Predesign Report

City of Port Townsend – Mill Road Pump Station and Force Main

Prepared for

City of Port Townsend Department of Public Works

September, 2012

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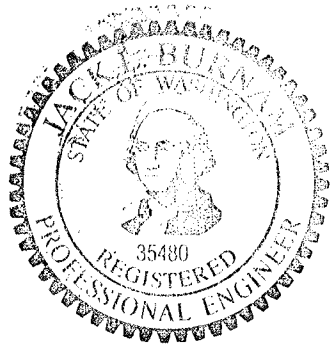
CERTIFICATION PAGE

CITY OF PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCE MAIN

CITY OF PORT TOWNSEND DEPARTMENT OF PUBLIC WORKS

The engineering material and data contained in this Predesign Report were prepared under the supervision and direction of the undersigned, whose seal as registered professional engineer is affixed below.



CH2M HILL

Jack Burnam, P.E. Project Manager

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Date of Issue

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Acronyms and Abbreviations

Cfs	cubic feet per second
Ft	feet
Fps	feet per second
Gpd	gallons per day
Gpm	gallons per minute
Hp	horsepower
Hrs	hours
Mgd	million gallons per day
MH	maintenance hole
Min	minutes
Rpm	revolutions per minute

1. Introduction

The intent of this Predesign Report is to further define the pump station identified as Alternative 7 in the December 2009 *Southwest Sewer Basin Study (Basin Study),* by Gray & Osborne, Inc. The Basin Study evaluated the City's sewer basins and presented a series of alternatives for future development within and adjacent to the existing City limits. The data presented in the Basin Study was used to develop a peak hourly flow rate to use in development of the predesign of the new Mill Road Pump Station.

It should be noted that the intent of the Mill Road Pump Station is to collect domestic sewage from Basins 1, 2 and 3 (as identified in the Basin Study) through the use of a yet to be constructed gravity collection system consisting of 8 inch through 12 inch gravity mains. The collected sewage would then be lifted (pumped) approximately 200 (vertical) feet using a new force main to the existing gravity system serving the southwest portion of the City. The following material is presented and discussed in this Predesign Report:

1. Evaluation of anticipated influent flow (Section 2).
2. Backbone Gravity Collection System Alignment (Section 3)
3. New Pump Station design criteria (Section 4), including:
    a. The pump station (physical) structure.
    b. Mechanical components
    c. Electrical Components
    d. Control System
4. Force Main Sizing and Alignment (Section 5), including:
    a. Force Main Sizing
    b. Force Main Alignment
5. Cost Estimate(Section 6)
6. Summary and Recommendations (Section 7)

2. Influent Flow

The Basin Study had previously established an anticipated peak hourly influent flow (at build out) of 1,185 gpm. CH2M HILL reviewed the hydraulic modeling data from the City of Port Townsend's (City's) wastewater collection system as presented in the Basin Study. The summary evaluation Technical Memorandum entitled *City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review*, February, 2012 is included herein as Appendix A and summarized in the following.

As shown in Table 1 the anticipated peak hourly loading based on the results of the Basin Study was compared to that developed using the Washington State Department of Ecology *Criteria for Sewage Works Design* (October, 2006, commonly called the Orange Book).

The peak hourly flow will be used for sizing and design of the Mill Road Pump Station. As shown in Table 1 (above) the comparison of the various calculation methods to determine the peak hourly flow for design results in a difference of only plus 6 gpm or minus 126 gpm (from less than 0.5% to roughly 10% on the minus side). Based on these results it was decided to utilize the Basin Study anticipated flow of 1,185 gpm for the predesign of the new pump station and force main.

The peak hourly flow above represents the ultimate flow for the pump station or the peak hourly flow it is expected to experience in year 2046. The near term flows will actually be significantly lower than this until the area becomes more developed and each of the 3 basins are connected to the pump station. Because of this variation, the pump station shall be designed to accommodate a wide range of flows.

TABLE 1
Calculated Influent Wastewater Loading at Build Out

Influent Flow	Row	Basin Study Calculation	Orange Book Calculation
Average Dry Weather Flow (gpd)	(1)	588,400	588,400
Peak Day Flow (gpd)	(2)	1,008,600	1,008,600
Calculated Peak Day to Average Day Peaking Factor	(3) = (2)/(1)	1.71	NA[1]
Peak Hour to Peak Day Factor	(4)	1.70	NA[1]
Calculated Peak Hour to Average Day Factor	(5) = (4) x (3)	2.91	2.59[2]
Peak Hour Flow (gpd)	(6) = (1) x (5)	1,714,620	1,524,935
Calculated Peak Hourly Flow (gpm)	(7) = (6)/1440 min/day	1,191	1,059

[1] Not applicable for this comparison. Only comparing the Peak Hour to Average Day Factor (Row (5))

[2] Calculation of Peak Hour to Average Day Factor from the Orange Book = $(18 + \sqrt{23,000})/4+\sqrt{23,000})$, where 23,000 is the population in 2046.

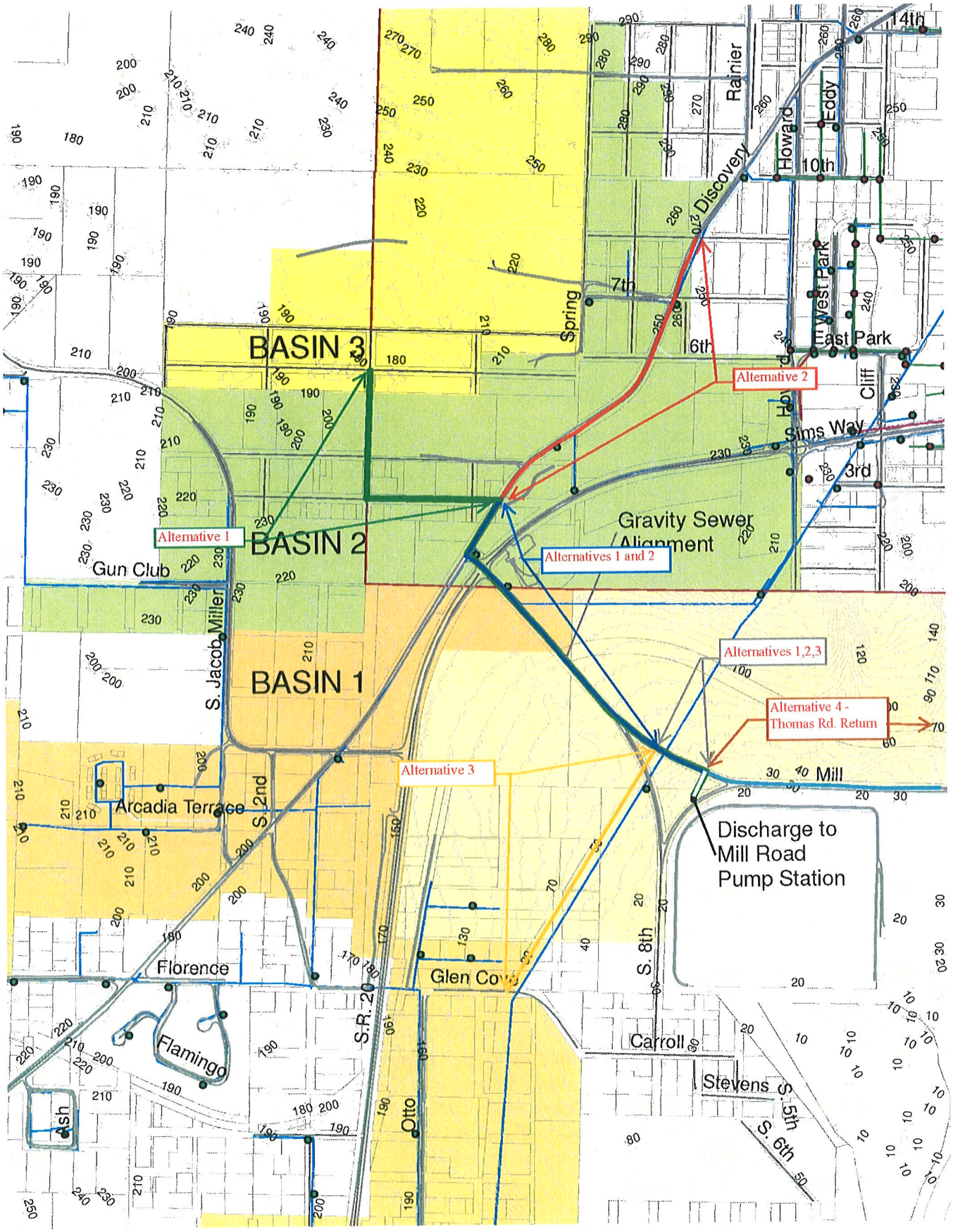
The following section describes the gravity system that will be needed to provide flow to the Mill Road Pump Station. The different alternatives are presented to give the City options when deciding which basin areas to connect first. These gravity lines (or a portion of them) will need to be constructed and individual users connected to this system before the Mill Road Pump Station can become operational.

3. Gravity Collection Mains

Transporting wastewater flows from Basins 1, 2, and 3 to the new Mill Road Pump Station requires the installation of a backbone collection main system. The backbone system described herein will just deliver flow from the individual basin areas to the new pump station. This backbone system **does not** include the required collection system within each basin to connect to the backbone line. The backbone collection system can be divided into four different alternatives, however, it should be realized that several alternatives may have to be installed (combined) to actually reach from the Basin indicated to the new pump station. The alternatives are shown graphically in Figure 1 and described in Table 2 (below).

It is very important to note here that the designation of the new backbone gravity line alignments and diameters are based on a cursory examination of Lidar survey elevations and resultant slopes. It is also important to note that road slopes on both Mill Road and Thomas Street have steep sections approaching 12 percent. In these sections installing the new gravity mains following the street profiles will result in flows running at supercritical velocities. It will be necessary to carefully design these reaches of sewer mains to eliminate (if possible) the supercritical flow reaches. Hydraulic jumps in the flow regime occur when flows transition from supercritical to subcritical velocities (the hydraulic jump dissipates the excess energy created in the supercritical flow). This jump can cause damage to the MHs as well as the immediately adjacent influent and effluent piping. In addition, the turbulence created by the hydraulic jump can release sulfides naturally occurring in sewage that can combine with the water and oxygen to form sulfide gasses (the rotten egg smell) or sulfuric acid which besides resulting in odor complaints could also affect the longevity of the pipe and MH at that location. The installation of new gravity sewers through such reaches is commonly accomplished by "stepping" the new sewer from MH to MH with either inside or outside drops at the downstream MH. This allows the gravity line to be installed at lesser slopes

Figure 1
Gravity Sewer Alignment



(avoiding supercritical flow velocities). By "stepping" the installation a balance between the required depth of the new gravity sewer to eliminate steep slopes and the cost of installation is also achieved.

TABLE 2
Gravity Collection Main Alternatives

Alternative	Description	Diameter (in)	Length (ft)
1	Allows flow collected in Basin 3 to extend south and east to a common collection point on Discovery Road.	8	1,690
2	Extends from the intersection of Discovery Road and 8th Street to the southwest to an intersection with Alternative 1 on Discovery Road.	8	2,200
Common Alternative 1,2	Extends from the common collection point on Discovery Road southwest to a cross over intersection with Mill Road, then southeast down Mill Road to an intersection with Alternative 3 (described below).	10	2,520
3	Extends from an unimproved road easement north from Glen Cove Road to a power line easement; then north and east in the power line easement (paralleling an existing water line) to a connection on Mill Road with Common Alternative 1,2.	8	1,870
Common Alternative 1,2,3	Extends east on Mill Road to the junction with Alternative 4 (below).	12	187
4	Parallels the new force main from the pump station – allows the City to pick up existing lots below (south) of the connection point of the new force main into the City's gravity collection system. This gravity line would begin on the lower reaches of Thomas Street and proceed south to Mill Road and then east on Mill Road to the connection with Common Alternative 1,2,3 and into the new pump station.	8	3,500

Anticipated gravity line diameters are based on assumed flows. The information contained herein is for planning level purposes only. A more detailed design survey would be required to confirm actual slopes, lengths and diameters of this gravity collection backbone system.

4. Pump Station Design Criteria

The design of the new pump station has to take into account the near term and long term uses that it will likely experience. In the near term, influent flows are not expected to be at or near the anticipated build out flows of 1,185 gpm. Accepted life span estimates for structures are commonly in the 50 to 100 year range assuming that standard operation and maintenance practices are performed. Accepted life span estimates for electrical equipment (pumps, controls, power, etc.) are in the 15 to 25 year span again assuming standard operation and maintenance practices.

There are three generic types of pump stations, each based on the type of pumps used to convey the flow from the station to its destination. These are:

1. Wet Pit/Dry Pit pump stations – these have a standalone wet well with a suction pipe extending from the wet well to the dry pit where the pumps are located at the same elevation as the wet well. These pump stations can come as a package however, when this does occur they are very tight quartered. This type of pump station is more expensive to design and construct. It is commonly considered for pump stations that would exceed 3 mgd (2,083 gpm). This is when the installation of the additional structures for separate or contiguous wet wells and dry pump pits can become more cost effective. This type of pump station will not be considered further herein.

2. Submersible pump stations – in this type of station the pumps actually sit down in the wet well. The footprint of the station is much reduced over wet pit/dry pit stations with an associated reduction in cost for design and construction. This is common for pump stations that are to accommodate influent flows of 3 mgd (2,083 gpm) or less.
3. Suction Lift pump stations – similar to the submersible pump station described above, but have the suction lift pumps sitting on top of the wet well out of the actual influent flow. Because of the additional components outside the wet well, this type of station is commonly more expensive than a submersible station due to the need for additional structures to protect the pumps, etc. from the elements but is still less expensive than the wet pit/dry pit pump stations. As above, this is also common for pump stations that are to accommodate influent flows of 3 mgd (2,083 gpm) or less.

4.1 Pump Station Structure

Current best practices for structures are to build the structure that is needed for the long term (up to build out) for the following reasons:

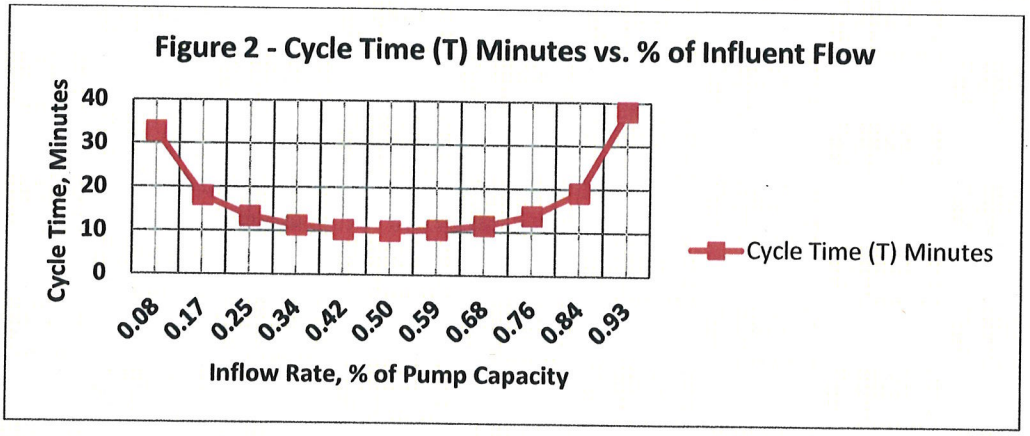
1. A properly constructed and maintained structure will last well past the anticipated planning horizon of 2046 (34 years into the future).
2. The construction of a wet well structure that would have to be expanded in the future is difficult and would require that the (then) existing structure be shut down to allow for the installation of additional storage.
3. This would require the excavation of the wet well which in this case is likely below the existing ground water level.
4. The new pump station is to be constructed on a limited site so the construction of an expansion to the existing wet well would likely also require the removal of much of the above grade equipment to make room for the construction. This would exacerbate the length of the shut down and would likely require additional property outside the station easement to stage and complete construction.
5. It should be recalled that at the time of the potential expansion, influent flows will have built up close to that of ultimate build out. Shutting down the station to accommodate the new construction on the structure would likely require the installation of a significant by-pass pumping operation so that those in the stations service area would not be adversely affected. The cost for a by-passing operation of this magnitude (approximately 1.7 mgd) can be as much as the cost for the excavation and installation of the additional wet well walls.
6. Any by-pass pumping operation increases the risk of a surface spill of raw wastewater. This can result in fines from controlling agencies as well as impact the public and businesses nearby the station.

For these reasons, the predesign is based on the construction of the physical features required to accommodate the ultimate build out influent flows.

4.1.1 Wet Well Sizing

Three criteria were used to determine the size of the required wet well:

1. Maintenance of an active storage volume that will require a single pump to go through one complete cycle from pump on to pump off and back to pump on in no less than 10 minutes (maintaining a maximum number of cycles to six (6) per hour). For a two pump redundant system this would mean that the number of cycles per hour would be twelve (2 X 6) per hour. Note that the worse case cycle time always occurs when influent flow is equal to one half (1/2) the pumping rate. This is shown graphically in Figure 2.



2. Providing a minimum of 60 minutes of storage between the high, high water alarm and the invert of the influent line to the station at anticipated build out influent flows of 1,185 gpm. Meeting this criterion while still allowing for the use of suction lift pumps (maximum lift of 17.5 feet) requires a wet well diameter of 45 feet. This allows for greater storage when the pump station is first brought on line and influent flows have not yet reached the peak hour rate anticipated at build out (1,185 gpm). The available storage times based on varying influent flows are shown in Table 3 (below).

TABLE 3
Wet Well Storage Times

Influent Flow (gpm)	Wet Well Diameter (ft)[1]	Storage Depth (ft)	Storage Time (min)	Storage Time (hrs)
200	45	5.98	355.5	5.93
400	45	5.98	177.8	2.96
600	45	5.98	118.5	1.98
800	45	5.98	88.9	1.48
1,000	45	5.98	71.1	1.19
1,185[2]	45	5.98	60.0	1.00

[1] The wet well diameter can vary while still maintaining the required 60 minutes of retention at peak hour flow by varying the storage depth. It should be noted that the depth of the wet well may be limited by the type of pump selected for use. Suction Lift pumps have a limit to the lift that they can accommodate.

[2] Peak Hour influent flows at build out (planning horizon)

3. For preliminary design purposes, set the wet well depth so that it will work for both submersible and suction lift pumps. Suction lift pumps will limit the depth of the wet well between pump volute and Pump Off elevation to approximately 17.5 feet. The diameter of the new wet well has to be balanced against the depth to insure that the required active storage volume is achieved. The other limit on this is the sensitivity of the controls for pump on and off – for the purposes of this preliminary design it was assumed that the minimum depth between pump on and pump off could be no less than six (6) inches. This allows for variations in instrument sensitivity and wet well diameter while still meeting the requirements for the use of suction lift pumps. A decision to use submersible pumps only would allow for a reduction in wet well diameter and deepening of the active storage volume.

It should be noted that accommodating influent flows that will be significantly less than those anticipated at build out will be accomplished through the control system and set levels on the pump operation. This is discussed further in the following.

4.2 Pump Station Mechanical Components

4.2.1 Pumps

As stated above, the use of a wet pit/dry pit pump station is not recommended for an application that is this far out in the service area and that experiences this type of low flow. Limiting the new pump station to a single wet well limits the types of pumps that may be used to either submersible pumps that are installed in the wet well or suction lift pumps that are installed on top of, or adjacent to, the wet well with suction piping that extends into the wet well. The advantages and disadvantages of submersible and suction lift pumps are presented in Table 4.

TABLE 4
Advantages and Disadvantages of Submersible and Suction Lift Pumps

Pump Type	Advantages	Disadvantages
Submersible Pumps	Smaller footprint than other pump types. Maintains surface construction to a minimum	Pulling pumps for maintenance or repairs is messy. Requires a wash down area at the wet well so that pumps can be cleaned off prior to loading on trucks, etc.
	Can accommodate deeper wet wells, suction lift limitations do not apply.	Requires the maintenance of a "dead" storage volume in the wet well that acts to cool the pump motors during operation
	Can accommodate a wide range of TDH and flow conditions.	Access to motors and impellers requires pulling the pumps from the wet well.
	Less costly because most mechanical equipment is below ground, does not require an above surface structure to house the equipment	Does require the wet well to have 2 to 3 feet of dead storage (depending on the pump) to act as cooling during pump operation.
	Simple Mechanical System	Pulling the pumps to perform maintenance operations will require a cleaning area.
Suction Lift Pumps	Motors, volutes, etc. are at ground surface and more accessible for operation and maintenance activities.	Requires more surface construction or installation of a package pump station on top of or adjacent to the wet well
	Pump wash down area is not required when taking pumps down for maintenance.	Limits depth of the wet well to the depth of maximum suction lift, available lift will vary based on suction pipe diameter, motor Hp and impellers.
	Commonly supplied as a "package" lift station such that all the associated station piping, priming pumps, controls, etc., come in one package contained in a steel container that is set on the new wet well.	More Costly when compared to a submersible system because more equipment is above grade and needs to be housed in a structure to protect it.
	Pulling the pumps for maintenance will not require a cleaning area.	More complex mechanical system including additional equipment (primer pump)
		Once maximum depth is reached the only way to create additional volume is by increasing the diameter.

It should be noted that there are additional expenses associated with the construction/installation of a suction lift package pump station that make it the more expensive option. As stated in Table 3, suction lift pumps are commonly supplied as part of a "package" lift station that includes all the ancillary equipment required to operate the station. This can include priming pumps, discharge piping, check valves and controls connected to an in station control system. This control system can then be connected to a PLC for operating the station and annunciating alarms via either the City's SCADA system or via telephone lines. Whether or not the advantages of the suction lift station outweigh the associated costs are a judgment call that the City will have to make.

The pump station shall include a minimum of two pumps, each capable of accommodating the anticipated peak hour influent flow of 1,185 gpm (providing full redundancy). It is further recommended that a third pump be purchased at the time of construction and provided to the City for storage as a replacement for one of the installed pumps should a failure occur. Supplier lead times for replacement pumps or even parts have been increasing and the relatively remote location of the City would support this recommendation.

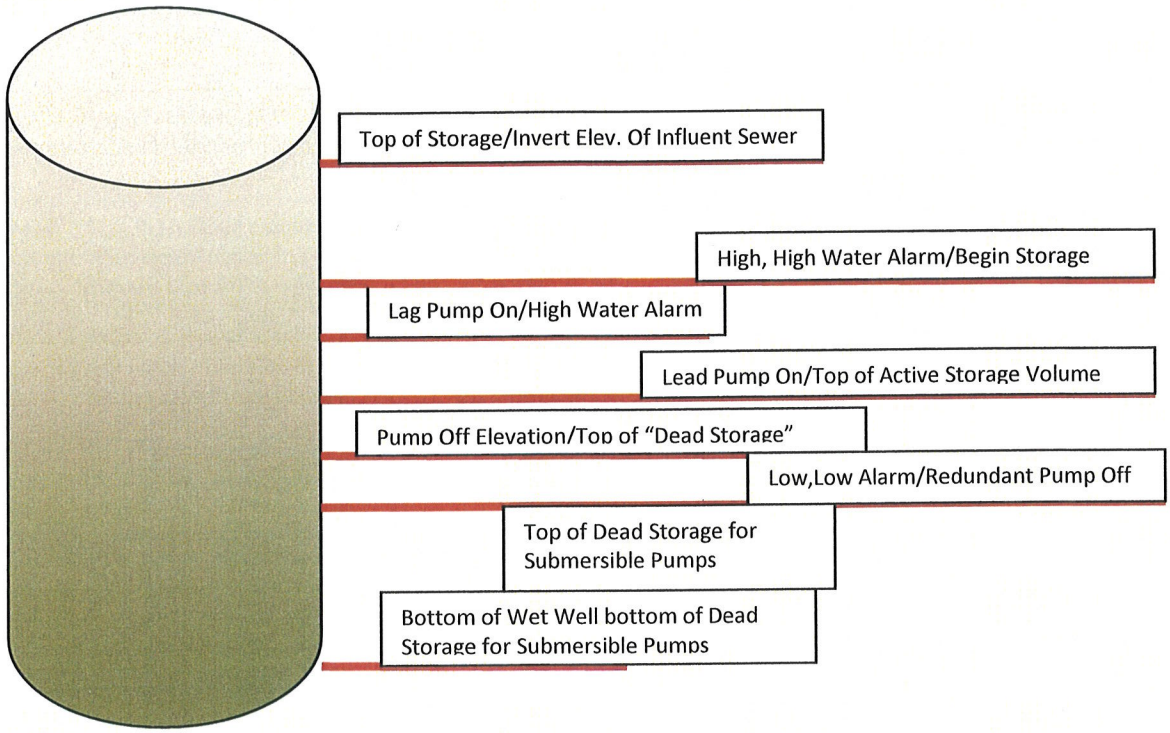
4.2.2 Station Operation

Pump station controls will operate the pumps/station in the following manner:

1. Pumps will operate in a lag/lead manner that automatically switches the lead pump to come on after every pumping cycle (one pump cycle is from pump on – to pump off and back to pump on again). This will equal out the hours that each pump operates over time.
2. Controls will include(starting from the bottom of the wet well):
    a. Dead storage – this extends from the bottom of the wet well to the height required to cover the pump motor and provide cooling as recommended by the manufacturer of the submersible pump. NOTE THAT THIS IS ONLY REQUIRED FOR SUBMERSIBLE PUMPS.
    b. Low, low level alarm/redundant pump off – this control elevation is approximately 6" below the Pump Off elevation. In a submersible pump station this level would also represent the top of the dead storage required to cool the pump motors. It actuates an alarm indicating that the pumps are not shutting off at the control point specified and are pumping down the wet well to an elevation where suction could be lost or the pump motor could overheat.
    c. Pump Off elevation – pump off set point for one pump operating or both pumps operating.
    d. Pump On elevation – the difference between this elevation and the pump off elevation represents the "Active Storage" volume of the wet well. At this elevation the lead pump is called into service to pump the "active storage" volume down to Pump Off elevation.
    e. High Water Alarm/Redundant Pump On elevation – this occurs if the lead pump is called to operate and either fails or cannot keep up with the influent flow and the level in the wet well continues to rise. Once it reaches this elevation the second pump (lag pump) is called to operate and an alarm is sent indicating that for whatever reason the lead pump could not keep up with influent flow (potential reasons for lead pump failure could include ragging, motor failure, power failure, impeller wear, etc.).
    f. High, High Water Alarm Elevation – is sent once both pumps have been called to operate and the level in the wet well continues to rise. The high, high water alarm elevation also represents the bottom elevation of storage included in the wet well design for situations such as this.
    g. Influent Sewer Invert Elevation – this is commonly the top of the storage volume included in the wet well design. The intent is to contain all storage within the wet well rather than depending on possible storage within the collection system.

Figure 3 below shows a representation of the wet well and control elevations. In order to size the wet well the operation of the station must be determined. These criteria should be used for design of the wet well in addition to the controls system.

Figure 3
Generic Wet Well Elevation Layout



4.2.3 Pump Station Design Criteria

The design criteria in Table 5 were used to develop the preliminary design for the Mill Road Pump Station.

TABLE 5
Pump Station Design Criteria

Peak Hour Influent Flow	1,185 gpm
No. of Pumps	2 (minimum) – each able to accommodate peak hourly influent flow (completely redundant) Whether or not to provide a third pump as a standby for replacement of the two operating pumps should be evaluated during final design. The speed of each operating pump shall be controlled by a adjustable frequency drive (AFD).
Storage Capacity	60 minutes at Build Out without utilizing the influent line for storage.
Standby Generator	Install as part of the initial construction sized to provide the ability to start both pumps (with a lag time in between starts) and run both pumps and the station lighting, controls and SCADA.
Pump Cycle Time	No more than 6 complete cycles per hour (Minimum 10 minute cycle time from pump on to pump on again assuming one pump in operation)
Active Storage Volume	Based on Equation T = V/i +V/(q-i) Where: T = time (min); V = volume (gallons); i = influent flow (gpm); q = pumping rate (gpm) NOTE: Minimum cycle time occurs when influent flow equals one-half of the pumping capacity.
Wet Well Construction	Wet well shall be designed and constructed to accommodate anticipated peak flow at build out (1,185 gpm). Design and construct bottom of wet well to be self cleaning – slope sides to a center channel that will direct solids to the pump suction and create velocities to the suction that will enhance lifting the solids into the pumps.

Peak Hour Influent Flow	1,185 gpm
Wet Well Construction	Predesign is based on the installation of a concrete caisson for the new wet well due to high groundwater concerns. Other installation methods may be possible but will require significant shoring and dewatering efforts.
Submersible Pump	Flygt NP 3315 HT 3~ 456 – 1760 RPM – 160 Hp (used for comparison purposes in predesign) Pump curves included herein in Appendix B – Pumps should be installed AFD's to limit inrush current during start up.
Suction Lift Pump	Smith & Loveless 8D4V – 1760 RPM – Maximum Suction Lift = 17.5 feet (conservative) – 150 Hp (used for comparison purposes in predesign) Pump curves included herein in Appendix B – Pumps should be installed with AFD's to limit inrush current during start up.
Station Operation	As described above (Section 4.2.2) Alarm modes and actual elevations to be confirmed in final design. Additional alarm sequences to be confirmed with the City if needed.
Required Generator to run Station during extended outage events	Required Standby Generator Power: either 150kW or 350kW. The 150 kW generator will run the station and one pump. The 350 kW generator will run the station and two pumps.

4.3 Pump Station Electrical Components

As previously stated, electrical components for a pump station of this nature commonly are assumed to have an average life span of 20 years. This is less than the planning horizon of 2046 (34 years into the future), however, logic would dictate that savings generated by putting in lower Hp pumps and electrical equipment for today would not exceed the cost required to install the higher Hp pumps and associated electrical equipment 20 years into the future. In addition, there is no way to truly tie down the rate at which flows would increase to the pump station over time. More recent experience would indicate that it would take longer to reach predicted peak influent flows rather than less time. But this cannot be guaranteed. For the purposes of this preliminary design it has been assumed that the electrical components will be designed for complete build out flows.

4.3.1 Electrical Service

Given the size range of the pumps, 160 hp to 150 hp, the electrical service from the local utility will need to be 480 volts, 3-phase. Assume 600 amperes for initial planning purposes.

4.3.2 Configuration

The electrical service will include a utility power meter with current transformer enclosure, main breaker, automatic transfer switch, and an installed standby generator. A preliminary one line diagram of this configuration is shown in Figure 4. Other components will depend upon the type of pumps selected

4.3.3 Size of Main Electrical Components

The above ground electrical equipment will need to be protected from the weather and securable. This can be accomplished using a shelter and lockable enclosures or a single lockable enclosure with components mounted inside. The footprint will vary depending again on the type of pumps selected but assume a shelter will be larger and allow a space 16ft long by 8ft wide. The other main component is the standby generator. Allow a space 7ft wide by 20ft long by 10ft high for a permanently installed generator capable of powering two 160hp pumps at the same time. (This assumes that the two pumps will start in a lead/lag configuration and that they will be controlled by AFD's or have solid state soft starts on them.)

4.3.4 Pump Motor Starters and Standby Generator

The pump motors are large enough to require means to reduce the motor starting current which is often six or more times the motor running current. There are several means to control the starting current, but the two to be

considered here are solid-state "softstarters" and adjustable frequency drives (AFDs). While AFDs are not "needed" for the operation of the pump station, they can be used to reduce the size of the mobile generator needed to operate the station during a utility power outage. A single pump operated on an AFD requires only a 150kW standby generator while a pump operated on a softstarter requires a 250kW standby generator. AFDs are generally twice as expensive as softstarters but AFDs have better power factor and reduce the starting current more. If both pumps are required to operate on a standby generator then the size of the generator will be the same for both types of starters, i.e. about 350kW.

4.3.5 Storage versus Standby Generator

The City has stated that they want to have the standby power generator installed at the time of initial construction. However, if desired, the large change anticipated between initial influent flows and those that would occur at build out can be used to delay the installation of a standby generator. By constructing the new structure so that it will have a minimum of 60 minutes of storage capacity following an alarm for a power outage or pump failure at ultimate peak hour conditions (1,185 gpm, build out) will mean that up to several hours of storage are available during the time from initial construction until build out flows are reached. As shown in Table 3 in the near term when influent flows will be less than those anticipated for build out the new system will exhibit larger retention times.

If delaying the installation of the standby mobile generator is chosen the design for the new station would include a connection point for a portable generator to plug in so that during an extended power outage the station could be brought back on line using the generator. The City would monitor flows at the pump station in order to decide when a permanent standby generator would be installed in the future.

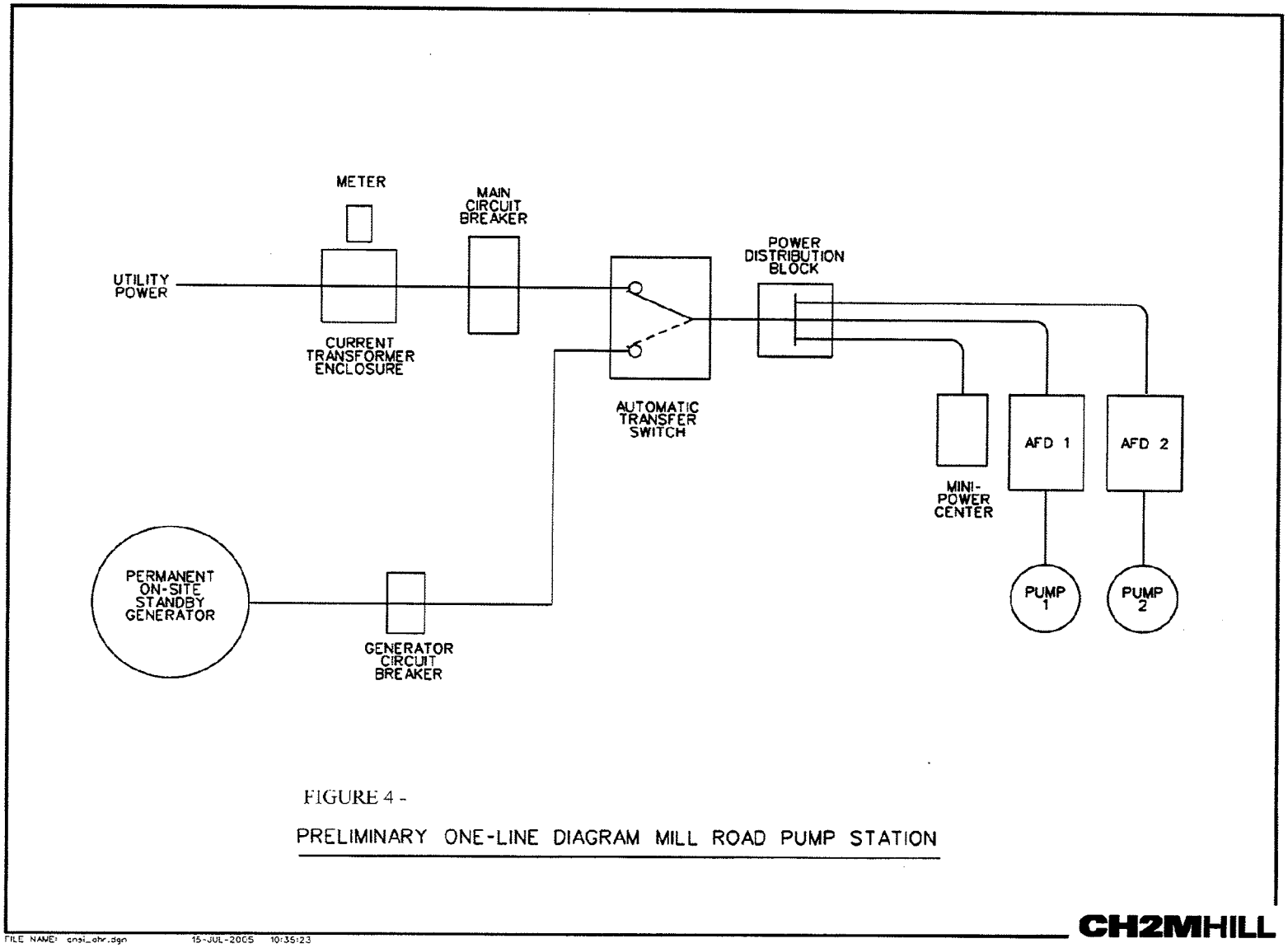
4.4 Pump Station Control System

The control system design for the pump station will be customized to meet current City standards for equipment and functionality. In addition to matching existing City technical standards, the control system will be designed to integrate the features and equipment associated with the selected pump station configuration.

Although specifics of the control system cannot be defined at this point, the following outlines the general elements of the control system that will be incorporated into the pump station design.

1. Programmable Logic Controller (PLC): A PLC will be used as the central controller for the pump station. For the submersible pump option, the PLC will control all functions of the pump station. For the suction lift pump option, the package controls for the pumps will be integrated with the pump station PLC to provide facility control. The PLC manufacturer and model will be selected to match City standards.
2. Local Operator Interface (OI): An operator interface device will be included to allow operations staff to locally monitor equipment operation, control equipment and adjust pump station operations setpoints. The OI manufacturer and model will be selected to match City standards.
3. SCADA System Communications Interface: The pump station PLC system will be integrated into the City's existing SCADA system. The communications interface will allow pump station operation, status and alarm signals to be viewed and controlled remotely. The communications system will be designed to match the communications systems currently in service.
4. Wet Well Level Sensor: A wet well level sensor will be installed to provide continuous measurement of the wet well level. Operator adjustable level setpoints for pumps off, lead pump start and lag pump start will be compared against the level signal for pump control.
5. Wet Well Float Switches: Float switches for low-low and high-high level detection will be installed (if applicable to City standards) for detection of the low-low water level/redundant pump off and high-high water level alarms. These float switches can also be used as a backup control to start and stop the pumps in the event of a wet well level sensor failure.

FIGURE 4
Preliminary One-Line Diagram Mill Road Pump Station



6. Intrusion Detection: Sensing devices will be installed within the pump station to detect intrusion into the facility. The types of devices used will be based upon the selected pump station configuration and City standards.

Support Systems Integration: The control system design will include PLC interfaces to pump station support systems such as the backup power generator and combustible gas monitors.

5. Force Main Sizing and Alignment

5.1 Force Main Sizing

Force mains should be sized to maintain a minimum flow velocity of 2.0 fps to prevent solids from settling in the line between each pumping cycle (in many cases a minimum velocity of 2.5 fps is preferred to insure movement of solids during each pumping cycle). Maximum force main velocities should not exceed 7.0 fps to prevent the creation of significant headlosses that would increase the pump power required, cost of operating the pumps and the required size of the standby generator. A breakdown of pumped flow versus velocity in force main diameters from 6 inches to 10 inches is shown in Table 6.

TABLE 6
Pumped Flow versus Force Main Velocities

		Velocity (fps)[1]		
Pumped Flow (gpm)	**Pumped Flow (cfs)**	**6 inch Force Main**	**8 inch Force Main**	**10 inch Force Main**
200	0.45	2.27	1.28	0.82
400	0.89	4.54	2.55	1.63
500	1.11	5.67	3.19	2.04
600	1.34	6.81	3.83	2.45
800	1.78	9.08	5.11	3.27
1000	2.23	11.35	6.38	4.09
1185	2.64	13.45	7.56	4.84

[1] Flow velocities within the acceptable range of 2.0 fps to 7.0 fps are highlighted

Based on the peak hourly flow of 1,185 gpm, a 10 inch diameter force main should be installed for this application for the following reasons:

1. It would not be cost effective to install a smaller force main and then replace it with a larger force main in the future. This would also require additional work at the pump station to revise the piping and increase easement widths required for the force main to allow installation of a second line while keeping the first line in service (to limit any required shutdowns of the pump station).
2. The installation of an 8 inch force main or 6 inch force main would result in increasing the TDH for the pump station by 82 feet and 324 feet, respectively, at the build out flow of 1,185 gpm. Both would increase required pump horsepower and electrical system design and installation costs.
3. During final design the City can look at reducing the flow rate from the recommended pumps by installing a trimmed impeller. This would also reduce the motor Hp required. However, if this is considered, it should be realized that the pump impellers and motors could require switching out before the end of their useful life.

The flow from the pumps will need to be at least 500 gpm to provide the needed minimum velocity in the forcemain.

5.2 Force Main Alignment

The alignment of the new force main from the pump station is shown on plan and profile sheets included herein Appendix C. Generally, the new force main will exit the pump station site on Mill Road (north side), then proceed east on Mill Road (remaining on the north side of the road) to the intersection with Thomas Street; north on Thomas Street (remaining on the west side) to a location just above Workman Street. As shown on the included plan and profile sheets the new forcemain would then proceed east again following an undeveloped road easement to an existing MH connected to the City's gravity collection system on the southern end of Logan Street. The force main would discharge into this MH. Alternatively, the new force main could continue north on Thomas Street to 4th Street and discharge into a MH at this location. Some resloping of the existing sewer on 4th Street would likely be required to make this alternative work. For planning purposes, the cost for either alignment would be roughly the same. The approximate length of the new force main is 4, 278 feet.

6. Cost Estimate

Table 7 is a summary of the estimate costs. The base construction cost shown includes mobilization, bonds, contingency and escalation. It does not include project costs such as design, administrative, legal, or services during construction. See Appendix D for a complete breakdown of the costs included in each category.

TABLE 7
Cost Estimate Summary

	Low Range	Estimate Range	High Range
	-20%	**Base Cost**	+30%
Submersible Pump Station & Force Main (yard piping)	$1,633,000	**$2,041,000**	$2,653,000
Suction Lift Pump Station & Force Main (yard piping)	$1,702,000	**$2,127,000**	$2,765,000
Force Main	$882,000	**$1,102,000**	$1,433,000
Gravity Pipe Alt 1	$306,000	**$383,000**	$498,000
Gravity Pipe Alt 2	$394,000	**$492,000**	$640,000
Gravity Pipe Common Alt 1 & 2	$542,000	**$678,000**	$881,000
Gravity Pipe Alt 3	$170,000	**$213,000**	$277,000
Gravity Pipe Common Alt 1, 2 & 3	$43,000	**$54,000**	$70,000
Gravity Pipe Alt 4	$674,000	**$843,000**	$1,096,000

6.1 Methodology

This cost estimate is considered a Schematic Design Estimate (Class 3) construction cost estimate. It is based upon the 15 percent design drawings and specification dated May 2012, and design information provided by the engineer at the time of the estimate.

Where possible, a quantity takeoff was developed for all elements shown in sufficient detail in the design drawings or described in the report. For an item known to exist but not defined in the project drawings, the cost estimator applied an allowance based on estimator experience and consultation with the project engineer.

The final costs of the project will depend on actual labor and material costs at the time of bid, actual site conditions, productivity, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from those presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

6.1.1 Markups

Table 8 summarizes various markups applied to the cost estimate to develop the overall construction cost. Unit costs include contractor overhead and profit. Mobilization, contingency, sales tax, market factor and escalation are also applied to the bottom line totals.

TABLE 8
Markup Summary

Markup	Percentage
Contractor Overhead & Profit (In unit costs)	18%
General Conditions	7%
Mobilization/Bonds/Insurance	5.16%
Construction Cost Estimate Contingency	40%
Escalation (Aug 2013)	3.58%
Sales Tax (Port Townsend)	9%
Market Conditions	0%

6.1.2 Assumptions

The following assumptions were used to develop the construction cost estimate:

General Assumptions:

1. Labor rates are based on the RS Means National Average Rate and adjusted for local wage rates using the RS Means regional adjustment factor.
2. The estimate currently includes escalation to mid-point of construction to August 2013.
3. Costs assume that the work is done during a regular 40 hour work week and does not include any overtime cost markups.
4. Costs do not include purchase of easements or right-of-way, engineering, administration or owner costs beyond the capital construction costs. The cost estimate is intended to represent the total contractor bid price as shown on the bid price schedule at the time of the bid opening.
5. Site access for the contractor and contractor staging areas are assumed to be adequate for the contractors needs.
6. The estimate is based on aggregates, drain sand, and clay materials being available locally to the contractor.
7. Temporary erosion and sediment control are expected to be minor. No wetland impacts are known at this time.
8. Pipe trenching is based on 5' of cover to the top of the pipe.
9. It is assumed that dewatering for pipe trenching can be controlled with sump pumps in trench.
10. Roadway patching is based on 6" of asphalt over 6" of crushed surface base course.
11. The pump station wet well construction is based on a dropped caisson construction.
12. Due to the pump cooling requirements the submersible pump station wet well is 30" deeper than the suction lift pump station.

13. The pipe alternatives costs with the exception of Alternative 3 are based on the pipeline being placed in the roadway and include ACP demo and patching. Alternative 3 is outside of the roadway and travels cross country.
14. The estimate includes a 350 KW standby generator at the pump station and VFD's controlling the pumps.

7. Summary and Recommendations

The following (Table 9) summarizes the previous discussions and presents recommendations for taking the new Mill Road Pump Station and Force Main into design.

TABLE 9
Summary

Item	Description	Recommendation
Pump Station		
Wet Well	Several methods of construction of the wet well were considered, however, due to the existence of high groundwater it appears that a circular wet well installed as a caisson would work best in this situation. It would limit the need for dewatering and for shoring which would be an advantage.	Install the new wet well as a caisson. This would be a concrete structure and would include a corrosion resistant lining (once completed and the bottom sealed)
Wet Well Diameter	For the purpose of this planning level evaluation, it was decided to make the wet well compatible with the use of either submersible or suction lift pumps. If submersible pumps are chosen for final design it may be possible to reduce the diameter and deepen the wet well creating a somewhat smaller footprint.	Anticipated ID of the wet well is 45 feet to obtain a standby storage capacity of 1 hour at buildout and keeping the wet well shallow enough to use suction lift pumps. Wall thickness is 2 feet. Anticipated OD of the wet well is 49 feet.
Wet Well Depth	Depth in this case is based on the anticipated elevation of the suction pump volute which has been estimated as 18" above the top cap of the wet well. From this point down the depth to the established pump off elevation can be no more than 17.5 feet.	Assuming surface elevation = 23.0 feet Suction Lift Station – depth from surface elevation to pump off elevation = 15.98 feet Submersible Pump Station - depth from surface elevation to bottom of dead storage = 17.98 to 18.98 feet (depending on depth of dead storage required to cool pump motors)
Pumps	System head curves for both the use of submersible pumps and suction lift pumps were developed. These were graphed against pumps curves for both types of pumps to identify pumps that could be used under this scenario. It was also noted that if suction lift pumps were used they would be supplied as a package that included the priming pumps, controls, station piping, etc. within a epoxy coated steel container.	Submersible pump recommendation: Flygt – Model NP 3315 HT3-456; 160 Hp; station piping diameter = 6"; Impeller diameter = 15 7/8" Suction Lift Pump recommendation: S&L – Model 8D4V, 150 Hp, Suction pipe Diameter = 12"; Station piping diameter = 8"; Impeller diameter = 14 5/8" – Included in a package suction lift station. *System head curves vs. pump curves are included in the appendix.*
Station Operation	See Section 4.2.2 and Table 5	See Section 4.2.2 and Table 5
Alarms and Communication	This would have to be in keeping with the City requirements and should be vetted early in the actual design phase.	See Section 4.4
Standby Generator	As discussed in Section 4.3.4 (above) the intent is to	Required Standby Generator Power: either 150kW or

Item	Description	Recommendation
	install the required standby generator during original construction. If this is revised during final design a plug in for the use of a mobile standby generator during the initial years of station operation will be included. This will continue as long as the City believes that the provided storage in the wet well is enough to allow City Maintenance Crews to access the station and provide standby power during any extended outage event. Once influent flows reach a point where either City Crews cannot access the station quickly enough or storage time reaches 60 minutes – then a permanent standby generator will be installed.	350kW.
Force Main		
Alignment	Generally, the new force main will exit the pump station site on Mill Road (north side), then proceed east on Mill Road (remaining on the north side of the road) to the intersection with Thomas Street; north on Thomas Street (remaining on the west side) to a location just above Workman Street; at this point the new force main can proceed either west again following an undeveloped road easement to an existing MH connected to the City's gravity collection system on the southern end of Logan Street or continue north to a connection to the existing collection system on 4th Street.	Plan and Profile Sheets contained in the attached Appendix.
Length		4,278 feet
Diameter		10"
Gravity (Backbone) Collection System		
Alternative		
1	Allows flow collected in Basin 3 to extend south and west to a common collection point on Discovery Road.	Length = 1,690 feet; Diameter = 8"
2	Extends from the intersection of Discovery Road and 8th Street to the southwest to an intersection with Alternative 1 on Discovery Road.	Length = 2,200 feet; Diameter = 8"
Common Alternative 1,2	Extends from the common collection point on Discovery Road southwest to a cross over intersection with Mill Road, then southeast down Mill Road to an intersection with Alternative 3 (described below).	Length = 2,520 feet; Diameter = 10"
3	Extends from an unimproved road easement north from Glen Cove Road to a power line easement; then north and east in the power line easement (paralleling an existing water line) to a connection on Mill Road with Common Alternative 1,2.	Length = 1,870 feet; Diameter = 8"
Common Alternative 1,2,3	Extends east on Mill Road to the new pump station site	Length = 187 feet; Diameter = 12"
4	Parallels the new force main from the pump station – allows the City to pick up existing lots below (south) of the connection point of the new force main into	Length = 3,500 feet; Diameter = 8"

Item	Description	Recommendation
	the City's gravity collection system. This gravity line would begin on the lower reaches of Thomas Street and proceed south to Mill Road and then east on Mill Road to the connection with Common Alternative 1,2,3 and into the new pump station.	
Estimated Cost		
	Based on planning level considerations including a 40% contingency for unknowns at this time. As shown here the estimate has been broken into several categories and a complete copy of the estimate is included in Appendix D:	
	Submersible Pump Station w/Force Main (yard piping)	$2,041,000
	Suction Lift Pump Station w/Force Main (yard piping)	$2,127,000
	Force Main (outside yard piping)	$1,102,000
	Gravity Lines	
	Alternative 1	$383,000
	Alternative 2	$492,000
	Alternative 1 & 2	$678,000
	Alternative 3	$213,000
	Alternative 1, 2 & 3	$54,000
	Alternative 4	$843,000

7.1 Recommendations

The following steps need to be undertaken to initiate and complete final design:

1. A complete survey of the gravity alternatives needs to be completed to better document the existing slopes that will have to be accommodated and what steps (if any) that will be required to eliminate or at least reduce the occurrence of supercritical flow regimes.
2. A survey of the alternative force main route to 4th Street needs to be completed to determine the feasibility of the alternative route and whether the static head requirements change significantly.
3. Soil borings need to be completed for the new pump station site and the alternative pipeline alignments (gravity and force main) to confirm design criteria, trench backfill requirements, etc. Recommend that there be at least two soil borings at the pump station site with one extending at least 25 feet below the invert of the wet well. Borings on the gravity and force main alignment should be spaced at 1,000 foot intervals and be completed to a depth of at least 5 feet below the proposed trench invert. This information will be critical to the final design process.
4. Property acquisition issues will have to be better identified and how they will affect the design addressed.
5. City and Engineer need to work closely together to better clarify the anticipated influent flow to the new pump station site.
6. The City needs to revisit and confirm whether or not the installation of a standby generator should be included in the final design or left as a future project.

7. A more definitive decision needs to be reached regarding the use of submersible or suction lift pumps.
8. The City needs to revisit the Master Plan completed by Gray & Osborn to confirm that there is capacity in the existing collection system downstream of the tie in point for the new force main all the way to the City's Wastewater Treatment Plant.

Appendix A:
City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review

City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review

PREPARED FOR: Mary Heather Ames
City of Port Townsend

COPY TO:

PREPARED BY: Amie Roshak

DATE: February 23, 2012

PROJECT NUMBER: 425179

This technical memorandum summarizes the review of hydraulic modeling data from the City of Port Townsend's (City's) wastewater collection system as presented in the December 2009 *Southwest Sewer Basin Study (Basin Study)*, by Gray & Osborne, Inc. The report evaluated the City's sewer basins and presented a series of alternatives for future development within and adjacent to the existing City limits. The data presented in the Basin Study will be used to develop a peak hourly flow rate to use as design criteria for the design of the new Mill Road Pump Station. The specific alternative in the Basin Study that was reviewed for the Mill Road Pump Station is Alternative 7. The areas that Alterative 7 represents are summarized below along with the review of the loading rates and peaking factors presented in the Basin Study.

Area of Interest for Mill Road Pump Station: Basin Areas for Alternative 7

Alternative 7 in the Basin Study represents the option for a common lift station (Mill Road Pump Station) to serve Basins 1, 2, and 3. In this alternative, Basin 1 also includes the Local Area of More Intense Rural Development (LAMIRD) south of the City. The analysis presented in the Basin Study included a layout of future gravity sewers that would serve the basins and discharge to the Mill Road Pump Station.

The areas summarized for Basins 1, 2, and 3 in the Basin Study were confirmed, and the basins are shown in Figure 1.

Design Flow Development

This section presents information on the calculation of the projected wastewater flow to be pumped by the Mill Road Pump Station. The projected average and peak day flow is presented as well as the determination of the peak hourly flow.

Wastewater Loading Rate Determination

In the *1999 City of Port Townsend Wastewater Comprehensive Plan* (Comprehensive Plan) by CH2M HILL, wastewater loading rates were defined based upon seventeen classes of Land Use. This approach also discounted the land dedicated to Right-of-Ways. Development factors for existing and future development density were also taken into account when determining the total amount of developable lands. During the Basin Study, the ultimate wastewater flows developed for each basin in the Comprehensive Plan were divided by the total number of acres in each basin to develop a basin-wide loading rate. This basin-wide loading rate was then applied to the new basins defined in the Basin Plan. The foundation of this approach in the Basin Plan was to apply the calculated basin-wide loading rate to a basin that was assumed to have a similar development pattern as the basin in the Comprehensive Plan. For the basins involved in this study (Basins 1, 2, and 3), the Southwest Basin in the Comprehensive Plan was identified as the similar basin. Figure 2 shows the overlay of the extent of the Southwest Basin from the Comprehensive Plan and Basins 1, 2, and 3 in the Basin Plan, and Table 1 summarizes the calculation of the basin-wide loading rate for the Southwest Basin and Table 2 summarizes the ultimate flows for Basins 1, 2, and 3 using the calculated Southwest Basin basin-wide loading rates shown in Table 1.

FIGURE 1
Mill Road Pump Station (Alternative 7)
Basin Areas

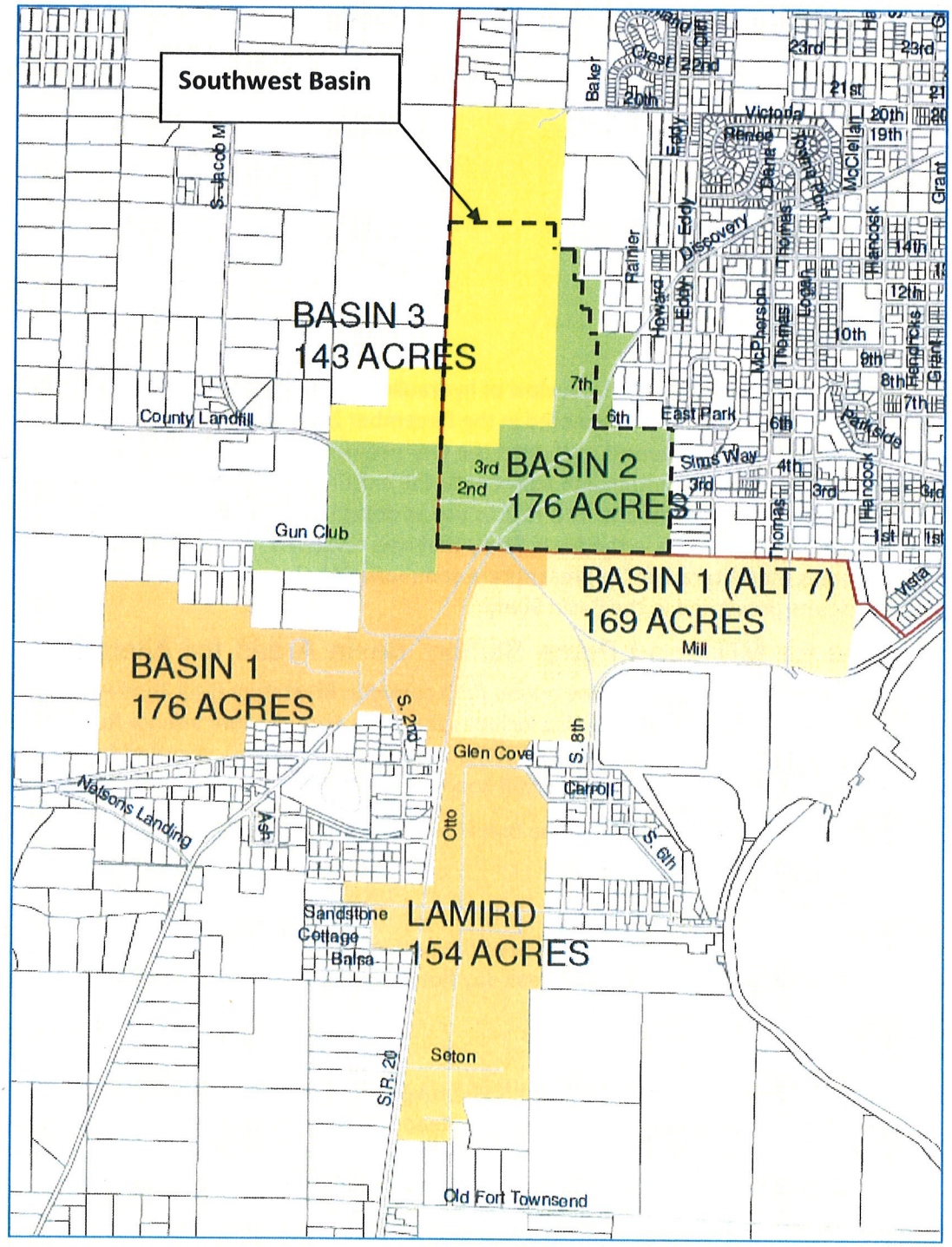


TABLE 1
Basin Flowrate Calculation: Basin-wide Loading Rate and Projection

	Southwest Basin Projected Ultimate Flows (2047)		
	Flow (gpd)	Basin Area (acres)	Calculated Basin-Wide Loading Rate (gpd/acre)
Average Dry Weather Flow	139,988[1]	195[1]	718
Peak Day Flow	240,521[1]	195[1]	1,233

[1]Source: CH2M HILL, Inc., City of Port Townsend Wastewater Comprehensive Plan, 1999.

TABLE 2
Calculated Wastewater Loading by Basin

	Calculated Basin-Wide Loading Rate (gpd/acre)	Basin Area (acres)	Flow (gpd)
Average Dry Weather Flow			
Basin 1 (with LAMIRD)	718	499	358,300
Basin 2	718	176	126,400
Basin 3	718	143	103,700
Total			588,400
Peak Day Flow			
Basin 1	1,233	499	615,300
Basin 2	1,233	176	217,000
Basin 3	1,233	143	176,300
Total			1,008,600

Peaking Factor

In the Basin Study, a peak hour to peak daily flow peaking factor of 1.7 was applied to the Peak Day Flow to determine peak hourly flow for each basin. The Basin Study stated that this factor was adjusted upward from a factor of 1.27 that was applied in the hydraulic modeling for the Comprehensive Plan. In the Comprehensive Plan, a diurnal curve was presented from flow monitoring in a residential area. This curve (Figure 5-2) indicated that the peak flow may be 1.79 times higher at the peak hour than the average. The Comprehensive Plan also notes that this diurnal curve is slightly conservative for non-residential areas.

According to the Department of Ecology, Criteria for Sewage Works Design (Orange Book), the minimum peaking factor that should be used to calculate peak hourly flow is 2.5, and the peak hour factor is based upon population. In addition, for the Orange Book methodology, the peaking factor is to be applied to the average daily flow, not the peak daily flow.

Peak Hourly Flow

A comparison was performed on the two different calculation methods of the peak hourly flow. This is summarized in Table 3. For the Basin Plan flows, the effective peak hour to average day peaking factor was determined to be 2.92. This peaking factor corresponds to a town with a population of approximately 11,000. The Orange Book calculated peaking factor is 2.59, assuming a population of approximately 23,000 for 2046, the year of the projected ultimate flows. See Figure C1.1 from the Orange Book (attached). Cities with smaller populations are assigned a higher peaking factor due to the nature of the variability of flow with smaller populations. According to the City of Port Townsend Comprehensive Plan, the City's population is expected to reach a population of about 14,000 in the year 2024 and may reach 23,000 by 2046

TABLE 3
Calculated Wastewater Loading by Basin (2047)

	Row	Basin Plan Calculation	Orange Book Calculation
Average Dry Weather Flow (gpd)	(1)	588,400	588,400
Peak Day Flow (gpd)	(2)	1,008,600	1,008,600
Calculated Peak Day to Average Day Peaking Factor	(3) = (2)/(1)	1.71	NA[1]
Peak Hour to Peak Day Factor	(4)	1.70	NA[1]
Calculated Peak Hour to Average Day Factor	(5) = (4) x (3)	2.91	2.59[2]
Peak Hour Flow (gpd)	(6) = (1) x (5)	1,714,620	1,524,935
Calculated Peak Hourly Flow (gpm)	(7) = (6) / 1440 min/day	1,191	1,059

[1]Not applicable for this comparison. Only comparing the Peak Hour to Average Day Factor (Row (5))

[2]Calculation of Peak Hour to Average Day Factor from the Orange Book = $(18 + \sqrt{23,000})/(4+\sqrt{23,000})$, where 23,000 is the population in 2046.

Selection of Peak Hourly (Design) Flow

The peak hourly flow will be used for sizing and design of the Mill Road Pump Station. Based on the comparison of the various calculation methods to determine the peak hourly flow for design of the Mill Road Pump Station, it is recommended that the peak hourly flow of 1,185 gpm be used for the design.

Appendix B:
Pump Curves for Submersible and Suction Lift Pumps

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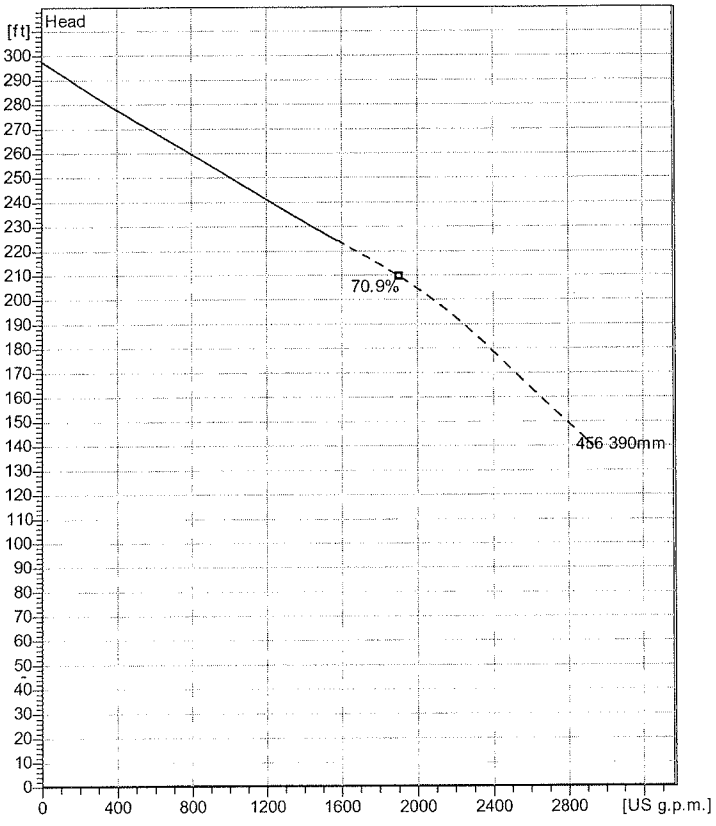
Technical specification

FLYGT



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

Note: Picture might not correspond to the current configuration.

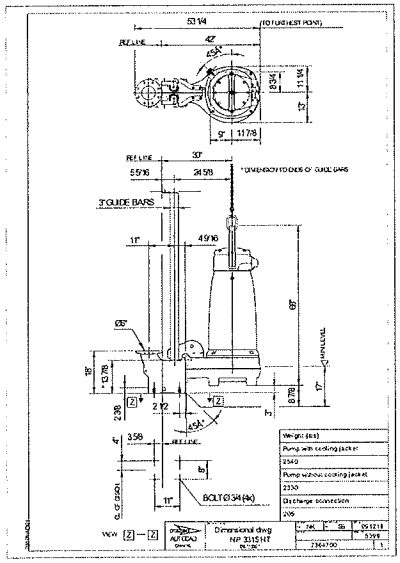
General

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	Grey cast iron
Outlet width	5 7/8 inch
Inlet diameter	150 mm
Impeller diameter	390 mm
Number of blades	3

Installation: P - Semi permanent, Wet



Motor

Motor #	N3315.180 35-35-4AA-W 130hp
Stator variant	
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	130 hp
Rated current	156 A
Starting current	705 A
Rated speed	1775 1/min
Power factor	
1/1 Load	0.83
3/4 Load	0.80
1/2 Load	0.71
Efficiency	
1/1 Load	93.5 %
3/4 Load	94.0 %
1/2 Load	94.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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Performance curve

Pump

Outlet width	5 7/8 inch
Inlet diameter	150 mm
Impeller diameter	15 3/8"
Number of blades	3

Motor

Motor #	N3315.180 35-35-4AA-W 130hp
Stator variant	
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	130 hp
Rated current	156 A
Starting current	705 A
Rated speed	1775 1/min

Power factor	
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Efficiency	
1/1 Load	93.5 %
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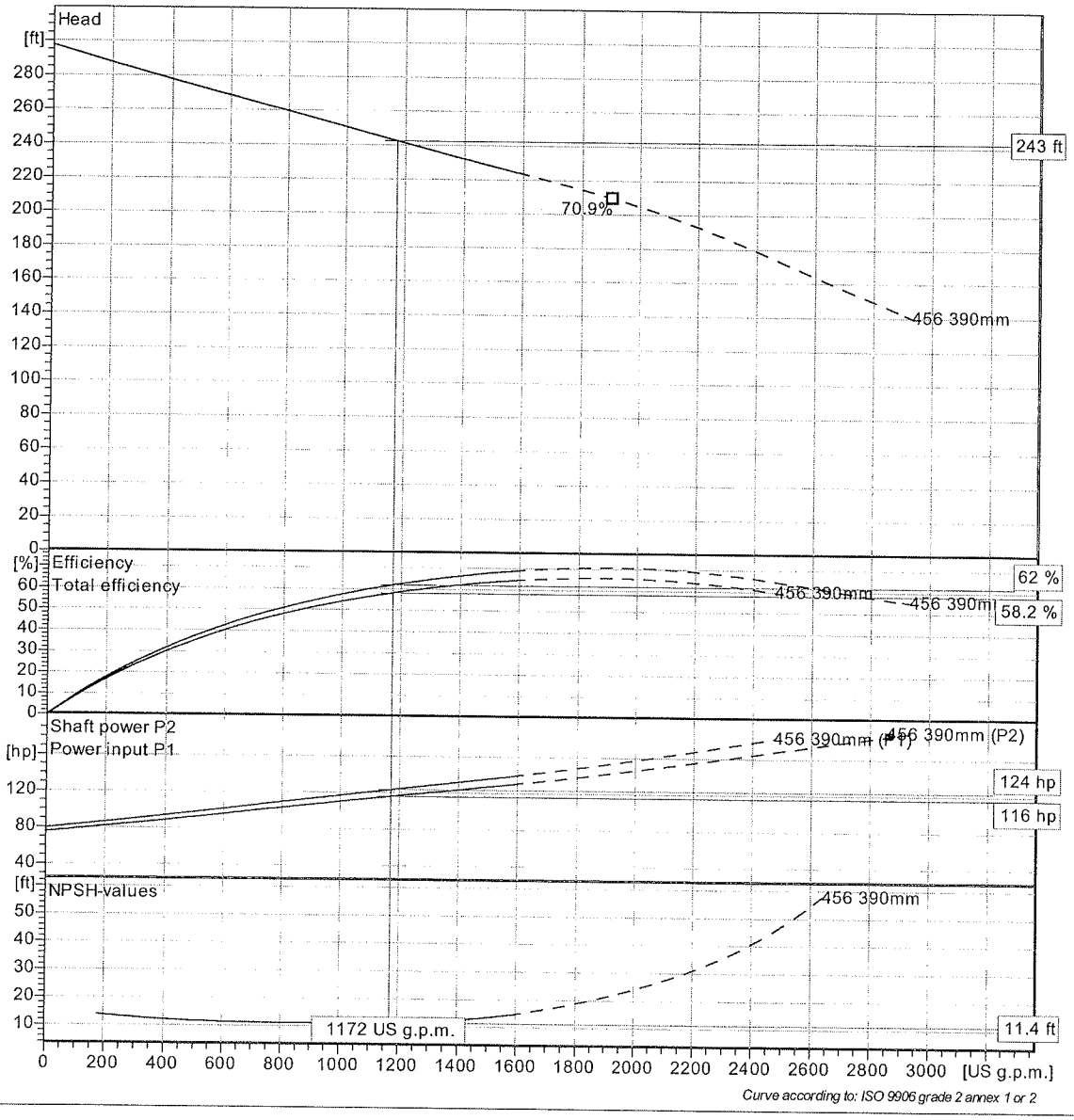

Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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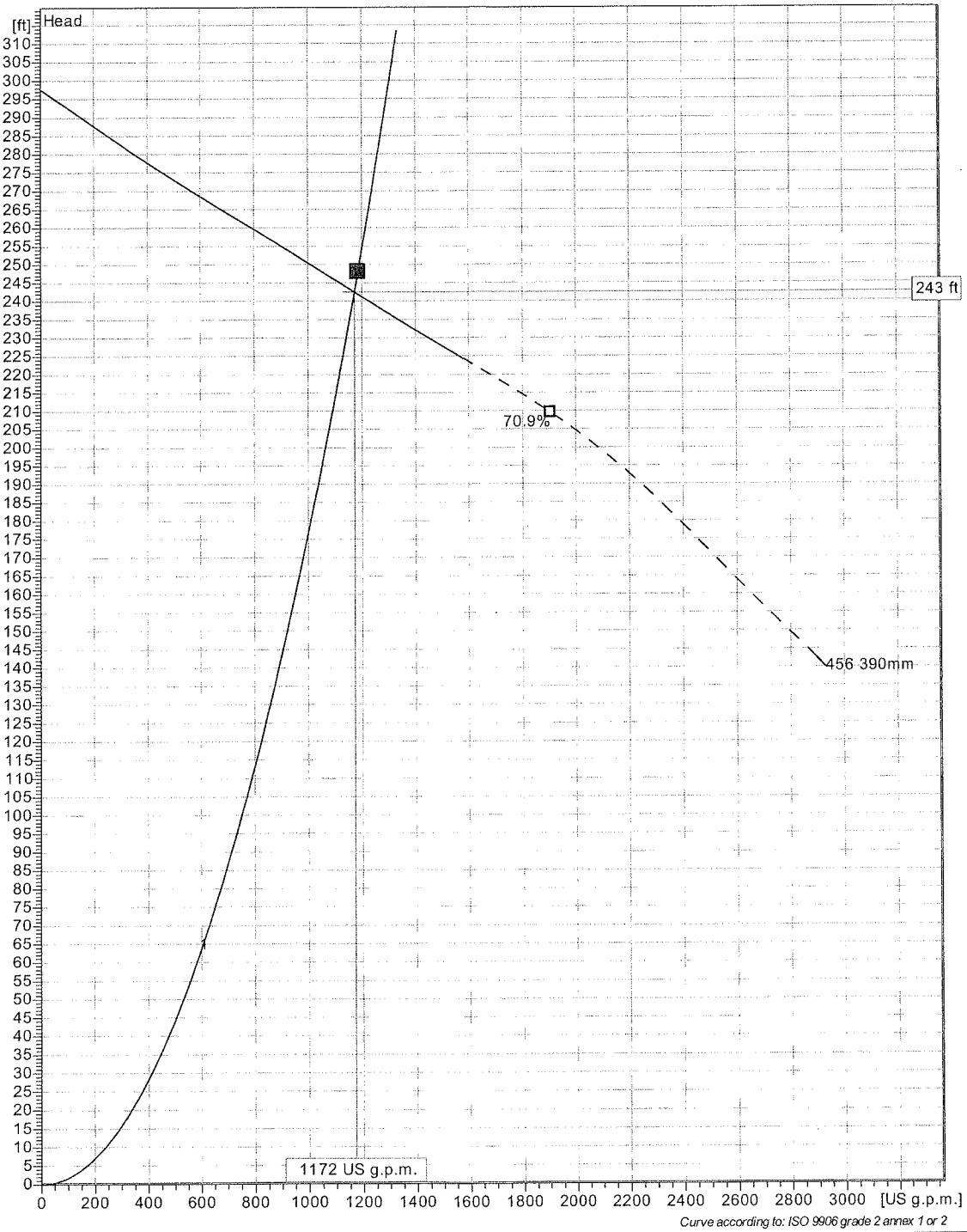
Duty Analysis



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

Pumps running /System	Individual pump			Total					
	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	1170 US g.p.m.	243 ft	116 hp	1170 US g.p.m.	243 ft	116 hp	62 %	1310 kWh/US MG	11.4 ft

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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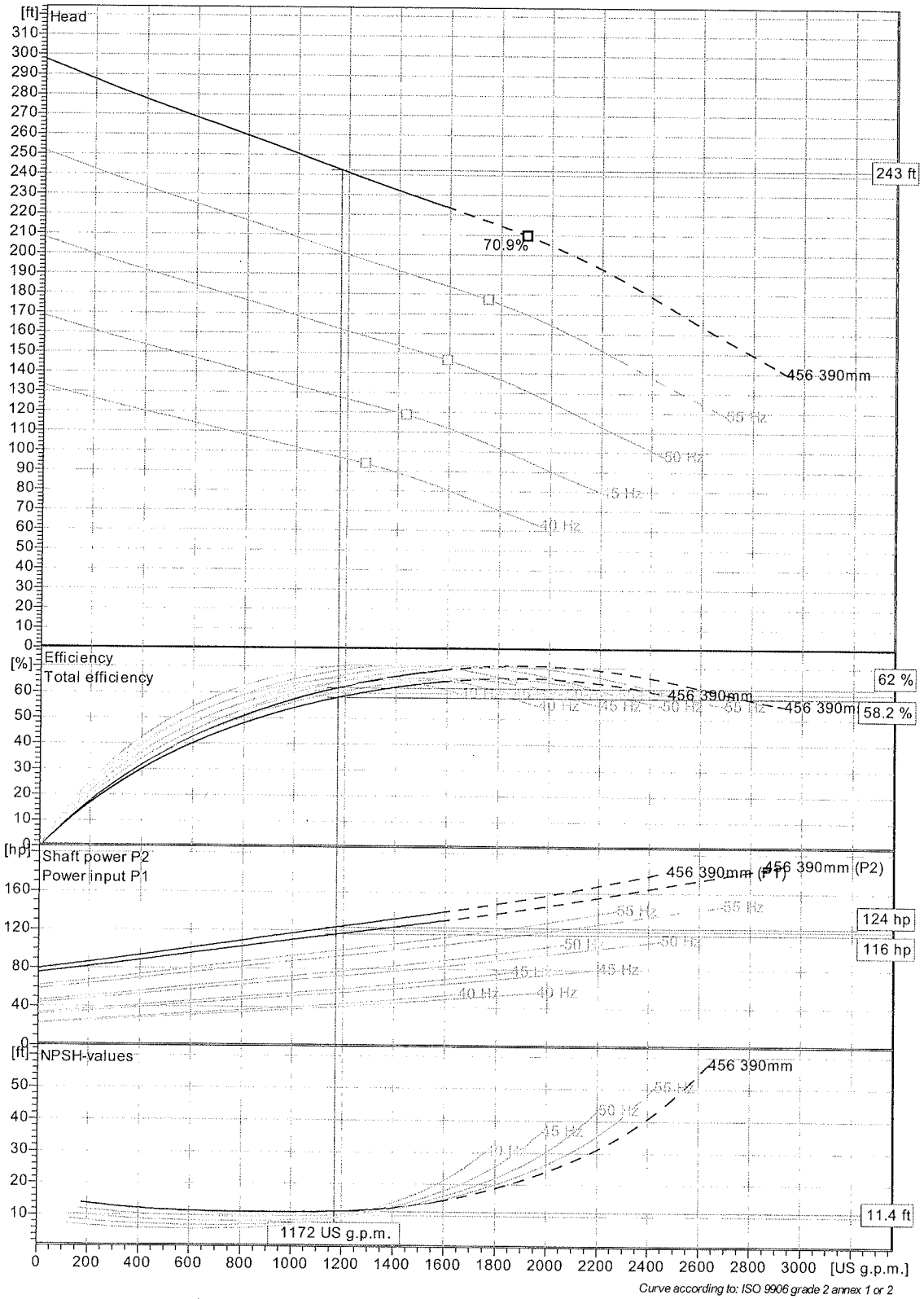
VFD Curve

FLYGT



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

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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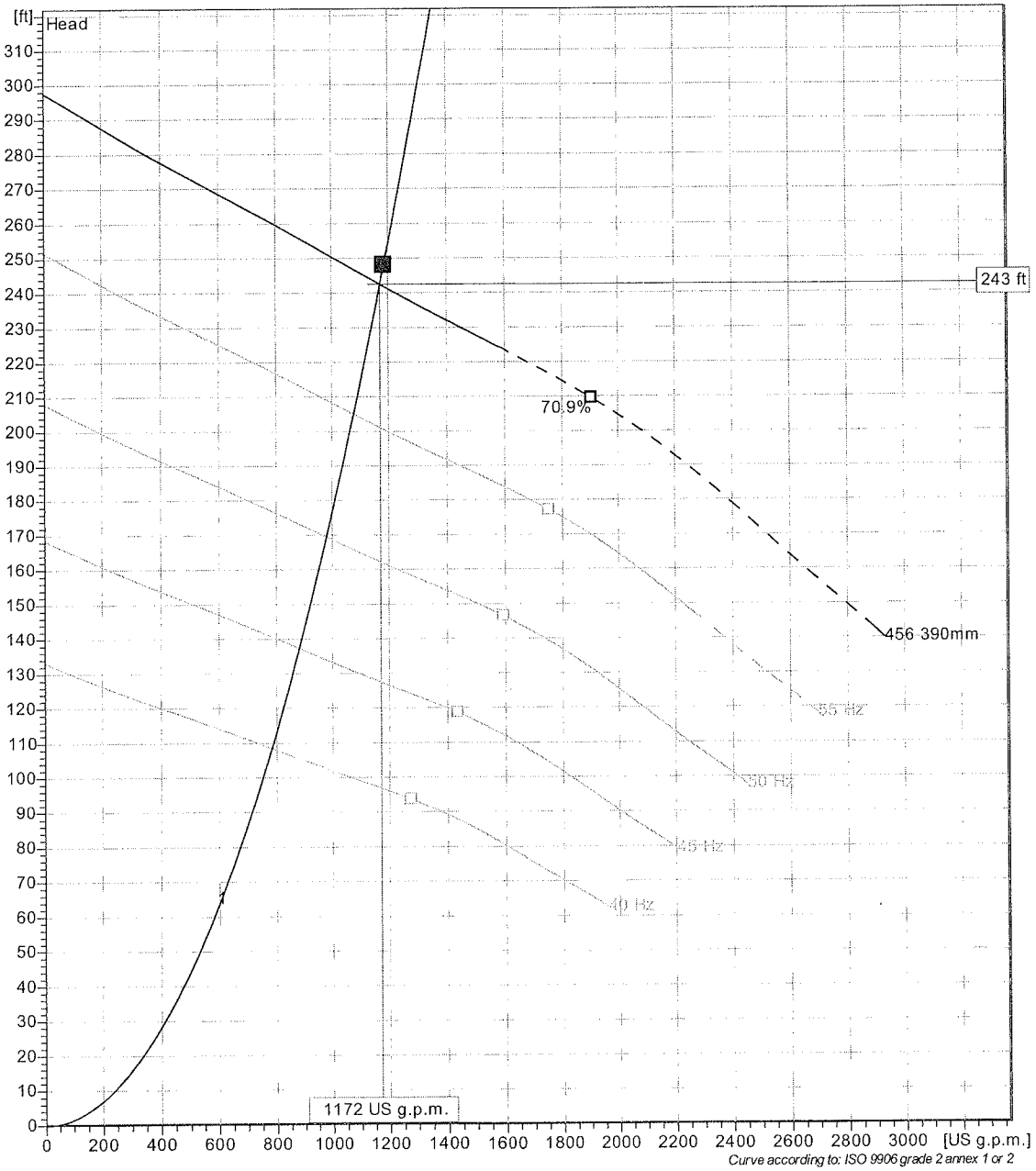
FLYGT

VFD Analysis



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	1170 US g.p.m.	243 ft	116 hp	1170 US g.p.m.	243 ft	116 hp	62 %	1310 kWh/US MG	11.4 ft
1	55 Hz	1080 US g.p.m.	205 ft	90.3 hp	1080 US g.p.m.	205 ft	90.3 hp	62 %	1100 kWh/US MG	9.96 ft
1	50 Hz	980 US g.p.m.	169 ft	67.8 hp	980 US g.p.m.	169 ft	67.8 hp	62 %	908 kWh/US MG	8.55 ft
1	45 Hz	882 US g.p.m.	137 ft	49.4 hp	882 US g.p.m.	137 ft	49.4 hp	62 %	738 kWh/US MG	7.22 ft
1	40 Hz	784 US g.p.m.	108 ft	34.7 hp	784 US g.p.m.	108 ft	34.7 hp	62 %	589 kWh/US MG	5.98 ft

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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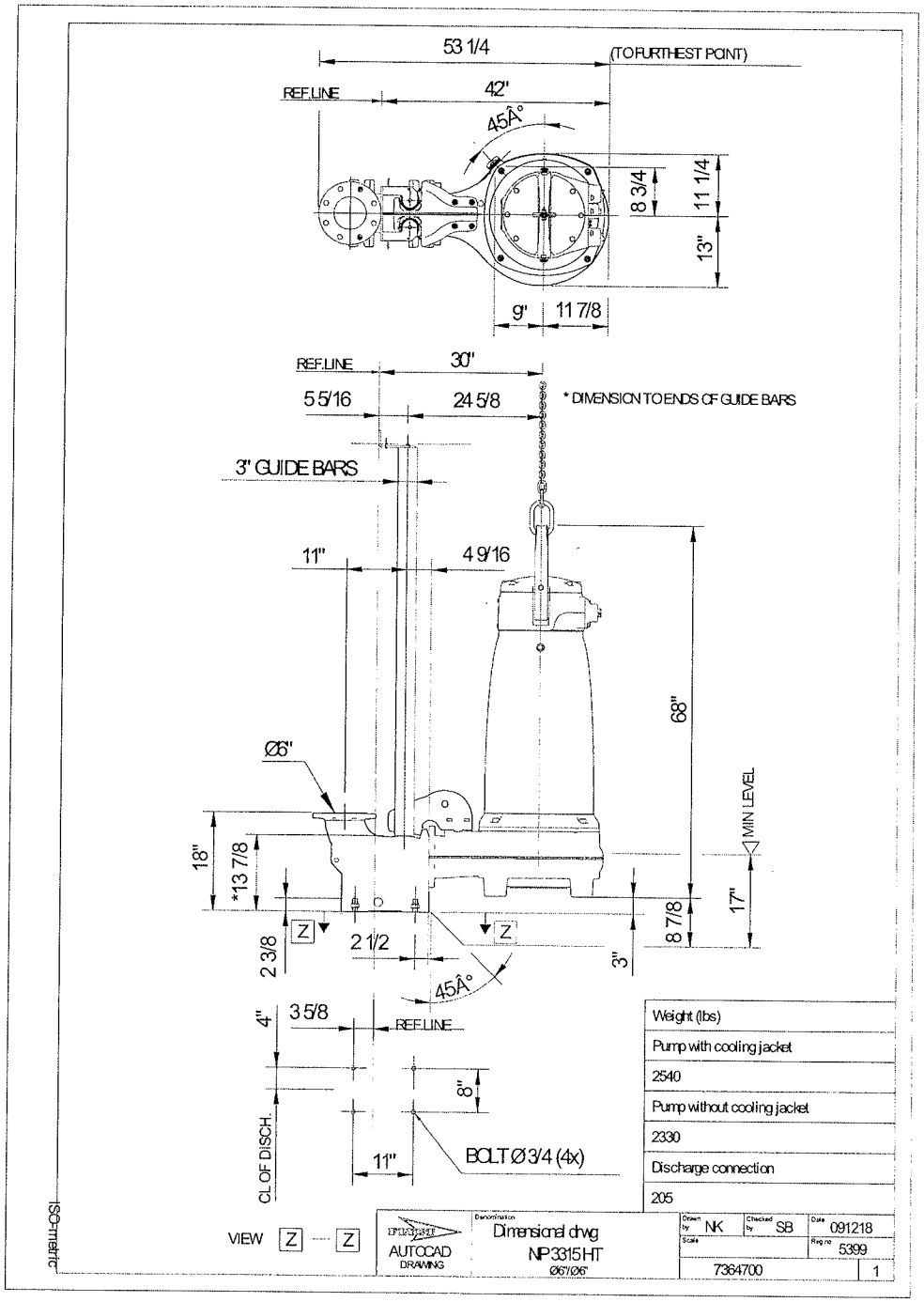
Dimensional drawing

FLYGT



Project	Project ID	Created by	Created on	Last update
			2012-04-13	

Pump ESP™

Smith & Loveless' Electronic Selection Program

14040 Santa Fe Trail Drive • Lenexa, Kansas 66215-1284 • Ph: 913-888-5201 • Fax: 913-888-2173 • answers@smithandloveless.com

Smith & Loveless Inc.

Location: Kitsap Co **Project Name:** Future

Customer: Kitsap Co **Engineer:** CH2M-Hill

Inquiry #: **WW Diam:** 12 **Type:** Classic **Pumps:** Duplex

Design Data:

Flow: 1200 GPM
Sta. piping size: 8"
Suction Piping Size: 12"
TDH: 229 FT.

Force Main Data:

Force main length:
Force main Dia.:
Force Main Vel: N/A

System Head (Max) C-Factor: → Static Head Max: → System Head Max: N/A

System Head (Min) C-Factor: → Static Head Min: → System Head Min: N/A

875 RPM Pumps:

	IMP. DIA.	BHP	EFF.	Suction Piping Recom.	Suction Piping Select	Station Piping Recom.	Station Piping Select	Max Suction Lift
○ 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 6B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 8D4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 8D4V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1170 RPM Pumps:

	IMP. DIA.	BHP	EFF.	Suction Piping Recom.	Suction Piping Select	Station Piping Recom.	Station Piping Select	Max Suction Lift
○ 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B2D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 6B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 8D4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 8D4V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1760 RPM Pumps:

	IMP. DIA.	BHP	EFF.	Suction Piping Recom.	Suction Piping Select	Station Piping Recom.	Station Piping Select	Max Suction Lift
○ 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B2D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 4D4B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
○ 6C3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
● 8D4V	14 5/8"	121.8	57.0%	8"	12"	8"	8"	19.4 FT.

585 RPM Pump:

○ 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1.) Max Suction lift is based on an elevation of 1000' ASL. For each 1000 foot increment, subtract an additional foot.

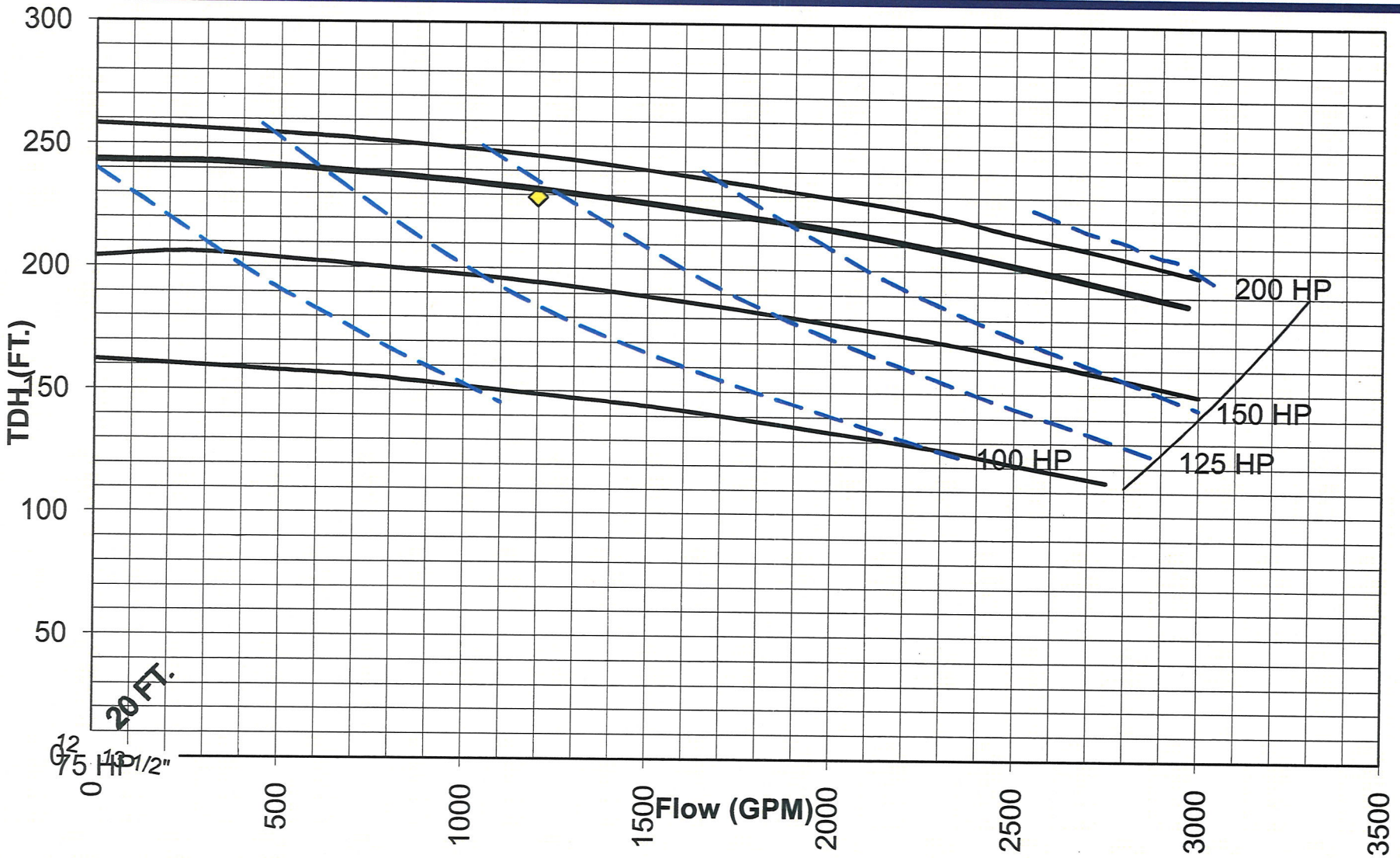
Max Suction Lift of pump must equal or exceed Required Suction Lift

Only stations with 8" or 12" pumps are available with 8" or larger station and discharge piping.

Representative: ADS Equipment, Inc Prepared By: Steve Azose Date: 4/8/2012

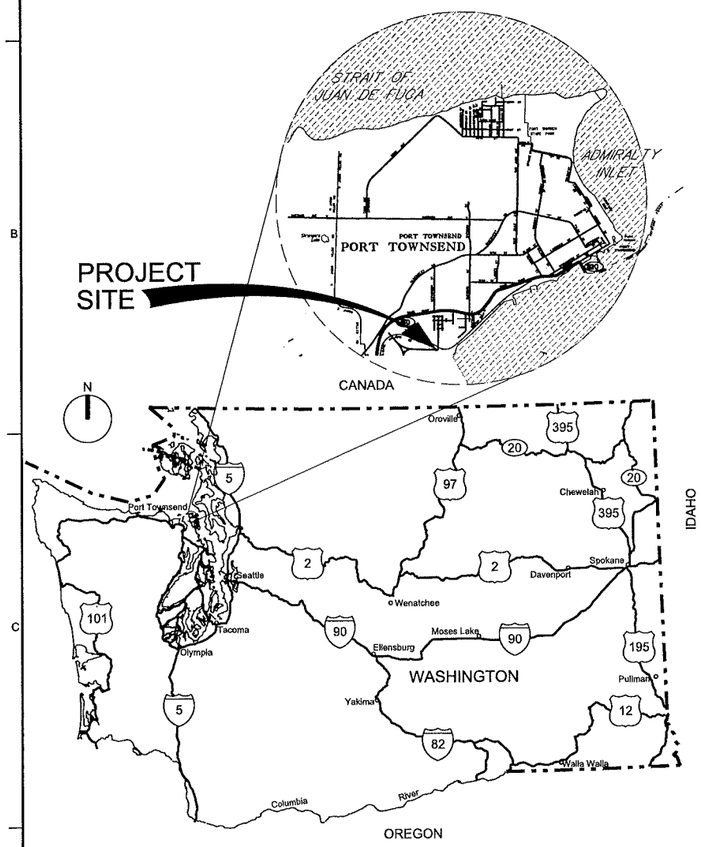
Pump Curve

Smith & Loveless Inc.

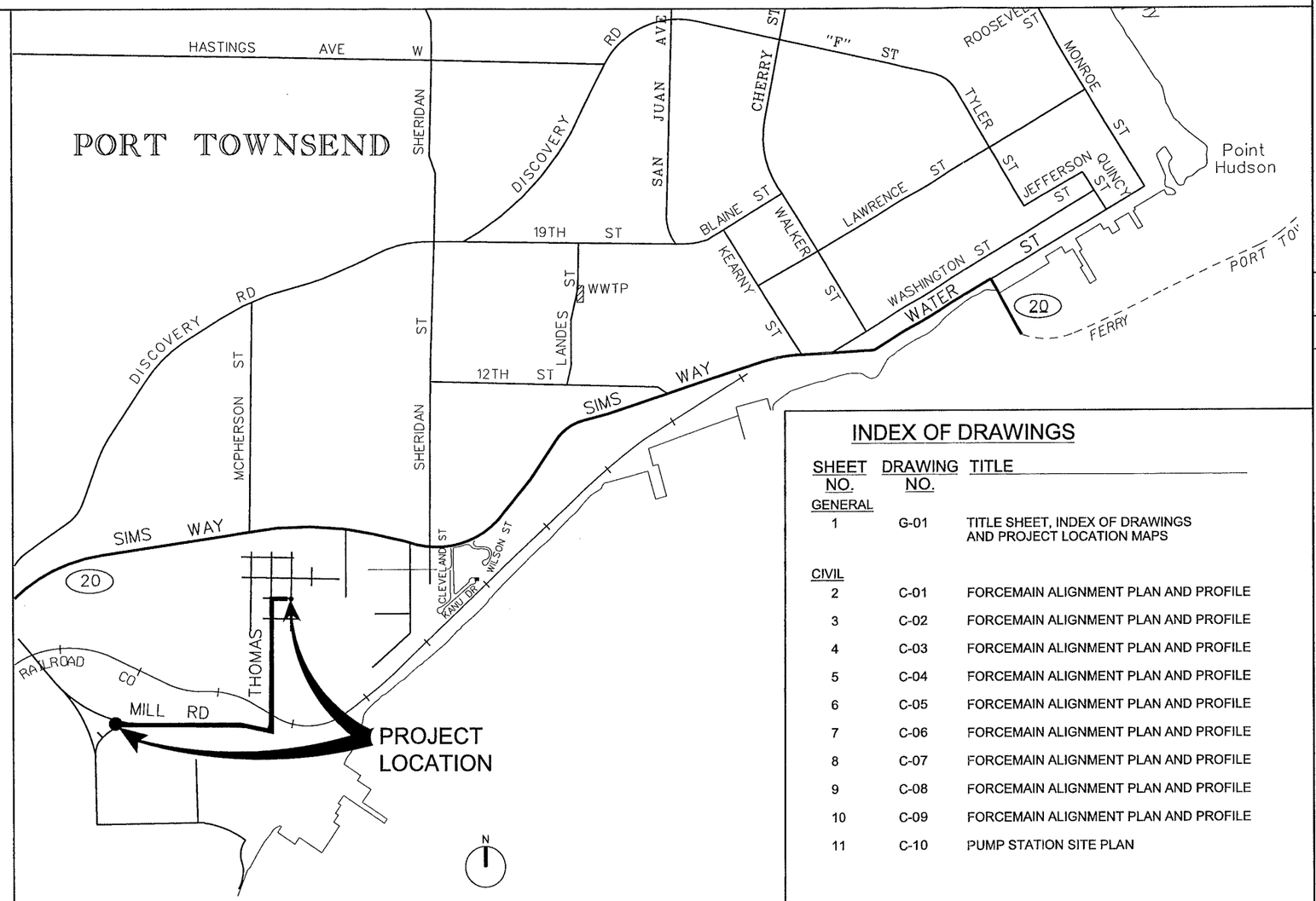


Appendix C:
Pump Station Force Main Alignment

PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCEMAIN
PORT TOWNSEND, WASHINGTON



VICINITY MAP
NTS



LOCATION MAP
NTS

INDEX OF DRAWINGS

SHEET NO.	DRAWING NO.	TITLE
GENERAL		
1	G-01	TITLE SHEET, INDEX OF DRAWINGS AND PROJECT LOCATION MAPS
CIVIL		
2	C-01	FORCEMAIN ALIGNMENT PLAN AND PROFILE
3	C-02	FORCEMAIN ALIGNMENT PLAN AND PROFILE
4	C-03	FORCEMAIN ALIGNMENT PLAN AND PROFILE
5	C-04	FORCEMAIN ALIGNMENT PLAN AND PROFILE
6	C-05	FORCEMAIN ALIGNMENT PLAN AND PROFILE
7	C-06	FORCEMAIN ALIGNMENT PLAN AND PROFILE
8	C-07	FORCEMAIN ALIGNMENT PLAN AND PROFILE
9	C-08	FORCEMAIN ALIGNMENT PLAN AND PROFILE
10	C-09	FORCEMAIN ALIGNMENT PLAN AND PROFILE
11	C-10	PUMP STATION SITE PLAN

30% Design - Not For Construction

NO.	DATE	REVISION	BY	APVD
DSGN	A. ROSHAK	DR K. WEIGUM	CHK J. BURNAM	APVD J. BURNAM

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

GENERAL

TITLE SHEET, INDEX OF DRAWINGS AND PROJECT LOCATION MAPS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	G-01
SHEET	1 of 5

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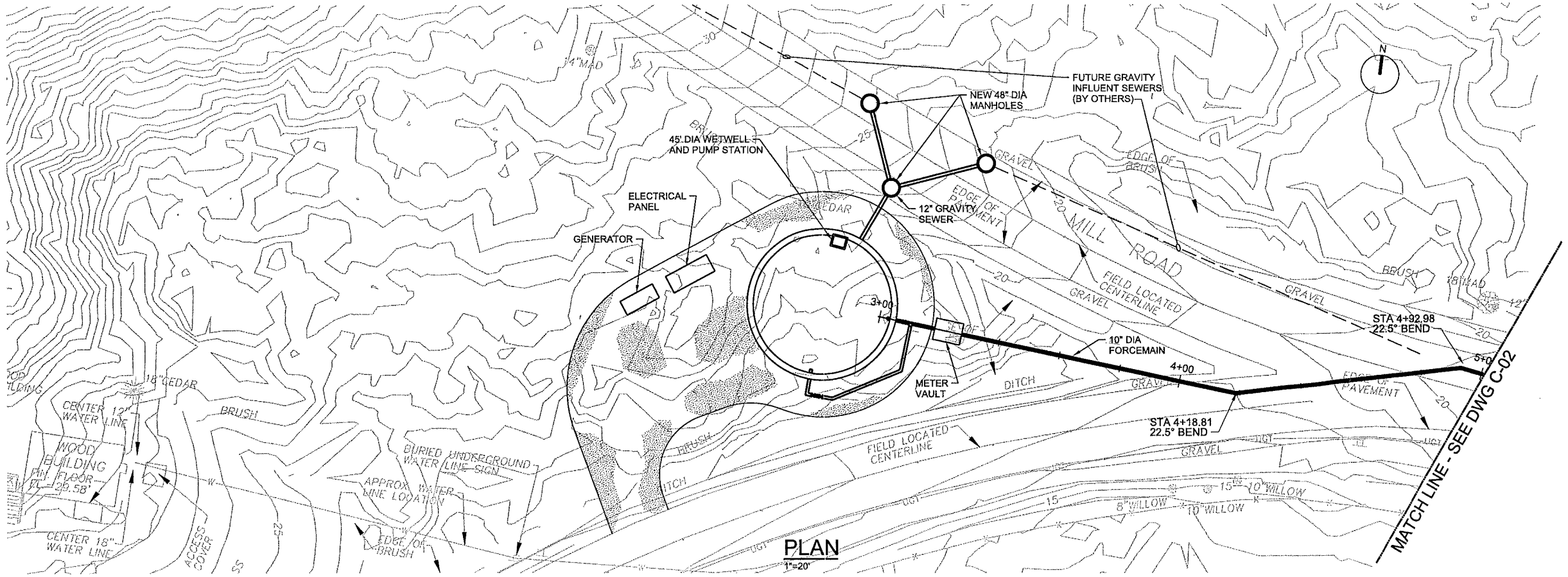

PLAN
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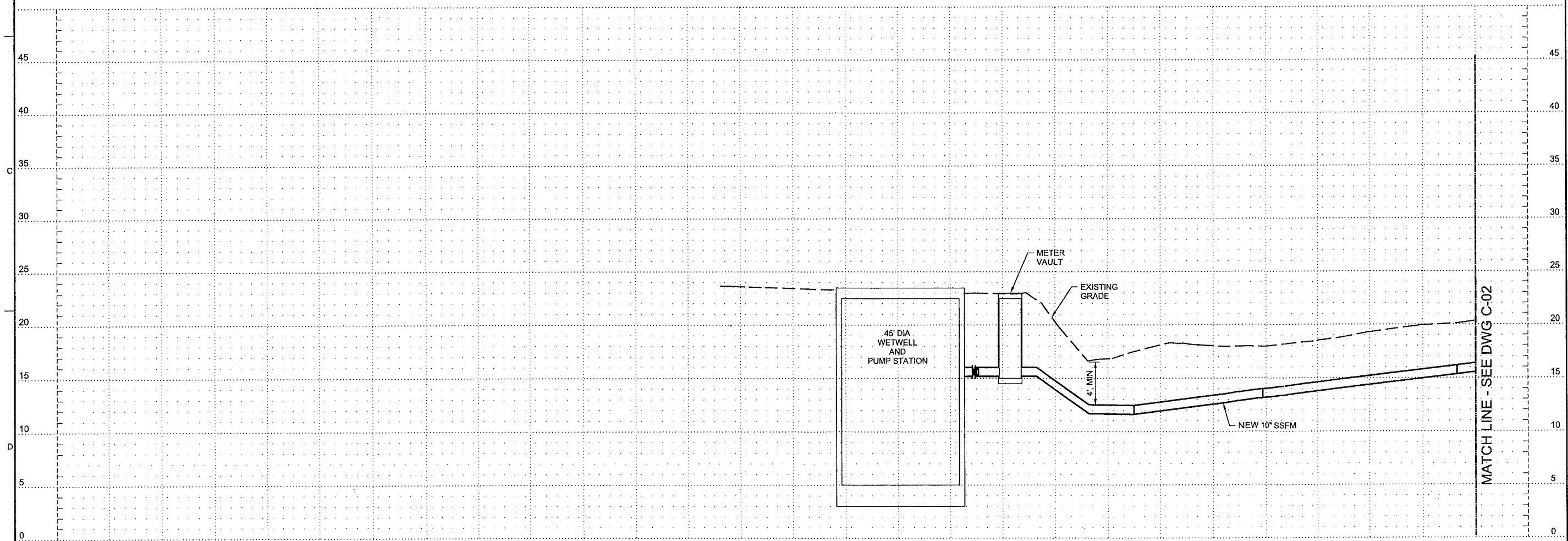

PROFILE
1"=20' HORIZ, 1"=5' VERT

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NO.	DATE	REVISION	BY	APVD
DSGN	A. ROSHAK	DR D SUNSERI	CHK J BURNAM	APVD J BURNAM

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MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

CIVIL
FORCEMAIN ALIGNMENT
PLAN AND PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-01
SHEET	

PRELIMINARY

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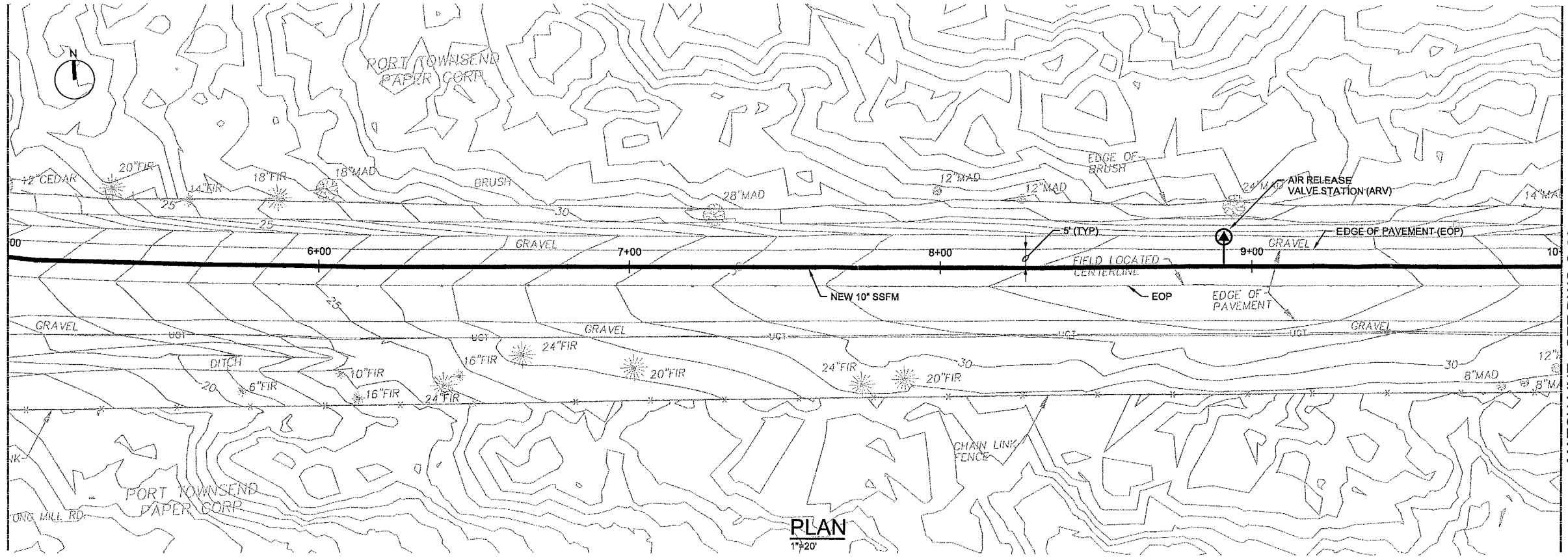
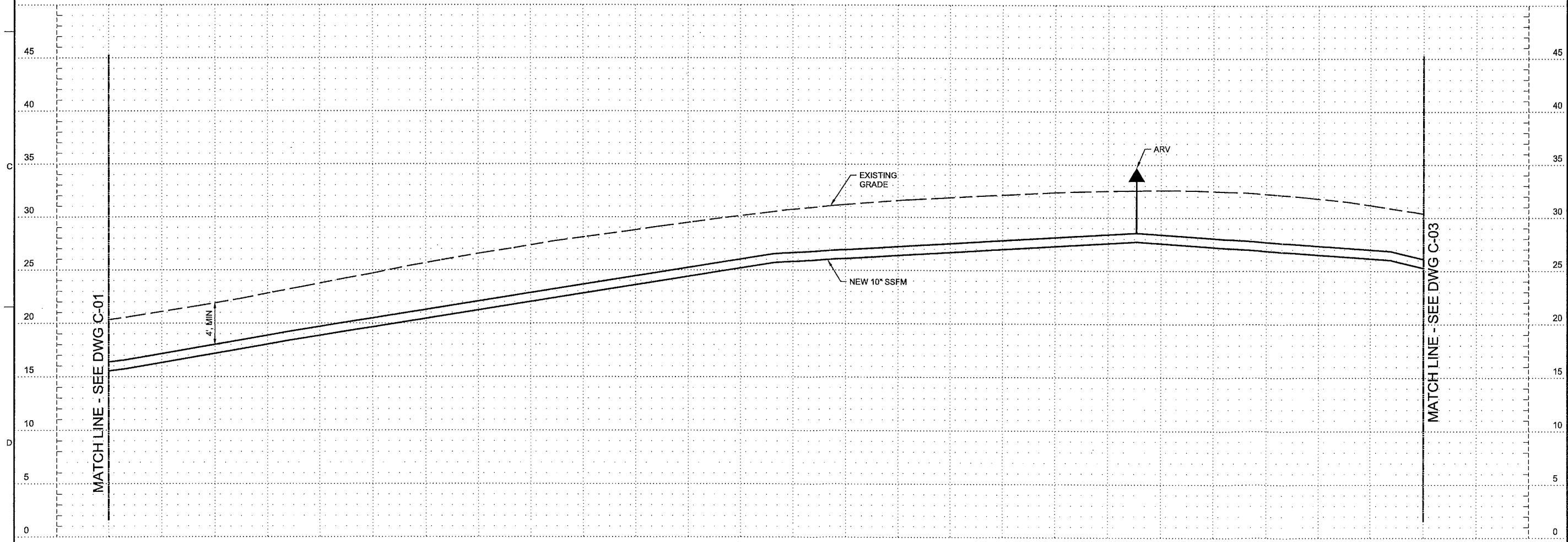


PLAN
1"=20'



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30% Design - Not For Construction

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DSGN	A.ROSHAK	DR D.SUNSERI	CHK J.BURNAM	APVD J.BURNAM

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MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA.

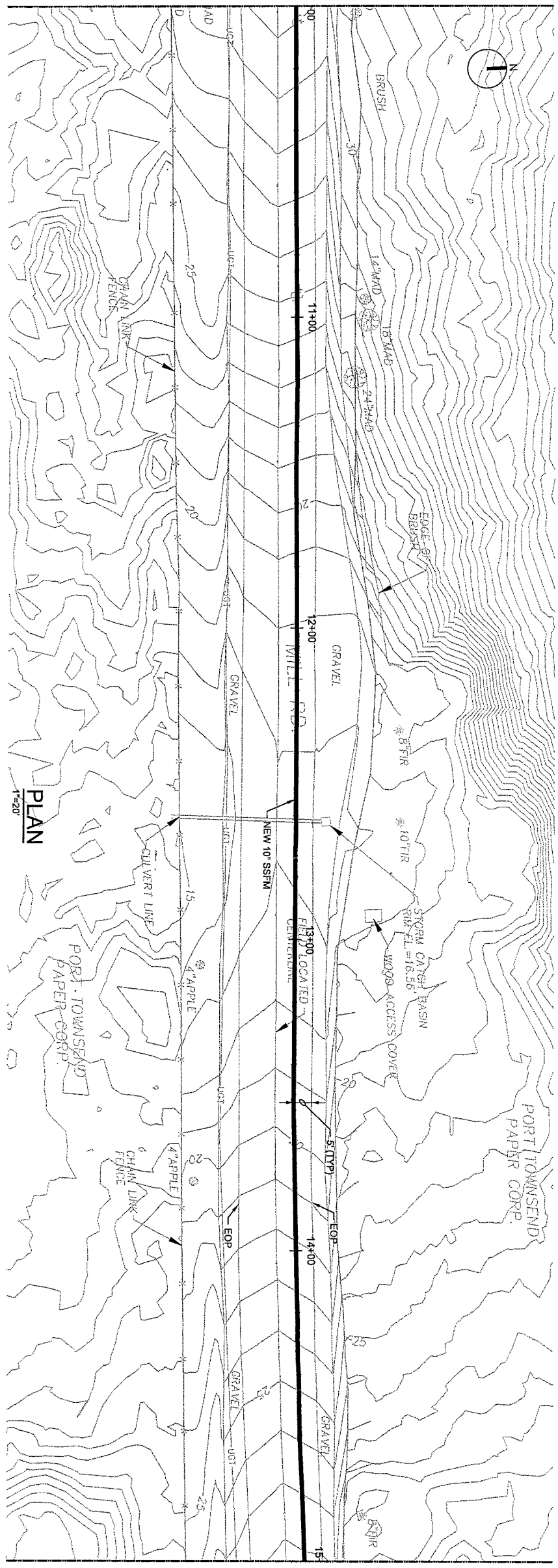
CIVIL
FORCEMAIN ALIGNMENT
PLAN AND PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-02
SHEET	

PRELIMINARY

MATCH LINE - SEE DWG C-02



MATCH LINE - SEE DWG C-04

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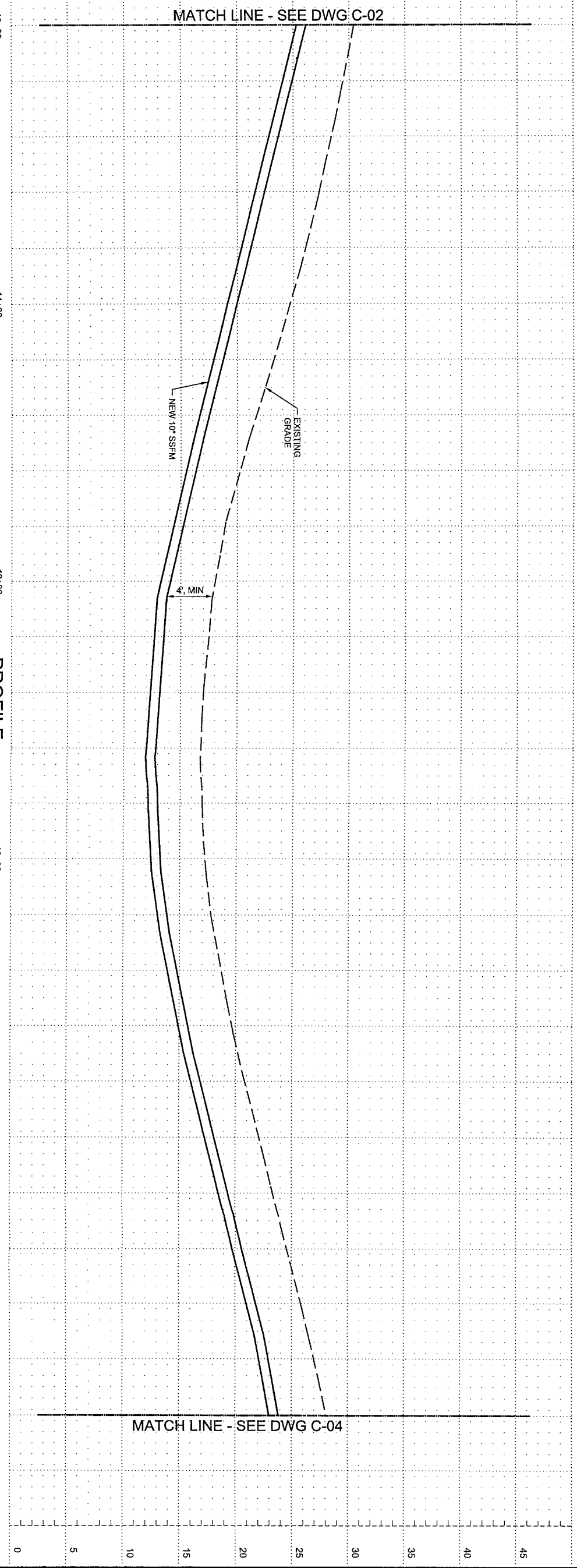

PROFILE
1"=20' HORIZ, 1"=5' VERT

30% Design - Not For Construction

FILENAME: C-003_425179.dgn PLOT DATE: 2012\10\09 PLOT TIME: 2:28:58 PM

PRELIMINARY

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FORCEMAIN ALIGNMENT
PLAN AND PROFILE

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN

PORT TOWNSEND, WA

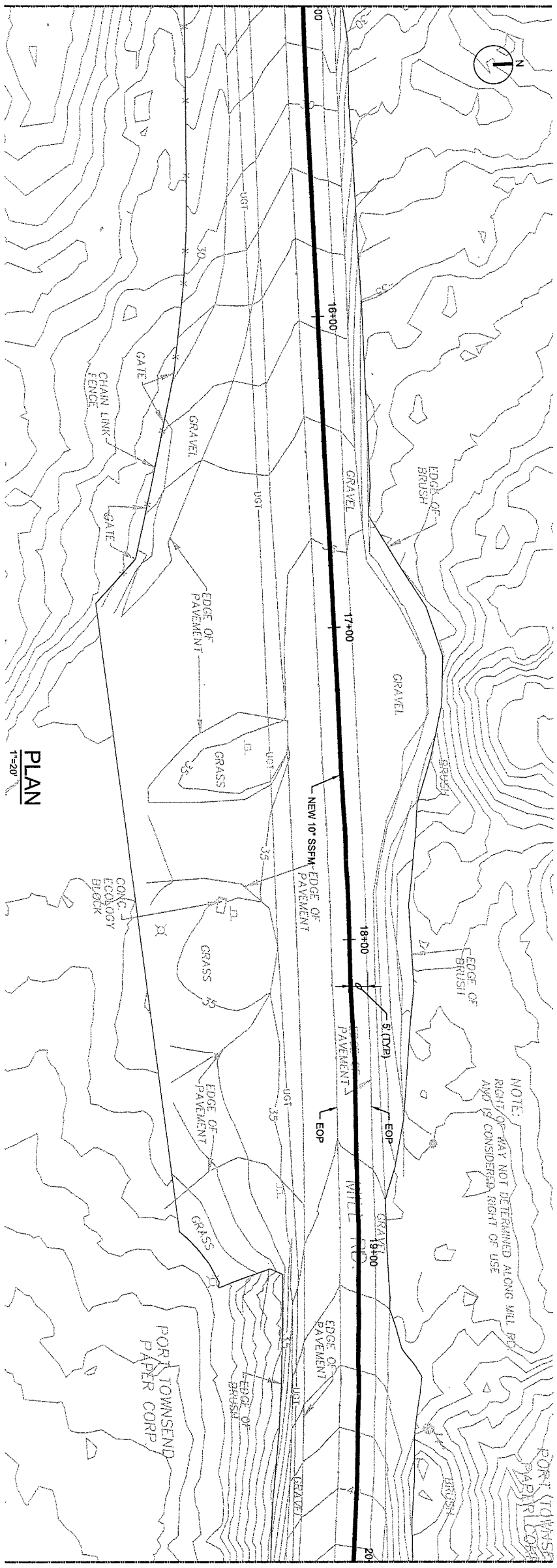
NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
A. ROSHAK	D SUNSERI	J BURNAM	J BURNAM

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET ADJUST SCALE ACCORDINGLY

DATE OCTOBER 2012
PROJ 425179
DWG C-03
SHEET

MATCH LINE - SEE DWG C-03



PLAN
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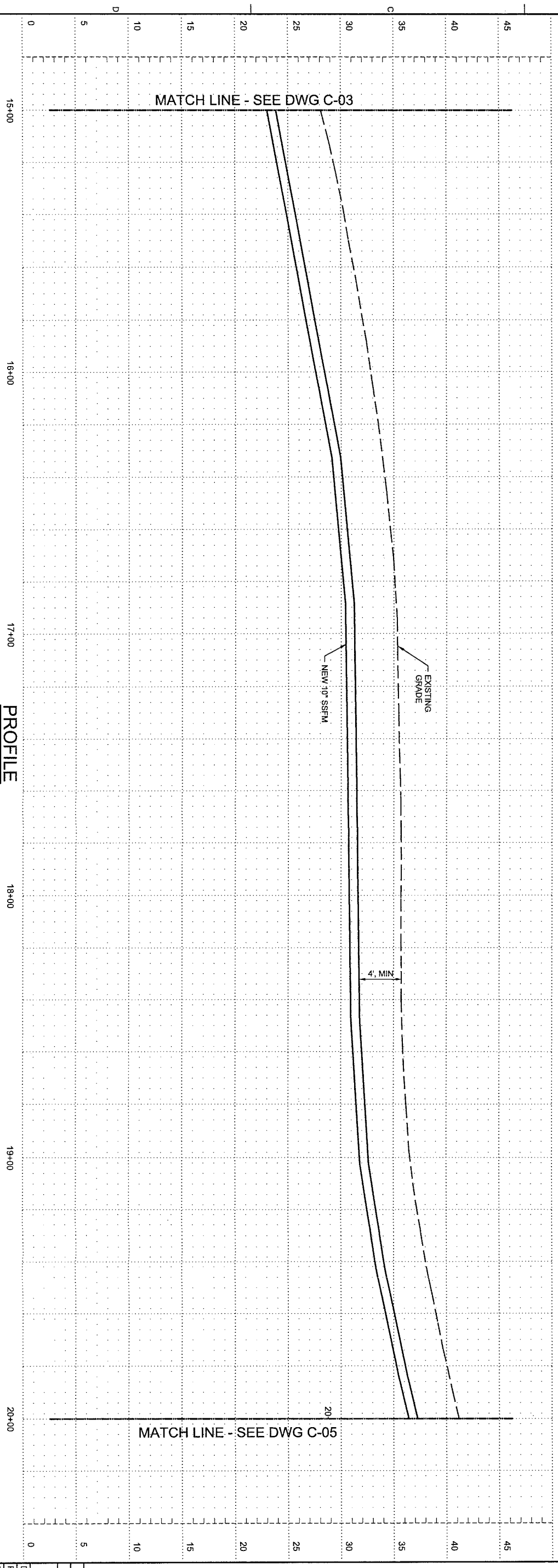
MATCH LINE - SEE DWG C-05

MATCH LINE - SEE DWG C-03



PROFILE
1"=20' HORIZ, 1"=5' VERT

MATCH LINE - SEE DWG C-05

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FORCEMAIN ALIGNMENT
PLAN AND PROFILE

PORT TOWNSEND
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AND FORCEMAIN

PORT TOWNSEND, WA

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
A. ROSHAK	D SUNSERI	J BURNAM	J BURNAM

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE OCTOBER 2012
PROJ 425179
DWG C-04
SHEET

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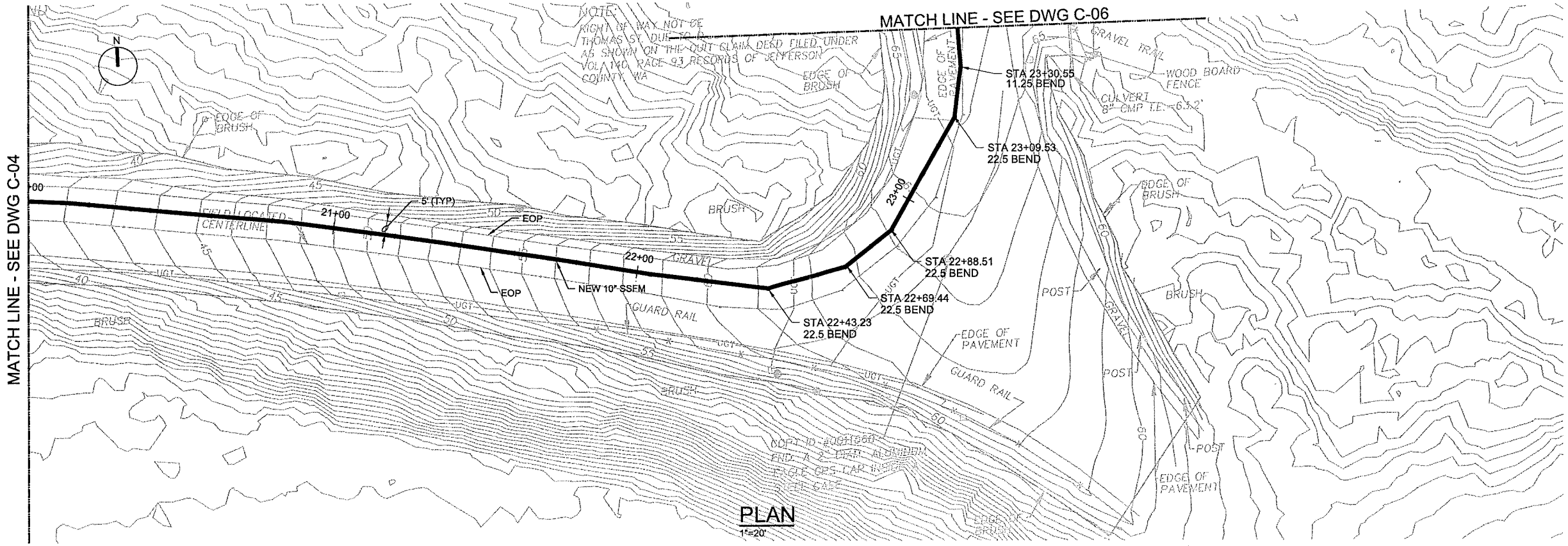
PRELIMINARY



NO.	DATE	DSGN	DR	CHK	APVD	BY
		A. ROSHAK	D.SUNSERI	J.BURNAM	J.BURNAM	

REVISION

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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PLAN AND PROFILE

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-05
SHEET	

PRELIMINARY

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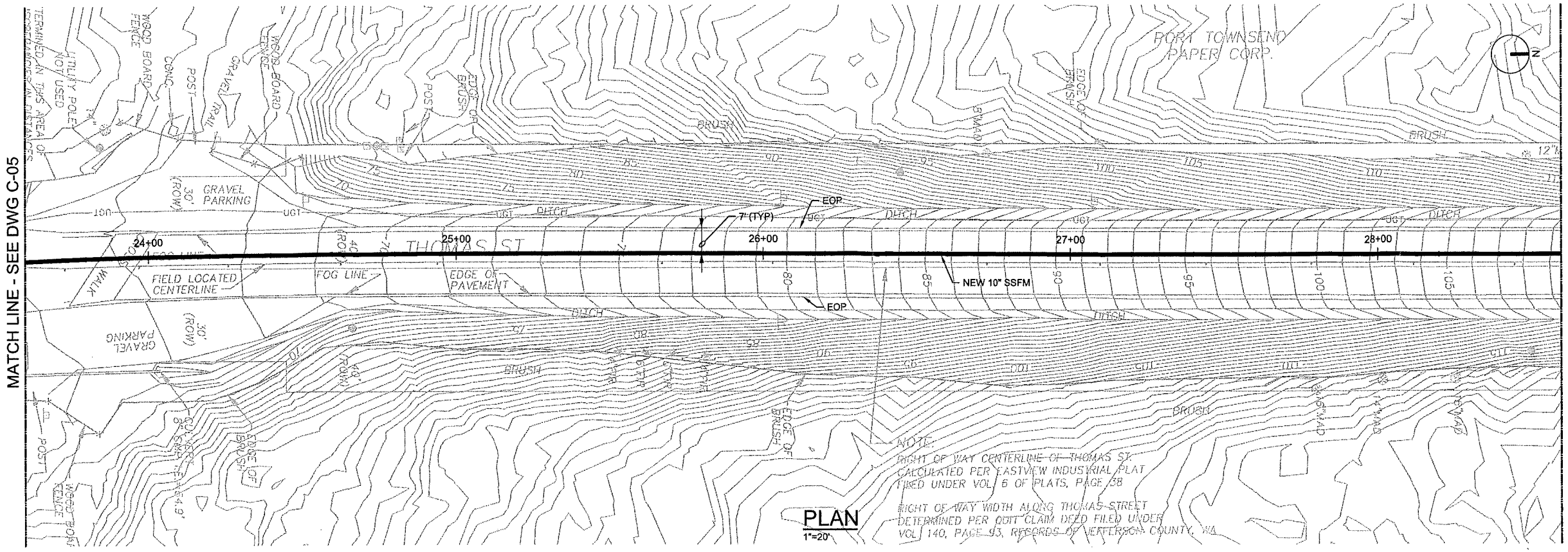
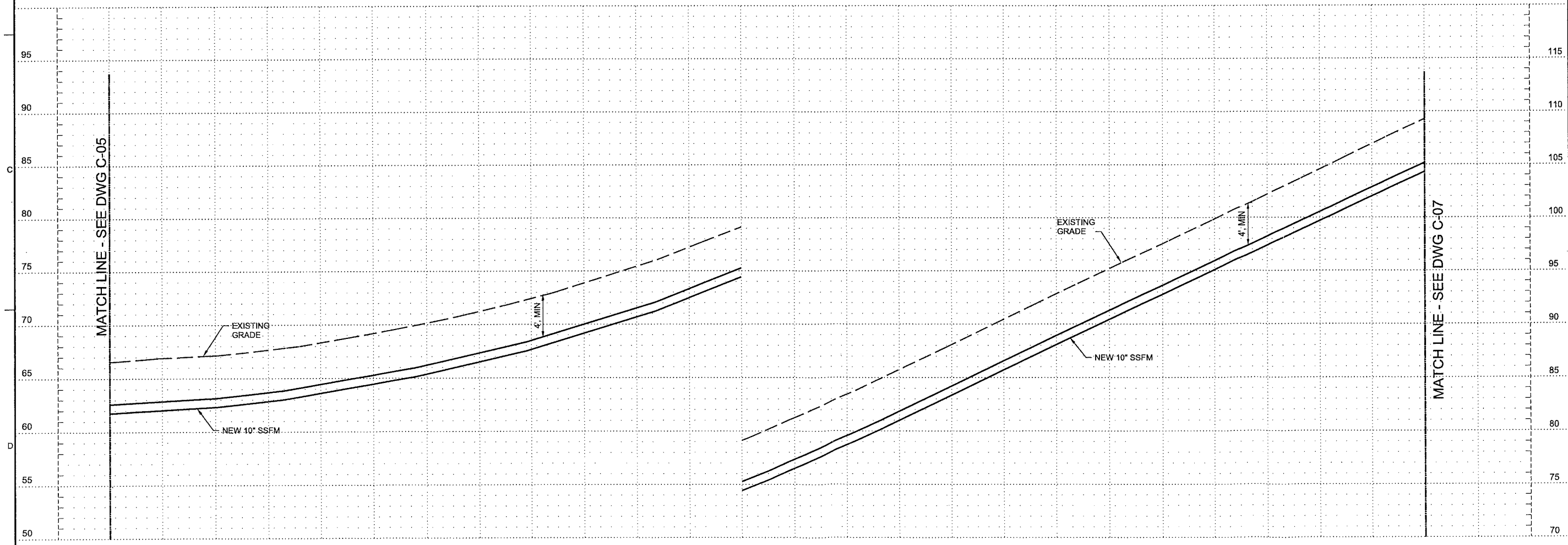


PLAN
1"=20'



PROFILE
1"=20' HORIZ, 1"=5' VERT

PROFILE
1"=20' HORIZ, 1"=5' VERT

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NO.	DATE	DSGN	DR	CHK	APVD	BY
		A. ROSHAK	D. SUNSERI	J. BURNAM	J. BURNAM	

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN

PORT TOWNSEND, WA

VERIFY SCALE
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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-06
SHEET	

PRELIMINARY

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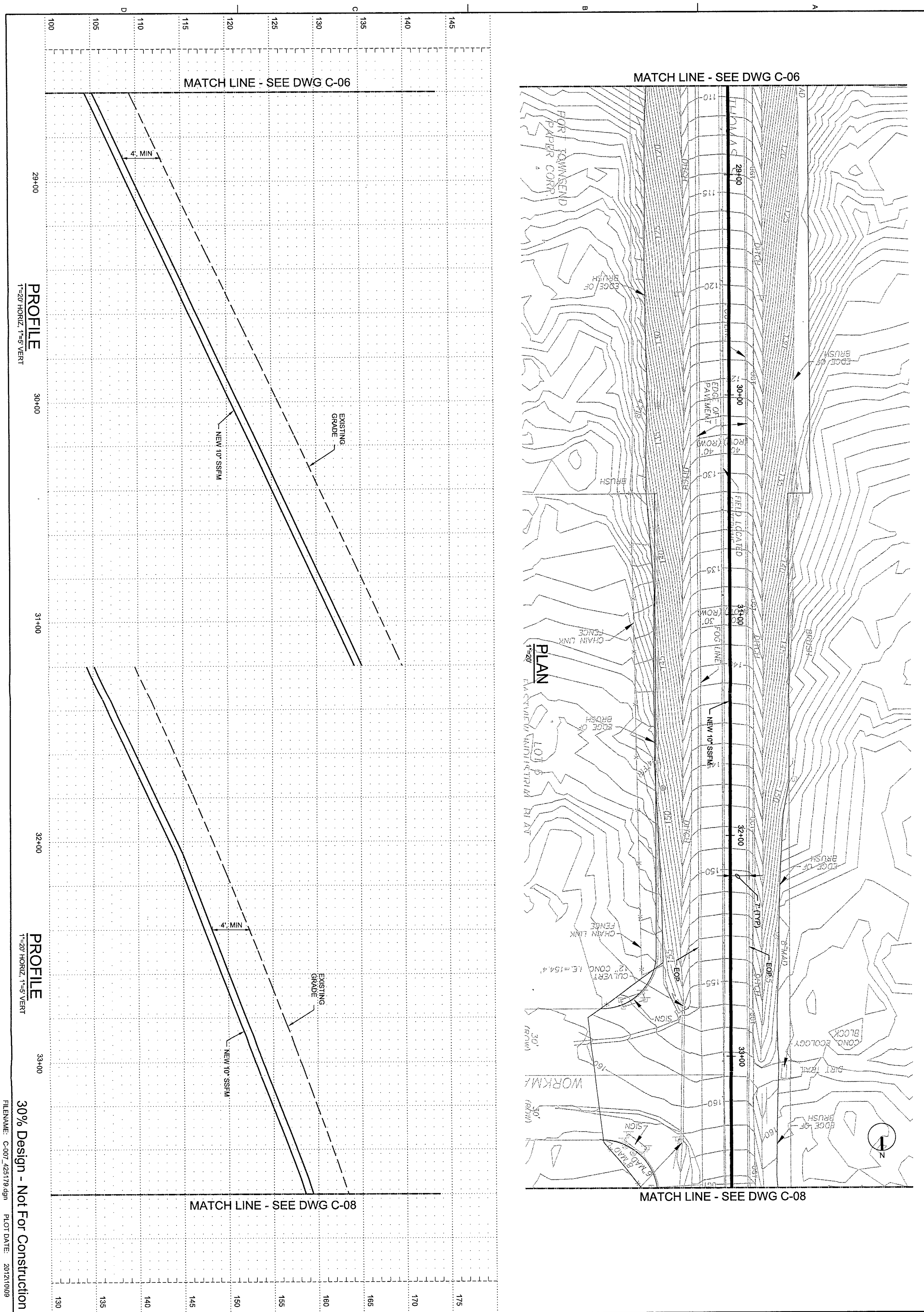

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PLOT TIME: 9:58:29 AM

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CIVIL

FORCEMAIN ALIGNMENT PLAN AND PROFILE

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN

PORT TOWNSEND, WA

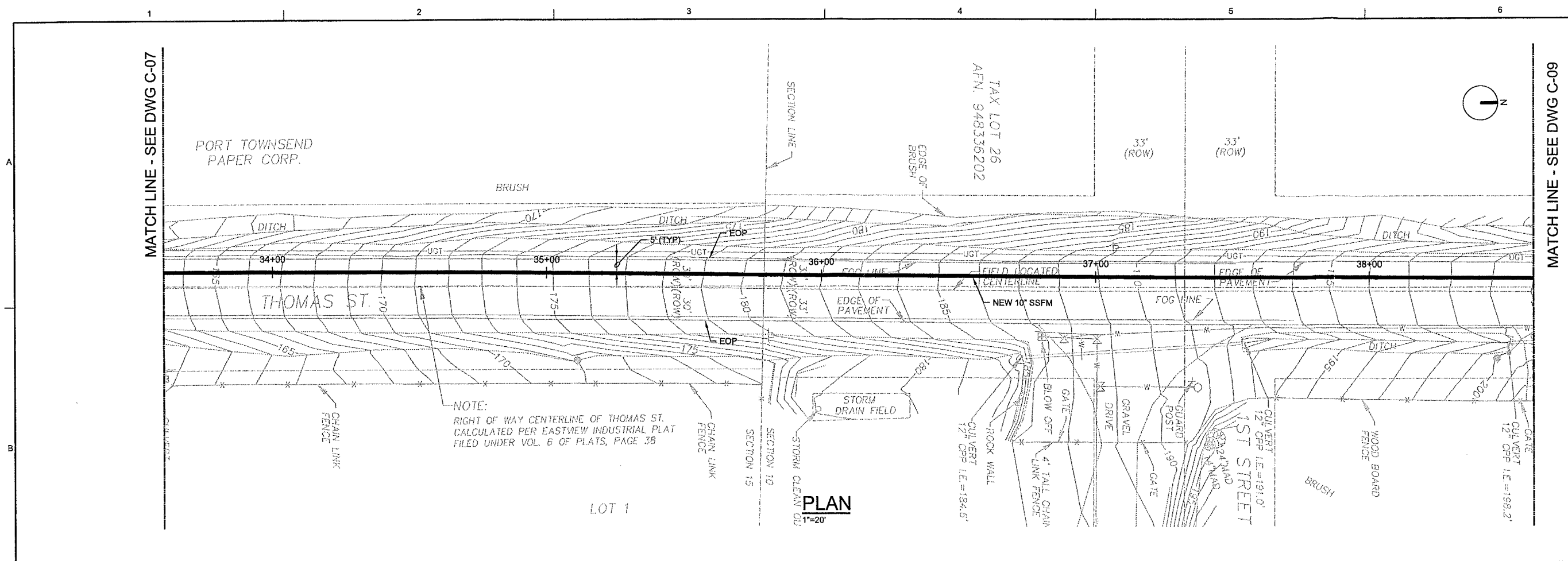
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-07
SHEET	

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
A. ROSHAK	D SUNSERI	J BURNAM	J BURNAM

PRELIMINARY



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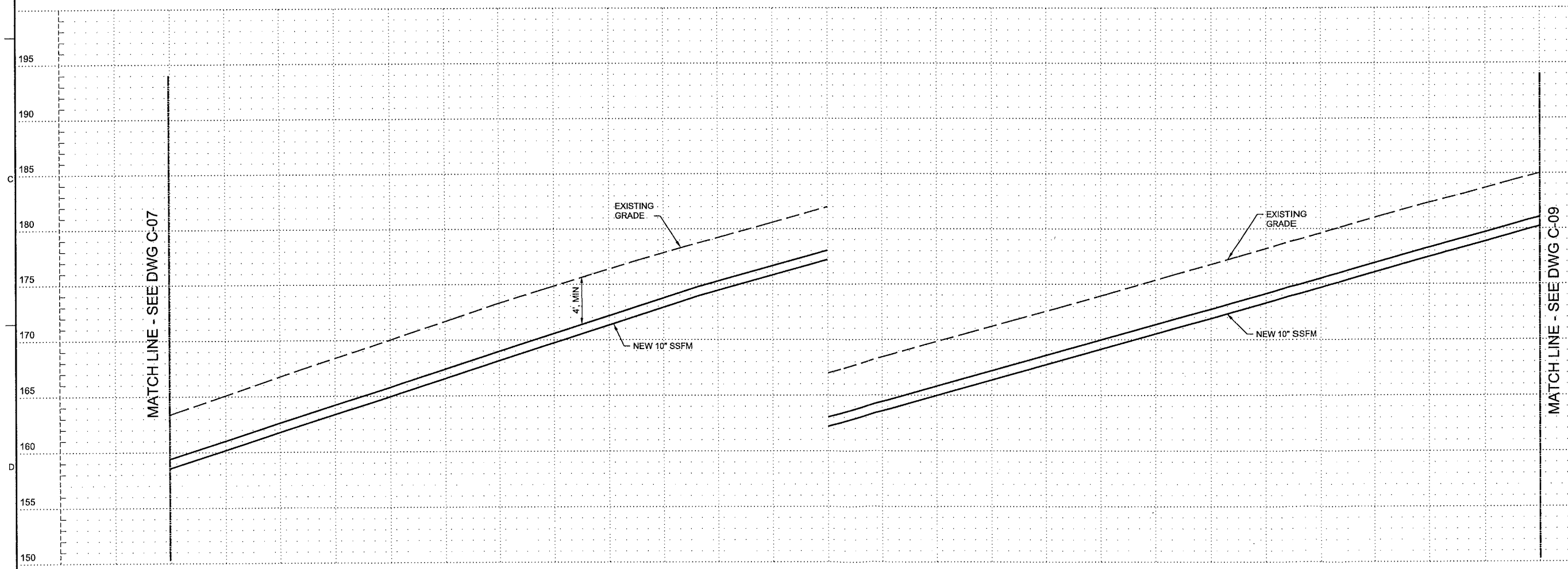

PROFILE
1"=20' HORIZ, 1"=5' VERT

PROFILE
1"=20' HORIZ, 1"=5' VERT

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PLAN AND PROFILE

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-08
SHEET	

PRELIMINARY

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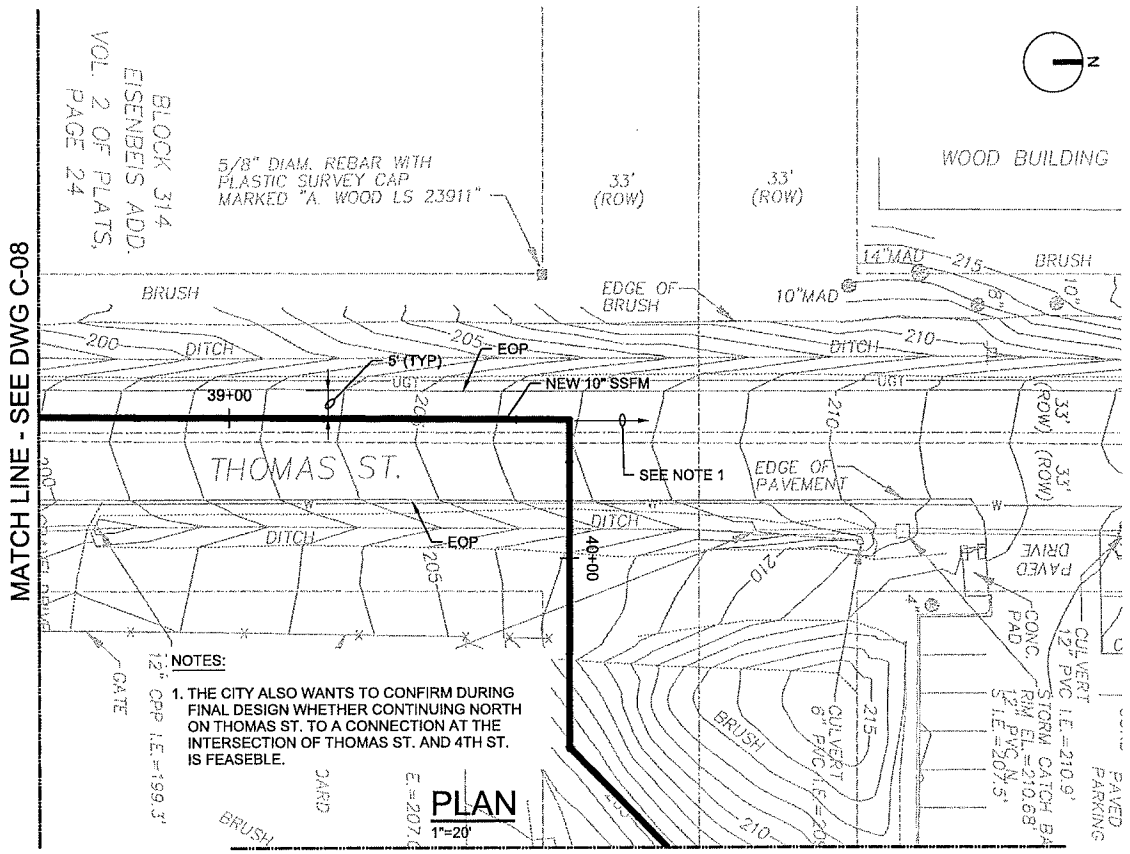
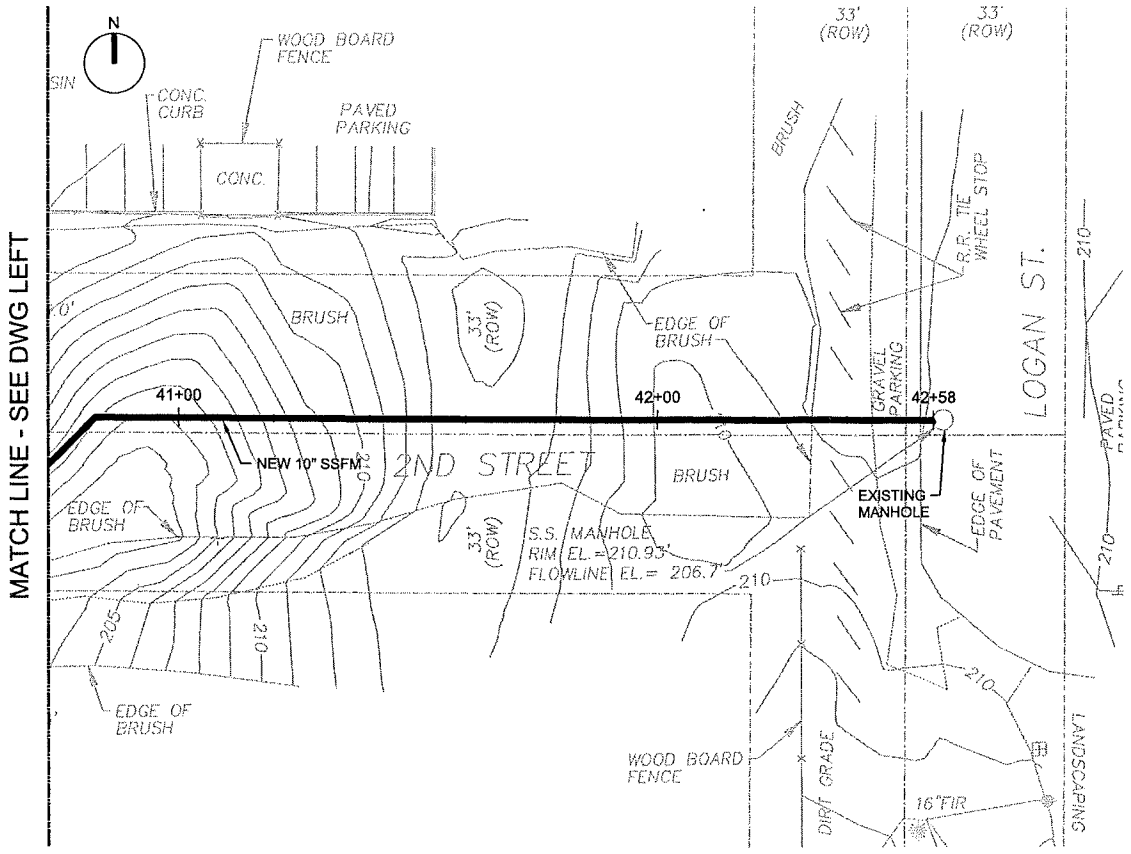


MATCH LINE - SEE DWG C-08

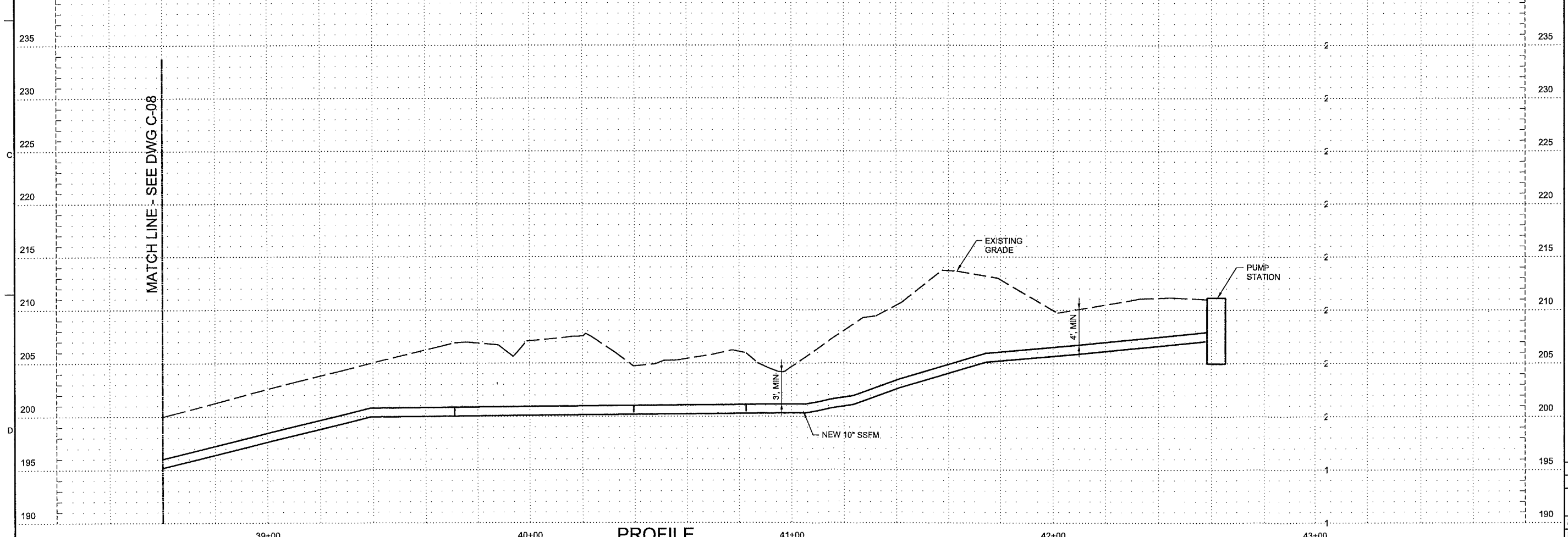
PLAN
1"=20'

MATCH LINE - SEE DWG RIGHT



MATCH LINE - SEE DWG LEFT

PLAN
1"=20'



PROFILE
1"=20' HORIZ, 1"=5' VERT

30% Design - Not For Construction

NO.	DATE	DSGN
		DR
		CHK
		APVD
		BY

REVISION

D SUNSERI
J BURNAM
APVD
J BURNAM

A. ROSHAK

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

CIVIL
FORCEMAIN ALIGNMENT
PLAN AND PROFILE

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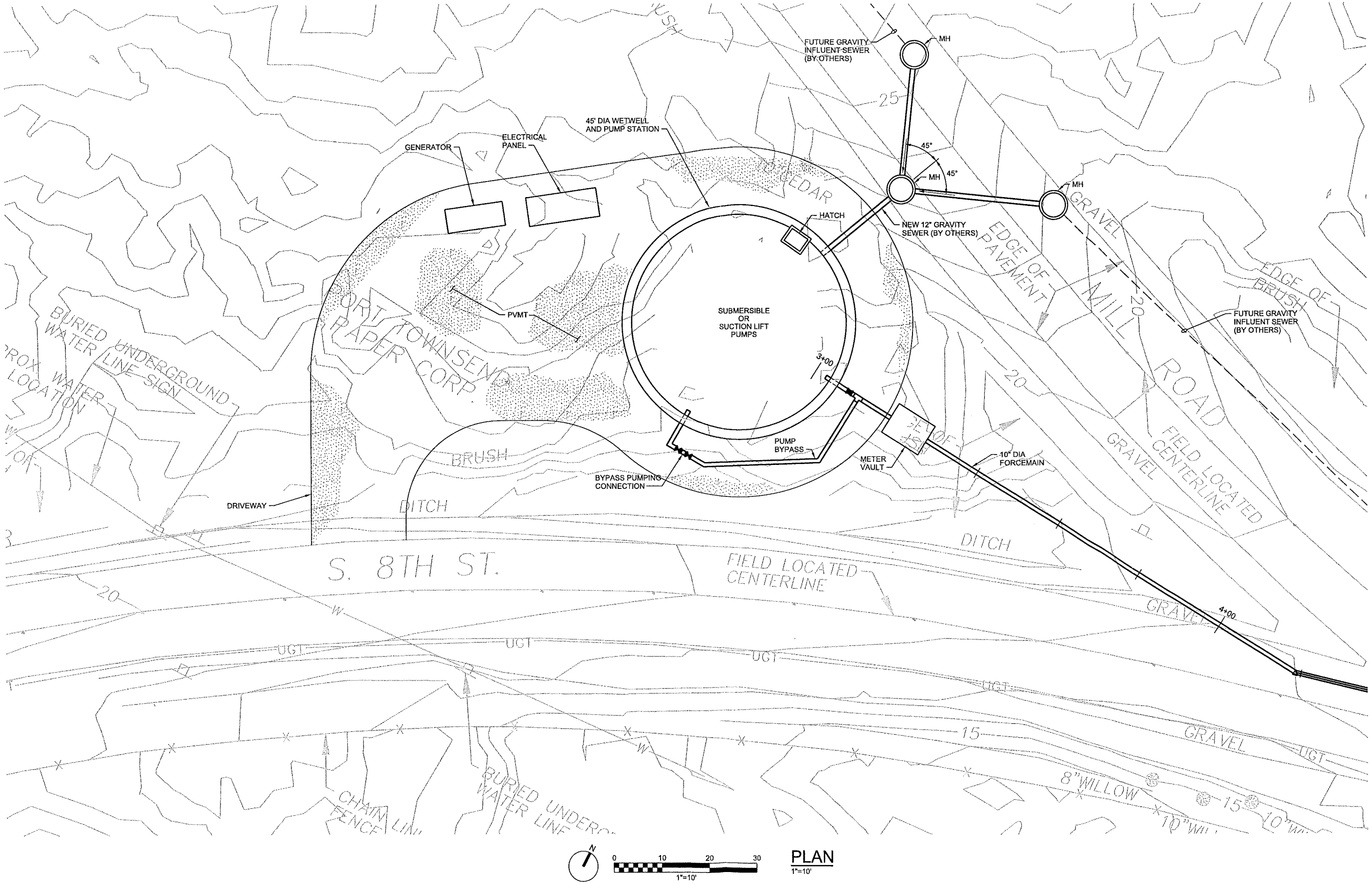
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-09
SHEET	

PRELIMINARY



N

0 10 20 30

1"=10'

PLAN

1"=10'

30% Design - Not For Construction

NO.	DATE	REVISION	BY	APVD
DSGN	A. ROSHAK	DR D SUNSERI	CHK J BURNAM	APVD J BURNAM

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN

PORT TOWNSEND, WA

CIVIL

PUMP STATION SITE PLAN

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-10
SHEET	

PRELIMINARY

FILENAME: C-011_425179.dgn PLOT DATE: 2012\10\09 PLOT TIME: 10:30:11 AM

Appendix D:
Cost Estimate

MEMORANDUM CH2MHILL

City of Port Townsend

Mill Road Pump Station & Force Main

Construction Cost Estimate

PREPARED FOR: Jack Burnam/SEA

PREPARED BY: Craig Moore/SEA

DATE: July 17, 2012

PROJECT NUMBER: 425179

Purpose

The purpose of this memorandum is to document the cost estimating methodology and assumptions used in preparing the Schematic Design construction cost estimate for the Port Townsend Pump Station and Force Main. The basis of this cost estimate is summarized below:

Original Estimate Date:	May 23, 2012
Revision:	July 17, 2012
Construction Cost Index (CCI) Number:	Seattle ENR CCI (April 2012) 9056
Estimate Type:	15% Estimate (Class 3)
Accuracy Level:	+30% to -20%

The following memorandum provides a description of the cost estimating methodology, overall costs, markups, assumptions, productivity rates, cost basis, and excluded costs.

Summary of Costs

The following is a summary of the estimate costs. The base construction cost shown includes mobilization, bonds, contingency and escalation. It does not include project costs such as design, administrative, legal, or services during construction. See the attached estimate for a breakdown of the costs included in the estimate.

Option Costs

	Low Range	Estimate Range	High Range
	-20%	**Base Cost**	+30%
Submersible Pump Station & Force Main	$1,633,000	**$2,041,000**	$2,653,000
Suction Lift Pump Station & Force Main	$1,702,000	**$2,127,000**	$2,765,000
Force Main	$882,000	**$1,102,000**	$1,433,000
Gravity Pipe Alt 1	$306,000	**$383,000**	$498,000
Gravity Pipe Alt 2	$394,000	**$492,000**	$640,000
Gravity Pipe Common Alt 1 & 2	$542,000	**$678,000**	$881,000
Gravity Pipe Alt 3	$170,000	**$213,000**	$277,000
Gravity Pipe Common Alt 1, 2 & 3	$43,000	**$54,000**	$70,000
Gravity Pipe Alt 4	$674,000	**$843,000**	$1,096,000

Methodology

This cost estimate is considered a Schematic Design Estimate (Class 3) construction cost estimate. It is based upon the 15 percent design drawings and specification dated May 2012, and design information provided by the engineer at the time of the estimate.

Where possible, a quantity takeoff was developed for all elements shown in sufficient detail in the design drawings or described in the report. For an item known to exist but not defined in the project drawings, the cost estimator applied an allowance based on estimator experience and consultation with the project engineer.

The final costs of the project will depend on actual labor and material costs at the time of bid, actual site conditions, productivity, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from those presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

Markups

Table 1 summarizes various markups applied to the cost estimate to develop the overall construction cost. Unit costs include contractor overhead and profit. Mobilization, contingency, sales tax, market factor and escalation are also applied to the bottom line totals.

TABLE 1
Markup Summary

Markup	Percentage
Contractor Overhead & Profit (In unit costs)	18%
General Conditions	7%
Mobilization/Bonds/Insurance	5.16%
Construction Cost Estimate Contingency	40%
Escalation (Aug 2013)	3.58%
Sales Tax (Port Townsend)	9%
Market Conditions	0%

Assumptions

The following assumptions were used to develop the construction cost estimate:

General Assumptions:

1. Labor rates are based on the RS Means National Average Rate and adjusted for local wage rates using the RS Means regional adjustment factor.
2. The estimate currently includes escalation to mid-point of construction to August 2013.
3. Costs assume that the work is done during a regular 40 hour work week and does not include any overtime cost markups.
4. Costs do not include purchase of easements or right-of-way, engineering, administration or owner costs beyond the capital construction costs. The cost estimate is intended to represent the total contractor bid price as shown on the bid price schedule at the time of the bid opening.
5. Site access for the contractor and contractor staging areas are assumed to be adequate for the contractors needs.
6. The estimate is based on aggregates, drain sand, and clay materials being available locally to the contractor.
7. Temporary erosion and sediment control are expected to be minor. No wetland impacts are known at this time.
8. Pipe trenching is based on 5' of cover to the top of the pipe.

9. It is assumed that dewatering for pipe trenching can be controlled with sump pumps in trench.

10. Roadway patching is based on 6" of asphalt over 6" of crushed surface base course.

11. The pump station wet well construction is based on a dropped caisson construction.

12. Due to the pump cooling requirements the submersible pump station wet well is 30" deeper than the suction lift pump station.

13. The pipe alternatives costs with the exception of Alternative 3 are based on the pipeline being placed in the roadway and include ACP demo and patching. Alternative 3 is outside of the roadway and travels cross country.

14. The revision adds a 350 KW emergency generator to the pump station and adds VFDs to the pumps.

Productivity Rates

The following assumptions were used in determining the Productivity Rates:

1. Contractor production rates for installation of standard items are taken from RS Means or are per the RS Means database and are based on 40 work weeks.

2. For equipment installation or non-standard items, production rates are per the cost estimator's best judgment based on experience and consultation with the design engineer.

Cost Basis

Various sources of cost data were used to develop this construction cost estimate. Construction costs were taken from RS Means Construction Cost Data. When applicable, recent bid tab information was used to establish costs for bid items.

Cost Quote

Cost quotes were received on the following items:

- Flygt 160 hp submersible pump from Whitney Equipment Comp Inc, 5/22/12
- Smith & Loveless lift pump from ADS Equipment Inc, 4/8/12

Excluded Costs

Construction costs do not include engineering, construction management, land acquisition (ROW) costs, hazardous materials mitigation, permitting, operations & maintenance costs or the client's financial, legal or administration costs.

Port Townsend Mill Rd Pump Station, Submersable, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 1

Project name	Port Townsend PS Sub Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Rev No. / Date	1/7-17-12
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
06					**SITEWORK**									
	31.0				Site/Civil									
		31-20			Earthworks, Site									
			CJM-005		**Sitework**									
				31-15-01-00	Site Preparation, Clearing and Grubbing									
					Clearing, Tree Removal, 6" - 12", Acre	0.20 acre	32.0		-	1,238	-	-	6,188.65 /acre	1,238
					Finish grading area to be paved with grader, small area	733.00 sy	29.3	2,020	-	-	2,527	-	6.20 /sy	4,546
					Compact Building Pads, Equipment Pads, and Misc. Out Structures	733.00 sy	8.1	547	-	-	383	-	1.27 /sy	930
					31-15-01-00 Site Preparation, Clearing and Grubbing	1.00 LS	69.5	2,566		1,238	2,910		6,713.96 /LS	6,714
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	733.00 sy	6.6		-	1,361	-	-	1.86 /sy	1,361
					Bituminous Pavement Import Aggregate Base	208.00 tn	2.7		-	7,981	-	-	38.37 /tn	7,981
					Bituminous Asphalt (tn), 4"	168.00 tn	1.3		-	20,794	-	-	123.77 /tn	20,794
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	733.00 SY	10.6			30,136			41.11 /SY	30,136
				31-45-01-00	Fencing, Chain Link									
					Security Fence, Chain Link, 8'	350.00 lf	45.5		-	10,830	-	-	30.94 /lf	10,830
					Fence Security Signage	8.00 ea	8.0		-	1,485	-	-	185.66 /ea	1,485
					Fence, double swing gates, 8' high, 12' opening	1.00 opng	15.0	911	637	-	26	-	1,574.77 /opng	1,575
					31-45-01-00 Fencing, Chain Link	350.00 LF	68.5	911	637	12,315	26		39.69 /LF	13,890
					CJM-005 Sitework		148.6	3,477	637	43,689	2,937			50,740
					31-20 Earthworks, Site	1.00 LS	148.6	3,477	637	43,689	2,937		50,739.64 /LS	50,740
					31.0 Site/Civil	1.00 LS	148.6	3,477	637	43,689	2,937		50,739.64 /LS	50,740
					06 SITEWORK		**148.6**	**3,477**	**637**	**43,689**	**2,937**			**50,740**
07					**YARD PIPING**									
	33.0				Buried Piping									
		33-00			Yard Piping									
			CJM-004		**Yard Piping**									
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,846.76 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	41.66 CY	1.2	85	-	-	106	-	4.58 /CY	191
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	9.47 cy	1.3	85	-	-	55	-	14.78 /cy	140
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	33.02 cy	1.0	73	-	-	60	-	4.02 /cy	133
					Pipe zone material	9.47 cy		-	328	-	-	-	34.66 /cy	328
					Pipe bedding material	2.86 cy		-	99	-	-	-	34.66 /cy	99
					Imported backfill material	33.02 cy		-	490	-	-	-	14.85 /cy	490
					Haul spoils, offsite, up to 10 miles	12.33 cy		-	-	153	-	-	12.38 /cy	153
					Dump fees, trench spoils	12.33 cy		-	76	-	-		6.19 /cy	76
					10" DI, MJ, Ell, 90	1.00 ea	4.2	357	388	-	174	-	919.19 /ea	919
					10" DI, MJ, Ell, 45	2.00 ea	8.4	714	633	-	348	-	847.71 /ea	1,695
					10" DI, MJ, tee	1.00 ea	5.8	493	633	-	240	-	1,366.61 /ea	1,367
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	45.00 LF		-	847	-	-	-	18.83 /LF	847
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	45.00 LF	6.8	582	-	-	283	-	19.22 /LF	865
					Pipe Marking, ID Tape	45.00 lf	0.5	41	7	-	-	-	1.08 /lf	49
					33-00-07-10 Yard Pipe, PVC, 10"	45.00 LF	29.1	2,431	3,503	153	1,978		179.20 /LF	8,064
				33-00-07-12	Yard Pipe, PVC, 12"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,846.80 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	30.50 CY	0.9	62	-	-	77	-	4.58 /CY	140
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	7.07 cy	0.9	64	-	-	41	-	14.78 /cy	105
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	23.89 cy	0.7	53	-	-	43	-	4.02 /cy	96
					Pipe zone material	7.07 cy		-	245	-	-	-	34.66 /cy	245
					Pipe bedding material	2.02 cy		-	70	-	-	-	34.66 /cy	70
					Imported backfill material	23.89 cy		-	355	-	-	-	14.85 /cy	355
					Haul spoils, offsite, up to 10 miles	9.09 cy		-	-	113	-	-	12.38 /cy	113
					Dump fees, trench spoils	9.09 cy		-	56	-	-		6.19 /cy	56
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	30.00 LF		-	797	-	-	-	26.56 /LF	797
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	30.00 LF	5.0	429	-	-	209	-	21.25 /LF	637
					Pipe Marking, ID Tape	30.00 lf	0.3	28	5	-	-	-	1.08 /lf	32
					33-00-07-12 Yard Pipe, PVC, 12"	30.00 LF	7.9	635	1,528	113	1,082		111.90 /LF	3,357
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	1.00 ea	2.8	184	292	-	86	-	561.74 /ea	562
					Manholes, concrete, precast, 5' I.D., 8' deep	1.00 ea	16.0	1,064	2,414	-	499	-	3,977.17 /ea	3,977

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
					33-15-01-05 Yard Structures, Manholes, 60" Dia	1.00 EA	18.8	1,248	2,706		585		4,538.91 /EA	4,539
				33-20-01-10	Yard Valves, Gate Valves, 10"									
					Install gate valve, Flgd, DIP, 10"	3.00 ea	15.9	1,352	-	-	659	-	670.28 /ea	2,011
					Gate valve, iron body, dbl disk, Flgd, 150#, HWO, 10"	3.00 ea		-	2,321	-	-	-	773.58 /ea	2,321
					33-20-01-10 Yard Valves, Gate Valves, 10"	3.00 EA	15.9	1,352	2,321		659		1,443.86 /EA	4,332
					CJM-004 Yard Piping	**45.00 LF**	**71.6**	**5,665**	**10,057**	**265**	**4,304**		**450.92 /LF**	**20,291**
					33-00 Yard Piping	45.00 LF	71.6	5,665	10,057	265	4,304		450.92 /LF	20,291
		33-15			Yard Structures									
			CJM-003		**Meter Vault**									
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Excavator and Trucks, Small Crew, 6' depth	24.00 cy	1.3	89	-	-	81	-	7.09 /cy	170
					Grade for slabs / Scarify and Recompact, Dozer and Traxcavator or Loader, Small Crew	7.00 sy	0.3	23	-	-	14	-	5.21 /sy	36
					Import Aggregate Base - under slab, Dozer and Traxcavator or Loader, Small Crew	4.00 tn	0.4	26	99	-	15	-	35.18 /tn	141
					Import Aggregate Base - along walls, Dozer and Traxcavator or Loader, Small Crew	18.00 tn	1.7	118	446	-	70	-	35.18 /tn	633
					Load Excess for Hauling, Rubber Tire Loader, Cat 930	24.00 cy	0.2	15	-	-	11	-	1.07 /cy	26
					Haul / Remove Excess, 17 yd capacity, 5 miles RT	24.00 cy	0.7	41	-	-	43	-	3.51 /cy	84
					Dump Charges for For Excess, 17 yd tandem, per cy	24.00 cy		-	306	-	-	-	12.75 /cy	306
					31-25-01-00 Earthworks, Structural, Excavation	24.00 CY	4.6	312	851		234		58.18 /CY	1,396
				33-40-03-01	Pipeline Structures, Vaults									
					Meter Vault, 6'x6' x 10' d	1.00 ls				8,751			8,750.73 /ls	8,751
					33-40-03-01 Pipeline Structures, Vaults	1.00 EA				8,751			8,750.73 /EA	8,751
				40-20-19-10	Flow Meter, 10"									
					Install magnetic flow meter, 10"	1.00 ea	5.3	479	5,941	-	-	-	6,419.76 /ea	6,420
					40-20-19-10 Flow Meter, 10"	1.00 EA	5.3	479	5,941				6,419.76 /EA	6,420
					CJM-003 Meter Vault		**9.9**	**791**	**6,792**	**8,751**	**234**			**16,567**
					33-15 Yard Structures	1.00 EA	9.9	791	6,792	8,751	234		16,566.88 /EA	16,567
					33.0 Buried Piping	45.00 LF	81.5	6,456	16,849	9,016	4,538		819.07 /LF	36,858
					07 YARD PIPING		**81.5**	**6,456**	**16,849**	**9,016**	**4,538**			**36,858**
58					**WASTEWATER - PUMP STATION**									
	03.0				Concrete Work									
		03-10			Cast-In-Place Concrete Work									
			CJM-002		**Wet Well Concrete**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Concrete pumping, subcontract, all inclusive price	29.80 cy		-	-	478	-	-	16.05 /cy	478
					Slab on grade edge forms, 7" to 12"	100.50 sf	18.1	1,490	134	-	-	-	16.16 /sf	1,624
					Reinforcing in place, A615 Gr 60, priced per lbs.	4,469.44 lb		-	2,989	1,196	-	-	0.94 /lb	4,185
					Concrete, ready mix, 4000 psi	29.80 CY		-	4,105	-	-	-	137.79 /CY	4,105
					Add for concrete waste, 4000 psi	1.49 cy		-	205	-	-	-	137.79 /cy	205
					Add amount for Environmental Fee - per concrete truck load	4.00 load		-	32	-	-	-	8.03 /load	32
					Placing concrete, concrete pump	29.80 cy	22.3	1,473	-	-	-	-	49.42 /cy	1,473
					Finishing floors, monolithic, trowel finish (machine)	804.50 sf	16.1	1,224	22	-	-	-	1.55 /sf	1,245
					Curing, membrane spray	804.50 sf	1.6	106	43	-	-	-	0.19 /sf	149
					Concrete Coating, Chemical Resistant, CRC-3	804.50 sf		-	-	3,229	-	-	4.01 /sf	3,229
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	29.80 CY	58.1	4,292	7,531	4,903			561.28 /CY	16,726
				03-10-05-24	Cast-In-Place Concrete, Tremie Slab, 24" thick									
					Fine grade, for slab on grade, by hand	804.50 sf	5.6	371	11	-	-	-	0.48 /sf	382
					Concrete pumping, subcontract, all inclusive price	59.59 cy		-	-	957	-	-	16.05 /cy	957
					Concrete, ready mix, 4000 psi	59.59 CY		-	8,211	-	-	-	137.79 /CY	8,211
					Add for concrete waste, 4000 psi	2.98 cy		-	411	-	-	-	137.78 /cy	411
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump	59.59 cy	44.7	2,945	-	-	-	-	49.42 /cy	2,945
					03-10-05-24 Cast-In-Place Concrete, Tremie Slab, 24" thick	59.59 CY	50.3	3,316	8,689	957			217.51 /CY	12,962
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete pumping, subcontract, all inclusive price	189.87 cy		-	-	3,048	-	-	16.05 /cy	3,048
					Forms in place, structural walls, to 8' high, hand set	5,126.40 sf	769.0	63,326	6,858	-	-	-	13.69 /sf	70,184
					Waterstop, PVC, center bulb, 6" wide	1,281.60 lf	102.5	8,443	3,429	-	-	-	9.26 /lf	11,872
					Speed Dowels, #6	1,272.00 ea		-	34,032	-	-	-	26.76 /ea	34,032
					Reinforcing in place, A615 Gr 60, priced per lbs.	42,720.00 lb		-	28,574	11,430	-	-	0.94 /lb	40,003

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete, ready mix, 4000 psi	189.87 CY		-	26,161	-	-	-	137.79 /CY	26,161
					Add for concrete waste, 4000 psi	9.49 cy		-	1,308	-	-	-	137.79 /cy	1,308
					Add amount for Environmental Fee - per concrete truck load	24.00 load		-	193	-	-	-	8.03 /load	193
					Placing concrete, concrete pump, for structural wall >12" - 24" thick	189.87 cy	142.4	9,384	-	-	-	-	49.42 /cy	9,384
					Patch & plug tieholes	5,126.40 sf	76.9	5,067	137	-	-	-	1.02 /sf	5,204
					Sack rub	5,126.40 sf	205.1	13,513	206	-	-	-	2.68 /sf	13,718
					Curing, membrane spray	5,126.40 sf	10.3	676	274	-	-	-	0.19 /sf	950
					Below grade damproofing, Bituminous Asphalt	2,562.00 sf		-	3,427	-	-	-	1.34 /sf	3,427
					Concrete Coating, Chemical Resistant, CRC-3	2,563.20 sf		-	-	10,287	-	-	4.01 /sf	10,287
					03-10-07-24 Cast-In-Place Concrete, Circular Walls, 24" thick	189.87 CY	1,306.1	100,409	104,598	24,764			1,210.15 /CY	229,771
				03-10-10-18	Cast-In-Place Concrete, Elevated Decks, 18" thick									
					Concrete pumping, subcontract, all inclusive price	61.30 cy		-	-	984	-	-	16.05 /cy	984
					Forms in place, elevated slab, soffit	1,018.00 sf	203.6	16,767	1,702	-	-	-	18.14 /sf	18,469
					Forms in place, elevated slab, edge form	169.50 sf	42.4	3,490	283	-	-	-	22.26 /sf	3,773
					Forms in place, elevated slab, box-out	36.00 sf	9.7	800	60	-	-	-	23.91 /sf	861
					Forms in place, monolithic beam, bottom	64.00 sf	12.8	1,054	128	-	-	-	18.48 /sf	1,183
					Forms in place, monolithic beam, sides	256.00 sf	38.4	3,162	428	-	-	-	14.03 /sf	3,590
					Slab shoring	20,360.00 cf	142.5	11,737	1,362	-	-	-	0.64 /cf	13,099
					Add labor for setting embedded frames	24.00 lf	24.0	1,976	-	-	-	-	82.35 /lf	1,976
					Reinforcing in place, A615 Gr 60, priced per lbs.	13,910.19 lb		-	9,304	3,722	-	-	0.94 /lb	13,026
					Concrete, ready mix, 4000 psi	61.30 CY		-	8,446	-	-	-	137.79 /CY	8,446
					Add for concrete waste, 4000 psi	3.07 cy		-	422	-	-	-	137.79 /cy	422
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump, for elevated slab over 12" thick	61.30 cy	27.6	1,818	-	-	-	-	29.65 /cy	1,818
					Finishing floors, monolithic, trowel finish (machine)	1,018.00 sf	20.4	1,548	27	-	-	-	1.55 /sf	1,576
					Curing, membrane spray	1,018.00 sf	2.0	134	54	-	-	-	0.19 /sf	189
					Concrete Coating, Chemical Resistant, CRC-2	1,018.00 sf		-	-	4,085	-	-	4.01 /sf	4,085
					03-10-10-18 Cast-In-Place Concrete, Elevated Decks, 18" thick	61.30 CY	523.4	42,487	22,274	8,791			1,199.88 /CY	73,553
					CJM-002 Wet Well Concrete		**1,937.9**	**150,505**	**143,092**	**39,414**				
			CJM-009		**Wet Well Generator & Elect Pad**									**333,011**
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Fine grade, for slab on grade, by hand	186.00 sf	1.3	86	2	-	-	-	0.48 /sf	88
					Fill, gravel subbase, under building slab on grade	3.45 cy	1.7	114	115	-	-	-	66.40 /cy	229
					Slab on grade edge forms, 7" to 12"	82.00 sf	14.8	1,216	110	-	-	-	16.16 /sf	1,325
					Reinforcing in place, A615 Gr 60, priced per lbs.	1,140.00 lb		-	763	305	-	-	0.94 /lb	1,068
					Concrete, ready mix, 4000 psi	6.89 CY		-	949	-	-	-	137.79 /CY	949
					Add for concrete waste, 4000 psi	0.35 cy		-	48	-	-	-	137.80 /cy	48
					Add amount for Environmental Fee - per concrete truck load	2.00 load		-	16	-	-	-	8.03 /load	16
					Placing concrete, direct chute	3.56 cy	1.8	117	-	-	-	-	32.94 /cy	117
					Finishing floors, monolithic, float finish	96.00 sf	1.9	146	1	-	-	-	1.53 /sf	147
					Curing, water	186.00 sf	0.6	41	12	-	-	-	0.29 /sf	53
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	6.89 CY	22.1	1,719	2,016	305			586.40 /CY	4,040
					CJM-009 Wet Well Generator & Elect Pad		**22.1**	**1,719**	**2,016**	**305**				**4,040**
					03-10 Cast-In-Place Concrete Work	347.45 CY	1,960.1	152,224	145,109	39,719			970.07 /CY	337,052
					03.0 Concrete Work	347.45 CY	1,960.1	152,224	145,109	39,719			970.07 /CY	337,052
04.0					Architectural									
	08-00				Openings									
			CJM-002		**Wet Well Concrete**									
				08-00-99-00	Openings, Other									
					Floor, indl, alum, 300 psf L.L., dbl leaf, 5' x 5' opening, 235#	1.00 opng	3.6	363	3,311	-	-	-	3,674.33 /opng	3,674
					08-00-99-00 Openings, Other	1.00 EA	3.6	363	3,311				3,674.33 /EA	3,674
					CJM-002 Wet Well Concrete		**3.6**	**363**	**3,311**					**3,674**
					08-00 Openings	1.00 SF	3.6	363	3,311				3,674.33 /SF	3,674
					04.0 Architectural	1.00 SF	3.6	363	3,311				3,674.33 /SF	3,674
26.0					Electrical Work									
	26-00				Electrical									
			CJM-007		**Wet Well Electrical**									
				26-00-99-00	Electrical, Other									
					Emergency Generator 350 KW, inlc battery, muffler, ATS & day tank	1.00 E	100.0	9,349	105,467	-	916	-	115,732.13 /E	115,732
					Power to Site	1.00 ls				20,816			20,815.90 /ls	20,816

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				26-00-99-00	Electrical, Other									
					MCC	1.00 ls				13,877			13,877.26 /ls	13,877
					Other Site Electrical & Wiring	1.00 ls				20,816			20,815.89 /ls	20,816
					26-00-99-00 Electrical, Other	1.00 LS	100.0	9,349	105,467	55,509	916		171,241.18 /LS	171,241
				26-25-05-10	Electrical Equipment, VFDs - 150 HP									
					VFD 150 HP NEMA-1	2.00 E	80.0	7,479	47,183	-	1,055	-	27,858.30 /E	55,717
					26-25-05-10 Electrical Equipment, VFDs - 150 HP	2.00 EA	80.0	7,479	47,183		1,055		27,858.30 /EA	55,717
				26-30-01-00	Communications Systems									
					I&C Allowance	1.00 ls				20,816			20,815.89 /ls	20,816
					26-30-01-00 Communications Systems	1.00 LS				20,816			20,815.89 /LS	20,816
					CJM-007 Wet Well Electrical	**1.00 LS**	**180.0**	**16,828**	**152,650**	**76,325**	**1,971**		**247,773.67 /LS**	**247,774**
					26-00 Electrical	1.00 LS	180.0	16,828	152,650	76,325	1,971		247,773.67 /LS	247,774
					26.0 Electrical Work	1.00 LS	180.0	16,828	152,650	76,325	1,971		247,773.67 /LS	247,774
	31.0				Site/Civil									
		31-16			Earthworks, Sheeting/Shoring									
			CJM-006		**Wet Well Site/Excavation**									
				31-17-02-00	Earthworks, Caissons									
					Mobilization, caission equip/crane, set up, large	1.00 ea	237.0	17,748	-	-	18,426	-	36,174.35 /ea	36,174
					Caisson Shoe	107.00 lf						66,218	618.86 /lf	66,218
					31-17-02-00 Earthworks, Caissons	1.00 LS	237.0	17,748			18,426	66,218	102,392.70 /LS	102,393
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,857	-	-	1,856.60 /ea	1,857
					Dewatering Minor, Set-up Generator and Install Pumps	4.00 ea	32.0	2,148	-	-	464	-	652.88 /ea	2,612
					Dewatering Minor, Sump Rock, delivered	5.00 cy		-	124	-	-	-	24.76 /cy	124
					Dewatering Minor, Large Generator and 4 Pumps, Rental, Monthly	3.00 mo		-	-	-	30,861	-	10,286.96 /mo	30,861
					Dewatering Minor, Generator and Pumps, Operation - Labor to maintain / check pumps/ fuel and lube	3.00 mo	270.0	17,059	-	-	2,408	-	6,488.80 /mo	19,466
					Dewatering Minor, Remove Generator and Pumps	4.00 ea	32.0	2,148	-	-	464	-	652.88 /ea	2,612
					Dewatering Minor, Generator and Pumps, Demob	1.00 ea	8.0		-	1,857	-	-	1,856.59 /ea	1,857
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	3.00 MO	350.0	21,354	124	3,713	34,196		19,795.76 /MO	59,387
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Caisson Crew, 22' depth	980.00 cy	209.1	13,700	-	-	14,040	-	28.31 /cy	27,740
					Load Excess for Hauling, Excavator, Cat 330	980.00 cy	4.9	387	-	-	699	-	1.11 /cy	1,086
					Haul / Remove Excess, 17 yd capacity, 10 miles RT	980.00 cy	33.7	2,020	-	-	2,082	-	4.19 /cy	4,102
					Dump Charges for For Excess, 17 yd tandem, per cy	980.00 cy		-	6,065	-	-	-	6.19 /cy	6,065
					31-25-01-00 Earthworks, Structural, Excavation	980.00 CY	247.7	16,107	6,065		16,822		39.79 /CY	38,993
					CJM-006 Wet Well Site/Excavation		**834.7**	**55,209**	**6,189**	**3,713**	**69,444**	**66,218**		**200,773**
					31-16 Earthworks, Sheeting/Shoring	1.00 LS	834.7	55,209	6,189	3,713	69,444	66,218	200,773.16 /LS	200,773
					31.0 Site/Civil	1.00 LS	834.7	55,209	6,189	3,713	69,444	66,218	200,773.16 /LS	200,773
	43.0				Process Equipment									
		43-05			Furnish and Install Process Equipment									
			CJM-008		**Wet Well Equipment**									
				44-05-49-04	Submersable Pumps									
					Submersable Pumps, 160 hp, w/out controls, Flygt	2.00 EA	192.0	16,132	172,866	-	2,775	-	95,887.02 /EA	191,774
					Set base elbow / pump assembly, 101 - 250 hp	2.00 ea	128.0	10,755	278	-	-	-	5,516.21 /ea	11,032
					Pump Control System	1.00 ls				41,632			41,631.79 /ls	41,632
					44-05-49-04 Submersable Pumps	2.00 EA	320.0	26,887	173,144	41,632	2,775		122,219.12 /EA	244,438
					CJM-008 Wet Well Equipment		**320.0**	**26,887**	**173,144**	**41,632**	**2,775**			**244,438**
					43-05 Furnish and Install Process Equipment	1.00 SF	320.0	26,887	173,144	41,632	2,775		244,438.24 /SF	244,438
					43.0 Process Equipment	1.00 SF	320.0	26,887	173,144	41,632	2,775		244,438.24 /SF	244,438
					58 WASTEWATER - PUMP STATION		**3,298.3**	**251,511**	**480,402**	**161,389**	**74,190**	**66,218**		**1,033,711**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	261,444		3,528.495 hrs		
Material	497,888				
Subcontract	214,094				
Equipment	81,665		3,428.594 hrs		
Other	66,218				
Total Subcontractor OH&P	1,121,309	1,121,309			
General Conditions	64,703			7.000 %	
Total Taxes	64,703	1,186,012			
Mobilization/Demobilization	61,234			3.000 %	
Bider's Risk & Gen Liab Ins -%	20,411			1.000 %	
Payment & Performance Bond	23,677			1.160 %	
Total Owner-Provided Equipment	105,322	1,291,334			
Contingency - %	516,533			40.000 %	
Total Contingency	516,533	1,807,867			
Escalation on Estimate Total	64,722			3.580 %	
Construction Total	64,722	1,872,589			
Gross Sales Tax	168,533			9.000 %	
Construction Total (with GST)	**168,533**	**2,041,122**			

Port Townsend Mill Rd Pump Station, Lift Pump, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 1

Project name	Port Townsend PS Lift Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Rev No. / Date	1/7-17-12
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
06					**SITEWORK**									
	31.0				Site/Civil									
		31-20			Earthworks, Site									
			CJM-005		**Sitework**									
				31-15-01-00	Site Preparation, Clearing and Grubbing									
					Clearing, Tree Removal, 6" - 12", Acre	0.20 acre	32.0		-	1,238	-	-	6,190.95 /acre	1,238
					Finish grading area to be paved with grader, small area	733.00 sy	29.3	2,020	-	-	2,528	-	6.20 /sy	4,548
					Compact Building Pads, Equipment Pads, and Misc. Out Structures	733.00 sy	8.1	547	-	-	384	-	1.27 /sy	930
					31-15-01-00 Site Preparation, Clearing and Grubbing	1.00 LS	69.5	2,567		1,238	2,911		6,716.41 /LS	6,716
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	733.00 sy	6.6		-	1,361	-	-	1.86 /sy	1,361
					Bituminous Pavement Import Aggregate Base	208.00 tn	2.7		-	7,984	-	-	38.38 /tn	7,984
					Bituminous Asphalt (tn), 4"	168.00 tn	1.3		-	20,802	-	-	123.82 /tn	20,802
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	733.00 SY	10.6			30,147			41.13 /SY	30,147
				31-45-01-00	Fencing, Chain Link									
					Security Fence, Chain Link, 8'	350.00 lf	45.5		-	10,834	-	-	30.96 /lf	10,834
					Fence Security Signage	8.00 ea	8.0		-	1,486	-	-	185.73 /ea	1,486
					Fence, double swing gates, 8' high, 12' opening	1.00 opng	15.0	911	638	-	26	-	1,575.33 /opng	1,575
					31-45-01-00 Fencing, Chain Link	350.00 LF	68.5	911	638	12,320	26		39.70 /LF	13,895
					CJM-005 Sitework		**148.6**	**3,478**	**638**	**43,705**	**2,938**			**50,759**
					31-20 Earthworks, Site	1.00 LS	148.6	3,478	638	43,705	2,938		50,758.59 /LS	50,759
					31.0 Site/Civil	1.00 LS	148.6	3,478	638	43,705	2,938		50,758.59 /LS	50,759
					06 SITEWORK		**148.6**	**3,478**	**638**	**43,705**	**2,938**			**50,759**
07					**YARD PIPING**									
	33.0				Buried Piping									
		33-00			Yard Piping									
			CJM-004		**Yard Piping**									
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,847.84 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	41.66 CY	1.2	85	-	-	106	-	4.58 /CY	191
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	9.47 cy	1.3	86	-	-	55	-	14.79 /cy	140
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	33.02 cy	1.0	73	-	-	60	-	4.02 /cy	133
					Pipe zone material	9.47 cy		-	328	-	-	-	34.67 /cy	328
					Pipe bedding material	2.86 cy		-	99	-	-	-	34.67 /cy	99
					Imported backfill material	33.02 cy		-	491	-	-	-	14.86 /cy	491
					Haul spoils, offsite, up to 10 miles	12.33 cy		-	-	153	-	-	12.38 /cy	153
					Dump fees, trench spoils	12.33 cy		-	76	-	-	-	6.19 /cy	76
					10" DI, MJ, Ell, 90	1.00 ea	4.2	357	388	-	174	-	919.52 /ea	920
					10" DI, MJ, Ell, 45	2.00 ea	8.4	714	633	-	348	-	848.02 /ea	1,696
					10" DI, MJ, tee	1.00 ea	5.8	493	633	-	240	-	1,367.11 /ea	1,367
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	45.00 LF		-	847	-	-	-	18.83 /LF	847
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	45.00 LF	6.8	582	-	-	284	-	19.23 /LF	865
					Pipe Marking, ID Tape	45.00 lf	0.5	41	7	-	-	-	1.08 /lf	49
					33-00-07-10 Yard Pipe, PVC, 10"	45.00 LF	29.1	2,432	3,504	153	1,979		179.26 /LF	8,067
				33-00-07-12	Yard Pipe, PVC, 12"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,847.84 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	30.50 CY	0.9	62	-	-	77	-	4.58 /CY	140
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	7.07 cy	0.9	64	-	-	41	-	14.79 /cy	105
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	23.89 cy	0.7	53	-	-	43	-	4.02 /cy	96
					Pipe zone material	7.07 cy		-	245	-	-	-	34.67 /cy	245
					Pipe bedding material	2.02 cy		-	70	-	-	-	34.67 /cy	70
					Imported backfill material	23.89 cy		-	355	-	-	-	14.86 /cy	355
					Haul spoils, offsite, up to 10 miles	9.09 cy		-	-	113	-	-	12.38 /cy	113
					Dump fees, trench spoils	9.09 cy		-	56	-	-	-	6.19 /cy	56
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	30.00 LF		-	797	-	-	-	26.57 /LF	797
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	30.00 LF	5.0	429	-	-	209	-	21.25 /LF	638
					Pipe Marking, ID Tape	30.00 lf	0.3	28	5	-	-	-	1.08 /lf	32
					33-00-07-12 Yard Pipe, PVC, 12"	30.00 LF	7.9	635	1,528	113	1,082		111.95 /LF	3,358
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	1.00 ea	2.8	184	292	-	86	-	561.94 /ea	562
					Manholes, concrete, precast, 5' I.D., 8' deep	1.00 ea	16.0	1,065	2,414	-	500	-	3,978.63 /ea	3,979

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
					33-15-01-05 Yard Structures, Manholes, 60" Dia	1.00 EA	18.8	1,248	2,707		586		4,540.57 /EA	4,541
				33-20-01-10	Yard Valves, Gate Valves, 10"									
					Install gate valve, Flgd, DIP, 10"	3.00 ea	15.9	1,352	-	-	659	-	670.52 /ea	2,012
					Gate valve, iron body, dbl disk, Flgd, 150#, HWO, 10"	3.00 ea		-	2,322	-	-	-	773.87 /ea	2,322
					33-20-01-10 Yard Valves, Gate Valves, 10"	3.00 EA	15.9	1,352	2,322		659		1,444.39 /EA	4,333
					CJM-004 Yard Piping	**45.00 LF**	**71.6**	**5,667**	**10,061**	**265**	**4,306**		**451.09 /LF**	**20,299**
					33-00 Yard Piping	45.00 LF	71.6	5,667	10,061	265	4,306		451.09 /LF	20,299
		33-15			Yard Structures									
			CJM-003		**Meter Vault**									
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Excavator and Trucks, Small Crew, 6' depth	24.00 cy	1.3	89	-	-	81	-	7.09 /cy	170
					Grade for slabs / Scarify and Recompact, Dozer and Traxcavator or Loader, Small Crew	7.00 sy	0.3	23	-	-	14	-	5.21 /sy	36
					Import Aggregate Base - under slab, Dozer and Traxcavator or Loader, Small Crew	4.00 tn	0.4	26	99	-	15	-	35.19 /tn	141
					Import Aggregate Base - along walls, Dozer and Traxcavator or Loader, Small Crew	18.00 tn	1.7	118	446	-	70	-	35.19 /tn	633
					Load Excess for Hauling, Rubber Tire Loader, Cat 930	24.00 cy	0.2	15	-	-	11	-	1.07 /cy	26
					Haul / Remove Excess, 17 yd capacity, 5 miles RT	24.00 cy	0.7	41	-	-	43	-	3.51 /cy	84
					Dump Charges for For Excess, 17 yd tandem, per cy	24.00 cy		-	306	-	-	-	12.75 /cy	306
					31-25-01-00 Earthworks, Structural, Excavation	24.00 CY	4.6	312	851		234		58.20 /CY	1,397
				33-40-03-01	Pipeline Structures, Vaults									
					Meter Vault, 6'x6' x 10' d	1.00 ls				8,754			8,754.02 /ls	8,754
					33-40-03-01 Pipeline Structures, Vaults	1.00 EA				8,754			8,754.02 /EA	8,754
				40-20-19-10	Flow Meter, 10"									
					Install magnetic flow meter, 10"	1.00 ea	5.3	479	5,943	-	-	-	6,422.15 /ea	6,422
					40-20-19-10 Flow Meter, 10"	1.00 EA	5.3	479	5,943				6,422.15 /EA	6,422
					CJM-003 Meter Vault		**9.9**	**791**	**6,794**	**8,754**	**234**			**16,573**
					33-15 Yard Structures	1.00 EA	9.9	791	6,794	8,754	234		16,573.07 /EA	16,573
					33.0 Buried Piping	45.00 LF	81.5	6,458	16,855	9,019	4,540		819.38 /LF	36,872
					07 YARD PIPING		**81.5**	**6,458**	**16,855**	**9,019**	**4,540**			**36,872**
58					**WASTEWATER - PUMP STATION**									
	03.0				Concrete Work									
		03-10			Cast-In-Place Concrete Work									
			CJM-002		**Wet Well Concrete**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Concrete pumping, subcontract, all inclusive price	29.80 cy		-	-	478	-	-	16.06 /cy	478
					Slab on grade edge forms, 7" to 12"	100.50 sf	18.1	1,490	134	-	-	-	16.17 /sf	1,625
					Reinforcing in place, A615 Gr 60, priced per lbs.	4,469.44 lb		-	2,991	1,196	-	-	0.94 /lb	4,187
					Concrete, ready mix, 4000 psi	29.80 CY		-	4,107	-	-	-	137.83 /CY	4,107
					Add for concrete waste, 4000 psi	1.49 cy		-	205	-	-	-	137.84 /cy	205
					Add amount for Environmental Fee - per concrete truck load	4.00 load		-	32	-	-	-	8.03 /load	32
					Placing concrete, concrete pump	29.80 cy	22.3	1,473	-	-	-	-	49.44 /cy	1,473
					Finishing floors, monolithic, trowel finish (machine)	804.50 sf	16.1	1,224	22	-	-	-	1.55 /sf	1,246
					Curing, membrane spray	804.50 sf	1.6	106	43	-	-	-	0.19 /sf	149
					Concrete Coating, Chemical Resistant, CRC-3	804.50 sf		-	-	3,230	-	-	4.02 /sf	3,230
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	29.80 CY	58.1	4,294	7,534	4,904			561.47 /CY	16,732
				03-10-05-24	Cast-In-Place Concrete, Tremie Slab, 24" thick									
					Fine grade, for slab on grade, by hand	804.50 sf	5.6	371	11	-	-	-	0.48 /sf	382
					Concrete pumping, subcontract, all inclusive price	59.59 cy		-	-	957	-	-	16.06 /cy	957
					Concrete, ready mix, 4000 psi	59.59 CY		-	8,214	-	-	-	137.83 /CY	8,214
					Add for concrete waste, 4000 psi	2.98 cy		-	411	-	-	-	137.84 /cy	411
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump	59.59 cy	44.7	2,946	-	-	-	-	49.44 /cy	2,946
					03-10-05-24 Cast-In-Place Concrete, Tremie Slab, 24" thick	59.59 CY	50.3	3,317	8,692	957			217.59 /CY	12,966
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete pumping, subcontract, all inclusive price	158.22 cy		-	-	2,541	-	-	16.06 /cy	2,541
					Forms in place, structural walls, to 8' high, hand set	4,272.00 sf	640.8	52,789	5,717	-	-	-	13.70 /sf	58,506
					Waterstop, PVC, center bulb, 6" wide	1,068.00 lf	85.4	7,039	2,858	-	-	-	9.27 /lf	9,897
					Speed Dowels, #6	1,060.00 ea		-	28,370	-	-	-	26.76 /ea	28,370
					Reinforcing in place, A615 Gr 60, priced per lbs.	35,600.00 lb		-	23,820	9,528	-	-	0.94 /lb	33,348

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete, ready mix, 4000 psi	158.22 CY		-	21,808	-	-	-	137.83 /CY	21,808
					Add for concrete waste, 4000 psi	7.91 cy		-	1,090	-	-	-	137.83 /cy	1,090
					Add amount for Environmental Fee - per concrete truck load	20.00 load		-	161	-	-	-	8.03 /load	161
					Placing concrete, concrete pump, for structural wall >12" - 24" thick	158.22 cy	118.7	7,822	-	-	-	-	49.44 /cy	7,822
					Patch & plug tieholes	4,272.00 sf	64.1	4,224	114	-	-	-	1.02 /sf	4,338
					Sack rub	4,272.00 sf	170.9	11,264	172	-	-	-	2.68 /sf	11,436
					Curing, membrane spray	4,272.00 sf	8.5	563	229	-	-	-	0.19 /sf	792
					Below grade damproofing, Bituminous Asphalt	2,135.00 sf		-	2,857	-	-	-	1.34 /sf	2,857
					Concrete Coating, Chemical Resistant, CRC-3	2,136.00 sf		-	-	8,575	-	-	4.02 /sf	8,575
					03-10-07-24 Cast-In-Place Concrete, Circular Walls, 24" thick	158.22 CY	1,088.4	83,701	87,195	20,644			1,210.59 /CY	191,540
				03-10-10-18	Cast-In-Place Concrete, Elevated Decks, 18" thick									
					Concrete pumping, subcontract, all inclusive price	61.30 cy		-	-	984	-	-	16.06 /cy	984
					Forms in place, elevated slab, soffit	1,018.00 sf	203.6	16,772	1,703	-	-	-	18.15 /sf	18,475
					Forms in place, elevated slab, edge form	169.50 sf	42.4	3,491	284	-	-	-	22.27 /sf	3,774
					Forms in place, elevated slab, box-out	36.00 sf	9.7	801	60	-	-	-	23.92 /sf	861
					Forms in place, monolithic beam, bottom	64.00 sf	12.8	1,054	128	-	-	-	18.48 /sf	1,183
					Forms in place, monolithic beam, sides	256.00 sf	38.4	3,163	428	-	-	-	14.03 /sf	3,592
					Slab shoring	20,360.00 cf	142.5	11,741	1,362	-	-	-	0.64 /cf	13,103
					Add labor for setting embedded frames	24.00 lf	24.0	1,977	-	-	-	-	82.38 /lf	1,977
					Reinforcing in place, A615 Gr 60, priced per lbs.	13,910.19 lb		-	9,307	3,723	-	-	0.94 /lb	13,030
					Concrete, ready mix, 4000 psi	61.30 CY		-	8,449	-	-	-	137.83 /CY	8,449
					Add for concrete waste, 4000 psi	3.07 cy		-	422	-	-	-	137.83 /cy	422
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump, for elevated slab over 12" thick	61.30 cy	27.6	1,818	-	-	-	-	29.66 /cy	1,818
					Finishing floors, monolithic, trowel finish (machine)	1,018.00 sf	20.4	1,549	27	-	-	-	1.55 /sf	1,576
					Curing, membrane spray	1,018.00 sf	2.0	134	54	-	-	-	0.19 /sf	189
					Concrete Coating, Chemical Resistant, CRC-2	1,018.00 sf		-	-	4,087	-	-	4.02 /sf	4,087
					03-10-10-18 Cast-In-Place Concrete, Elevated Decks, 18" thick	61.30 CY	523.4	42,501	22,282	8,794			1,200.28 /CY	73,577
			CJM-009		**CJM-002 Wet Well Concrete** **Wet Well Generator & Elect Pad**		**1,720.3**	**133,813**	**125,703**	**35,299**				**294,815**
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Fine grade, for slab on grade, by hand	186.00 sf	1.3	86	2	-	-	-	0.48 /sf	88
					Fill, gravel subbase, under building slab on grade	3.45 cy	1.7	114	115	-	-	-	66.41 /cy	229
					Slab on grade edge forms, 7" to 12"	82.00 sf	14.8	1,216	110	-	-	-	16.17 /sf	1,326
					Reinforcing in place, A615 Gr 60, priced per lbs.	1,140.00 lb		-	763	305	-	-	0.94 /lb	1,068
					Concrete, ready mix, 4000 psi	6.89 CY		-	950	-	-	-	137.83 /CY	950
					Add for concrete waste, 4000 psi	0.35 cy		-	48	-	-	-	137.88 /cy	48
					Add amount for Environmental Fee - per concrete truck load	2.00 load		-	16	-	-	-	8.03 /load	16
					Placing concrete, direct chute	3.56 cy	1.8	117	-	-	-	-	32.96 /cy	117
					Finishing floors, monolithic, float finish	96.00 sf	1.9	146	1	-	-	-	1.54 /sf	147
					Curing, water	186.00 sf	0.6	41	12	-	-	-	0.29 /sf	53
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	6.89 CY	22.1	1,719	2,017	305			586.60 /CY	4,042
					CJM-009 Wet Well Generator & Elect Pad		**22.1**	**1,719**	**2,017**	**305**				**4,042**
					03-10 Cast-In-Place Concrete Work	315.80 CY	1,742.4	135,532	127,720	35,604			946.35 /CY	298,857
					03.0 Concrete Work	315.80 CY	1,742.4	135,532	127,720	35,604			946.35 /CY	298,857
04.0					Architectural									
	08-00				Openings									
			CJM-002		**Wet Well Concrete**									
				08-00-99-00	Openings, Other									
					Floor, indl, alum, 300 psf L.L., dbl leaf, 5' x 5' opening, 235#	1.00 opng	3.6	364	3,312	-	-	-	3,675.69 /opng	3,676
					08-00-99-00 Openings, Other	1.00 EA	3.6	364	3,312				3,675.69 /EA	3,676
					CJM-002 Wet Well Concrete		**3.6**	**364**	**3,312**					**3,676**
					08-00 Openings	1.00 SF	3.6	364	3,312				3,675.69 /SF	3,676
					04.0 Architectural	1.00 SF	3.6	364	3,312				3,675.69 /SF	3,676
26.0					Electrical Work									
	26-00				Electrical									
			CJM-007		**Wet Well Electrical**									
				26-00-99-00	Electrical, Other									
					Emergency Generator 350 KW, incl battery, muffler, ATS & day tank	1.00 E	100.0	9,352	105,503	-	916	-	115,770.67 /E	115,771
					Power to Site	1.00 ls				20,823			20,822.88 /ls	20,823

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				26-00-99-00	Electrical, Other									
					MCC	1.00 ls				13,882			13,881.90 /ls	13,882
					Other Site Electrical & Wiring	1.00 ls				20,823			20,822.87 /ls	20,823
					26-00-99-00 Electrical, Other	1.00 LS	100.0	9,352	105,503	55,528	916		171,298.32 /LS	171,298
				26-25-05-10	Electrical Equipment, VFDs - 150 HP									
					VFD 150 HP NEMA-1	2.00 E	80.0	7,482	47,199	-	1,055	-	27,867.54 /E	55,735
					26-25-05-10 Electrical Equipment, VFDs - 150 HP	2.00 EA	80.0	7,482	47,199		1,055		27,867.54 /EA	55,735
				26-30-01-00	Communications Systems									
					I&C Allowance	1.00 ls				20,823			20,822.87 /ls	20,823
					26-30-01-00 Communications Systems	1.00 LS				20,823			20,822.87 /LS	20,823
					CJM-007 Wet Well Electrical	**1.00 LS**	**180.0**	**16,834**	**152,701**	**76,351**	**1,971**		**247,856.26 /LS**	**247,856**
					26-00 Electrical	1.00 LS	180.0	16,834	152,701	76,351	1,971		247,856.26 /LS	247,856
					26.0 Electrical Work	1.00 LS	180.0	16,834	152,701	76,351	1,971		247,856.26 /LS	247,856
	31.0				Site/Civil									
		31-16			Earthworks, Sheeting/Shoring									
			CJM-006		**Wet Well Site/Excavation**									
				31-17-02-00	Earthworks, Caissons									
					Mobilization, caission equip/crane, set up, large	1.00 ea	237.0	17,754	-	-	18,433	-	36,187.43 /ea	36,187
					Caisson Shoe	107.00 lf						66,243	619.10 /lf	66,243
					31-17-02-00 Earthworks, Caissons	1.00 LS	237.0	17,754			18,433	66,243	102,430.65 /LS	102,431
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,857	-	-	1,857.29 /ea	1,857
					Dewatering Minor, Set-up Generator and Install Pumps	4.00 ea	32.0	2,149	-	-	464	-	653.11 /ea	2,612
					Dewatering Minor, Sump Rock, delivered	5.00 cy		-	124	-	-	-	24.76 /cy	124
					Dewatering Minor, Large Generator and 4 Pumps, Rental, Monthly	3.00 mo		-	-	-	30,872	-	10,290.82 /mo	30,872
					Dewatering Minor, Generator and Pumps, Operation - Labor to maintain / check pumps/ fuel and lube	3.00 mo	270.0	17,065	-	-	2,408	-	6,491.08 /mo	19,473
					Dewatering Minor, Remove Generator and Pumps	4.00 ea	32.0	2,149	-	-	464	-	653.11 /ea	2,612
					Dewatering Minor, Generator and Pumps, Demob	1.00 ea	8.0		-	1,857	-	-	1,857.28 /ea	1,857
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	3.00 MO	350.0	21,362	124	3,715	34,209		19,802.99 /MO	59,409
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Caisson Crew, 22' depth	830.00 cy	177.1	11,607	-	-	11,896	-	28.32 /cy	23,502
					Load Excess for Hauling, Excavator, Cat 330	830.00 cy	4.2	328	-	-	593	-	1.11 /cy	920
					Haul / Remove Excess, 17 yd capacity, 10 miles RT	830.00 cy	28.6	1,712	-	-	1,764	-	4.19 /cy	3,476
					Dump Charges for For Excess, 17 yd tandem, per cy	830.00 cy		-	5,138	-	-	-	6.19 /cy	5,138
					31-25-01-00 Earthworks, Structural, Excavation	830.00 CY	209.8	13,646	5,138		14,252		39.80 /CY	33,037
					CJM-006 Wet Well Site/Excavation		**796.8**	**52,762**	**5,262**	**3,715**	**66,894**	**66,243**		**194,877**
					31-16 Earthworks, Sheeting/Shoring	1.00 LS	796.8	52,762	5,262	3,715	66,894	66,243	194,876.51 /LS	194,877
					31.0 Site/Civil	1.00 LS	796.8	52,762	5,262	3,715	66,894	66,243	194,876.51 /LS	194,877
	43.0				Process Equipment									
		43-05			Furnish and Install Process Equipment									
			CJM-008		**Wet Well Equipment**									
				44-05-49-04	Suction Lift Pump									
					Suction Lift Pump, 150 hp, w/ controls, Smith&Loveless	2.00 EA	192.0	16,137	305,402	-	2,776	-	162,157.86 /EA	324,316
					Set base elbow / pump assembly, 101 - 250 hp	2.00 ea	128.0	10,758	278	-	-	-	5,517.94 /ea	11,036
					44-05-49-04 Suction Lift Pump	2.00 EA	320.0	26,896	305,680		2,776		167,675.80 /EA	335,352
					CJM-008 Wet Well Equipment		**320.0**	**26,896**	**305,680**		**2,776**			**335,352**
					43-05 Furnish and Install Process Equipment	1.00 SF	320.0	26,896	305,680		2,776		335,351.60 /SF	335,352
					43.0 Process Equipment	1.00 SF	320.0	26,896	305,680		2,776		335,351.60 /SF	335,352
					58 WASTEWATER - PUMP STATION		**3,042.7**	**232,387**	**594,675**	**115,669**	**71,642**	**66,243**		**1,080,617**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	242,323		3,272.903 hrs		
Material	612,168				
Subcontract	168,394				
Equipment	79,119		3,390.684 hrs		
Other	66,243				
Total Subcontractor OH&P	1,168,247	1,168,247			
General Conditions	67,411			7.000 %	
Total Taxes	67,411	1,235,658			
Mobilization/Demobilization	63,797			3.000 %	
Bider's Risk & Gen Liab Ins -%	21,266			1.000 %	
Payment & Performance Bond	24,668			1.160 %	
Total Owner-Provided Equipment	109,731	1,345,389			
Contingency - %	538,156			40.000 %	
Total Contingency	538,156	1,883,545			
Escalation on Estimate Total	67,431			3.580 %	
Construction Total	67,431	1,950,976			
Gross Sales Tax	175,588			9.000 %	
Construction Total (with GST)	**175,588**	**2,126,564**			

Port Townsend Mill Rd Pump Station, Force Main, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend FM Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

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Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend FM
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					OFFSITE - PIPELINES									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-001		10 dia Force Main									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	462.00 cy	18.5	1,240	-	-	659	-	4.11 /cy	1,900
					02-01-01-01 General Site Demolition, Aspalt Pavement	34,224.00 SF	18.5	1,240			659		0.06 /SF	1,900
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,825	-	-	1,825.12 /ea	1,825
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	1.00 mo		-	-	-	6,124	-	6,124.48 /mo	6,124
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	1.00 MO	8.0			1,825	6,124		7,949.60 /MO	7,950
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	3,803.00 sy	34.2		-	6,941	-	-	1.83 /sy	6,941
					Bituminous Pavement Import Aggregate Base, 6"	1,109.00 tn	14.4		-	41,830	-	-	37.72 /tn	41,830
					Bituminous Asphalt (tn), 6"	1,300.00 tn	10.4		-	181,903	-	-	139.93 /tn	181,903
					Pavement Marking, 4" Pavement striping	4,278.00 lf	8.6		-	7,808	-	-	1.83 /lf	7,808
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	3,803.00 SY	67.6			238,482			62.71 /SY	238,482
				33-00-07-10	Yard Pipe, PVC, 10"									
					Traffic Control, Labor per Day	25.00 day	400.0	24,329	-	-	-	-	973.17 /day	24,329
					Trench Box, 8' x 24' x 10'	1.00 mo		-	-	-	2,799	-	2,798.51 /mo	2,799
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	3,960.38 CY	114.9	7,955	-	-	9,874	-	4.50 /CY	17,828
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	900.55 cy	119.8	8,001	-	-	5,096	-	14.54 /cy	13,097
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	3,139.10 cy	91.0	6,807	-	-	5,610	-	3.96 /cy	12,417
					Pipe zone material	900.55 cy		-	30,681	-	-	-	34.07 /cy	30,681
					Pipe bedding material	272.71 cy		-	9,291	-	-	-	34.07 /cy	9,291
					Imported backfill material	3,139.10 cy		-	45,834	-	-	-	14.60 /cy	45,834
					Haul spoils, offsite, up to 10 miles	1,173.26 cy		-	-	14,276	-	-	12.17 /cy	14,276
					Dump fees, trench spoils	1,173.26 ls		-	7,138	-	-		6.08 /ls	7,138
					10" DI, MJ, Ell, 90	1.00 ea	4.2	352	381	-	171	-	904.06 /ea	904
					10" DI, MJ, Ell, 45	1.00 ea	4.2	352	311	-	171	-	833.80 /ea	834
					10" DI, MJ, Ell, 22 1/2	8.00 ea	33.6	2,812	2,570	-	1,369	-	843.83 /ea	6,751
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	4,278.00 LF		-	79,172	-	-	-	18.51 /LF	79,172
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	4,278.00 LF	650.3	54,423	-	-	26,489	-	18.91 /LF	80,912
					Pipe Marking, ID Tape	4,278.00 lf	42.8	3,869	677	-	-	-	1.06 /lf	4,546
					33-00-07-10 Yard Pipe, PVC, 10"	4,278.00 LF	1,460.7	108,899	176,054	14,276	51,578		82.00 /LF	350,807
				33-20-07-01	Yard Valves, Other									
					Air Release Valve	1.00 ea				6,084			6,083.72 /ea	6,084
					33-20-07-01 Yard Valves, Other	1.00 EA				6,084			6,083.72 /EA	6,084
					CJM-001 10 dia Force Main	**4,278.00 LF**	**1,554.8**	**110,140**	**176,054**	**260,667**	**58,362**		**141.47 /LF**	**605,222**
					33-35 Pipelines	4,278.00 LF	1,554.8	110,140	176,054	260,667	58,362		141.47 /LF	605,222
					33.0 Buried Piping	4,278.00 LF	1,554.8	110,140	176,054	260,667	58,362		141.47 /LF	605,222
					92 OFFSITE - PIPELINES		**1,554.8**	**110,140**	**176,054**	**260,667**	**58,362**			**605,222**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	110,140		1,554.774 hrs		
Material	176,054				
Subcontract	260,667				
Equipment	58,362		1,548.992 hrs		
Other					
Total Subcontractor OH&P	605,223	605,223			
General Conditions	34,923			7.000 %	
Total Taxes	34,923	640,146			
Mobilization/Demobilization	33,051			3.000 %	
Bider's Risk & Gen Liab Ins -%	11,017			1.000 %	
Payment & Performance Bond	12,780			1.160 %	
Total Owner-Provided Equipment	56,848	696,994			
Contingency - %	278,797			40.000 %	
Total Contingency	278,797	975,791			
Escalation on Estimate Total	34,933			3.580 %	
Construction Total	34,933	1,010,724			
Gross Sales Tax	90,965			9.000 %	
Construction Total (with GST)	**90,965**	**1,101,689**			

Port Townsend Mill Rd Pump Station, Alt 1, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 1 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 1
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	183.00 cy	7.3	491	-	-	261	-	4.11 /cy	752
					02-01-01-01 General Site Demolition, Aspalt Pavement	13,520.00 SF	7.3	491			261		0.06 /SF	752
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,531	-	6,124.32 /mo	1,531
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,531		6,124.32 /MO	1,531
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	1,502.00 sy	13.5		-	2,741	-	-	1.83 /sy	2,741
					Bituminous Pavement Import Aggregate Base, 6"	438.00 tn	5.7		-	16,521	-	-	37.72 /tn	16,521
					Bituminous Asphalt (tn), 6"	514.00 tn	4.1		-	71,920	-	-	139.92 /tn	71,920
					Pavement Marking, 4" Pavement striping	1,690.00 lf	3.4		-	3,084	-	-	1.83 /lf	3,084
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	1,502.00 SY	26.7			94,266			62.76 /SY	94,266
				31-45-01-00	Fencing, Chain Link									
					Traffic Control, Labor per Day	10.00 day	160.0	9,731	-	-	-	-	973.15 /day	9,731
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	700	-	2,798.44 /mo	700
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,422.68 CY	41.3	2,858	-	-	3,547	-	4.50 /CY	6,404
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	313.99 cy	41.8	2,790	-	-	1,777	-	14.54 /cy	4,566
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,143.27 cy	33.2	2,479	-	-	2,043	-	3.96 /cy	4,522
					Pipe zone material	313.99 cy		-	10,697	-	-	-	34.07 /cy	10,697
					Pipe bedding material	101.73 cy		-	3,466	-	-	-	34.07 /cy	3,466
					Imported backfill material	1,143.27 cy		-	16,692	-	-	-	14.60 /cy	16,692
					Haul spoils, offsite, up to 10 miles	415.72 cy		-	-	5,058	-	-	12.17 /cy	5,058
					Dump fees, trench spoils	415.72 ls		-	2,529	-	-		6.08 /ls	2,529
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	1,690.00 LF		-	20,830	-	-	-	12.33 /LF	20,830
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	1,690.00 LF	216.3	18,104	-	-	8,812	-	15.93 /LF	26,916
					Pipe Marking, ID Tape	1,690.00 lf	16.9	1,528	267	-	-	-	1.06 /lf	1,796
					31-45-01-00 Fencing, Chain Link	1,690.00 LF	509.4	37,491	54,481	5,058	16,878		67.40 /LF	113,908
					CJM-010 Gravity Pipe		**543.4**	**37,982**	**54,481**	**99,324**	**18,670**			**210,457**
					33-35 Pipelines	1,690.00 LF	543.4	37,982	54,481	99,324	18,670		124.53 /LF	210,457
					33.0 Buried Piping	1,690.00 LF	543.4	37,982	54,481	99,324	18,670		124.53 /LF	210,457
					92 OFFSITE - PIPELINES		**543.4**	**37,982**	**54,481**	**99,324**	**18,670**			**210,457**

CH2MHILL

Detail Report

Job Size: 1 LS
Duration:

Project: Port Townsend Alt 1
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	37,982		543.417 hrs		
Material	54,481				
Subcontract	99,324				
Equipment	18,670		466.883 hrs		
Other					
Total Subcontractor OH&P	210,457	210,457			
General Conditions	12,144			7.000 %	
Total Taxes	12,144	222,601			
Mobilization/Demobilization	11,493			3.000 %	
Bldr's Risk & Gen Liab Ins -%	3,831			1.000 %	
Payment & Performance Bond	4,444			1.160 %	
Total Owner-Provided Equipment	19,768	242,369			
Contingency - %	96,948			40.000 %	
Total Contingency	96,948	339,317			
Escalation on Estimate Total	12,148			3.580 %	
Construction Total	12,148	351,465			
Gross Sales Tax	31,632			9.000 %	
Construction Total (with GST)	**31,632**	**383,097**			

Port Townsend Mill Rd Pump Station, Alt 2, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 2 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 2
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					OFFSITE - PIPELINES									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		Gravity Pipe									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	238.00 cy	9.5	639	-	-	340	-	4.11 /cy	978
					02-01-01-01 General Site Demolition, Aspalt Pavement	17,600.00 SF	9.5	639			340		0.06 /SF	978
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,531	-	6,123.52 /mo	1,531
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,531		6,123.52 /MO	1,531
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	1,956.00 sy	17.6		-	3,569	-	-	1.83 /sy	3,569
					Bituminous Pavement Import Aggregate Base, 6"	570.00 tn	7.4		-	21,496	-	-	37.71 /tn	21,496
					Bituminous Asphalt (tn), 6"	669.00 tn	5.4		-	93,595	-	-	139.90 /tn	93,595
					Pavement Marking, 4" Pavement striping	2,200.00 lf	4.4		-	4,015	-	-	1.83 /lf	4,015
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	1,956.00 SY	34.8			122,675			62.72 /SY	122,675
				33-00-07-08	Yard Pipe, PVC, 8"									
					Traffic Control, Labor per Day	10.00 day	160.0	9,730	-	-	-	-	973.02 /day	9,730
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	700	-	2,798.04 /mo	700
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,852.01 CY	53.7	3,719	-	-	4,616	-	4.50 /CY	8,336
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	408.74 cy	54.4	3,631	-	-	2,312	-	14.54 /cy	5,943
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,488.28 cy	43.2	3,227	-	-	2,659	-	3.96 /cy	5,886
					Pipe zone material	408.74 cy		-	13,923	-	-	-	34.06 /cy	13,923
					Pipe bedding material	132.43 cy		-	4,511	-	-	-	34.06 /cy	4,511
					Imported backfill material	1,488.28 cy		-	21,727	-	-	-	14.60 /cy	21,727
					Haul spoils, offsite, up to 10 miles	541.17 cy		-	-	6,584	-	-	12.17 /cy	6,584
					Dump fees, trench spoils	541.17 ls		-	3,292	-	-		6.08 /ls	3,292
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	2,200.00 LF		-	27,112	-	-	-	12.32 /LF	27,112
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	2,200.00 LF	281.6	23,565	-	-	11,470	-	15.93 /LF	35,034
					Pipe Marking, ID Tape	2,200.00 lf	22.0	1,989	348	-	-	-	1.06 /lf	2,337
					33-00-07-08 Yard Pipe, PVC, 8"	2,200.00 LF	614.8	45,862	70,912	6,584	21,757		65.96 /LF	145,115
					CJM-010 Gravity Pipe		**659.1**	**46,500**	**70,912**	**129,258**	**23,628**			**270,299**
					33-35 Pipelines	2,200.00 LF	659.1	46,500	70,912	129,258	23,628		122.86 /LF	270,299
					33.0 Buried Piping	2,200.00 LF	659.1	46,500	70,912	129,258	23,628		122.86 /LF	270,299
					92 OFFSITE - PIPELINES		**659.1**	**46,500**	**70,912**	**129,258**	**23,628**			**270,299**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	46,500		659.117 hrs		
Material	70,912				
Subcontract	129,258				
Equipment	23,628		568.540 hrs		
Other					
Total Subcontractor OH&P	270,298	270,298			
General Conditions	15,597			7.000 %	
Total Taxes	15,597	285,895			
Mobilization/Demobilization	14,761			3.000 %	
Bider's Risk & Gen Liab Ins -%	4,920			1.000 %	
Payment & Performance Bond	5,708			1.160 %	
Total Owner-Provided Equipment	25,389	311,284			
Contingency - %	124,514			40.000 %	
Total Contingency	124,514	435,798			
Escalation on Estimate Total	15,602			3.580 %	
Construction Total	15,602	451,400			
Gross Sales Tax	40,626			9.000 %	
Construction Total (with GST)	**40,626**	**492,026**			

Port Townsend Mill Rd Pump Station, Com Alt 1&2, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Com 1&2 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Com 1&2
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	272.00 cy	10.9	730	-	-	388	-	4.11 /cy	1,118
					02-01-01-01 General Site Demolition, Aspalt Pavement	20,160.00 SF	10.9	730			388		0.06 /SF	1,118
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.50 mo		-	-	-	3,063	-	6,125.12 /mo	3,063
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.50 MO					3,063		6,125.12 /MO	3,063
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	2,240.00 sy	20.2		-	4,089	-	-	1.83 /sy	4,089
					Bituminous Pavement Import Aggregate Base, 6"	653.00 tn	8.5		-	24,633	-	-	37.72 /tn	24,633
					Bituminous Asphalt (tn), 6"	766.00 tn	6.1		-	107,194	-	-	139.94 /tn	107,194
					Pavement Marking, 4" Pavement striping	2,520.00 lf	5.0		-	4,600	-	-	1.83 /lf	4,600
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	2,240.00 SY	39.8			140,516			62.73 /SY	140,516
				33-00-07-10	Yard Pipe, PVC, 10"									
					Traffic Control, Labor per Day	15.00 day	240.0	14,599	-	-	-	-	973.26 /day	14,599
					Trench Box, 8' x 24' x 10'	0.50 mo		-	-	-	1,399	-	2,798.82 /mo	1,399
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	2,332.90 CY	67.7	4,686	-	-	5,817	-	4.50 /CY	10,503
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	530.48 cy	70.6	4,714	-	-	3,002	-	14.55 /cy	7,716
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,849.12 cy	53.6	4,010	-	-	3,305	-	3.96 /cy	7,315
					Pipe zone material	530.48 cy		-	18,075	-	-	-	34.07 /cy	18,075
					Pipe bedding material	160.64 cy		-	5,473	-	-	-	34.07 /cy	5,473
					Imported backfill material	1,849.12 cy		-	27,002	-	-	-	14.60 /cy	27,002
					Haul spoils, offsite, up to 10 miles	691.12 cy		-	-	8,410	-	-	12.17 /cy	8,410
					Dump fees, trench spoils	691.12 ls		-	4,205	-	-		6.08 /ls	4,205
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	2,520.00 LF		-	46,642	-	-	-	18.51 /LF	46,642
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	2,520.00 LF	383.0	32,062	-	-	15,605	-	18.92 /LF	47,667
					Pipe Marking, ID Tape	2,520.00 lf	25.2	2,279	399	-	-	-	1.06 /lf	2,678
					33-00-07-10 Yard Pipe, PVC, 10"	2,520.00 LF	840.1	62,350	101,795	8,410	29,128		80.03 /LF	201,683
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	4.00 ea	11.0	723	1,149	-	339	-	552.50 /ea	2,210
					Manholes, concrete, precast, 5' I.D., 8' deep	4.00 ea	64.0	4,191	9,492	-	1,964	-	3,911.52 /ea	15,646
					Manholes, conc, precast, 5' I.D., for DS over 8', add	16.00 vlf	32.0	2,095	3,505	-	982	-	411.36 /vlf	6,582
					Drop Structure Piping	4.00 ea			1,460				365.06 /ea	1,460
					33-15-01-05 Yard Structures, Manholes, 60" Dia	4.00 EA	107.0	7,009	15,605		3,284		6,474.53 /EA	25,898
					CJM-010 Gravity Pipe		**997.8**	**70,089**	**117,400**	**148,926**	**35,863**			**372,278**
					33-35 Pipelines	2,520.00 LF	997.8	70,089	117,400	148,926	35,863		147.73 /LF	372,278
					33.0 Buried Piping	2,520.00 LF	997.8	70,089	117,400	148,926	35,863		147.73 /LF	372,278
					92 OFFSITE - PIPELINES		**997.8**	**70,089**	**117,400**	**148,926**	**35,863**			**372,278**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	70,089		997.805 hrs		
Material	117,400				
Subcontract	148,926				
Equipment	35,863		948.431 hrs		
Other					
Total Subcontractor OH&P	372,278	372,278			
General Conditions	21,482			7.000 %	
Total Taxes	21,482	393,760			
Mobilization/Demobilization	20,330			3.000 %	
Bider's Risk & Gen Liab Ins -%	6,777			1.000 %	
Payment & Performance Bond	7,861			1.160 %	
Total Owner-Provided Equipment	34,968	428,728			
Contingency - %	171,491			40.000 %	
Total Contingency	171,491	600,219			
Escalation on Estimate Total	21,488			3.580 %	
Construction Total	21,488	621,707			
Gross Sales Tax	55,954			9.000 %	
Construction Total (with GST)	**55,954**	**677,661**			

Port Townsend Mill Rd Pump Station, Alt 3, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 3 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-001		**10 dia Force Main**									
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,533	-	6,132.84 /mo	1,533
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,533		6,132.84 /MO	1,533
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	701	-	2,802.32 /mo	701
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,574.21 CY	45.7	3,166	-	-	3,930	-	4.51 /CY	7,096
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	347.43 cy	46.2	3,091	-	-	1,969	-	14.56 /cy	5,059
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,265.03 cy	36.7	2,747	-	-	2,264	-	3.96 /cy	5,010
					Pipe zone material	347.43 cy		-	11,853	-	-	-	34.12 /cy	11,853
					Pipe bedding material	112.57 cy		-	3,840	-	-	-	34.12 /cy	3,840
					Imported backfill material	1,265.03 cy		-	18,496	-	-	-	14.62 /cy	18,496
					Haul spoils, offsite, up to 10 miles	460.00 cy		-	-	5,605	-	-	12.18 /cy	5,605
					Dump fees, trench spoils	460.00 ls		-	2,802	-	-	-	6.09 /ls	2,802
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	1,870.00 LF		-	23,080	-	-	-	12.34 /LF	23,080
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	1,870.00 LF	239.4	20,058	-	-	9,764	-	15.95 /LF	29,822
					Pipe Marking, ID Tape	1,870.00 lf	18.7	1,693	296	-	-	-	1.06 /lf	1,989
					33-00-07-10 Yard Pipe, PVC, 10"	1,870.00 LF	386.6	30,755	60,367	5,605	18,627		61.69 /LF	115,354
					CJM-001 10 dia Force Main	**1,870.00 LF**	**386.6**	**30,755**	**60,367**	**5,605**	**20,160**		**62.51 /LF**	**116,887**
					33-35 Pipelines	1,870.00 LF	386.6	30,755	60,367	5,605	20,160		62.51 /LF	116,887
					33.0 Buried Piping	1,870.00 LF	386.6	30,755	60,367	5,605	20,160		62.51 /LF	116,887
					92 OFFSITE - PIPELINES		**386.6**	**30,755**	**60,367**	**5,605**	**20,160**			**116,887**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	30,755		386.606 hrs		
Material	60,367				
Subcontract	5,605				
Equipment	20,160		497.904 hrs		
Other					
Total Subcontractor OH&P	116,887	116,887			
General Conditions	6,745			7.000 %	
Total Taxes	6,745	123,632			
Mobilization/Demobilization	6,383			3.000 %	
Bider's Risk & Gen Liab Ins -%	2,128			1.000 %	
Payment & Performance Bond	2,468			1.160 %	
Total Owner-Provided Equipment	10,979	134,611			
Contingency - %	53,844			40.000 %	
Total Contingency	53,844	188,455			
Escalation on Estimate Total	6,747			3.580 %	
Construction Total	6,747	195,202			
Gross Sales Tax	17,568			9.000 %	
Construction Total (with GST)	**17,568**	**212,770**			

Port Townsend Mill Rd Pump Station, Com Alt 1,2&3, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Com 1,2&3 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Com 1,2&3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					OFFSITE - PIPELINES									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		Gravity Pipe									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	20.00 cy	0.8	54	-	-	29	-	4.11 /cy	82
					02-01-01-01 General Site Demolition, Aspalt Pavement	1,496.00 SF	0.8	54			29		0.06 /SF	82
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.10 mo		-	-	-	613	-	6,126.10 /mo	613
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.10 MO					613		6,126.10 /MO	613
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	166.00 sy	1.5		-	303	-	-	1.83 /sy	303
					Bituminous Pavement Import Aggregate Base, 6"	49.00 tn	0.6		-	1,849	-	-	37.73 /tn	1,849
					Bituminous Asphalt (tn), 6"	57.00 tn	0.5		-	7,978	-	-	139.97 /tn	7,978
					Pavement Marking, 4" Pavement striping	187.00 lf	0.4		-	341	-	-	1.83 /lf	341
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	166.00 SY	3.0			10,471			63.08 /SY	10,471
				33-00-07-12	Yard Pipe, PVC, 12"									
					Traffic Control, Labor per Day	2.00 day	32.0	1,947	-	-	-	-	973.42 /day	1,947
					Trench Box, 8' x 24' x 10'	0.10 mo		-	-	-	280	-	2,799.30 /mo	280
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	190.11 CY	5.5	382	-	-	474	-	4.50 /CY	856
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	44.08 cy	5.9	392	-	-	249	-	14.55 /cy	641
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	148.94 cy	4.3	323	-	-	266	-	3.96 /cy	589
					Pipe zone material	44.08 cy		-	1,502	-	-	-	34.08 /cy	1,502
					Pipe bedding material	12.58 cy		-	429	-	-	-	34.08 /cy	429
					Imported backfill material	148.94 cy		-	2,175	-	-	-	14.61 /cy	2,175
					Haul spoils, offsite, up to 10 miles	56.66 cy		-	-	690	-	-	12.17 /cy	690
					Dump fees, trench spoils	56.66 ls		-	345	-	-		6.09 /ls	345
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	187.00 LF		-	4,884	-	-	-	26.12 /LF	4,884
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	187.00 LF	31.4	2,630	-	-	1,280	-	20.91 /LF	3,910
					Pipe Marking, ID Tape	187.00 lf	1.9	169	30	-	-	-	1.06 /lf	199
					33-00-07-12 Yard Pipe, PVC, 12"	187.00 LF	81.0	5,843	9,365	690	2,550		98.65 /LF	18,447
					CJM-010 Gravity Pipe		**84.7**	**5,897**	**9,365**	**11,161**	**3,191**			**29,613**
					33-35 Pipelines	187.00 LF	84.7	5,897	9,365	11,161	3,191		158.36 /LF	29,613
					33.0 Buried Piping	187.00 LF	84.7	5,897	9,365	11,161	3,191		158.36 /LF	29,613
					92 OFFSITE - PIPELINES		**84.7**	**5,897**	**9,365**	**11,161**	**3,191**			**29,613**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	5,897		84.742 hrs		
Material	9,365				
Subcontract	11,161				
Equipment	3,191		99.590 hrs		
Other					
Total Subcontractor OH&P	29,614	29,614			
General Conditions	1,709			7.000 %	
Total Taxes	1,709	31,323			
Mobilization/Demobilization	1,617			3.000 %	
Bldr's Risk & Gen Liab Ins -%	539			1.000 %	
Payment & Performance Bond	625			1.160 %	
Total Owner-Provided Equipment	2,781	34,104			
Contingency - %	13,641			40.000 %	
Total Contingency	13,641	47,745			
Escalation on Estimate Total	1,709			3.580 %	
Construction Total	1,709	49,454			
Gross Sales Tax	4,451			9.000 %	
Construction Total (with GST)	**4,451**	**53,905**			

Port Townsend Mill Rd Pump Station, Alt 4, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 4 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 4
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	378.00 cy	15.1	1,015	-	-	539	-	4.11 /cy	1,554
					02-01-01-01 General Site Demolition, Aspalt Pavement	28,000.00 SF	15.1	1,015			539		0.06 /SF	1,554
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.75 mo		-	-	-	4,593	-	6,124.64 /mo	4,593
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.75 MO					4,593		6,124.64 /MO	4,593
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	3,111.00 sy	28.0		-	5,678	-	-	1.83 /sy	5,678
					Bituminous Pavement Import Aggregate Base, 6"	907.00 tn	11.8		-	34,212	-	-	37.72 /tn	34,212
					Bituminous Asphalt (tn), 6"	1,064.00 tn	8.5		-	148,885	-	-	139.93 /tn	148,885
					Pavement Marking, 4" Pavement striping	3,500.00 lf	7.0		-	6,388	-	-	1.83 /lf	6,388
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	3,111.00 SY	55.3			195,163			62.73 /SY	195,163
				33-00-07-08	Yard Pipe, PVC, 8"									
					Traffic Control, Labor per Day	20.00 day	320.0	19,464	-	-	-	-	973.19 /day	19,464
					Trench Box, 8' x 24' x 10'	0.75 mo		-	-	-	2,099	-	2,798.59 /mo	2,099
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	2,946.37 CY	85.4	5,918	-	-	7,346	-	4.50 /CY	13,264
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	650.27 cy	86.5	5,778	-	-	3,680	-	14.54 /cy	9,457
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	2,367.71 cy	68.7	5,134	-	-	4,231	-	3.96 /cy	9,366
					Pipe zone material	650.27 cy		-	22,155	-	-	-	34.07 /cy	22,155
					Pipe bedding material	210.69 cy		-	7,178	-	-	-	34.07 /cy	7,178
					Imported backfill material	2,367.71 cy		-	34,572	-	-	-	14.60 /cy	34,572
					Haul spoils, offsite, up to 10 miles	860.96 cy		-	-	10,476	-	-	12.17 /cy	10,476
					Dump fees, trench spoils	860.96 ls		-	5,238	-	-		6.08 /ls	5,238
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	3,500.00 LF		-	43,141	-	-	-	12.33 /LF	43,141
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	3,500.00 LF	448.0	37,496	-	-	18,250	-	15.93 /LF	55,747
					Pipe Marking, ID Tape	3,500.00 lf	35.0	3,165	554	-	-	-	1.06 /lf	3,719
					33-00-07-08 Yard Pipe, PVC, 8"	3,500.00 LF	1,043.6	76,956	112,837	10,476	35,606		67.39 /LF	235,874
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	4.00 ea	11.0	723	1,149	-	339	-	552.45 /ea	2,210
					Manholes, concrete, precast, 5' I.D., 8' deep	4.00 ea	64.0	4,190	9,491	-	1,964	-	3,911.22 /ea	15,645
					Manholes, conc, precast, 5' I.D., for DS over 8', add	16.00 vlf	32.0	2,095	3,504	-	982	-	411.33 /vlf	6,581
					Drop Structure Piping	4.00 ea			1,460				365.03 /ea	1,460
					33-15-01-05 Yard Structures, Manholes, 60" Dia	4.00 EA	107.0	7,008	15,604		3,284		6,474.03 /EA	25,896
					CJM-010 Gravity Pipe		**1,221.1**	**84,979**	**128,441**	**205,639**	**44,023**			**463,081**
					33-35 Pipelines	4,278.00 LF	1,221.1	84,979	128,441	205,639	44,023		108.25 /LF	463,081
					33.0 Buried Piping	4,278.00 LF	1,221.1	84,979	128,441	205,639	44,023		108.25 /LF	463,081
					92 OFFSITE - PIPELINES		**1,221.1**	**84,979**	**128,441**	**205,639**	**44,023**			**463,081**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 4
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	84,979		1,221.052 hrs		
Material	128,441				
Subcontract	205,639				
Equipment	44,023		1,194.695 hrs		
Other					
Total Subcontractor OH&P	463,082	463,082			
General Conditions	26,721			7.000 %	
Total Taxes	26,721	489,803			
Mobilization/Demobilization	25,288			3.000 %	
Bldr's Risk & Gen Liab Ins -%	8,429			1.000 %	
Payment & Performance Bond	9,778			1.160 %	
Total Owner-Provided Equipment	43,495	533,298			
Contingency - %	213,319			40.000 %	
Total Contingency	213,319	746,617			
Escalation on Estimate Total	26,729			3.580 %	
Construction Total	26,729	773,346			
Gross Sales Tax	69,601			9.000 %	
Construction Total (with GST)	**69,601**	**842,947**			

Appendix E:
Calculations

Gravity Line Evaluation for Critical Depth and Supercritical Flow

Port Townsend - Mill Road Pump Station and Force Main Predesign

Critical Depths

From Brater and King, 6th Edition
Table 8-10 (page 8-61)

Equation: $Q = K'_c d^{5/2}$ Solving for K'_c = $Q/d^{5/2}$

Where : Q = flow in cfs
K'c = Table Value
d = Pipe Diameter

Normal Depth

From Brater and King, 6th Edition
Table 7-14 (page 7-04)

Equation: $Q=(K'/n)d^{8/3}s^{1/2}$ Solving for $K' = Qn/(d^{8/3}s^{1/2})$

Where: Q = flow in cfs
K' = Table Value
d = Pipe Diameter
s = Slope ft/ft
n = Manning's Friction Factor = 0.013

Flow (gpm) divided by 448.80 = Flow cfs

Maximum Slope on Mill Road = 12.00% = 0.120 ft/ft

Maximum Slope on Thomas Street = 11.00% = 0.11 ft/ft

Critical Depth Calculations

Pipe Diameter = 8 inches = 0.67 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	1.2280	0.4676	0.31	3.74
400.00	0.89	2.4560	0.6714	0.45	5.37
600.00	1.34	3.6841	0.8182	0.55	6.55
800.00	1.78	4.9121	0.9122	0.61	7.30
1,000.00	2.23	6.1401	0.9689	0.65	7.75

Pipe Diameter = 10 inches = 0.83 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	0.7030	0.3500	0.23	2.80
400.00	0.89	1.4059	0.5019	0.33	4.02
600.00	1.34	2.1089	0.6204	0.41	4.96
800.00	1.78	2.8118	0.7191	0.48	5.75
1,000.00	2.23	3.5148	0.8010	0.53	6.41

Pipe Diameter = 12 inches = 1.00 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	0.4456	0.2763	0.18	2.21
400.00	0.89	0.8913	0.3957	0.26	3.17
600.00	1.34	1.3369	0.4888	0.33	3.91
800.00	1.78	1.7825	0.5684	0.38	4.55
1,000.00	2.23	2.2282	0.6384	0.43	5.11

Normal Depth Calculations - Mill Road

Pipe Diameter = 8 inches = 0.67 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0493	0.2200	0.15	1.76
400.00	0.89	0.0986	0.3133	0.21	2.51
600.00	1.34	0.1479	0.3884	0.26	3.11
800.00	1.78	0.1972	0.4557	0.30	3.65
1,000.00	2.23	0.2465	0.5194	0.35	4.16

Pipe Diameter = 10 inches = 0.83 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0272	0.1644	0.11	1.32
400.00	0.89	0.0544	0.2315	0.15	1.85
600.00	1.34	0.0816	0.2841	0.19	2.27
800.00	1.78	0.1088	0.3300	0.22	2.64
1,000.00	2.23	0.1360	0.3712	0.25	2.97

Pipe Diameter = 12 inches = 1.00 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0167	0.1300	0.09	1.04
400.00	0.89	0.0334	0.1818	0.12	1.45
600.00	1.34	0.0502	0.2222	0.15	1.78
800.00	1.78	0.0669	0.2515	0.17	2.01
1,000.00	2.23	0.0836	0.2877	0.19	2.30

In all cases, at 12% slope, normal depth is less than critical depth - flow is in supercritical mode.

Highlighted columns represent a calculated value from the Tables identified above.

Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Peak Flow at Ultimate Buildout = 1185 gpm = 2.64 cfs

Goal - Maintain flows between 2.0 to 7.0 fps

Based on the following use a 10 inch force main in the 30 percent design.

Potential Force Main Diameters

6 inches	=	0.5 feet	Area =	0.20 ft^2
8 inches	=	0.7 feet	Area =	0.35 ft^2
10 inches	=	0.8 feet	Area =	0.55 ft^2

Flow Velocity (fps) = Q/A

Pumped Flow (gpm)	Pumped Flow (cfs)	Force Main Velocity 6 inch	Force Main Velocity 8 inch	Force Main Velocity 10 inch
200	0.45	2.27		
400	0.89	4.54		
500	1.11	5.67		
600	1.34	6.81		
800	1.78	9.08		
1000	2.23	11.35		
1185	2.64	13.45		
200	0.45		1.28	
400	0.89		2.55	
500	1.11		3.19	
600	1.34		3.83	
800	1.78		5.11	
1000	2.23		6.38	
1185	2.64		7.56	
200	0.45			0.82
400	0.89			1.63
500	1.11			2.04
600	1.34			2.45
800	1.78			3.27
1000	2.23			4.09
1185	2.64			4.84

Highlighted areas represent those that meet the stated criteria of maintaining velocities between 2.0 and 7.0 fps. The intent is to install the physical facilities such that ultimate buildout flows can be accommodated - realizing that mechanical equipment (say pumps) can be changed relatively simply over time without requiring the expenditure of significant costs to adapt to varying influent flow conditions.

Find pumps that can be modified to deliver between 500 gpm and 1200 gpm. Possibly through impeller changes.

Want to install the 10" force main. Installing either of the smaller mains to keep velocities higher would just mean that they would have to be replaced once the influent flows and the pumped flows got to the higher velocity range. By installing the 10 inch line pumped velocities don't vary too much and it will help to keep headlosses low.

Force Main Headloss Calculations

Headloss = S*Length

Slope = $(3.03/D^{1.16})(V/C)^{1.85}$

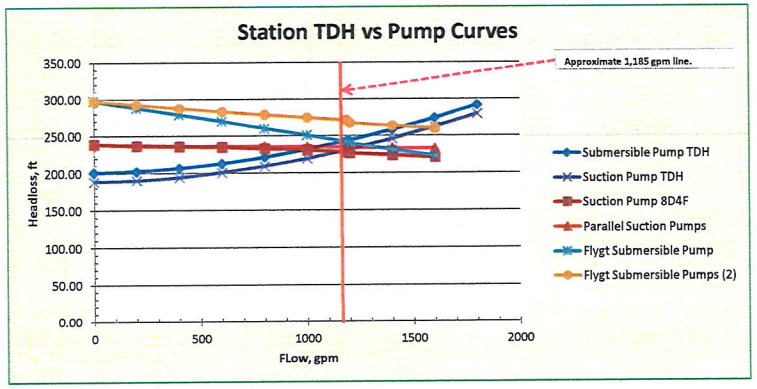
Force Main Length = 4,278 ft
Force Main Diameter 10 inches = 0.83 ft
Force Main Area 0.55 ft^2
Assume Force Main Material is DIP C = 130
Assumed Additional Losses to account for bends/angles in the Force Main, Pump Station Piping, etc. = 15.00% percent of calculated losses
Elevation of Forcemain at Pump Station = 19 ft (4 ft below ground surface)
Elevation of Forcemain at Discharge MH = 208 ft

Flow (gpm)	Flow (cfs)	Force Main Diameter (ft)	Velocity (fps)	Slope ft/ft	Headloss (S*L) (ft)	Additional Losses	Total HL (ft)	Static Head Suction Lift	TDH Suction Lift	Static Head Submer.	TDH Submer.
0	0.00	0.83	0.00	0	0.00	0.00	0.00	189	189.00	200.98	200.98
200	0.45	0.83	0.82	0.000316	1.35	0.20	1.56	189	190.56	200.98	202.53
400	0.89	0.83	1.63	0.00114	4.88	0.73	5.61	189	194.61	200.98	206.59
600	1.34	0.83	2.45	0.002415	10.33	1.55	11.88	189	200.88	200.98	212.86
800	1.78	0.83	3.27	0.004111	17.59	2.64	20.23	189	209.23	200.98	221.20
1000	2.23	0.83	4.09	0.006212	26.58	3.99	30.56	189	219.56	200.98	231.54
1185	2.64	0.83	4.84	0.008504	36.38	5.46	41.84	189	230.84	200.98	242.81
1200	2.67	0.83	4.90	0.008704	37.24	5.59	42.82	189	231.82	200.98	243.80
1400	3.12	0.83	5.72	0.011577	49.53	7.43	56.95	189	245.95	200.98	257.93
1600	3.57	0.83	6.54	0.014821	63.40	9.51	72.91	189	261.91	200.98	273.89
1800	4.01	0.83	7.35	0.018429	78.84	11.83	90.67	189	279.67	200.98	291.64

Pump Curves

Smith & Loveless 8D4F Suction Pump

Flow (gpm)	Head (ft)	Head (2 P's) (ft)
0	239	239
200	237	238
400	236	237
600	235	236.5
800	233	236
1000	231	235.4
1185	228	234.8
1200	227	234.2
1400	224	233.6
1600	221	233



Flygt MP 3315 HT

Flow (gpm)	Head (ft)	Head (2 P's) (ft)
0	298	298
200	288	293
400	279	288
600	270	283.5
800	260	279
1000	251	275.2
1185	242	271.4
1200	240	267.6
1400	231	263.8
1600	223	260

Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Active Storage Volume

Eqn. $T = V/I + V/(Q-I)$ Where: T = allowable minimum cycle time between starts (time to fill plus time to empty) (minutes
V = the active volume between LWL and HWL (fixed) (gallons)
I = inflow rate (gpm)
Q = pump rate (gpm)

Note: Worse case cycle time occurs when influent flow is 1/2 of pumping capacity.

Assumptions:

1 Duplex Pump Station - each pump capable of accommodating peak flow; operating in a lag/lead fashion to balance operating hours
2 Lag pump automatically called to operate if lead pump fails or cannot match influent flow
3 Want pumps to go through full on-off-on cycle no more than "X" time per hour. For a duplex station operating in lag/lead this allows for "2X' starts per hour. However active storage volume is based on a single pump to remain conservative.

Known variables: T = 6 cycles per hour = 10 minutes For an individual pump
I = 1185 gpm At buildout
Q = 1185 gpm

Solving above equation for V: $V = TQ/4$

Required Active Storage Volume = 2962.5 gallons (say) 3000 gallons

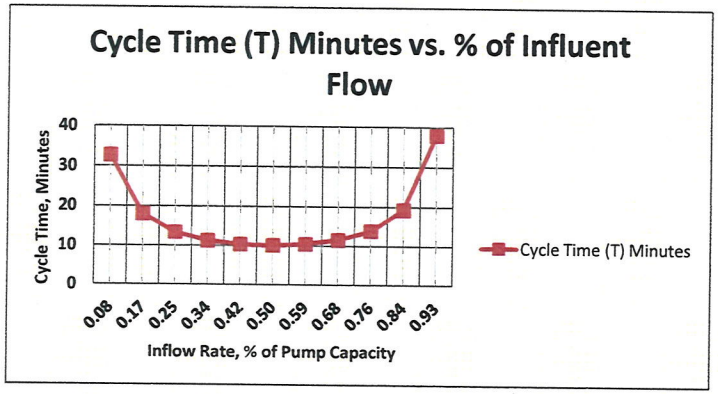
Check - cycle time when I = Q/2 : T = 10.12658 minutes

Graphing Cycle Time Curve:

Inflow Rate Vs. Percent (%) of Pump Capacity

Inflow Rate (gpm)	Percent of Pump Capacity (gpm)	Pump Capacity (gpm)	Cycle Time (T) (min)
1	0.00	1185	3002.534
100	0.08	1185	32.76498
200	0.17	1185	18.04569
300	0.25	1185	13.38983
400	0.34	1185	11.32166
500	0.42	1185	10.37956
592.5	0.50	1185	10.12658
700	0.59	1185	10.47128
800	0.68	1185	11.54221
900	0.76	1185	13.85965
1000	0.84	1185	19.21622
1100	0.93	1185	38.02139
1185	1.00	1185	#DIV/0!

Do not plot lowest and highest Inf. flow rates as they approach infinity.



Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Wet Well Sizing

Assumptions:

1 Desire is to design and install the physical facilities of the wet well for complete buildout of the area; but retain the capability to use the facilities during the interim before complete buildout occurs.
2 Used "X" feet as an active storage depth to allow for adjustments in depth for lower influent flows during the early years of the station.
3 Utilized a circular wet well, easier to clean, maintain than a rectangular one.

Circular Wet Well Sizing:

Circle Area: $Pi(D^2)/4$

Assumed Active Storage Volume Depth = 0.50 feet

7.48 gal/ft^3

Required Wet Well Diameter -

Active Volume = 3000 gallons = 401.0695 ft^3

Diameter =

Volume	Pi	Diameter
ft^3		ft
401.07	3.14	31.96

Say 32.00 ft Use 45 foot diameter to allow for 1 hours storage at peak (ultimate buildout) flow

Area = 804.2496 ft^2 1,590.44 ft^2

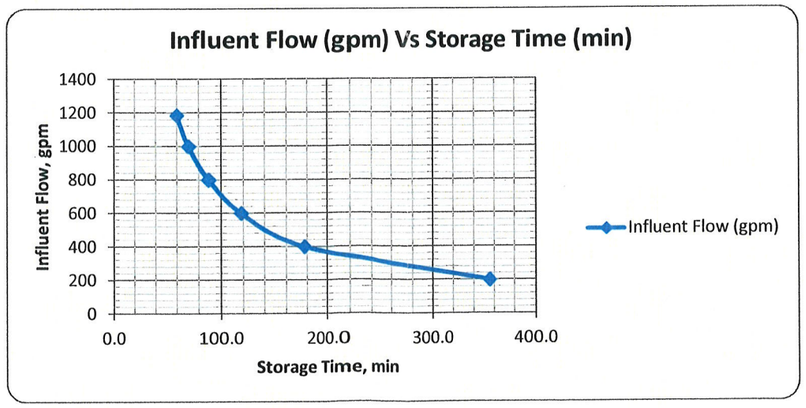
Active Storage Volume available using larger diameter Caisson = 5,948.23 gallons

Standby Storage Capacity -

Required if Station experiences complete loss of power or both pumps fail.

Storage Time @ Peak Inf. (min)	Peak Influent Flow (gpm)	Volume Required (gallons)	Volume Required (ft^3)	Depth in Wet Well (ft)
30	1,185	35,550	4,753	2.99
60	1,185	71,100	9,505	5.98
90	1,185	106,650	14,258	8.96
120	1,185	142,200	19,011	11.95
240	1,185	284,400	38,021	23.91

Note: depth indicated is for distance **below** invert of influent sewer only and does not include active storage volumes. Nor does it include depth from sewer invert to ground surface.



Potential Storage above High, High Alarm at different flow rates.

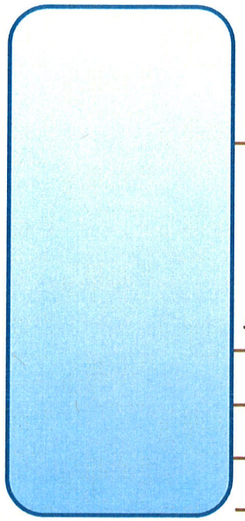
Assumption: Set storage to be equal to 30 minutes at buildout peak flows.

Influent Flow (gpm)	Storage Volume (ft^3)	Storage Time (min)	Storage Time (hours)
200	71,100	355.5	5.93
400	71,100	177.8	2.96
600	71,100	118.5	1.98
800	71,100	88.9	1.48
1000	71,100	71.1	1.19
1185	71,100	60.0	1.00

Mill Road Pump Station Preliminary Design
Wet Well Sizing

Note: Layout for Suction Lift Pumps only differs
by elimination of most of Dead Storage.

Figure 1
Generic Pump Layout



Influent to Wet Well = 9.4765709 = 10.00

Standby Storage Volume = 5.98 ft

High, High Water Alarm = 0.5 ft

Pump On (Lag Pump) = 0.50

High Water Alarm

Pump On (Lead Pump)

Active Storage = 0.50 ft

Pump Off Elevation

Dead Storage = 2.00 ft

(Submersible pumps only)

Bottom of Wet Well

Assumed Suction Pump Volute Elevation = 24.50 1.5 Assumed elevation of suction pump volute above GS.

Actual Pump Station Depth:

Surface Elevation = 23.00 ft

Influent Sewer Elevation = 14.50 ft

Standby Storage Elevations = 14.50 ft to 8.52 ft = 5.98 ft

High, high water alarm Elev = 8.52 ft

Lag Pump on Elevation = 8.02 ft 0.50 ft = Active Storage Volume

High water alarm Elev = 8.02 ft

Lead Pump On Elev = 7.52 ft

Pump Off Elev = 7.02 ft

Bottom of Dead Storage Elev = 5.02 ft

Using submersible pumps the station wet well would be - 17.98 ft deep

If suction lift pumps were used the difference between pump off and surface elevation (assuming that the suction lift pumps were on top of the wet well and the volute was elevated 1.5 feet above the top of slab, cannot exceed 17.5 feet maximum. To make that work the top slab would have to be lowered by:

-0.02 ft