Sooke Wastewater Treatment Plant Expansion – Conceptual Design

Prepared for:
District of Sooke

Prepared by:
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Sign-off Sheet

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INTRODUCTION

GENERAL

Stantec Consulting Ltd. (Stantec) was retained by the District of Sooke to undertake a conceptual design for the Sooke Wastewater Plant Expansion which will be used in conjunction with a Class C cost estimate to aid the District in obtaining a grant to fund this project. This design report summarizes the details of the conceptual design.

REPORT CONTENT

This design report is organized into 8 sections:

Section 1	Introduction
Section 2	Design Flows and Loads
Section 3	Process Design
Section 4	Civil Design
Section 5	Structural Design
Section 6	Electrical Design
Section 7	Instrumentation and Controls Design
Section 8	Cost Estimate

A conceptual design drawing package has been submitted to complement this report (bound separately).

BACKGROUND

The District of Sooke built a wastewater collection system and wastewater treatment plant in Sooke, BC using a Design/Build/Operate procurement methodology. Prior to the construction of the wastewater collection and treatment system, Sooke residents and businesses relied on septic systems to treat their wastewater. Due to failures of numerous septic fields and systems as well, health concerns, and issues with water quality and aquatic life health in the Sooke basin, the District of Sooke decided to build a wastewater system. Construction of the wastewater treatment plant began in December 2004 with completion in November 2005.

The WWTP includes a secondary wastewater treatment process utilizing sequencing batch reactors (SBR's). Currently, raw wastewater influent enters the treatment plant via gravity flow into the headworks building and is then screened for removing large solids, rags and debris. Grit removal also takes place in the headworks building. Once screened and de-gritted, the wastewater flows into two SBRs operated in parallel. The SBR's receive the raw screened and degritted influent and biological removal of contaminants in the wastewater begins. The SBR's work on a fill and draw principle in that when one SBR is under aeration and is receiving influent, the other SBR is drawing off supernatant from the top of the aeration basin.

The clear treated supernatant is drawn from the SBR's, flows through a UV disinfection channel where disinfection of microbial organisms occurs. After disinfection, the wastewater flows via gravity to the outfall, which is located 1.7 km into Juan de Fuca Strait. The excess secondary sludge produced in the SBR's is stabilized into Aerobic Digesters before being dewatered via a centrifuge. The final cake is sent for disposal.

The Sooke wastewater collection and treatment system serves a core area of 5,500 residents including the downtown commercial and industrial core. The collection system comprises over 58km of piping and seven (7) municipally operated pump stations.

The plant is currently designed for a capacity of 3,000 m3 per day annual average daily flow and 6,900 m3 per day peak wet weather flow capacity. Growing demand on the existing system and expected increases in projected future flows is causing the need for greater capacity at the WWTP. The plant was designed to allow for future expansion.

PROPOSED SOOKE WWTP EXPANSION

The proposed expansion of the Sooke WWTP will include the following unit processes/systems:

- One (1) Screened raw sewage splitter box
- One (1) Sequencing Batch Reactor (SBR)
- One (1) Aerobic Digester
- One (1) SBR blower and aeration diffusion system
- One (1) Digester blower and aeration diffusion system
- Motor Control Centre Extension

The proposed expansion will further load the electrical and control systems, therefore additional upgrades are being recommended on:

- Programmable Logic Controller replacement (obsolete, full technology upgrade and expansion)
- Generator replacement (existing undersized depending on the defined operating load determined in design)

DESIGN FLOWS AND LOADS

EXISTING DESIGN OVERVIEW

At the time of conception, historic wastewater flow information was not available for the District of Sooke. To estimate future flows, values typical of Capital Regional District (CRD) at the time were selected. These values were then adjusted for direct discharge to the sewer. Based on the CRD flow review, a per capita flow of 300 Liters per capita per day was used to determine the average annual flow rate (AAF). This value incorporated some inflow and infiltration (I&I). The predicted flow rates used for the proposed treatment plant are presented in **Figure 1**. No reduction in the 300 L/c/d flow rate was incorporated in the flow assessment. The original design was based on a 20-year horizon.

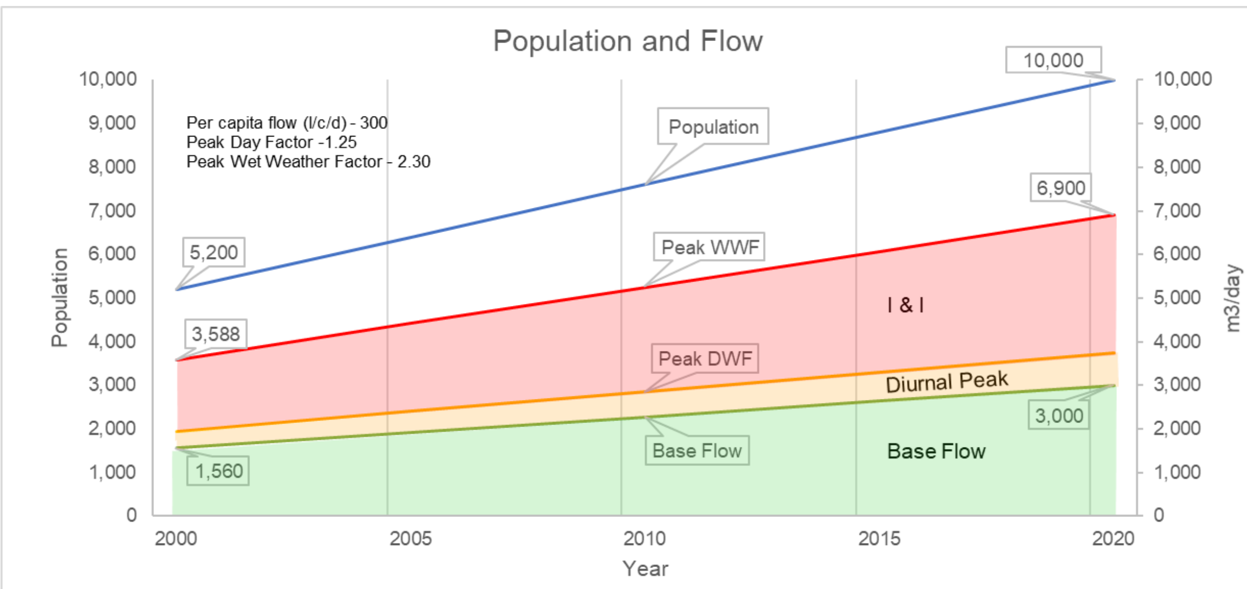

Figure 1: Design Wastewater Flows

Based on data from other treatment facilities in the CRD, a relatively low peak wet weather factor of 2.3 was selected (typical values ranged between 2.3 - 3.5). It was assumed that there was minimal I&I in the new collection system.

The design of the SBR facility will accommodate expansion. Each SBR tank is designed to handle 1500 m^3/d average flow. Expansion beyond the current Average Dry Weather Flow (ADWF) of 3000 m^3/d can be achieved by adding trains in 1500 m^3/d capacity increments.

DESIGN POPULATION

The 1999 population equivalent in the catchment area was estimated at 5,200. The population equivalent value incorporated a commercial equivalence factor which accounted for higher sewage generation by commercial establishments. A growth rate between 2 and 2.5% was estimated based on previous reports at the time. The estimated total population equivalent for the year 2020 was 10,000 people.

In 2018, the District provided data on effluents flows from 2007 through 2017. **Table 1** summarizes this data. The growth during the 2007-2009 period (47.4%) was significantly higher than the growth during the 2009-2017 period (3.2%), The higher growth rate during the early years of plant operation corresponds to the build out of the collection system and connection of houses in the first 2 years following start of the WWTP. The District has recommended that an annual growth of 3.5% is appropriate for forecasting future flows.

Table 1 – Historical Flow Data for Sooke WWTP

Year	Effluent Flow (m^3/year)	% Change Year/Year	% Change Period
2007	282,955	-	47.4%
2008	473,802	67.4%	
2009	614,987	29.8%	
2010	630,258	2.5%	3.2%
2011	670,443	6.4%	
2012	696,347	3.9%	
2013	663,532	-4.7%	
2014	726,340	9.5%	
2015	741,573	2.1%	
2016	776,729	4.7%	
2017	792,821	2.1%	

DESIGN FLOWS AND LOADS

Existing ADWF plant capacity is rated for treatment of 3,000 m^3 a day of wastewater. Current data from the plant as shown in Table 2 below indicates that for the recent years, the average daily flows received at the plant are 2,200 m^3 a day or 73.4% of it's current design capacity.

Table 2 - Sooke WWTP Average Daily Flows

	2016	2017	2018	2019
Month	**Effluent**	**Effluent**	**Effluent**	**Effluent**
January	2479	2310	3192	3030
February	2884	2655	2859	2291
March	2599	2813	2168	1948
April	1805	2283	2437	2094
May	1650	1860	1888	1875
June	1610	1747	1821	1782
July	1601	1688	1772	1786
August	1596	1656	1732	1796
September	1604	1648	1745	1905
October	2056	1903	1785	2268
November	2751	2800	2807	2413
December	2857	2744	3300	2801
Average	2124	2172	2292	2166

Growth increases estimated at 3.5% per year and the inability for the operators to effectively perform maintenance on the existing SBR tanks is the primary driver to expand the treatment plant. With each SBR tank designed to handle 1500 m^3/d average flow. Expansion to bring an additional SBR online will bring the current ADWF of 3000 m^3/d capacity up to a 4500 m^3/d capacity. This will in turn allow for the expansion of the current Sewer Serviced Area (SSA) and enable the addition of two communities currently outside the SSA. Kaltasin and Whiffin Spit have been flagged as communities of interest to bring online in an effort to reduce environmental impacts to the Sooke Basin.

Table 3 below depicts the expected increases in plant capacity as a result of the proposed expansion works.

Table 3 - Sooke Wastewater Treatment Plant Capacity

Year	1999	2020 (projected)	Expansion
Population	5,200	10,000	15,000
Per capita flow (L/c-d)	300	300	300
Peak Day Factor	1.25	1.25	1.25
Peak Wet Weather Factor	2.3	2.3	2.3
Average Dry Weather Flow (ADWF) (m^3/d)	1,500	3,000	4,500
Peak Dry Weather Flow (PDWF) (m^3/d)	1,900	3,800	5,700
Peak Wet Weather Flow (PWWF) (m^3/d)	3,600	6,900	10,350

In 2002, influent water quality was estimated through a review of CRD WWTPs typical wastewater characteristics. The design values that were selected are slightly higher than typical domestic waste, but include no major commercial, industrial or septage waste. The values for the wastewater influent characteristics used in the original design are shown in **Table 4**

Table 4 – Wastewater Design Characteristics

Characteristic	Value
BOD_5	250 mg/L
Total Suspended Solids	250 mg/L
NH_3^+	25 mg/L
TKN	45 mg/L
Temperature	14 °C

Table 5 is a summary of actual influent quality data from 2017. These data correspond closely to the original design criteria from 2002.

Table 5 – Influent Loading and Effluent Discharges from 2017

			Influent				Combined Effluent						
2017	Effluent flow	pH	CBOD	TSS	NH_3-N	TP	pH	UVT	CBOD	TSS	NH_3-N	TP	FC
	m³/d		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	CFU /100 mL
Min	1515	7.0	142	25	5.6	4.7	6.3	33.0	4	2	0.1	0.7	2
Max	5927	8.2	411	416	75.0	11.2	6.9	70.0	22	84	8.5	6.2	3800
Avg	2172	7.8	256	232	41.4	8.1	6.6	55.4	7	11	1.4	2.7	184

PROCESS DESIGN

The Sooke WWTP Expansion Project will have the following unit processes/systems:

- Influent splitter box
- Sequencing batch reactor (x1) (SBR);
- Process air system including blowers and diffusers;
- Aerobic digester (x1);

SECONDARY TREATMENT

Sequencing Batch Reactors (SBR's)

The secondary treatment consists of a two train ABJ Intermittent Cycle Extended Aeration System (ICEAS©) sequencing batch reactor (SBR). A third train will be added as part of this expansion. The wastewater flows by gravity from the headworks to the SBR system. SBR treatment is a fill-and-draw, non-steady state activated sludge type treatment system, where the biological reaction and sedimentation occur in the same tank. The bioreactor tanks are operated in a timed sequence to achieve the desired level of treatment. The size of the SBR tanks are 29 x 10 metres with a 3.9 metre minimum and 5 metre maximum side wall depth (SWD). The SBR is designed to achieve an effluent quality of 20 mg/L BOD_5, 20 mg/L of TSS and ≤ 5 mg/L of NH_3-N on a monthly average basis. The plant is designed to pass the LT_{50} effluent toxicity test. To achieve this, the SBR system will operate on a "Continuous feed – intermittent decant" type strategy. An influent splitter box with control weir gates is provided to distribute screened and degritted wastewater continuously to the two SBR cells.

The SBRs are designed to handle a hydraulic flow variation of 3000 m^3/d (AAF) to 6900 m^3/d (PWWF). The typical hydraulic retention time (HRT) of the system under average conditions is estimated to be 21 hours with a sludge age of 25 days. Under these conditions the proposed system will provide effective removal of BOD_5, TSS and ammonia-nitrogen (via nitrification). A minimum mixed liquor operating temperature of 10°C is required for complete nitrification. The SBR treatment cycles are key to overall process operation. The mode of operation is as follows:

Table 6 - SBR Cycle Times

Cycle	Aeration	Settle	Decant	Total
Normal	120 min	60 min	60 min	4 hours
Storm[1]	90 min	45 min	45 min	3 hours

[1]Note: A storm cycle is initiated during the peak wet weather flow conditions

Aeration is provided by a Sanitaire® fine bubble 230 mm Silver Series II membrane grid diffusers and by utilizing two (one duty, one standby) positive displacement blowers to meet the air requirements. A dissolved oxygen (DO) feedback control system with DO probes is provided to optimize plant efficiency and to match blower output to process oxygen demand. Blower output is adjusted with variable speed drives. This arrangement will provide greater flexibility in power savings during periods of low organic loading. Treated effluent from the SBR is collected by a decanting system in each of the SBR trains. Two decanters are provided, each 4.6 meters long with a stainless-steel trough, scum exclusion float, down comer pipes, collection pipe and 0.75 HP decanter drive. The effluent is collected in an effluent box where it will flow by gravity to the ultraviolet disinfection (UV) system.

Sludge Treatment

390 kg/day Waste Activated Sludge (WAS) is discharged to the aerobic digesters for stabilization. The purpose of the aerobic digesters is to stabilize the WAS produced in the SBR system. The stabilization process is designed to reduce pathogens, reduce or eliminate the potential for putrefaction and make the sludge less odorous for downstream processing and final disposal. The aerobic digesters consist of two (2) cells to provide flexibility of operation and maintenance. A third cell will be provided as part of this expansion. The digesters are operated to reduce the VSS by 40% and satisfy the BC requirement for a Class B sludge. Aerobic conditions (minimum dissolved oxygen of 1 mg/L) is maintained through an aeration system consisting of fixed grid fine bubble diffusers. The air supply is provided by dedicated blowers. The contents of the aerobic digester will periodically be allowed to settle after switching off the aeration system. It is expected that the sludge is thickened to about 8000 - 10,000 mg/L via gravity settling, which will leave a partially clarified supernatant on top of the sludge blanket. A portion of the supernatant is decanted and returned to the supernatant pump station and pumped back to the SBR splitter box.

Settled sludge from the digesters is periodically pumped with submersible pumps to the centrifuge for dewatering. The centrifuge is housed in a new building adjacent to the SBRs. No dewatering upgrades are included in this project.

CIVIL DESIGN

UTILITIES

The Sooke WWTP Expansion anticipates having minimal implications of civil works. With all existing utilities having been installed during the original plant construction and with the original design having accounted for footprint to accommodate this expansion, no utility relocation is expected to be required. No additional utilities are expected to be required to complete this expansion.

ACCESS ROAD & SITE GRADING

The additional SBR tank will be installed in a location currently occupied by the treatment plant access road. As such, the existing access road alignment will be modified to contour the new SBR. Regrading of the adjacent property will be provided to ensure proper sheet flow and drainage.

STRUCTURAL DESIGN

The new structures for Sooke WWTP expansion must be designed to meet the many unique challenges that are associated with the processes involved as well as with the particular site. The following sections describe the proposed design criteria that will be used and summarize the proposed structural concepts for each major component of the facility.

EXISTING STRUCTURES

The original Sooke wastewater treatment plant structures were designed in 2004 to the 1998 British Columbia Building Code (BCBC). The existing tank structure consists of two digester tanks and two SBR tanks constructed of a reinforced concrete foundation slab and reinforced concrete walls. The existing slab foundation is 400mm and 500mm in the digester tank and SBR tank respectively. The existing exterior tank walls vary from 400mm to 450mm thick. The existing tanks are open topped and there are concrete catwalks with guard rails for access to the tanks and the headworks building located on the north-west wall of the SBR tanks.

Due to the growing population in Sooke, a new digester and SBR tank are proposed to be constructed on the south wall of the existing structure. The existing concrete structure was designed to include provisions for future expansion. The existing record drawings include details showing keyway joints and threaded rebar couplers along the south walls as shown in Figure 1, as well as, rebar couplers for the top row of reinforcing in the foundation slab. The record drawings also show that the south reinforced concrete wall was designed to resist loading from both sides, as opposed to the north wall which is only designed to resist the loading from the inside face.

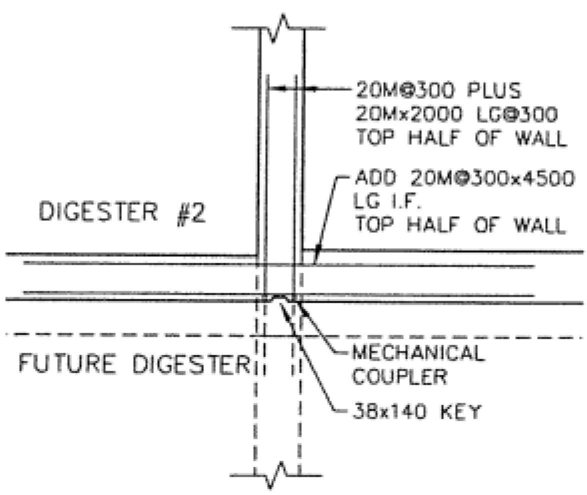

Figure 1 - Expansion provisions including construction joint keyway and rebar couplers (Lockerbie Stanley Inc. Structural Drawings, 2004)

APPLICABLE CODES AND STANDARDS

Applicable systems for the proposed expansion of the wastewater treatment plant will be designed in accordance to the following codes and standards adopted by the Authorities Having Jurisdiction (Sooke) at the time of the detailed design, anticipated to be the following:

- British Columbia Building Code (BCBC) 2018.
- CSA A23.3: Design of Concrete Structures.
- ACI 350: Code Requirements for Environmental Engineering Concrete Structures
- ACI 350.3: Seismic Design of Liquid-Containing Concrete Structures and Commentary

DESIGN CRITERIA

In accordance with the BCBC 2018, the design criteria to be used for the expansion are as follows:

Importance Factors:

- As per the BCBC 2018 a wastewater treatment facility is considered a “post-disaster” building and therefore as shown in **Table 7**, the following importance factors apply to the structural design.

Table 7 - SBR Cycle Times

	Ultimate Limit States (ULS)	Serviceability Limit States (SLS)
Is (snow load)	1.25	0.90
Iw (wind load)	1.25	0.75
Ie (seismic load)	1.50	N/A

Snow loading:

- Ss = 1.3 kPa, Sr = 0.3 kPa (1/50 years) plus snow drifts
- One day rain = 130 mm

Reference wind pressure:

- 1/10 years for cladding = 0.37 kPa
- 1/50 years for structure = 0.48 kPa

Live load:

- Concrete Walls = Hydrostatic Pressure

- Concrete catwalks = 4.8 kPa

Seismic criteria:

- PGA = 0.605
- Sa(0.2) = 1.34, Sa(0.5) = 1.24, Sa(1.0) = 0.752, Sa(2.0) = 0.456
- Site Class C (Assumed – to be verified by a Geotechnical Engineer)

DESIGN DISCUSSION

The existing reinforced concrete tank was designed in 2004 to the 1998 British Columbia Building Code (BCBC). The record drawings include design criteria stating that the structure was designed to be post-disaster using a seismic importance factor, IE = 1.5. However, the record drawings do not indicate the design methodology used to determine seismic loads on the structure.

In present day, the ACI 350.3-06 Seismic Design of Liquid-Containing Concrete Structures is the industry standard code to determine lateral forces imposed on concrete liquid-containing structures during an earthquake. The existing structure was assessed, using this code, in order to determine the feasibility of expanding the facility by constructing additional reinforced concrete tanks on the south wall. The existing tank walls were assessed for hydrostatic forces imposed by the contained liquid, as well as, hydrodynamic forces imposed on the structure due to the motion of the contained liquid during a seismic event. The hydrodynamic forces were determined using ACI 350.3-06. It was found that the existing reinforced concrete walls have a maximum demand-over-capacity ration of approximately 105% under hydrostatic and hydrodynamic loading. During the assessment, it was found that the worst-case loading condition occurs for exterior tank walls or interior walls where only one side of the wall is under load. This condition may occur if one tank is full of liquid while the adjacent tank is empty. Therefore, it was found that constructing an additional tank on the south wall of the existing is feasible because the loads imposed on the existing wall will not be increased.

The ACI 350.3 also includes guidelines for concrete tanks containing hazardous materials, stating that provisions should be made to accommodate the maximum wave height due to the contained liquid sloshing during a seismic event. The existing structure has 500mm of freeboard from the high-water line to the top of the concrete tank walls. During the assessment of the existing structure it was found that the height of the wave due to sloshing would overtop the tank walls. The ACI 350.3 does not include requirements for existing structures to be retrofitted to comply with guidelines to accommodate sloshing. However, the design of the new tank structure should include higher tank walls to accommodate the sloshing of the liquid and avoid overtopping. To increase the height of the new tank, the existing south wall of the tank will need to be retrofitted by increasing the height of the wall by 700mm to match the height of the new walls. As a result, during a seismic event the liquid in the new tank will be contained and will not overtop into the existing tanks or into the surrounding environment.

Soil conditions used for the preliminary design of the proposed expansion have been assumed using the limited information indicated on the record drawings. The record drawings indicate a seismic foundation factor, f= 1.0, which corresponds to rock, dense and very dense coarse-grained soils or very stiff and hard fine-grained soils. The drawings also indicate foundations for liquid containing structures are designed for an allowable bearing capacity of 200 kPa. Considering these parameters, it is reasonable to assume a seismic site class of “C” corresponding to very dense soil or soft rock. The geotechnical report referenced in the record drawings was not available at the time of this assessment. Further investigation should be done to determine the current geotechnical conditions onsite prior to additional work being done.

ELECTRICAL DESIGN

The electrical loads for the plant are currently fed from a back-to-back motor control centre (MCC) installed in the electrical room.

- The existing BC Hydro electrical service appears to be suitable for additional expansion (600Amp, 600VAC).
- The existing MCC has limited ability to accept new starters in the existing structure (following the dewatering project, 2020).
- The existing generator (300kW diesel, located within the electrical building) is possibly undersized depending on operating load determined during the design process; the generator also takes up significant interior space which may be required for expansion of the MCC structure.

APPLICABLE CODES AND STANDARDS

The electrical design and system upgrades will follow latest editions of all applicable Federal, Provincial and local Municipal codes; and the functional and environmental requirements of the facility through effective lighting, power and control systems design. Note that as the facility was constructed under a different set of code requirements, it is likely that items 'touched' will need to be updated to meet latest codes and standards.

ELECTRICAL LOADS

Electrical switches, gear, and an expanded motor control centre (MCC) will be required to support the electrical loads and equipment for the expansion program. The intention is that all equipment added will use only high-efficient motors suitable for the specific process applications.

The MCC structure will be designed with enough capacity to accommodate the proposed and future electrical loads. The existing MCC will be modified as required to accommodate the expansion, and in addition it is proposed to update the Transient Voltage Surge Suppressors (TVSS) with a more current Surge Protective Device (SPD).

GROUNDING

The design includes grounding systems for all equipment to:

1. ensure stable system voltage reference; and
2. ensure limitation of over-voltages, switching surges, ground faults and other conditions.

This will enable proper operation of circuit protective devices by providing a low impedance path for the fault current. The grounding system will ensure personnel and equipment safety, as well as proper equipment operation.

Grounding systems for the MCC, control panels, distribution panel boards, dry transformers, and instrumentation bus will be connected to the main grounding bus for the treatment plant.

FACILITY LIGHTING

The following summarizes the lighting design and lighting systems to be implemented for the proposed upgrades (only in expansion areas requiring lighting; no lighting replacements are being proposed in this project):

- Lighting systems will be designed as energy efficient, quality artificial lighting systems determined by analysis of alternate designs incorporating an appropriate effective recurring lighting maintenance program. Energy consumption will meet or exceed ASHRAE 90.1-2001;
- Lighting design will be in accordance with the IESNA lighting handbook;
- The design includes luminaires in all new areas. Luminaires will include linear fluorescent and HID systems for process and exterior areas;
- All luminaires will be suitable for the environment where they are located;
- Emergency battery packs and remote heads will be provided for immediate illumination in areas of emergency egress, electrical rooms and process mechanical equipment rooms and areas to illuminate evacuation routes during emergency conditions or power outages until the standby power is activated. All units will be sized for half hour emergency operation; and
- Exit signs will be LED type with “EXIT” written in 150mm high red lettering on white background and with removable directional arrows. Exit lights will be connected to AC power with all breakers feeding these devices in the locked-on position.

The general use spaces and individual areas, which are generally separated from adjacent occupancies by walls, are individually illuminated to the recommended IES lighting levels. The design levels for lighting in LUX (maintained average) will be:

- Control Room / Laboratory Space 550Lx
- Corridors 200 Lx
- Equipment / Maintenance Room 250-300 Lx
- Mechanical and Electrical rooms 250 Lx
- Process Areas 300 Lx

WIRING METHODS AND EQUIPMENT

TECK90 armoured cable on tray will be used for process and exterior feeders. To ensure the quality of power distribution, and to compensate for voltage transients that can occur on site, an SPD will be installed at the MCC distribution.

All wiring will be RW90XLPE copper. The minimum size of wire for lighting and HVAC loads will be No. 12 AWG and No.14 AWG for control. Conductors for lighting and miscellaneous power wiring will be colour coded. The minimum conduit size will be 19 mm.

All wiring and equipment installed or operated within any of the hazardous locations (defined in Sections 18 and 22 of the Canadian Electrical Code) will comply with applicable provisions of Section 18 of the Canadian Electrical Code. Area classification will be assigned in accordance with NFPA 820 provisions.

All underground wiring will be installed in PVC conduits with termination fittings approved for the location. In certain examples, armoured cable direct-buried will also be considered in the design. In process areas and areas exposed to mechanical damage conduits will be rigid aluminum.

STANDBY POWER

Critical electrical loads will be powered in the event of a utility power failure. It is anticipated that the existing standby generator is not adequately sized for the future loads. The current Automatic Transfer Switch (ATS) appears to be sized to the maximum rating of the MCC structure. The size of the existing generator is 300 kW and the ATS 600Amp at 600VAC.

A new generator will be recommended to be sized to the operating load of the facility, with the generator minimum loading to be 20% of the maximum size of the system (to prevent long term damage and additional maintenance of the unit). The generator is proposed to be a diesel unit with a skin-tight enclosure installed on a concrete pad (seismically designed) outside of the building.

INSTRUMENTATION & CONTROLS DESIGN

This section contains the instrumentation and control design information for the WWTP expansion. It also outlines some of the general concepts for design of the Plant Control System (PCS) — utilizing technology that is reliable, field proven and integrates with existing control systems components (Ethernet/IP, iFIX SCADA).

CONTROLS ARCHITECTURE MODIFICATIONS

The existing facility is based on an Allen Bradley SLC500 Programmable Logic Controller. This controller was programmed with Logix500, a software package sold by Rockwell Automation (part of Allen Bradley). This hardware and software are both no longer supported by the manufacturer and obsolete.

As part of the proposed upgrades, it is strongly recommended to proceed with a complete PLC upgrade. This will impact the entire facility and is likely to uncover issues within the plant not under the process scope of work.

This upgrade would be based on the Allen Bradley Compact Logix PLC family, which allows for a streamlined transition from the older Logix500 software to the new Logix5000 software. The PLC will be either the Compact Logix or Control Logix architecture.

The existing ethernet network and SCADA collector (iFIX5.x, upgraded within the last 5 years) would be re-used, and by using the same manufacturer, the revisions will be relatively minor (tag pointers can be emulated to use the legacy data mapping, or the new tagging could be used).

PROCESS CONTROL MODES

The following control modes will be employed:

- All individual process equipment and packaged process units will have Automatic and Manual control modes, selectable by the operator; and
- All process equipment or packaged process units, such as aeration blowers, will be controlled by a “maintained control mode”. Contact ‘close’ will cause the equipment to operate and contact ‘open’ will cause the respective equipment to stop.

Pumps, blowers and exhaust fans will be run from Variable Frequency Drives and FVNR starters installed in the MCC. Control stations for local control will be provided at the starter in the MCC and will not rely on the control system to operate in Local mode.

In the 'Local' position, manual control of the equipment will be activated. These control devices will be grouped as a remote-control panel/station for individual equipment.

In the 'Remote' position, the PLC will control the operation and sequencing of the process equipment.

Each electrical motor will be supplied with the following functions as part of its control system (communication to the plant control system through Ethernet):

- Run permissive to indicate to the control system that it can run in ‘Auto’ mode;
- Run status;
- Process interlocks;
- Alarms and Faults;
- Electrical Motor Current;
- Motor speed (for VFD driven motors);
- Local-Off-Remote in ‘Remote’;
- If emergency shut-down (ESD) is provided on the packaged unit, then provisions shall be made for additional ESD remotely mounted on the process floor. Status of the ESD will be monitored by the PLC; and
- The pumps, blowers and exhaust fans will automatically restart after power failure and power restoration if that is part of an automatic restart-after-power-failure routine.

PROCESS ALARMS

All process alarms will be wired in fail-safe mode. 'Open contact' will indicate an alarm condition; 'Closed contact' will indicate a normal condition.

All alarms will be shown and logged on the plant control system.

PROCESS INTERLOCKS

All process interlocks will be wired into the PLC. The PLC will determine the correct process control action based on the status of the interlock.

SAFETY INTERLOCKS

Two types of safety interlocks have been identified:

Equipment safety - protects process equipment against unusual process conditions. A typical equipment safety interlock would be 'level low low' to prevent a pump from running dry. All equipment safety interlocks will be wired into the PLC. The PLC will then determine the correct equipment shut down action or will prevent the equipment start.

Personnel safety - protects personnel against injury. A typical personnel safety interlock is 'Emergency Shutdown Device' (ESD). The personnel safety interlock will be hard wired to a properly selected point or points in the control system to immediately shut down the process in case of emergency. The ESD will bypass the PLC based control system and will either completely de-energize the process equipment or will cause the equipment to come to a full stop regardless of any process condition. Emergency stop push buttons or pull strings will be strategically located in process areas and by exit doors from process rooms.

FACILITIES CONTROL PANELS

The main control function of the facility is based on a PLC-based supervisory control system with local control panels (LCP) provided by the system suppliers to facilitate the complete control and monitoring of the facility in accordance with the process requirements.

All PLC components and I/O modules will be sized to provide sufficient capacity to handle the logic and data requirements plus an additional 20% spare CPU and memory.

Each PLC control panel shall be equipped with an Ethernet switch with copper connection ports.

Expansion modules I/O signal voltage/parameters will be based on the following:

- Digital inputs and outputs: 120 VAC (to be verified against existing system), quantity to be determined at final design. All digital output modules are to be based on isolated contact type for each individual point. Digital input modules shall be isolated and non-isolated types to meet the I/O circuit requirements.

- Analog inputs and outputs: 4-20 mA, 24 Vdc; quantity to be determined at final design. All analog modules shall be based on 4-20 mA dc isolated type.

The control panel will provide minimum 10% spare I/O of each type and 5% spare slot capacity including all necessary cables, communication cards, and accessories for a full functional system. The local control panels will include incoming power transient surge suppression and an UPS. The installation will connect the surge suppressor dry contacts and UPS unit to a PLC input and configure as an alarm on the control system as soon as a major surge occurs and / or the UPS battery has a low condition.

The PLC software applications installed will control and monitor all the aspects of the process. It will store, display and control operating parameters and generate alarms and reports to local operating interface (OI) when parameters and equipment are out of normal functional range. Alarms will be treated locally by generating the alarm condition and stopping/halting the equipment that generated the condition or the “cause” associated with the equipment. All alarms will be enunciated through the plant control system computers as it currently operates.

The PLC system will be provided with a “watch-dog” module to monitor power failure and utility black-outs, to revert to functioning condition once the power is re-established though the plant (or emergency generator started). The supervision module hardware/software will discriminate between normal operation (on utility power) and on stand-by power.

FIELD INSTRUMENTS

Field bus technology offers many advantages (devices provide considerably more information than just the ‘traditional’ measured variables) and provides an economical system that will support future expansions. However, the technology where instruments are hardwired to the associated PLCs will also be considered. The final decision will be made once the number of instruments is determined during detailed design.

Examples of technology, complete with connection method to the control system, that would be utilized are as follows:

- MCC equipment – Fieldbus (Ethernet/IP)
- Magnetic flow meters for piped liquid flow applications (Siemens or equivalent) – hardwired
- Hardwired floats for low level and overflow protection (Flygt/Xylem or equivalent) - hardwired
- Thermal mass flowmeters for air flow (FCI, E+H, or equivalent) – 4-20mA hardwired
- DO sensors for dissolved oxygen measurement (E+H, Hach, or equivalent) – hardwired
- Motorized Actuators (Rotork or equivalent) – hardwired
- Pressure Transmitters (Siemens or equivalent) – 4-20mA hardwired
- On/Off Valves – hardwire

APPENDIX A

Conceptual Design Drawings

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DISTRICT OF SOOKE

SOOKE WASTE WATER TREATMENT PLANT EXPANSION

Sooke British Columbia, Canada

File Name: 20092_P_101.DWG	AF	EM	EM	2020.02.21
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Title

SITE WORKS

Project No. 111720092

Scale 1:100 (0 1 3 5m)

Drawing No. P-101

Sheet 1 of 5

Revision 0

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Title

SBR-PLAN

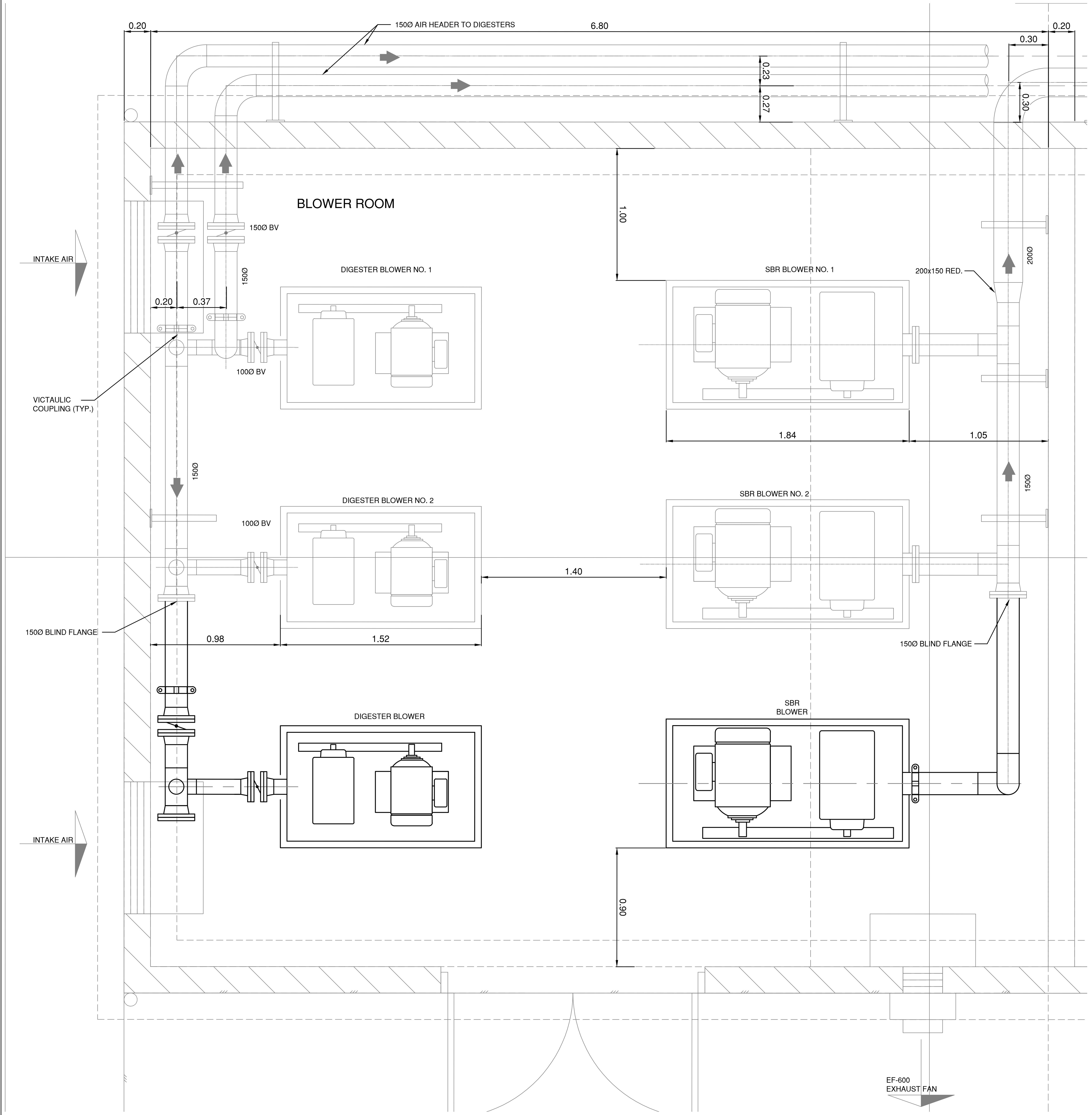
Project No. 111720092

Scale 1:50 (0 0.5 1.5 2.5m)

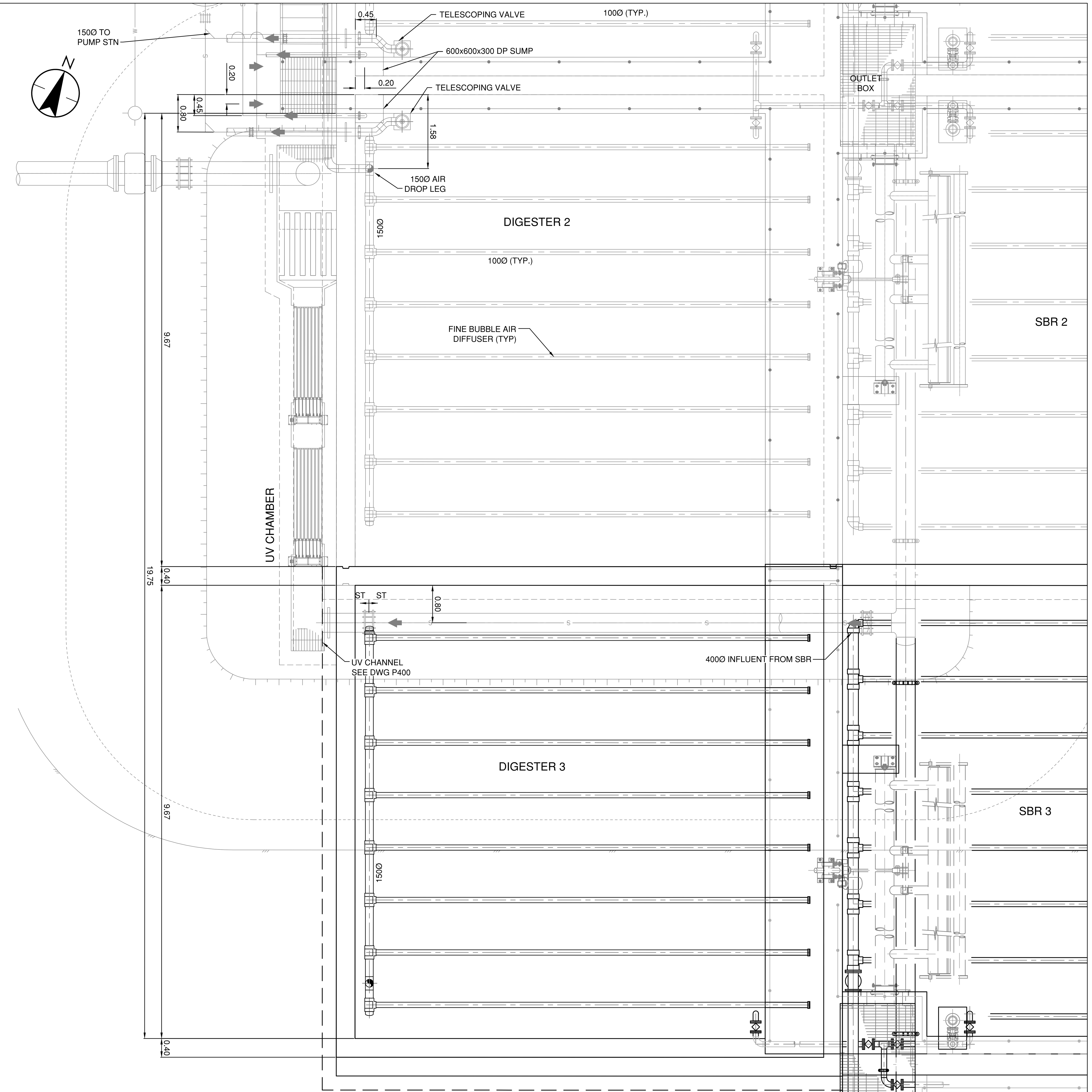
Drawing No. P-102

Sheet 2 of 5

Revision 0



1 P-101 BLOWER ROOM
SCALE: 1:20



2 P-101 DIGESTERS
SCALE: 1:50

1:50 0 0.5 1.5 2.5m
1:20 0 0.2 0.6 1.0m

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Title
BLOWER ROOM AND DIGESTERS

Project No.	Scale	
111720092	AS SHOWN	
Drawing No.	Sheet	Revision
P-103	3 of 5	0

B
P-101
SECTION
SCALE: 1:50

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SOOKE WASTE WATER TREATMENT PLANT EXPANSION

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Title
SBR SECTION

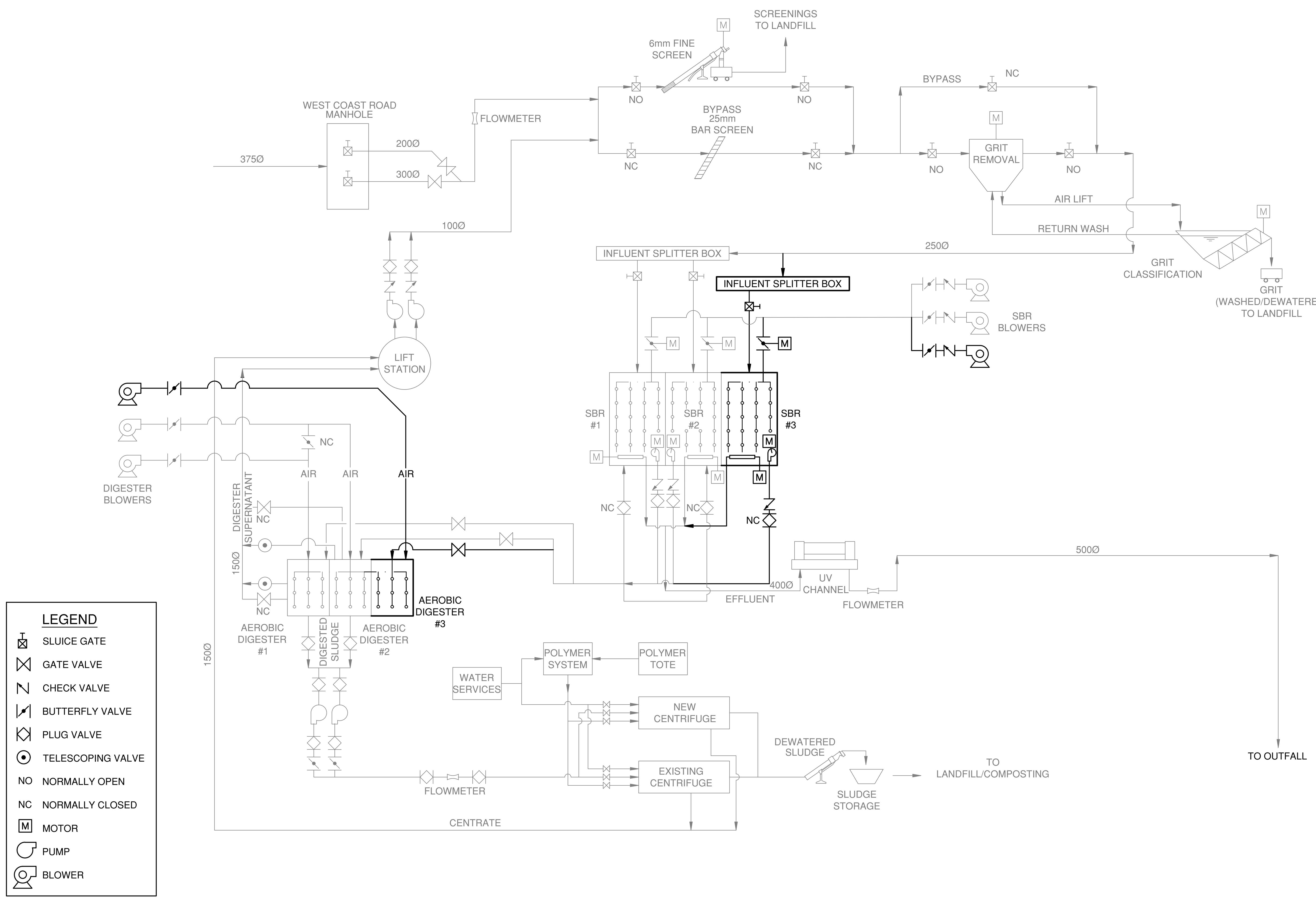
Project No. 111720092

Scale 1:50 0 0.5 1.5 2.5m

Drawing No. P-201

Sheet 4 of 5

Revision 0



FLOW CONDITION	20 YEAR DESIGN
ADWF	4.5 MLD
PDWF	5.7 MLD
PWWF	10.4 MLD

MLD = MILLION LITRES PER DAY
WAS = WASTE ACTIVATED SLUDGE
ADWF = AVERAGE DRY WEATHER FLOW
PDWF = PEAK DRY WEATHER FLOW
PWWF = PEAK WET WEATHER FLOW

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Sooke British Columbia, Canada

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	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Title

PROCESS FLOW DIAGRAM

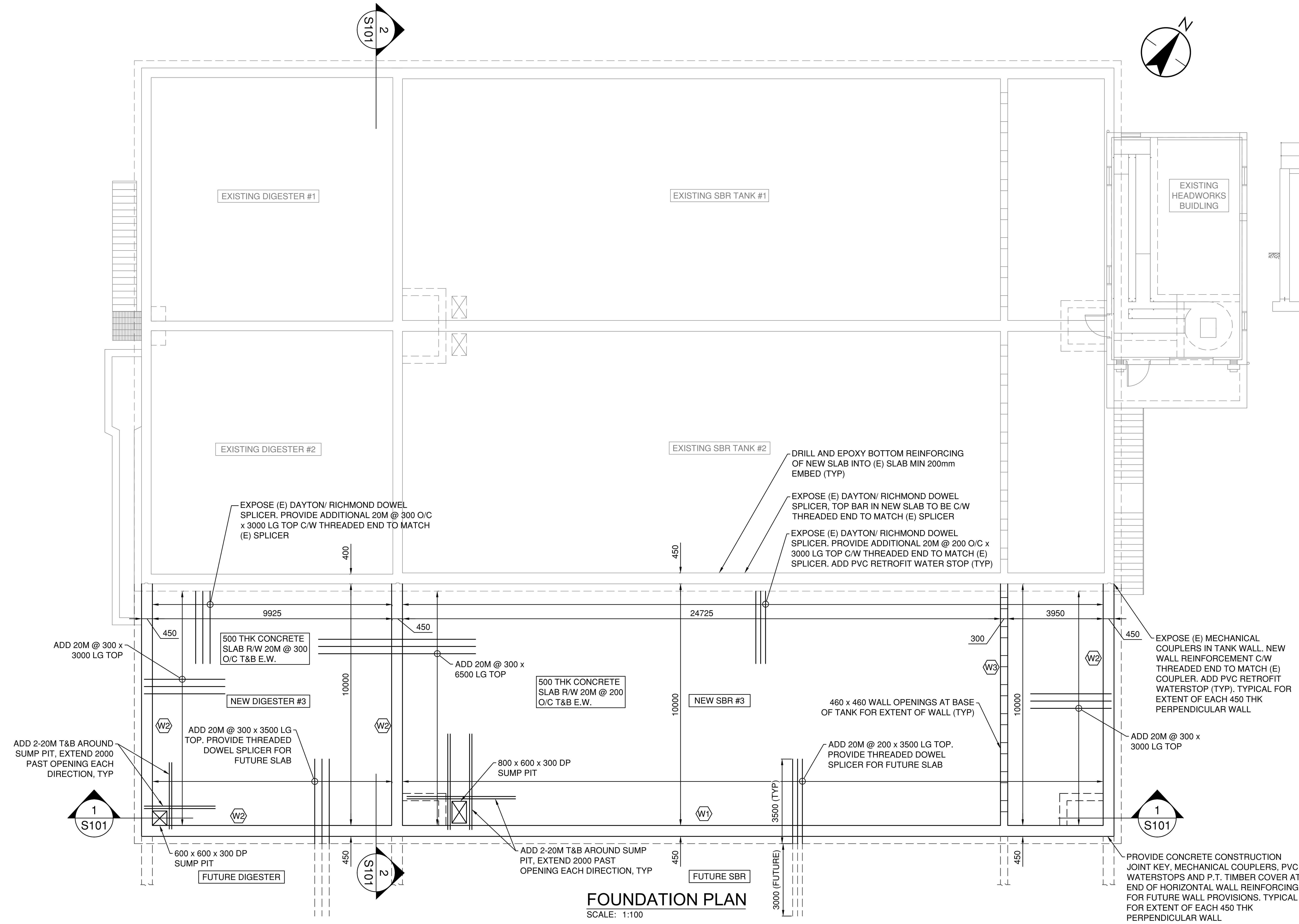
Project No. 111720092

Scale NOT TO SCALE

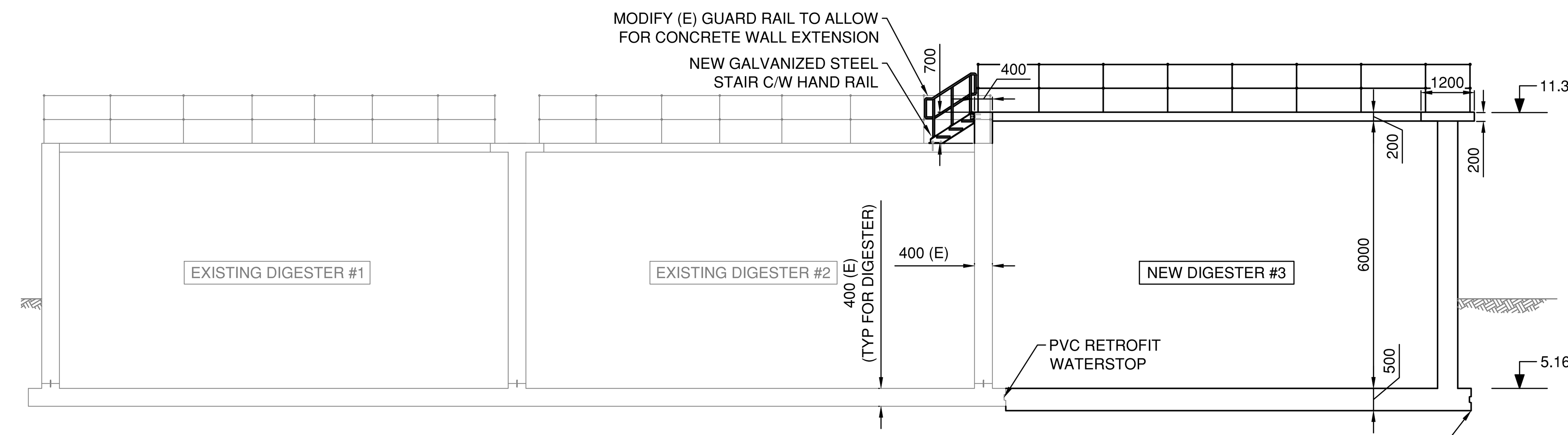
Drawing No. P-301

Sheet 5 of 5

Revision 0



FOUNDATION PLAN
SCALE: 1:100

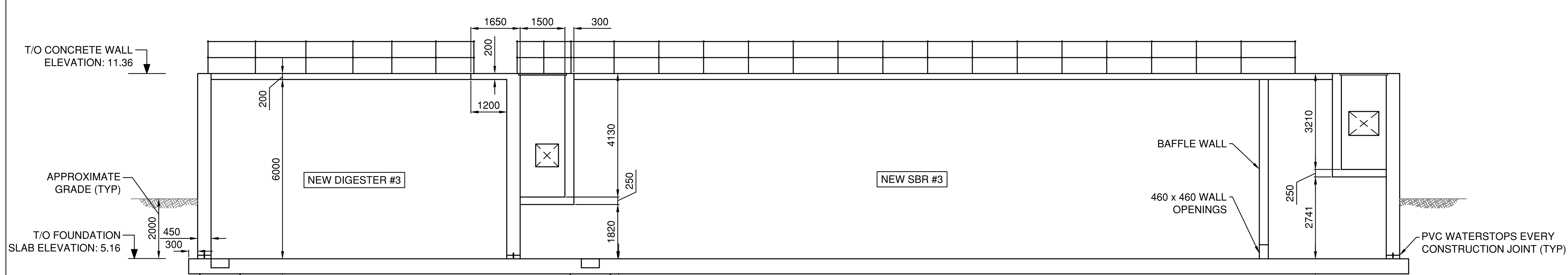


2 SECTION
SCALE: 1:100

CONCRETE WALL SCHEDULE

TYPE	THICKNESS	OUTSIDE FACE (O.F.)		INSIDE FACE (I.F.)	
		VERTICAL	HORIZONTAL	VERTICAL	HORIZONTAL
W1	450	25M @ 100	20M @ 300	25M @ 100	20M @ 300
W2	450	25M @ 150	20M @ 300	25M @ 150	20M @ 300
W3	300	15M @ 150	15M @ 150	15M @ 150	15M @ 150

NOTE:
PROVIDE HORIZONTAL REINFORCEMENT @ 150 O.C. EACH FACE AT BASE OF WALL (LOWEST 1500mm) FOR W1 AND W2



1 SECTION
SCALE: 1:100

PLAN NOTES:

- PRELIMINARY DESIGN HAS BEEN DONE IN ACCORDANCE WITH THE BRITISH COLUMBIA BUILDING CODE 2018 AND REFERENCED STANDARDS THEREIN AS WELL AS THE ACI 350-06
- SEISMIC LATERAL LOADS HAVE BEEN CALCULATED IN ACCORDANCE WITH THE ACI 350.3-06.
- UPDATED GEOTECHNICAL STUDY SHALL BE COMPLETED PRIOR TO FINAL STRUCTURAL DESIGN.
- ALL STRUCTURAL STEEL TO BE HOT DIPPED GALVANIZED.
- WHERE NEW CONCRETE IS BEING CAST AGAINST EXISTING CONCRETE, THE EXISTING CONCRETE SURFACE IS TO BE ROUGHENED AND CLEANED.
- PROVIDE WATERSTOP IN ALL BASE SLAB AND EXTERIOR WALL JOINTS OF LIQUID CONTAINMENT STRUCTURES (FULL HEIGHT OF WALLS).
- PROVIDE STANDARD HOOK IN BARS WHICH TERMINATE AT WALL OR SLAB EDGES /INTERSECTIONS.
- ALL CONCRETE TO BE TYPE S-1 WITH 35 MPa COMPRESSIVE STRENGTH.
- SITE MEASURE SIZE OF MECHANICAL COUPLERS AND DOWEL SPLICERS TO PROVIDE NEW REINFORCING WITH THREADED END TO MATCH.

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SOOKE WASTE WATER TREATMENT PLANT EXPANSION

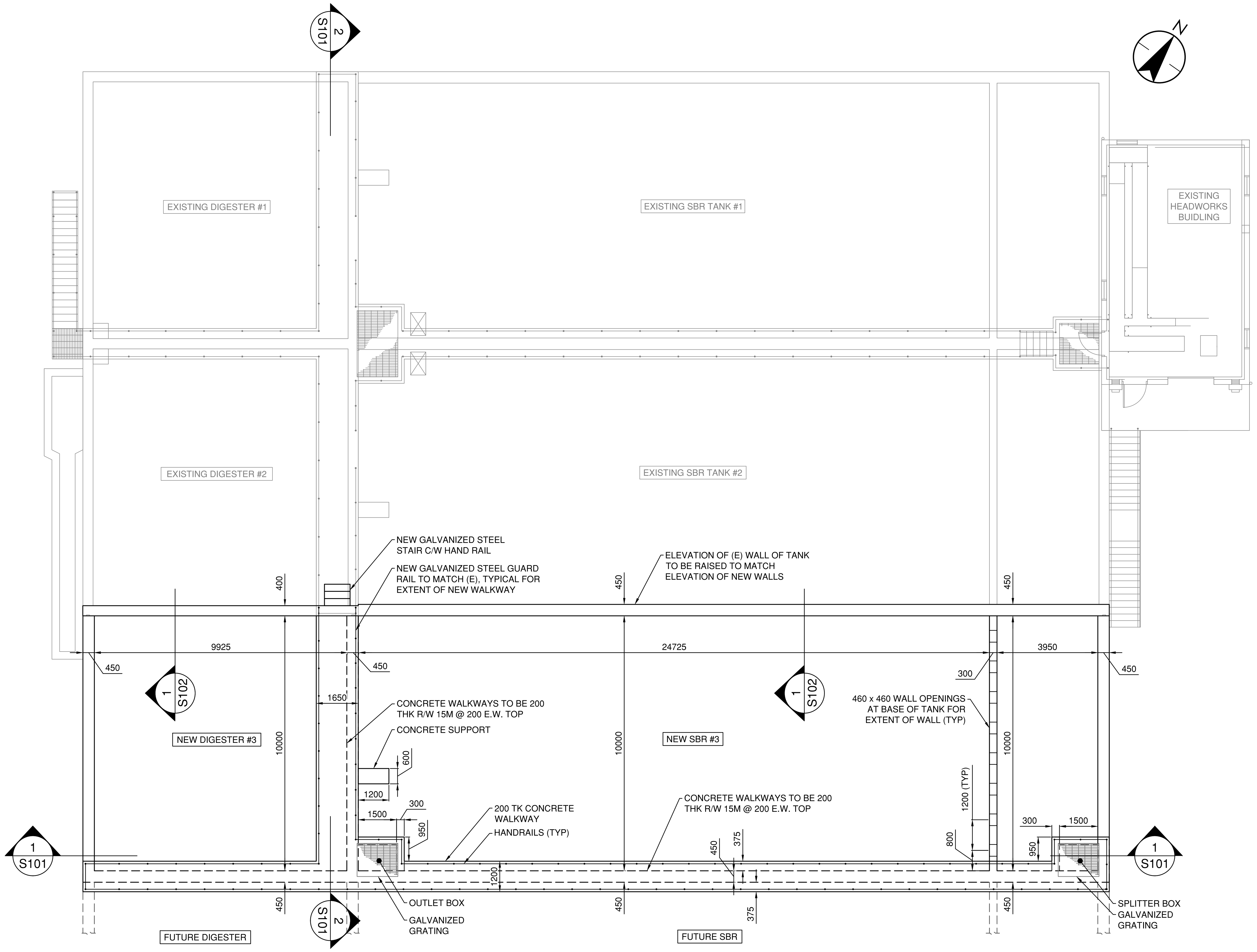
Sooke British Columbia, Canada

Title
FOUNDATION PLAN

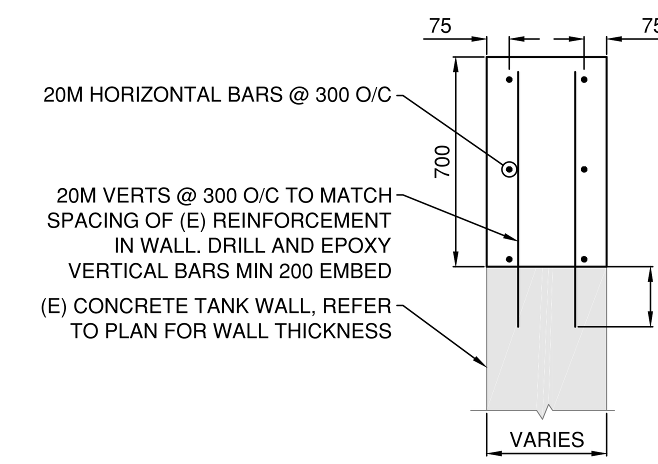
Project No.
111720092

Scale
1:100 0 1 3 5m

Drawing No.
S101



TOP PLAN
SCALE: 1:100



1
S102
EXISTING CONCRETE WALL EXTENSION DETAIL
SCALE: 1:20

PLAN NOTES:

- PRELIMINARY DESIGN HAS BEEN DONE IN ACCORDANCE WITH THE BRITISH COLUMBIA BUILDING CODE 2018 AND REFERENCED STANDARDS THEREIN AS WELL AS THE ACI 350-06
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SOOKE WASTE WATER TREATMENT PLANT EXPANSION

Sooke British Columbia, Canada

Title
TOP PLAN

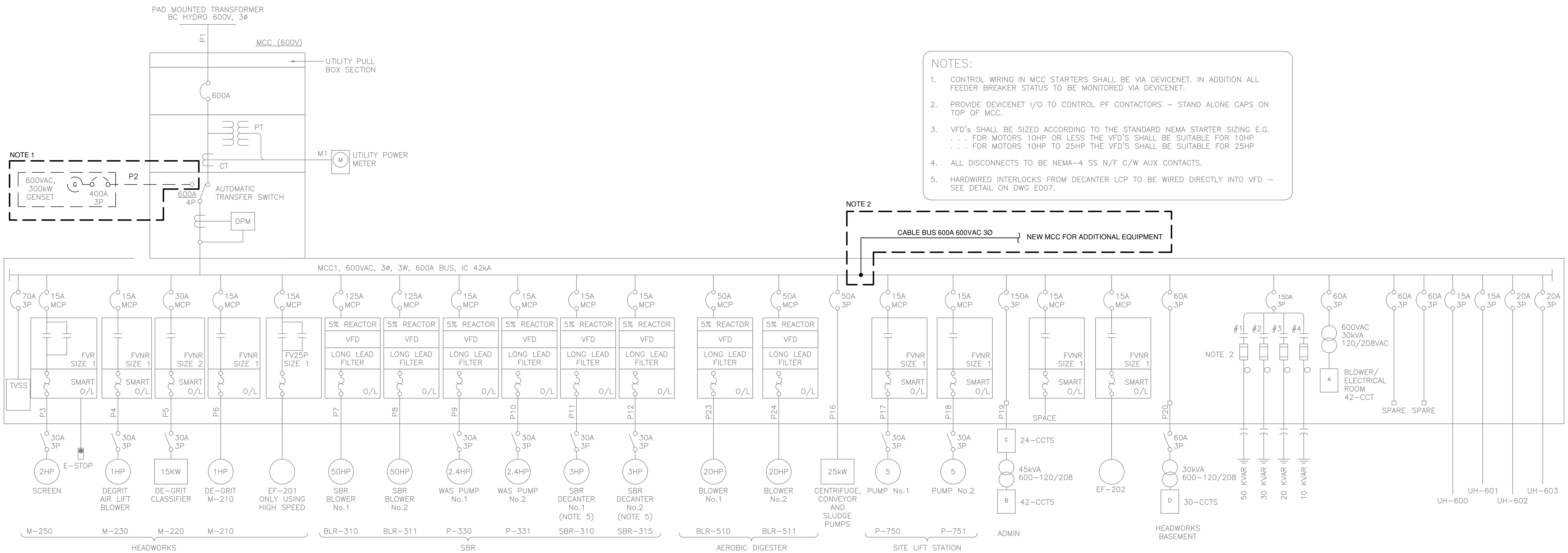
Project No.
111720092

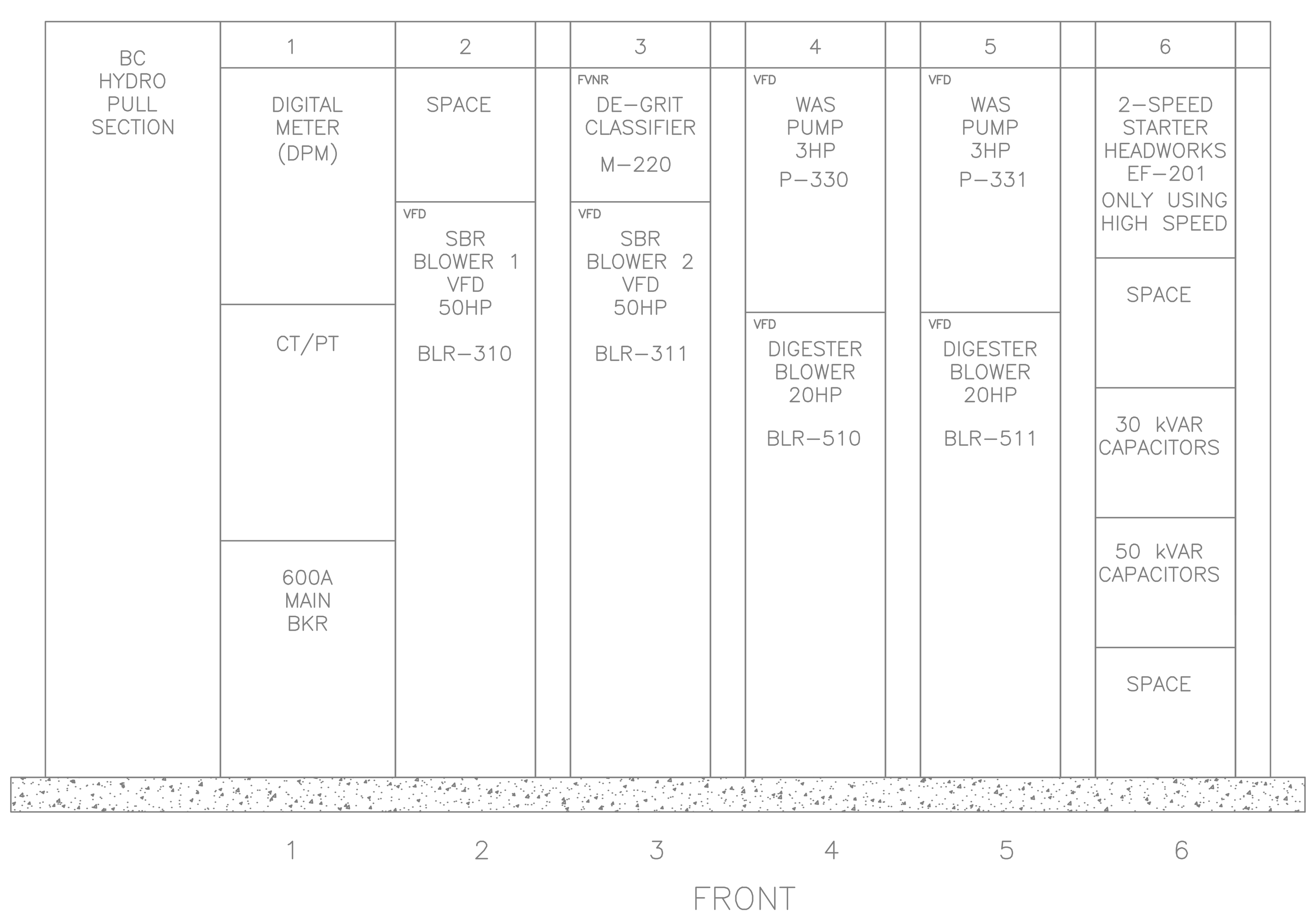
Scale
1:100
0 1 3 5m

Drawing No.
S102

NOTES:

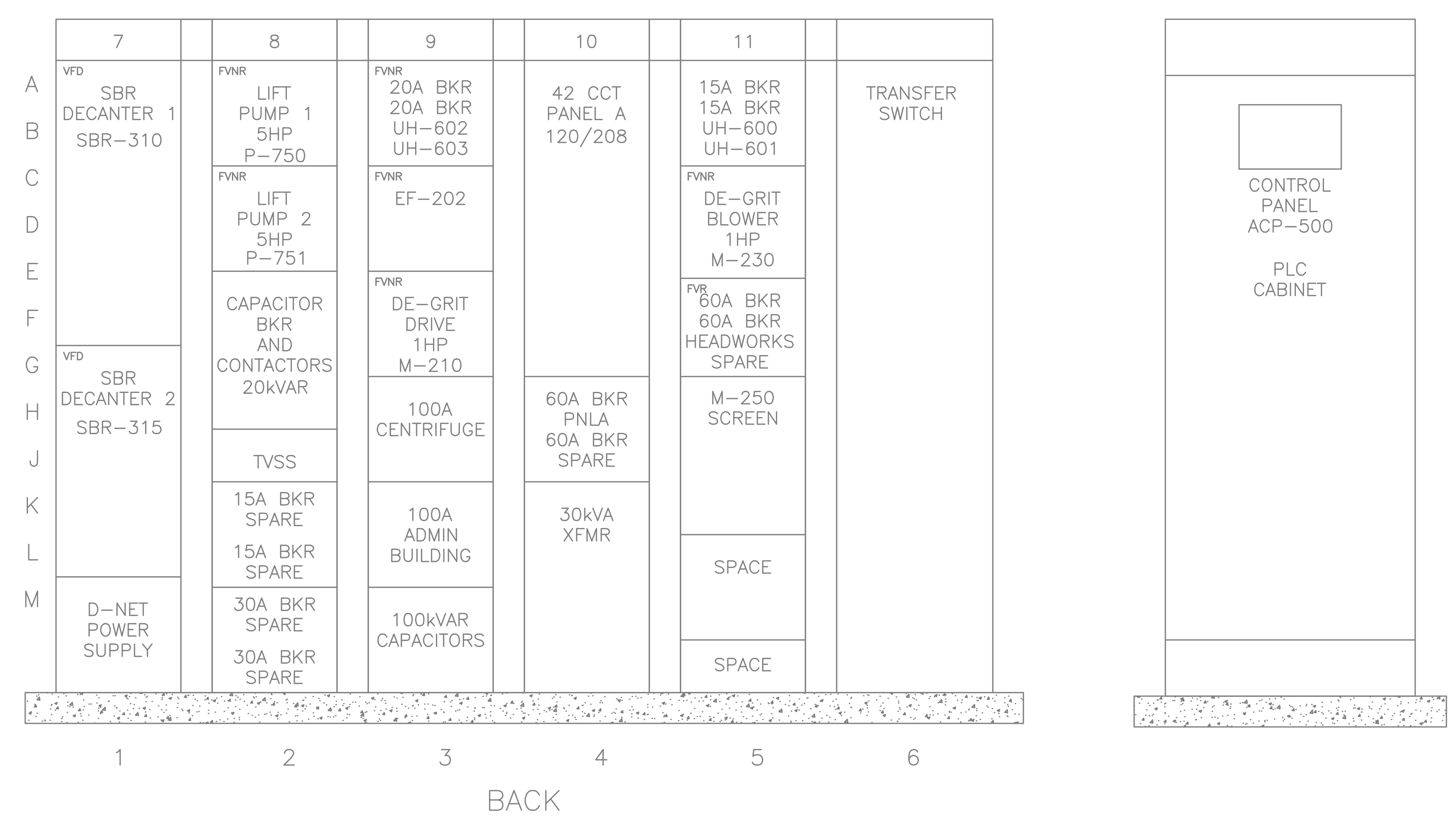
1. CONTROL WIRING IN MCC STARTERS SHALL BE VIA DEVICENET. IN ADDITION ALL FEEDER BREAKER STATUS TO BE MONITORED VIA DEVICENET.
2. PROVIDE DEVICENET I/O TO CONTROL PF CONTACTORS – STAND ALONE CAPS ON TOP OF MCC.
3. VFD's SHALL BE SIZED ACCORDING TO THE STANDARD NEMA STARTER SIZING E.G.
   . . . FOR MOTORS 10HP OR LESS THE VFD'S SHALL BE SUITABLE FOR 10HP
   . . . FOR MOTORS 10HP TO 25HP THE VFD'S SHALL BE SUITABLE FOR 25HP
4. ALL DISCONNECTS TO BE NEMA-4 SS N/F C/W AUX CONTACTS.
5. HARDWIRED INTERLOCKS FROM DECANTER LCP TO BE WIRED DIRECTLY INTO VFD – SEE DETAIL ON DWG E007.





MCC1 SECTION LAYOUT

N.T.S.



MCC1 SECTION LAYOUT

N.T.S.

LEGEND:

— — — SCOPE OF WORK

NOTES:

1. EXISTING 300KW GENSET TO BE REPLACED WITH NEW 500KW GENSET.
2. NEW MCC SECTION TO BE BOLTED TO EXISTING

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DISTRICT OF SOOKE

SOOKE WASTE WATER TREATMENT PLANT EXPANSION

Sooke British Columbia, Canada

Title

SINGLE LINE DIAGRAM

Project No. 111720092

Scale NO SCALE

Drawing No. E601

APPENDIX B
Opinion of Probable Cost

District of Sooke
Opinion of Probable Costs for Sooke WWTP Expansion

Item No.	Description	Unit	Quantity	Material or Equipment Costs: Unit Price	Material or Equipment Costs: Total Price	Labour & Overhead	Total Costs
Sooke WWTP							**Prepared by: Stan Spencer, P. Eng.**
Plant Expansion - 3rd SBR Train and Digester							**2/21/2020**
1.0	**General Requirements**						
1.1	Mobilization/Demobilization	%	1		2%		$45,500
1.2	Bonding	%	1		1.5%		$34,100
1.3	Insurance	%	1		1.5%		$34,100
1.4	General Conditions - other	%	1		15%		$341,300
						Subtotal General Requirements	**$455,000**
2.0	**Civil**						
2.1	Excavation	m^3	1,300	$50	$65,000	Included	$65,000
2.2	Backfill (including slab prep)	m^3	270	$35	$9,450		$9,450
						Subtotal Civil	**$74,450**
3.0	**Structural**						
3.1	Foundation Slabs (500mm thick)	m^3	224	$800	$178,800	Included	$178,800
3.2	Reinforced Concrete Walls (450mm thick W1/W2)	m^3	196	$1,500	$294,300	Included	$294,300
3.3	Reinforced Concrete Baffle Walls (300mm thick)	m^3	20	$1,500	$29,250	Included	$29,250
3.4	Extend Existing Concrete Walls by 700mm	m	40	$690	$27,600	Included	$27,600
3.5	Reinforced Concrete Walkway (200mm thick)	m^3	14	$1,500	$21,000	Included	$21,000
3.6	Expose Existing Couplers and Prepare for new Dowels	m	52	$100	$5,200	Included	$5,200
3.7	Dowels for New Foundation Slab	m	40	$200	$8,000	Included	$8,000
3.8	Supply and Install New Couplers for Future Tanks	m	52	$100	$5,200	Included	$5,200
3.9	New Galvanized Steel Stair	L.S.	1	$8,000	$8,000	Included	$8,000
3.10	New Galvanized Steel Guardrails	m	62	$400	$24,800	Included	$24,800
3.11	Galvanized Steel Grating	m^2	4	$300	$1,200	Included	$1,200
						Subtotal Structural	**$603,350**
4.0	**Process**						
4.1	SBR Decanters and Control	each	1	$200,000	$200,000	$80,000	$280,000
4.2	Blowers	each	2	$30,000	$60,000	$18,000	$78,000
4.3	WAS pump	each	1	$20,000	$20,000	$6,000	$26,000
4.4	SBR Aeration grid	each	1	$30,000	$30,000	$9,000	$39,000
4.5	Digestion aeration grid	each	1	$15,000	$15,000	$4,500	$19,500
4.7	Gates and Telescoping Valves	each	1	$20,000	$20,000	$6,000	$26,000
4.8	Piping / Valving	LS	1	$85,000	$85,000	$25,500	$110,500
						Subtotal Process	**$579,000**
5.0	**Electrical**						
5.1	Generator (500kW skin tight diesel 8hr), demo of existing	each	1	$240,000	$240,000	$7,000	$247,000
5.2	MCC expansion, all EIC cable, associated equipment, overhead, travel	LS	1	$50,000	$50,000	$80,000	$130,000
						Subtotal Electrical	**$377,000**
6.0	**Instrumentaion and Controls**						
6.1	Control System Upgrade (new PLC, new Programming, Commissioning of new Control System)	LS	1	$75,000	$75,000	$75,000	$150,000
6.2	Instrumentation	LS	1	$27,000	$27,000	$9,500	$36,500
						Subtotal Instrumentaion and Controls	**$186,500**
						Total Construction Costs	**$2,275,300**
Direct Costs:							
	Construction Costs						$2,275,300
	Estimating Contingency (% of Construction Costs)			10%			$227,500
	Construction Contingency (% of Construction Costs)			20%			$455,100
	Inflation to Mid-point of Construction - (% per annum)	2.5%	Mid-point	9/30/2021	1.61	Years	$120,000
						Total Direct Costs	**$3,077,900**
Indirect Costs:							
	Design Engineering (% of Direct Costs)			10%			$307,800
	Construction Services (% of Direct Costs)			6%			$184,700
	Administration & Program Managemant (% of Direct Costs) - District of Sooke			6%			$184,700
	Miscellaneous/Specialty Consultants (% of Direct Costs)			2%			$61,600
						Total Indirect Costs	**$738,800**
						Subtotal (Direct + Indirect Costs)	**$3,816,700**
	Project Contingency (% of Subtotal)			10%			$381,670
	Total Capital Costs						**$4,198,370**

Notes:
1 Costs are in 2020 Canadian Dollars.
2 Construction costs will vary depending on market conditions at the time of tender. The Engineer has no control over those conditions.