# DRAINAGE PUMP DESIGN

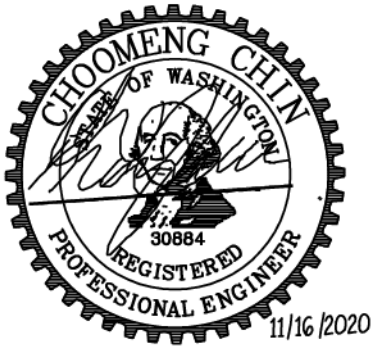
**FOR**

# SINGLE FAMILY RESIDENCE

# 4245 90TH AVE SE

# MERCER ISLAND, WA 98040

November 16, 2020

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# I. PROJECT OVERVIEW

This report provides the drainage pump system design calculation for the redevelopment of a single-family residence building. The detention system is too deep for gravity discharge to the roadway drainage system and hence a pump is needed. The pump system is designed to discharge the maximum allowable flow rate from the detention system including the 100-year storm frequency.

## A. Pump Design Requirements:

Per city requirements:

a. The pump system shall have dual, alternating pumps with emergency on-site, back-up power supply and an external alarm system for system failure and high water level indicator.

b. Provide a detail section for the pump system and the structure with all dimensions and invert elevations shown.

c. Pumped flows shall not exceed the allowable discharge rates set forth herein. Each pump shall be capable of discharging the design flow rate for the 100-year, 24-hour design storm. Provide detail calculations for the pump system including pump curve.

d. If a stormwater detention system is not required the pump system shall have a storage facility (pond, tank, or vault) sized to hold 25 percent of the total volume of runoff for the developed tributary drainage area for the 2-year, 24-hour design storm.

e. The pump system shall discharge to an elevation higher than the downstream design water surface elevation to prevent backwater/backflow conditions. Provide such design.

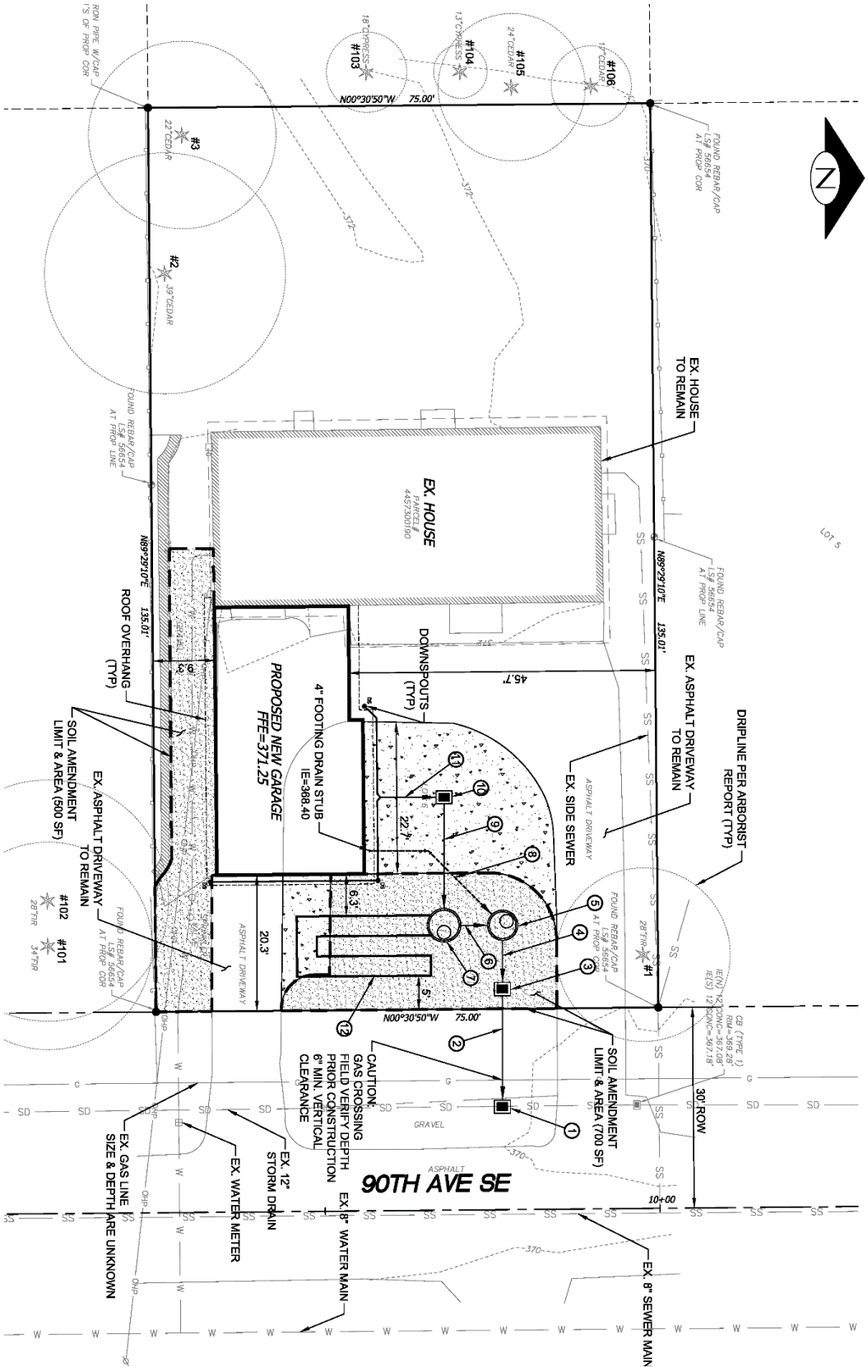


**FIGURE 1: PROPOSED SITE DEVELOPEMENT MAP (NTS)**

## II. PUMP DESIGN DESIGN

The calculated peak runoffs using the SBUH methodology are as follow:

Drainage area= 1728 S.F. (0.0397 acs)

The allowable discharge per the detention standards are as follow:

- 2-yr/24hr – 0.0058 cfs (5 gpm) (50% of existing condition flow rate)
- 10-yr/24hr – 0.0205 cfs (11 gpm) (Existing condition flow rate)
- 25-yr/24hr – 0.0251 cfs (13 gpm) (Existing condition flow rate)
- 100-yr/24hr – 0.0298 cfs (15 gpm) (Existing condition flow rate)

Minimum Pump Design working depth = 1.73 feet (

The 4-ft diameter pump well with 3' sump provide 281.99 gallon of volume > 162.68 gallon. O.k.

## A. SUMMARY OF INPUT DATA:

Drainage area = 1005 SF

TIME OF CONCENTRATION CALCULATIONS

24 hr. ISOPLUVIALS:

| | | |
|---|---|---|
| P2= | 2.00 | in/day |
| P10= | 3.00 | in/day |
| P100= | 4.00 | in/day |

sheet flow: Tt = {(.42)(Ns*L)^0.8}/{(P2)^0.5*(So)^0.4}
conc. flow: Tt = L/(60*Ks*(So)^0.5)

**TIME OF CONCENTRATION CALCULATIONS**

| **Existing** | Status | | | | | | |
|---|---|---|---|---|---|---|---|
| Segment | | Length | Ns | Ks | So%(ave) | Tt(min) | Tc Used (min.) |
| Impervious | | 40 | 0.011 | | 2.5 | 0.7 | 5 |
| | | | | | | | |
| Pervious | Sheet Flow | 37 | 0.15 | | 2 | 5.6 | 5.6 |
| | | . | | | | | |
| | | | | | | | |
| **Proposed** | | | | | | | |
| | | | | | | | |
| Impervious | Sheet Flow | 16 | 0.011 | | 8.3 | 0.2 | 5 |
| | | | | | | | |
| Pervious | Sheet Flow | 0 | 0.15 | | 9.3 | 0.0 | 5 |
| | | | | | | | |

## B. DEVELOPED PEAK FLOW CALCULATION:

### Project Precips

| | |
|---|---|
| [2 yr] | 2.00 in |
| [5 yr] | 2.80 in |
| [10 yr] | 3.00 in |
| [25 yr] | 3.50 in |
| [100 yr] | 4.00 in |
| [6-mo] | 1.28 in |

### PRE1 Event Summary:

| BasinID | Peak Q (cfs) | Peak T (hrs) | Peak Vol (ac-ft) | Area ac | Method /Loss | Raintype | Event |
|---|---|---|---|---|---|---|---|
| PRE1 | 0.0116 | 7.83 | 0.0042 | 0.04 | SBUH/SCS | TYPE1A | 2 yr |
| PRE1 | 0.0205 | 7.83 | 0.0071 | 0.04 | SBUH/SCS | TYPE1A | 10 yr |
| PRE1 | 0.0251 | 7.83 | 0.0087 | 0.04 | SBUH/SCS | TYPE1A | 25 yr |
| PRE1 | 0.0298 | 7.83 | 0.0102 | 0.04 | SBUH/SCS | TYPE1A | 100 yr |

### Drainage Area: PRE1

| | | | | |
|---|---|---|---|---|
| Hyd Method: | SBUH Hyd | | Loss Method: | SCS CN Number |
| Peak Factor: | 484.00 | | SCS Abs: | 0.20 |
| Storm Dur: | 24.00 hrs | | Intv: | 10.00 min |
| | Area | CN | TC | |
| Pervious | 0.0218 ac | 86.00 | 0.09 hrs | |
| Impervious | 0.0179 ac | 98.00 | 0.01 hrs | |
| Total | 0.0397 ac | | | |

**Supporting Data:**

**Pervious CN Data:**

| | | |
|---|---|---|
| Lawn | 86.00 | 0.0218 ac |

**Impervious CN Data:**

| | | |
|---|---|---|
| Driveway | 98.00 | 0.0179 ac |

**Pervious TC Data:**

| Flow type: | Description: | Length: | Slope: | Coeff: | Travel Time |
|---|---|---|---|---|---|
| Sheet | Lawn | 37.00 ft | 2.00% | 0.1500 | 5.59 min |

**Impervious TC Data:**

| Flow type: | Description: | Length: | Slope: | Coeff: | Travel Time |
|---|---|---|---|---|---|
| Sheet | Asphalt | 40.00 ft | 2.50% | 0.0110 | 0.67 min |

### Dev1 Event Summary:

| BasinID | Peak Q (cfs) | Peak T (hrs) | Peak Vol (ac-ft) | Area ac | Method /Loss | Raintype | Event |
|---|---|---|---|---|---|---|---|
| Dev1 | 0.0178 | 7.83 | 0.0059 | 0.04 | SBUH/SCS | TYPE1A | 2 yr |
| Dev1 | 0.0275 | 7.83 | 0.0092 | 0.04 | SBUH/SCS | TYPE1A | 10 yr |
| PRE1 | 0.0323 | 7.83 | 0.0087 | 0.04 | SBUH/SCS | TYPE1A | 25 yr |
| Dev1 | 0.0370 | 7.83 | 0.0125 | 0.04 | SBUH/SCS | TYPE1A | 100 yr |

### Drainage Area: Dev1

| | | | | |
|---|---|---|---|---|
| Hyd Method: | SBUH Hyd | | Loss Method: | SCS CN Number |
| Peak Factor: | 484.00 | | SCS Abs: | 0.20 |
| Storm Dur: | 24.00 hrs | | Intv: | 10.00 min |
| | Area | CN | TC | |
| Pervious | 0.0000 ac | 86.00 | 0.00 hrs | |
| Impervious | 0.0397 ac | 98.00 | 0.00 hrs | |
| Total | 0.0397 ac | | | |

**Supporting Data:**

**Impervious CN Data:**

| | | |
|---|---|---|
| Driveway+Walkway | 98.00 | 0.0161 ac |
| Garage | 98.00 | 0.0236 ac |

**Impervious TC Data:**

| Flow type: | Description: | Length: | Slope: | Coeff: | Travel Time |
|---|---|---|---|---|---|
| Sheet | Overland | 16.00 ft | 8.30% | 0.0110 | 0.20 min |

## C. STORM DUPLEX PUMP DESIGN:

**4245 90th Ave SE, Mercer Is. - STORM PUMP CAPACITY ANALYSIS**

STORM WATER LIFT STATION DESIGN

A. DETERMINE THE REQUIRED RATE OF PUMPING;

| | | | | | | |
|---|---|---|---|---|---|---|
| 100-YR PEAK FLOW, Qmax = | 0.0298 | cfs | = | 15.4 | GPM | (Allowable flow rate from ex condition - See Storm Shed Calc.) |

B. COMPUTE THE STORAGE REQUIREMENT FOR THE WETWELL:

USING 2 PUMPS AND 4 CYCLES PER HOUR
TIME FOR ONE PUMP CYCLE:

$$T=(V/Q-S)+(V/S)$$

Where:

| | | | |
|---|---|---|---|
| T = THE TIME FOR ONE PUMP CYCLE IN MINUTES = | 60 | | |
| V = THE EFFECTIVE VOLUME OF THE WETWELL IN GALLON = | V | | |
| Q = THE PUMPING RATE IN GALLONS PER MINUTE = | 15 | | |
| S = THE FLOW INTO THE WETWELL IN GALLONS PER MINUTE = | 5 | 0.0058 cfs | (Allowable 50% of 2-yr ex flow rate) |

V = TS(Q-S)/Q = **193**

| | | | | | |
|---|---|---|---|---|---|
| USE | 4 | FEET DIAMETER WET WELL | | | |
| VOLUME PER FOOT = | **94.00** | GAL/FT | | | |
| WORKING DEPTH = | **2.06** | FEET = | 193.49 | Gallons | |
| Availale Storage Vol., 3 feet= | **281.99** | GAL | OK | | |

C. DETERMINE THE FORCEMAIN DIAMETER:

| | | | | |
|---|---|---|---|---|
| Qmax = | 15 | GPM = | 0.03 | CFS |
| MAXIMUM CROSS SECTION REQUIRED = | | | 0.01 | SF |
| (FOR VEL. = | 3 | FPS) = | 1.64 | SI |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| USE | 2 | INCH DIAMETER HDPE PIPE, V= Q/A | | | | | |
| (AREA = | 0.02 | SF) | = | 1.57 | FPS | ~ 3 FPS | ~OK |

D. DETERMINE HEAD LOSS OF HDPE FORCE MAIN:

H = (Q/(0.006757)( C )(D^2.63))^1.85

| | | | |
|---|---|---|---|
| WHERE: | H = THE HEAD LOSS IN FEET PER 1000 FEET OF PIPE = | H | |
| | Q = THE FLOW IN GALLON PER MINUTE = | 15 | |
| | C = THE HAZEN-WILLIAM COEFFICIENT OF ROUGHNESS = | 140 | |
| | D = THE PIPE DIAMETER IN INCHES = | 2 | USED |

H = 5.96 FEET (for 2-in Diameter Pipe)

LENGTH OF PIPE = 6 FEET HEAD LOSS IN PIPE = **0** FT.

E. COMPUTE THE TOTAL DYNAMIC HEAD (TDH)

| | | |
|---|---|---|
| a) STATIC DISCHARGE HEAD = | **5.82** | FEET |
| DISCHARGE ELEVATION = | 368.76 | |
| PUMP OFF ELEVATION = | 362.85 | |
| b) MINOR LOSSES = | **5.9** | |
| 2 - 90 DEG. ELL = | 1.4 | |
| 1 - GATE VALVE = | 0.2 | |
| 1 - CHECK VALVE = | 2.5 | |
| 1 - TEE | 1.8 | |

c) TOTAL DISCHARGE HEAD LOSS = **11.76** FEET

G. COMPUTE THE REQUIRED BRAKE HORSEPOWER:

USE 1/3 HP SUBMERSIVE PUMP WITH

Hpbrake = (GPMxTDH) / (3960 X EFF.) = **0.076** EFF. OF 60 %

WHERE: GPM = FLOW RATE IN GALLON PER MINUTE
TDH = TOTAL DYNAMIC HEAD OF THE SYSTEM IN FEET
WHEN DELIVERING THE REQUIRED FLOW RATE
3930 = A CONSTANT
EFF = PUMP EFFICIENCY EXPRESSED IN DECIMAL FORM

## D. PUMP CURVE:

Use Goulds Pump WS_BHF Series, Model WS0311 BHF (1/3 HP) or Equal.
See Plan for pump details.