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MEMORANDUM

To:	Rob Holmlund (Humboldt Bay Harbor, Recreation, and Conservation District)
From:	Jeremy Patapoff
Date:	April 16, 2024
Subject:	On-Site Drainage
Project:	Redwood Marine Multipurpose Terminal Replacement Project
Location:	Eureka, California
M&N Job No.:	212991-03
Cc:	Shane Phillips & Michael Jokerst Jared O'Barr and Cole Collins

Disclaimer: *This draft technical memorandum is a work-in-progress and is intended to be an internal document for use by the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal Project team as a part of the conceptual design process and the ongoing permitting process. This memorandum is meant to be read as a part of a comprehensive packet of technical analyses. It is not written to be a standalone document and it is assumed that the reader has substantial project knowledge and context to understand the memorandum's content. All aspects of this memorandum are subject to change and may become less accurate over time. To better understand the project, please review the more comprehensive and up to date documents posted to the Humboldt Bay Harbor District's website at https://humboldtbay.org/humboldt-bay-offshore-wind-heavy-lift-marine-terminal-project-3.*

The purpose of this memorandum is to document Moffatt & Nichol's (M&N's) evaluation process that led to the selection of pipe sizes and number of pipes to provide storm water conveyance within the site. This memorandum is organized as follows:

1. Introduction
2. Design Criteria
3. Drainage Evaluation
4. Conclusion
5. Limitations
6. Next Phase Considerations

1. INTRODUCTION

The proposed Redwood Multi-Purpose Marine Terminal (RMMT) includes two wharves and a wet storage tie-up pier to meet the operational needs of a heavy-lift marine terminal facility to support the offshore wind energy industry and other coastal-dependent industries. The main function of the delivery wharf is to provide berthing, mooring, and offloading capabilities for the delivery vessels and launching of Wind Turbine Devices (WTD) foundations. The assembly berth's main functions include staging, and assembly of WTDs. The "North Wharf" will be built in two phases. The first phase wharf will be 800 linear feet (LF) and will be wide enough to be able to accommodate a large crane that will be used for assembly of the WTD. The second phase will extend the North Wharf 800 LF and would be used primarily as a delivery berth. The second wharf will be the "South Wharf," and will similarly be able to accommodate both delivery and assembly operations with a total length of 1600 LF.

The roughly 170 acres of backland will be graded to provide protection against future sea level rise, provide laydown area for the windfarm components, be compacted to sustain the loads of the component/cranes/SPMTs that move the components around, and provide positive drainage to the proposed stormwater collection facilities.

- Existing Drainage Conditions

  The north half of the site currently has five Bay Outfall locations as identified on an old photo atlas map, See Attachment 1. Four of the locations connect to on-site collection systems and one connects to a system that terminates at the east end of Samoa near the project boundary. It is unknown if any of the existing storm drain systems currently function as the site generally undulates with natural high-low points where stormwater can pond. Eyewitness accounts have confirmed both ponding within the site and at the location of the Samoa system. Secondary overflow is provided by the site sloping from west to east and from south to north so stormwater runoff eventually ends up in the Bay.

- Proposed Drainage Conditions

  Due to the proposed surcharge that will promote settlement across the site all existing storm drain systems identified within the site will be removed or abandoned in place with slurry fill based on geotechnical recommendations. See Preliminary Geotechnical Memo (EMI, Jan 2024). The new site drainage proposes to take advantage of the proposed east-west crowned grading to allow surface flow collection around the perimeter of the site. Bio-filtration planters with 10-yr and 100-yr overflow risers are proposed not only for stormwater collection, but also for Low Impact Development (LID) treatment. Backlands adjacent to the wharfs will collect stormwater in trench drains along the wharf which will connect to trash capture devices, LID mechanical treatment and then outfall to the Bay. See Stormwater Treatment memo for reference. Reconstructed storm drain systems from the town of Samoa will be constructed through the site to maintain existing drainage patterns. See Offsite Drainage memo for more information.

2. DESIGN CRITERIA

Table 1 – Summary of Stormwater Design Criteria

Design Storm	10-yr with 100-yr overflow protection
Intensity (in/hr)	10-yr, 10-min with 100-yr, 10-min protection
Depth (in)	10-yr, 24-hr with 100-yr, 24-hr protection
Runoff Coeff	0.9 for compacted DGA
Time of Concentration	5 to 17 minutes
Min pipe slope flowing half full @ 3 fps	24” (0.0018 ft/ft), 36” (0.0011 ft/ft)

3. DRAINAGE EVALUATION

A hydrology map for the project site was prepared as part of the Storm Drain Site Plan (see Attachment 2). The subarea boundaries were delineated in the east-west direction from the high point crown as established by the grading plan to the project boundary. Subareas were further divided north-south by areas that would drain to the perimeter bio-planter or wharf deck drain. In all, 11 subarea boundaries were created.

The site was first evaluated for the 10-yr, 24-hr storm with a rainfall depth of 4.14-in as provided by NOAA14 data for the project location (See Attachment 3). Based on the project area, flow path distance, slope and runoff coefficient, a volume and runoff rate was calculated for each subarea. Calculations were also performed for the 100-yr, 24-hr storm with a rainfall depth of 6.18-in. A summary of the volume and runoff rates is provided in Table 2.

Table 2 – Volume and Runoff Summary *

Subarea	10-yr		100-yr	
	Volume (cu-ft)	Runoff (cfs)	Volume (cu-ft)	Runoff (cfs)
1	165315	17.3	250137	30.1
2	408149	40.2	617565	68.7
3	262875	26.7	397753	45.9
4	450861	47.2	682192	82.1
5	107079	11.2	162019	18.7
6	470535	54.8	711957	94.3
7	72771	11.0	110103	17.7
8	119865	18.1	181359	31.8
9	69014	12.2	104419	18.3
10	72897	12.9	110294	19.3
11	69889	9.9	105745	17.0

* Values are based on preliminary subarea boundaries and will be refined in futures phases of design

24-inch and 36-inch pipes were evaluated to convey runoff from the treatment devices / BMPs to the bay. Since the inverts of the bio-planters along the project boundary are at elevation 12' in comparison to the target bay outfall elevation of 10' this was considered a constraint on pipe slope. The proposed site surface has 3-feet of dense graded aggregate (DGA), which places additional constraints on minimum pipe cover. See Aggregate Sourcing Memo (M&N, Jan 2024). With these constraints in mind, 24-pipes are better suited for most locations. Should the DGA be less than the current proposed depth of 3-feet, 36-pipes may be considered for their higher capacity. The full flow capacity of a 24-inch pipe at 0.2% is 10 cfs (See Attachment 4). Each subarea was then assigned a number of 24-inch pipes based on its 10-yr and 100-yr runoff rates. Table 3 below provides a summary of the number of pipes that will be necessary to convey each area's 10-yr and 100-yr flow volumes for 24-inch pipes at the minimum required slope to maintain a "self-cleaning" velocity of 3 fps.

Table 3 – Storm Drain System Pipe Quantity and Sizing

Subarea	Area (acre)	Length (feet)	Slope	CN	Q10 (cfs)	Q100 (cfs)	No. 24" Pipes Required*	
							Q10, 0.2% Slope	Q100, 0.2% Slope
1	13.2	895	0.005	0.9	17.3	30.12	2	1
2	32.59	1150.3	0.005	0.9	40.24	68.68	4	3
3	20.99	1086	0.005	0.9	26.67	45.95	3	2
4&9	41.51	946.6	0.005	0.9	59.37	100.42	6	4
5	8.55	982.8	0.005	0.9	11.21	18.72	2	0
6	25.97	455.81	0.005	0.9	54.78	94.31	6	4
7	9.78	474	0.005	0.9	10.96	17.68	2	0
8&10	21.51	433	0.005	0.9	30.93	51.07	4	2
11	7.09	532	0.005	0.9	9.88	16.98	1	1

*Q100 is number of additional pipes to the Q10 number

4. CONCLUSIONS

Based on M&N assessment, it will be necessary to construct storm drain systems along the perimeter of the site to inhibit storm runoff from draining off the project site and inundating the Town of Samoa and the Great Redwood Trail (GRT). The implementation of trench drains at the wharfs and bio-planters around the perimeter of the site, with 10-yr and 100-yr overflow protection, will capture the 10-yr storm but will pond until the 100-yr storm is reached. Storm events beyond the 100-yr will pond and potentially inundate the site and the GRT.

Approximately 30 each 24” pipes are required to convey the site’s 10-yr design flow volumes and an additional 17 each 24” pipes are required to convey the site’s 100-yr design flow volumes. These quantities and sizes have been determined as part of this schematic design phase and are based on the current known information of the site. As the project moves into the construction design phase the quantities and sizes of pipes may change.

5. LIMITATIONS

The purpose for the work conducted in this phase was to help advance a conceptual design for purposes of project planning, initiation of environmental permitting and regulatory processes, and to aid in development of an overall project narrative and budget estimate. This phase of storm drain design was limited by insubstantial topographical information and existing site survey. Information regarding the existing drainage systems in the area was provided to M&N on a scan of a folded pdf (see Attachment 1) which provided limited information and may have resulted in inaccuracies. Certain information that is pertinent to design is still unavailable at this phase, including rate of sea level rise, thickness of the dense graded aggregate (DGA) layer for the site surface, and site infiltration rates. The lack of the former variables made it difficult to determine for certain storm drain system type (gravity vs pumped) and pipe sizing. Additional calculations and analysis will be required in subsequent phases of work to refine and update the results and recommendations outlined in this memorandum.

6. NEXT PHASE CONSIDERATIONS

At the start of the next phase of work, the following are critical steps in the continuation of the planning, analysis, and design work:

- Obtaining more detailed topographic information and survey of the site area to aid in the further analysis and design of on-site drainage conditions and solutions.
- Obtaining more information regarding the rate of sea level rise at the site, which may determine the long-term viability of a gravity storm system.
- Determining depth of DGA, which will dictate the size of storm drain pipes and the possible need for additional pipe reinforcement. Should the DGA be less than the current proposed depth of 3-feet, 36-pipes may be considered for higher capacity.
- Determine site infiltration rates to see if a portion of the storm can be retaining and infiltrated on site, resulting in possible reduction in the number of outfall pipes into the bay.

Attachment 1 - Existing Bay Outfall Locations

NOTES

1. PURPOSE: THE PURPOSE OF THIS WORMAP IS TO SHOW THE APPROXIMATE LOCATIONS OF EXISTING SEWER MAINS AND STORM DRAIN MAINS AND THE APPROXIMATE LOCATION OF A NEW SEWER LIFT STATION.
2. PROPERTY LINE INFORMATION: CALCULATED PROPERTY LINES ARE SHOWN, BASED ON BOOK 25 OF MAPS, PAGES 127 - 141.
3. UNDERGROUND DISCLAIMER: NO RESEARCH OR INVESTIGATION REGARDING UNDERGROUND PIPES, ELECTRIC LINES, OR OTHER SUBSURFACE FEATURES HAS BEEN PERFORMED. NO LIABILITY IS ASSUMED FOR ANY UNDERGROUND INFORMATION.
4. BEFORE ANY EARTHWORK IS PERFORMED ON SUBJECT PROPERTY, PROPERT OWNER IS ADVISED TO CONTACT UNDERGROUND SERVICES ALERT (USA) FOR ACCURATE LOCATION OF UNDERGROUND UTILITIES (800-227-2600).
5. THE EXISTING BARK FILTER SEWER TREATMENT FACILITY, SEWER LIFT STATIONS AND DRAIN INLETS (DI) ARE FROM AERIAL MAPPING BY 3D1 IN APRIL 2001.

LEGEND

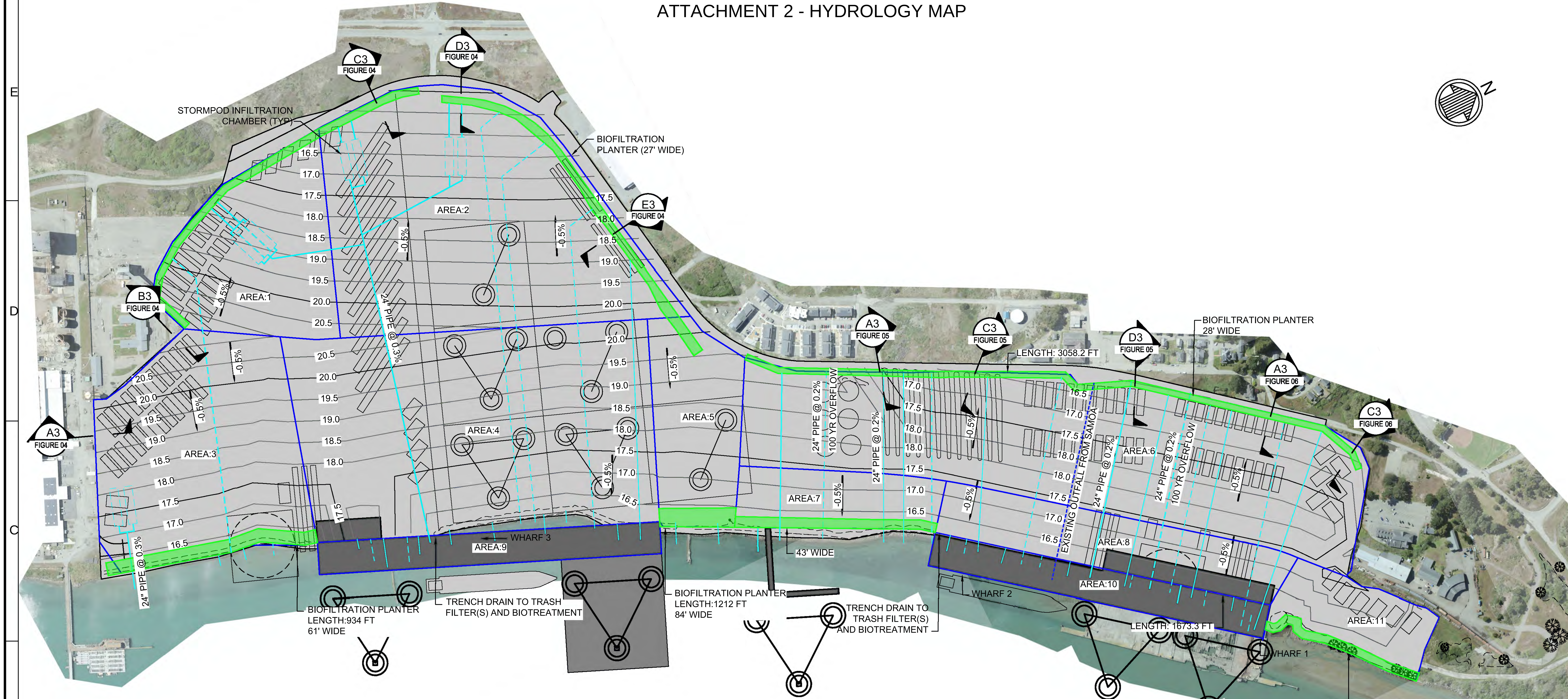
PERMANENT EASEMENT FOR SANITARY SEWER PIPE LINE AND SEWER LIFT STATION

TEMPORARY EASEMENT FOR INGRESS AND EGRESS DURING CONSTRUCTION

CURVE TABLE

	RADIUS	DELTA	LENGTH
C1	1622.09	12°24'48"	351.43
C2	1622.09	4°12'19"	119.05
C3	1622.09	3°47'29"	107.34
C4	709.65	11°29'13"	142.27

ATTACHMENT 2 - HYDROLOGY MAP



PARCEL AREA TABLE

PARCEL #	AREA (Sq. ft)	AREA (Acres)	Q10 (cfs)	Q100 (cfs)
1	571578.18	13.12	17.3	30.12
2	1419799.14	32.59	40.24	68.68
3	914227.65	20.99	26.67	45.95
4	1568142.74	36.00	47.18	82.14
5	372498.88	8.55	11.21	18.72
6	1636522.69	37.57	54.78	94.31
7	253011.64	5.81	10.96	17.68
8	416685.85	9.57	18.05	31.76
9	240000.00	5.51	12.19	18.28
10	253572.42	5.82	12.88	19.31
11	242970.69	5.58	9.88	16.98

LEGEND:

24" PIPE

24" PIPE 100YR OVERFLOW

250' 0' 250' 500'

SCALE: 1"=250'

FOR CONCEPTUAL DESIGN
ISSUED: 2023-08-21
NOT TO BE USED FOR CONSTRUCTION

DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

moffatt & nichol
1300 CLAY STREET, SUITE 350
OAKLAND, CA 94612

INSERT SUB-CONSULTANT OR CLIENT LOGO AND INFO HERE

Designed by: #### | Date: #### | Rev. ####
Dwn by: #### | Ckd by: #### | M&N Project No. 212991-03
Reviewed by: #### | Drawing code:
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL | Drawing Scale: Plot scale: 1:1 (D SHEET)

MPDG HUMBOLDT WIND PORT

GRADING AND DRAINAGE PLAN

SEAL

Sheet Reference No.

FIGURE 03

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File: Q:\SEA\212991-03\20 CADD_Active_Exhibits\Z21299103FIG-003 ; Plotted: 11/8/2023 4:50 PM by SAMANIEGO, RUBEN ; Saved: 11/8/2023 4:03 PM by RSAMANIEGO

ATTACHMENT 3 - NOAA14 LOCAL PRECIPITATION DATA

NOAA Atlas 14, Volume 6, Version 2
Location name: Samoa, California, USA*
Latitude: 40.8167°, Longitude: -124.1825°
Elevation: 7 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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.128** (0.112-0.147)	**0.164** (0.144-0.189)	**0.215** (0.188-0.249)	**0.260** (0.224-0.303)	**0.324** (0.269-0.393)	**0.377** (0.306-0.468)	**0.433** (0.342-0.554)	**0.495** (0.379-0.654)	**0.584** (0.426-0.809)	**0.658** (0.462-0.948)
10-min	**0.183** (0.160-0.211)	**0.235** (0.206-0.271)	**0.309** (0.269-0.357)	**0.372** (0.322-0.435)	**0.464** (0.386-0.563)	**0.540** (0.438-0.671)	**0.621** (0.490-0.794)	**0.709** (0.543-0.937)	**0.838** (0.611-1.16)	**0.944** (0.662-1.36)
15-min	**0.221** (0.194-0.255)	**0.285** (0.249-0.328)	**0.373** (0.326-0.432)	**0.450** (0.389-0.526)	**0.561** (0.467-0.681)	**0.653** (0.530-0.812)	**0.751** (0.593-0.960)	**0.858** (0.656-1.13)	**1.01** (0.739-1.40)	**1.14** (0.801-1.64)
30-min	**0.302** (0.264-0.347)	**0.388** (0.340-0.447)	**0.509** (0.444-0.589)	**0.613** (0.530-0.716)	**0.765** (0.636-0.929)	**0.890** (0.723-1.11)	**1.02** (0.808-1.31)	**1.17** (0.895-1.54)	**1.38** (1.01-1.91)	**1.56** (1.09-2.24)
60-min	**0.425** (0.372-0.489)	**0.546** (0.478-0.630)	**0.716** (0.625-0.829)	**0.863** (0.747-1.01)	**1.08** (0.896-1.31)	**1.25** (1.02-1.56)	**1.44** (1.14-1.84)	**1.65** (1.26-2.18)	**1.94** (1.42-2.69)	**2.19** (1.54-3.15)
2-hr	**0.665** (0.583-0.766)	**0.828** (0.725-0.955)	**1.06** (0.923-1.22)	**1.26** (1.09-1.47)	**1.55** (1.29-1.88)	**1.79** (1.45-2.22)	**2.05** (1.62-2.62)	**2.33** (1.78-3.08)	**2.74** (2.00-3.80)	**3.09** (2.17-4.45)
3-hr	**0.852** (0.747-0.981)	**1.05** (0.917-1.21)	**1.32** (1.15-1.53)	**1.56** (1.35-1.82)	**1.91** (1.59-2.32)	**2.20** (1.78-2.73)	**2.50** (1.98-3.20)	**2.84** (2.18-3.76)	**3.34** (2.44-4.62)	**3.75** (2.63-5.40)
6-hr	**1.24** (1.09-1.43)	**1.50** (1.31-1.73)	**1.86** (1.63-2.16)	**2.18** (1.88-2.55)	**2.64** (2.19-3.20)	**3.01** (2.45-3.74)	**3.41** (2.70-4.37)	**3.85** (2.95-5.09)	**4.48** (3.27-6.21)	**5.01** (3.51-7.21)
12-hr	**1.77** (1.55-2.04)	**2.12** (1.86-2.45)	**2.61** (2.28-3.02)	**3.03** (2.62-3.54)	**3.63** (3.02-4.40)	**4.11** (3.34-5.11)	**4.62** (3.65-5.91)	**5.17** (3.95-6.82)	**5.95** (4.34-8.23)	**6.58** (4.62-9.48)
24-hr	**2.44** (2.18-2.78)	**2.93** (2.62-3.34)	**3.59** (3.20-4.10)	**4.14** (3.67-4.77)	**4.92** (4.23-5.84)	**5.54** (4.67-6.70)	**6.18** (5.10-7.64)	**6.86** (5.52-8.70)	**7.81** (6.05-10.3)	**8.58** (6.44-11.7)
2-day	**3.16** (2.83-3.60)	**3.82** (3.42-4.36)	**4.70** (4.19-5.37)	**5.42** (4.80-6.25)	**6.42** (5.52-7.63)	**7.20** (6.08-8.72)	**8.01** (6.61-9.90)	**8.84** (7.12-11.2)	**9.99** (7.74-13.2)	**10.9** (8.18-14.8)
3-day	**3.54** (3.17-4.04)	**4.31** (3.86-4.92)	**5.33** (4.75-6.09)	**6.16** (5.45-7.10)	**7.29** (6.27-8.66)	**8.16** (6.89-9.88)	**9.06** (7.47-11.2)	**9.98** (8.03-12.7)	**11.2** (8.70-14.8)	**12.2** (9.16-16.6)
4-day	**3.88** (3.47-4.42)	**4.75** (4.24-5.42)	**5.88** (5.25-6.73)	**6.80** (6.02-7.84)	**8.05** (6.92-9.56)	**9.01** (7.60-10.9)	**9.98** (8.23-12.3)	**11.0** (8.83-13.9)	**12.3** (9.54-16.2)	**13.4** (10.0-18.2)
7-day	**4.89** (4.38-5.58)	**6.06** (5.42-6.91)	**7.56** (6.74-8.64)	**8.76** (7.76-10.1)	**10.4** (8.91-12.3)	**11.6** (9.77-14.0)	**12.8** (10.6-15.8)	**14.0** (11.3-17.8)	**15.7** (12.2-20.7)	**16.9** (12.7-23.0)
10-day	**5.73** (5.13-6.53)	**7.12** (6.37-8.13)	**8.91** (7.95-10.2)	**10.3** (9.16-11.9)	**12.2** (10.5-14.5)	**13.6** (11.5-16.5)	**15.0** (12.4-18.6)	**16.5** (13.2-20.9)	**18.3** (14.2-24.1)	**19.7** (14.8-26.8)
20-day	**8.00** (7.16-9.11)	**9.96** (8.91-11.4)	**12.4** (11.1-14.2)	**14.4** (12.7-16.6)	**16.9** (14.5-20.1)	**18.7** (15.8-22.7)	**20.6** (17.0-25.4)	**22.4** (18.0-28.4)	**24.7** (19.2-32.6)	**26.5** (19.9-36.0)
30-day	**9.95** (8.91-11.3)	**12.4** (11.1-14.1)	**15.4** (13.7-17.6)	**17.7** (15.7-20.4)	**20.7** (17.8-24.5)	**22.9** (19.3-27.7)	**25.0** (20.6-30.9)	**27.1** (21.8-34.4)	**29.8** (23.1-39.2)	**31.8** (23.8-43.2)
45-day	**12.9** (11.6-14.8)	**16.0** (14.3-18.2)	**19.7** (17.6-22.5)	**22.6** (20.0-26.0)	**26.2** (22.5-31.1)	**28.9** (24.4-34.9)	**31.4** (25.9-38.9)	**33.9** (27.3-43.0)	**37.1** (28.7-48.9)	**39.4** (29.6-53.6)
60-day	**15.3** (13.7-17.5)	**18.8** (16.8-21.5)	**23.0** (20.6-26.4)	**26.3** (23.3-30.3)	**30.4** (26.1-36.1)	**33.3** (28.1-40.3)	**36.2** (29.8-44.7)	**38.9** (31.3-49.4)	**42.4** (32.8-55.8)	**44.9** (33.7-61.0)

[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 checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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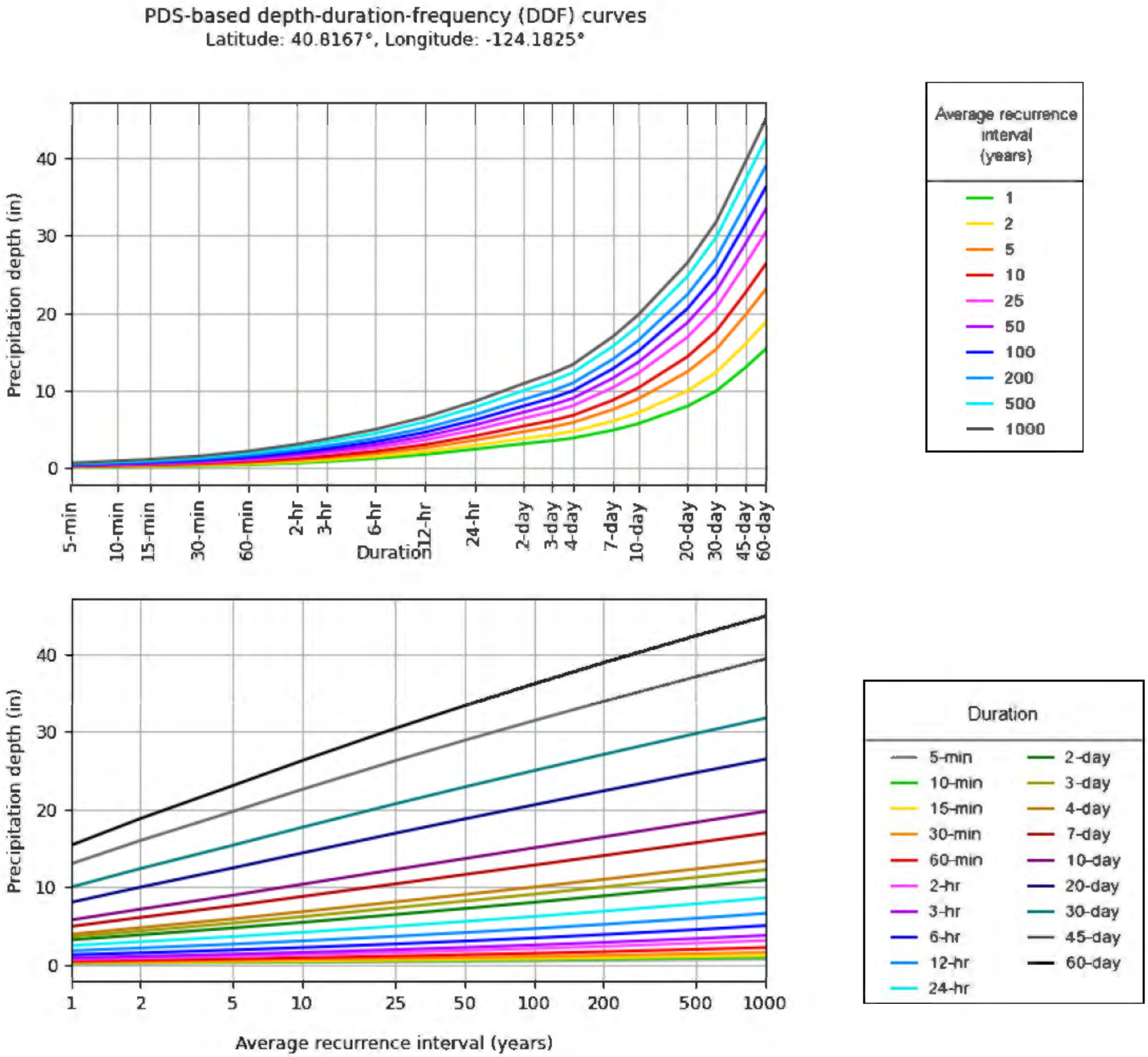
PF graphical



NOAA Atlas 14, Volume 6, Version 2

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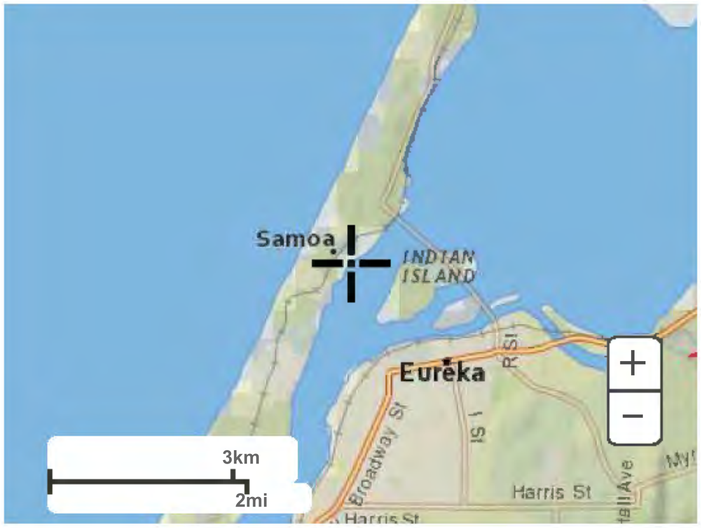
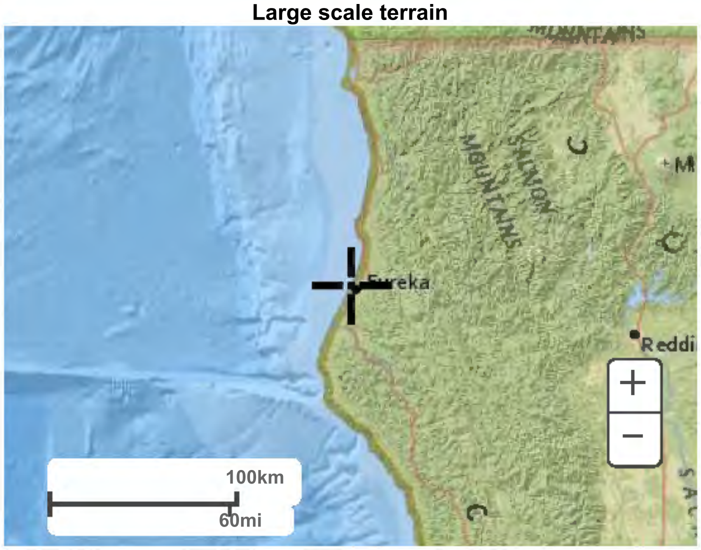
Maps & aerials

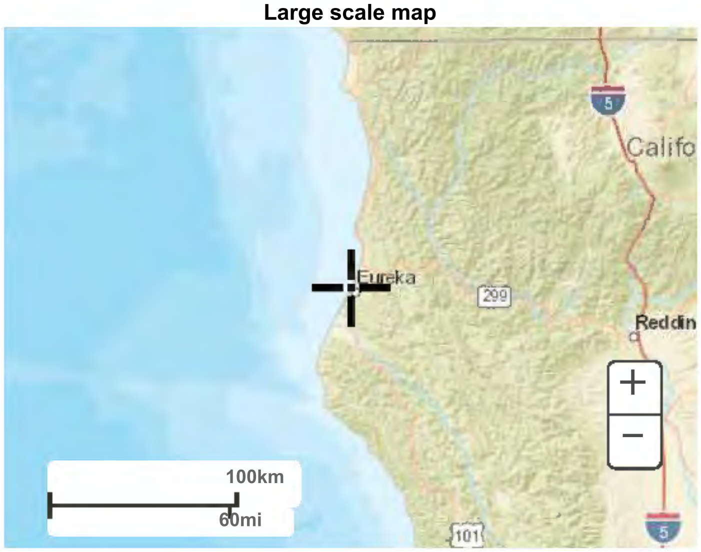
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

ATTACHMENT 4 - 24" PIPE CAPACITY

Worksheet for 24-in Circular Pipe - 0.2%

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.002 ft/ft
Normal Depth	24.0 in
Diameter	24.0 in

Results	
Discharge	10.12 cfs
Flow Area	3.1 ft²
Wetted Perimeter	6.3 ft
Hydraulic Radius	6.0 in
Top Width	0.00 ft
Critical Depth	13.7 in
Percent Full	100.0 %
Critical Slope	0.005 ft/ft
Velocity	3.22 ft/s
Velocity Head	0.16 ft
Specific Energy	2.16 ft
Froude Number	(N/A)
Maximum Discharge	10.88 cfs
Discharge Full	10.12 cfs
Slope Full	0.002 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	10.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	24.0 in
Critical Depth	13.7 in
Channel Slope	0.002 ft/ft
Critical Slope	0.005 ft/ft