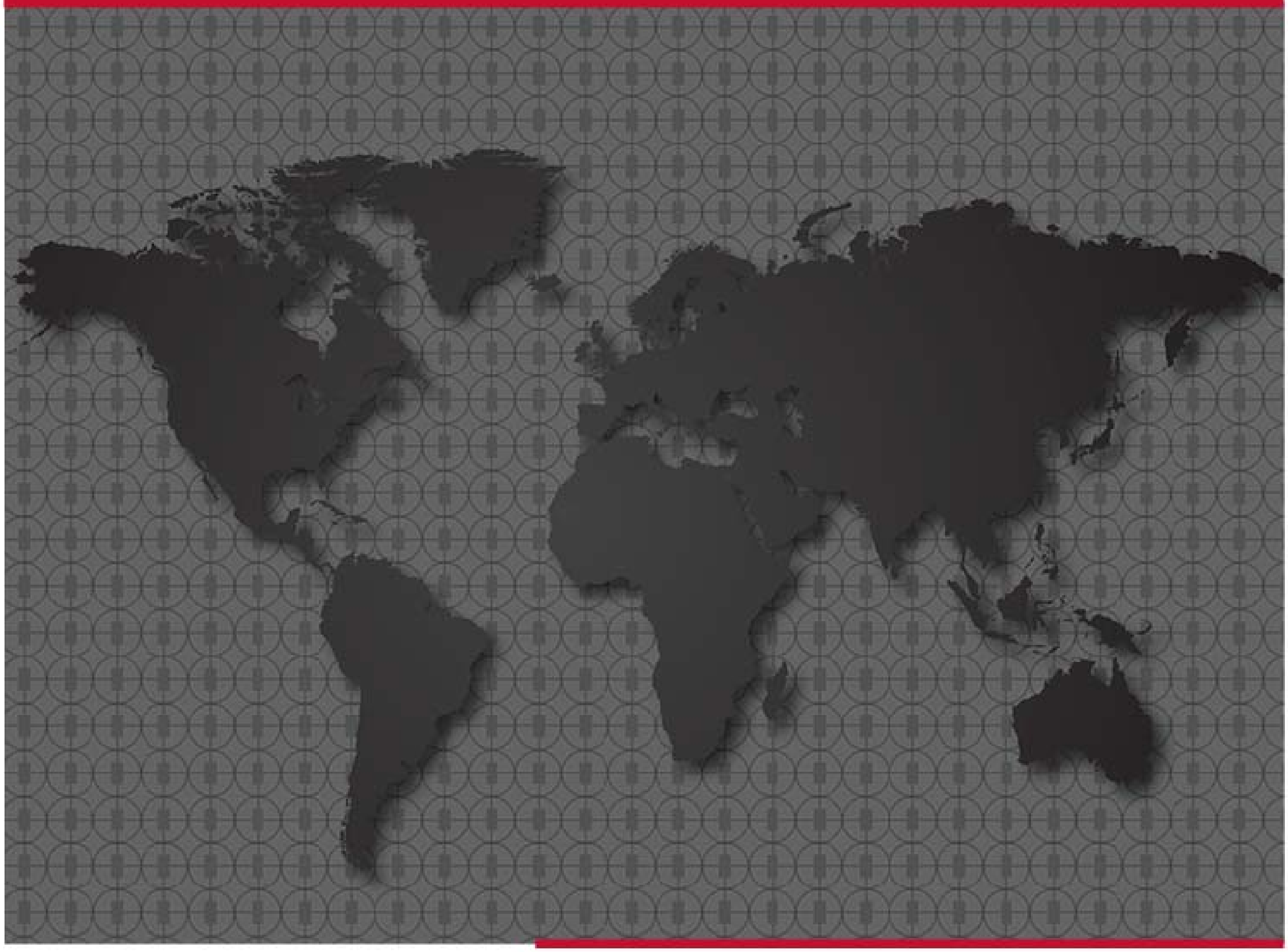

Dayton Street Stormwater Pump Station Predesign Final Report

City of Edmonds

May 2015

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Louis Berger

Dayton Street Stormwater Pump Station Predesign Report

City of Edmonds

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Section 1
INTRODUCTION, BACKGROUND AND PURPOSE

The intersection of Dayton Street and State Route (SR) 104 in downtown Edmonds has flooded on numerous occasions in recent years resulting in disruptions to traffic and ferry operations. Figure 1-1 shows the location of the intersection and the general vicinity. The intersection is in a low-lying area and is drained by a pipe system extending west along Dayton Street to outfall to Puget Sound. The outfall is equipped with a valve to prevent tidal flow from backing up into the drainage system.

The intersection is located just north of the Edmonds Marsh, a contiguous low-lying area. Shellabarger Creek crosses SR 104 and enters into the marsh about 1,000-feet south of the intersection. The flow from Shellabarger Creek through the culvert crossing is affected by a number of factors that can inhibit flow entering the marsh such as tidal conditions, sediment and debris accumulation, and an abundance of vegetation that clogs the creek channel. As such, during storm events, flow through the culvert backs up causing water levels on the east side of SR 104 to rise. The high water levels cause Shellabarger Creek to inundate a low-lying wetland on the east side of SR 104 and then overflow north to the Dayton Street and SR 104 intersection. This flow, in combination with the runoff from other tributary areas to the intersection, can overwhelm the existing Dayton Street stormwater conveyance system and result in periodic flooding, particularly when high tides coincide with heavy rainfall. Figures 1-2, 1-3, and 1-4 show the intersection and adjacent area flooding during three recent large storm events. High water levels in the marsh have also contributed to flooding of portions of the parking area and two buildings at the nearby Port of Edmonds' Harbor Square development.

The Dayton Street drainage system and the Shellabarger Creek system were studied previously as a part of the *Dayton Street and SR 104 Storm Drainage Alternatives Study* (Louis Berger, formerly SAIC, 2013). The study included hydrologic and hydraulic modeling of the systems as well as an evaluation of several alternative solutions to reduce flooding. The study recommended a comprehensive set of drainage system improvement projects to help reduce flooding of the intersection. One of the key recommendations focusing on the Dayton Street drainage system included the construction of a pump station to pump stormwater, particularly when the tide is high and restricts gravity flow from the drainage system to Puget Sound. The study identified a preliminary location for the pump station near the intersection of W Dayton Street and Admiral Way. The study also recommended isolating the drainage from the Shellabarger Creek system from the Dayton Street system so that the creek system does not contribute to the intersection flooding.

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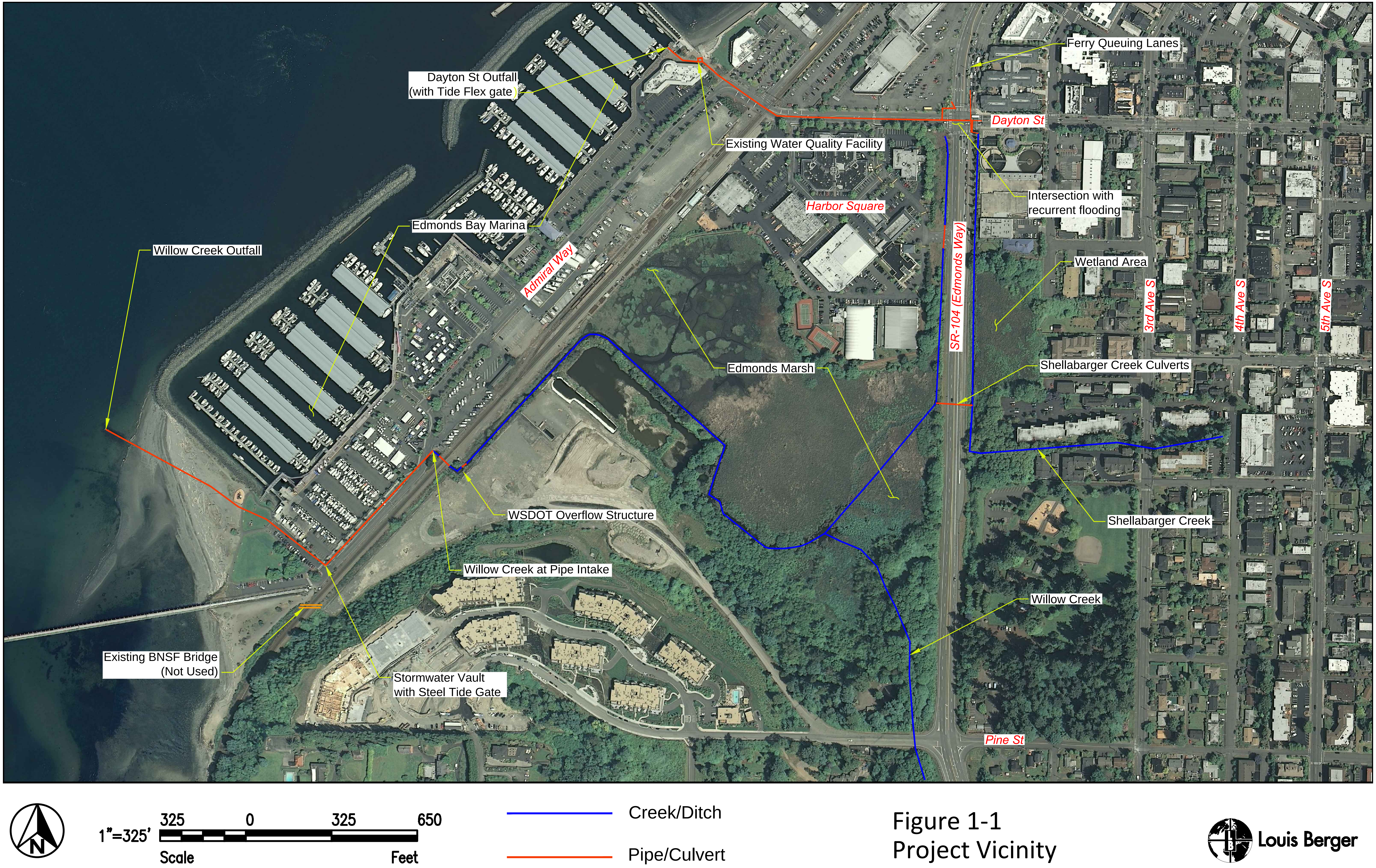


Figure 1-1
Project Vicinity

Louis Berger

The purpose of this current study is to perform preliminary design investigations for the proposed stormwater pump station. More specifically, this study is intended to confirm the pump(s) size and type, pump station location and configuration, outlet piping size and configuration, provide predesign level cost estimate, and assess implementation and permit requirements. To provide the predesign level information, the following major tasks were undertaken:

- Field survey in the vicinity of the proposed pump station that can be used for siting analysis and also serve as "base mapping" for future design.
- Conduct additional hydrologic and hydraulic modeling to confirm pump station capacity requirements.
- Perform geotechnical investigations using available data to assess soils conditions that could impact construction.
- Perform alternative analysis as needed to select the best option for pump station siting, and configuration.

The predesign study includes a description of the existing drainage system followed by a section that evaluates pump stations options and considerations.

Figure 1-2. Photograph: Dayton St/SR 104 Intersection looking south, Dec 03, 2007

Figure 1-3. Photograph: Salish Crossing Parking Lot adjacent to Dayton Street/SR 104 Intersection looking NW, Dec 12, 2010

Figure 1-4. Photograph: Salish Crossing Parking Lot and Dayton Street/SR 104 Intersection looking NW, November 19, 2012

Section 2
EXISTING DRAINAGE SYSTEM

The Dayton Street system drains an approximate 33.5-acre area that extends east as far as 3rd Avenue S and as far north as Main Street. From the intersection with SR 104, the system extends west along Dayton to Admiral Way, where it continues west through an easement on Port of Edmonds property. At the outlet to Puget Sound, the system includes a tide gate (tide flex valve) that prevents flows backing up in the system during high tides. Figure 2-1 presents a graphic of the existing drainage systems in the project area. This figure also shows the drainage system associated with the Edmonds Marsh/Shellabarger Creek, located to the south of Dayton Street. Figure 2-2 depicts drainage basin boundaries tributary to both the Dayton Street drainage system and the Edmonds Marsh system.

Approximately 80-feet west of Admiral Way the drainage system was modified in 2004 to include a water quality facility. This construction changed the system profile and added a swirl concentrator stormwater quality treatment facility. While water quality has been improved with this facility, a disadvantage is that it backs up water (about five-feet high) upstream of its location so much of the system is constantly under water.

The intersection for Dayton Street and SR 104 is low-lying and the low point of the road is at about elevation 10. High tides are often in the range of 9 to 11-feet (NAVD88) and sometimes higher during extreme tides. The intersection receives flow from both the north and the south. Drainage from the north includes both SR 104 to about Main Street as well as drainage from the Washington State Ferry's north queuing area. The drainage from the south includes overflows from the Edmonds Marsh/Shellabarger creek system. These overflows enter a pipe system located on the east side of SR 104 that extends north to the Dayton Street system.

There are two small areas that lie adjacent to Dayton Street but to do not drain to the Dayton Street drainage system. These include a portion of the Salish Crossing property which is located north of Dayton Street and west of SR 104 (See Subbasin 420 on Figure 2-2), and Harbor Square which is located south of Dayton Street and west of SR 104 (See Subbasin 410 on Figure 2-2). The drainage from the southwestern portion of Salish Crossing is directed south across Dayton Street and connects to a pipe system within Harbor Square. The Harbor Square drainage system includes storm drains that extend south and west to the Edmonds Marsh.

Additional information on the Edmonds Marsh/Shellabarger Creek drainage system can be found in *Dayton Street and SR 104 Storm Drainage Alternatives Study (Louis Berger, formerly SAIC, 2013).*

N

1"=300'–0"

300 0 300 600

Scale Feet

Figure 2-1
Existing Drainage System

Louis Berger

Figure 2-2
Drainage Basins

Preliminary Identification of Alternatives

The original concept identified as part of the *Dayton Street and SR 104 Storm Drainage Alternatives Study* was a 13 +/- cfs electric submersible pump station near the downstream end of the Dayton Street system that would include a force main discharge to Puget Sound. Following a notice to proceed on this current project, the consulting team met with City staff regarding advancing the pump station project and to identify any preferences for pump station configurations or what alternatives should be considered when advancing the pump station design. The following paragraphs provide discussions of certain aspects of the pump station configuration.

Pump Station and Outfall Location

The ideal location for the proposed pump station is near the downstream outlet of the system to reduce overall pumping length to Puget Sound. The location should also be close to the existing system to reduce the construction length of gravity main from the existing system to the pump station. It is also desirable to have the pump station pump into a force main that ties back into the existing gravity system prior to its outfall to Puget Sound. The advantages of using the existing outfall are both cost and the difficulty in getting environmental permits for a new stormwater outfall. Ideally, the force main would tie back into the existing system at a catch basin upstream of the existing water quality facility, so that even during pump station operation, stormwater is routed through the water treatment facility. The pump station location must also be readily accessible by City maintenance personnel.

With regard to connecting the force main back to the system upstream of the water quality facility, there was some concern regarding potential negative consequences of routing pressure flow through the facility. The water quality facility includes an upstream diversion manhole and a swirl concentrator. The upstream manhole routes flows up to the design flow of 8.5 cfs through the swirl concentrator. The diversion structure bypasses excess flow through a 30-inch diameter high flow bypass pipe to a downstream manhole. The manufacturer of the swirl concentrator (AquaShield) was contacted to solicit input on the option of routing pressure flow through the swirl concentrator. The manufacturer's engineers had no concern about routing pumped flows through the system and considered it better than discharging downstream of the treatment facility in order to increase the amount of stormwater receiving water quality treatment (Andy Gersen, personal communication. 2/23/15).

Use of the existing gravity concrete pipe system as an occasional pressure flow conduit is not of concern. Typically, concrete pipe is pressure tested during its initial installation to pressures more than that anticipated for the low head pumping from this project.

Two possible pump station locations were identified with the consulting team and City staff. These are shown on Figure 3-1. The first location (Option 1) is Beach Place parking lot, which is jointly owned by the City of Edmonds and the Port of Edmonds. The other location (Option 2) is in a gravel parking lot to the south of Dayton Street, which is a Port of Edmonds property. To use either site, approvals from the Port of Edmonds would be required. Both sites would be easily accessible by City maintenance personnel.

One disadvantage of the potential site south of Dayton Street is the number of other utilities within Dayton Street that a new gravity storm drain would need to cross (between the existing 24-inch storm drain system in Dayton Street and the proposed pump station). This includes the 36-inch wastewater force main from the City wastewater treatment plant and an 8-inch diameter gravity sewer. Based on potential vertical conflicts with these systems, it was concluded that the site to the south of Dayton Street (Option 2) is not preferred so it was eliminated from further consideration.

Figure 3-2 presents the proposed location of the pump station and force main on the new surveyed base map (by DHA associates, a subconsultant to Louis Berger). This figure shows an alignment for the force main between the pump station and the existing system as well as additional storm drain improvements that would be required. The figure also shows the pump station as a duplex centrifugal pump station configuration option, discussed later in this section. One of the improvements is the installation of a new backflow prevention device upstream of the new force main connection. The preliminary concept of the backflow prevention device is a “Checkmate” valve, which can be inserted directly to the existing 24-inch pipe. The backflow prevention device is needed in order to prevent recirculation of pump station flows back up into the Dayton Street system.

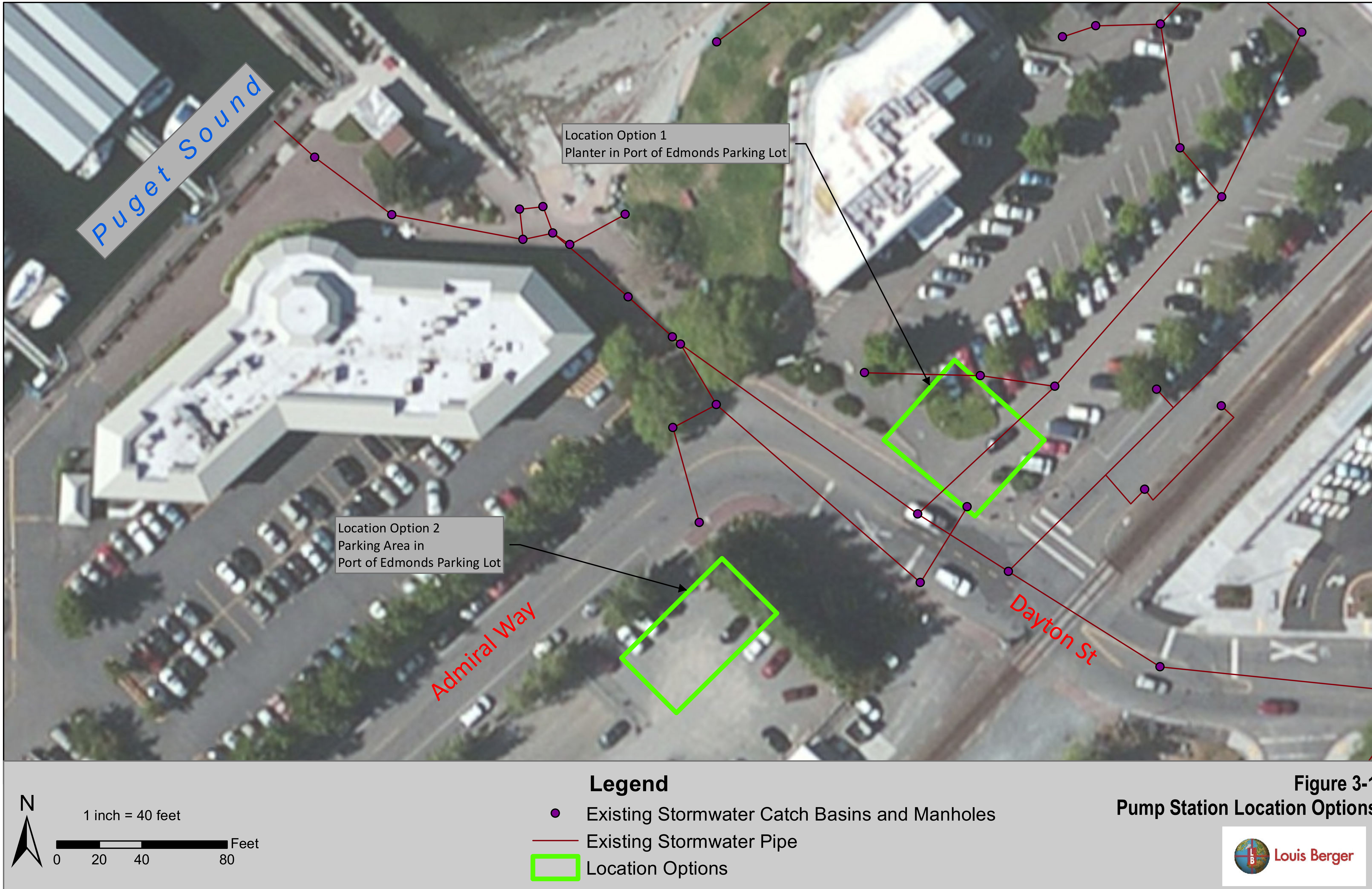
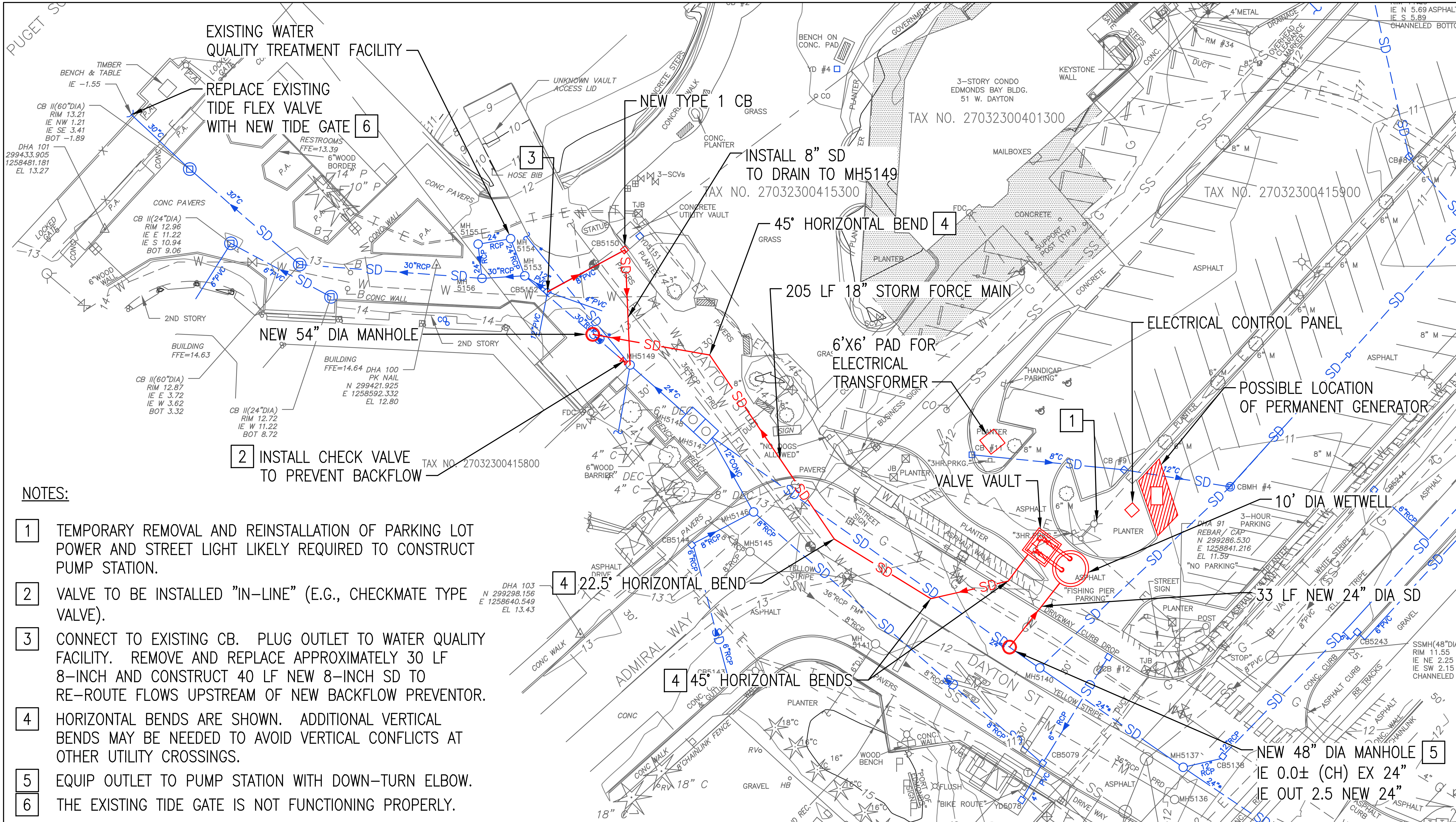


Figure 3-1
Pump Station Location Options



NOTES:

1. TEMPORARY REMOVAL AND REINSTALLATION OF PARKING LOT POWER AND STREET LIGHT LIKELY REQUIRED TO CONSTRUCT PUMP STATION.
2. VALVE TO BE INSTALLED "IN-LINE" (E.G., CHECKMATE TYPE VALVE).
3. CONNECT TO EXISTING CB. PLUG OUTLET TO WATER QUALITY FACILITY. REMOVE AND REPLACE APPROXIMATELY 30 LF 8-INCH AND CONSTRUCT 40 LF NEW 8-INCH SD TO RE-ROUTE FLOWS UPSTREAM OF NEW BACKFLOW PREVENTOR.
4. HORIZONTAL BENDS ARE SHOWN. ADDITIONAL VERTICAL BENDS MAY BE NEEDED TO AVOID VERTICAL CONFLICTS AT OTHER UTILITY CROSSINGS.
5. EQUIP OUTLET TO PUMP STATION WITH DOWN-TURN ELBOW.
6. THE EXISTING TIDE GATE IS NOT FUNCTIONING PROPERLY.

1"=30' Scale 30 15 0 30 60 Feet

Existing SD Features

New SD Features

Figure 3-2
Preliminary Site Plan

Louis Berger

The other storm drain improvements includes the “re-routing” of some of the local catch basins immediately near the stormwater quality treatment facility. Approximately four small catch basins, each having rim elevations of about 12 currently drain directly to the stormwater quality treatment facility. If these catch basins were not re-routed to drain to a location upstream of the backflow prevention device, there would be some risk that during extreme tides, stormwater could exit out of the catch basin grates when the pump station is operating. Note that the stormwater quality treatment facility manholes and the manholes downstream of the facility are equipped with solid locking lids, so flows exiting these manholes are less of a concern.

The force main alignment is preliminary. Horizontal bends are shown, but it is noted that additional vertical bends may be required. Future design work should include potholing at potential vertical conflicts.

A new manhole would be constructed along the existing 24-inch system to connect a new gravity storm drain to the new pump station. The entrance of the 24-inch pipe at the manhole should include a “down-turned” elbow to minimize floatables from entering the pump station.

At one point during this study, it was assumed that the preferred location of the pump station would be within the planter at the center of the beach place parking lot. However, City staff indicated it would be undesirable to lose the limited amount of landscaping that exists in this parking lot. As such, the proposed location of the pump station and valve vault were moved into the paved travel way southwest of the planter as shown on Figure 3-2.

Figure 3-2 also calls for replacing the existing tide flex valve at the outfall of the existing drainage system because the existing valve is not functioning properly.

One optional location and configuration that was also considered but then eliminated from further consideration was a full removal and replacement of the stormwater quality treatment facility. That is, full replacement was considered such that the treatment facility would be set deep and prior to the new pump station so as to keep the existing 24-inch storm drain in Dayton Street drained during non-flow periods. As noted previously, the existing 24-inch storm drain is constantly full of water because of the higher control at the downstream water quality facility. Ideally, this system would drain freely during non-flow periods which would be better for the long-term pipe condition. A high level evaluation was undertaken to assess the feasibility of this option, however, due to the anticipated high costs, the required depths of excavation (on the order of 25 feet) and concern about controlling groundwater to this depth, and the need for a much larger wetwell (because of not using the storage in the existing 24-inch pipe system), this option was not considered feasible and eliminated from further consideration.

Hydrology and Hydraulics

The XPSWMM model developed as part of the *Dayton Street and SR 104 Storm Drainage Alternatives Study* was modified and used to analyze pump station capacity and operation. The XPSWMM model is an unsteady state model that accounts for tidal conditions and can also simulate pump system operations. While more detailed information about the model can be found in the *Dayton Street and SR 104 Storm Drainage Alternatives Study,* the following paragraphs summarize some of the important aspects of applying the model to this pump station predesign project.

- The tributary area to the Dayton Street system includes basin adjustments recommended in the *Dayton Street and SR 104 Storm Drainage Alternatives Study,* which proposed re-routing some flow to the Dayton Street system away from the Edmonds Marsh to take advantage of the pump station capacity. These adjustments are described below;
    - Re-routing the portion of the Salish Crossing property that currently drains south to the Edmonds Marsh so that it drains to the Dayton Street system. (Subbasin 420 on Figure 2-2).
    - Installing an overflow drainage connection from Harbor Square (Subbasin 410 on Figure 2-2) to the Dayton Street system in the future so that its drainage system can "overflow" into the Dayton Street system when stormwater is incapable of flowing by gravity during very high water levels in the Edmonds Marsh. The model includes an overflow connection from the Harbor Square system to the Dayton Street system set at elevation 9 (NAVD 88).
- All overflows from high water levels in the Edmonds Marsh to the Dayton Street drainage system are assumed to be cut off by berming along the south side of Harbor Square and along SR104 as well as plugging the existing 24-inch pipe along the east side of SR 104.
- With the assumption that the 24-inch pipe along the east side of SR 104 is plugged, the WSDOT ferry queuing area drainage system connection to the Dayton Street system is limited to an 8-inch pipe. This is assumed to be corrected in the future by connecting the ferry queuing drainage system directly to the Dayton Street system.
- The hydrologic analysis is based upon existing land use.
- Pump station operation was checked using two significant flood events that were defined in the prior study. These include the 25-yr event and 100-year event which were defined as follows:

  - 25- year: Date: 1-1-1997 (no hydrologic adjustment factor)
  - 100-year: Date: 12-3-2007 (+1.05 hydrologic adjustment factor)

In addition, a full year of simulation was run to test pump operation on smaller scale storm events. The selected year was hydrologic year 1997 (10/1/1996 – 9/30/1997). The precipitation during this year was 53.13 inches which was above the average precipitation in Edmonds in the last 20 years (40.6 inches) using the Alderwood rain gage data.

New data was added to the model for specific evaluation of pump station options. Preliminary pump curves were selected from available submersible pumps as test cases to determine the appropriate capacity needed to prevent flooding for the 100-year storm. The following paragraphs describe how the pumps were configured in the model:

- The pump station discharge force main was sized to have velocities of 2 fps to 8 fps over the full operational range of pumping and the associated pipe friction is accounted for in the dynamic head on the pumps. The force main size was selected as 18-inch diameter.
- It was assumed the pump station would include two pumps that would alternate from one pump to the other. Having two pumps increases reliability should one pump fail. It also provides a smaller capacity (by one-half) that can operate during lower flow conditions.
- Preliminary pump on and off elevations were identified with consideration of solving flooding and maintaining non-pumped gravity flow when possible. The control elevations were set as follows:
  - When the first pump engages: Pump on at 8.0, Pump off at 4.6 (invert elevation to the gravity system)
  - If the second pump engages (during major events): Pump on at 8.5, Pump off at 1.5 (in order to evacuate the whole system and create sufficient storage capacity).
- Wetwell sizing needs to consider minimum cycle times. A standard minimum cycle time for pumps of the anticipated size is 10 minutes. For the Dayton Street system, the City can take advantage of the current volume of the 24-inch pipe system that is always inundated. Another advantage of this “dead storage” is that sediments will tend to drop within the pipe (as opposed to being conveyed to the proposed pump station). The elevation of the 24-inch pipe system ranges from about elevation 0.0 near Admiral Way to about 2.6 near Dayton Street.

Using the available storage in the pipe system enables the use of a wetwell consisting of a 10-ft diameter manhole.

- During initial simulations, it became clear that the previously identified 13 cfs capacity, while solving flooding, provided excess capacity such that only one of the pumps would turn on (and the minimum cycle time was below 10 minutes). A trial and error process, using gradually smaller pump curves that met the head requirements was conducted. This resulted in determining that two 4.5 cfs pumps were needed. For the model results summarized below, Xylem Flygt Pump NP 3153 was used for a pump curve, which yielded a pump capacity of 4.5 cfs at 11.5 ft TDH (See Appendix C for pump curves).

The following table provides the results of the modeling simulations. This results in the elimination of the flooding during the simulated storms.

Table 3-1
Model Summary Results

Parameter	25-Year Simulation Results	100-Year Simulation Results
Maximum WSE at Pump Station	8.0	8.5
Maximum WSE at Dayton St.	9.52	9.55
Peak Flow into the Pump Station	7.37	9.5 cfs
Maximum Flow in the Force Main	6.42	9.31 cfs
Two Pumps Engage Simultaneously?	No	Yes

Parameter	Simulation of One Hydrologic Year (1997)
Two Pumps Engage Simultaneously ?	No
No. of Pump Starts	114
Pump Run Time	45 hours

Pump Station Type and Configuration

The pump station was initially presumed to be configured as a duplex submersible sewage-style station, since the City is familiar with such stations and their associated solids handling centrifugal sewage pumps. Because of the station's high flow rate (initially estimated at 13 cfs as described above), vertical turbine solids handling (VTSH) pumps were also initially considered but rejected early for being cost-prohibitive, at three to five times the cost of comparable capacity centrifugal sewage pumps. In addition, they would require a substantial above-grade housing structure.

Although the station's final required capacity (9 cfs) is still quite large for a typical circular wetwell, the substantial storage available in the upstream stormwater conveyance system can be considered in order to reduce wetwell volume and as a result, the primary factor influencing wetwell sizing is the physical size of the pumps themselves. With each pump required to convey 4.5 cfs, the minimum available pump size is a 12-inch (suction size) pump, resulting in a relatively large wetwell nevertheless. Figure 3-3 shows this configuration, including a 10-foot (inside) diameter circular wetwell. This would be a precast manhole configuration. This configuration also typically includes a separate valve vault to house check valves and pump isolation valves, all of which must be at least 12-inch diameter in order to maintain reasonable (<8.5 fps) velocities at peak flows.

Pump availability for the anticipated head conditions is very limited. Static head could vary from a high of over 10 feet (at a historical tide of 11.67, versus a pump station low water level of 1.50) to a low of *negative* 0.5 foot (assuming a connection upstream of the water quality facility a invert of 8.00, versus a pump station high water level of 8.5), and there will be very little friction loss in the short force main to mitigate this wide variability. Therefore, Louis Berger sought other pump style options and determined that a submersible axial flow pump may also be a suitable alternative. This style of pump has no directly connected piping but rather sits in a column, drawing the pumped fluid through the open bottom of and into the column, past the pump and motor to the top of the column where it is discharged. Because of the pumps' vertical orientation and resulting small footprint, the station's at-grade or above-ground components are minimized, and the wetwell may be able to be somewhat smaller. Figure 3-4 shows this configuration in a rectangular wetwell. Although the pumps' footprint is significantly smaller than that of the centrifugal sewage pumps, an oversized wetwell is shown to improve pump inlet hydraulic conditions. Alternate methods of straightening flow into the axial flow pumps' inlets may be able to further reduce the wetwell size. The wetwell structure would likely be constructed using a combination of precast vault base with cast in place features such as the interior wall.

Head conditions complicate either pump selection, particularly on the low-head end of the system operating range. Most pump manufacturers investigated could not provide a pump selection that would reliably operate with very low total dynamic heads of 3 to 4 feet. One centrifugal sewage pump manufacturer (Flygt) was able to provide a pump selection operable within the full anticipated system range. One axial flow manufacturer was able to provide a suitable pump option (Grundfos); however, they recommended limiting the operating range of 5 to 13 feet.

The operating limits of the axial flow pump necessitates that the pump always pump against a minimum head of 5 feet. Figure 3-4 shows a pump station configuration of how this can be accomplished (pumping from 9 to 14). In terms of a site plan arrangement, it would be similar to that shown on Figure 3-2 which shows the duplex centrifugal arrangement, except that the location would have to be shifted north so that the portion of the pump station above grade would be in the landscape planter. An advantage of this is that it eliminates the need for check valves and pump isolation valves. The disadvantage is that the structure must extend above grade by approximately 3-4-feet. It is noted that the centrifugal pump could be configured is a similar way (without the valve vault), but it was assumed that the City would prefer traditional configuration (without being above grade).

With either pump station configuration, access hatches should be provided and adequately sized for removal of pumps, valves and other equipment. Access hatches should be constructed of aluminum or noncorrosive alloys. Manhole frame and covers or access hatches should also be provided over the wet well area to facilitate access.

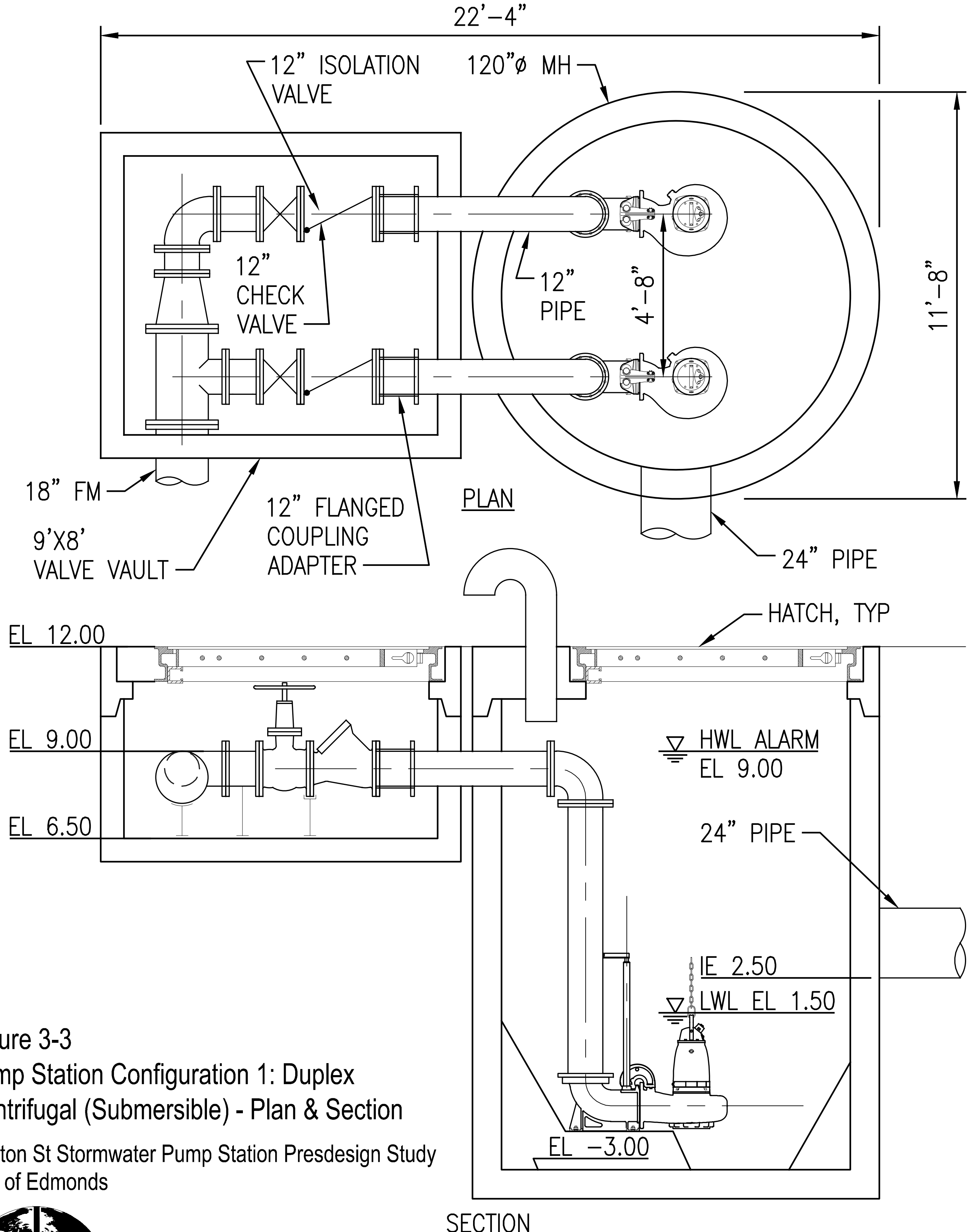


Figure 3-3
Pump Station Configuration 1: Duplex Centrifugal (Submersible) - Plan & Section

Dayton St Stormwater Pump Station Presdesign Study
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1/4"=1'–0"

4 2 0 4 8
Scale Feet

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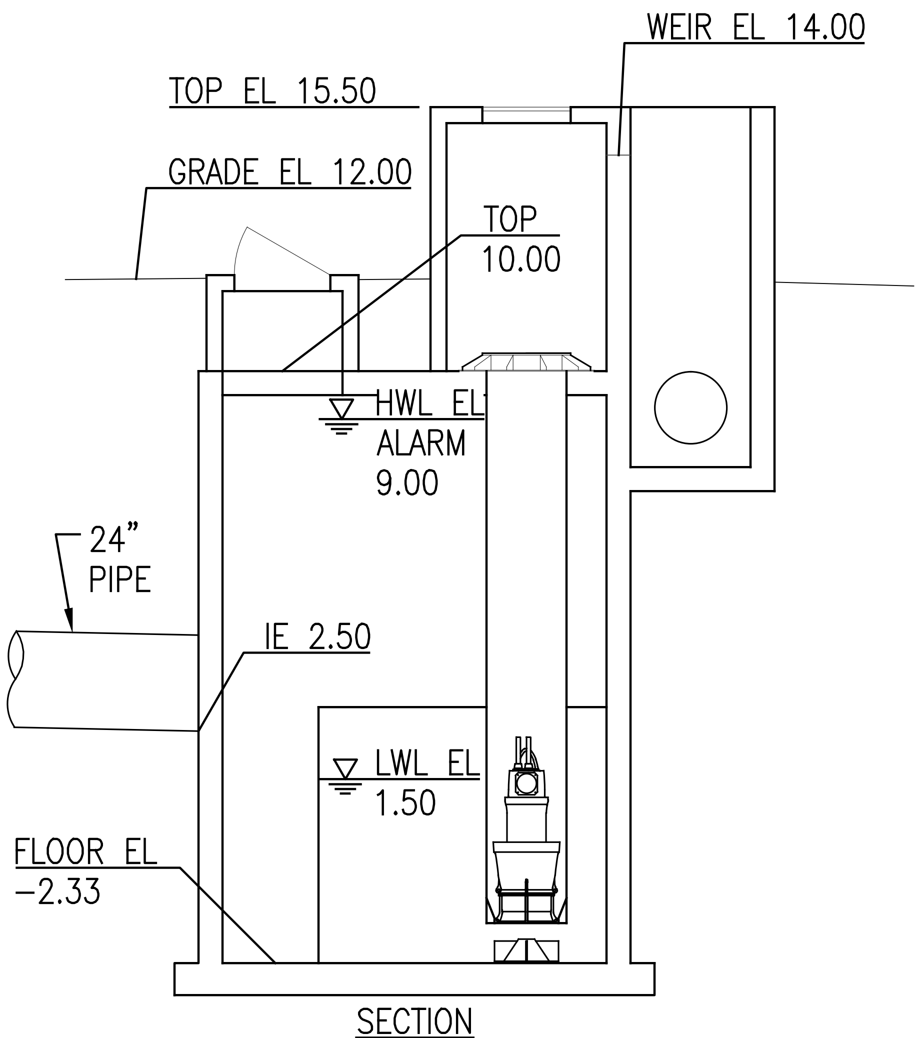

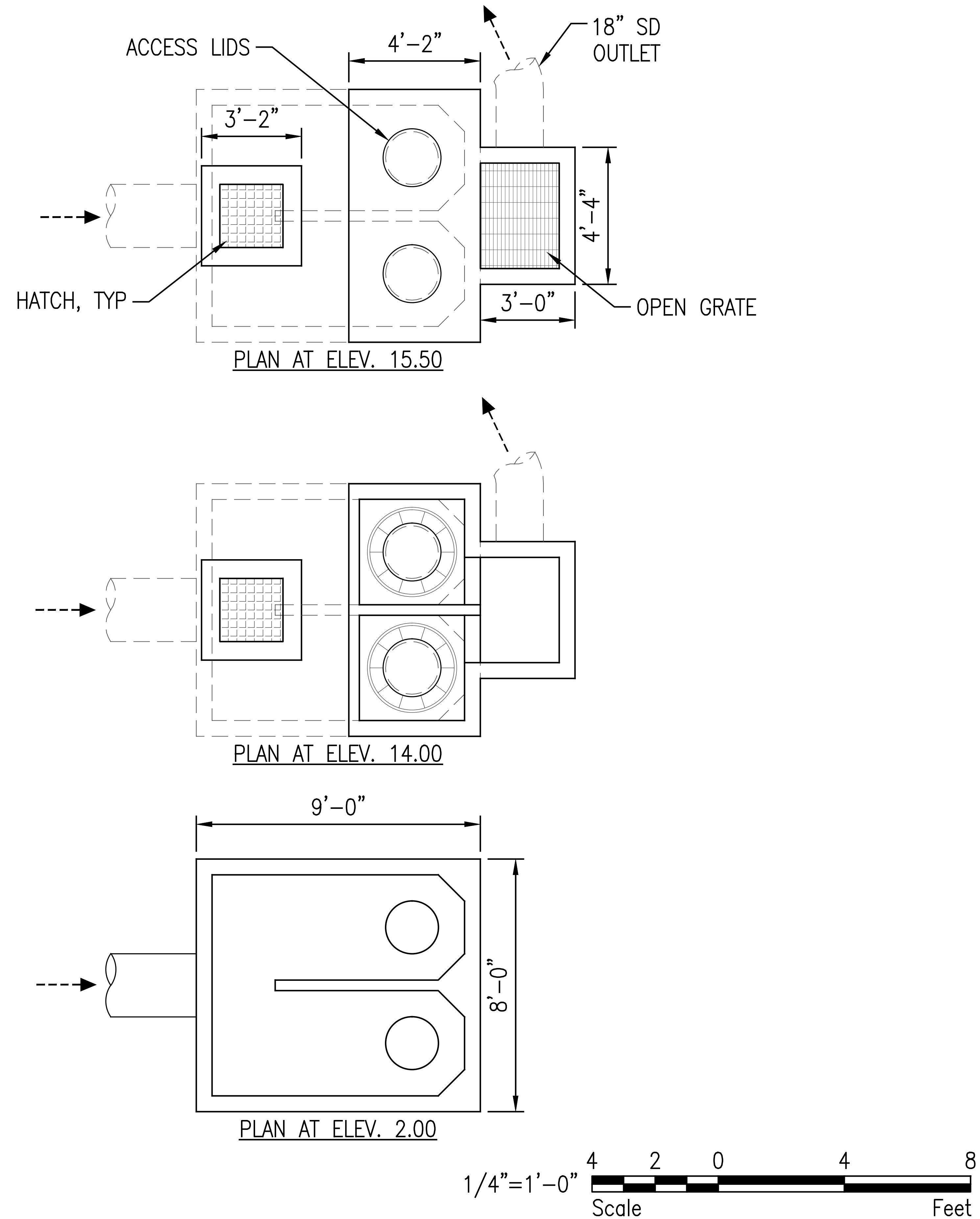

Figure 3-4
Pump Station Configuration 2: Coaxial Flow Pump - Plan & Section

Dayton St Stormwater Pump Station Presdesign Study
City of Edmonds

Louis Berger

Power Availability and Electrical Design Requirements

Louis Berger contacted the Snohomish County Public Utilities District (SNOPUD) on March 11, 2015 to ascertain the availability of electrical service at the proposed site. Based on discussion with Mary McAllister, both 208/120-Volt 3-Phase and 277/480-Volt 3-Phase power are available in the northwest quadrant of the intersection of Railroad Avenue and Dayton Street. An existing SNOPUD electrical junction box exists approximately 160 feet from the parking lot island which is the recommended pump station location. To service the pump station, the project design would need to include a 4-inch conduit from the junction box to a vault adjacent to the station, the vault itself, and SNOPUD-approved clearances around the vault. If the conduit is to be installed using trenchless technology, SNOPUD requires that the installation be performed by their contractors, the cost of which is added to the power service connection fee. After these items have been installed and when the pump station is ready for electrical service, SNOPUD runs the cable, places the necessary transformer and meter, and makes final connections.

The station would require a 200-amp 277/480-Volt 3-Phase service, and at a minimum would also include a manual transfer switch so that a portable emergency generator (sized for at least 50 kW) could be connected. This electrical equipment, as well as a meter, main disconnect, 480/120-Volt transformer, motor control center, control panel, and 480-Volt and 120-Volt panelboards would all be mounted in a cabinet enclosure approximately 4-feet by 3 feet, and 3 feet high.

The City could also opt for a permanently-mounted generator, which would likely require a residential-grade acoustic enclosure given the prominent and public location proposed. A 12- to 24-hour fuel supply would be stored in a fuel tank on which the generator would be mounted. Overall size of this unit would be approximately 8 feet by 3 feet, and 6-7 feet high, depending on fuel tank size. A preliminary cost estimate for a 50KW 208/120 volt, 3-phase generator with a 60 Hz Sound Attenuated enclosure is $50,000 (personal communication, Ray Bishop Generac Energy Systems).

Controls

The following paragraphs provide description of a preliminary pump station control approach. This would be further refined as the design progresses working closely with the City:

- A submersible level transducer in the pump station wetwell/vault is proposed as the primary level sensing mechanism. This will send analog signals to the controls system, providing easily variable setpoints for station operation. In addition, backup floats would be provided for High and Low alarm conditions.
- Normal pump operation will be according to a lead-lag scheme, with the lead pump coming on at a wetwell elevation of 8.0, and the lag pump starting at an elevation of 8.5. To prevent routine complete drawdown of the stored stormwater volume (which would

allow the system to reset to gravity flow when possible through the water quality facility), the lead pump will stop at an elevation of 4.50. The lag pump will stop at a wetwell elevation of 1.50, and pumpdown to this level will only occur during extreme stormwater events. High wetwell levels above 9.0 will trigger a High Water Alarm, and low wetwell levels below 1.0 will trigger a Low Water Alarm if a pump is also continuing to operate.

  - Motor starters would be configured with H-O-A switches. In the "A" (Auto) position, the pumps will operate according to the Normal Operation described above. If a pump is in the "O" position, it will be removed from the Normal Operation logic.
  - Alarms will be enunciated locally via audio-visual indication at the station incorporating a red light and an alarm horn. Each alarm will require manual acknowledgement to resume operation of stopped equipment. Visual indication will remain until the condition is cleared. Alarms should also trigger an autodialer to a City designated telephone number, unless a more sophisticated telemetry system is utilized.
  - The City owns, operates and manages a Supervisory Controls and Data Acquisition (SCADA) system to control their wastewater system with the main operation center at the wastewater treatment plant. An additional option for controls would be to include SCADA improvements in order to monitor pump operation (on / off), wetwell level, and trouble/alarm conditions from the treatment plant. Cost for implementing the SCADA system controls would likely be on the order of $10,000 to $15,000.

- All equipment will be mounted inside a NEMA rated enclosure suitable for the environment in which it is installed.
- Pedestal-mounted enclosures will be 72 inches tall by 24 inches wide by 24 inches deep, minimum.
- Wiring methods and materials for all panels will be in accordance with the NEC requirements.
- Consideration should be given to use of explosion proof electrical systems in the pump station during design. Although flammable gases are typically unlikely in storm drain system, the Dayton Street system has been observed to occasionally contain high degree of petroleum/oils.

Preliminary Permit Assessment

The scope of work included a preliminary permit assessment in order to identify project permits for implementation. This work was completed by Shannon & Wilson, Inc., a subconsultant to Louis Berger. The site of the proposed pump station is within the Beach Place parking lot owned jointly by the City of Edmonds and the Port of Edmonds, approximately 200 feet from the Puget Sound shoreline. For the permit assessment, the following project elements were assumed to be included in the project.

- Construction of a new pump station to reduce the flood hazard at the intersection of State Route 104 and Dayton Street, which is located approximately 700 feet to the east. This intersection is subject to periodic flooding due to the restriction of outflows during high tides. The new pump station is anticipated to alleviate flooding by assisting outflow during combined high tides and local precipitation events.
- The pump station will be constructed in an existing parking lot. A new storm drain force main pipe will also be constructed to convey water from the pump station to an existing storm drain that discharges to the Puget Sound approximately 250 feet west of the proposed pump station location. Thus, no new outfall is included in the project, which would significantly increase permit requirements. Also, all construction will occur in developed areas and no wetlands or other critical areas will be impacted by this project.

Based on a review of the Federal Emergency Management Agency's (FEMA's) current Flood Insurance Rate Map (FIRM) and FEMA's proposed draft FIRM, it appears that the project is located outside of mapped flood areas. It is also understood that the project does not include a federal nexus (federal funding, federal land use, and/or federal permits). Based on this information, the table below summarizes the likely permits that will be required for this project.

Table 3-2
Preliminary Project Permit Requirements

Permit	Permit Application and Supporting Documents	Issuing Agency
Shoreline Substantial Development Permit	Land Use Application Form, Adjacent Property Owner List, SEPA Checklist	City of Edmonds
State Environmental Policy Act (SEPA) Review	SEPA Checklist, Critical Areas Checklist	City of Edmonds
Building Permit, Grading Permit	Development Permit Application, Plan Set	City of Edmonds

Shannon & Wilson, Inc. contacted the City of Edmonds (City) Development Services Department on January 12 and 13, 2015 to verify the above summary of permits likely to be required for the project. Based on discussions with Linda Thornquist in the Building Department and Jen Machuga in the Planning Department, no other local permits are likely required. Ms. Machuga indicated that if the pump station reduces the amount of parking stalls, the City would need to verify that the site would still contain adequate parking in accordance with the City's Municipal Code prior to approving the project.

In addition to the project-specific permits above, the City's current Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) General Permit may need to be modified to include discharging this additional stormwater through the City's existing outfall to the Puget Sound. The need for any permit modifications will be assessed during final design.

Geotechnical Considerations

The scope of work included a preliminary geotechnical review to evaluate existing subsurface data and provide preliminary design information for the construction of the pump station. The review also considered geotechnical issues that warrant further study during the design phase. This work was completed by Shannon & Wilson (S&W), Inc., a subcontractor to Louis Berger, and is summarized in the following paragraphs. A full copy of the report is included in Appendix A.

Eleven soil borings had been completed in the vicinity as a part of other projects. These ranged from a distance of 100 to 500 feet from the proposed pump station location. These borings were reviewed to determine likely existing subsurface information at the proposed station location. Locations and description of the borings can be found in Appendix A.

In general most borings encountered loose to dense, poorly graded, fine to coarse sand from just below ground surface (bgs) to a depth of 20 to 30 feet bgs. The density of these soils was found to increase significantly at 15 to 25 feet bgs. In some borings, silt, silty sand, silty sand with gravel, or sand with silt was encountered in discrete layers. Gravel and organic material and asphalt, was also found in some borings. Typically, groundwater was encountered at depths of 5 to 10 feet bgs. Based on this review, the soil profile at the proposed pump station location most likely consists of 5 to 6 feet of medium dense fill material overlying soft wetland and marsh deposits (silt and peat) to a depth of about 10 feet. This is likely further underlain by dense glacial outwash sandy gravel and silty sand belonging to the Whidbey Formation.

The elevations at the proposed pump station site are approximately 12-13. The bottom of the proposed wetwell/vault is anticipated to be between elevation -3 and -4.

Based on a review of the data and proposed improvements, the soils present at the proposed base of the wetwell/vault appear to be competent for bearing. Certain geotechnical issues however, will require further analysis during the design phase of the pump station, including:

- Foundation Design. Design of a suitable foundation for the pump station will depend upon the load that the structure will exert on underlying soil and the soil reaction. Included in a foundation design analysis will be recommendations for bearing capacity, estimated settlements, buoyancy resistance, and lateral earth pressures.
- Seismically Induced Geologic Hazard Analysis (i.e., ground rupture, liquefaction, and increased lateral earth pressures).
- Earthwork. Construction–specific recommendations such as methods and requirements for excavation and shoring, foundation preparation, and backfill and compaction.

S&W recommends further exploration, such as a soil boring(s) specifically at the location of the pump station in order to provide a better understanding of the subsurface conditions.

S&W also noted the potential for soils contamination during excavation. Although none of the eleven borings indicated the presence of contaminated soils, both the Washington State Department of Ecology and a recent report by Landau Associates in 2012, for the Beach Place Sanitary Sewer Replacement project, indicate contaminates, including petroleum hydrocarbons and/or metals may be present in the soils within the vicinity of the project. The construction documents should include provisions should contaminants be found during project work. In addition, because space may be limited during construction without space for temporary stockpiling, the plans should allow for transporting materials directly to a permitted landfill. One such facility is Republic Services Landfill (3rd and Lander) in Seattle.

With regard to groundwater and dewatering, hydraulic conductivity analysis in the vicinity was conducted under a previous study. S&W reviewed the data and estimated that water may seep into the wet well excavation at a rate of 15 to 20 gallons per minute. Based on this information, S&W recommends a system of well points before and during excavation to lower the groundwater table. Well points are typically installed around or near the perimeter of an excavation and control seepage rates until the structure is installed and backfilled. Design of the dewater system should be performed by a hydrogeologist licensed in the State of Washington.

Operation and Maintenance

The two pump configuration options are substantially similar with respect to operation and maintenance concerns. Both are submersible pumps and by their nature are not designed to require significant maintenance. To maintain factory warranties against water intrusion into the submersible motor, electrical components are intended to be serviced only by the manufacturer, if needed. Wet end components including the impeller and mechanical seal can be serviced or replaced by City maintenance personnel in the field, and the seals are expected to need replacement at five- to ten-year intervals, depending on severity of operating conditions. Each pump option is expected to have a service life of up to twenty years, when operated and maintained in accordance with the manufacturer's recommendations. Operating efficiency and therefore power use is slightly better with the axial flow pumps, but energy consumption is not expected to be a significant factor since the pumps are expected to operate less than 50 hours per year.

The use of a weir discharge box (necessary for the axial flow pumps, but also possible with the submersible pumps) eliminates the need for check valves and pump isolation valves, which also periodically require maintenance.

Some debris accumulation could also require periodic maintenance of the wetwell, although it is not anticipated to be much because most sediment would accumulate in the existing 24-inch pipe system in Dayton Street.

Costs Estimates

Cost estimates were developed for the two main alternative pump station configurations. The cost estimates are provided in Table 3-3 and 3-4. Costs include a 30 percent construction contingency, and a 35 percent allowance for soft costs including design, permitting, and construction administration. The cost estimates do include cost for SCADA, assuming the City would prefer to have it integrated into the control system. The cost estimates include a permanent emergency generator (as requested by the City), which is estimated at $50,000.

Based on the amount of pump run time per year and the relative similar performance in pump operation, the difference in energy costs between the two pump configuration options is negligible (probably no more than $5/year difference in energy consumption). Therefore, a lifecycle cost analysis was not performed.

Table 3-3
Cost Estimate – Duplex Centrifugal (Submersible) Pump

	BID ITEM CONSTRUCTION COSTS	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Traffic Control	1	LS	$ 20,000	$ 20,000
2	Pump Station and Valve Vault Excavation	280	CY	$ 40	$ 11,200
3	Removal of Obstructions	1	LS	$ 5,000	$ 5,000
4	Shoring for Wetwell	1000	SF	$ 28	$ 28,000
5	Shoring for Valve Vault	250	SF	$ 28	$ 7,000
6	Dewatering	1	LS	$ 20,000	$ 20,000
7	Pump Vault Hatches	2	EA	$ 2,500	$ 5,000
8	Foundation Preparation	1	LS	$ 5,000	$ 5,000
9	4.5 cfs submersible pumps	2	EA	$ 25,000	$ 50,000
10	120" Dia Catch Basin Type 2 Wetwell	1	EA	$ 26,000	$ 26,000
11	Wetwell & Valve Vault Pipe & Fittings	1	LS	$ 12,000	$ 12,000
12	Pump Controls & MCC	1	LS	$ 40,000	$ 40,000
13	SCADA	1	LS	$ 15,000	$ 15,000
14	Electrical Cabinet and Starters	1	LS	$ 10,000	$ 10,000
15	Manual Transfer Switch	1	LS	$ 5,000	$ 5,000
16	Dry Transformer	1	LS	$ 5,000	$ 5,000
17	Site Electrical	1	LS	$ 10,000	$ 10,000
18	Electrical Controls	1	LS	$ 10,000	$ 10,000
19	Miscellaneous Electrical Site Labor	1	LS	$ 20,000	$ 20,000
20	On-site Back-up Generator	1	LS	$ 50,000	$ 50,000
21	Electrical Service Fee	1	LS	$ 25,000	$ 25,000
22	Swing Check Valve - 12"	2	EA	$ 14,000	$ 28,000
23	Eccentric Plug Valve - 12"	2	EA	$ 6,000	$ 12,000
24	Check Valve - 30" (Checkmate Type)	2	EA	$ 17,500	$ 35,000
25	Storm Drain - 24"	48	LF	$ 200	$ 9,600
26	Storm Drain - 8"	70	LF	$ 90	$ 6,300
27	48" Dia Type 3 Saddle Type Manhole	1	EA	$ 10,000	$ 10,000
28	54" Dia Type 3 Saddle Type Manhole	1	EA	$ 6,000	$ 6,000
29	Catch Basin Type 1	1	EA	$ 1,500	$ 1,500
30	Ductile Iron Force Main - 18"	205	LF	$ 250	$ 51,250
31	Connect to Existing Drainage structure	5	EA	$ 1,000	$ 5,000
32	Plug Existing Pipe	1	EA	$ 1,000	$ 1,000
33	Pavement Removal	250	SY	$ 15	$ 3,750
34	Pavement Restoration	250	SY	$ 35	$ 8,750
35	New concrete curb and gutter	40	LF	$ 40	$ 1,600
36	Utility Relocations	1	LS	$ 10,000	$ 10,000
37	Planter Restoration	1	LS	$ 2,000	$ 2,000
38	Relocation of Parking Lot Street Light	1	LS	$ 4,000	$ 4,000
39	Remove and Reinstall Parking Sign	1	LS	$ 500	$ 500
				Subtotal	$ 575,450
	Miscellaneous Construction Items (small incidentals)	10%			$ 57,545
	Temporary Erosion & Sediment Control	5%			$ 28,773
				Subtotal	$ 661,768
	Mobilization	10%			$ 66,177
				Subtotal	$ 727,944
	State Sales Tax	9.50%			$ 69,155
				Subtotal	$ 797,000
	CONTINGENCIES				
	Multi-Year Inflation	3%		(2 Years)	$ 47,820
	Design Contingency	30%			$ 239,100
	Management Reserve	10%			$ 79,700
				Total Estimated Construction Cost (Rounded)	$ 1,163,620
	INDIRECT COSTS				
	Surveying and Design	12%			$ 139,634
	Permitting	5%			$ 58,181
	City Project Management / Administration	3%			$ 34,909
	Construction Management	15%			$ 174,543
				Total Estimated Project Cost (Rounded)	$ 1,571,000

Table 3-4
Cost Estimate – Axial Flow Pump

	BID ITEM CONSTRUCTION COSTS	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Traffic Control	1	LS	$ 20,000	$ 20,000
2	Pump Station and Valve Vault Excavation	125	CY	$ 40	$ 5,000
3	Removal of Obstructions	1	LS	$ 5,000	$ 5,000
4	Shoring	950	SF	$ 28	$ 26,600
5	Dewatering	1	LS	$ 20,000	$ 20,000
6	Pump Vault Hatches	1	EA	$ 2,000	$ 2,000
7	Foundation Preparation	1	LS	$ 5,000	$ 5,000
8	4.5 cfs Axial Flow pumps	2	EA	$ 40,000	$ 80,000
9	8'-0" X 9'-0" X 12'-4" Pump Vault	1	LS	$ 50,000	$ 50,000
10	Pump Controls & MCC	1	LS	$ 40,000	$ 40,000
11	SCADA	1	LS	$ 15,000	$ 15,000
12	Electrical Cabinet and Starters	1	LS	$ 10,000	$ 10,000
13	Manual Transfer Switch	1	LS	$ 5,000	$ 5,000
14	Dry Transformer	1	LS	$ 5,000	$ 5,000
15	Site Electrical	1	LS	$ 10,000	$ 10,000
16	Electrical Controls	1	LS	$ 10,000	$ 10,000
17	Miscellaneous Electrical Site Labor	1	LS	$ 20,000	$ 20,000
18	Electrical Service Fee	1	LS	$ 25,000	$ 25,000
19	On-site Back-up Generator	1	LS	$ 50,000	$ 50,000
20	Check Valve - 30" (Checkmate Type)	2	EA	$ 17,500	$ 35,000
21	Storm Drain - 24"	48	LF	$ 200	$ 9,600
22	Storm Drain - 8"	70	LF	$ 90	$ 6,300
23	48" Dia Type 3 Saddle Type Manhole	1	EA	$ 10,000	$ 10,000
24	54" Dia Type 3 Saddle Type Manhole	1	EA	$ 6,000	$ 6,000
25	Catch Basin Type 1	1	EA	$ 1,500	$ 1,500
26	Ductile Iron Force Main - 18"	205	LF	$ 250	$ 51,250
27	Connect to Existing Drainage structure	5	EA	$ 1,000	$ 5,000
28	Plug Existing Pipe	1	EA	$ 1,000	$ 1,000
29	Pavement Removal	250	SY	$ 15	$ 3,750
30	Pavement Restoration	250	SY	$ 35	$ 8,750
31	New concrete curb and gutter	40	LF	$ 40	$ 1,600
32	Utility Relocations	1	LS	$ 10,000	$ 10,000
33	Planter Restoration	1	LS	$ 2,000	$ 2,000
34	Relocation of Parking Lot Street Light	1	LS	$ 4,000	$ 4,000
35	Remove and Reinstall Parking Sign	1	LS	$ 500	$ 500
				Subtotal	$ 559,850
	Miscellaneous Construction Items (small incidentals)	10%			$ 55,985
	Temporary Erosion & Sediment Control	5%			$ 27,993
				Subtotal	$ 643,828
	Mobilization	10%			$ 64,383
				Subtotal	$ 708,000
	State Sales Tax	9.50%			$ 67,260
				Subtotal	$ 775,000
	CONTINGENCIES				
	Multi-Year Inflation	3%	(2 Years)		$ 46,500
	Design Contingency	30%			$ 232,500
	Management Reserve	10%			$ 77,500
		Total Estimated Construction Cost (Rounded)			$ 1,131,500
	INDIRECT COSTS				
	Surveying and Design	12%			$ 135,780
	Permitting	5%			$ 56,575
	City Project Management / Administration	3%			$ 33,945
	Construction Management	15%			$ 169,725
		Total Estimated Project Cost (Rounded)			$ 1,528,000

Alternatives Evaluation Summary and Recommendations

This section includes a comparative evaluation between the two main types of pump station configurations and a recommendation. It also includes a set of recommendations for advancing the design work.

A comparison between the two primary pump station configurations is presented in Table 3- 5 for a variety of design, operation, maintenance, and appearance considerations.

Table 3-5
Summary Comparison of Pump Station Configuration Options

Consideration	Duplex Centrifugal (standard submersible)	Duplex Axial Flow
Footprint (at grade area)	22' x 12' + Electrical	12' x 8' + Electrical
Excavation to Max Depth	10'Ø Wetwell to a depth of -3 ft NAVD88	8' x 9' Vault to a depth of -2.33 NAVD88
Above-Grade area	Electrical Transformer and Panel (and permanent backup generator, if included)	Electrical, Discharge Riser/Vault to elevation of 15.5 +/- (and permanent backup generator, if included)
Pump Efficiency (at anticipated operation range)	55 – 65 percent	60-73 percent
Horsepower	15 each pump	15 each pump
RPM	1200 nominal	1200 nominal
Discharge Size	12"	n/a
Valve Sizes	12" check valve & 12” isolation valve	n/a
Pump Removal	Jib Crane / Hoist	Jib Crane / Hoist
Field Serviceability	Electrical - none	Electrical - none
	Wet end - impeller, seal	Wet end-impeller, seal
Reliability Concerns	seal leakage, power cable damage, motor water intrusion	seal leakage, power cable damage, motor water intrusion
Solids Passing	3-inch	1.9-inch
Expected Maintenance	seal @ 5-10 year intervals	seal @ 5-10 year intervals
Field-Installable Spare Parts	Lower seal, Impeller, wear ring	Lower seal, Impeller
Expected Pump Life	~15-20 years	~20 years
Pump / Motor Cost	$25,000 ea	$40,000 ea
Project Total Cost	$1,571,000	$1,528,000

In general, the major advantageous to the duplex centrifugal (submersible) station are:

- The station would be very similar to other pump stations operated by the City and therefore maintenance procedures would be more familiar to City staff.
- It would not need the above grade vault, and could be entirely located in a drive lane, so it would have less impact on existing landscaping; however the at-grade concrete structure would be larger (12' manhole and 9' x 58 valve vault).
- It passes larger solids (3.0 inch versus 1.9 inch) than the duplex axial flow pumps.

The major advantageous to the duplex axial flow pumps are:

- Elimination of the valve vault and valves, and associated maintenance.
- Smaller overall facility and at-grade footprint (although an approximate 7' x 8' structure would be above grade).
- Simpler pump construction, resulting in less pump maintenance (albeit, different maintenance procedures than City maintenance staff is used to).
- Overall cost is $1,528,000 which is estimated to be $43,000 lower than the duplex centrifugal cost estimate.

Based on this comparison, the duplex centrifugal pump (submersible) is the preferred option. Although the duplex axial pump cost estimate is slightly lower, there is probably greater benefit of having a common type pump station configuration (i.e., submersible) that City maintenance crews are very familiar with. Although probably less important, but also should be considered, are the reduced solids passing dimension and the need to have an above grade structure are also disadvantages with the duplex axial option. As mentioned previously, the duplex axial pump would take up more of the existing site landscaping, which is less desirable.

In terms of advancing the implementation of the pump station, the following paragraphs describe some of the key considerations in the future design, permitting and construction:

Future Design and Permitting:

- Coordinate with the Port of Edmonds for use of the Beach Place parking lot, including temporary impacts to parking lot and access, relocation of parking lot lights and landscaping.
- Coordinate with City Parks Department for temporary impacts to Park access.
- Pothole the potential utilities where the proposed gravity or force main lines need to cross.
- Conduct additional geotechnical investigations, including boring(s) at the proposed site.
- Future upstream improvements including isolating the Shellabarger Creek overflows to the Dayton Street system, and subcatchment diversions of Subbasins 410 and 420 to the Dayton Street system (See Figure 2-2).

Construction Considerations:

- It is likely the access driveway from Dayton Street W into the parking lot will need to be temporally closed. Access is available off of Railroad Avenue. Temporary closure of the driveway will also necessitate re-orienting the traffic flow directions within the parking area.
- Because of limited space in the area, the City may also want to request to use the vacant gravel parking area on the south side of Dayton Street for staging from the Port of Edmonds.
- Consideration of "saddle" type manholes over the existing 24-inch diameter pipe would allow the existing system to maintain conveyance during construction of the pump station and related pipe work and limit the need for temporary bypasses.

References

Louis Berger (formerly SAIC), 2013.*Dayton Street and SR 104 Storm Drainage Alternatives Study*

Personal Communication, Andy Gersen. Manufacturer's Representative, Isomedia (for AquaShield). 2/23/15.

Personal Communication, Ray Bishop, Generac Energy Systems. 3/13/15.

Personal Communication, Mary McAllister, Snohomish County PUD. 3/10/15.

Appendix A
Preliminary Geotechnical Review, Shannon & Wilson, Inc.

Preliminary Geotechnical Review
Dayton Street Pump Station
Edmonds, Washington

February 20, 2015

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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Submitted To:
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WASHINGTON

February 20, 2015

Mr. Mike Giseburt, P.E.
The Louis Berger Group (Domestic), Inc.
520 Pike Street, Suite 1005
Seattle, WA 98101

RE: PRELIMINARY GEOTECHNICAL REVIEW, DAYTON STREET PUMP STATION, EDMONDS, WASHINGTON

Dear Mr. Giseburt:

This report represents a summary of our preliminary geotechnical review for the proposed construction of a new Pump Station in Edmonds, Washington, located as shown in the Vicinity Map, Figure 1. The purpose of this geotechnical review is to evaluate existing subsurface data and provide preliminary design information for the construction of the Pump Station. This report also discusses geotechnical issues that may warrant further study during the design phase. Shannon & Wilson, Inc. reviewed existing data to evaluate seismic site class, possible soil contamination, groundwater seepage rates, and other considerations that will affect the construction of the Pump Station as outlined in Task 1.0 – Preliminary Geotechnical Review Services, 2014. Results of the review are presented herein.

BACKGROUND

We understand that the Dayton Street and State Route (SR) 104 Storm Drainage Alternatives Study presents the construction of a new Pump Station as an option to reduce flood hazard at the intersection of SR 104 and Dayton Street. This intersection is subject to periodic flooding due to the restriction of outflows during high tides. A new Pump Station will alleviate flooding by assisting outflow during combined high tides and local precipitation events.

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The site of the proposed Pump Station is within the Port of Edmonds, near the intersection of Admiral Way and Dayton Street. Depending on the finalized plan, pump station construction may occur on the north or south sides of Dayton Street, as shown in the Site and Exploration Plan, Figure 2. The existing ground surface at the site varies between approximate elevations 12 and 14 feet. The bottom of the proposed wet well would be at elevation -4.5 feet.

REVIEW OF EXISTING SUBSURFACE DATA

Several soil boring logs were reviewed for existing subsurface information (Site and Exploration Plan, Figure 2). Descriptions of the boring logs are presented in Appendix A. Boring logs were chosen based on proximity to the proposed Pump Station, and were in many cases made available through the Washington State Department of Natural Resources (DNR) Subsurface Geology Information System. The following explorations were reviewed:

- Four borings performed by Landau Associates, Inc., and presented in a report for the design of the Dayton Street Outfall (2003). The report references boring **B-1 (LB-1** in Figure 2) and older (Landau Associates, Inc.) borings **BH-1**, **BH-2**, and **BH-3**.
- Three borings performed by the Washington State Highway Commission Department of Highways. Subsurface explorations were performed for the construction of a 66-inch storm drain along SR 104 (1970). **Hole 3**, **Hole 4**, and **Hole 5** were included in this report.
- Three borings performed by Landau Associates, Inc., for the design of the Port of Edmonds Marine Support Buildings (1995). Included are borings **B-1**, **B-2**, and **B-3**.
- One boring completed by Zipper Zeman Associates, Inc., for the Edmonds Commuter Rail Station (2008). Included is **Boring No. 4**.

In general, most borings encountered loose to dense, poorly graded, fine to coarse sand from just below ground surface (bgs) to a depth of 20 to 30 feet bgs. The density of these soils was found to increase significantly at 15 to 25 feet bgs. In some borings, silt, silty sand, silty sand with gravel, or sand with silt was encountered in discrete layers. Gravel and organic material and asphalt, was also found in some borings. Typically, groundwater was encountered at depths of 5 to 10 feet bgs.

Based on our review of the boring logs, the soil profile at the proposed pump station locations most likely consists of 5 to 6 feet of medium dense fill material overlying soft wetland and marsh deposits (silt and peat) to a depth of about 10 feet. This is further underlain by dense glacial outwash sandy gravel and silty sand belonging to the Whidbey Formation.

CONCLUSIONS AND RECOMMENDATIONS

Seismic Site Class and Seismic Design Coefficients

It is likely that the design of the proposed Pump Station will utilize base shear methods outlined in the 2012 International Building Code (IBC) (International Code Council, Inc. 2012). This design code is based on levels of ground motion anticipated for an event with a 2,500-year recurrence interval. The proposed Pump Station is most likely underlain by fill and alluvium to depths of at least 20 to 30 feet. Below that the soils are likely glacially overridden and dense to very dense. Given the nature of these soils, we have identified the site classification as Site Class D.

Based on the mapped spectral accelerations provided by the U.S. Geological Survey (USGS) and using the site classification procedures outlined in IBC 2012, Section1615, this area is likely to be subjected to a peak ground acceleration of 0.53g, which is associated with a seismic event with a 2,500-year recurrence interval. The maximum considered spectral accelerations for short periods and the 1-second period are 1.27g and 0.50g, respectively. The mapped S_S and S_1 values in the vicinity of the site are shown in Table 1, and are from the probabilistic ground motion studies completed in 2008 by the USGS. The soil response coefficients F_A and F_V corresponding to Site Class D are also provided in Table 1.

TABLE 1
INTERNATIONAL BUILDING CODE 2012
GROUND MOTION PARAMETERS

S_S (g's)	S_1 (g's)	Site Class	F_A	F_V	S_{MS} (g's)	S_{M1} (g's)	S_{DS} (g's)	S_{D1} (g's)
1.27	0.50	D	1.0	1.5	1.3	0.75	0.85	0.50

Assessment of Geotechnical Design Issues

In general, the soils present at the proposed base of the wet well appear to be competent for bearing. Certain geotechnical issues, however, will require further analysis during the design phase of the Pump Station. Based on our review of pertinent site information, we recommend that three general areas receive additional consideration as follows:

1. Foundation Design. Design of a suitable foundation for the Pump Station will depend on the load that the structure will exert on underlying soil and the soil reaction. Included in a foundation design analysis will be recommendations for bearing capacity, estimated settlements, buoyancy resistance, and lateral earth pressures.
2. Seismically Induced Geologic Hazard Analysis (i.e., ground rupture, liquefaction, and increased lateral earth pressures).
3. Earthwork. Construction-specific recommendations, such as fill placement and compaction and excavation shoring considerations, will address the techniques that should be used during construction of the Pump Station.

Prior to addressing these items, further exploration, such as a soil boring(s) at the location of the Pump Station, is recommended in order to provide a better understanding of subsurface conditions.

Possible Soils Contamination

Typically, contaminated material is found within the upper layers of a soil boring, and is detected due to a strong odor or with the use of a device such as a photoionization detector. Because the detection of contaminated material may be a subjective experience, dependent on sense of smell, contamination may go unnoticed in some cases. Also, soils contamination is often local, only present within a relatively small section of soils or within a specific soil layer that may have been bypassed during sampling.

According to the Washington State Department of Ecology (DOE), some locations near the area of proposed construction have the potential to release waste material into the surrounding environment. These are known to the DOE as Hazardous Waste Generators, i.e., facilities that generate any quantity of dangerous waste, and are often industrial or commercial production facilities. The DOE has also noted past instances of site cleanup within the vicinity of the proposed Pump Station.

A recent geotechnical report by Landau Associates, Inc, (2012) indicates that petroleum hydrocarbons and/or metals may be present in soils within the vicinity of the proposed project area. . Although borings reviewed for this study did not indicate the presence of contaminated soils near the location of proposed construction, the potential for contaminated soils exists due to nearby industrial or commercial (Port of Edmonds) facilities.

Stockpiling space may be limited on site. Therefore, we recommend that plans be put into place such that, if contamination is found during excavation, the material can easily be exported to an appropriately permitted landfill. One such nearby facility is Republic Services landfill (3rd and Lander facility) in Seattle, Washington. Shannon & Wilson, Inc. can provide further services for the identification and disposal of contaminated soil if necessary.

Groundwater Seepage Rates and Construction Dewatering

It is our understanding that a 12-foot-diameter wet well will be constructed as part of the Pump Station. The excavation for the wet well is expected to extend to an elevation of about -4.5 feet (a depth of about 17 to 18 feet). Previous subsurface explorations near the proposed wet well indicate that the groundwater table is at a depth of about 5 feet. Given the granular nature of soils present at the proposed excavation depth, we estimate that water seepage rates will be relatively high and will require dewatering during excavation and construction of the wet well.

HWA Geosciences, Inc. performed a hydraulic conductivity analysis near the location of proposed construction (2006). Using the results of this analysis, we determined that water may seep into the wet well excavation at a rate of 15 to 20 gallons per minute. We recommend using a system of well points before and during excavation to lower the groundwater table. Well points are typically installed around or near the perimeter of an excavation and control seepage rates until the structure is installed and backfilled. Design of the dewatering system should be performed by a hydrogeologist licensed in the State of Washington.

LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are preliminary. We have reviewed site conditions as they presently exist, and further assume that the existing subsurface explorations are representative of the subsurface conditions throughout the project alignment; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If subsurface conditions different from those encountered in the explorations are encountered or appear to be present during 60% design, 90% design, or during construction, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

This report was prepared for the exclusive use of the City of Edmonds, The Louis Berger Group, and their design team in the design of the Dayton Street Pump Station project. The data and report should be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions discussed in this report.

The scope of our present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater should any be encountered.

Shannon & Wilson, Inc. has prepared and included Appendix B, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

Sincerely,

SHANNON & WILSON, INC.

Justin P.B. Cook
Geotechnical Staff

MARTIN W. PAGE
STATE OF WASHINGTON
30308
REGISTERED
PROFESSIONAL ENGINEER
2/20/15

Martin Page, P.E., L.E.G.
Vice President
Geotechnical Engineer, LEED AP, DBIA™

JPC/jpc

Enc: Figure 1 – Vicinity Map
Figure 2 – Site and Exploration Plan
Appendix A – Subsurface Explorations
Appendix B – Important Information About Your Geotechnical/Environmental Report

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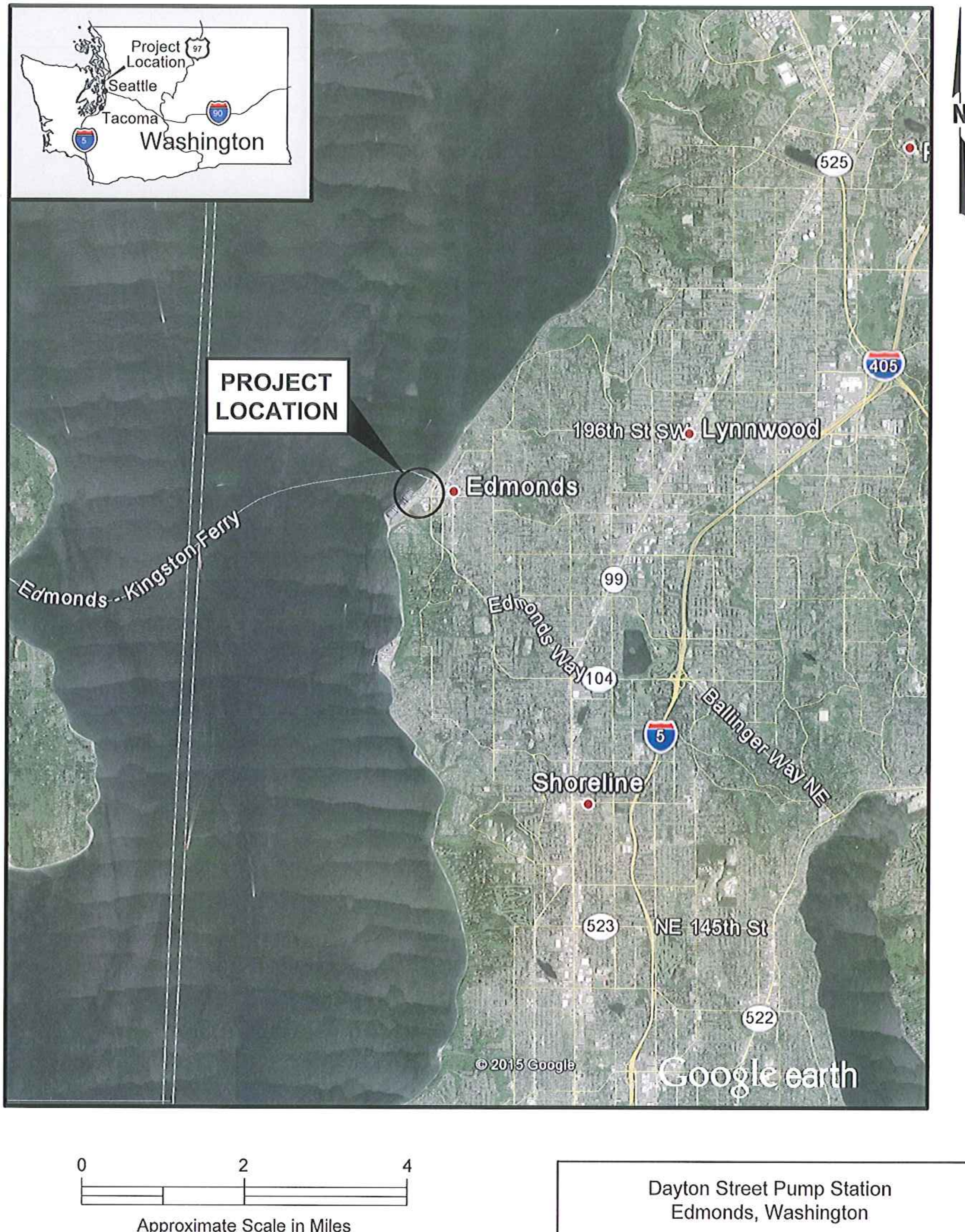

NOTE

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth ™ Mapping Service.

Dayton Street Pump Station
Edmonds, Washington

VICINITY MAP

February 2015 21-1-22042-001

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: J:\211\22042-001\21-1-22042-001 Vic.dwg Date: 02-11-2015 Login: lr

LEGEND

BH-1	Boring Designation and Approximate Location (Landau Associates, 2002)
Boring No. 4	Boring Designation and Approximate Location (Zipper Zeman Associates, 2008)
Hole 5	Boring Designation and Approximate Location (Washington State Highway Commission Department of Highways, 1970)
B-1	Boring Designation and Approximate Location (Landau Associates, 1995)
LB-1	Boring Designation and Approximate Location (Landau Associates, 2003)
(circle)	Possible Pump Station Location

0 100 200

Approximate Scale in Feet

NOTE

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth ™ Mapping Service.

Dayton Street Pump Station
Edmonds, Washington

SITE AND EXPLORATION PLAN

February 2015 21-1-22042-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2

Filename: J:\211\22042-001\21-1-22042-001 Site.dwg Date: 02-11-2015 Login: Sandy Cottrell

APPENDIX A

SUBSURFACE EXPLORATIONS

APPENDIX A

SUBSURFACE EXPLORATIONS

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FIGURES

APPENDIX A

SUBSURFACE EXPLORATIONS

Subsurface conditions at the proposed Dayton Pump Station site were interpreted based on 11 historic soil borings. These borings were conducted by various entities from 1970 to 2008, and are believed to provide adequate reference for this geotechnical review. Soil properties and expected groundwater conditions used in this review were estimated based on these borings. The approximate locations of the previous field explorations are shown in Figure 2. Selected boring logs are included as Figures A-1 through A-11.

B-1

Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 15.5
Drilled By: Holocene Drilling

SAMPLE DATA

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data
0	15				
		S-1	b2	14	W = 3
5	10	S-2	b2	11	W = 5 GS
		S-3	b2	18	W = 13
10	5	S-4	b2	11	W = 16 GS
15	0	S-5	b2	18	W = 23
20	-5	S-6	b2	25	W = 18 GS
25	-10	S-7	b2	35	W = 16
30					
35					

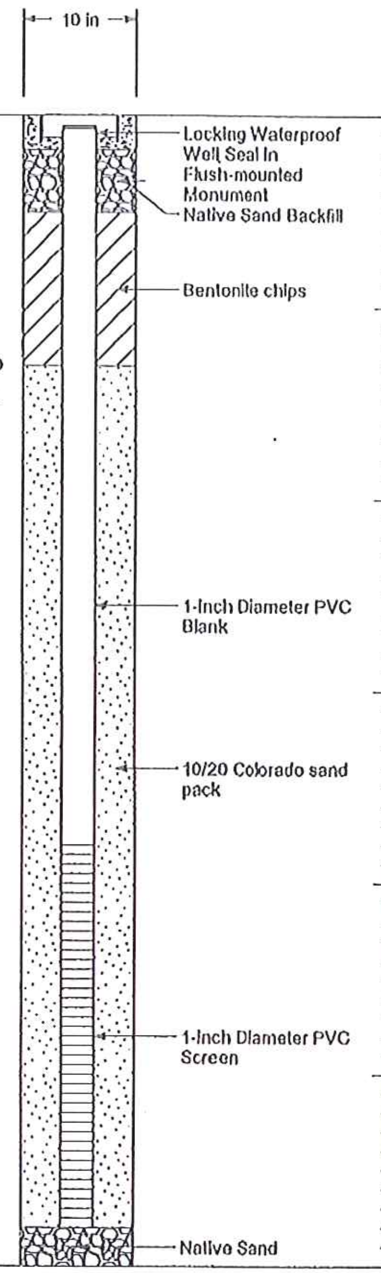
SOIL PROFILE

- SP — Olive-gray, gravelly, poorly graded, fine to medium SAND (medium dense, moist) (fill)
- SP — Olive-gray, very gravelly, poorly graded, fine to medium SAND (medium dense, moist)
- SP — Olive-gray, gravelly, poorly graded, fine to medium SAND (medium dense, wet)
- SP — Olive-gray, gravelly, poorly graded, fine to medium SAND (medium dense, wet) (native sands)
  - Becomes dense

GROUNDWATER

Water Level: ATD ∇

Detail



Boring Completed 09/09/03
Total Depth of Boring = 30.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

BH-1

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 15 (MLLW)

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0					SM	3 inches of sod over dark brown, silty SAND (medium dense, moist) (topsoil)	
	S-1	b2	11	W = 3	SP	Grayish brown to dark gray, poorly graded, fine to medium SAND, trace fine subrounded gravel (medium dense to loose, moist to wet) (fill)	
5	S-2	b2	10	W = 7			
							∇ ATD
	S-3	b2	7				
						- Wood encountered at about 9 ft	
10	S-4	b2	13			- 4 inches of sawdust encountered at about 11 ft	
					SP	Gray, poorly graded, fine to medium SAND, trace silt, trace fine subrounded gravel (medium dense, wet) (beach deposits)	
15	S-5	b2	15	W = 23			
20	S-6	b2	22	W = 21 GS			
25	S-7	b2	19			Grades to a light gray, poorly graded, fine to coarse SAND, trace silt	
					SP-SM	Dark gray, poorly graded, fine SAND with silt (medium dense, wet)	
30	S-8	b2	24				

Boring Completed 07/16/02
Total Depth of Boring = 31.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

53074.01 9/25/02 S:\MODELING\GINT\W\PROJECTS\053074.GPJ SOIL BORING LOG

LANDAU ASSOCIATES

Mid-waterfront Seawall Replacement
Edmonds, Washington

Log of Boring BH-1

Fig. A-2

BH-2

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 14.9 (MLLW)

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0					SM	3 inches of sod over dark brown, silty SAND (medium dense, moist) (topsoil)	
					SP	Grayish brown, poorly graded, fine to medium SAND, trace fine to coarse subrounded gravel (loose to medium dense, moist) (fill)	
	S-1	b2	6	W = 5			
5	S-2	b2	11	W = 7			
					SP-SM	Dark gray, poorly graded, fine to medium SAND with silt, sawdust, and wood debris, trace fine subrounded gravel (loose to medium dense, wet)	∇ ATD
	S-3	b2	7				
10	S-4	b2	16				
					SP-SM	Gray, poorly graded, fine to medium SAND with silt and fine subrounded gravel (medium dense to dense, wet) (beach deposits)	
15	S-5	b2	15	W = 18 GS			
20	S-6	b2	33	W = 18			
25	S-7	b2	26			Grades to a light gray, poorly graded, fine to medium SAND with silt	
						Grades to a dark gray, poorly graded, fine SAND with silt	
30	S-8	b2	28				

Boring Completed 07/16/02
Total Depth of Boring = 31.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

53074.01 9/25/02 S:\MODELING\GINTW\PROJECTS\053074.GPJ SOIL BORING LOG

LANDAU ASSOCIATES

Mid-waterfront Seawall Replacement
Edmonds, Washington

Log of Boring BH-2

Fig. A-3

BH-3

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 14.3 (MLLW)

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0					SM	3 inches of sod over dark brown, silty SAND (medium dense, moist) (topsoil)	
					SP	Grayish brown, poorly graded, fine to medium SAND (loose to medium dense, moist) (fill)	
	S-1	b2	7	W = 5			
5	S-2	b2	22	W = 8			
					SP	Dark gray, poorly graded, fine to medium SAND mixed with sawdust (very loose to loose, wet)	ATD
	S-3	b2	2				
10	S-4	b2	5				
					SP-SM	Gray, poorly graded, fine to medium SAND with silt, trace fine subrounded gravel (medium dense to dense, wet) (beach deposits)	
15	S-5	b2	26	W = 26			
20	S-6	b2	23	W = 20			
25	S-7	b2	31	W = 18 GS			
						Grades to a dark gray, poorly graded, fine SAND with silt	
30	S-8	b2	25				
35							

Boring Completed 07/16/02
Total Depth of Boring = 31.5 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

53074.01 9/25/02 S:\MODELING\GINT\WPROJECTS\053074.GPJ SOIL BORING LOG

LANDAU ASSOCIATES

Mid-waterfront Seawall Replacement Edmonds, Washington	Log of Boring BH-3	Fig. A-4

. 26.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
Copy to Bridge Engineer
Copy to District Engineer
Copy to

...er line 4+24

LOG OF TEST BORING

S.H. ______ S.R. ______ Section Ferry Dock to 5th Ave Job No. L-3242
...le No. 3 Sub Section 66" Sewer Line Cont. Sec.
...tion 14+70 (Dayton St.) Offset 37' Lt. Ground El. +6.0'
...pe of Boring M-7 Casing No W.T. El. -9.5'
...pector Don Ruhle Date Mar 27, 1970 Sheet 1 of 2

...H	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				SAND & GRAVEL: F.C. to Silty
	3		1 2 P-1	
			1 1	
			U-1	SILT: Organic w/seams of peat - Soft
...				
	2		1 1 P-2	
5			1 1	
	20		9 12 P-3	
...			8 8	SAND: Silty, Gravelly, F. & M.
	30		3 9 P-4	
			21 25	
...				

Fig. A-5

6.66-A (Rev. 5-67)

ole No. 3 Sub Section 66" Sewer Line Sheet 2 of 2

…H 0	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	47	↓	10 14 33 41 P-5	
5	52	↓	8 16 36 41 P-6	
		T.D. 27'		

26.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
Copy to Bridge Engineer
Copy to District Engineer
Copy to

...er line 6+25

LOG OF TEST BORING

S.H. ____ S.R. ____ Section Ferry Dock to 5th Ave Job No. L-3242
...e No. 4 Sub Section 66" Sewer Line Cont. Sec.
...ion 16+70 (Dayton St.) Offset 40' Lt. Ground El. -3.0'
...e of Boring M-7 Casing No W.T. El. -1.0'
...pector Dan Rudhe. Date Mar. 30, 1970 Sheet 1 of 2

BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			SAND & GRAVEL: F.C. to Silty
1		1 3 1 P-1	SILT: Organic - Soft
15		4 7 8 9 P-2	
35		4 12 23 28 P-3	SAND: F.C., Gravelly, F. & M.
65		21 30 35 P-4	

Fig. A-6

26.66-A (Rev. 5-67)

Hole No. 4 Sub Section 66" Sewer Line Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	45	↓	20 17 28 P-5	
		T.D. 21½'		

. 26.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
Copy to Bridge Engineer
Copy to District Engineer
Copy to ______

ewer line 8+96

LOG OF TEST BORING

S.H. ______ S.R. ______ Section Ferry Dock to 5th Ave. Job No. L-3242
le No. 5 Sub Section 66' Sewer Line Cont. Sec. ______
tion 19405 (Dayton St.) Offset 5' Rt. Ground El. 0.0
oe of Boring M-7 Casing No W.T. El. -8.0'
pector Dan Rudhe Date Mar. 30, 1970 Sheet 1 of 2

	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
2				ASPHALT PAVEMENT
	6		3, 3, 3, 2 P-1	
				SAND & GRAVEL: F.C.
	6		2, 2, 4, 8 P-2	
	11		3, 5, 6, 6 P-3	
	23		4, 8, 15, 18 P-4	
	33		13, 17, 16 P-5	

Fig. A-7

?. 26.66-A (Rev. 5-67)

Hole No. 5 Sub Section 66" Sewer Line Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
20	138	↓	32 / 60 / 78 P-6	
25	78	↓	12 / 28 / 50 P-7	
		T.D. 26½'		

B-1

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Moisture Content (%)	USCS Symbol	Soil Profile
						Drilling Method: 4-1/4" HSA/SPT
						Ground Elevation (ft): 16.2
0					GW	1-1/4" crushed SURFACING
	1	2b	31	2.6	SP-SM	Brown, gravelly, fine to coarse SAND with silt (dense, moist) (fill)
	2	2b	13	3.5		Grades medium dense
10	3	2b	17		SP	Gray, fine to medium SAND, scattered wood fragments (medium dense, wet) (beach deposits) ▽ ATD
	4	2b	48	11.7	SW	Gray, gravelly, fine to coarse SAND (dense, wet) (glacial outwash deposits)
20	5	2b	50/6"			Grades less GRAVEL, very dense
	6	2b	55/6"			Trace gravel
30	7	2b	78	20.4	SP	Gray, fine to medium SAND with gravel and trace silt (very dense, wet) (glacial outwash deposits)
	8	2b	49			Grades to fine sand, dense
40	9	2b	48			

Bottom of boring at depth 41.5 ft;
Backfilled with bentonite chips with soil cap

Boring Completed 08/30/95
Total Depth : 41.5 ft.

50

60

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate. Refer to the text for an explanation of subsurface conditions.
2. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

B-2

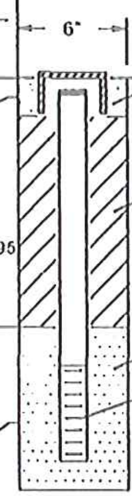
Drilling Method: 4-1/4" HSA/SPT

Ground Elevation (ft): 15.7

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Moisture Content (%)	USCS Symbol	Soil Profile
0					GW	1-1/4" crushed SURFACING
	1	2b	20	4.8	SP	Brown, gravelly fine to coarse SAND (medium dense, moist) (fill)
	2	2b	11	7.3		
10	3	2b	14		SP	Dark gray, fine to medium SAND, 1-inch bed of fine sandy silt (medium dense, wet) (beach deposits) ▽ 9-6-95
	4	2b	63		SP	Gray, fine to medium SAND with trace fine gravel (very dense, wet) (glacial outwash deposits)
20	5	2b	61		SW	Gray, gravelly, fine to coarse SAND (very dense, wet) (glacial outwash deposits)

Boring Completed 08/30/95
Total Depth = 21.5 ft.

WELL DETAIL



Well Completed 08/30/95

Depth (ft): 0, 10, 20, 30, 40, 50, 60

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate. Refer to the text for an explanation of subsurface conditions.
2. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

B-3

SAMPLE DATA / SOIL PROFILE

Drilling Method: 4-1/4" HSA/SPT

Ground Elevation (ft): 15.5

Sample Number & Interval	Sampler Type	Blows/Foot	Moisture Content (%)	USCS Symbol	Soil Profile
				GW	1-1/4" crushed SURFACING
1	2b	11	4.6	SP	Brown, gravelly fine to coarse SAND (medium dense, moist) (fill)
2	2b	16	15.4		
				SM	Gray, silty, fine to medium SAND with gravel, scattered bits of wood (medium dense, wet) (beach deposits) ▽ ATD
3	2b	34		SP	Dark gray, fine to medium SAND (dense, wet) (beach deposits)
4	2b	48		SW	Gray, gravelly, fine to coarse SAND with trace silt (dense, wet) (glacial outwash deposits)
5	2b	79	7.5		
6	2b	50/5.5"		SP	Gray, fine to medium SAND (very dense, wet) (glacial outwash deposits)
7	2b	50/5.5"			
8	2b	50/5"			Bottom of boring at depth 35.9 ft; Backfilled with bentonite chips with soil cap

Depth (ft): 0, 10, 20, 30, 40, 50, 60

Boring Completed 08/30/95
Total Depth = 35.9 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate. Refer to the text for an explanation of subsurface conditions.
2. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

173005.10 Port of Edmonds/Marine Support Building/Geotech. Report 11/95

Boring B-3 | Fig. A-10

LOG OF BORING NO. 4

CLIENT: KPFF Consulting Engineers

SITE: Edmonds, WA

PROJECT: Edmonds Commuter Rail Station

Approx. Surface Elev.: 11.30 ft

DESCRIPTION	DEPTH, ft	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
5½" **ASPHALT**		SM		HS					
SILTY SAND WITH GRAVEL, gray, medium dense, moist to wet (Fill) ▽		SM	1	SS	12	19	11		
		SM		HS					
5.5	5	SM	2	SS	18	4	96		
SILT WITH PEAT, gray, soft, wet to saturated		ML	2	SS					
		ML		HS					
grades to medium stiff		ML	3	SS	18	6	57		
9.5		ML		HS					
	10	SP		HS					
GRAVELLY SAND, TRACE SILT, gray, dense, saturated		SP	4	SS	18	32	18		
				HS					
16.5	15	SP							
SANDY GRAVEL, TRACE SILT, gray, dense, saturated		GP		HS					
19		GP	5	SS	18	40	8		
BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: In-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 4.5	WD	▼
WL	▽		▼
WL			

Zipper Zeman Associates, Inc.
Geotechnical and Environmental Consulting
A Terracon Company

BORING STARTED			3-9-07
BORING COMPLETED			3-9-07
RIG	CME 85	CO.	E.D.I.
LOGGED	BAG	Fig. A-11	

APPENDIX B

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

Date: February 20, 2015
To: Mr. Mike Gisebur, P.E.
The Louis Berger Group (Domestic), Inc.

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland

Appendix B
Survey/Base Mapping, DHA

SCALE IN FEET

20' 10' 0 20' 40'

LINETYPES:

- FENCING
- UNDERGROUND STORM LINE
- UNDERGROUND SEWER FORCE MAIN LINE
- UNDERGROUND SEWER LINE
- UNDERGROUND WATER LINE
- UNDERGROUND TELEPHONE LINE
- UNDERGROUND POWER LINE

LEGEND

SYMBOLS:

- IRRIGATION CONTROL VALVE
- FIRE HYDRANT
- WATER VALVE
- WATER METER
- POWER POLE W/ LIGHT
- POWER POLE
- POWER POLE ANCHOR
- SANITARY SEWER MANHOLE
- DHA SURVEY CONTROL
- MONUMENT IN CASE
- POWER METER
- DECIDUOUS
- CONIFER
- SIGN
- MAILBOX
- CO SANITARY SEWER CLEANOUT
- STORM DRAIN CATCH BASIN(TYPE I)
- STORM DRAIN CATCH BASIN(TYPE II)
- 3-12"DIAMETER COLUMN

ABBREVIATIONS:

CLF	CHAIN LINK FENCE
VBF	VERTICAL BOARD FENCE
C/CONC	CONCRETE
P.A.	PLANTED AREA
PVC	POLYVINYL CHLORIDE PIPE
DI	DUCTILE IRON
(A)	APPROXIMATE
CMP	CORRUGATED METAL PIPE
MB	MAIL BOX
RV	RV HOOK-UP
HB	HOSE BIB
PRD	PIER RECORD DRAWING
B	BOLLARD
FFE	FINISH FLOOR ELEVATION
JB	JUNCTION BOX

TREES:

C	C
CON	CONIFER
P	PINE
DEC	DECIDUOUS
M	M

HORIZONTAL DATUM:

WASHINGTON STATE COORDINATE SYSTEM, NORTH ZONE NAD83(91), US FEET UTILIZING RTK GPS FIELD PROCEDURES

CONTOUR INTERVAL: (1') ONE FOOT CONTOURS

VERTICAL DATUM: NAVD88, US FEET.

UTILITIES MAPPING:

ALL EXISTING UTILITIES SHOWN HEREON ARE TO BE VERIFIED HORIZONTALLY AND VERTICALLY PRIOR TO ANY CONSTRUCTION. ALL EXISTING FEATURES INCLUDING BURIED UTILITIES ARE SHOWN AS INDICATED BY RECORD LOCATION OR FIELD TIED AS A RESULT OF A UTILITY PAINT-OUT DURING THE COURSE OF THE FIELD SURVEY. DUANE HARTMAN & ASSOCIATES, INC. (DHA) ASSUMES NO LIABILITY FOR THE ACCURACY OF THE RECORD INFORMATION. FOR THE FINAL LOCATION OF THE EXISTING UTILITIES IN AREAS CRITICAL TO CONSTRUCTION, CONTACT THE UTILITY OWNER/AGENCY AND UTILITIES UNDERGROUND CENTER (800/424-5555).

TOPOGRAPHIC MAPPING:

THE MAP SHOWN HEREON IS THE RESULT OF A TOPOGRAPHIC SURVEY BY DUANE HARTMAN & ASSOCIATES, INC. (DHA) COMPLETED ON DECEMBER 2014. DHA ASSUMES NO LIABILITY, BEYOND SAID DATE, FOR ANY FUTURE SURFACE FEATURE MODIFICATIONS OR CONSTRUCTION ACTIVITIES THAT MAY OCCUR WITHIN OR ADJOINING THE PERIMETER OF THIS SURVEY. CONTACT DHA (425) 483-5355 FOR SITE UPDATES AND VERIFICATIONS.

DRAINAGE STRUCTURE DATA TABLE

SLOT #9 RIM=12.58 IE=11.88

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SLOT#11 RIM=12.58 IE=12.18

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SLOT #14 RIM=12.61 IE=11.86

SLOT#15 RIM=12.59 IE=11.89

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MH5136 RIM=12.09 IE=N/A FULL OF SAND

CB1002 RIM=11.82 IE=11.24

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CB1005 RIM=11.87 IE=9.87

CB1006 RIM=12.28 IE=9.53

CB1007 RIM=12.42 IE=9.75

CB1008 RIM=12.35 IE SW=9.50 IE NE=9.50 IE N=9.60 IE NW=8.20 IE SE=8.25

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MH5153 RIM=12.60 IE ESE=8.40 IE SE=4.40 IE W=5.90 IE N=3.95

CB1009 RIM=12.61 IE N=9.17 IE SE=8.16 IE NW=8.11

CB1010 RIM=12.03 IE=11.28

CB1012 RIM=11.66 IE NW=8.82 IE NE=9.68 IE SE=8.96 IE SW=9.81

CB1229 RIM=11.55 IE=10.95

CB1230 RIM=11.72 IE=10.97

CB1262 RIM=11.94 IE SE=10.54 IE SW=10.64 IE N=10.79

CB1330 RIM=12.38 IE=10.76

MH1341 W/SUMP PUMP RIM=12.22 IE NW=10.17 IE SW=10.32 IE SSE=10.22 IE SE=10.27 IE NE=10.32

CB1342 RIM=12.45 IE NE=11.10 IE NW=11.15

YD1356 RIM=12.19 IE=11.49

MH5154 RIM=12.74 (VAULT) IE=N/A

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CB1504 RIM=11.49 IE SW=9.84 IE NE=10.19 IE NW=9.49

MH1682 RIM=12.13 IE=4.68

CB1832 RIM=11.14 IE SE=9.64 IE NE=9.69 IE SW=9.79

CB1833 RIM=11.28 IE NW=9.08 IE SW=9.43 IE NE=9.28 IE SE=8.98

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CB1837 RIM=11.28 IE=10.48

CB1838 RIM=11.22 IE=10.55

YD1871 RIM=11.87 IE=10.77

YD1900 RIM=11.15 IE=10.70

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YD1951 RIM=10.86 IE=10.11

YD5078 RIM=11.03 IE=10.13

CB5079 RIM=11.04 IE NE=9.19 IE SW=9.69 IE NW=8.88

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MH5133 RIM=11.67 NO PIPES VISIBLE BOT.=0.42

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MH5141 RIM=12.22 IE CHANNEL=1.42 IE SW=8.82

CB5143 RIM=12.43 IE=11.13

CB5144 RIM=12.68 IE E=10.68 IE S=10.73

MH5145 RIM=13.21 IE=1.56

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MH5147 RIM=13.78 IE=7.48 BAFFLE=9.58 BOT.=-0.52

MH5148 RIM=13.85 BOT.=6.55

MH5149 RIM=13.17 IE NW=4.97 IE S=-0.33 BOT=-0.33

CB5152 RIM=12.55 IE S=9.75 IE NE=9.65 IE NW=9.40 IE W=9.40

MH5155 RIM=12.89 IE E=3.74 IE S=3.69

MH5156 RIM=12.63 IE W=4.08 IE N=3.68 IE E=5.23

CB5150 RIM=12.60 IE=10.30

YD5151 RIM=13.04 IE=N/A

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CB5199 RIM=11.59 IE=N/A

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CB5243 RIM=11.10 IE SW=9.05 IE SE=9.15

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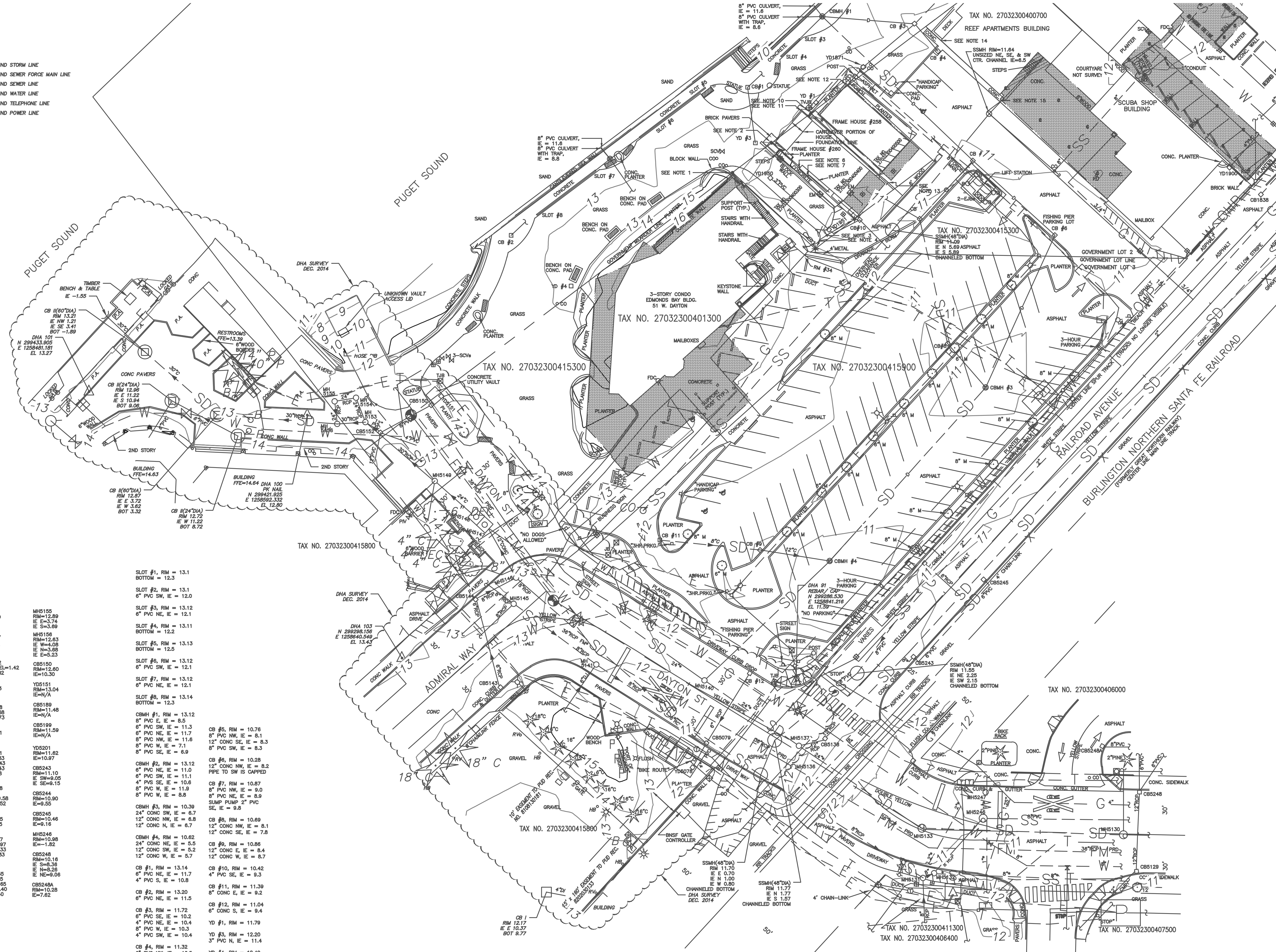
CB5248 RIM=10.16 IE S=8.36 IE N=8.26 IE NE=9.06

CB5248A RIM=10.28 IE=7.62

SURVEYING AND MAPPING BY:
DUANE HARTMAN & ASSOCIATES, INC.
Surveyors



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SLOT #7, RIM = 13.12
6" PVC NE, IE = 12.1

SLOT #8, RIM = 13.14
BOTTOM = 12.3

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4" PVS SE, IE = 10.6
8" PVC W, IE = 11.9
8" PVC W, IE = 8.8

CBMH #3, RIM = 10.39
24" CONC SW, IE = 6.7
12" CONC NW, IE = 6.8
12" CONC N, IE = 6.7

CBMH #4, RIM = 10.62
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12" CONC W, IE = 5.7

CB #1, RIM = 13.14
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4" PVC S, IE = 10.8

CB #2, RIM = 13.20
6" PVC NE, IE = 11.5

CB #3, RIM = 11.72
6" PVC SE, IE = 10.2
4" PVC NE, IE = 10.4
8" PVC W, IE = 10.3
4" PVC SW, IE = 10.4

CB #4, RIM = 11.32
6" PVC NW, IE = 10.5

CB #5, RIM = 10.76
8" PVC NW, IE = 8.1
12" CONC SE, IE = 8.3
8" PVC SW, IE = 8.3

CB #6, RIM = 10.28
12" CONC NW, IE = 8.2
PIPE TO SW IS CAPPED

CB #7, RIM = 10.87
8" PVC NW, IE = 9.0
8" PVC NE, IE = 8.9
SUMP PUMP 2" PVC
SE, IE = 9.8

CB #8, RIM = 10.69
12" CONC NW, IE = 8.1
12" CONC SE, IE = 7.8

CB #9, RIM = 10.86
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12" CONC W, IE = 8.7

CB #10, RIM = 10.42
4" PVC SE, IE = 9.3

CB #11, RIM = 11.39
8" CONC E, IE = 9.2

CB #12, RIM = 11.04
6" CONC S, IE = 9.4

YD #1, RIM = 11.79

YD #3, RIM = 12.20
3" PVC N, IE = 11.4

YD #4, RIM = 12.49

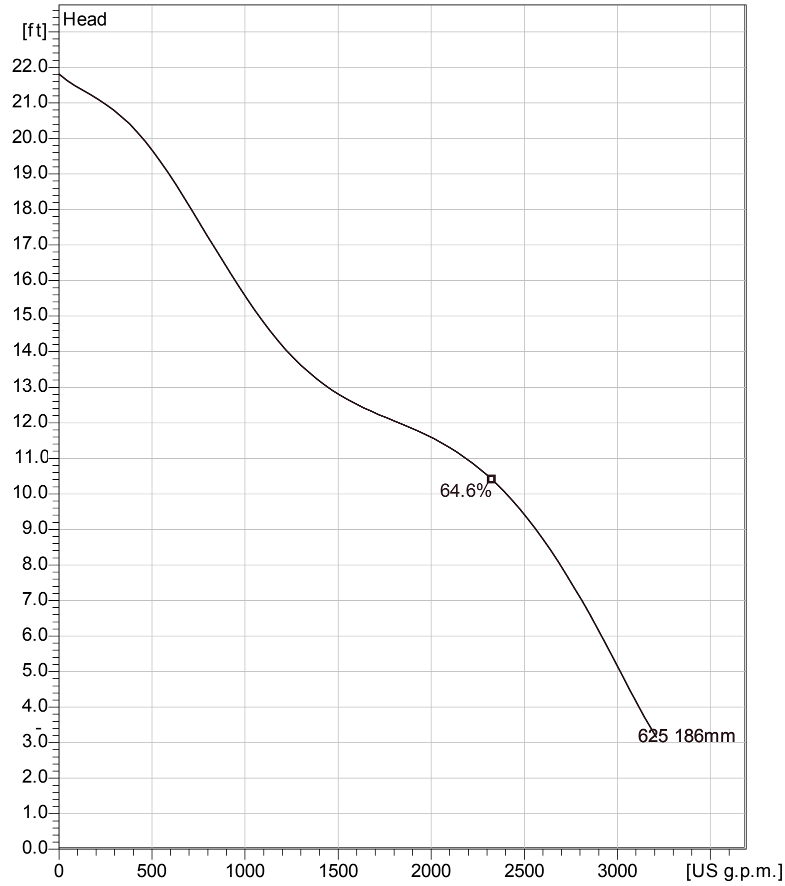
1"=50' 50 25 0 50 100
Scale Feet

Louis Berger

Appendix C
Pump Manufacturing Data

NP 3153 LT 3~ 625

Technical specification



Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Note: Picture might not correspond to the current configuration.

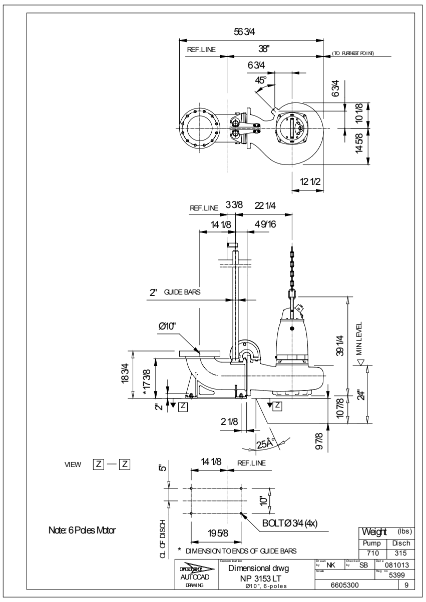
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	250 mm
Impeller diameter	186 mm
Number of blades	3

Installation: P - Semi permanent, Wet



Motor

Motor #	N3153.095 21-18-6AA-W 15hp
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	15 hp
Rated current	22 A
Starting current	101 A
Rated speed	1155 rpm
Power factor	
1/1 Load	0.73
3/4 Load	0.67
1/2 Load	0.55
Efficiency	
1/1 Load	87.0 %
3/4 Load	88.0 %
1/2 Load	87.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2015-02-04	

xylem
Let's Solve Water

NP 3153 LT 3~ 625

Performance curve

FLYGT

Pump

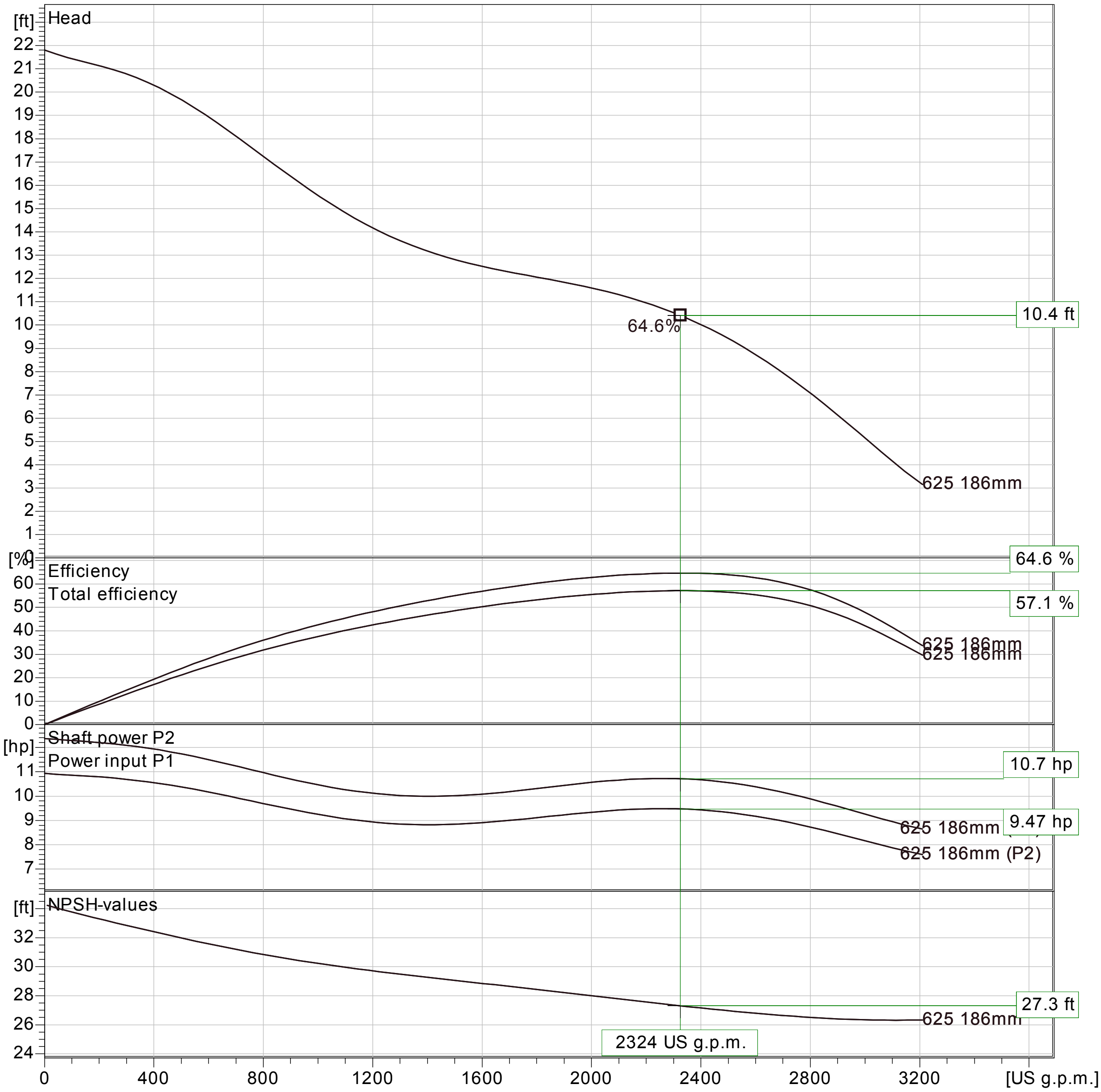
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	250 mm
Impeller diameter	7 5/16"
Number of blades	3

Motor

Motor #	N3153.095 21-18-6AA-W 15hp
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	15 hp
Rated current	22 A
Starting current	101 A
Rated speed	1155 rpm

Power factor	
1/1 Load	0.73
3/4 Load	0.67
1/2 Load	0.55

Efficiency	
1/1 Load	87.0 %
3/4 Load	88.0 %
1/2 Load	87.5 %



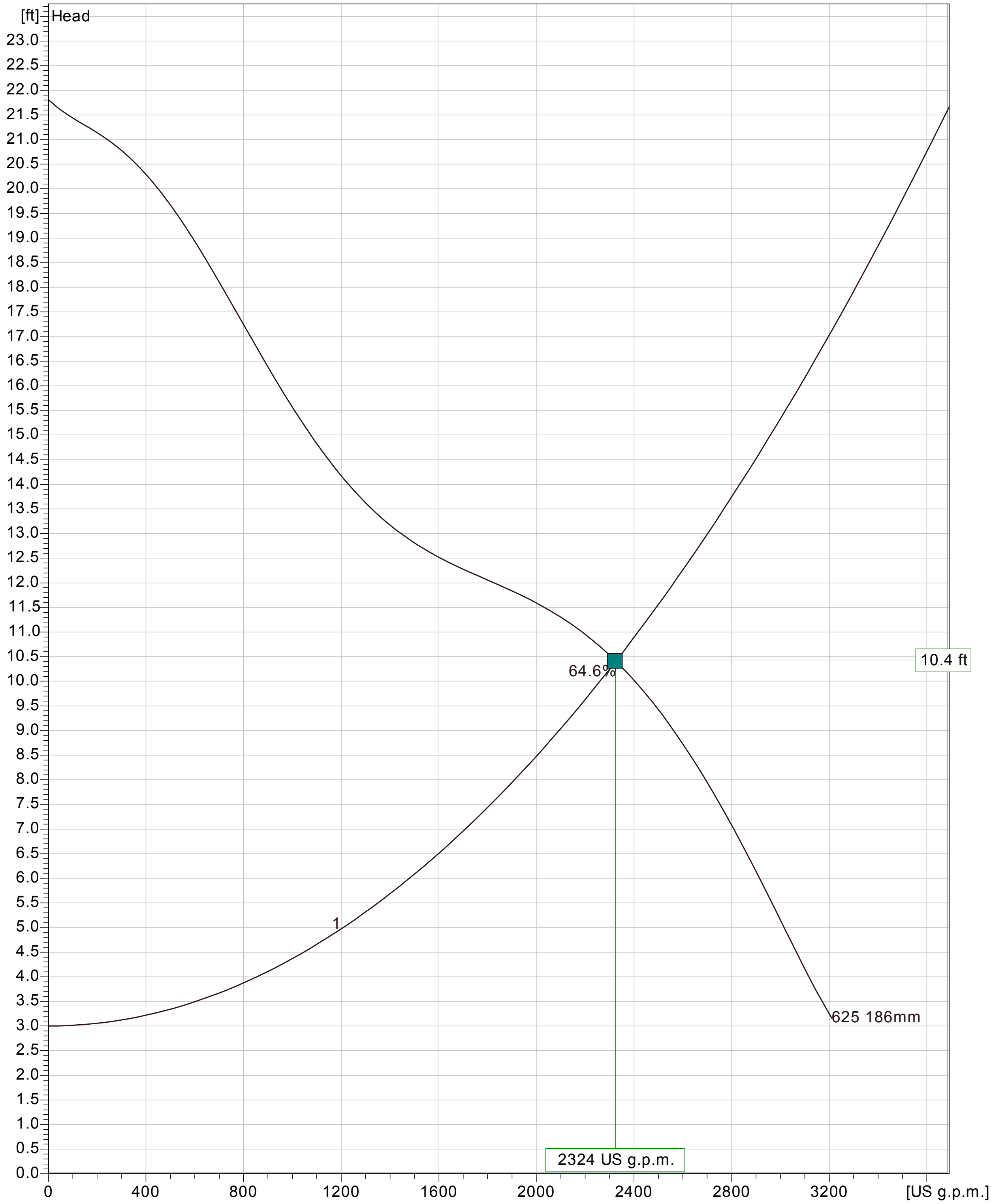
Water, pure

Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2015-02-04	

NP 3153 LT 3~ 625

Duty Analysis



Water, pure

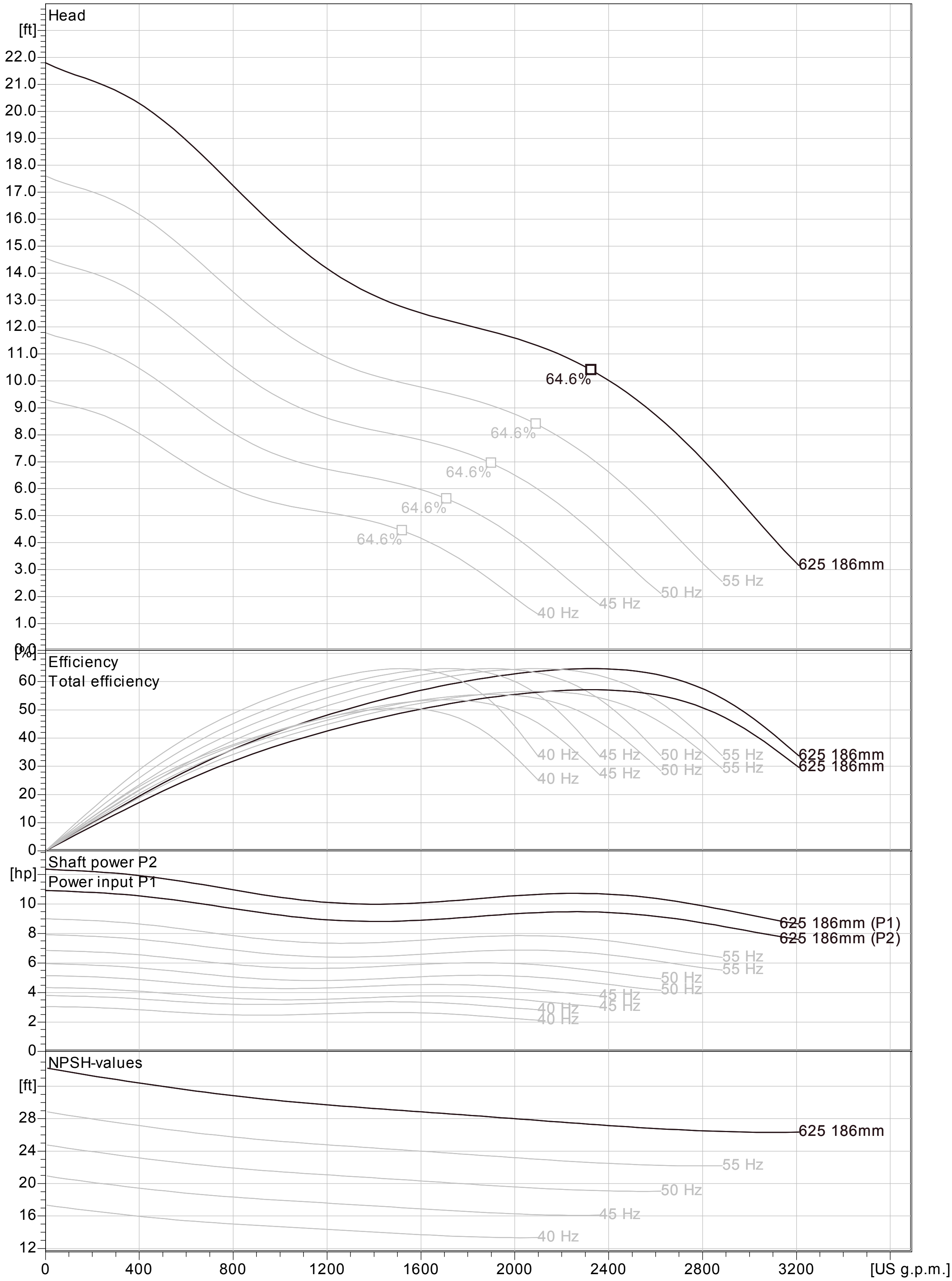
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump			Total					
Pumps running /System	**Flow**	**Head**	**Shaft power**	**Flow**	**Head**	**Shaft power**	**Pump eff.**	**Specific energy**	**NPSHre**
1	2320 US g.p.m.	10.4 ft	9.47 hp	2320 US g.p.m.	10.4 ft	9.47 hp	64.6 %	57.3 kWh/US MG	27.3 ft

Project	Project ID	Created by	Created on	Last update
			2015-02-04	

NP 3153 LT 3~ 625

VFD Curve



Water, pure

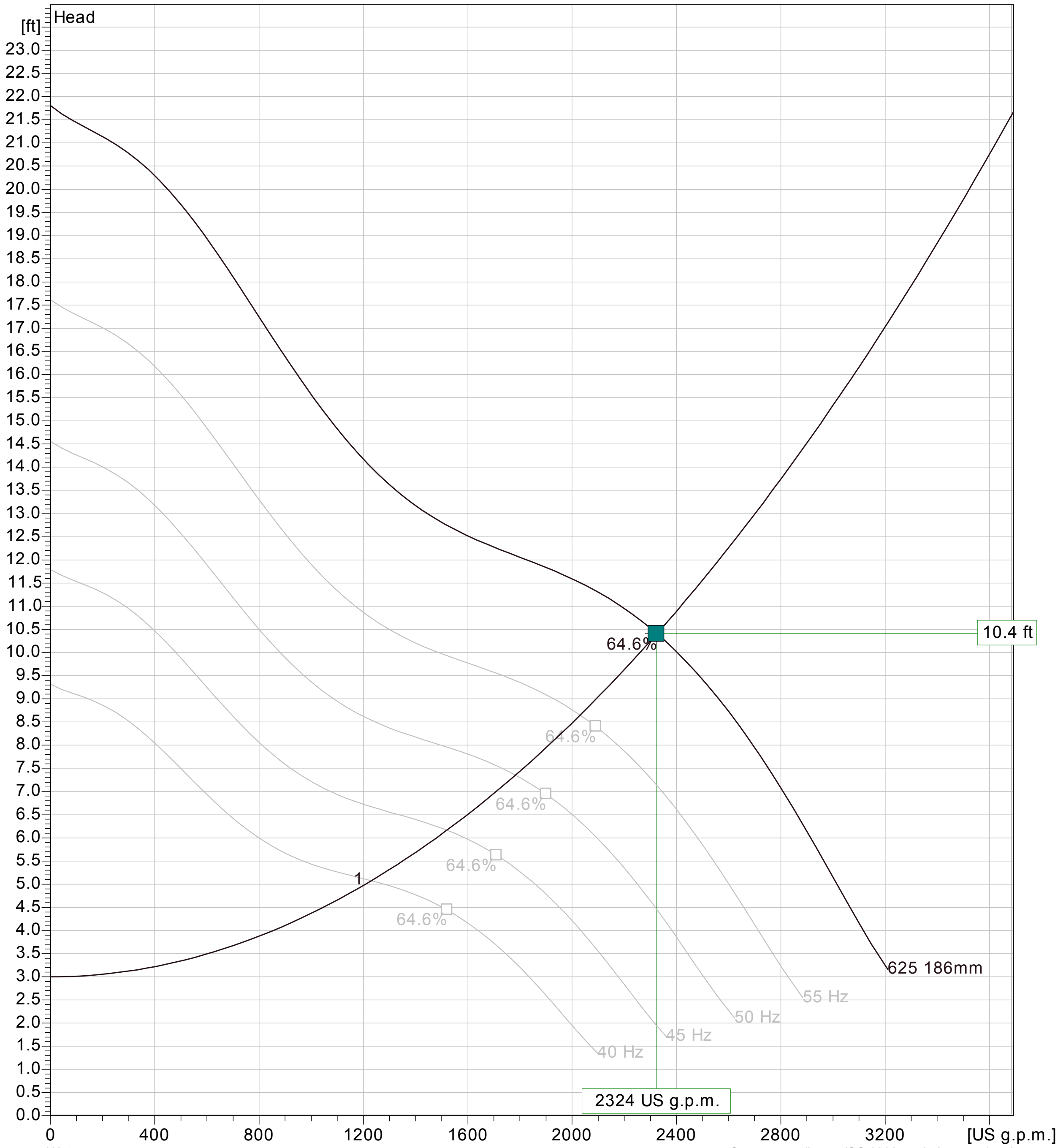
Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2015-02-04	

xylem
Let's Solve Water

NP 3153 LT 3~ 625

VFD Analysis

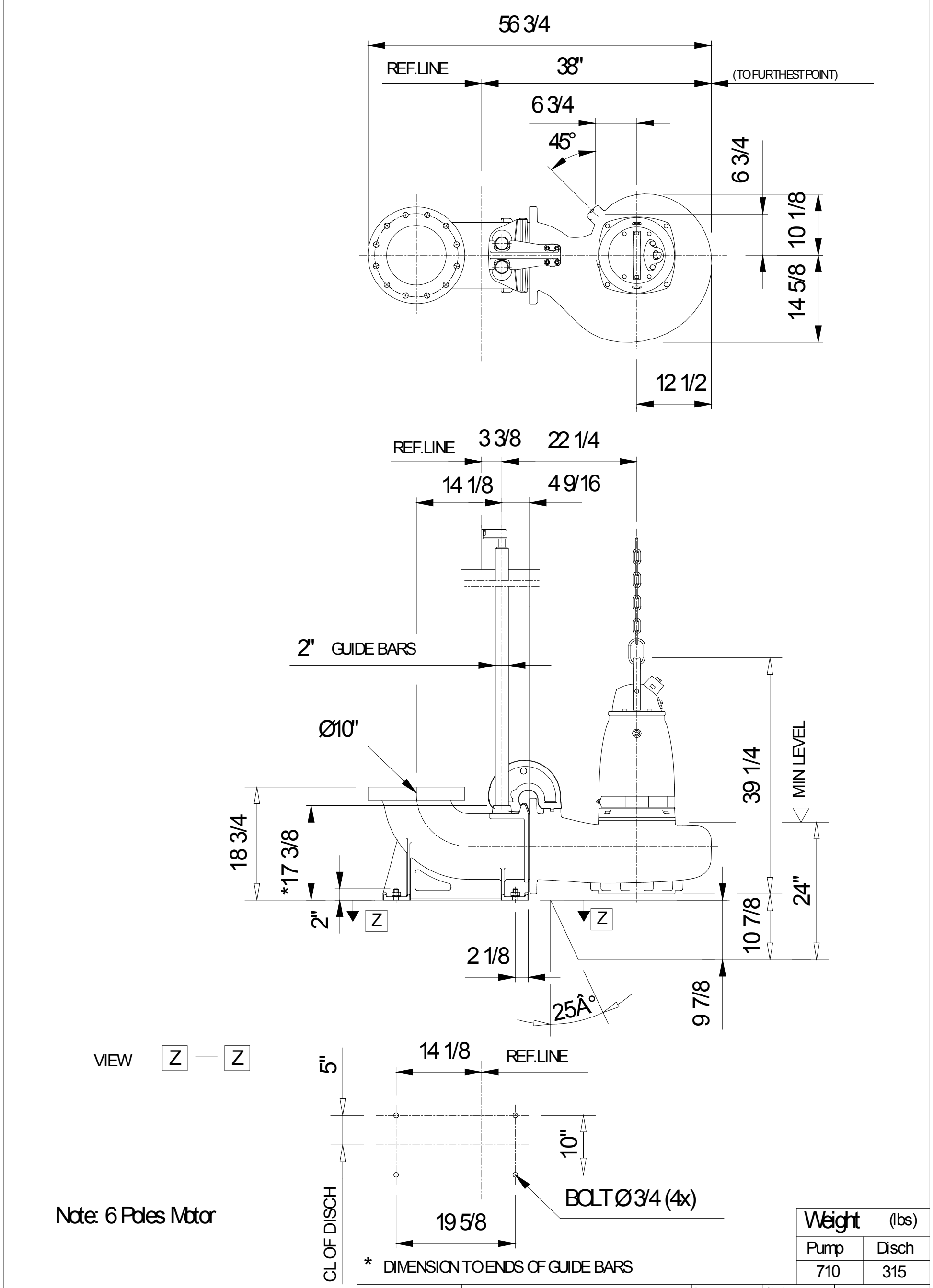


Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Pumps running /System	Individual pump: Frequency	Flow	Head	Shaft power	Total: Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	2320 US g.p.m.	10.4 ft	9.47 hp	2320 US g.p.m.	10.4 ft	9.47 hp	64.6 %	57.3 kWh/US MG	27.3 ft
1	55 Hz	2030 US g.p.m.	8.65 ft	6.88 hp	2030 US g.p.m.	8.65 ft	6.88 hp	64.5 %	48.1 kWh/US MG	23.1 ft
1	50 Hz	1780 US g.p.m.	7.35 ft	5.16 hp	1780 US g.p.m.	7.35 ft	5.16 hp	64.2 %	41.9 kWh/US MG	20 ft
1	45 Hz	1520 US g.p.m.	6.16 ft	3.74 hp	1520 US g.p.m.	6.16 ft	3.74 hp	63.4 %	36.9 kWh/US MG	17 ft
1	40 Hz	1230 US g.p.m.	5.07 ft	2.57 hp	1230 US g.p.m.	5.07 ft	2.57 hp	61.4 %	33.3 kWh/US MG	14.3 ft

NP 3153 LT 3~ 625

Dimensional drawing



Weight	(lbs)
Pump	Disch
710	315

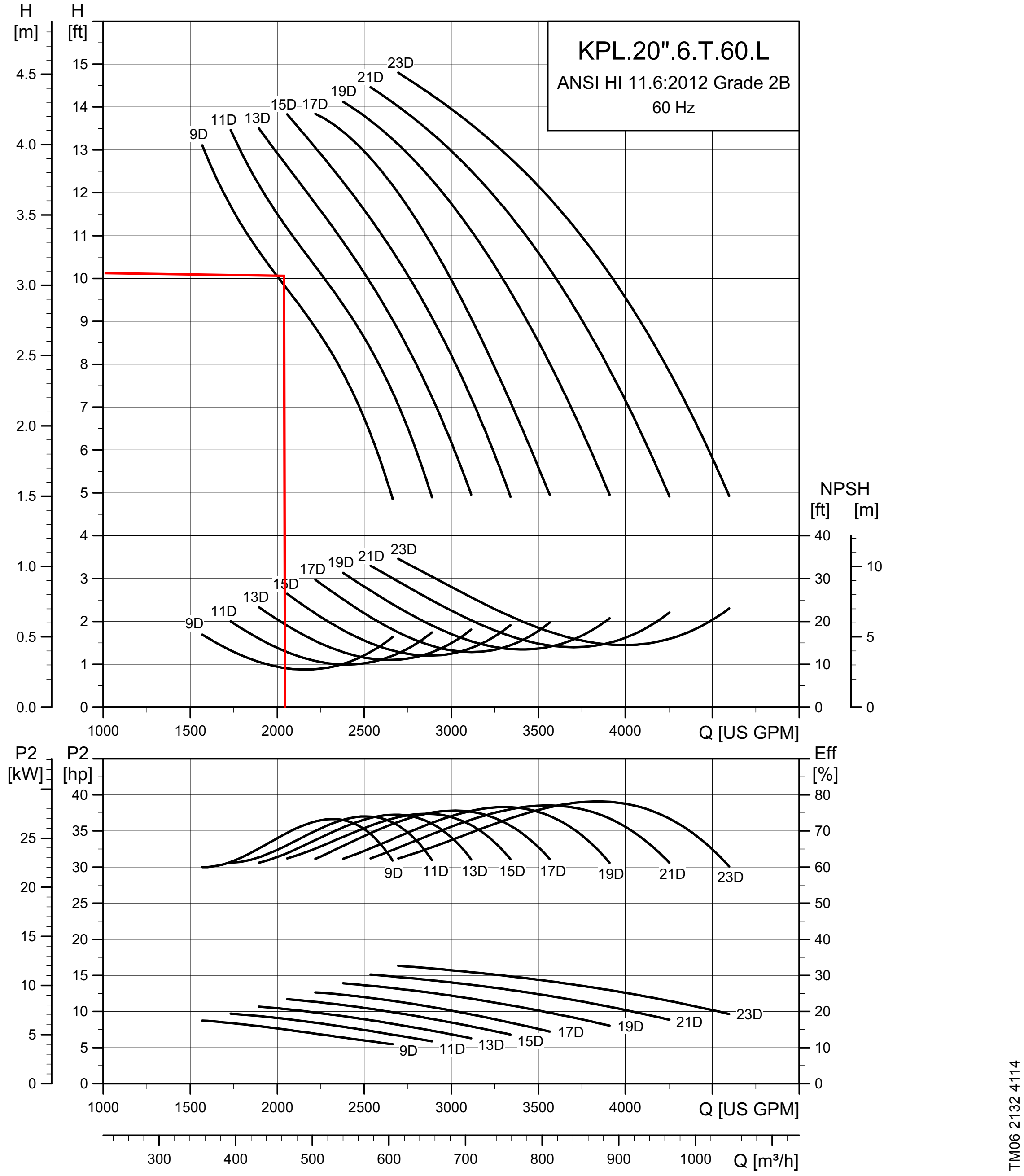
AUTOCAD DRAWING	Denomination: Dimensional drwg NP 3153 LT Ø10", 6-poles	Drawn by NK	Checked by SB	Date 081013
		Scale		Reg no 5399
		6605300		9

Project	Project ID	Created by	Created on	Last update
			2015-02-04	

Axial Flow Pump Data Sheets

9. Curve charts

KPL.20".---.6.T.60.L



Angle	9	11	13	15	17	19	21	23
Free passage [in. (mm)]	1.4 (35)	1.6 (40)	1.8 (45)	1.9 (48)	2.0 (50)	2.2 (55)	2.4 (60)	2.6 (66)

Model	Motor [Hp]	Frequency [Hz]	Rated speed [rpm]	No. of poles	Tube size [in. (mm)]	Propeller diameter [in. (mm)]	No. of blades
KPL.20".15.6.T.60.L	15	60	1165	6	20 (508)	11 (280)	4
KPL.20".20.6.T.60.L	20						

10. Technical data

Dimensions

KPL

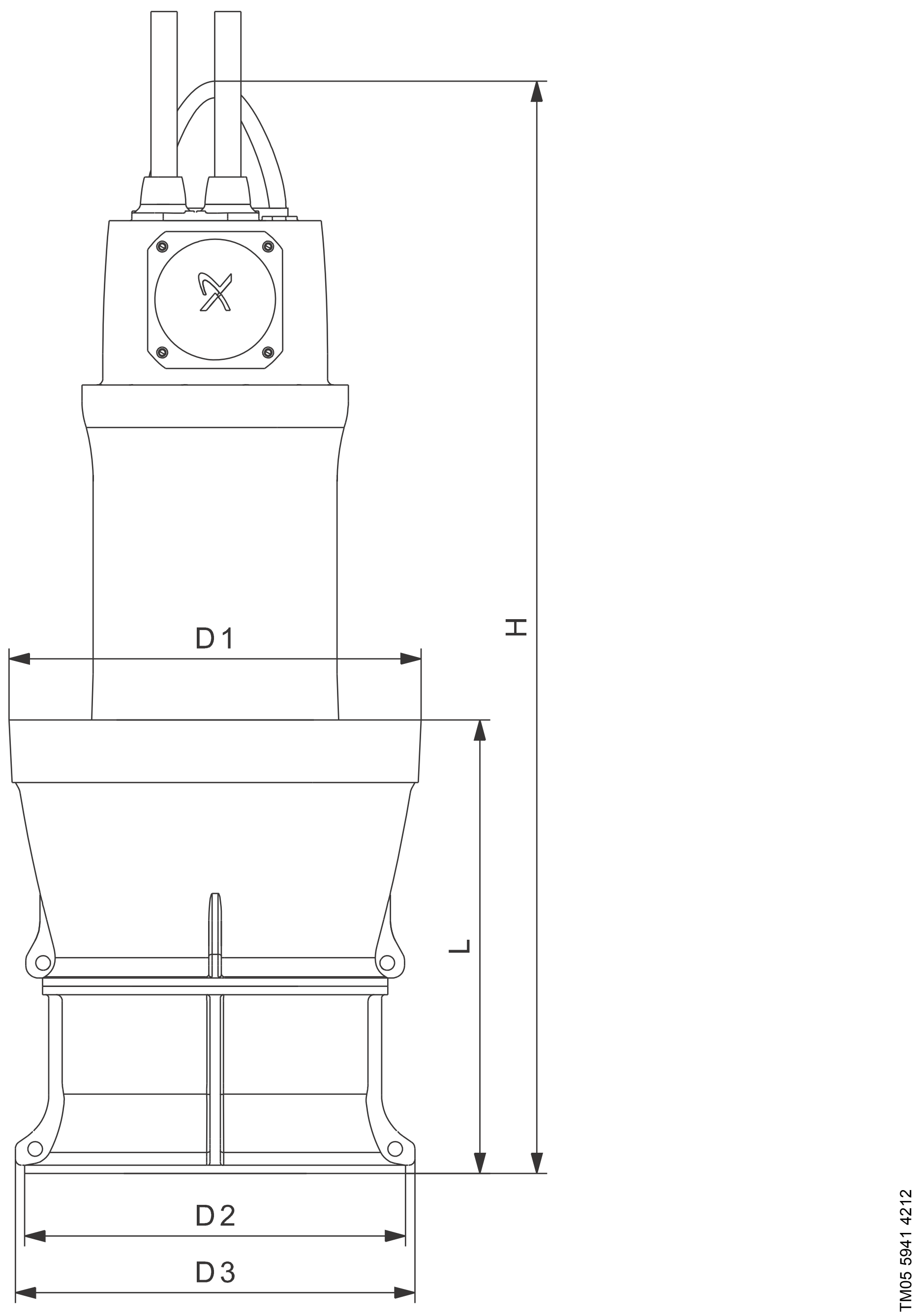


Fig. 12 Dimensional sketch, KPL

Pump type	Weight [lb (kg)]	H [in. (mm)]	L [in. (mm)]	D1 [in. (mm)]	D2 [in. (mm)]	D3 [in. (mm)]
KPL.20".15.6.T.60.L	727 (330)	44 (1118)	20.25 (515)	19.29 (490)	15.35 (390)	16.94 (430)
KPL.20".20.6.T.60.L	815 (370)	44 (1118)				
KPL.24".20.8.T.60.L	1124 (510)	56 (1423)	25.82 (655)	23.22 (590)	20.47 (520)	22.07 (560)
KPL.24".25.8.T.60.L	1146 (520)	56 (1423)				
KPL.28".50.8.T.60.L	1829 (830)	74 (1880)	27.57 (700)	27.16 (690)	24.41 (620)	25.97 (660)
KPL.28".60.8.T.60.L	1895 (860)	74 (1880)				
KPL.28".75.8.T.60.L	2028 (920)	81 (2058)				
KPL.28".100.8.T.60.L	2138 (970)	81 (2058)				
KPL.28".30.10.T.60.L	1653 (750)	71 (1804)				
KPL.28".40.10.T.60.L	1719 (780)	71 (1804)				
KPL.28".50.10.T.60.L	2028 (920)	81 (2058)				
KPL.32".100.8.T.60.L	2403 (1090)	88 (2236)	36.44 (925)	31.10 (790)	28.35 (720)	29.91 (760)
KPL.32".120.8.T.60.L	2601 (1180)	88 (2236)				
KPL.36".150.8.T.60.L	4739 (2150)	101 (2566)	37.38 (950)	35.04 (890)	32.29 (820)	33.85 (860)
KPL.36".175.8.T.61.L	5224 (2370)	102 (2591)				
KPL.36".215.8.T.62.L	5313 (2410)	108 (2744)				
KPL.36".60.10.T.60.L	4166 (1890)	101 (2566)				
KPL.36".75.10.T.60.L	4365 (1980)	101 (2566)				
KPL.36".100.10.T.60.L	4563 (2070)	101 (2566)				
KPL.36".120.10.T.60.L	4761 (2160)	101 (2566)				
KPL.40".175.10.T.60.L	5930 (2690)	113 (2871)	44.13 (1121)	38.97 (990)	35.82 (910)	37.79 (960)
KPL.40".215.10.T.60.L	6591 (2990)	118 (2998)				
KPL.40".265.10.T.60.L	7098 (3220)	118 (2998)				
KPL.40".335.10.T.60.L	7495 (3400)	118 (2998)				
KPL.40".120.12.T.60.L	5754 (2610)	113 (2871)				
KPL.40".175.12.T.60.L	5930 (2690)	113 (2871)				
KPL.40".215.12.T.60.L	7187 (3260)	118 (2998)				
KPL.48".215.14.T.60.L	9303 (4220)	132 (3353)	52.57 (1336)	46.85 (1190)	43.32 (1100)	45.66 (1160)
KPL.48".265.14.T.60.L	9303 (4220)	132 (3353)				
KPL.48".335.14.T.60.L	10890 (4940)	134 (3404)				
KPL.56".335.14.T.60.L	12235 (5550)	141 (3582)	59.82 (1520)	54.72 (1390)	50.79 (1290)	53.54 (1360)
KPL.56".400.14.T.60.L	12500 (5670)	140 (3556)				
KPL.56".500.14.T.60.L	13690 (6210)	149 (3785)				
KPL.56".600.14.T.60.L	14087 (6390)	149 (3785)				
KPL.56".215.16.T.60.L	12103 (5490)	140 (3556)				
KPL.56".265.16.T.60.L	12500 (5670)	140 (3556)				
KPL.56".335.16.T.60.L	13095 (5940)	149 (3785)				
KPL.56".400.16.T.60.L	14087 (6390)	149 (3785)				
KPL.60".500.14.T.60.L	14925 (6770)	156 (3963)	66.13 (1680)	58.66 (1490)	55.13 (1400)	57.47 (1460)
KPL.60".600.14.T.60.L	15322 (6950)	156 (3963)				
KPL.60".665.14.T.60.L	17659 (8010)	160 (4064)				
KPL.60".730.14.T.60.L	18055 (8190)	160 (4064)				
KPL.60".800.14.T.60.L	18254 (8280)	160 (4064)				
KPL.64".400.16.T.60.L	15917 (7220)	158 (4014)	69.69 (1771)	62.22 (1580)	59.07 (1500)	61.41 (1560)
KPL.64".465.16.T.60.L	18055 (8190)	162 (4115)				
KPL.64".535.16.T.60.L	18651 (8460)	162 (4115)				
KPL.64".600.16.T.60.L	19268 (8740)	168 (4268)				
KPL.64".665.16.T.60.L	20458 (9280)	168 (4268)				
KPL.72".665.18.T.60.L	21737 (9860)	171 (4348)	76.00 (1931)	70.10 (1780)	66.94 (1700)	69.29 (1760)
KPL.72".730.18.T.60.L	23523 (10670)	171 (4348)				
KPL.72".800.18.T.60.L	24515 (11120)	171 (4348)				
KPL.72".930.18.T.60.L	26543 (12040)	171 (4348)				
KPL.72".1060.18.T.60.L	27138 (12310)	171 (4348)				

Installation dimensions

KPL

The requirements for installation are shown in the table below. See installation examples, fig. 14 through 17.

⌀D [in. (mm)]	C [in. (mm)]	S [in. (mm)]	M.W.L* [in. (mm)]
20 (508)	10 (254)	30-47 (750-1200)	39-57 (1000-1450)
24 (610)	12 (305)	43-55 (1100-1400)	55-67 (1400-1700)
28 (712)	14 (356)	51-69 (1300-1750)	65-83 (1650-2100)
32 (813)	16 (407)	55-83 (1400-2100)	71-98 (1800-2500)
36 (915)	18 (458)	59-100 (1500-2550)	77-118 (1950-3000)
40 (1016)	20 (508)	65-110 (1650-2800)	85-130 (2150-3300)
48 (1220)	24 (610)	79-134 (2000-3400)	102-157 (2600-4000)
56 (1423)	28 (712)	91-150 (2300-3800)	118-177 (3000-4500)
60 (1524)	30 (762)	96-159 (2450-4050)	126-189 (3200-4800)
64 (1626)	31 (788)	118-165 (3000-4200)	150-197 (3800-5000)
72 (1829)	35 (889)	157-181 (4000-4600)	193-217 (4900-5500)

* Minimum water level

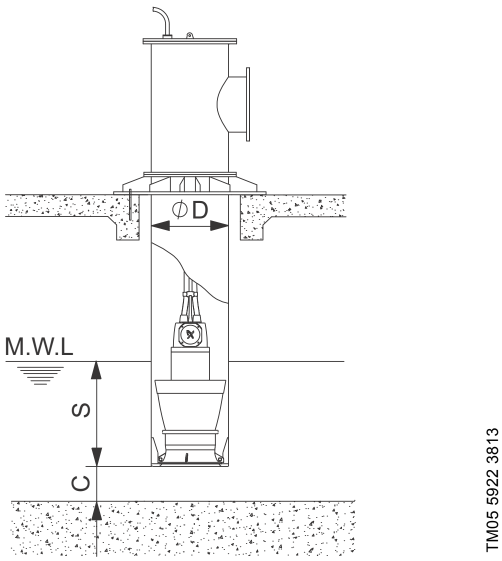


Fig. 14 Minimum water level, KPL pump

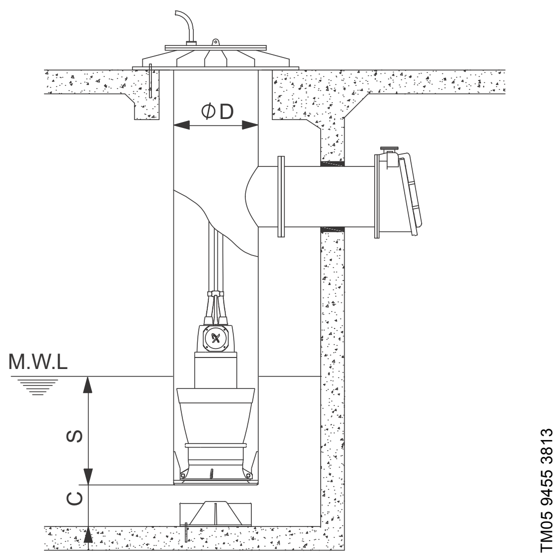
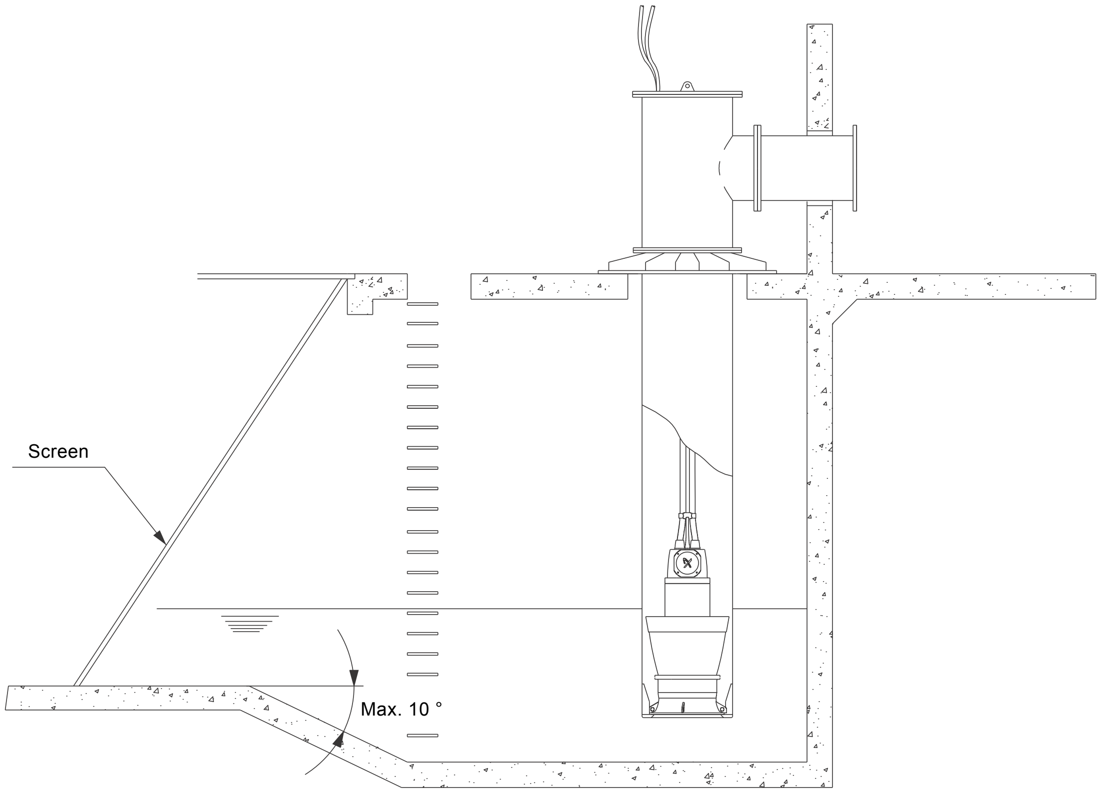
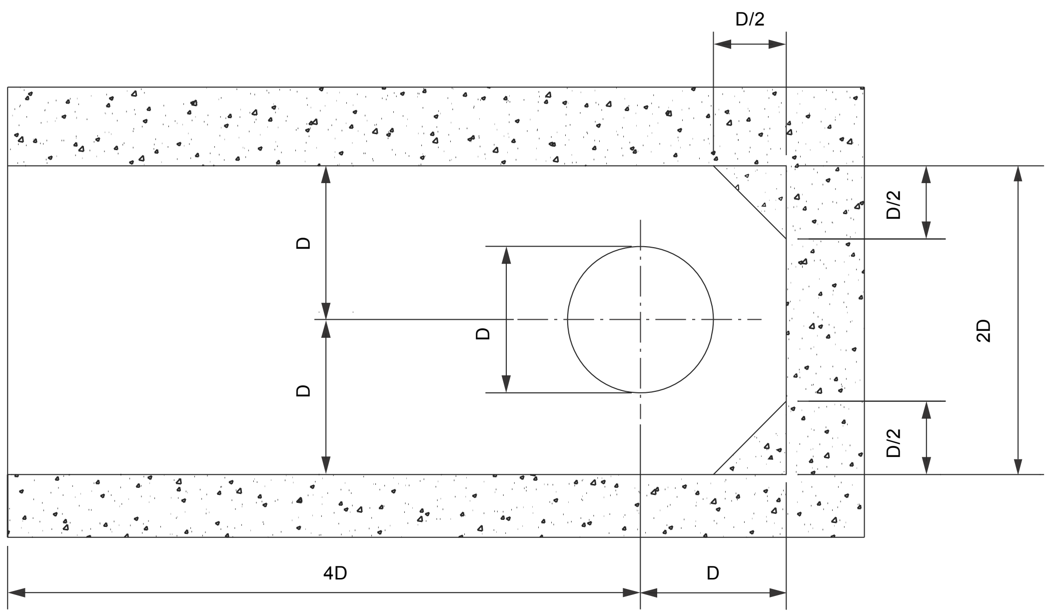


Fig. 15 Installation dimensions, KPL pump, ACC installed

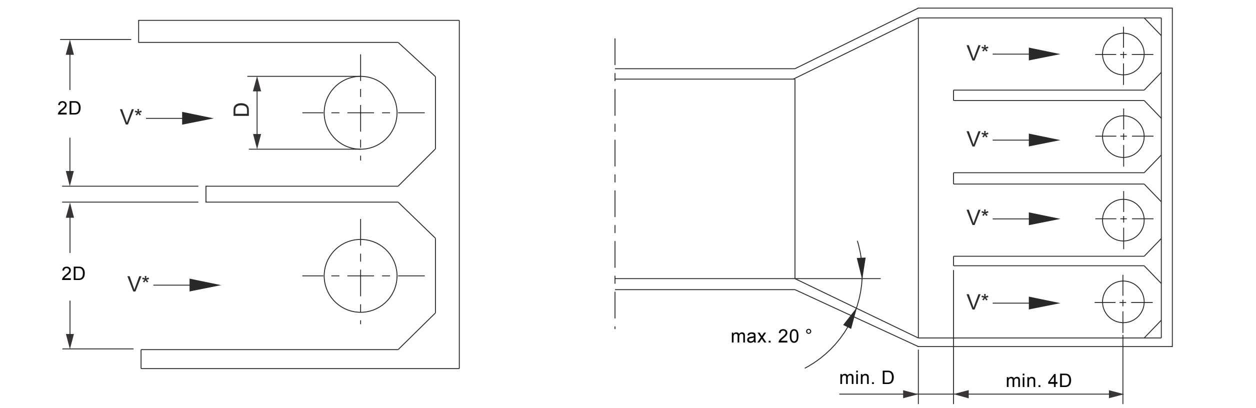
Pit construction

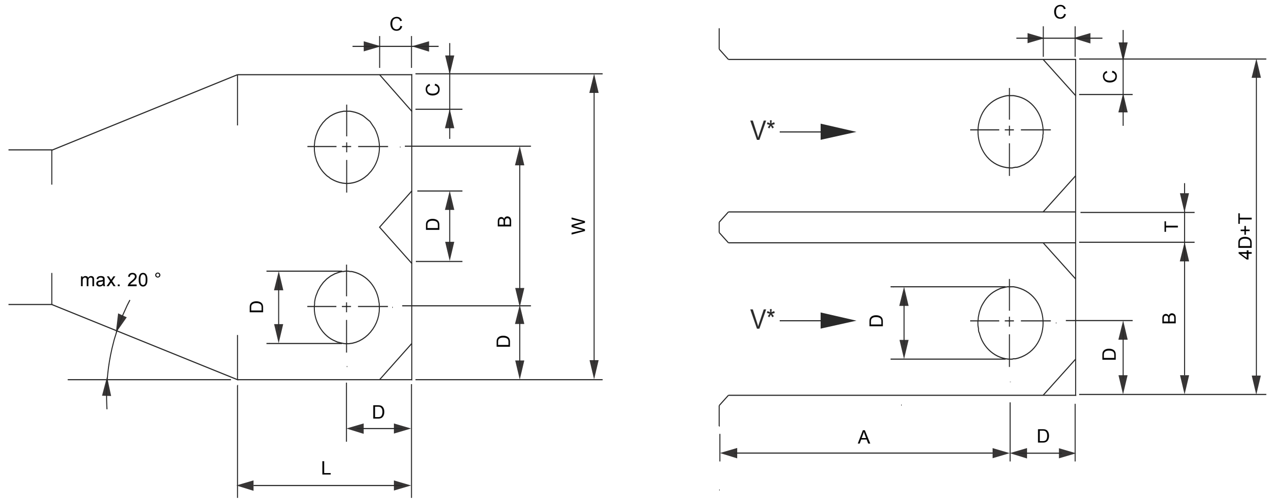


TM03 9470 4007



TM03 9471 4212





V*: 2.3 ft/sec (0.7 m/sec) for stormwater and wastewater containing particles.
1.0 ft/sec (0.3 m/sec) for screened stormwater and wastewater without particles.

Dimensions

D (pipe dia. ANSI) [in. (mm)]	A [in. (mm)]	B [in. (mm)]	C [in. (mm)]	W [in. (mm)]	T	L [in. (mm)]
20 (508)	79 (2000)	39 (1000)	10 (250)	79 (2000)	Depending on construction	79 (2000)
24 (610)	94 (2400)	47 (1200)	12 (300)	94 (2400)		94 (2400)
28 (712)	110 (2800)	55 (1400)	14 (325)	110 (2800)		110 (2800)
32 (813)	126 (3200)	63 (1600)	16 (400)	126 (3200)		126 (3200)
36 (915)	142 (3600)	71 (3800)	18 (450)	142 (3600)		142 (3600)
40 (1016)	157 (4000)	79 (2000)	20 (500)	157 (4000)		157 (4000)
44 (1118)	173 (4400)	87 (2200)	22 (550)	173 (4400)		173 (4400)
48 (1220)	189 (4800)	94 (2400)	24 (600)	189 (4800)		189 (4800)
56 (1423)	220 (5600)	110 (2800)	28 (700)	220 (5600)		220 (5600)
60 (1524)	236 (6000)	118 (3000)	30 (750)	236 (6000)		236 (6000)
64 (1626)	252 (6400)	126 (3200)	31 (800)	252 (6400)		252 (6400)
72 (1829)	283 (7200)	142 (3600)	35 (900)	283 (7200)		283 (7200)

Installation type

This section gives an overview of installation types.

The installation types shown in this section are only examples. For more information on suitable installation types, contact Grundfos.

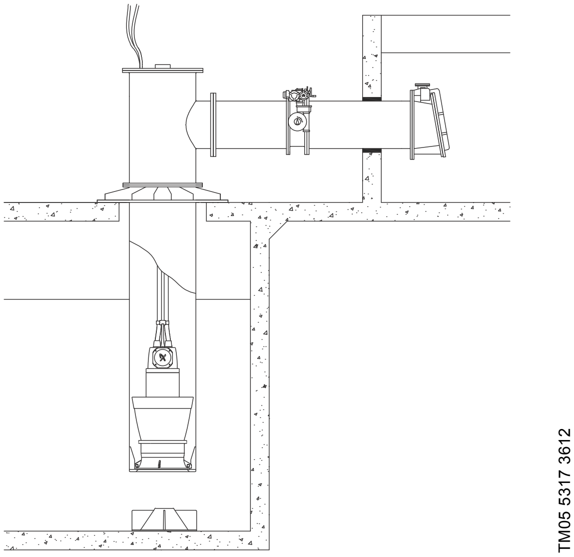


Fig. 28 Discharge above floor and with discharge pipe valve, non-return valve and ACC

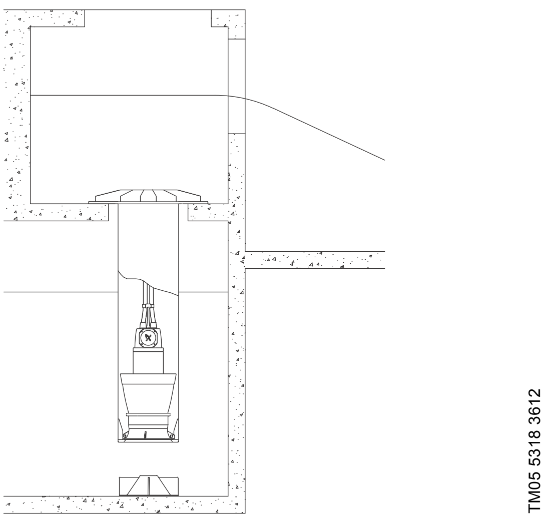


Fig. 29 Discharge above floor and with discharge pipe and ACC

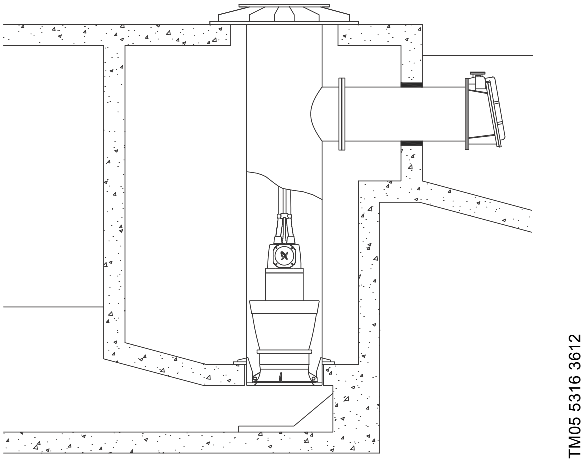


Fig. 30 Discharge above floor for low suction water levels and formed suction intake (FSI)

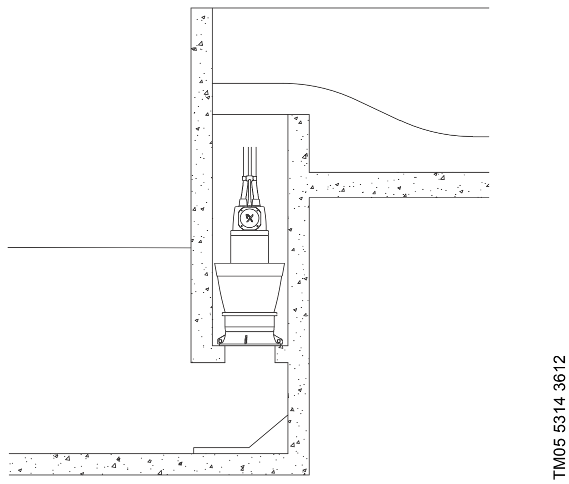


Fig. 31 Discharge above floor and with concrete column and channel