300 WWW.SHERWOODENGINEERS.COM

Hydrology & Hydraulics Report
and
Stormwater Control Plan

FOR

Dunphy Park

1601 Bridgeway

Sausalito, CA 94965

PREPARED FOR:

CITY OF SAUSALITO

PREPARED BY:

SHERWOOD DESIGN ENGINEERS

58 MAIDEN LANE, 3RD FLOOR

SAN FRANCISCO, CA 94108

(415) 677-7300

August 21, 2017

Contents

A. Project Description

Dunphy Park is located in the City of Sausalito along Bridgeway, bound by Napa Street to the north and the extension of Litho Street to the south. The existing project site (see Figure 1) consists of a large, grassy area located along Richardson's Bay. Existing site features include a sand volleyball court, two bocce ball courts, and a gazebo. A gravel parking lot is located on the north end of the site. Large, mature trees are scattered around the central, grassy zone and lush vegetation covers most of the shoreline towards the south side of the site. A compacted, raised aggregate strip exists within the project site parallel to Bridgeway where a railroad easement is located and railroad tracks were previously located. The soils at the existing site are predominately Bay Mud, characterized by layers of sand and gravel, along with sandy and clayey soils.

Figure 1: Existing Site Conditions

Under existing conditions, on-site drainage primarily sheet flows towards the bay with no inlet structures within the project limits. The project site sits at the base of a large hillside and the

off-site tributary area extends to the inland community. These flows are conveyed into a series of parallel pipes and manholes which outlet to Richardson Bay via two storm drain pipes: 24-inch and 30-inch. These pipes run across the site east to west from Bridgeway and discharge at the bay. The outfalls are currently corroded and HDPE caps cover the pipes as a temporary solution for public safety.

The proposed project improvements include a new restroom facility, two observation decks, replacement of the volleyball and bocce ball courts, and parking lot resurfacing and reconfiguration. The proposed project will also include new site walkways and improved shoreline access. Overall, the proposed site will have very little impervious surface area, therefore the drainage strategy primarily involves infiltration and sheet flow to the bay. Proposed improvements include permeable paving along pathways and the parking lot, and drainage inlets throughout the parking and recreational areas to collect local runoff which does not infiltrate into porous hardscapes.

Proposed improvements will route on-site stormwater to a main double barrel culvert that will outfall at the beach. A preliminary study was completed by Prunuske Chatham, Inc, that recommended installation of a "sediment collection device" to control inland stormwater flows from king tides and rising sea level. These were incorporated into the proposed improvement plan. Additionally, new on-site drainage at the parking lot was accounted for in the new stormwater design. It is assumed that all storms up to 100-year will infiltrate into the parking lot with a pervious paving surface. The parking lot was graded with an average 0.5% slope towards the landscape area drains to account for clogging and overland release.

With such little proposed impervious surface (383 square feet), this is categorized as a small project, according to the Bay Area Stormwater Management Agencies Association (BASMAA). Underdrains are provided in the proposed parking lot improvement and underdrains will be set 3" above subgrade per BASMAA recommendations. See Attachment 1 for the small site Project Data Form.

B. Calculation Methodology

The Rational Method was used to determine design flows for the site. As the Rational Method does not take into account time of concentration, this is a conservative calculation approach. The design flow, Q, is given by the relationship

$$Q = CIA$$

where

Q = flow in cubic feet per second

C = runoff coefficient (dimensionless)

I = rainfall intensity in inches per hour

A = area in acres

The following are the design parameters that were selected to be used for the Rational Method:

1. **Runoff coefficient, C.** The runoff coefficient was determined using a weighted average of the runoff coefficients for the different land uses in each watershed per values provided by the California State Water Resources Control Board, included as Attachment 2 of this report. The coefficient of 0.3 was used for parks and a conservative coefficient of 0.9 was used for pavement areas.
2. **Rainfall intensity, I**. The rainfall intensity was found using the NOAA Atlas 14 Precipitation Frequency Estimates for the Tiberon Topham Station. Based on a storm duration of five minutes, chosen to match the conservative time of concentration estimate of 5 minutes, the rainfall intensity for the 10-year storm and 100-year storm are 3.49 inches/hour and 5.60 inches/hour, respectively. See Attachment 3 for the NOAA station information and the precipitation intensity data for the station.

Manning's Equation was used to determine the hydraulic capacity for proposed storm drain pipes. The pipe capacity, Q, is given by the relationship

$$Q = \frac{1.486}{n} AR^{3/2}S^{1/2}$$

where

Q = flow in cubic feet per second

A = cross-sectional area of flow in square feet

R = hydraulic radius in feet

S = slope of pipe or channel (dimensionless)

n = Manning equation roughness coefficient (dimensionless)

=0.012 for HDPE (proposed storm drain pipes)

C. Proposed Storm Drain System Capacity Analysis

Hydrology and hydraulic calculations were performed to demonstrate that proposed drainage facilities are designed to provide capacity necessary to carry off the 10-year storm and provide overland release for the 100-year storm. The Rational Method was used to determine the runoff entering each proposed inlet for the 10-year storm. Manning's equation was used to determine that the capacities of the proposed storm drain pipes exceed the design flow through the pipes.

The hydraulic capacity of the drainage inlets and trench drains were provided by the manufacturers.

Each proposed drainage inlet has a designated watershed area and most of the landscape area is designed to sheet flow towards the bay. See Attachment 4 for a hydrology map of the site, showing watershed boundaries, storm drain pipes and inlets, and node ID labels. The pipe capacity at each note was compared to the 10-year design flow for the entire upstream area. Inlets were sized by comparing the runoff information against capacity information from the manufacturers, referenced in Attachment 5. The main dual-pipe trunkline running across the site is sized to handle the 10-year off-site runoff along with the newly calculated on-site runoff. See Attachment 6 for the Hydraflow Storm Sewer analysis completed on the dual-pipe trunkline and hydraulic capacity calculations that demonstrate the proposed drainage facilities were designed to provide capacity necessary to carry off the 10-year storm.

D. Attachments

1. Stormwater Control Plan – Project Data Form
2. California State Water Resources Control Board Runoff Coefficient Fact Sheet
3. NOAA Precipitation Data
4. Project Hydrology Map
5. Inlet Capacity Information
6. Proposed Storm Drain System Hydraulic Capacity Calculations

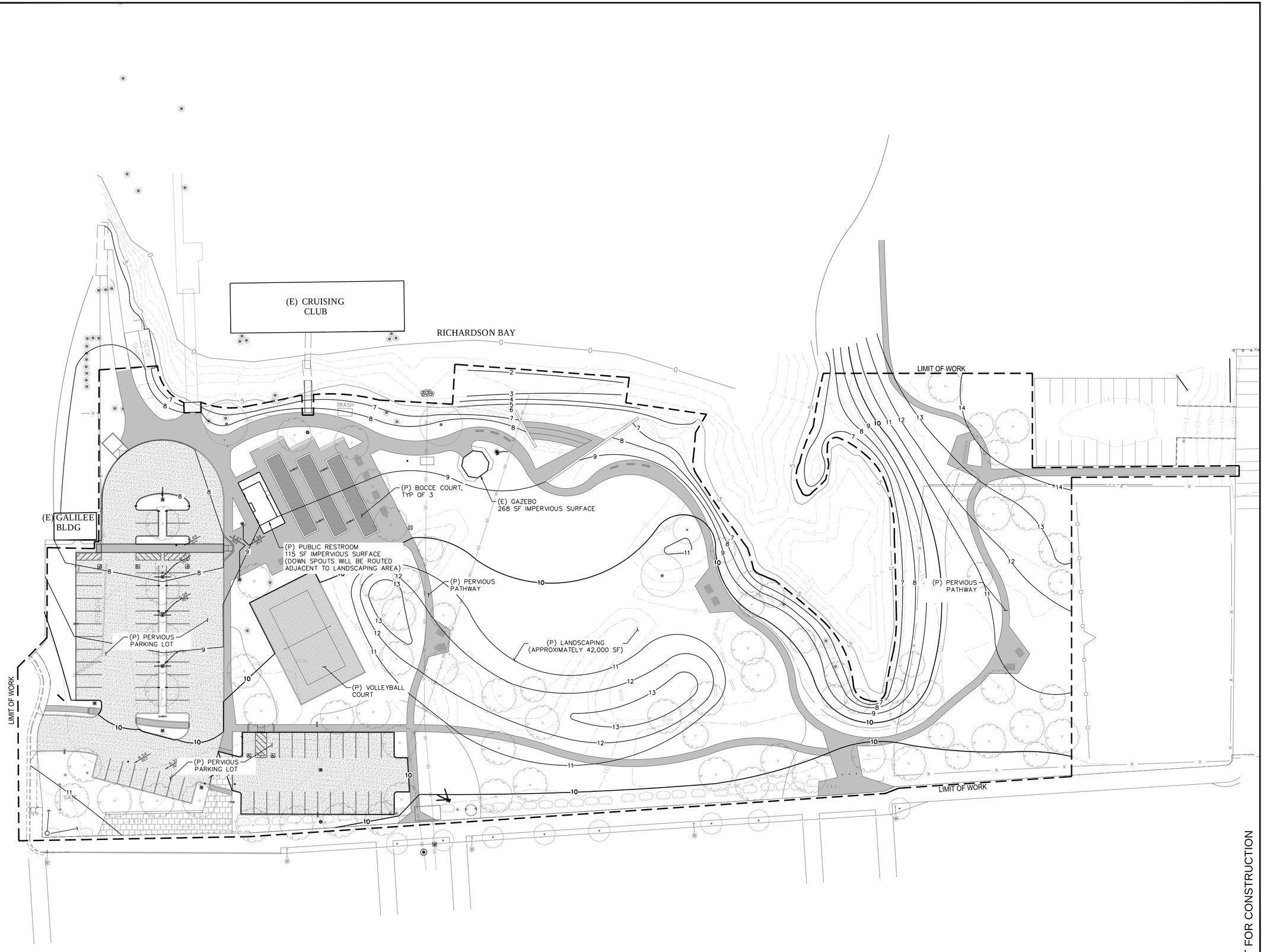
Attachment 1

Stormwater Control Plan – Project Data Form

Project Data Form and Runoff Reduction Measure Selection

Complete all fields.

Project Name/Number	DUNPHY PARK (17-029)
Application Submittal Date [to be verified by municipal staff]	AUGUST 21ST, 2017
Project Location [Street Address if available, or intersection and/or APN]	200 Napa Street Sausalito, CA APN #: 064-084-02
Name of Owner or Developer	City of Sausalito
Project Type and Description [Examples: "Single Family Residence," "Parking Lot Addition," "Retail and Parking"]	Public Park Improvements include a large grass area, sand volleyball court, bocce ball courts, pervious parking lots, pervious pathways and a public restroom building.
Total Project Site Area (acres)	4.45 ACRES
Total New or Replaced Impervious Surface Area (square feet) [Sum of impervious area that will be constructed as part of the project]	115 SF
Total Pre-Project Impervious Surface Area	268 SF
Total Post-Project Impervious Surface Area	383 SF
Runoff Reduction Measures Selected (Check one or more)	☒ 1. Disperse runoff to vegetated area ☒ 2. Pervious pavement ☐ 3. Cisterns or Rain Barrels ☐ 4. Bioretention Facility or Planter Box



P:\2017\17-029_Dunphy\04_Design Exhibits\SCP\SCP Exhibit.dwg,SCP-EXHIBIT,Leonardo DeSousa,8/17/2017 11:12:05 AM,ARCH expand D (36.00 x 24.00 Inches),1:1

Date Plotted: 8/17/2017 11:12 AM

rhaa
LANDSCAPE ARCHITECTURE + PLANNING
225 Miller Avenue, Mill Valley, CA 94941
T 415 383 7900 F 415 383 1433 www.rhaa.com

PROJECT/CLIENT NAME

Dunphy Park

200 Napa Street
Sausalito, CA 94965

Owner:
City of Sausalito
420 Litho St.
Sausalito, CA 94965

RHAA PROJECT NUMBER

16042A

CONSULTANT

SHERWOOD
DESIGN ENGINEERS
58 Maiden Lane, Third Floor
San Francisco, CA 94108
www.sherwoodengineers.com

SUBMITTAL

STORMWATER CONTROL PLAN

DATE

21 August 2017

REVISIONS

No.	Date	Description

REGISTRATION AND SIGNATURE

N
0 15' 30' 60'
1" = 20'

SHEET TITLE

STORMWATER CONTROL PLAN

DRAWN BY: LD **CHECKED BY:** MW

1.0

Attachment 2

California State Water Resources Control Board

Runoff Coefficient Fact Sheet

Runoff Coefficient (C) Fact Sheet

What is It?

The runoff coefficient (C) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well vegetated areas (forest, flat land).

Why is It Important?

It is important for flood control channel construction and for possible flood zone hazard delineation. A high runoff coefficient (C) value may indicate flash flooding areas during storms as water moves fast overland on its way to a river channel or a valley floor.

How is It Measured?

It is measured by determining the soil type, gradient, permeability and land use. The values are taken from the table below. The larger values correspond to higher runoff and lower infiltration.

Land Use	C	Land Use	C
Business:		***Lawns:***	
Downtown areas	0.70 - 0.95	Sandy soil, flat, 2%	0.05 - 0.10
Neighborhood areas	0.50 - 0.70	Sandy soil, avg., 2-7%	0.10 - 0.15
		Sandy soil, steep, 7%	0.15 - 0.20
		Heavy soil, flat, 2%	0.13 - 0.17
		Heavy soil, avg., 2-7%	0.18 - 0.22
		Heavy soil, steep, 7%	0.25 - 0.35
Residential:		***Agricultural land:***	
		Bare packed soil	
		*Smooth	0.30 - 0.60
		*Rough	0.20 - 0.50
		Cultivated rows	
Single-family areas	0.30 - 0.50	*Heavy soil, no crop	0.30 - 0.60
Multi units, detached	0.40 - 0.60	*Heavy soil, with crop	0.20 - 0.50
Munti units, attached	0.60 - 0.75	*Sandy soil, no crop	0.20 - 0.40
Suburban	0.25 - 0.40	*Sandy soil, with crop	0.10 - 0.25
		Pasture	
		*Heavy soil	0.15 - 0.45
		*Sandy soil	0.05 - 0.25
		Woodlands	0.05 - 0.25

Industrial:		*Streets:*	
Light areas	0.50 - 0.80	Asphaltic	0.70 - 0.95
Heavy areas	0.60 - 0.90	Concrete	0.80 - 0.95
		Brick	0.70 - 0.85
Parks, cemeteries	0.10 - 0.25	Unimproved areas	0.10 - 0.30
Playgrounds	0.20 - 0.35	Drives and walks	0.75 - 0.85
Railroad yard areas	0.20 - 0.40	Roofs	0.75 - 0.95

Note: The designer must use judgment to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest "C" values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should assigned the highest "C" values.

http://water.me.vccs.edu/courses/CIV246/table2b.htm accessed 11/19/09

Attachment 3

NOAA Precipitation Data

NOAA Atlas 14, Volume 6, Version 2 TIBERON
TOPHAM
Station ID: 84-8922
Location name: Belvedere Tiburon, California, USA*
Latitude: 37.874°, Longitude: -122.453°
Elevation:
Elevation (station metadata): 400 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

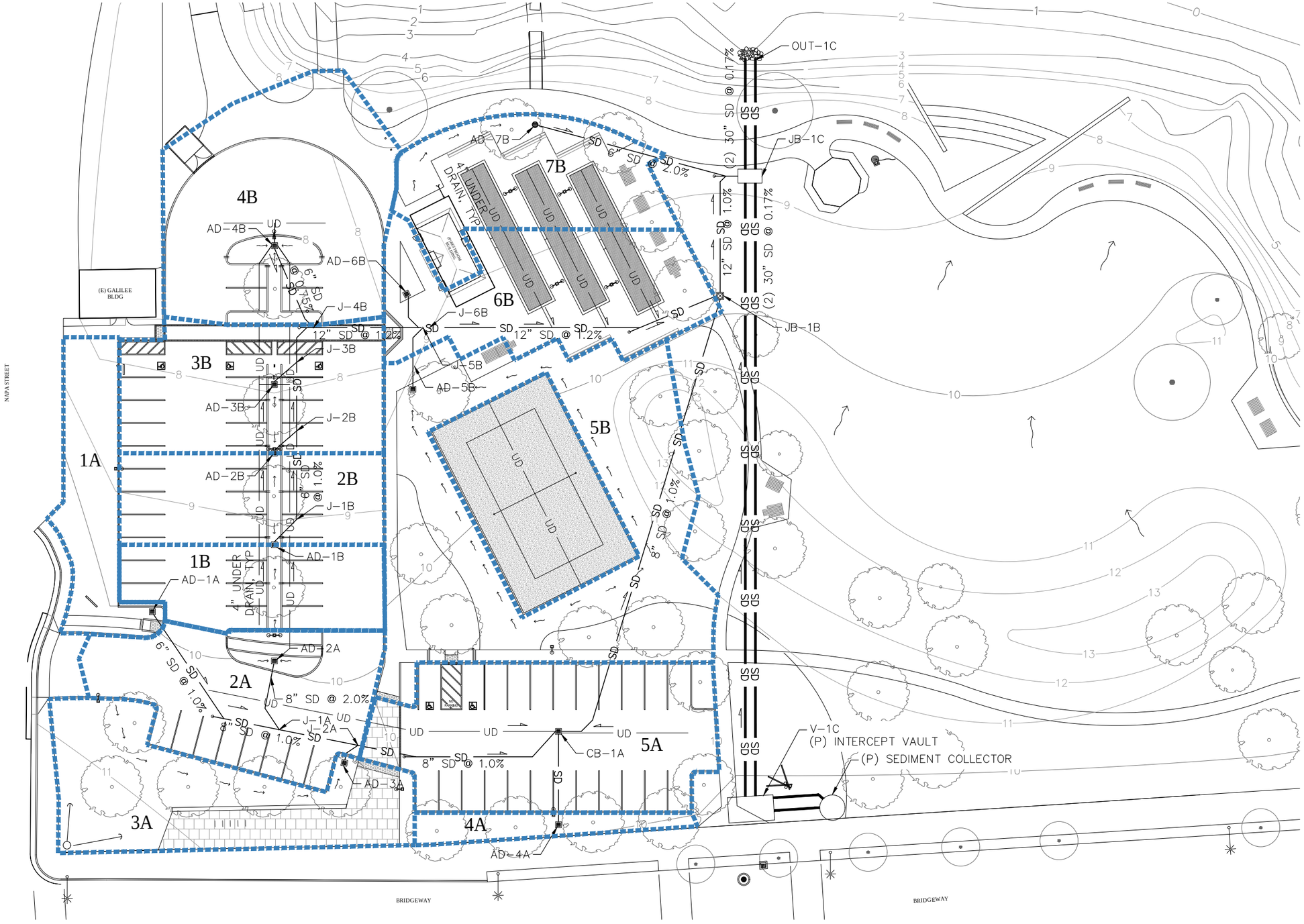
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.86** (1.66-2.11)	**2.32** (2.06-2.63)	**2.95** (2.62-3.36)	**3.49** (3.07-4.02)	**4.27** (3.60-5.12)	**4.91** (4.03-6.02)	**5.58** (4.45-7.06)	**6.30** (4.86-8.24)	**7.34** (5.39-10.1)	**8.20** (5.77-11.7)
10-min	**1.33** (1.19-1.51)	**1.66** (1.48-1.88)	**2.12** (1.88-2.41)	**2.50** (2.20-2.88)	**3.06** (2.58-3.67)	**3.52** (2.89-4.32)	**4.00** (3.19-5.06)	**4.52** (3.49-5.91)	**5.26** (3.86-7.23)	**5.87** (4.14-8.41)
15-min	**1.08** (0.956-1.22)	**1.34** (1.19-1.52)	**1.70** (1.51-1.94)	**2.02** (1.77-2.32)	**2.47** (2.08-2.96)	**2.84** (2.33-3.48)	**3.22** (2.57-4.08)	**3.64** (2.81-4.76)	**4.24** (3.12-5.83)	**4.73** (3.34-6.78)
30-min	**0.752** (0.670-0.852)	**0.938** (0.834-1.06)	**1.19** (1.06-1.36)	**1.41** (1.24-1.63)	**1.73** (1.46-2.07)	**1.98** (1.63-2.44)	**2.26** (1.80-2.85)	**2.55** (1.97-3.34)	**2.97** (2.18-4.08)	**3.31** (2.34-4.74)
60-min	**0.531** (0.474-0.602)	**0.662** (0.590-0.752)	**0.844** (0.748-0.961)	**0.999** (0.877-1.15)	**1.22** (1.03-1.46)	**1.40** (1.15-1.72)	**1.59** (1.27-2.02)	**1.80** (1.39-2.36)	**2.10** (1.54-2.88)	**2.34** (1.65-3.35)
2-hr	**0.388** (0.346-0.440)	**0.481** (0.428-0.546)	**0.611** (0.542-0.696)	**0.722** (0.634-0.832)	**0.884** (0.746-1.06)	**1.02** (0.835-1.25)	**1.16** (0.923-1.46)	**1.31** (1.01-1.71)	**1.53** (1.12-2.10)	**1.71** (1.20-2.44)
3-hr	**0.327** (0.291-0.370)	**0.405** (0.360-0.459)	**0.513** (0.455-0.584)	**0.606** (0.532-0.697)	**0.741** (0.625-0.888)	**0.852** (0.700-1.05)	**0.970** (0.775-1.23)	**1.10** (0.848-1.44)	**1.28** (0.943-1.77)	**1.44** (1.01-2.06)
6-hr	**0.234** (0.209-0.265)	**0.290** (0.258-0.329)	**0.368** (0.326-0.419)	**0.435** (0.382-0.500)	**0.531** (0.448-0.636)	**0.610** (0.501-0.749)	**0.693** (0.553-0.877)	**0.784** (0.605-1.03)	**0.914** (0.672-1.26)	**1.02** (0.721-1.46)
12-hr	**0.156** (0.139-0.177)	**0.196** (0.175-0.223)	**0.251** (0.223-0.286)	**0.298** (0.262-0.343)	**0.365** (0.308-0.437)	**0.418** (0.344-0.514)	**0.475** (0.379-0.602)	**0.536** (0.414-0.702)	**0.623** (0.458-0.856)	**0.693** (0.489-0.993)
24-hr	**0.104** (0.094-0.118)	**0.132** (0.119-0.150)	**0.171** (0.153-0.194)	**0.203** (0.181-0.233)	**0.250** (0.216-0.295)	**0.286** (0.243-0.345)	**0.325** (0.270-0.400)	**0.367** (0.297-0.463)	**0.425** (0.331-0.557)	**0.473** (0.357-0.639)
2-day	**0.065** (0.058-0.074)	**0.082** (0.074-0.093)	**0.106** (0.095-0.120)	**0.126** (0.112-0.144)	**0.154** (0.133-0.181)	**0.176** (0.149-0.212)	**0.200** (0.166-0.246)	**0.225** (0.182-0.284)	**0.260** (0.203-0.341)	**0.289** (0.218-0.390)
3-day	**0.051** (0.046-0.058)	**0.065** (0.058-0.073)	**0.083** (0.075-0.094)	**0.098** (0.088-0.113)	**0.120** (0.104-0.142)	**0.137** (0.117-0.165)	**0.156** (0.129-0.191)	**0.175** (0.142-0.221)	**0.202** (0.158-0.265)	**0.225** (0.170-0.304)
4-day	**0.043** (0.039-0.049)	**0.054** (0.049-0.061)	**0.069** (0.062-0.079)	**0.082** (0.073-0.094)	**0.100** (0.087-0.118)	**0.114** (0.097-0.138)	**0.129** (0.107-0.159)	**0.145** (0.118-0.183)	**0.168** (0.131-0.220)	**0.186** (0.140-0.251)
7-day	**0.030** (0.027-0.034)	**0.038** (0.035-0.044)	**0.049** (0.044-0.056)	**0.058** (0.052-0.067)	**0.071** (0.061-0.083)	**0.080** (0.068-0.097)	**0.090** (0.075-0.111)	**0.101** (0.082-0.128)	**0.116** (0.090-0.152)	**0.128** (0.097-0.173)
10-day	**0.025** (0.023-0.029)	**0.032** (0.029-0.036)	**0.041** (0.037-0.047)	**0.048** (0.043-0.055)	**0.058** (0.051-0.069)	**0.066** (0.056-0.080)	**0.074** (0.062-0.092)	**0.083** (0.067-0.105)	**0.095** (0.074-0.124)	**0.104** (0.078-0.140)
20-day	**0.016** (0.014-0.018)	**0.020** (0.018-0.023)	**0.026** (0.023-0.030)	**0.031** (0.027-0.035)	**0.037** (0.032-0.043)	**0.041** (0.035-0.050)	**0.046** (0.038-0.056)	**0.051** (0.041-0.064)	**0.057** (0.044-0.074)	**0.062** (0.047-0.083)
30-day	**0.013** (0.011-0.014)	**0.016** (0.015-0.019)	**0.021** (0.019-0.024)	**0.025** (0.022-0.028)	**0.029** (0.025-0.035)	**0.033** (0.028-0.039)	**0.036** (0.030-0.045)	**0.040** (0.032-0.050)	**0.044** (0.034-0.058)	**0.047** (0.036-0.064)
45-day	**0.011** (0.010-0.012)	**0.014** (0.012-0.015)	**0.017** (0.016-0.020)	**0.020** (0.018-0.023)	**0.024** (0.021-0.028)	**0.027** (0.023-0.032)	**0.029** (0.024-0.036)	**0.032** (0.026-0.040)	**0.035** (0.027-0.046)	**0.037** (0.028-0.051)
60-day	**0.010** (0.009-0.011)	**0.012** (0.011-0.014)	**0.016** (0.014-0.018)	**0.018** (0.016-0.021)	**0.021** (0.018-0.025)	**0.023** (0.020-0.028)	**0.026** (0.021-0.031)	**0.028** (0.022-0.035)	**0.030** (0.024-0.040)	**0.032** (0.024-0.044)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not

Attachment 4

Project Hydrology Map



North

0 20' 40' 80'

SHERWOOD DESIGN ENGINEERS
58 Maiden Lane, Third Floor
San Francisco, CA
94108
www.sherwoodengineers.com

HYDROLOGY EXHIBIT

DUNPHY PARK
SAUSALITO, CALIFORNIA

August 21, 2017

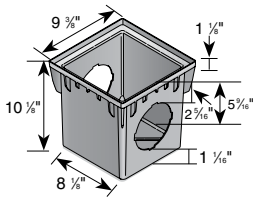
Attachment 5

Inlet Capacity Information

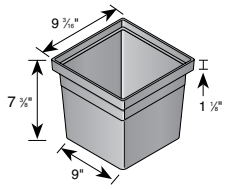
CATCH BASINS

9" Catch Basin Series

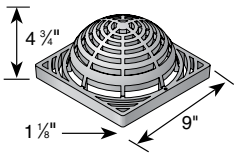
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
900FF	9" Catch Basin Filter	Blue Frame/ Black Bag	8	0.06	10ND	Polypropylene Frame Fabric is non-woven geotextile 956 PM/SF.
	Compatible with these basins: 900, 900-4 and 916 NDS Catch Basins, Risers and Kits					



Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
900BLKIT	9" x 9" Catch Basin Kit	Black Grate	4	4.90	10ND	9" x 9" tapered Catch Basin. Polypropylene. Kits include 2-opening Catch Basin, Grate, Screws, 2 Outlets and 1 Plug. DISP includes display box.
900GRKIT	9" x 9" Catch Basin Kit	Green Grate	4	4.90	10ND	
900KITDISP	9" x 9" Catch Basin Kit	Black Grate	8	39.2	10ND	
900	9" x 9" Catch Basin 2-opening	Black	4	2.18	10ND	
900-4	9" x 9" Catch Basin 4-opening	Black	4	2.00	10ND	
	Requires either #1206, #1242, #1243, #1245 or #1266 Universal Outlet to connect pipe to basin. (see pages 32-33)					

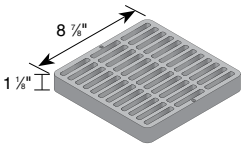


Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
916	9" x 9" Catch Basin Riser	Black	4	1.75	10ND	6" Riser for 9" x 9 Catch Basin. Styrene.
	Use with 9" x 9" Catch Basin Series. Stacks on top of 9" catch basins to add up to 6" to top of basin. Can be cut to size.					



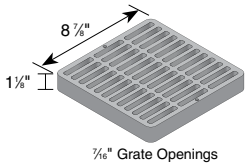
⅜" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
981	9" x 9" Atrium Grate	Black	6	0.87	10ND	9" Structural Foam Polyolefin Dome Atrium Grate with UV inhibitor. Open surface area 31.50 square inches. 96.36 GPM.
991	9" x 9" Atrium Grate	Green	6	0.87	10ND	
	Use with 9" x 9" Catch Basin Series.					



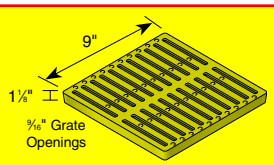
⁷⁄₁₆" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
980	9" Square Grate	Black	8	1.50	10ND	9" Square Structural Foam Polyolefin Grate with UV inhibitor. Open surface area 37.49 square inches. 114.69 GPM.
990	9" Square Grate	Green	8	1.50	10ND	
999	9" Square Grate	Gray	8	1.50	10ND	
999S	9" Square Grate	Sand	8	1.50	10ND	
	Use with 9" x 9" Catch Basin Series. NDS #980, 990, 999, 999S: Class A Load Rated. ADA Compliant. NDS #930B: Class B Load Rated. (see page 74). ADA Compliant.					



⁷⁄₁₆" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. lbs.	Product Class	Specifications
930B	9" Square Brass Grate	Brass	1	5.11	15BR	Open surface area 34.00 square inches. 104.01 GPM. Includes SS Screws.
	(see page 74). ADA Compliant.					

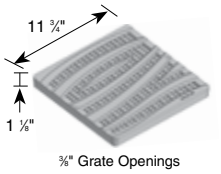


⁹⁄₁₆" Grate Openings

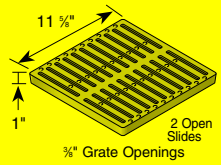
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
913	9" Square Ductile Iron Grate	Black	4	7.89	10ND	9" Square Heavy-Duty Ductile Iron Grate. Open surface area 21.70 square inches. 66.38 GPM.
	Use with 9" x 9" Catch Basin Series. (see page 74)					

CATCH BASINS

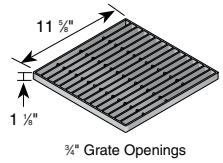
12" Catch Basin Series (continued)



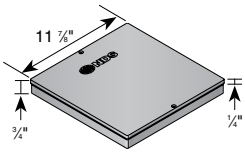
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1224CI	12" x 12" Square Wave Cast Iron Grate	Raw Iron	1	13.90	10ND	12" Square Cast Iron Wave Grate. Open surface area 25.60 square inches. 78.31 GPM. Class B load rated.
629	Stainless Steel Screws, FH #20 x 1-1/2"	Metal	40	n/a	10ND	
	(see page 74). ADA Compliant/Heel-proof.					



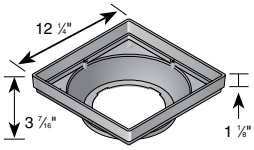
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1213	12" x 12" Square Ductile Iron Grate	Black	1	15.30	10ND	12" Square Heavy-Duty Ductile Iron Grate. Open surface area 37.20 square inches. 113.80 GPM.
	Use with 12" x 12" Catch Basin Series. (see page 74). ADA Compliant.					



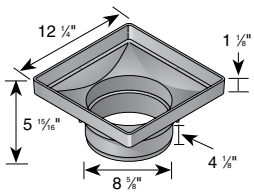
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1215	12" x 12" Square Galvanized Steel Grate	Galvanized Steel	1	5.85	10ND	12" Square Heavy-Duty Galvanized Steel Bar Grate. Open surface area 113.78 square inches. 348.07 GPM.
	Use with 12" x 12" Catch Basin Series. (see page 74)					



Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1220	12" x 12" Sump Pump Box	Black	8	2.23	10ND	NDS #1220, 12" Square Structural Foam Polyolefin Solid Cover.
	Use with NDS 12" x 12" Catch Basin Series and NDS #1219 Backwater Valve Box.					



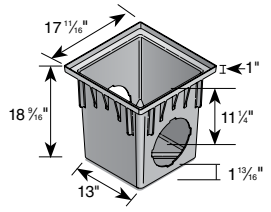
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1230	12" x 12" Low-Profile Adapter	Black	8	1.25	10ND	12" x 12" Low-Profile Adapter. Styrene.
	Requires either #1243, #1245, #1266 or #1889 Universal Outlet for connection to 3", 4" or 6" Sewer and Drain or Corrugated Pipe. (see page 33)					



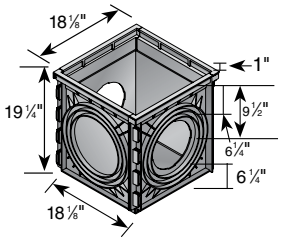
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1221	12" x 12" Square, Low-Profile Adapter	Black	12	1.92	10ND	12" x 12" Low-Profile Adapter. Styrene.
1222	12" x 12" Square, Low-Profile Spigot Adapter	Black	12	1.92	10ND	
	Fits 8" Corrugated Pipe, Sch 40, Corrugated Spigot, S&D Hub.					

CATCH BASINS

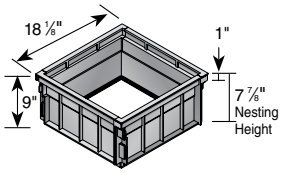
18" Catch Basin Series



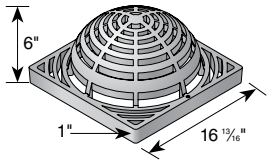
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1882	18" One-Piece Catch Basin 2 Openings	Black	1	10.00	10ND	18"x18" One-Piece Tapered Catch Basin. Structural Foam Polyolefin.
1884	18" One-Piece Catch Basin 4 Openings	Black	1	9.65	10ND	
	Requires either #1206, #1242, #1243, #1245, #1266, #1888 or #1889 Universal Outlet to connect pipe to basin. Includes 2 or 4 #1890 Reducer Rings.					



Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1800	18" x 18" Expandable Catch Basin 2 Openings*	Black	1	16.00	10ND	18" x 18" Modular Catch Basin with Locking Tabs. Styrene.
1804	18" x 18" Expandable Catch Basin 4 Openings*	Black	1	16.00	10ND	
	Assembly Required. #1800 includes: 2 #1822, 2 #1820, 1 #1828. #1804 includes: 4 #1822, 1 #1828. Use #1800 and #1804 with #1206, #1243, #1245, #1266 or #1888 Universal Outlets to connect pipes to basin. Includes 2 or 4 #1890 Reducer Rings. (Note: Use Silicone to seal joints.)					

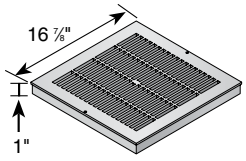


Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1816	8" Riser for 18" Catch Basin	Black	1	6.00	10ND	8" Riser for 18" x 18" Catch Basin. Styrene.
	Riser package includes 4 sides. Use with #1800, #1804, #1882 or #1884.					



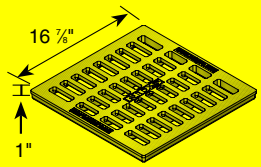
½" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1881	18" x 18" Atrium Grate	Black	2	6.51	10ND	18" Structural Foam Polyolefin Dome Atrium Grate with UV inhibitor. Open surface area 89.40 square inches. 273.49 GPM.
1891	18" x 18" Atrium Grate	Green	2	6.51	10ND	
	Use with 18" x 18" Catch Basin Series.					



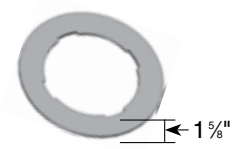
7⁄16" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1810	18" x 18" Square Grate	Gray	4	7.72	10ND	18" Square Structural Foam Polyolefin Grate with UV inhibitor. Open surface area 86.31 square inches. 264.03 GPM.
1811	18" x 18" Square Grate	Black	4	7.72	10ND	
1812	18" x 18" Square Grate	Green	4	7.72	10ND	
	Use with 18" x 18" Catch Basin Series. (see page 74). ADA Compliant.					



1" Grate Openings

Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1813	18" x 18" Cast Iron Square Grate	Black	1	46.00	10ND	18" Square Heavy-Duty Cast Iron Grate. Open surface area 110.70 square inches. 338.65 GPM. H-20 Load Rating.
	Use with 18" x 18" Catch Basin Series.					

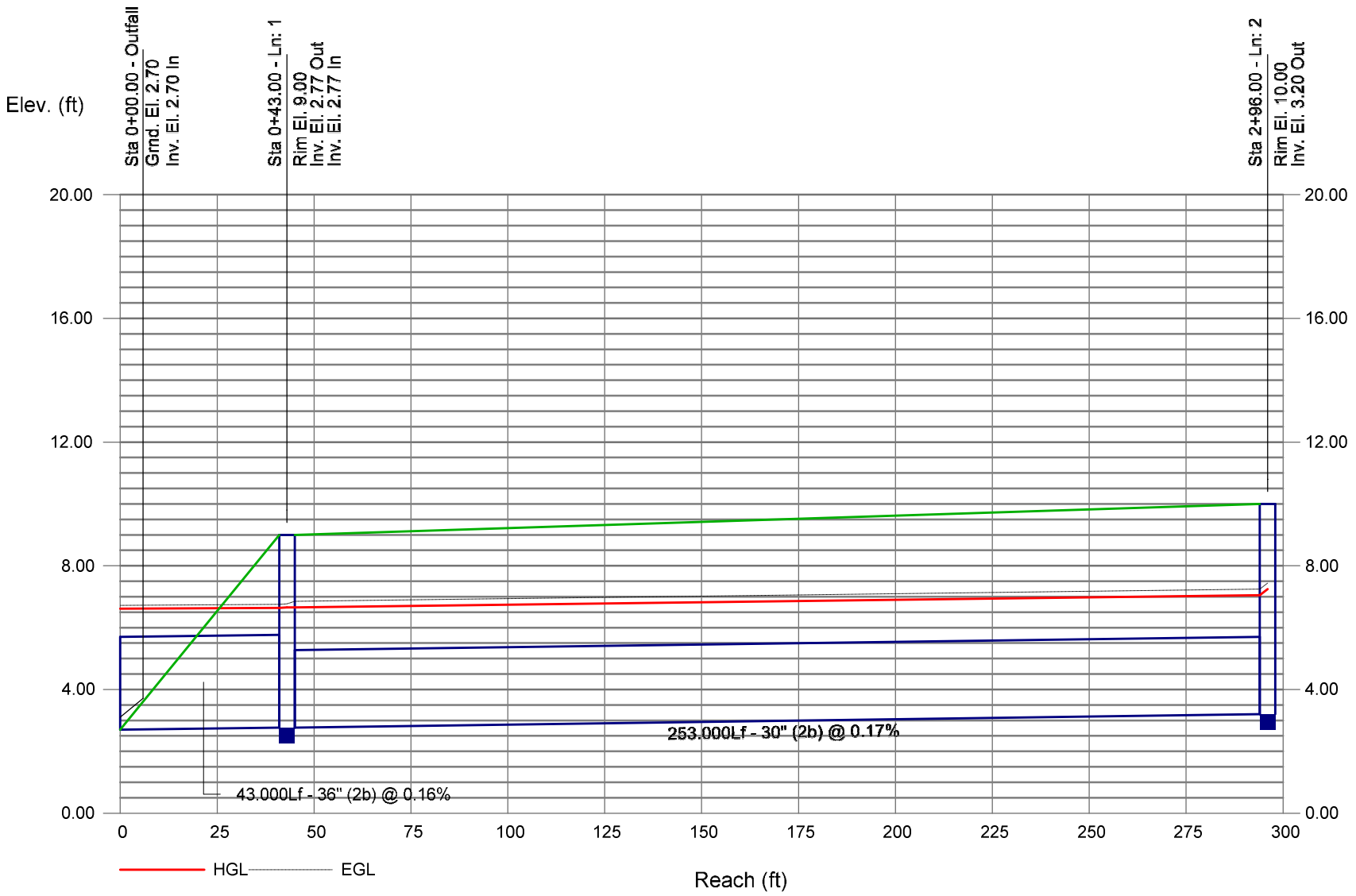


Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class	Specifications
1890	Universal Outlet Reducer Ring	Black	8	0.33	10ND	Styrene.
	Required on #1821 basin side when using 3", 4" or 6" pipe. Required on #1821 basin side when connecting to #1206, #1243, #1245, #1266 or #1889 Universal Outlets.					

Storm Sewer Profile

Proj. file: Hydraflow_Dual Pipes.stm

10-YEAR STORM



Storm Sewer Summary Report

10-YEAR STORM

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Inserted Line	38.00	36	Cir(2b)	43.000	2.70	2.77	0.163	6.61*	6.64*	0.02	6.66	End	Manhole
2		35.00	30	Cir(2b)	253.000	2.77	3.20	0.170	6.66*	7.05*	0.20	7.25	1	Manhole

Project File: Hydraflow_Dual Pipes.stm | Number of lines: 2 | Run Date: 8/17/2017

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown).

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	36(2b)	38.00	2.70	6.61	3.00	14.13	2.69	0.11	6.72	0.069	43.000	2.77	6.64	3.00	14.14	2.69	0.11	6.75	0.069	0.069	0.030	0.15	0.02
2	30(2b)	35.00	2.77	6.66	2.50	9.82	3.57	0.20	6.85	0.155	253.000	3.20	7.05	2.50	9.82	3.57	0.20	7.25	0.155	0.155	0.393	1.00	0.20

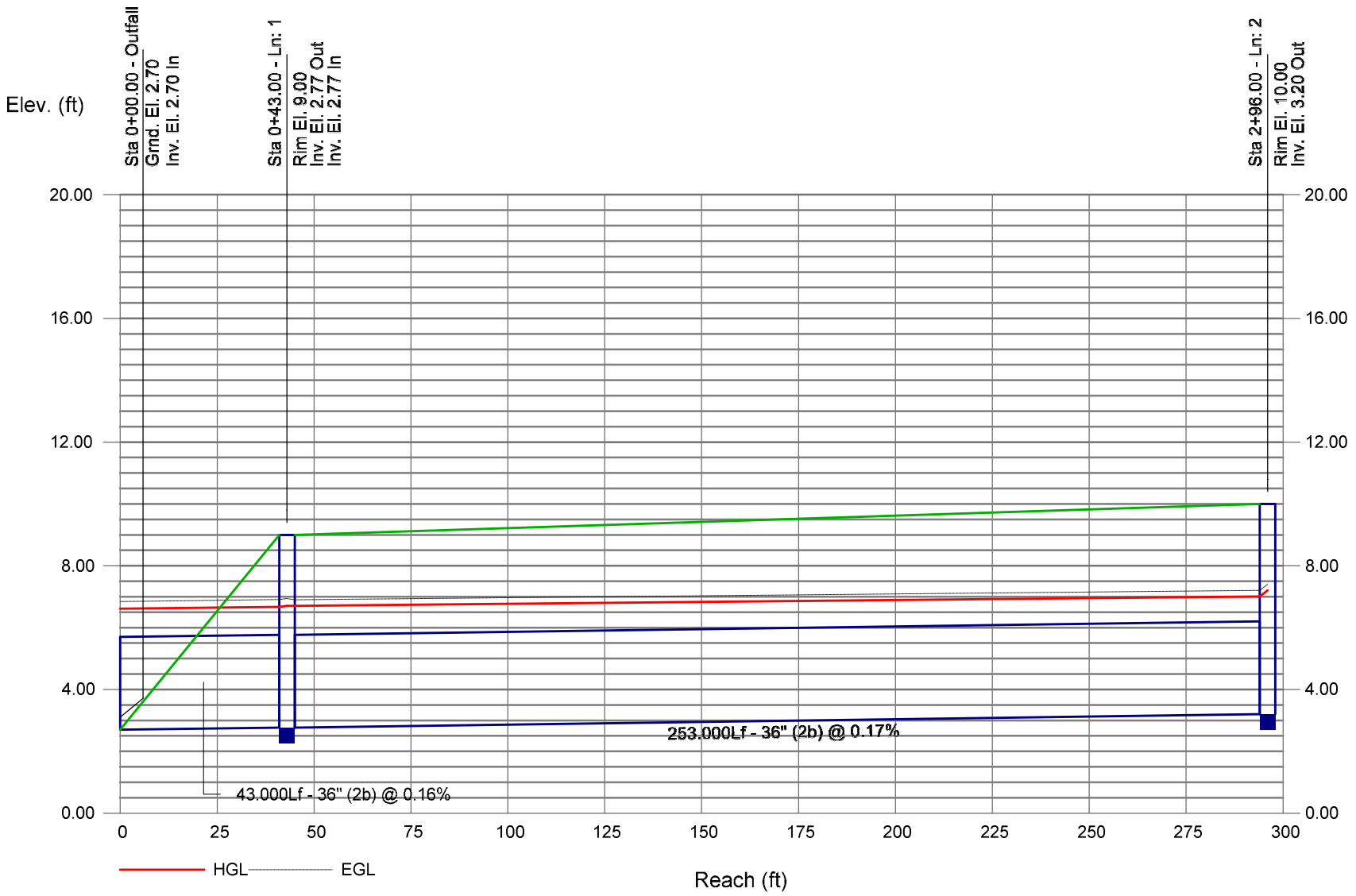
Project File: Hydraflow_Dual Pipes.stm | Number of lines: 2 | Run Date: 8/17/2017

; c = cir e = ellip b = box

Storm Sewer Profile

Proj. file: Hydraflow_Dual Pipes.stm

100-YEAR STORM



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Inserted Line	54.88	36	Cir(2b)	43.000	2.70	2.77	0.163	6.61*	6.67*	0.04	6.71	End	Manhole
2		50.00	36	Cir(2b)	253.000	2.77	3.20	0.170	6.71*	7.01*	0.19	7.20	1	Manhole

Project File: Hydraflow_Dual Pipes.stm | Number of lines: 2 | Run Date: 8/17/2017

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown).

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	36(2b)	54.88	2.70	6.61	3.00	14.13	3.88	0.23	6.84	0.144	43.000	2.77	6.67	3.00	14.14	3.88	0.23	6.91	0.144	0.144	0.062	0.15	0.04
2	36(2b)	50.00	2.77	6.71	3.00	14.13	3.54	0.19	6.90	0.120	253.000	3.20	7.01	3.00	14.14	3.54	0.19	7.20	0.120	0.120	0.303	1.00	0.19

Project File: Hydraflow_Dual Pipes.stm | Number of lines: 2 | Run Date: 8/17/2017

; c = cir e = ellip b = box

Attachment 6

Proposed Strom Drain System Hydraulic Capacity Calculations

Proposed Storm Drain System Hydraulic Capacity Calculations

10-Year Storm Event

Node abbreviations: P=pipe, CB=catch basin, AD=area drain, J=junction, JB=junction box, SDMH=storm drain manhole

start pipe network A

Node ID	Downstream Node	Tributary Area Name	Tributary Area (sf)	Tributary Area (ac)	Tributary C	Upstream Area (ac)	Total Area A (ac)	Weighted C	Rainfall Intensity I (in/hr)	Tributary Runoff (cfs)	Total Runoff Q (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Manning's n	Pipe Size (in)	Pipe Area (ft^2)	Pipe Perimeter (ft)	Full Flow Velocity (ft/s)	Full Flow Capacity (cfs)	Inlet Size (in)	Inlet Capacity (cfs)	Pipe Capacity?	Inlet Capacity?
AD-1A	J-1A	1A	2,785	0.064	0.30	0.000	0.064	0.30	3.49	**0.067**	**0.067**	76	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
AD-2A	J-1A	2A	5,393	0.124	0.90	0.000	0.124	0.86	3.49	**0.372**	**0.372**	24	0.0100	0.012	8	0.349	2.09	3.76	**1.31**	18	**0.75**	OK	OK
J-1A	J-2A					0.188	0.188		3.49	**0.000**	**0.439**	37	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
AD-3A	J-2A	3A	5,556	0.128	0.30	0.000	0.128	0.30	3.49	**0.134**	**0.134**	11	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
AD-4A	CB-1A	4A	930	0.021	0.30	0.000	0.021	0.30	3.49	**0.022**	**0.022**	11	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
J-2A	CB-1A					0.315	0.315		3.49	**0.000**	**0.573**	83	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
CB-1A	JB-1B	5A	3,315	0.076	0.90	0.315	0.391	0.90	3.49	**0.239**	**0.834**	180	0.0100	0.012	8	0.349	2.09	3.76	**1.31**	12	**0.25**	OK	OK

end pipe network A

start pipe network B

Node ID	Downstream Node	Tributary Area Name	Tributary Area (sf)	Tributary Area (ac)	Tributary C	Upstream Area (ac)	Total Area A (ac)	Weighted C	Rainfall Intensity I (in/hr)	Tributary Runoff (cfs)	Total Runoff Q (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Manning's n	Pipe Size (in)	Pipe Area (ft^2)	Pipe Perimeter (ft)	Full Flow Velocity (ft/s)	Full Flow Capacity (cfs)	Inlet Size (in)	Inlet Capacity (cfs)	Pipe Capacity?	Inlet Capacity?
AD-1B	J-1B	1B	3,314	0.076	0.90	0.000	0.076	0.87	3.49	**0.231**	**0.231**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	12	**0.25**	OK	OK
J-1B	J-2B					0.076	0.076		3.49	**0.000**	**0.231**	36	0.0100	0.012	6	0.196	1.57	3.10	**0.61**			OK	N/A
AD-2B	J-2B	2B	3,743	0.086	0.90	0.000	0.086	0.87	3.49	**0.261**	**0.261**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-2B	J-3B					0.162	0.162		3.49	**0.000**	**0.493**	27	0.0100	0.012	6	0.196	1.57	3.10	**0.61**			OK	N/A
AD-3B	J-3B	3B	5,225	0.120	0.90	0.000	0.120	0.88	3.49	**0.369**	**0.369**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-3B	J-4B					0.282	0.282		3.49	**0.000**	**0.862**	25	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
AD-4B	J-4B	4B	7,773	0.178	0.90	0.000	0.178	0.86	3.49	**0.536**	**0.536**	39	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-4B	J-5B					0.460	0.460		3.49	**0.000**	**1.398**	36	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-5B	J-5B	5B	10,912	0.251	0.30	0.000	0.251	0.40	3.49	**0.353**	**0.353**	16	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-5B	J-6B					0.711	0.711		3.49	**0.000**	**1.751**	5	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-6B	J-6B	6B	5,016	0.115	0.90	0.000	0.115	0.33	3.49	**0.132**	**0.132**	17	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
J-6B	JB-1B					0.826	0.826		3.49	**0.000**	**1.883**	113	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-7B	JB-1B	7B	4,553	0.105	0.30	0.000	0.105	0.76	3.49	**0.279**	**0.279**	78	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
JB-1B	JB-1C					0.496	0.496		3.49	**0.000**	**2.996**	51	0.0100	0.012	12	0.785	3.14	4.93	**3.87**	18	**0.75**	OK	OK

end pipe network B

start pipe network C

V-1C	JB-1C			0.000		0.000	0.000	0.00	3.49	**0.000**	**35.000**	253	0.0017	0.012	30	4.906	7.85	3.74	**36.72**	0	**0.00**		OK	N/A
JB-1C	OUT-1C			0.000		0.496	0.496	0.00	3.49	**0.000**	**37.996**	53	0.0017	0.012	36	7.065	9.42	4.23	**59.71**	0	**0.00**		OK	N/A

Proposed Storm Drain System Hydraulic Capacity Calculations

100-Year Storm Event

Node abbreviations: P=pipe, CB=catch basin, AD=area drain, J=junction, JB=junction box, SDMH=storm drain manhole

start pipe network A

Node ID	Downstream Node	Tributary Area Name	Tributary Area (sf)	Tributary Area (ac)	Tributary C	Upstream Area (ac)	Total Area A (ac)	Weighted C	Rainfall Intensity I (in/hr)	Tributary Runoff (cfs)	Total Runoff Q (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Manning's n	Pipe Size (in)	Pipe Area (ft^2)	Pipe Perimeter (ft)	Full Flow Velocity (ft/s)	Full Flow Capacity (cfs)	Inlet Size (in)	Inlet Capacity (cfs)	Pipe Capacity?	Inlet Capacity?
AD-1A	J-1A	1A	2,785	0.064	0.30	0.000	0.064	0.30	5.60	**0.107**	**0.107**	76	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
AD-2A	J-1A	2A	5,393	0.124	0.86	0.000	0.124	0.86	5.60	**0.597**	**0.705**	24	0.0100	0.012	8	0.349	2.09	3.76	**1.31**	18	**0.75**	OK	OK
J-1A	J-2A					0.188	0.188		5.60	**0.000**	**0.812**	37	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
AD-3A	J-2A	3A	5,556	0.128	0.30	0.000	0.128	0.30	5.60	**0.214**	**0.214**	11	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	12	**0.25**	OK	OK
AD-4A	CB-1A	4A	930	0.021	0.30	0.000	0.021	0.30	5.60	**0.036**	**0.036**	11	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	9	**0.15**	OK	OK
J-2A	CB-1A	4A				0.315	0.315		5.60	**0.000**	**1.026**	83	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
CB-1A	JB-1B	5A	3,315	0.076	0.90	0.315	0.391	0.90	5.60	**0.384**	**1.410**	180	0.0100	0.012	12	0.785	3.14	4.93	**3.87**	18	**0.75**	OK	OK

end pipe network A

start pipe network B

Node ID	Downstream Node	Tributary Area Name	Tributary Area (sf)	Tributary Area (ac)	Tributary C	Upstream Area (ac)	Total Area A (ac)	Weighted C	Rainfall Intensity I (in/hr)	Tributary Runoff (cfs)	Total Runoff Q (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Manning's n	Pipe Size (in)	Pipe Area (ft^2)	Pipe Perimeter (ft)	Full Flow Velocity (ft/s)	Full Flow Capacity (cfs)	Inlet Size (in)	Inlet Capacity (cfs)	Pipe Capacity?	Inlet Capacity?
AD-1B	J-1B	1B	3,314	0.076	0.90	0.000	0.076	0.87	5.60	**0.371**	**0.371**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-1B	J-2B					0.076	0.076		5.60	**0.000**	**0.371**	36	0.0100	0.012	6	0.196	1.57	3.10	**0.61**			OK	N/A
AD-2B	J-2B	2B	3,743	0.086	0.90	0.000	0.086	0.87	5.60	**0.419**	**0.419**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-2B	J-3B					0.162	0.162		5.60	**0.000**	**0.790**	27	0.0100	0.012	8	0.349	2.09	3.76	**1.31**			OK	N/A
AD-3B	J-3B	3B	5,225	0.120	0.90	0.000	0.120	0.88	5.60	**0.593**	**0.593**	12	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-3B	J-4B					0.282	0.282		5.60	**0.000**	**1.383**	25	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-4B	J-4B	4B	7,773	0.178	0.90	0.000	0.178	0.86	5.60	**0.860**	**0.860**	39	0.0100	0.012	8	0.349	2.09	3.76	**1.31**	24	**0.95**	OK	OK
J-4B	J-5B					0.460	0.460		5.60	**0.000**	**2.243**	36	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-5B	J-5B	5B	10,912	0.251	0.30	0.000	0.251	0.40	5.60	**0.566**	**0.566**	16	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	18	**0.75**	OK	OK
J-5B	J-6B					0.711	0.711		5.60	**0.000**	**2.809**	5	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-6B	J-6B	6B	5,016	0.115	0.90	0.000	0.115	0.33	5.60	**0.212**	**0.212**	17	0.0100	0.012	6	0.196	1.57	3.10	**0.61**	12	**0.25**	OK	OK
J-6B	JB-1B					0.826	0.826		5.60	**0.000**	**3.021**	113	0.0100	0.012	12	0.785	3.14	4.93	**3.87**			OK	N/A
AD-7B	JB-1B	7B	4,553	0.105	0.30	0.000	0.105	0.76	5.60	**0.447**	**0.447**	113	0.0100	0.012	12	0.785	3.14	4.93	**3.87**	18	**0.75**	OK	OK
JB-1B	JB-1C					0.496	0.496		5.60	**0.000**	**4.878**	113	0.0100	0.012	18	1.766	4.71	6.45	**11.40**			OK	N/A

end pipe network B

start pipe network C

V-1C	JB-1C			0.000		0.000	0.000	0.00	5.60	**0.000**	**50.000**	253	0.0017	0.012	36	7.065	9.42	4.23	**59.71**	0	**0.00**		OK	N/A
JB-1C	OUT-1C			0.000		0.496	0.496	0.00	5.60	**0.000**	**54.878**	53	0.0017	0.012	36	7.065	9.42	4.23	**59.71**	0	**0.00**		OK	N/A

end pipe network C