STORM PUMP AND FORCE MAIN CALCULATIONS

Freeman Logistics
22nd Ave NW and 82nd Ave E
Puyallup, WA

12/1/2023

Prepared for:
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October 14th, 2022
REVISED: November 2023

Our Job No. 21585

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION/GENERAL INFORMATION

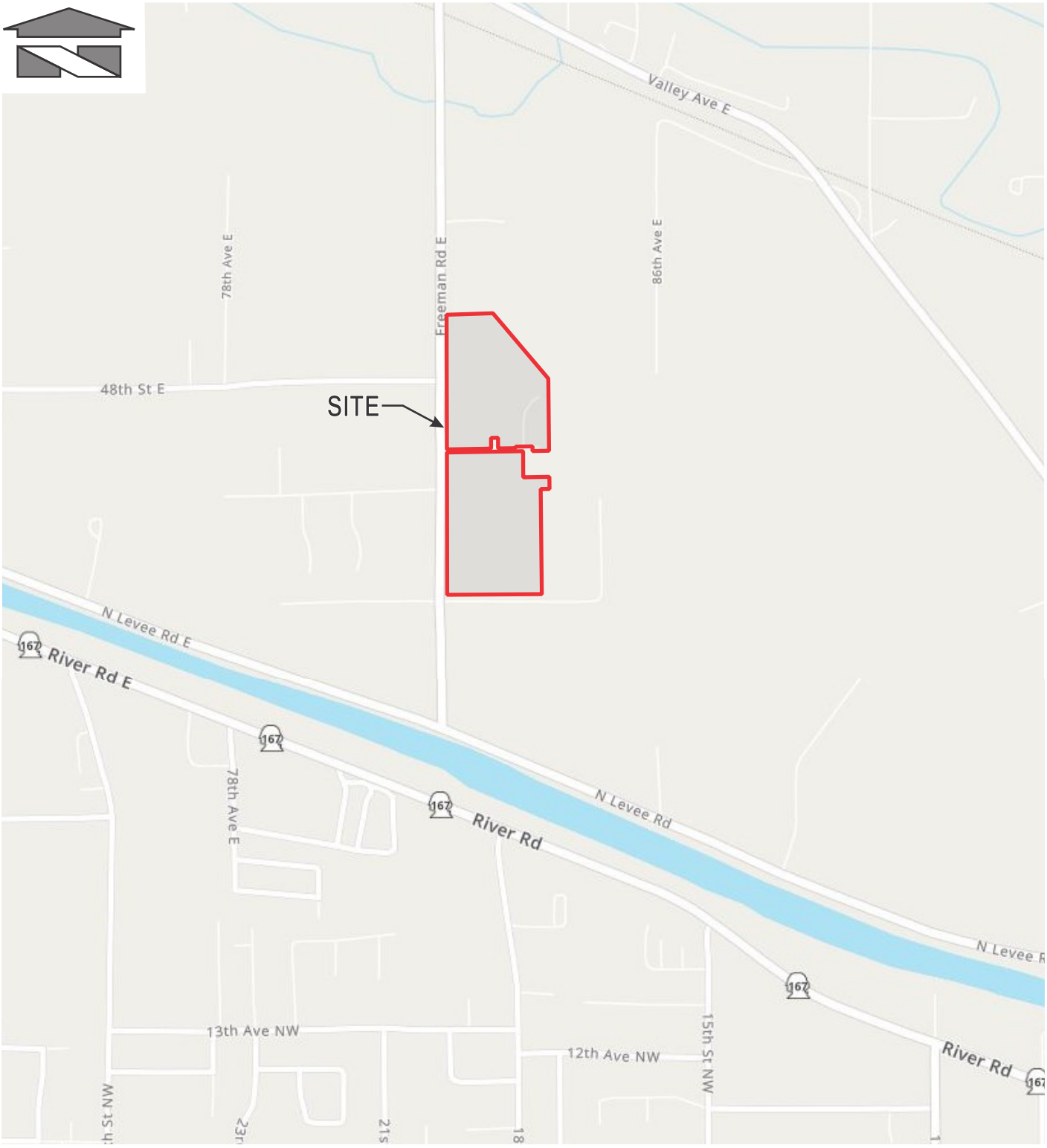
The following pages of this report delineate the criteria followed and the methodology used for sizing the storm pump and force main servicing the Freeman Logistics project.

The project includes 2 warehouse buildings with associated parking and frontage improvements totaling 25.50 acres of total disturbed area. Onsite, two separate detention vaults are proposed. The frontage improvement will be collected and detained separately with a detention tank. These detention facilities will detain and release stormwater in accordance with the Flow Control Standard per the Department of Ecology drainage manual (2019 Department of Ecology manual). The 100-year peak storm release rate of the vaults is 2.242 ft^3/sec. Released stormwater will then be treated for water quality using a DOE-approved proprietary structure. Following treatment, all flows, both onsite and offsite, will be conveyed to a manhole pump station. The pump station will convey flows northwest via a new 6-inch force main and then release further downstream, within an existing structure within the private road 78th Ave E. The new force main will be approximately 2,515 feet in length.

Emergency standby power is proposed using a generator (natural gas or approved alternative). Additional storage volume is not required downstream of the detention vault.

This report also includes buoyancy calculations for the pump manhole due to the shallow seasonal high groundwater elevation on the site.

Figure 1
Vicinity Map



REFERENCE: MapQuest (2022)

Scale:
Horizontal: **N.T.S.** Vertical: **N/A**

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For:
Freeman Road Logistics
Fife, Washington

Title:
VICINITY MAP

Job Number
21585

DATE: 09/01/22

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Appendix A
Pump Design

STORM PUMP DESIGN

Pump Criteria:

- Design a submersible duplex pump with variable speed which can meet or exceed the 100-year peak release rate of the detention system.

  100-year peak release rate of combined facilities = 2.24 cfs = 1,006 gpm

- **Suggested pump size = dual 600 gpm at ±75-feet TDH**

Pump Cycles

- To meet the desired discharge characteristics for matching the flow control standard, the pump controls include a VFD (Variable Frequency Drive) and level sensor which allow a wide range of pump speed to match the outflow rate from the control structure on the vault. The pumps can be controlled down to a flow rate of approximately 90 gpm. Assuming the pump starts at the lowest speed, the cycle time would be:

  Wet well storage = Pump On - Pump Off x 118.96 gallons per linear feet of MH = 13.94 – 11.44 x 118.96 = 446 gallons

  Cycle time = 446 gal / 45 gpm = 9.91 minutes

  Cycles per hour = 6.05

Appendix B
Force Main Sizing

STORM FORCE MAIN DESIGN

Pump System

Force main design for proposed force main:

- Design flow in the force main = 600 gpm = 1.34 cfs

- Use 6-inch force main
  - Velocity = 1.34 cfs/0.196 sf = 6.84 fps
  - 6.84 fps < 8 fps OK

Static Head = Invert at downstream end of force main - Pump Off Elevation

Invert elevation at tie-in structure = 27.73

Pump off elevation = 10.50

Static Head = 27.73 – 10.50 = ±17.5 feet

Total Dynamic Head = based on pump configuration and force main (to be verified by pump manufacturer)

Force Main is HDPE (Sch. 40 Pipe)

New 6" Force Main Pipe Length = 2,515 feet

Friction loss in 6-inch main = 2,515/100 x 2.19 = 55.1 feet

Fitting losses in equivalent length of 6" straight pipe (From Friction Loss chart)

Elbows and valves: 90 deg = 15.2
45 deg = 8.1
Ball & check valve = 4

Head loss = (15.2+(2)(8.1)+4)/100 x 1 = 0.35 feet

Total Head = Static Head + Friction Loss = 17.5 + 55.1 feet + 0.35 feet = 72.95 feet

Pump System

Pump Station Control Panel Specification

Primary power shall be from the proposed recreational building. Contractor is to verify available power source and sizing prior to ordering the pump station. Each pump system shall have its own control panel.

The control panel for each sanitary pump station shall include:

- Control for a duplex pump system (controls to be hard wired)
- VFD control for each pump
- Enclosure for installation outside (installation to be near the pump station)
- Visual alarm – flashing light
- Display at control panel to monitor station performance
- 12-hour battery backup for control panel
- Manual and remote reset for alarms
- Alarms for:
    - Pump failure
    - Seal failure
    - High temperature
    - Low water
    - High water
    - Low battery
    - Power failure
- Duplex cycle counter
- Duplex elapsed run time meter
- Surge protection
- Dial up to 8 phone numbers during an alarm condition
- Minimum 1 year warranty

Table A.2 Friction Loss Data for PVC Pipe. Data courtesy IPEX Inc.

GPM	cu ft / sec	Velocity (ft/s)	Friction Head Loss (ft water / 100 ft)	Friction Pressure (psi / 100 ft)	Velocity (ft/s)	Friction Head Loss (ft water / 100 ft)	Friction Pressure (psi / 100 ft)	Velocity (ft/s)	Friction Head Loss (ft water / 100 ft)	Friction Pressure (psi / 100 ft)	Velocity (ft/s)	Friction Head Loss (ft water / 100 ft)	Friction Pressure (psi / 100 ft)
		1/2"											
1	0.002	1.13	1.16	0.50	3/4"								
2	0.004	2.26	4.19	1.81	1.26	1.03	0.44	1"			1 1/4"		
5	0.011	5.64	22.88	9.90	3.16	5.60	2.42	1.93	1.69	0.73	1.10	0.43	0.19
7	0.016	7.89	42.66	18.47	4.43	10.44	4.52	2.70	3.14	1.36	1.55	0.81	0.35
10	0.022				6.32	20.21	8.75	3.86	6.08	2.63	2.21	1.57	0.68
12	0.027				7.59	28.33	12.26	4.63	8.53	3.69	2.65	2.20	0.95
15	0.033				9.48	42.82	18.54	5.79	12.89	5.58	3.31	3.32	1.44
20	0.045							7.72	21.96	9.51	4.42	5.65	2.45
25	0.056							9.65	33.20	14.37	5.52	8.55	3.70
30	0.067							11.58	46.54	20.15	6.63	11.98	5.19
35	0.078										7.73	15.94	6.90
40	0.089	4"									8.84	20.41	8.84
45	0.100	1.15	0.13	0.06							9.94	25.39	10.99
50	0.111	1.28	0.16	0.07							11.05	30.86	13.36
55	0.123	1.41	0.19	0.08									
60	0.134	1.53	0.23	0.10									
65	0.145	1.66	0.26	0.11	5"								
70	0.156	1.79	0.30	0.13	1.14	0.10	0.04						
75	0.167	1.92	0.34	0.15	1.22	0.11	0.05						
80	0.178	2.05	0.39	0.17	1.30	0.13	0.06						
90	0.201	2.30	0.48	0.21	1.46	0.16	0.07	6"					
100	0.223	2.56	0.59	0.25	1.62	0.19	0.08	1.12	0.08	0.03			
125	0.279	3.20	0.89	0.38	2.03	0.29	0.13	1.40	0.12	0.05			
150	0.334	3.84	1.24	0.54	2.44	0.41	0.18	1.69	0.17	0.07			
175	0.390	4.47	1.65	0.72	2.84	0.55	0.24	1.97	0.22	0.10	8"		
200	0.446	5.11	2.12	0.92	3.25	0.70	0.30	2.25	0.29	0.12	1.30	0.08	0.03
250	0.557	6.39	3.20	1.39	4.06	1.06	0.46	2.81	0.43	0.19	1.62	0.11	0.05
300	0.668	7.67	4.49	1.94	4.87	1.49	0.64	3.37	0.61	0.26	1.94	0.16	0.07
350	0.780	8.95	5.97	2.58	5.69	1.98	0.86	3.93	0.81	0.35	2.27	0.21	0.09
400	0.891	10.23	7.64	3.31	6.50	2.54	1.10	4.49	1.03	0.45	2.59	0.27	0.12
450	1.003				7.31	3.15	1.36	5.06	1.29	0.56	2.92	0.34	0.15
500	1.114				8.12	3.83	1.66	5.62	1.56	0.68	3.24	0.41	0.18
600	1.337				9.75	5.37	2.33	6.74	2.19	0.95	3.89	0.57	0.25
700	1.560				11.37	7.15	3.09	7.87	2.92	1.26	4.54	0.76	0.33
800	1.782	18"						8.99	3.73	1.62	5.18	0.98	0.42
900	2.005	1.30	0.03	0.01				10.11	4.64	2.01	5.83	1.22	0.53
1000	2.228	1.45	0.04	0.02							6.48	1.48	0.64
1250	2.785	1.81	0.06	0.03	20"						8.10	2.24	0.97
1500	3.342	2.17	0.08	0.04	1.75	0.05	0.02				9.72	3.14	1.36
2000	4.456	2.89	0.14	0.06	2.33	0.08	0.04	24"					
2500	5.570	3.62	0.21	0.09	2.91	0.12	0.05	2.01	0.05	0.02			
3000	6.684	4.34	0.29	0.13	3.49	0.17	0.08	2.41	0.07	0.03			
3500	7.798	5.06	0.39	0.17	4.07	0.23	0.10	2.81	0.09	0.04			
4000	8.912	5.79	0.50	0.22	4.65	0.30	0.13	3.22	0.12	0.05			
4500	10.026	6.51	0.62	0.27	5.24	0.37	0.16	3.62	0.15	0.06			
5000	11.140	7.23	0.76	0.33	5.82	0.45	0.19	4.02	0.18	0.08			
5500	12.254	7.96	0.91	0.39	6.40	0.53	0.23	4.42	0.22	0.09			
6000	13.368	8.68	1.06	0.46	6.98	0.63	0.27	4.83	0.25	0.11			
6500	14.482	9.40	1.23	0.53	7.56	0.73	0.31	5.23	0.30	0.13			
7000	15.596	10.13	1.42	0.61	8.14	0.83	0.36	5.63	0.34	0.15			
7500	16.710				8.73	0.95	0.41	6.03	0.39	0.17			
8000	17.824				9.31	1.07	0.46	6.43	0.43	0.19			
8500	18.938				9.89	1.19	0.52	6.84	0.49	0.21			
9000	20.052				10.47	1.33	0.57	7.24	0.54	0.23			
9500	21.166							7.64	0.60	0.26			
10000	22.280							8.04	0.66	0.28			

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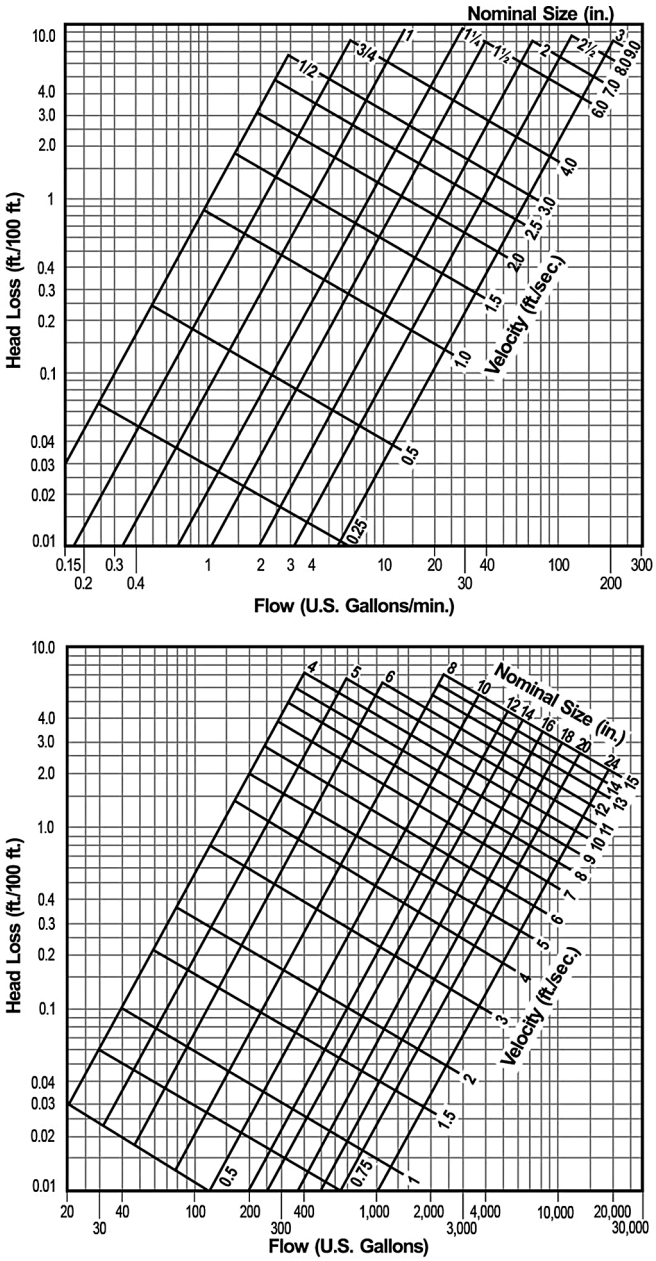

Figure A.1 Graphical depiction of friction loss through PVC pipe. Data courtesy IPEX Inc.

Table A.3 Friction Loss Through Fittings in Equivalent Footage of Pipe. Data Courtesy IPEX Inc.

	FITTINGS			
Size (in.)	Tee Run	Tee Branch	90° Elbow	45° Elbow
½	1.0	3.8	1.5	0.8
¾	1.4	4.9	2.0	1.1
1	1.7	6.0	2.5	1.4
1 ¼	2.3	7.3	3.8	1.8
1 ½	2.7	8.4	4.0	2.1
2	4.0	12.0	5.7	2.6
2 ½	4.9	14.7	6.9	3.1
3	6.1	16.4	7.9	4.0
4	7.9	22.0	11.4	5.1
6	12.3	32.7	16.7	8.0
8	14.0	49.0	21.0	10.6
10	17.5	57.0	26.0	13.5
12	20.0	67.0	32.0	15.5
14	25.0	78.0	37.0	18.0
16	27.0	88.0	43.0	20.0
18	32.0	107.0	53.0	23.0
20	35.0	118.0	58.0	25.0
24	42.0	137.0	67.0	30.0

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Appendix C
Buoyancy Calculations

FREEMAN STORM BUOYANCY CALCULATIONS

- **SD Pump Manhole, Type 2 - 54 inches**
  Rim: 32.64
  Inside Bottom = 8.10
  Outside Bottom = 7.43

- **Weight of Manhole**

  Top Slab = ~2,600 lbs
  Barrell = 1,100 lb/lf x (32.64 -0.67- 12.43) = 21,494 lbs
  Bottom 5' base = 7,600 lbs
  Total (manhole) = 31,694 lbs
  $P_{Manhole}$ = 31.7 Kip↓

- **Water Weight**

  Max groundwater height (~5' bge) = 27.64 feet
  Manhole displacement = (27.64 – 7.43) x π r^2 = 20.21 π $(2.625)^2$ = 437.3 CF
  Water unit weight = 62.4 lb/ft^3
  P_{Water} = 437.3 x 62.4 = 27,285 lb = 27.3 Kip↑

- **Buoyancy**

  $\sum_F = P_{Manhole} - P_{Buoyancy}$ = 31.7K↓ - 27.3K↑ = 4.4 K↓

  $FS = \frac{31.7}{27.3}$ = 1.16