



Pump Analysis

Helix Design-Build Mercer Island
6922 SE 33rd Street
Mercer Island, WA 98040

March 2022



2106 Pacific Avenue, Suite 300
Tacoma, WA 98402

PUMP ANALYSIS

DATE: 03/30/2022

PROJECT:

Helix Design Build Mercer Island
6922 SE 33rd Street
Mercer Island, WA 98040

OWNER:

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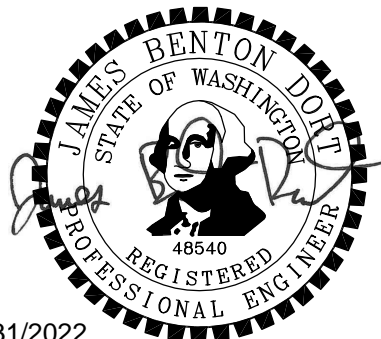
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I hereby state that this report for the Helix Design Build Mercer Island has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers.



03/31/2022



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Section A – Introduction

The new Helix Design Build Residence on Mercer Island, WA will include 3,971 sq ft of new and replaced hard surfaces, consisting of a single-family home and driveway. The project is eligible to use the Mercer Island Standard On-site Detention System Worksheet to meet Minimum Requirement #5: Low Impact Development standards. Initial design iterations using the Standard On-site Detention System Worksheet have proven the project site does not have sufficient elevation drop between the below grade driveway elevation of the new home and the municipal storm system to utilize the recommended detention tanks through gravity alone. To meet Minimum Requirement 5 a pump system will be used to convey the water from these lower locations (the driveway, the window well, and roof drains on the west side of the building) into the recommended detention tanks.

Section B – Pump Information

The pump system is an alternating duplex design to increase reliability and provide redundancy in the event of pump failure. Additionally, the house will have a backup generator to supply the pumps in case of loss of power service to the house. The pumps chosen are two Zoeller N57s which will be located in a Zoeller 31-0803 basin and be controlled by a Zoeller 10-1041 control panel. In the event of pump failure, the Zoeller 10-1041 control panel features an external alarm that will sound and flash if the high-water level is reached. This external alarm is being paired with an APak Z Control Indoor Alarm that will alert occupants of the house via noise and notifications to their phones or other paired internet connected devices.

Section C – Flow to Pumps

These pumps were chosen using the flow received from the tributary areas during a 100-year storm. To find the flows the 100-year storm data from the Western Regional Climate Center's isopluvial maps was entered into StormShed 3G, as can be seen in Figure 1.

Figure 1: 100-Year Storm Data

The screenshot shows the 'Project Precip' configuration window in StormShed 3G. It includes a table of design events and precipitation values, and several control options.

Design Event	Precip
0.5 Year	1.44
2 yr 24 hr	2.00
5 year	2.60
10 year	3.00
25 year	3.50
100 year	4.10

Additional settings shown in the interface include:

- Use SI units (metric)
- Use AMC for Project:
 - AMC 1
 - AMC 2
 - AMC 3
- IDF Curves in Selection Drop Down:
 - Equation Only
 - Family Only
 - Both
- TC Thresholds:
 - SCS Perv TC: 5.00 min
 - SCS Imp TC: 5.00 min
 - Rational TC: 5.00 min

Using an assumed 5-minute time of concentration this storm data was applied to the approximately 1,200 sf of roof, driveway, and window well (as can be seen in Figure 2) to result in flows of 0.0353 cfs,



as can be seen in Figure 3. This flow is used to calculate the pump cycle lengths, as can be seen in Section D.

Figure 2: Pump Basin Area

Description	Subarea	CN	
Residential districts - 1/8 acre t..	0.0275	85.00	

Abstraction Coeff: Total Area (ac) Avg CN:

Figure 3: 100-Year Storm Flow

Select Design Event:

AMC for this Computation: AMC 1 AMC 2 AMC 3 Project AMC: 2

Results

Peak Rate: 0.0353 cfs
Time to Peak: 480.70 min / (8.01 hrs) from start.
Hyd Vol: 509.62 cf / 0.011699 acft

Section D – Pump Sizing

To check that the Zoeller N57s would work for this site, a system curve had to be calculated to compare to the pump curve supplied by Zoeller. The system curve was calculated using the Hazen-Williams Equation. This calculation was done via Excel and can be seen in Figure 4. (Yellow highlighted areas are where information was entered from the pipe design/site plan. The site plan can be found under a separate document within this submittal).

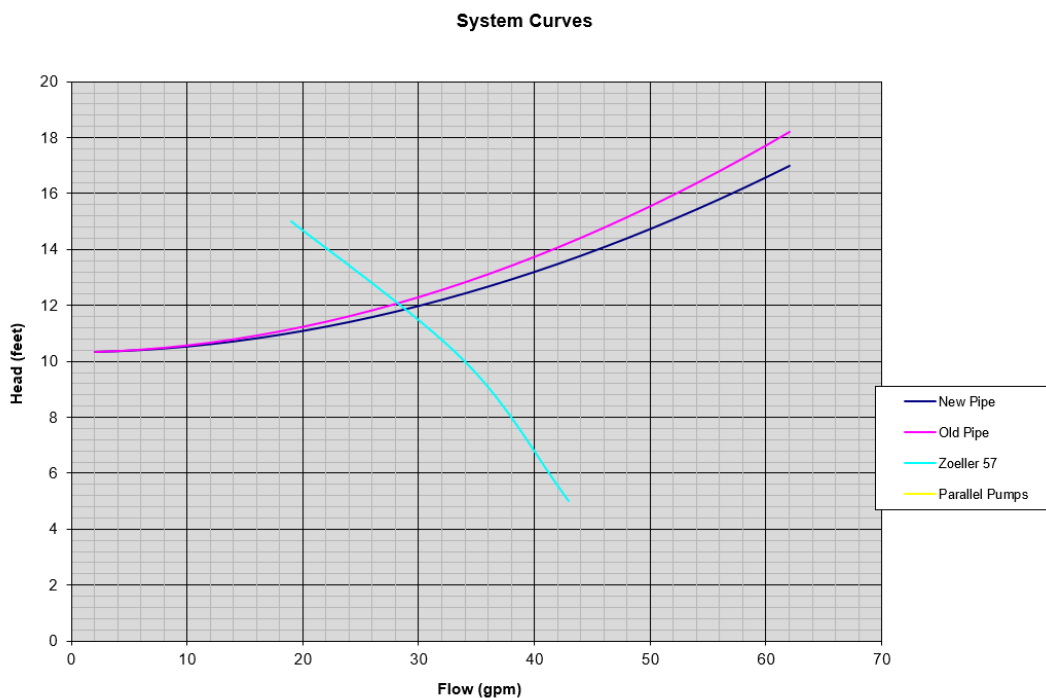


Figure 4: Hazen-Williams Spreadsheet

System Analysis Calculations												
Variable:	d	A	L	K	DE	PE	h_s					
	Pipe Size (in)	Cross-Sectional Area (in ²)	Length of Pipe (ft)	Total Minor Loss Coefficient	Discharge Elevation (ft)	Pump Elevation (ft)	Static Head (ft)					$A = \frac{d^2 \pi}{4}$
	2	3.14	45	5.0	263.59	253.26	10.33					$v = 0.3208 \frac{Q}{A}$
Minor Loss Coefficient Calculations												
Fitting	Swing Check Valve	Ball Valve	Flanged Tee	Flanged 90° Elbow	Flanged 180° Return Bend	Expansion (3x4)	Contraction (4x3)	Exit	Total K			
K	2.00	0.05	1.00	0.30	1.50	0.56	0.22	1.00				
Number	1	1	1	3	0	0	0	1	4.95			
$h_z = DE - PE$ $h_{maj} = \frac{3.022 v^{1.85} L}{C^{1.85} (d/12)^{4.87}}$ $h_{min} = K \frac{v^2}{2g}$ $h_f = h_{maj} + h_{min}$ $TDH = h_z + h_f$												
New Pipe				Old Pipe								
	Q	v	h_{maj}	h_{min}	h_f	TDH	Q	v	h_{maj}	h_{min}	h_f	TDH
	Flow (gpm)	Velocity (fps)	Major Head Loss (ft)	Minor Head Loss (ft)	Total Head Loss (ft)	Total Dynamic Head (ft)	Flow (gpm)	Velocity (fps)	Major Head Loss (ft)	Minor Head Loss (ft)	Total Head Loss (ft)	Total Dynamic Head (ft)
	2	0.20	0.01	0.00	0.01	10.34	2	0.20	0.01	0.00	0.01	10.34
	4	0.41	0.02	0.01	0.04	10.37	4	0.41	0.03	0.01	0.04	10.37
	6	0.61	0.05	0.03	0.08	10.41	6	0.61	0.06	0.03	0.09	10.42
	8	0.82	0.08	0.05	0.13	10.46	8	0.82	0.11	0.05	0.16	10.49
	10	1.02	0.12	0.08	0.20	10.53	10	1.02	0.16	0.08	0.24	10.57
	12	1.23	0.17	0.12	0.29	10.62	12	1.23	0.23	0.12	0.34	10.67
	14	1.43	0.23	0.16	0.39	10.72	14	1.43	0.31	0.16	0.46	10.79
	16	1.63	0.29	0.21	0.50	10.83	16	1.63	0.39	0.21	0.60	10.93
	18	1.84	0.37	0.26	0.62	10.95	18	1.84	0.49	0.26	0.75	11.08
	20	2.04	0.44	0.32	0.76	11.09	20	2.04	0.59	0.32	0.91	11.24
	22	2.25	0.53	0.39	0.92	11.25	22	2.25	0.70	0.39	1.09	11.42
	24	2.45	0.62	0.46	1.08	11.41	24	2.45	0.83	0.46	1.29	11.62
	26	2.65	0.72	0.54	1.26	11.59	26	2.65	0.96	0.54	1.50	11.83
	28	2.86	0.83	0.63	1.46	11.79	28	2.86	1.10	0.63	1.73	12.06
	30	3.06	0.94	0.72	1.66	11.99	30	3.06	1.25	0.72	1.97	12.30
	32	3.27	1.06	0.82	1.88	12.21	32	3.27	1.41	0.82	2.23	12.56
	34	3.47	1.18	0.93	2.11	12.44	34	3.47	1.58	0.93	2.50	12.83
	36	3.68	1.32	1.04	2.36	12.69	36	3.68	1.75	1.04	2.79	13.12
	38	3.88	1.46	1.16	2.61	12.94	38	3.88	1.94	1.16	3.09	13.42
	40	4.08	1.60	1.28	2.88	13.21	40	4.08	2.13	1.28	3.41	13.74
	42	4.28	1.75	1.41	3.17	13.50	42	4.28	2.33	1.41	3.74	14.07

The results of the Hazen-Williams Equation were graphed against the Zoeller N57's pump curve to result in the system curve seen below in Figure 5. Where the curves cross is the operation point of the system, this operating point is also shown in the green highlighted area in Figure 4.

Figure 5: System Curve





Since the operating point is not in an extreme area of the pump curve (it is close to the middle) the Zoeller N57 pump will be able to meet the head and flow requirements of the system. The last element of the pumps that had to be checked was the cycle length of the pumps (how long they would run for and how long they would be off). To check this the flow found in Section C (0.0353 cfs) was plugged into the formulas seen below in Figure 6.

Figure 6: Pump Cycle Calculations
Wetwell Volume and Pump Cycle Calculations

Base Elev. (ft)	Top of Sump Elev. (ft)	Pump OFF Elev. (ft)	Lead ON Elev. (ft)	Lag ON Elev. (ft)	Alarm ON Elev. (ft)	Invert In Elev. (ft)	Top Elev. (ft)
252.76	NA	253.26	253.61	NA	253.94	253.94	256.44
Sump Depth (ft)	Base - Pump OFF (ft)	Pump OFF - Lead ON (ft)	Lead ON - Lag ON (ft)	Pump ON - Alarm ON (ft)	Alarm ON - Invert In (ft)	Invert In - Top (ft)	Storage Freeboard (ft)
NA	0.50	0.35	NA	0.33	0.00	2.50	0.00
Wetwell Diameter (ft)	Sump Diameter (ft)	Wetwell Area (ft ²)	Sump Area (ft ²)	Dead Storage Volume (gal)	Working Volume (gal)	Emergency Storage* (gal)	
2.50	NA	4.91	NA	18	13	117	
Total Capacity (ft ³)	Total Capacity (gal)	2-Year Cycle ON (min)	2-Year Cycle OFF (min)	100-Yr Cycle ON (min)	100-Yr Cycle OFF (min)	2-Year Cycles/Day	100-Yr Cycles/Day
18	135	0.51	2.71	1.02	0.74	92.6	296.6

$$PeakCycleON(min) = \frac{WorkingVolume(gal)}{PumpFlow\left(\frac{gal}{min}\right) - PeakInflow\left(\frac{gal}{min}\right)}$$

*Emergency storage defined as volume between Pump Off and top of wetwell per DOE

$$PeakCycleOFF(min) = \frac{WorkingVolume(gal)}{PeakInflow\left(\frac{gal}{min}\right)}$$

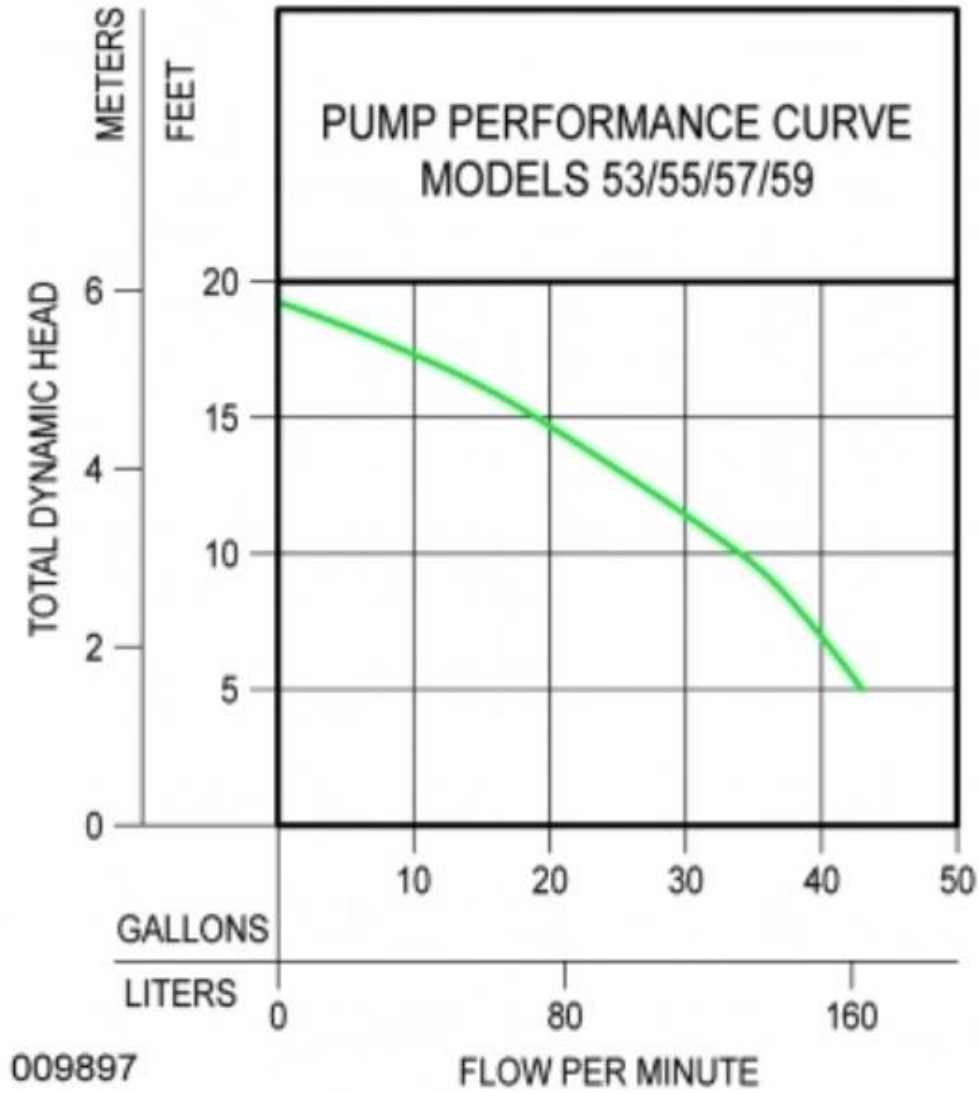
$$AvgCycleON(min) = \frac{WorkingVolume(gal)}{PumpFlow\left(\frac{gal}{min}\right) - AvgInflow\left(\frac{gal}{min}\right)}$$

$$AvgCycleOFF(min) = \frac{WorkingVolume(gal)}{AvgInflow\left(\frac{gal}{min}\right)}$$

These cycle lengths are reasonable for the Zoeller N57 pumps, especially since they will be alternating with each cycle.



Appendix A – Pump Information





Product information presented here reflects conditions at time of publication. Consult factory regarding discrepancies or inconsistencies.

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zoellerpumps.com

DUPLEX CONTROL PANEL RECOMMENDED APPLICATIONS

PUMP					CONTROL PANEL		PUMP					CONTROL PANEL	
MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X	MODEL #	VOLT	PHASE	AMPS	HP	NEMA 1	NEMA 4X
N53	115	1	9.7	0.3	10-1039	10-1041	E188	230	1	14.0	1.5	10-0092	10-1044
E53	230	1	4.8	0.3	10-0092	10-1043	F188	230	3	8.9	1.5	10-1110«	10-1110
N55	115	1	9.7	0.3	10-1039	10-1041	I188	200	1	16.8	1.5	10-0092	10-1045
E55	230	1	4.8	0.3	10-0092	10-1043	J188	200	3	10.3	1.5	10-1111«	10-1111
N57	115	1	9.7	0.3	10-1039	10-1041	G188	460	3	4.6	1.5	10-1108«	10-1108
E57	230	1	4.8	0.3	10-0092	10-1043	BA188	575	3	3.5	1.5	10-1156«	10-1156

Pumps are N57

Control Panel is 10-1041

Basin is 31-0803

Alarm is APak Z Control Indoor Alarm

According to the Zoeller representative you can ask for all the fittings, wires, and pipes required for the internal basin plumbing while ordering and from there it is essentially a plug and play system.

N145	115	1	13.0	0.75	10-1039	10-1041	G267	460	3	1.5	0.5	10-1104«	10-1104
N151	115	1	6.0	0.3	10-0092	10-1043	J267	200	3	2.6	0.5	10-1106«	10-1106
E151	230	1	3.2	0.3	10-0092	10-1043	I267	200	1	6.2	0.5	10-0092	10-1043
N152	115	1	8.5	0.4	10-1039	10-1041	N268	115	1	10.4	0.5	10-1039	10-1044
E152	230	1	4.3	0.4	10-0092	10-1043	E268	230	1	5.5	0.5	10-0092	10-1043
N153	115	1	10.5	0.5	10-1039	10-1041	F268	230	3	2.6	0.5	10-1106«	10-1106
E153	230	1	5.3	0.5	10-0092	10-1043	G268	460	3	1.5	0.5	10-1104«	10-1104
N161	115	1	15.5	0.5	10-1040	10-1042	J268	200	3	2.6	0.5	10-1106«	10-1106
E161	230	1	7.5	0.5	10-0092	10-1044	I268	200	1	6.2	0.5	10-0092	10-1043
F161	230	3	5.2	0.5	10-1108«	10-1108	N270	115	1	15.0	1.0	10-1040	10-1045
I161	200	1	8.8	0.5	10-0092	10-1044	E270	230	1	7.5	1.0	10-0092	10-1044
J161	200	3	6.4	0.5	10-1110«	10-1110	N282	115	1	10.3	0.5	10-1039	10-1044
G161	460	3	2.9	0.5	10-1106«	10-1106	E282	230	1	5.0	0.5	10-0092	10-1043
BA161	575	3	2.4	0.5	10-1154«	10-1154	F282	230	3	3.0	0.5	10-1106«	10-1106
N163	115	1	15.0	0.5	10-1040	10-1042	I282	200	1	6.1	0.5	10-0092	10-1043
E163	230	1	7.5	0.5	10-0092	10-1044	J282	200	3	3.6	0.5	10-1106«	10-1106
F163	230	3	4.8	0.5	10-1108«	10-1108	G282	460	3	1.7	0.5	10-1104«	10-1104
I163	200	1	8.5	0.5	10-0092	10-1044	BA282	575	3	1.4	0.5	10-1152«	10-1152
J163	200	3	6.0	0.5	10-1110«	10-1110	E284	230	1	8.9	1.0	10-0092	10-1044
G163	460	3	2.9	0.5	10-1106«	10-1106	F284	230	3	5.0	1.0	10-1108«	10-1108
BA163	575	3	2.4	0.5	10-1154«	10-1154	I284	200	1	9.3	1.0	10-0092	10-1044
E165	230	1	10.2	1.0	10-0092	10-1044	J284	200	3	5.5	1.0	10-1108«	10-1108
F165	230	3	7.4	1.0	10-1110«	10-1110	G284	460	3	2.6	1.0	10-1106«	10-1106
I165	200	1	12.6	1.0	10-0092	10-1044	BA284	575	3	2.2	1.0	10-1154«	10-1154
J165	200	3	7.5	1.0	10-1110«	10-1110	N292	115	1	15.0	0.5	10-1040	10-1045
G165	460	3	3.7	1.0	10-1106«	10-1106	E292	230	1	7.5	0.5	10-0092	10-1044
BA165	575	3	3.0	1.0	10-1156«	10-1156	I292	200	1	8.8	0.5	10-0092	10-1044
E185	230	1	9.8	1.0	10-0092	10-1044	F292	230	3	5.2	0.5	10-1108«	10-1108
F185	230	3	7.4	1.0	10-1110«	10-1110	J292	200	3	6.4	0.5	10-1110«	10-1110
I185	200	1	11.5	1.0	10-0092	10-1044	G292	460	3	2.9	0.5	10-1106«	10-1106
J185	200	3	7.5	1.0	10-1110«	10-1110	BA292	575	3	2.4	0.5	10-1154«	10-1154
G185	460	3	3.7	1.0	10-1106«	10-1106	E293	230	1	10.2	1.0	10-0092	10-1044
BA185	575	3	3.3	1.0	10-1156«	10-1156	F293	230	3	7.6	1.0	10-1110«	10-1110
E186	230	1	13.7	1.5	10-0092	10-1044	I293	200	1	12.0	1.0	10-0092	10-1044
F186	230	3	9.2	1.5	10-1110«	10-1110	J293	200	3	8.2	1.0	10-1110«	10-1110
I186	200	1	17.2	1.5	10-0092	10-1045	G293	460	3	4.0	1.0	10-1108«	10-1108
J186	200	3	10.3	1.5	10-1111«	10-1111	BA293	575	3	3.3	1.0	10-1156«	10-1156
G186	460	3	4.6	1.5	10-1108«	10-1108							
BA186	575	3	3.6	1.5	10-1108«	10-1108							

