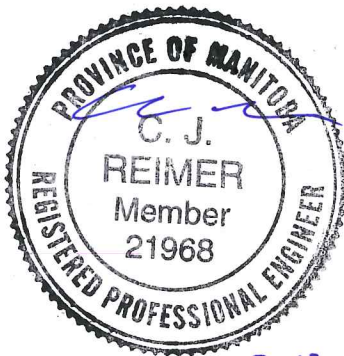


APPENDIX A – AUBREY WASTEWATER PUMPING STATION PRELIMINARY DESIGN REPORT



City of Winnipeg

Aubrey Wastewater Pumping Station



2013-04-25

Preliminary Design Report

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Appendix A - Drawings

1.0 INTRODUCTION

The Aubrey Wastewater Pumping Station is located at 1016 Palmerston Ave, near the south end of Aubrey Street. The site contains a sewer, gate structure with overflow to the river, the wastewater pumping station, and a flood pumping station. In addition, it should be noted that a water forcemain crosses the Assiniboine river via a bridge structure at the same site.

The City of Winnipeg (City) is planning to upgrade Aubrey Wastewater Pumping Station to install new pumps and piping, improve station reliability and to bring the station into compliance with the latest codes and standards, particularly with respect to new requirements for electrical installations within hazardous rated sewage lift stations.

This report identifies the recommended work regarding structural, process mechanical, ventilation, electrical distribution upgrades, motor control, and instrumentation and control. In addition, cost estimates are provided to guide the City in budgeting for the work.

2.0 STRUCTURAL REVIEW

A visual examination of the Aubrey Waste Water Pumping Station was performed on March 22nd, 2012 for the purpose of structural assessment. The station was built in the 1930s, and a small addition was constructed (below grade) in the 1950s to allow for the installation of a hydraulically actuated gate valve. The station is comprised of five spaces, with four of them below grade. It should also be noted that the below-grade footprint of the station is greater than that of the building superstructure. The observations of the visual structural inspection are identified below.

2.1 Main Floor

The main floor interior of the station is approximately 3.1 x 2.9 m, with a single exterior door facing west. The main floor contains the electrical and control equipment. The station was originally built with three floor openings: one for the ladder access hatch, one for pumping equipment, and a third discontinued opening for the comminutor chamber equipment. There are two lift beams, located above the equipment openings, which are pocketed into the brick walls. The following issues were identified with the main floor interior space:

- The walls and ceiling are lined with exposed Styrofoam insulation boards. This insulation is a fire hazard and should be removed and replaced with a non-combustible alternative.
- A piece of the ceiling insulation was removed to inspect above. There is a Hardi-board above the insulation, attached to the underside of the ceiling joists. When a similar ceiling board was tested at Mager Drive Pump Station, which is of a similar vintage, it was determined to contain asbestos fibers. It is recommended that this board be removed and disposed of in accordance with asbestos abatement regulatory requirements.
- The access hatch in the main floor above the comminutor chamber access hatch is not longer in use. This hatch is made of wood, and should either be replaced

with a more durable material or closed off and turned back into floor space (see Figure 2-1).

- The ladder access hatch presents a fall hazard to personnel.



Figure 2-1 : Comminutor Chamber Main Floor Access Hatch

2.2 Lower Level 1

The Lower Level 1 is the first level below the main floor. It was formerly the comminutor motor room, but the associated motor has since been removed. From this room, access hatches are provide to the comminutor chamber and motor room below. This room contains a ventilation fan and ducting for the station. In the 1950s, an addition was constructed to provide a room for a hydraulic actuated sewer gate actuator, which allows the station to be isolated from the trunk sewer. The following issues were identified with the space:

- The exposed Styrofoam insulation on the walls must be replaced, as it is a fire hazard.
- The hatch lid to the comminutor chamber is made of wood. It projects above floor level and is a tripping hazard (see Figure 2-2). This should be replaced with an appropriate aluminum or FRP hatch cover, installed flush to the floor.
- The motor mounts on the floor should be removed and the shaft hole be closed off (see left side of Figure 2-2).
- The ladder access hatch presents a fall hazard to personnel.



Figure 2-2 : Comminutor Motor Mount and Chamber Access Hatch

2.3 Comminutor Chamber

The Comminutor Chamber is located beneath Lower Level 1, on the south side of the station. As a comminutor is no longer installed, the chamber simply acts as an extension of the sewer line to allow the wastewater to enter the wet well. The addition in the 1950s also expanded the comminutor chamber to allow for the installation of the hydraulically actuated gate valve. On this visit the chamber was not entered for inspection, although viewing from the chamber hatch revealed no visible issues with the concrete walls or floor. There is however, corrosion on the imbedded steel channel surrounding the opening to the chamber, and repair is recommended (see Figure 2-3).



Figure 2-3 : Comminutor Chamber Access Hatch Surround

2.4 Motor Room

The motor room houses two motors for the wastewater pumps in the pump room below. The following issues were identified with the space:

- Abandoned epoxy injection ports line across approximately half the width of the arched opening to the room, and are a safety hazard (see Figure 2-4). These should be cut off flush and any remaining holes filled in. Patch and smooth the surface.
- The walls of the motor room are defaced by some dripping fluid. The leaks, not already repaired, need to be addressed. It is also recommended to clean and repaint the walls.
- A lifting bracket attached to the ceiling is out of alignment and should be adjusted (see Figure 2-5).
- Lifting hooks should be painted to prevent further corrosion.
- The ladder access hatch presents a fall hazard to personnel.

As the pumping station was constructed in the 1930s, there is potential that the existing paint in the station could be lead-based. It is recommended that testing be performed at the detailed design stage, and the lead content be included in the Bid Opportunity for the contractor, to ensure appropriate safety measures are taken as part of the work.



Figure 2-4 : Abandoned Epoxy Injection Ports in Motor Room



Figure 2-5: Motor Room Lifting Bracket

2.5 Pump Room

The pump room is located at the lowest level within the pumping station. It houses the two wastewater pumps, and a sump pump. The following issues were identified with the pump room:

- There is damage to the ceiling (underside of the motor room floor) in three locations, whereby the steel rebar is exposed (see Figure 2-6). These locations require repair.
- The ceiling in several locations has fluorescence occurring from the concrete and is causing the paint to peel (see Figure 2-7). It is recommended that these areas be cleaned and repainted.
- There is no cover on the sump pit located in the corner of the room. This could be a fall/trip hazard. An FRP cover and new supporting lip should be installed.



Figure 2-6 : Exposed Rebar in Ceiling of Pump Room



Figure 2-7 : Fluorescence on Ceiling of Pump Room

The City also requested that the potential for a second access to the pump room be reviewed. The pump room is currently fairly congested, and access to the far side of the pump room requires that personnel climb over piping. The concept of installing a ladder between the motor room and pump room on the north side was discussed. However, as the work progressed, it became clear that the existing piping arrangement would not be retained, and the new piping arrangement, as shown on SK-M01, would reduce the congestion of the pump room piping. Thus, installation of a second access to the pump room is not proposed.

2.6 Lifting Devices

The lifting devices currently in the station are identified in Table 2-1. The load ratings are based upon the report by MMM Group Limited, dated July 2010.

Table 2-1 : Existing Lifting Devices

Location	Type	Load Rating
Main Floor	W150x22Lifting Beam	1.5 tons
	S150x19Lifting Beam	1.0 ton
Pump Room, Motor Room, & Comminutor Motor Room	Eye-shaped lifting hooks	1.0 ton
Pump Room	U-shaped hook	0.5 tons
Motor Room	Bracket Hook	1.0 ton

The weights of the new pumps and motors supplied by the City are believed to be:

- Pump: 708 kg (1560 lb)
- Motor: 650 kg (1435 lb)

These weights are more than 0.5 ton, and thus the U-shaped hook should be removed and replaced with an appropriately rated hook.

2.7 Access Ladders

There are two access ladders located in the pumping station. The main ladder allows access from ground floor down to the Lower Level 1, down to the motor room, and down to the pump room. The second ladder is from the Lower Level 1, down to the comminutor chamber.

The main ladder is in good condition, with very minimal corrosion, and is in suitable condition for continued use. It is noted however that the ladder does not meet code with respect to clearance for toes and hand holds behind the ladder, due to the insulation on

the exterior walls in the upper areas. Although the comminutor chamber was not entered, the comminutor ladder was checked from the hatch opening. The ladder appears to be in acceptable condition, with minimal corrosion. As there is no insulation in this area, no issue exists with clearances.

A safety cage is provided for the main ladder, on the section between the Lower Level 1 and the motor room. This section is the only one with height great enough and clearance to warrant use of a cage. No safety fall arrest system is in use either. During the site investigation, one of the City Operations personnel indicated there is a procedure in place such that only one level's access hatch is to be removed at any time, thus eliminating the chance of freefalling the full height of the ladder. However, the frequently open access hatches on each level provide a significant potential fall hazard, and it is recommended to increase the safety of the ladder installation by installing a guardrail and swing gate at each ladder access hatch that is routinely utilized.

It is recommended when the insulation is replaced, that a minimal amount be placed behind the ladder, or omitted entirely behind the ladder, to allow the required clearances to be provided and maximize safety.

The entry ladder into the comminutor chamber does not have a safety cage. The height is sufficient to warrant installation, however installation of a safety cage would impede the use of the hatch for lifting equipment. It is suggested, given the infrequent access required for this space, to provide an anchor point above the opening on the concrete wall to allow attachment of a lifeline. The City would need to ensure that appropriate procedures are in place for the use of a fall arrest system.

2.8 Building Exterior

The building is composed of three layers of clay brick, with a wood framed roof structure. The roof is covered with asphalt shingles, and has wood soffits, fascia, and architectural brackets. The entry door is a steel door that appears to have been recently replaced. In general the building is in satisfactory condition, however the following issues were identified:

- Two of the four walls originally had windows installed, however in the past these were closed over by plywood. The plywood covers are a maintenance issue, and are unsightly (see Figure 2-8). These should be replaced with a more durable and attractive covering.
- One corner of the exterior clay brick has been damaged. This should be repaired (see Figure 2-9).
- An unused electrical mast still remains, which should be removed and the holes patched.
- The existing wood soffits and fascia should be replaced with prefinished metal to reduce maintenance (painting).
- A ventilation duct was mounted by screwing to the fascia trim, which has pulled away from the building exposing the framing behind (see Figure 2-10). This should be repaired.
- There is a bulge in the roof on the west side of the building (see Figure 2-11). The cause should be determined and fixed.



Figure 2-8 : Plywood Window Covers



Figure 2-9 : Damaged Brick at Building Corner



Figure 2-10 : Damaged Fascia Board



Figure 2-11 : Bulge in Roof

3.0 PROCESS PUMPING AND PIPING

3.1 Existing Configuration

The Aubrey Pumping Station is a conventional pumping wastewater station with a wet well / drywell arrangement. The comminutor chamber allows for flow from the sewer on the west side of the station to the wet well located on the east side of the station. The comminutor chamber once utilized a motorized comminutor, which has previously been removed. The station contains two vertically mounted centrifugal pumps, with the motors located in the motor room above the pump room. Isolation valves are provided on the suction and discharge of each pump, with three of the four valves being knife gate valves. The piping material appears to be carbon steel, although a section of one discharge pipe has been replaced with PVC piping. The piping configuration is such that access to the far side of the pump room requires climbing over piping.

3.2 Pump Control

The existing pumps at Aubrey Wastewater Pumping Station are started by full voltage starters. It is desired, at minimum, to utilize soft starters to reduce mechanical stress on equipment. In addition, a brief analysis was performed to determine if the use of VFDs would be advantageous.

3.2.1 General Characteristics of VFD Pumping

Potential advantages of VFDs include:

- They potentially allow a pumping station to operate with a reduced wet well size.
- Energy savings by operating the pump at its most efficient design condition, even with variable conditions.
- Reduced energy demand costs by reducing the current surge at pump start-up.
- Operation of the pump at reduced speeds, which contributes to overall pump life.
- Provide the ultimate in pump speed and flow ramping during start-up and stopping, and can reduce the stress on forcemains under normal operation.
- In some cases, can run the pump at over 100% speed for certain operating conditions.
- Reduce downstream surges due to rapid flow changes.

Potential disadvantages of VFDs include:

- Operation at too low of a speed could result in clogging of pumps or overheating of motors.
- Additional capital cost.
- Heat removal from electrical equipment area must be assessed to ensure that the life of the VFDs is not degraded by excessive operating temperatures.
- Potential electrical harmonics issues must be identified and addressed if they are a problem.
- Additional automation complexity.

3.2.2 Pump Cycle Time Analysis

A primary factor in determining the requirement for a VFD in this application is the pump cycle time. For a pump started across-the-line (no soft start), a typical guideline is to limit the number of pump starts for a 75 HP motor to 6.6 or less per hour, as per NEMA

MG 10. This is primarily due to motor heating that occurs during start-up, and an excessive frequency of motor starts can reduce the life of the motor. Motors fitted with soft starters will have different starting characteristics. In some cases motor heating during start-up may be reduced, and in other cases it may be increased. Detailed analysis, appropriate pump parameter setting, and potential soft starter over-sizing would be required to achieve a higher number of starts-per hour. The maximum starts-per-hour that could potentially be achievable with a soft start would be approximately 10, but a more realistic value of 7.0 starts per hour is recommended for this analysis. It is also recommended that starts-per-hour (SPH) calculation be performed with one pump out of service.

It should also be noted that VFDs have the potential to reduce energy consumption. However, in this facility, it is expected that the potential energy savings would be negligible and would not alone provide motivation to select a VFD for pump control.

The following information provided by the City was utilized to assess the operational impact of a VFD pump installation:

- Pump start/stop historical data.
- New pump datasheets with pump curves.
- An existing average Dry Weather Flow Rate (ADWF) of 120 l/s
- An existing Peak Dry Weather Flow (PDWF) rate of 155 l/s.
- Pump start/stop setpoints, which are as shown in Table 3-1. They were obtained from handwriting on the wall of the station, adjacent to the RTU panel.
- The dimensions of the wet well / sump, which are as shown in drawing 168 and 169.

Table 3-1 : Pump Start / Stop Setpoints

Pump	Start Setpoint		Stop Setpoint	
	m	ft	m	ft
Pump 1	1.08	3.54	0.21	0.69
Pump 2	1.22	4.00	0.27	0.9

Assumptions made in the calculations include:

- The measured wet level is referenced with zero (0) being the bottom of the wet well.
- There is no delay in pump operation from the time the level setpoint is reached.
- Pump flow rate is 208 l/s for a single pump, and 374 l/s for two pumps into one forcemain.
- Peak wet weather flow is 3 x ADWF, or 360 l/s.

Based upon approximated pump flow rates, with pump alternation, the pumps would experience 3.3 starts-per-hour at ADWF, 2.8 starts-per-hour at 0.5 ADWF and 2.6 SPH at Peak Dry Weather Flow (1.75x). However, without pump alternation, peak cycle times would be 6.8 starts per hour at 0.9 ADWF. The calculated cycle times for various flow scenarios are shown in Table 3-2.

Table 3-2 : Calculated Expected Pump Cycle Time

Case	InFlow Rate (l/s)	# Pumps	Cycles / Hour Without Alternation	Cycles / Hour With Alternation
0.5 ADWF	60	1	5.6	2.8
0.6 ADWF	72	1	6.1	3.1
0.7 ADWF	84	1	6.5	3.3
0.8 ADWF	96	1	6.7	3.4
0.9 ADWF	108	1	6.8	3.4
1.0 ADWF	120	1	6.6	3.3
1.25 ADWF	150	1	5.4	2.7
PDWF	155	1	5.1	2.6
2.0 ADWF	240	2	3.0	3.0
2.5 ADWF	300	2	4.8	4.8
PWWF (3x)	360	2	1.5	1.5

Notes:

1. *Cycles per Hour with Alternation assumes two pumps are available.*

Historical pump cycle times are summarized in Table 3-3 below. For both pumps, less than 2% of all historical pump starts within the period analyzed occurred at a rate above 6 starts-per-hour (SPH). However, the average SPH of both pumps is over 6. The reason for the high average SPH was investigated and it was noted that there are periods where the pumps start and stop very frequently, with runtimes down to seconds, which result in very high SPH calculations. It should also be noted the SPH were calculated for each pump cycle, based upon the time interval of the last complete pump cycle. The wet well level was reviewed during some of the rapid pump cycles, but does not appear to support any basis for the frequent pump operation. It is not clear from the available data why the pumps start so frequently in some cases, but it is suspected that this may be an issue with the pumping station controls. Based upon general inspection of samples of historical data, it was noted that pump cycle times are typically in the

range of 2 – 3 SPH. As replacement of the pumping controls is proposed as part of the overall work, further investigation into the controls issue was not performed as part of this work.

Table 3-3 : Historical Pump Cycle Times: 2010-02-23 to 2012-04-26

Pump	Item	Value
Pump 1	No. Starts	33,742
	Average SPH	7.69
	SPH > 6	1.88%
Pump 2	No. Starts	30,469
	Average SPH	6.38
	SPH > 6	1.48%

Based upon an analysis of pump cycling frequency, the peak calculated cycle time is 4.8 cycles per hour with alternation and 6.8 cycles per hour, without pump alternation. Given that the maximum recommended number of cycles per hour with a soft start is deemed to be 7.0, there is not a basis for the installation of VFDs at the Aubrey Pumping Station, provided that pump alternation is provided under normal use.

3.3 Comminutor Chamber Piping

The wastewater flows from the adjacent sewer to the wastewater pumping station wet well through the comminutor chamber. At one time, a comminutor was installed within the station, however the associated equipment has been removed many years ago. Currently, the wastewater flow through the comminutor chamber is open, which results in foul gases being present in the station. In addition, the open channel flow is also a concern with respect to ventilation and electrical classification requirements, and if not addressed, would require higher ventilation requirements and electrical classification. Similar to recent upgrades at other pumping stations, it is proposed to eliminate the exposed raw sewage in the comminutor chamber via the installation of piping in the

chamber. This reduces station ventilation requirements and eliminates the requirement to electrically classify the pumping station interior.



Figure 3-1 : Comminutor Chamber

A hydraulically actuated valve is present on the inflow channel into the comminutor chamber. The actuator for the valve is shown in Figure 3-2. This valve is currently operated via a float mechanism, and protects the station from flooding. Similar hydraulic valves are installed at numerous other stations in the City, and have been a frequent cause of failure. As it is proposed to enclose the open sewage within piping, it is proposed that the automatically operated valve can be replaced with a standard wedge gate valve with a pedestal mounted manual actuator.



Figure 3-2 : Hydraulic Valve Actuator

Currently the sump pump discharges into the open sewage in the comminutor chamber. It is proposed to modify the piping to discharge into the new comminutor chamber piping. A second check valve, in addition to the one installed at the sump pump itself, will be installed along with a manual isolation valve. It is also proposed that the sump pump piping, fittings and valves be replaced with stainless steel, to avoid corrosion and a potential flooding risk from a piping failure. Current City piping standards will be utilized for piping component selection.

As part of the scope of work, the City requested that the purpose of a “diagonal pipe” located in the comminutor chamber be identified. The diagonal pipe can be seen in Figure 3-1. Upon closer inspection during a site investigation, it became obvious that the “diagonal pipe” is the abandoned drive shaft for the removed comminutor. See Figure 3-3. It is proposed to cut the shaft as required and remove from the station as part of the work.



Figure 3-3 : Old Comminutor Drive Shaft

3.4 Pump Room Piping

3.4.1 Existing Installation

The existing pump piping is contained entirely within the pump room, as per existing drawing 1218. The existing piping appears to be carbon steel, although one section of piping has been replaced with PVC pipe. The existing pump isolation valves are knife gate valves.

There are three suction lines from the wet well into the pump well. The first two are connected to the existing pumps, while the third is capped with a blind flange. The existing suction lines through the wall appear to be constructed of cast iron, and utilize link-seal to join to the 250mm pump suction pipes. The suction lines through the wall appear to be in fair condition and consideration of replacement should include review of flow losses, as described in the following sections.

3.4.2 New Pumps

The pumps to be installed at Aubrey Pumping Station have previously been selected and purchased by the City of Winnipeg. Some pertinent details regarding the pumps are summarized in Table 3-4. The pumps will be installed in the pump room, and the corresponding motors in the motor room above.

Table 3-4 : Pump Data

Rated Capacity	208 l/s @ 18.00 m
Hydraulic Power	49.2 HP
Pump Speed	1175 RPM
Rated Power	61.3 HP
Maximum Power	61.5 HP
Motor Power	75 HP

During the course of the work, it was noted that the pump sizing for the application is suspect. Detailed review of the pump sizing is not within the scope of work of this project. It is recommended that a full review of the pump sizing be performed as part of the detailed design phase of the work.

3.4.3 New Piping Requirements

The existing piping installation does not meet the current design and operational requirements of the City. The City requires the following:

- The existing knife gate valves are to be replaced with bronze-seated wedge gate valves, as per the City's standard.
- Installation of a discharge flowmeter to gauge station throughput and detect pump failures and plug situations.
- All suction and discharge piping within the pump room, including all fittings and valves, are to be replaced.

A photo of one of the pump suction lines is shown in Figure 3-4. Based upon a visual inspection of the pump suction lines and fittings, the piping is in fair condition and consideration of replacement should include review of flow losses. The current pump inlet piping diameter is 250 mm, which is smaller than the replacement pump manufacturer's recommended sizing. The pump manufacturer has identified faulty inlet (suction) piping as being the major source of pump trouble for centrifugal pump

installations, other than misalignment. Since the pump manufacturer recommends 350 mm piping at the inlet and the inlet piping is in fair condition, it is recommended that the pump suction lines to the wet well be replaced.



Figure 3-4 : Pump Suction Line

The City has previously standardized on magnetic flowmeters, which have proven to be effective in wastewater applications. For accurate flow measurement, they typically require five pipe diameters upstream and two pipe diameters downstream of straight pipe flow. Given that the common pipe discharge header diameter is proposed to be 450mm, the installation of a single flowmeter on the discharge pipe would require 3.15m of straight pipe length. Alternately, a flowmeter could be installed on each pump discharge pipe, and this would reduce the pipe straight length requirements. Given that 300mm diameter pipe is proposed for the individual pump discharge piping, this scenario would require a total of 2.1 m of straight pipe on each pump discharge. Neither scenario is feasible by keeping the piping exclusively within the pump room, however the arrangement where an individual flowmeter is provided on each of the pump discharges was discussed with the City and deemed to be preferable.

3.4.4 Piping Arrangement

The proposed piping arrangement is shown on sketch SK-M01. It allows for the possibility of three pumps as requested by the City, although it would be a tight

installation. It utilizes individual flowmeters located on the individual pump discharges at the motor level. In addition, it utilizes a new 450mm diameter discharge header and pipe out of the station from the motor room level. The existing discharge pipe exits the station at the pump level, and is believed to be 400 mm cast iron pipe. There is no indication on the drawings received from the City of this pipe being replaced in the past, and thus there is a possibility that this pipe could date to the original station construction in the 1930s.

The proposed pipe discharge is 300 mm diameter at each pump, which is sized according to pump manufacturer recommendations, in order to minimize friction losses and hydraulic noise. The pipe size could potentially be reviewed at the detailed design stage, to determine if 250mm pipe would be acceptable, as this would allow the size of the valves and valve actuators to decrease. The piping from the three pumps transitions to the proposed 450 mm discharge header pipe, and flow velocities in the 450 mm pipe are within the recommended 3 m/s with two pumps running. Confirmation of this piping arrangement would be completed during detailed design.

It should be noted that the proposed configuration will not achieve the typical recommended five pipe diameters upstream and two pipe diameters downstream, required for high accuracy installations. However, it is deemed that the accuracy losses with the proposed installation are acceptable, and a reasonable compromise given the limited space.

The advantages of this configuration are:

- Ability to detect individual pump flow issues when two pumps are running through the use of the dedicated flowmeters.
- Replacement of the discharge pipe external to the station, which is of unknown age, and insufficiently sized for the new pumps.
- Acceptable flow losses.

The proposed piping arrangement was discussed with the City and the arrangement, as proposed in SK-M01 was accepted by the City.

3.4.5 Installation of a Third Pump

The City requested that the feasibility of installation of a third pump be investigated. The primary purpose of the third pump would be to provide firm capacity of two pumps, with one pump out of service. As shown on the piping arrangements provided, it is physically possible to install a third pump and the associated piping within the existing station, although the installation of a third pump would significantly impact the available space in the pump and motor rooms.

However, the working space associated with the installation is very tight and there are interferences associated with the wet well level transmitter installation. Based upon preliminary flow calculations, use of three pumps in parallel would exceed the recommended flow velocities in the proposed 450 mm discharge piping, and review of the capacity of the connection between the sewer and the wet well would be required. Thus, it would be recommended to limit the pump operation to a maximum of two pumps operating simultaneously. In addition, there are also electrical considerations, which are discussed in Section 5.0.

The City has subsequently indicated that installation of a 3rd pump is desired, and shall be included in the work. The City has also noted that pumping should be limited to 2 out of three pumps at any given time, and while the 3rd pump would be in the alternation rotation, its effective purpose would be to provide a firm pumping capacity equal to two pumps, when one pump is out of service.

3.5 Miscellaneous Items

3.5.1 Water Service Piping

The water service to the station enters the facility at the Lower Level 1, as shown in Figure 3-5. It includes a water meter and backflow preventer. There is significant corrosion present on all the metallic water service piping. Piping within the pump room has been replaced by PVC pipe, which appears to be in good condition.



Figure 3-5 : Existing Water Service

It is proposed to replace the entire water service piping within the pumping station. To ensure the service water for pump seal water requirements is of suitable quality, and to ensure the water line is sufficiently rugged for the working environment, stainless steel tubing is recommended for the service water system. The backflow preventer will be replaced with a reduced pressure backflow preventer, and located on the main floor of the station to meet current cross-contamination requirements. Hose bibs will be installed in the Lower Level 1, Motor Level, and in the Pump Room.

3.5.2 Sump Pump

A single fractional horsepower sump pump is currently installed in the station. In addition to any weepage into the station, it handles the seal water discharge from the

pumps. In the event of sump pump failure, the pump room would flood and the station flood switch would actuate to send an alarm to collections personnel. There would be some advantage in the installation of a second sump pump for redundancy purposes, however this would require the installation of a second, or larger, sump pit. This is presented for consideration, however sump pump redundancy is not in the current proposed scope of work.

3.5.3 Wet Well Cleaning

The wet well is a critical component to pumping station operation. It is not known when the solids built-up within the wet well were last removed. It is proposed to clean the wet well as part of the work.

3.5.4 Removal of the Existing Discharge Pipe Tee and Thrust Block

The existing discharge pipe exits the station in the north-west corner of the pump room, and utilizes a tee, embedded in a concrete thrust block, to combine the flow from both pumps. As it is proposed to install a new discharge pipe, exiting the station from the motor room, the existing tee and thrust block will no longer be required. While it would be most straightforward to simply place a blind flange over each port on the tee, removal of the thrust block is recommended to improve the working space in the pump room. This becomes almost imperative in a three pump scenario.



Figure 3-6 : Existing Discharge Tee and Thrust Block

3.6 Design Basis

3.6.1.1 Piping

All piping inside the station will be Class 52 ductile iron or schedule 80 ASTM carbon steel. All piping will be painted.

Fittings will be cast iron (AWWA C110) or schedule 80 carbon steel (Grade B conforming to ASTM standards).

As per the City's standards and the Ontario MOE recommendations, the recommended flow velocities should be between 0.6 m/s (2 ft/s) and 3.0 ms (9.8 ft/s). Ideally flow velocities would exceed 0.9 m/s to provide a cleansing velocity.

3.6.1.2 Valves and Fittings

Each pump will be fitted with suction and discharge valves, to allow for pump isolation. In addition, check valves will be installed between the pump and the discharge isolation valve.

All valves will be bronze trimmed cast iron wedge gate valves with cast iron body.

4.0 VENTILATION ANALYSIS

4.1 Existing

The existing ventilation is provided by a single fan, located in the Lower Level 1 space of the station, which supplies unheated air into the station. The fan is not typically operated when unoccupied during the winter months. The following issues were also noted to exist with the current installation:

- There is a significant amount of moisture build-up in the pump room, and some in the motor room, due to the lack of ventilation.
- There are significant odour and corrosion issues in areas of the station, which are indicative of lack of sufficient ventilation.

The current ventilation is summarized in Table 4-1, however it should be noted that the ventilation rates shown are based upon old data and assumptions, and are not likely to be accurate.

Table 4-1 : Current Ventilation

Area	Occupied	Winter Unoccupied	Summer Unoccupied
Main Floor	Natural Ventilation	None	Natural Ventilation
Lower Level	0 – 6.8 ACH	None	6.8 ACH
Motor Room	0 - 4.5 ACH (See Note 2)	None	4.5 ACH
Pump Room	0 – 5.4ACH (See Note 2)	None	5.4 ACH
Comminutor Chamber	0 – 6.8 ACH	None	6.8 ACH

Notes:

1. *Occupied ventilation rates are assumed to be worst case, winter rates. Some occupied ventilation is present during the summer, if personnel turn the fan on.*
2. *While a fan is present, no heating is installed. It is assumed that personnel do not continuously run the ventilation fan at full capacity during the winter, as it would likely freeze the station.*

4.2 Ventilation Analysis - Comminutor Chamber

The comminutor chamber currently has exposed raw sewage flowing through it, and thus must currently be considered as a wet well space. To provide for safe entry into this space, significant ventilation and electrical classification is required. However, it is potentially feasible to pipe the raw sewage across the comminutor chamber, such that no raw sewage would be exposed. This would allow the comminutor chamber to be treated as a drywell space, and is the basis for the remaining analysis.

4.3 Ventilation Analysis - Drywell Spaces

The drywell spaces within the facility are deemed to be the following:

- Main Floor
- Lower Level 1
- Motor Room
- Pump Room
- Comminutor Chamber

The comminutor chamber is included in the drywell space, however this is dependent upon the comminutor chamber being modified to eliminate the exposed raw sewage within the facility.

It is recommended to ventilate the drywell spaces with 6 ACH of ventilation, utilizing 75% recirculation when unoccupied in the winter. This generally meets the requirements of NFPA 820, although NFPA 820 does require that combustible gas detection be installed and that recirculation be disabled upon combustible gas detection. Note that the Ontario MOE and the Alberta Design Guide recommendations do not indicate an option for 75% recirculation.

The operating costs for the station ventilation with electric heating were calculated, and are shown in Table 4-2.

Unoccupied Ventilation	Occupied Ventilation	Electric Heat	
		Annual Operating Cost	Net Present Cost
6 ACH 75% Recirc.	6 ACH	\$1,809	\$47,900

Table 4-2 : Proposed Station Ventilation Operating Costs

Notes:

- The energy calculation for the Drywell assumes that the space will be occupied for eight (8) hours per week.*
- The net present value calculation assumes a 5% annual rate of increase of operating costs, 7% cost of capital and 40 years of operation.*
- Current electricity rates for a Manitoba Hydro owned electrical service of this size are as follows:*

<i>First 11,000 kWh</i>	<i>\$0.0729 / kWh</i>
<i>Next 8,500 kWh</i>	<i>\$0.0506 / kWh</i>
<i>Balance of kWh</i>	<i>\$0.0334 / kWh</i>
<i>Demand Charge</i>	<i>8.55 / kVA</i>

- Based upon obtained historical electric power usage at the station, it is assumed that the average incremental winter electric rates for the heating will be \$0.0506 / kWh and \$0 / KVA, which is used in the calculations. See Section 5.5.3 for a discussion on demand charges for the station.*

4.4 Proposed Ventilation

It is recommended to supply 6 ACH of ventilation, with 75% recirculation when unoccupied all drywell spaces in the building, including the existing comminutor chamber. This proposed ventilation option meets NFPA 820 would provide a safe working environment for personnel, and reduce the potential corrosive gases and moisture in the space.

The ventilation recommendations, as summarized in Table 4-3, have been presented on the basis of currently accepted good engineering practice, and published codes and guidelines. Note however that local Manitoba Code regulations do not require

conformance to the utilized codes and standards described, and while not recommended, do not preclude the use of a lower level of ventilation.

Table 4-3 : Proposed Ventilation

Area	Occupied	Winter Unoccupied	Summer Unoccupied
Drywell Area Main Floor Comminutor Chamber Lower Level 1 Motor Room Pump Room	A1	A2	A3
Ventilation Legend:			
A1 6 ACH continuous, 15°C minimum, pressurized to + 25 Pa			
A2 6 ACH continuous, 6°C minimum, pressurized to +2.5 Pa, 75% recirculation			
A3 6 ACH continuous, no heating, pressurized to +25 Pa			

Notes:

1. *It is assumed that the Comminutor Chamber will be piped across, to avoid raw sewage being present in the drywell.*

The proposed heater size for the installation is 18kW. This is based upon a minimum heated discharge temperature of 15°C when the outdoor air temperature is -40°C. In reality, the discharge temperature may be set higher, such as 18°C or 20°C, when the station is occupied. During typical weather, the heating system would be able to maintain the desired setpoint. However, during the coldest weather (-40°C), the discharge temperature would be limited to 15°C. Note that the energy calculations are based upon a discharge temperature of 20°C when occupied.

The ventilation equipment will be located on the Lower Level 1 space. The space requirement for the equipment was reviewed, and although the installation will be tight, with limited maintenance access, it will fit within the given space. The requirement to route the supply and exhaust ductwork through the main floor space was reviewed, and it was noted that it would impact the available space for electrical and controls equipment, as well as create potential structural issues with the main floor. Thus, it is

proposed to provide intake and exhaust penetrations through the station wall below grade. The exterior ducts could be constructed either of pipe, or a concrete duct. It is deemed that the concrete duct could be integrated architecturally into the building and be more aesthetically pleasing, but with addition cost over a pipe duct. At this time, installation of exterior concrete duct is proposed, although this could be reviewed at the detailed design stage.

4.5 Detection of Combustible and Toxic Gases

The proposed ventilation rate of 6 ACH, with 75% recirculation when unoccupied is based upon NFPA 820. However, NFPA 820 requires that recirculation is turned off automatically upon combustible gas detection via a permanently installed gas detector. In discussion with the City, it is understood that City personnel utilize portable gas detectors when entering the pumping station and the City has decided in the past against the installation of any permanent fixed gas detection, partially due to the requirement to maintain and calibrate the gas detection. While NFPA 820 does not address toxic gases, such as H₂S, good practice also dictates that toxic gas detection be installed. The Ontario MOE recommendations imply that when a two speed ventilation system is installed, which is effectively that proposed for Aubrey Pumping Station, that gas detection be utilized to automatically transition the ventilation to the higher rate.

Note that the Alberta Guidelines require that equipment for the measurement of hydrogen sulphide, oxygen depletion, and combustible gas should be provided, but it may be either portable or permanent.

It is recommended that permanent combustible and toxic gas detection be installed, and connected to the HVC system to eliminate ventilation recirculation. Given the City's previous decisions at other pumping stations not to utilize permanent installed gas detection, this is presented as an option in Section 8.4.2.

5.0 ELECTRICAL

5.1 Existing

The existing electrical distribution is powered by a 1000 kVA padmount transformer, which provides 600 V power to the Aubrey Flood Pumping Station and Aubrey Wastewater Lift Station. A CSTE is mounted on the south exterior wall of the wastewater lift station and distributes power to the lift station and flood station. Inside the lift station, a 200 A fused service disconnect is installed. It should be noted that the existing arc flash rating of the CSTE and fused disconnect is “Dangerous”, indicating that there is no safe PPE (Personal Protective Equipment), to protect a worker from the potential arc flash hazard when working on energized equipment. A 600 V splitter distributes power the two wastewater lift pump starters and a 15 kVA, 120/240V transformer. The two pump starters are FVNR starters, controlled via a Precision Digital process meter in the existing RTU panel.

The existing 120/240V distribution is a 120/240V residential / light commercial-grade loadcenter, with 24 circuits. The existing 120V distribution is via conduit and significant portions are estimated to date over 50 years old. The existing lighting is incandescent and no emergency lighting is provided.

5.1.1 4160V – 600V Transformer Issues

The 1000 kVA transformer that provides power to the Wastewater Lift and Flood Pumping stations is currently owned by the City of Winnipeg. It does not meet code requirements for a non-utility owned transformer, which include:

- There is no primary 4160V disconnect installed.
- The secondary cable from the transformer is assumed to be 2-3C, 750MCC RWU90, aluminum conductors installed in two 5" PVC conduits. This cable has an ampacity of 762 A, where the ampacity required by code is 1203 A.
- The metering is installed on the transformer secondary, and not on the primary as is typical for customer owned transformation.
- The transformer is located within 2184 mm of the pumping station, and the wood soffit overhang of the station is even closer to the transformer. The Canadian Electrical Code requires that liquid oil filled transformers be installed at least 3m away from any combustible surface or material on a building and 6m from any, door, window, or ventilation inlet or outlet. It should be noted that there is an exemption if the transformer contains a current limiting fuse and a pressure relief device, but the currently installed transformer does not meet these requirements.
- The transformer may not meet CSA requirements for customer owned transformers.

In addition, as the available arc flash energies on the secondary side of the transformer are at Dangerous levels.

5.2 Service Transformer Analysis

5.2.1 Manitoba Hydro Ownership Option

The City has previously indicated a preference to sell the transformer to Manitoba Hydro to eliminate the code compliance issues, as well as transfer any transformer maintenance requirements to Manitoba Hydro. This would address the first three code concerns, as these issues are not applicable to utility owned transformer installations.

However, simple transfer of ownership does not address the clearance issues identified or lower the available arc flash energy at the first 600V main breaker.

Consideration was given to replacing the existing transformer with a Manitoba Hydro owned transformer with the appropriate current limiting fuses and pressure relief device, which would eliminate the clearance requirements, and would likely reduce the arc flash energy due to the internal bay-o-net fusing. Note that a standard 1000 KVA transformer with a primary voltage of 4160V fusing is not available in the typical configuration with Bay-o-net and current limiting fusing, however an option was identified and is discussed further in Section 5.2.2.

An alternative would be to install two service transformers, with one for the lift station and one for the flood station. This would eliminate issues on the lift station service due to the smaller size, but the flood station transformer will still need to be rated at 1000 KVA, and be subject to similar arc flash rating issues.

Additional alternatives identified, to mitigate the high arc flash energies are as follows:

- Install the 600V main breaker in an outdoor arc resistant switchgear enclosure, such that any internal arc is safely vented to a safe location. It is expected that the main breaker would need to be in a switchgear style (vacuum or air insulated) to allow such a configuration.
- Install a motorized operator on the 600V main breaker to allow the electrician to remotely operate the breaker from a safe location.

5.2.2 City Ownership Option

The transformer is currently owned by the City and ownership could potentially be retained, although replacement of the existing transformer would be required. The replacement transformer would need to be constructed to the following CSA standards:

- CAN/CSA-C2 Single Phase and Three Phase Distribution Transformers
- CAN/CSA-C88 Power Transformers and Reactors
- CAN/CSA-C227.4 Three Phase, Dead Front Pad-mounted, Distribution Transformers

The location for the new transformer would be dependent upon whether the transformer was fitted with a pressure relief device and integral current limiting fuses. As noted in Section 5.2.1, the specific transformer required is not available in the required standard configuration. However, in discussion with a transformer manufacturer, it was noted that it is possible to construct a transformer with an under-oil weak-link fuse in series with a current limiting fuse in the required 1000 KVA rating. Further investigation into this option would be required to confirm that it fully meets the requirements of the application.

Under this scenario, the following requirements would apply:

- If not fitted with a current limiting fusing and a pressure relief device, the transformer would need to be relocated to a location at least 3m away from any combustible surface or material on a building and 6m from any, door, window, or ventilation inlet or outlet.
- A ganged primary 4160V disconnect would need to be installed.
- The transformer secondary cable would need to be sized per Canadian Electrical Code requirements.
- The metering should be installed on the transformer primary.
- Primary fusing may need to be installed, in a padmount enclosure, to provide transformer protection and potentially reduce the available arc flash energy on the transformer secondary.

5.2.3 Assumed Configuration

For the purpose of this report, it is assumed that the City will engage Manitoba Hydro to install a new 1000 KVA transformer at an acceptable location away from the building. The arc flash energy at the 600V main breaker will be high, and this will be addressed through the use of an electric motor operator with a remote control station.

However, further review of the available options, including cost analysis is required, and must be investigated as part of the detailed design process.

5.3 Electrical Load Analysis

The capacity of the electrical service was investigated to determine if it is sufficient to power the new equipment loads. An electrical load estimate for the current station configuration was performed and is summarized in Table 5-1.

Table 5-1 : Existing Configuration - Load Estimate @ 600V

Load	Connected (A)	Demand Factor	Load Estimate (A)
Lift Station			
Pump 1 – 60 HP	60	0.9	54
Pump 2 – 60 HP	60	0.9	54
15 KVA Transformer (120/208V loads)	12.2	0.8	9.8
Supply Fan	1.5	0.9	1.4
Subtotal (without PFC)	171		119.2
Flood Station			
Pump P-F01 – 250 HP	242	0.9	217.8
Pump P-F02 – 250 HP	242	0.9	217.8
Pump P-F03 – 250 HP	242	0.9	217.8
Pump P-F04 – 175 HP	173	0.9	155.7
Temporary Storm Pump P-F12 – 30 HP	30	0.9	27
15 KVA Transformer (120/208V loads)	14.4	0.8	11.5
EF-F1 (existing identifier)	1.2	0.9	1.2
P-F11 Sump Pump (existing identifier)	8.5	0.9	8.5
Subtotal	953.2		856.4
Total Loads	1086.9		975.6

The historical recorded electrical demand was obtained from Manitoba Hydro for the dates from January 2006 to March 2012. The peak demand was 973 kVA, recorded in June 2010. This is very close to the calculated demand load estimate in Table 5-1, and thus the demand factors utilized are deemed to be representative.

The load estimate for the proposed configuration was calculated and is shown Table 5-2.

Table 5-2 : Proposed Configuration - Load Estimate @ 600V

Load	Connected (A)	Demand Factor	Load Estimate (A)
Lift Station			
P-L01 – 75 HP	70	0.9	63
P-L02 – 75 HP	70	0.9	63
P-L03 – 75 HP (See Note 3)	70	0	0
15 KVA Transformer (120/208V loads)	12.2	0.8	9.8
SF-L61	1.5	0.9	1.4
HCE-L61 (Electric Heating Coil) 18 kW (See Note 2)	17.3	0	0
Subtotal (without PFC)	171		137.2
Flood Station			
Pump P-F01 – 250 HP	242	0.9	217.8
Pump P-F02 – 250 HP	242	0.9	217.8
Pump P-F03 – 250 HP	242	0.9	217.8
Pump P-F04 – 175 HP	173	0.9	155.7
Temporary Storm Pump P-F12 – 30 HP	30	0.9	27
15 KVA Transformer (120/208V loads)	14.4	0.8	11.5
EF-F62 (was EF-F1)	1.2	0.9	1.2
P-F51 (was P-F11) Sump Pump	8.5	0.9	8.5
Subtotal	953.2		856.4
Total Loads	1124.2		993.6

Notes:

- 1. Loads shown are preliminary and should be reviewed at detailed design.*
- 2. Worst case demand is typically during spring or summer. It is assumed that heating will be off during this time.*
- 3. The City has indicated that only 2 out of 3 pumps will operate at any given time.*

The minimum service size is based upon the maximum load and a motor starting factor (25% of the largest motor load). Thus, the minimum service size for the proposed configuration is 1054.1 A. However, the service must be capable of supporting the calculated load of 993.6A continuously. Typically, breakers are rated at 80% of their rating for continuous loads, which for a 1200A breaker is 960A. Thus, while a 1200A service breaker is acceptable, it would need to be rated for 100% continuous current.

While the City has noted that only operation of two out of three pumps is required at any given time, the electrical requirement to run three pumps simultaneously was reviewed. In this case, with a 3rd 75 HP pump, the continuous demand load would be 1057A and the minimum service size, including motor starting, would be 1117A. Thus, this scenario could be supported with a 100% rated, 1200A service. If other significant loads were to be added to the wastewater pumping station or the flood pumping station, the service size would need to be increased to 1600A. This option was discussed with the City, and the City deemed that a 1600A service was not required.

5.4 Required Electrical Distribution

It is proposed to replace the existing electrical distribution with a Motor Control Center (MCC). The MCC would contain five sections. The first section, starting from the left, would contain starter for P-L01, the first wastewater pump. It is expected to require almost a full height section, due to the requirement for bypass and isolation contactors, in addition to the soft starter. The second and 3rd sections would contain the starters for pump P-L02 and P-L03 respectively. The fourth section would contain the optional power factor correction capacitors, the breakers for the heating coil and 120/208V transformer, and a 30 kVA 120/208V transformer. The transformer is proposed to be installed in the MCC, as clearance issues in the tight space can be avoided with installation in the MCC. The fifth section would contain a voltage relay (ESL-L711) and voltmeter, supply fan motor starter, TVSS, and incoming main lugs. Optionally, the MCC could contain a main breaker. The proposed configuration is shown in Figure 5-1.

	Section 1	Section 2	Section 3	Section 4	Section 5
A	Space	Space	Space	PNL-L72 (120/208V)	SF-L61
B	P-L01	P-L02	P-L03		ESL-L711 & VM
C					TVSS
D					HCE-L61
E				Space	
F	XFMR-L72	Main Lugs			
G					
H					
J					
K					
L					
M					

Figure 5-1 : Proposed MCC Elevation – Three Pumps

See sketch SK-E02 for the proposed main floor plan with five MCC sections. While the physical space available on the main floor for electrical equipment is limited, the proposed layout can accommodate the proposed MCC. Note however, that the available space for the controls is quite limited, and it is expected that some compromises will be required.

The existing CSTE (Customer Service Termination Equipment) is shown in Figure 5-2. It contains the utility metering CTs and PTs, as well as a splitter that provides power to both the wastewater lift and flood pumping stations. The age of the CSTE is not known. As the CSTE has no circuit breaker or fuse protection, it cannot limit the arc flash energy available within the wastewater lift and flood pumping stations. The City has requested that all equipment within the wastewater lift station have an arc flash hazard category of 2 or less. Thus, it will be required to replace the CSTE to allow for the installation of overcurrent protection.



Figure 5-2 : Existing CSTE

It is proposed to replace the CSTE with a new padmount distribution panel, located to the east of the existing transformer location. The distribution panel, identified as DP-F60 on the proposed single line diagram would contain a main breaker, a 1200A distribution feeder breaker to the flood pumping station, a 300A breaker to the wastewater lift station. In addition, it is proposed to install a 400A interlocked breaker to allow for the connection of a temporary generator.

5.5 Design Basis

5.5.1 General and Environmental Requirements

Electrical equipment in conditioned spaces will be rated 0°C to 35°C, 0 – 95% RH.

All electrical equipment will be CSA approved, or equivalent. Where existing electrical equipment is modified, an appropriate Department of Labour inspection will be performed.

Enclosures will be either Type 1 or Type 12 on the main floor of the pumping station. On lower levels, enclosures will either be NEMA 12 or NEMA 4.

5.5.2 Protection and Coordination

Circuit protection will generally be provided by circuit breakers, rated for the available interrupting current. The available interrupting current will be based upon the Winnipeg Electrical Bylaw, which requires assumption of an infinite bus on the main transformer primary, and assumption of a minimum transformer impedance of 4%. Thus, the utility short circuit current at the transformer secondary terminals is deemed to be 24,057 A. With motor contribution, the required design fault currents are as shown in column three of Table 5-3.

Table 5-3: Short Circuit Currents

Bus	Description	Bylaw Short Circuit Current (kA)	Actual Maximum Short Circuit Current (kA)
DP-F70	Outdoor Distribution Panel	27,913	17,336
MCC-L71	Wastewater Lift Station MCC	24,866	16,108
DP-F71	Flood Station 600V Distribution Panel	26,853	17,009

However, the actual impedance of the service transformer is known to be 5.33%, and the utility maximum fault currents have been obtained from Manitoba Hydro. The maximum short circuit currents were calculated for the actual case, and are shown in column four of Table 5-3. The short circuit currents will require final calculation once the details of the service transformer configuration are known.

It is proposed to ensure that the DP-F70 breakers are rated at 35kA, and rate the MCC-L71 breakers at 25 kA. However, this must be reviewed at detailed design to ensure this is adequate.

5.5.3 Power Factor Correction

In this installation, the economic case for power factor correction is not straight-forward. The utility service supplies both the wastewater lift station and the flood pumping station. As the wastewater lift pumps are a relatively small percentage of the overall service

size, and the flood station operates only intermittently, the power factor correction associated with the wastewater lift pumps only provides an effective reduction in billed electricity amounts infrequently through the year. Typically, power factor correction provides economic benefit from reduction in the demand charges. However, Manitoba Hydro charges a minimum demand charge of 25% of the contract demand, which in this case is 25% of the transformer size, or 250 kVA. The historical demand for 2006 to 2011 was reviewed and it was noted that the actual measured monthly demand only exceeded 250 kVA eight times over six years. In a month, where the demand would exceed 250 kVA, the installation of power factor correction could potentially reduce the monthly charge by approximately \$175 / month. When the actual measured demand is less than 250 kVA, there is no economic benefit to the City associated with power factor correction at this facility. If it is assumed that the demand will exceed 250 kVA on average 1.5 times per year, which is slightly above the existing historical demand, the annual savings would be approximately \$267 / year. Note that the savings would be greater in wet years, and lower in dry years. Given the cost to install power factor correction for three pumps is approximately \$8000, the simple payback period is 30 years. This is a long time, given that the life of the capacitors is approximately 25 years. Thus, power factor correction is not included in the proposed work.

5.5.4 Grounding

Based on existing drawings, it is believed that the existing CSTE is grounded via a three ground-rod electrode, however the location and condition of the existing ground rods is unknown. As part of this work, it is proposed to install a new three-rod grounding electrode adjacent to the proposed outdoor 600V distribution panel. The City has previously indicated that it would like to have a ground well installed on each rod.

In the event that the transformer installation ownership is maintained by the City, additional grounding would be required.

5.5.5 Electrical Classification

Provided that the ventilation is upgraded as proposed, the interior drywell spaces and comminutor chamber would be electrically unclassified. However, the wet well would be

a Class I, Zone 1 location, as well as a Category 2 Wet location as per CEC Section 22. In the pumping station, limited locations below piping, where condensation could form, would be considered Category 1 wet locations.

5.5.6 Distribution Panel DP-F70

Distribution panel DP-F70 will be an exterior, pad-mounted distribution panel, which will have the following features:

- NEMA 3R or NEMA 4 construction.
- 1200A, 100% rated main breaker, with LSIG protection.
- Utility metering compartment. (if utility owns transformer).
- 1200A feeder breaker to feed the flood station, with LSIG protection.
- 400AF (300AT) breaker to feed the lift station.
- 400AF breaker for temporary generator interconnection, interlocked.
- Anti-condensation heater.
- If required, control power to allow for operation of the main breaker motorized operator.

5.5.7 Motor Control Center

The proposed new MCC will be fed from the proposed utility transformer via the proposed outdoor distribution panel DP-F70. Specific requirements for the 600V MCC are as follows:

- Rating – 600 V, 3 ph, 3 wire.
- Main Bus Ampacity: 600 A Minimum Vertical Bus Ampacity: 300 A
- Bus Material: Copper
- Interrupting Rating: 25 kA (To be confirmed at detailed design)
- Enclosure – NEMA 1A gasketed.
- Arrangement: Front Access Only

- Other features:
 - A 600V three-phase voltage monitor to provide voltage alarming to the RTU.
 - A three phase voltmeter (An option to upgrade the voltmeter to a full power meter is discussed in Section 8.4.6)
 - TVSS.

5.5.8 Motor Starters

The existing motor starters will be replaced with new soft starters. The soft starters will include a separate bypass starter with a motor overload to allow for starting of the motor in the event of a soft starter failure. Isolation contactors will be utilized to isolate the soft starter when in bypass mode of operation.

Motor starters will typically contain motor circuit protectors, NEMA rated contactors, electronic overloads with ground fault protection, and dedicated control power transformers. Motor starters will be capable of manual operation independent of any other power source.

Front panel controls for the pump motor starters will consist of:

- MOA (Man-Off-Auto) switch, and Start and Stop pushbuttons.
- Soft Starter / Bypass selector switch.
- Blue “Ready” light
- Green pilot light to indicate running status.
- Amber soft starter fault and overload pilot lights.
- Hour-meter.
- Ammeter.
- Overload reset pushbutton (may be mechanical).

600 V motor starters will be located in the existing Motor Control Center (MCC). Each motor starter will be lockable, providing an isolation lock-off point for maintenance purposes. Local motor disconnect switches will not be installed.

5.5.9 Transformers – 600-120/208 V

It is proposed to replace the existing single phase transformer with a 30 kVA, three-phase 120/208V transformer, located in the MCC structure. While the load requirements do not necessitate a 30 kVA transformer, there are selective coordination benefits associated with this size, compared to a smaller transformer.

5.5.10 Panelboards – 120/208 V

It is proposed to install a new panelboard with the following features:

- 120/208V distribution panelboard with bolt-on breakers
- 225A, 120/208V, 3 phase, 4 wire
- 100A main breaker
- 30 or 42 circuits
- Mounting: Motor Control Centre

5.5.11 Uninterruptible Power Supply

It is proposed to install a UPS for control power to critical controls. It will be installed in a power supply panel (PSP-L82) adjacent to the RTU panel. The panel will be ventilated if the battery is installed inside the enclosure. Alternately, the battery may be wall-mounted adjacent to the power distribution panel.

5.5.12 Lighting

The existing lighting is incandescent, and replacement with fluorescent fixtures is recommended. In addition, it is recommended to install battery based emergency lighting throughout all commonly occupied areas of the pumping station. Proposed lighting is summarized in Table 5-4.

Table 5-4 : Proposed Lighting

Space	Purpose	Type	Voltage	Recommended Illumination (lux)	Notes
Main Floor	Normal	Fluorescent	120 V	250-350	1
	Emergency	Battery Based - LED	120 V	>10	
Lower Level 1	Normal	Fluorescent	120 V	150-250	1
	Emergency	Battery Based - LED	120 V	>10	
Motor Room	Normal	Fluorescent	120 V	150-250	1
	Emergency	Battery Based - LED	120 V	>10	
Pump Room	Normal	Fluorescent	120 V	150-250	1
	Emergency	Battery Based - LED	120 V	>10	
Comminutor Chamber	Normal	Fluorescent	120 V	100	2
Exterior	Night	High Pressure Sodium	120 V		3

Specific Notes:

1. *Station occupancy will be determined from the light switches. The station will be deemed to be occupied if any interior light switch is on.*
2. *Emergency lighting is not deemed to be required for the comminutor chamber due to the infrequent occupancy.*
3. *Exterior lighting will be controlled by photocell, with a dedicated circuit breaker to turn off the power.*

5.5.13 Receptacles

There are a limited number of 120V convenience electrical receptacles throughout the station. It is proposed to replace all existing receptacles and install additional receptacles to reduce the use of extension cords. All receptacles located below grade will be individually GFI protected with weatherproof type covers. An exterior mounted receptacle will also be provided, and switched via an interior mounted switch.

5.5.14 Cables and Wiring

As the existing electrical distribution is aged, it is proposed to replace all interior conduit and wiring. New 120/208V wiring would generally be RW90 in conduit. As most areas have the potential for mechanical abuse associated with removing pumps and motors from the station, it is deemed that all conduit is to be rigid aluminum.

A summary of the proposed wiring is presented in Table 5-5.

Table 5-5 : Proposed Wiring

Service	Wiring Type	Conduit	
Main Service	By Manitoba Hydro	PVC	
MCC Feeder	Teck90, 1000V	-	
Flood Station Feeder	Teck90, 1000V	-	
600V Motor Cables	Teck90, 1000V	-	
120/208V Distribution	RW90, 300V	Rigid Aluminum	

5.5.15 Miscellaneous

The sump pump located in the pump room is currently powered from a 120V receptacle, located approximately 762mm off the floor. It is recommended to install a new receptacle at the highest practical elevation to improve dewatering capability in the event of flood event.

5.5.16 Arc Flash Review

A preliminary review of expected arc flash energies was performed to determine if the proposed distribution resulted in acceptable arc flash energies. The expected arc flash Hazard / Risk Categories are shown in Table 5-6 below, however these values require confirmation at detailed design.

Table 5-6 : Expected Arc Flash Ratings

Equipment	Description	Expected HRC Rating
DP-F70.MCB	Exterior Padmount Distribution Panel – Main Breaker Compartment	TBD
DP-F70	Exterior Padmount Distribution Panel	3
MCC-L71	Lift Station Motor Control Centre	0
DP-F71	Flood Station Distribution Panel	2

Note: The arc flash rating of the DP-F70 main circuit breaker is highly dependent upon the course of action taken associated with the service transformer. If the existing transformer installation were to be retained, the arc flash rating of DP-F70.MCB is expected to be dangerous (> 40 cal/cm²).

5.5.17 Engineering Studies Required

The following electrical engineering studies will be required as part of the design and performed by the Engineer.

1. A short circuit study is required to ensure that the electrical equipment is adequately rated.
2. A coordination study is required to ensure that selective tripping, in the event of a fault, occurs to the greatest extent possible.
3. An arc flash study is required to evaluate the potential arc energy and potential hazards, and provide labels for installation on the electrical equipment.

5.5.18 Implementation Requirements

The Aubrey Pumping Station is critical to the wastewater collection system in Winnipeg. All work must be staged and shutdowns must be planned with limited durations to prevent sewer overflows or backing up into basements. Continuity of pumping station operation must be considered during all aspects of the design and construction. It is expected that a temporary electrical distribution will be required during the renovation of the main floor space. A potential sequence of work is as follows:

1. Install a new temporary splitter on Lower Level 1.
2. Relocate the Pump 2 motor starter to Lower Level 1, connected to the splitter.
3. Install the pad-mounted power distribution panel DP-F70.
4. Connect the splitter on Lower Level 1 to DP-F70.
5. Shutdown – Connect DP-F70 to the transformer. Connect the temporary splitter to the Pump 1 motor starter on the main level. The generator breaker on DP-F70 would be utilized (remove key interlock) to feed the temporary splitter.
6. Shutdown – Relocate the existing RTU panel to the Lower Level 1, while operating the pumps in manual.
7. Relocate pump 1 motor starter to Lower Level 1, connected to the splitter.
8. Temporarily remove all CSO instrumentation in the pumping station.
9. Relocate the existing 120/240V transformer and panelboard to Lower Level 1.
10. Refurbish the main floor space.
11. Install the MCC and connect to DP-F70.
12. Shutdown – Connect pump motors to new MCC starters. Controls to be from existing RTU panel. Connect existing panelboard to temporary breaker in new panelboard.
13. Install the new RTU panel and associated instrument and automation equipment. Commission.

6.0 AUTOMATION

6.1 Existing Installation

The existing wastewater pumping station control system is based around the RTU panel, which is located in the north-west corner of the main floor. It partially blocks the equipment access hatch to the lower levels, and is also located quite close to the personnel access hatch to the lower levels. The RTU panel is shown in Figure 6-1.

The RTU panel contains a Precision Digital process meter, which receives a signal from the wet well level transmitter. The process meter has integral relays, which signal the actuation of pump start signals. The actual pump run commands are toggled via an alternator in the RTU panel.



Figure 6-1 : Existing RTU Panel

The RTU panel also contains a SCADAPack 357 RTU, which collects alarm and status signals, and delivers them to the McPhillips Control Center via a PSTN modem connection. The RTU panel was installed in 2010 as part of the CSO upgrades associated with the adjacent sewer outfall. The CSO instrumentation connects into the CSO panel, shown in Figure 6-2, which is located on the south wall of the station. The signals from the CSO instrumentation are transmitted to the McPhillips Control Center via the RTU panel.



Figure 6-2 : Existing CSO Panel

6.2 Level Sensor

Aubrey Wastewater Pumping Station currently has a single wet well level sensor, based upon differential pressure. The existing installation is shown in Figure 6-3. While this configuration has proven effective operation, it should be noted that all automatic pump control is based upon this single sensor. Should the level sensor fail, the station would be inoperable until an operations crew arrives at site, establishes an alternate means of level measurement, and manually control the pumps. To increase reliability, a second level sensor is recommended. In addition to providing backup control, the second level sensor allows for comparison between the two level sensors, and an alarm can be set when the level difference exceeds a specified tolerance level.



Figure 6-3 : Existing Level Sensor Installation

An option for the backup level sensor is a submersible pressure sensor. This type of sensor would typically be installed in the wet well, and serviced via a manhole. At the Aubrey Wastewater Pumping Station, the wet well manhole is adjacent to the comminutor chamber discharge into the wet well and near to an existing pump suction intake. The turbulence of the fluid at the manhole would affect the reading on the submersible pressure sensor. The turbulence could be combated to a degree by the installation of a stilling well.

A submersible based level sensor was recently installed at Marion Wastewater Pumping Station and is understood to be performing well. A simple stilling well utilizing PVC conduit was created to provide for less turbulence due to the adjacent comminutor chamber discharge. However, at Marion Pumping Station, the pump suction intakes are significantly further from the wet well manhole, and thus do not disturb the submersible pressure transmitter.

Given that it is proposed to install new pump suction lines into the wet well, which would be further from the wet well, it may be possible to install a submersible pressure transmitter, provided an appropriate stilling well is provided.

An alternative option is to utilize the existing CSO level sensor in the sewer next to the wastewater lift station. The potential level sensor would be the submersible (hydrostatic) level sensor located in the Inlet Flume Chamber for the Flood Station. This data point is currently identified as S-551-FIT. While there is expected to be some difference in the level measurement between these points, there is potential that comparison between the sensors could provide an alarm of failure, and some level of backup control. This is included in the proposed work, while installation of a submersible pressure transmitter in the wet well is presented as an option in Section 8.4.8.

It should also be noted that the existing level sensor installation is located very close to the third pump suction inlet and would likely be subject to some turbulence. It is recommended that this be reviewed at detailed design, but an allowance to relocate the level sensor to the north end of the pump room is included.

6.3 Pump Control

The existing control system utilizes the wet well level to control the operation of the two wastewater lift pumps. The wet well level sensor sends a 4-20 mA signal to a Precision Digital meter, which has output relays that turn on at setpoint levels. These level setpoint signals pass through an alternator, which in turn controls pump operation. This system is similar to many other pumping stations and is well proven within City pumping stations.

One disadvantage with this system is that it is not easy for operators to change the wet well level setpoint. The Precision Digital meter is not intuitive in its setup, and it is anticipated that an instrument technician would typically be required to change the level setpoint.

It may be desirable during certain operating events to change the desired wet well operating level. This could be accomplished by utilizing the SCADA system.

As discussed in Section 6.2, it is also recommended to provide level sensor redundancy. This is not feasible with the existing Precision Digital meter installation.

This functionality could be accomplished via either a PLC or utilization of the SCADA RTU.

It is proposed to install either a PLC or RTU with control capability for station control. The City has previously indicated a preference for RTU control, and this will be subsequently assumed to be utilized for control. It is proposed that the RTU would also provide control for the ventilation at the station. This control approach is consistent with that designed for Montcalm Wastewater Pumping Station. The existing control approach at Marion Wastewater Pumping Station is similar, except that PLC control is utilized.

It is proposed to install a local colour touchscreen HMI on the main floor of the pumping station to provide full alarm display, and pump control capability local at the station. This would provide operators with alarm indication, a process mimic graphic indicating the status of the pumps and ventilation in the station, as well as manual control capability for the station. Wet well levels and discharge flows would be displayed on the HMI.

At Montcalm Wastewater Pumping Station, the City requested that backup control via a Precision Digital Process Meter be implemented to control the pumps in the event of a RTU control failure. This could be implemented at Aubrey Pumping Station as well, and is presented as an option in Section 8.4.7.

However, as indicated in other sections of the report, the space available on the main floor of the pumping station for controls is limited. It is expected that some desired capabilities may not be possible within the limited space available. This will require confirmation at the detailed design stage.

6.4 RTU Communication

The RTU communication to the McPhillips Control Center is currently via a PSTN modem. It is proposed that the new communication be primarily based upon DNP3 over a cellular based connection, to allow for full-time high speed monitoring of the station. In

addition, an analog PSTN modem would be installed for backup communication in the event of cellular system failure.

6.5 Flowmeter

For recent lift station upgrades, it has been typical to install a single flowmeter to measure the entire station discharge flow. However, as discussed in Section 3.4, it is proposed to install a flowmeter on each individual pump discharge. This will allow the control system to monitor the performance of individual pumps, when both pumps are operational.

It is noted that it is the City's preference for the flowmeter transmitters to be installed on the main floor of the pumping station. If the building size is not increased, it is believed that there will be insufficient space for the flowmeter transmitters on the main floor of the station. This will be reviewed during the detailed design, and if space can be made available, the transmitters will be located on the main floor.

6.6 Ventilation Controls

The following additional controls will be required to achieve the proposed ventilation strategy for the station:

- New supply fan control and monitoring.
- Recirculation damper control, based upon occupancy.
- Main floor room temperature sensor
- Determination of occupancy, based upon the light switch(es) for the station.
- Occupied override switch and ventilation controls, mounted on the control panel.

6.7 Other Instrumentation

Other instrumentation to be installed includes the following:

- Power Fail Contact from the Power 600V Voltage Relay
- Comminutor Chamber Flood Alarm – Flygt Ball
 - Despite the proposed work that will enclose the wastewater in this space, it is proposed that this alarm be retained, to alarm any potential pipe leakage in the comminutor chamber. It is proposed that the sensor and all wiring be replaced.
- Pump Room Flood Alarm – Flygt Ball
 - It is proposed that the sensor and all wiring be replaced.
- Station High and Low Temperature Alarming
 - The alarming will be provided via the proposed new room temperature sensor.

6.8 Control Panel

Due to the requirement to free up wall space and install new controls, it is recommended to install a single, larger control panel to address station control and monitoring requirements. While the existing RTU panel is only a few years old, it is not deemed practical to modify the panel, given the extensive modifications required. The front of the control panel would contain the following controls:

- Touchscreen HMI
- Digital Process Meter indicating Wet Well Level
- Occupancy – Occupied, Unoccupied, Auto switch

Note: While the existing CSO instrumentation installation has digital process meters for the Inflow Level and Outfall Level transmitters, it is proposed that these values be displayed on the touchscreen HMI, rather than dedicated displays.

The space available for the control panel is quite limited, and it is deemed that the maximum feasible size for the control panel in the existing space is 1830H x 916W x 459D (72" x 36" x 18"). Even with a separate power distribution panel, it is deemed that

some compromises would need to be made, relative to the Control panel provided for Montcalm Pumping Station. While it is known that the City's preference is to utilize SCADAPack series RTU controllers, it is proposed that a PLC based control system could potentially take less physical space. Further discussion with the City regarding the controls will be required at the detailed design stage.

A ventilation control panel is proposed to provide manual control for the ventilation system in the event of the RTU being out of service. There is no space for this panel on the main floor, and it is deemed that it will be located in the Lower Level 1 space.

7.0 BUILDING SPACE

7.1 Summary of Proposed Configuration

The space available within the available building is quite limited. The proposed piping arrangement, as shown in the attached drawing SK-M01, is deemed to be the most space effective piping arrangement possible, within the given constraints. It is believed that the maintainability of the pump room will be improved compared to the existing installation.

The existing configuration of the motor room is such that the motors are the only significant equipment located in the space. The proposed piping configuration will install the magnetic flowmeters, valves, and discharge piping in the motor room, which will significantly reduce the space. Given the limited maintenance requirements for motors, this is deemed to be acceptable.

The Lower Level 1 space use is currently limited to a ventilation fan, water service piping, and various access hatches. As part of the proposed work, the installation of a comprehensive HVAC system will significantly reduce the available space. The hydraulic actuated valve will be replaced with a manual actuator for the intake valve. While the space will be limited, it is believed that the proposed configuration for this space will be acceptable for maintenance personnel.

The main floor space is the most congested space within the station. Space requirements include electrical distribution equipment, control panels, instrumentation, access hatches, and the water service backflow preventer. A proposed configuration for the space is shown in SK-E02. While this configuration is believed to be workable, it is not ideal. The following are deemed to be compromises, which would be addressed differently given the availability of additional space:

- The ventilation ductwork and dampers may not be easily accessible for maintenance.
- The space available for pump removal is limited.
- It will not be possible to insulate behind the existing ladder due to clearance issues.
- The control panel size will be reduced from an ideal size, leading to a more compact, and tighter installation. Some non-mandatory options may be determined to not be practical during detailed design.
- The ventilation control panel will be located on the Lower Level 1, rather than the main floor. In the event of RTU failure, personnel will be required to access the below grade level to manually adjust the HVAC controls.
- The flowmeter transmitters will likely be located in the motor room, rather than the main floor as desired by City instrumentation maintenance personnel.

7.2 Potential Building Expansion

A brief review of potential building expansion options was performed. Approximately 6 sq. meters of floor space could be added by expanding the building 1.7 meters west. The original station below grade was expanded in this direction in the 1950s, to expand the comminutor chamber, and thus this below grade structure could potentially act a part of the foundation for the new structure.

The entire main floor structure would be demolished and replaced with a new structure. For this configuration, the main floor elevation would be raised slightly by pouring the new floor over the old floor, with appropriate access hatches as required. The new building would provide additional space, to address some of the issues identified in Section 7.1. It should also be noted that the existing building dates back to the 1930s.

This building expansion is presented as a concept only, and no design, feasibility, or costs are presented. Further analysis of this potential expansion may be performed upon request by the City

8.0 PROPOSED WORK

8.1.1 Summary of Base Work

It is proposed to perform the following work:

- Building Structural
 - Exterior
 - Replace existing plywood window covers with a more durable and attractive covering. It is proposed at this time to utilize a coloured pre-finished metal cladding, however this will be reviewed at detailed design.
 - Repair the damaged clay brick on the building north-west corner.
 - Remove and repair the holes associated with the abandoned electrical mast.
 - Repair the damaged fascia trim, which is due to the ventilation duct.
 - Cover or replace the existing soffits and fascia with prefinished metal trim.
 - Repair the roof bulge on west side of the roof.
 - Install a metal roofing system to replace the shingles.
 - Repaint the entire building exterior.
 - Install concrete ducts on the exterior of the station to provide station ventilation intake and exhaust. The ducts would be architecturally integrated into the station exterior. The concrete would be anchored into the existing foundation walls for support.
 - Main Floor Interior:
 - Remove the existing exposed Styrofoam insulation, and replace with a fire-resistant material, such as Roxul RHT-80 insulation board.
 - Test the ceiling panels for asbestos material. Remove and dispose of, if found to be asbestos based, in accordance with regulatory requirements.
 - Insulate the ceiling with batt insulation and cover with painted plywood.

- Close off the unused wooden access hatch above the Comminutor space with concrete. Some steel reinforcement below the floor may be required.
 - Provide electrical and HVAC ducting penetrations as required.
 - Provide a guardrail and swinging gate around the ladder access hatch.
 - Replace the ladder access hatch cover with a FRP cover. (required when the backflow preventer is being serviced).
- Lower Level 1:
 - Pressure-wash clean and paint the walls.
 - Remove the existing exposed Styrofoam insulation, and replace with a fire-resistant material, such as Roxul RHT-80 insulation board, for the top 1.2 m.
 - Remove the discontinued motor mount and close the shaft hole in the floor.
 - Replace the existing wood access hatch cover to the Comminutor Chamber with a hinged FRP hatch cover.
 - Replace the existing wood access hatch cover to the Motor Room with a hinged FRP hatch cover.
 - Provide a guardrail and swinging gate around the Motor Room ladder access hatch.
- Comminutor Chamber
 - As there appears to be some corrosion damage on the access hatch steel channel surround, it is proposed to replace the channel. This will also allow easier coordination with the proposed FRP cover.
- Motor Room
 - Remove abandoned epoxy injection ports on arched opening, and patch holes.
 - Repair the leaks in the walls. Pressure-wash clean and paint the walls and ceiling.
 - Realign the lifting bracket at room entrance.
 - Paint the lifting hooks to prevent future corrosion.

- Provide new piping penetrations, motor mounts, and reinforcing as required for the proposed process pumping upgrades.
 - Provide a guardrail and swinging gate around the ladder access hatch.

 - Pump Room
 - Pressure-wash clean and paint the walls and ceiling.
 - Repair the damaged locations in the concrete ceiling.
 - Ensure appropriately rated lifting hooks are placed appropriately to lift pumps for service. If the existing lifting hooks are re-utilized, paint the lifting hooks to prevent future corrosion.
 - Replace the existing 0.5 ton u-hook with an appropriately rated hook.
 - For the sump pit, replace the lip and provide a removable FRP cover. The lip material should be corrosion resistant.

 - Access Ladders
 - Ensure that required clearances are maintained behind the ladders. This may require that minimal or no insulation is placed behind ladders when insulation is replaced.
 - Repaint the ladders to provide extended life.
 - For the ladder to the comminutor chamber, provide a lanyard attachment point (bracket) supported from the concrete wall above the hatch opening.

 - Process Pumping
 - Comminutor Chamber
 - As part of the detailed design, review the size of the comminutor chamber piping to ensure that the size is sufficient for the proposed pump sizing.
 - Install a new gate valve with manual pedestal actuator at the Lower Level 1.
 - Install piping across the Comminutor Chamber to enclose the wastewater flow.

 - Wastewater Pumping
-

- It is recommended that a full review of the pump sizing be performed as part of the detailed design phase of the work.
- Demolish the existing pumps and piping.
- Core new suction lines into the wet well.
- Install new centrifugal pumps as provided by the City. The City has indicated that three identically sized pumps are desired. The City to advise how the procurement of the 3rd pump will be addressed.
- Install 300mm dia. discharge piping from each pump along with a check valve, dedicated flowmeter, and gate valve.
- Install a new 450mm dia. discharge header in the motor room.
- Demolish the existing tee and thrust block in the pump room. Install a blind flange on the abandoned pipe.

- Service Water
 - Replace all service water piping with stainless steel tubing. Install hose bibs on the Lower Level 1, Motor Room, and Pump Room levels. Provide
 - Install a reduced pressure backflow preventer on the main level.
 - Install systems to provide water to the pumps seals as required.

- Sump Pumps
 - Install stainless steel piping from the sump pump to the proposed comminutor chamber piping.

- Miscellaneous
 - Seal the pipes for the existing wet well level transmitter installation and install new metallic piping connections at the north end of the pump room.
 - Clean out the wet well.

- Discharge Pipe Replacement
 - Excavate and remove the existing discharge pipe between the station and the secondary sewer manhole. It is deemed that the piping below the elevation of the new piping may be abandoned.

- Ensure that the existing wet well vent pipe, water service pipe, and any other buried service piping within the excavation area are maintained. It is recommended that these services be located as part of detailed design to ensure that the location is reflected as best possible on the design drawings.
- Install a new 450mm dia. discharge pipe between the motor room and the manhole.
- Backfill and landscape.
- HVAC
 - Install ventilation equipment to supply 6 ACH of ventilation to the pumping station, with up to 75% recirculation when the station is unoccupied.
 - Install an electric duct heater for heating.
 - Install ducting and relief dampers as required.
 - Install dampers with electric actuators on the outdoor air, return, and exhaust ducts.
 - Route ducting as required to avoid interferences.
- Electrical
 - Coordinate with Manitoba Hydro to install a new Manitoba Hydro owned 1000 kVA transformer in a new location an acceptable distance from the building. (Note that other transformer options must be reviewed and selection of the appropriate solution must be made at the detailed design stage.)
 - Install a new 1600A, 600V outdoor distribution panel (DP-F70) with a main 1200A, 100% rated breaker and branch breakers for the flood and wastewater lift stations.
 - Install new buried Teck90 style feeder cables from the new DP-F70 to the wastewater lift station and the flood pumping station. At this time, it is proposed that the feeder cable for the lift station enter the station below grade, sealed with Roxtec seals on both the station interior and exterior.
 - Replace the buried feeder cables to the Flood Station.
 - Install a new 600V MCC in the wastewater lift station, identified as MCC-L71.
 - Install two new soft starters, complete with bypass and isolation contactors, for powering the two wastewater lift pumps.
 - Replace all existing conduit and wiring within the station.

- Replace the existing lighting in the station. Install lighting in the comminutor chamber
- Install new battery based emergency lighting for regularly occupied areas of the station.
- Install new convenience receptacles throughout the station. Convenience receptacles below grade would be GFI protected.
- Replace the receptacle for the sump pump.
- Provide temporary electrical installations as required to implement the work.
- Instrumentation
 - Install a new RTU based control panel on the main floor of the pumping station. The control panel would include a touchscreen HMI and a dedicated level indicator, for use in the event of an HMI failure.
 - Install a mushroom stop pushbutton near each pump and motor to provide local emergency stop capability.
 - Provide UPS capability to power critical controls in the event of a power failure.
 - Provide a ventilation control panel for the ventilation systems.
 - Integrate all the existing CSO instrumentation into the new control system.
 - Relocate the wet well level transmitter located on the pump level to make room for the 3rd pump installation.
 - Provide Ethernet networking as required.
 - Provide for a flowmeter on each pump discharge. The discharge flowmeters would be connected to the PLC via both analog input (flowrate) and pulse input (totalized flow).
 - Provide ventilation instrumentation as shown on the P&ID drawings.
- Other
 - Install a fire extinguisher on each level of the pumping station.

8.1.2 Cost Estimate

A cost estimate for the base proposed work is shown in Table 8-1 below.

Table 8-1: Base Work - Cost Estimate Summary

Description	Item Cost	Cost
Mobilization and Demobilization		\$ 50,000
Landscaping		\$ 25,000
Structural		\$ 172,000
Temporary Bypass Pumping		\$ 313,000
Wet Well Cleanout		\$ 18,000
Process Mechanical		\$ 294,000
Discharge Pipe Excavation and Replacement		\$ 221,000
Heating and Ventilation		\$ 56,000
Temporary Electrical Installation		\$ 13,000
Electrical		\$ 331,000
Automation - General		\$ 94,000
Automation – Programming, Training, Commissioning		\$ 78,000
Allowance for Additional Work		\$ 25,000
Total Direct Costs – Contractor		\$ 1,690,000
Contingency (20%)		\$ 338,000
Taxes (PST – 7%)		\$ 125,000
Indirect Costs – Owner (Finance & Admin Charge)		\$ 65,000
Total		\$ 2,218,000

Notes:

1. *The cost estimate is a Class 4 cost estimate and is in 2013 dollars.*
2. *The cost estimate does not include the supply of the 3rd pump. Installation is included.*
3. *The cost estimate does not include resolution of the issues associated with the supply transformer.*
4. *Engineering is not included in the cost estimate.*

8.2 Detailed Design Work

Specific tasks required at the detailed design phase include, but are not limited to:

- Review the pump sizing to ensure that the pumps are sized appropriately for the application. This will include a review of the flows measurements provided by the City, and calculation of the system losses.
- Test the paint on all below grade levels to determine if the paint is lead-based, and include the test results in the Bid Opportunity.
- The City has indicated that a trolley system is desired on the pump and motor levels to allow for removal of the pumps and motors. The feasibility of this installation should be reviewed at the detailed design stage.
- Review the options available associated with the service transformer, and provide a complete design, including medium voltage systems as required to achieve a code compliant installation.
- Provide a short circuit study is required to ensure that the electrical equipment is adequately rated.
- Provide a selective coordination study is required to ensure that selective tripping, in the event of a fault, occurs to the greatest extent possible.
- Provide an arc flash study is required to evaluate the potential arc energy and potential hazards, and provide labels for installation on the electrical equipment.
- Provide a detailed Functional Requirements Specification to indicate all required functionality in the pumping station control system.

8.4 Options

8.4.1 Floor Resurfacing

The concrete floors within the station are generally covered with a red protective coating. The type of coating material utilized is not known, however given the wear, it is assumed that it significantly dated. As an option, it is proposed to remove the floor coating within the entire station, and provide a new surface coating. At this time a epoxy floor coating, such as that manufactured by Stonehard, is proposed.

The additional capital cost of this option is expected to be in the range of \$20,000.

8.4.2 Comminutor Chamber Drainage

The comminutor chamber currently contains an open channel for wastewater, which is proposed to be modified to enclose the wastewater in a pipe. With the proposed configuration, any liquids that collect within the comminutor chamber will not have a means to be drained. Options for draining include drainage to the pump room sump pump, or installation of a small sump pump within the comminutor chamber. To reduce the flooding risk of the pump room, it is preferred to install an additional small sump pump. However, given the limited space within the chamber, it is expected that some concrete demolition and reconstruction will be required to construct a sump basin.

The additional capital cost of this option is expected to be in the range of \$12,000.

8.4.3 Permanent Gas Detection

As discussed in Section 4.5, NFPA 820 requires that the proposed ventilation recirculation be disabled in the event of combustible gas detection. It is also good practice to install oxygen deficiency and H₂S gas detection. While it is understood that the City's current policy is to utilize portable gas detection, installation of permanently installed gas detection is proposed as an option.

The additional capital cost of this option is expected to be in the range of \$10,000.

8.4.4 Portable Generator Connection

It is good design practice to provide a connection point for a portable generator in the event of an extended utility failure. This would involve installation of a second main breaker in the MCC, interlocked with the utility breaker. A special receptacle or termination enclosure would be provided to allow for connection of a portable generator. The minimum size of generator that should be capable of powering the station and starting the pumps would be calculated for future reference by City operations and electrical personnel.

The additional capital cost of this option is expected to be in the range of \$20,000.

8.4.5 Flood Pumping Station Arc Flash Mitigation

As part of the Arc Flash Study performed for the Aubrey Flood Pumping Station, the following recommendations were made for the Flood Pumping Station:

1. Replace the breaker CB-P-F12 (existing identifier).
2. Add a circuit breaker to feed RLY-F1 (existing identifier).

It would be potentially be practical to perform this work in conjunction with the Wastewater Station upgrade work.

The additional capital cost of this option is expected to be approximately \$5,000.

8.4.6 MCC Power Meter

As discussed in Section 5.5.6, a three-phase voltmeter is proposed for the MCC in the wastewater lift station. Optionally, the voltmeter could be upgraded to a full power meter, such as one shown in Figure 8-1. This would require the installation of CTs in the MCC, and provide current monitoring as well.



Figure 8-1 : Typical Power Meter

The additional capital cost of this upgrade is estimated to be \$5,000.

8.4.7 Backup Control With Process Meter

The base proposed work includes pump control from the RTU. In the event of RTU failure, which should be very infrequent, manual control of the pumps would be required until automatic pump control was restored. At the Montcalm Pumping Station, the City requested that a second level of automated backup control be provided with a Precision Digital process meter, in the event of RTU control failure. Buttons would also be provided on the control panel to manually switch between the two control modes for testing. The discussed backup control is presented as an option.

The additional capital cost of this upgrade is estimated to be \$4,000.

Note: Implementation of this option would be dependent upon available control panel space, as discussed in Section 6.8

8.4.8 Wet Well Backup Level Transmitter

As an option, a submersible level transmitter could be installed in the wet well as a redundant level sensor to the differential pressure based level sensor. As an upstream level sensor is already available in the sewer, this is not deemed to be a mandatory requirement, but would provide for more effective control in the event of failure of the primary level sensor.

The additional capital cost of this upgrade is estimated to be approximately \$10,000.

8.4.9 Flood Pumping Station Automation Link

Currently, the flood pumping station and lift station have separate phone lines and RTU's. Other than sharing a common electrical service, there is no automation link between the facilities. It would be useful to provide a network connection between the two facilities. The flood station communications could be integrated with the RTU station communications over a cellular DNP3 connection, allowing for full on-line communications and immediate alarming of the flood pumping station. In addition, one of the phone lines could be abandoned, eliminating the monthly service costs. To fully implement this, it is expected that the RTU panel in the flood pumping station will require replacement.

The City could approach this either completely as part of this project, or as a staged approach, whereby the lift station infrastructure is set up now, but the flood station infrastructure is deferred to a later project. As the scope of this project is limited to the wastewater lift station, it is assumed that the City will prefer a staged approach, with replacement of the flood pumping station controls at a later date.

The additional work included in this option, assuming a staged approach, consists of the following:

- Ensure that the network switch has a port for available for the Flood station.
- Provide a buried network cable or conduit to the flood station.

The additional capital cost of this option is expected to be approximately \$6,000.

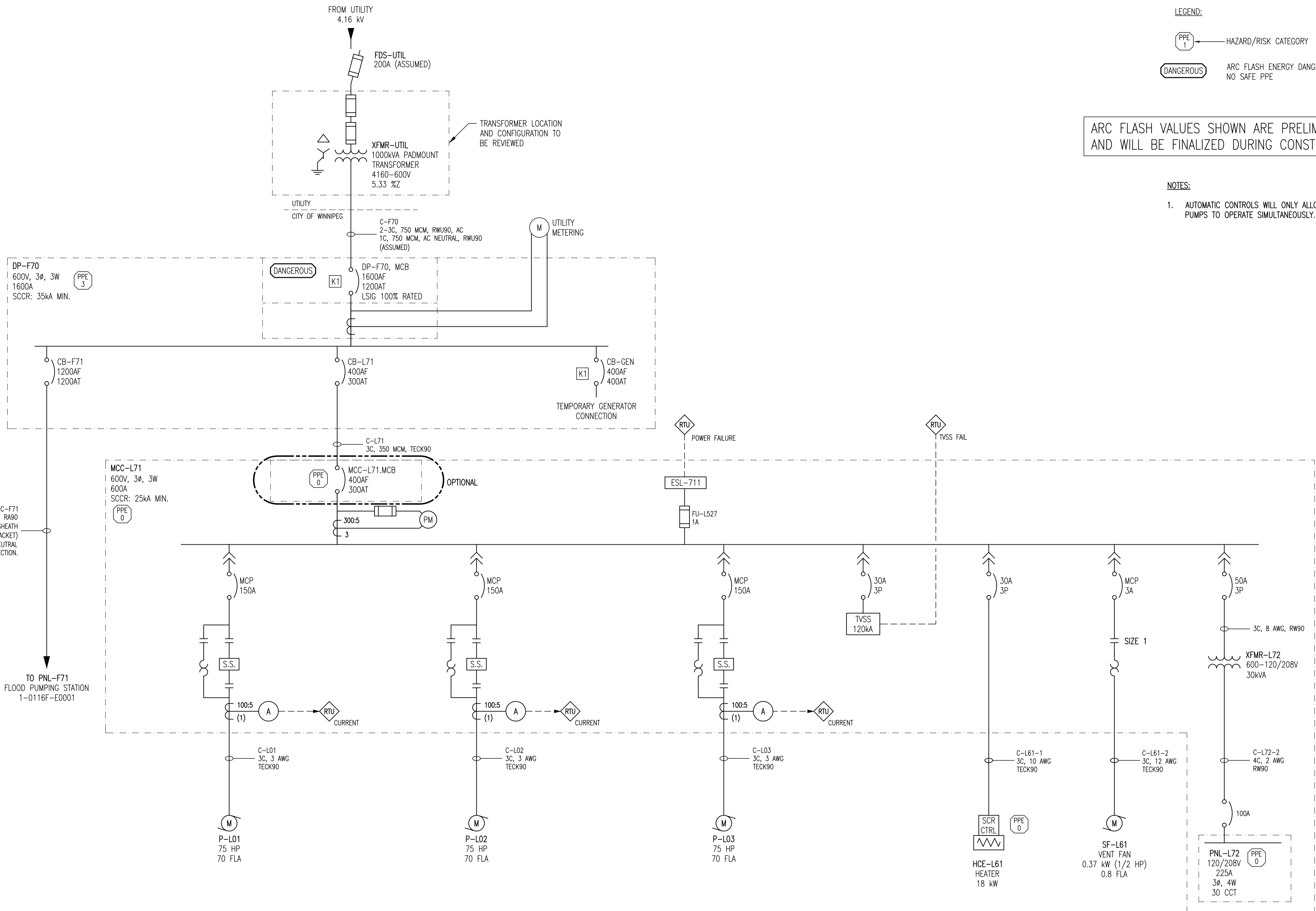
8.5 Geotechnical Work Required

As part of the proposed work, excavation is required to replace the existing 400mm discharge pipe with a 450 mm discharge pipe between the motor room and the manhole just north of the station. Assuming that the section of pipe that is below the motor room elevation is abandoned, it is expected that the depth of excavation required will be approximately 7 m. A waterways permit will be required as part of this excavation, as it will be within 106.7 m (350 feet) of the Assiniboine river. For significant construction within the waterways permit zone, it is typically required to provide a geotechnical engineer's report to support the waterways permit application. This project was discussed with Kendal Thiessen of the Waterways Branch, and he informally advised that a geotechnical's engineer's report is not expected to be required for this excavation.

APPENDIX A

Drawings

Drawing Number	Rev	Description
SK-E01	00	Single Line Diagram, Preliminary Design
SK-E02	00	Electrical Plan Layout, Main Floor, Preliminary Design
SK-M01	00	Piping Arrangement
SK-P01	00	Process & Instrumentation Diagram, Wet Well and Pump P-L01, Preliminary Design
SK-P02	00	Process & Instrumentation Diagram, Pumps P-L02 and P-L03, Preliminary Design
SK-P03	00	Process & Instrumentation Diagram, Ventilation, Preliminary Design
SK-P04	00	Process & Instrumentation Diagram, Miscellaneous, Preliminary Design
SK-P015	00	Process & Instrumentation Diagram, Sewer and Outfall, Preliminary Design



LEGEND:

- HAZARD/RISK CATEGORY
- ARC FLASH ENERGY DANGEROUS NO SAFE PPE

ARC FLASH VALUES SHOWN ARE PRELIMINARY AND WILL BE FINALIZED DURING CONSTRUCTION.

NOTES:

1. AUTOMATIC CONTROLS WILL ONLY ALLOW TWO OF THREE PUMPS TO OPERATE SIMULTANEOUSLY.



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00	ISSUED WITH REPORT	2013/04/25	CJR	CJR

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 Winnipeg, MB, Canada R3P 0X7
 204-786-8080

DESIGNED BY: C. REIMER
 CHECKED BY: C. REIMER
 DRAWN BY: M.J. PERSSON
 APPROVED BY: C. REIMER
 SCALE: NTS
 RELEASED FOR CONSTRUCTION BY: [Signature]
 DATE: 2012/03/20

CONSULTANT NO.:

ENGINEER'S SEAL

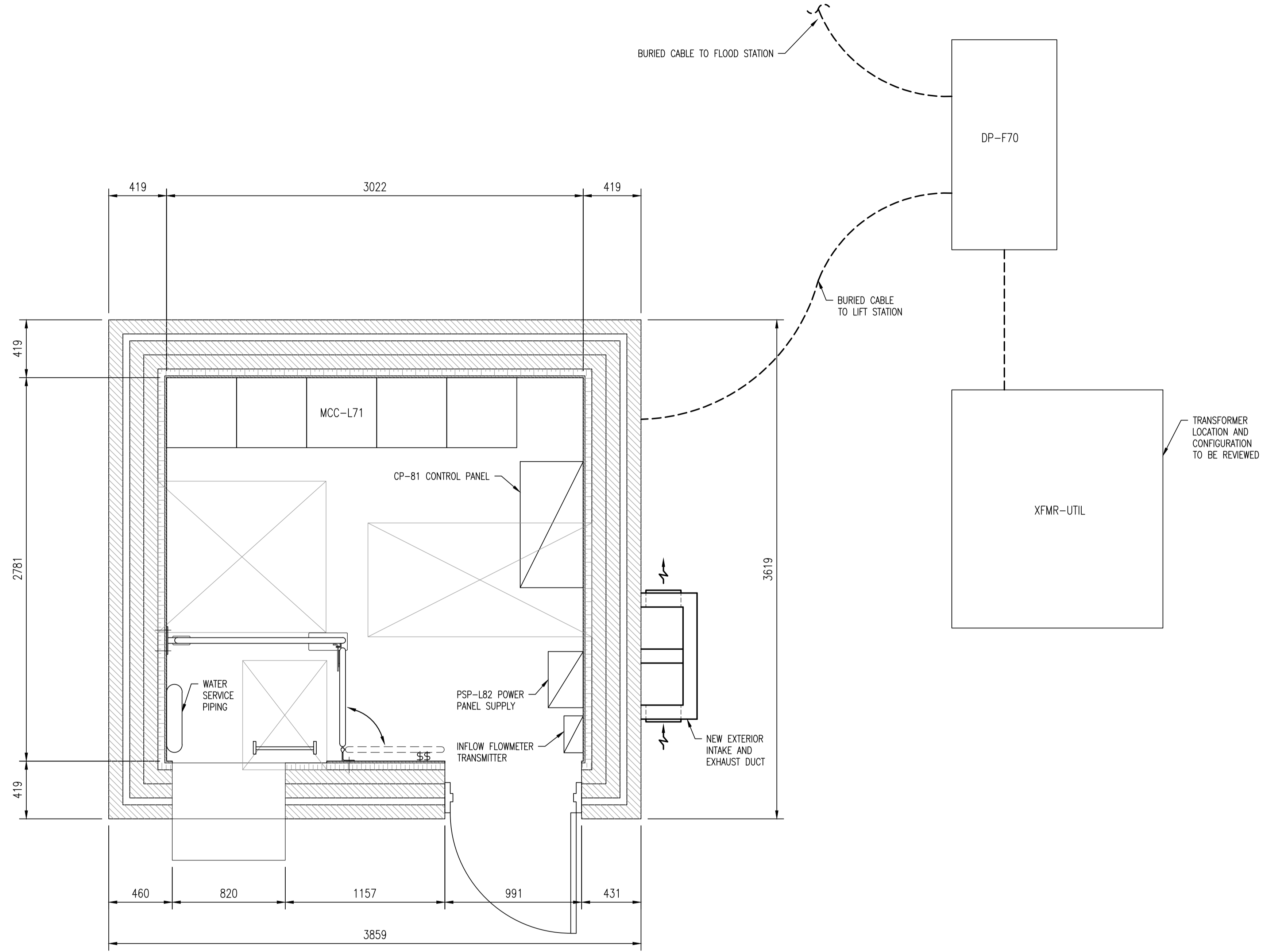
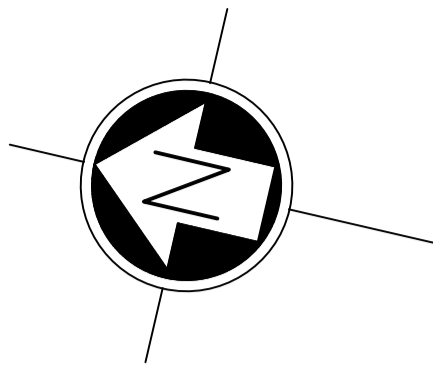
PRELIMINARY
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THE CITY OF WINNIPEG
 WATER AND WASTE DEPARTMENT

AUBREY WASTEWATER LIFT STATION

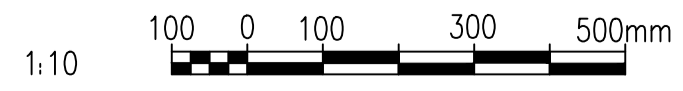
SINGLE LINE DIAGRAM
 PRELIMINARY DESIGN

CITY DRAWING NUMBER: SK-E01
 SHEET: 001
 REV: 00
 SIZE: A1



ELECTRICAL PLAN LAYOUT - MAIN FLOOR
SCALE: 1 : 20

1-0157L-E0006	ELECTRICAL SCHEDULES
DRAWING NUMBER	REFERENCE DRAWINGS

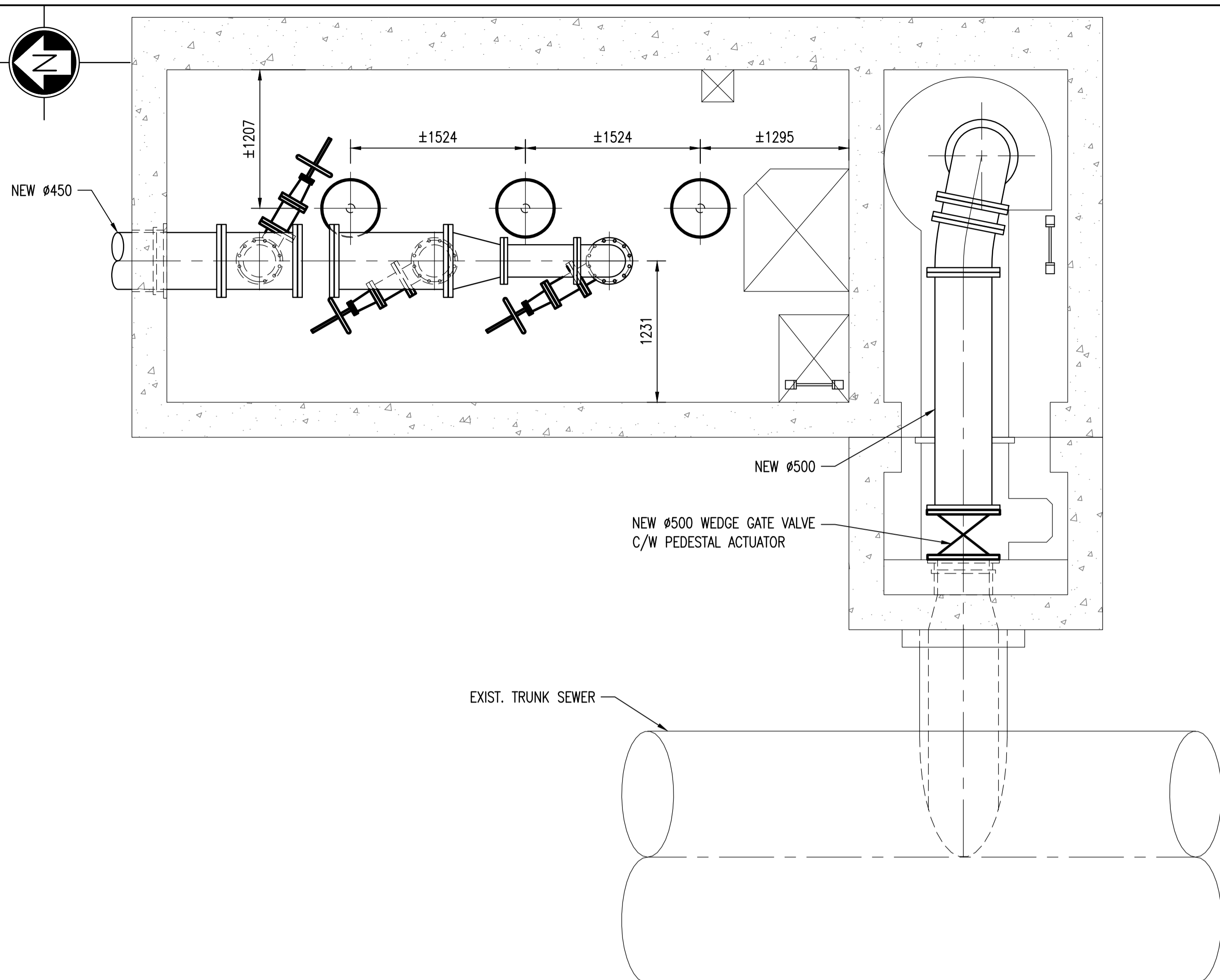


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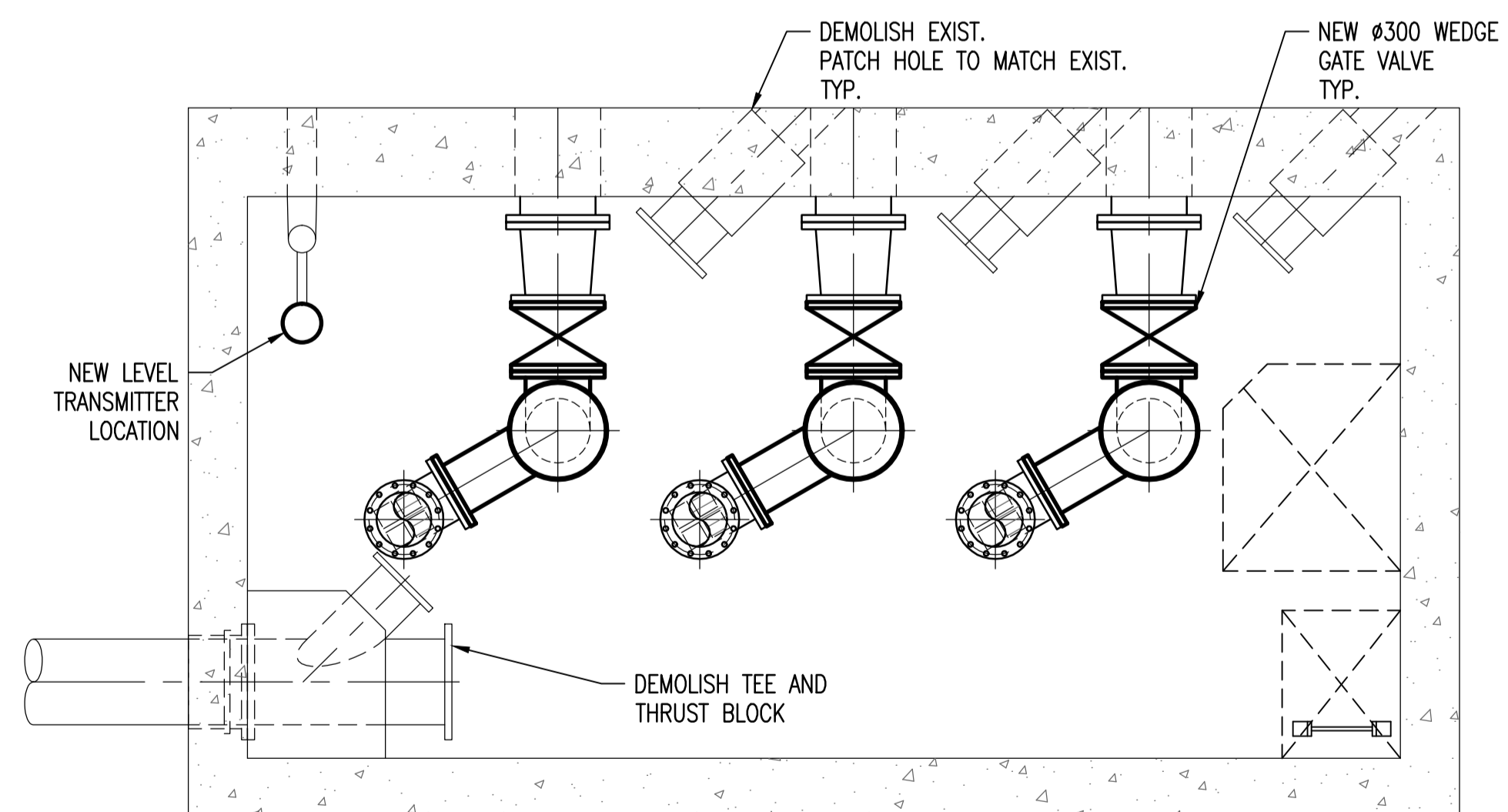
<p>SNC-LAVALIN INC. 148 Nature Park Way Winnipeg, MB, Canada R3P 0X7 204-786-8080</p>	
DESIGNED BY: B. CLEVEN	CHECKED BY: C. REIMER
DRAWN BY: M.J. PERSSON	APPROVED BY: C. REIMER
SCALE: 1:20	RELEASED FOR CONSTRUCTION BY: DATE:
DATE: 2012/03/20	DATE:
CONSULTANT NO.:	

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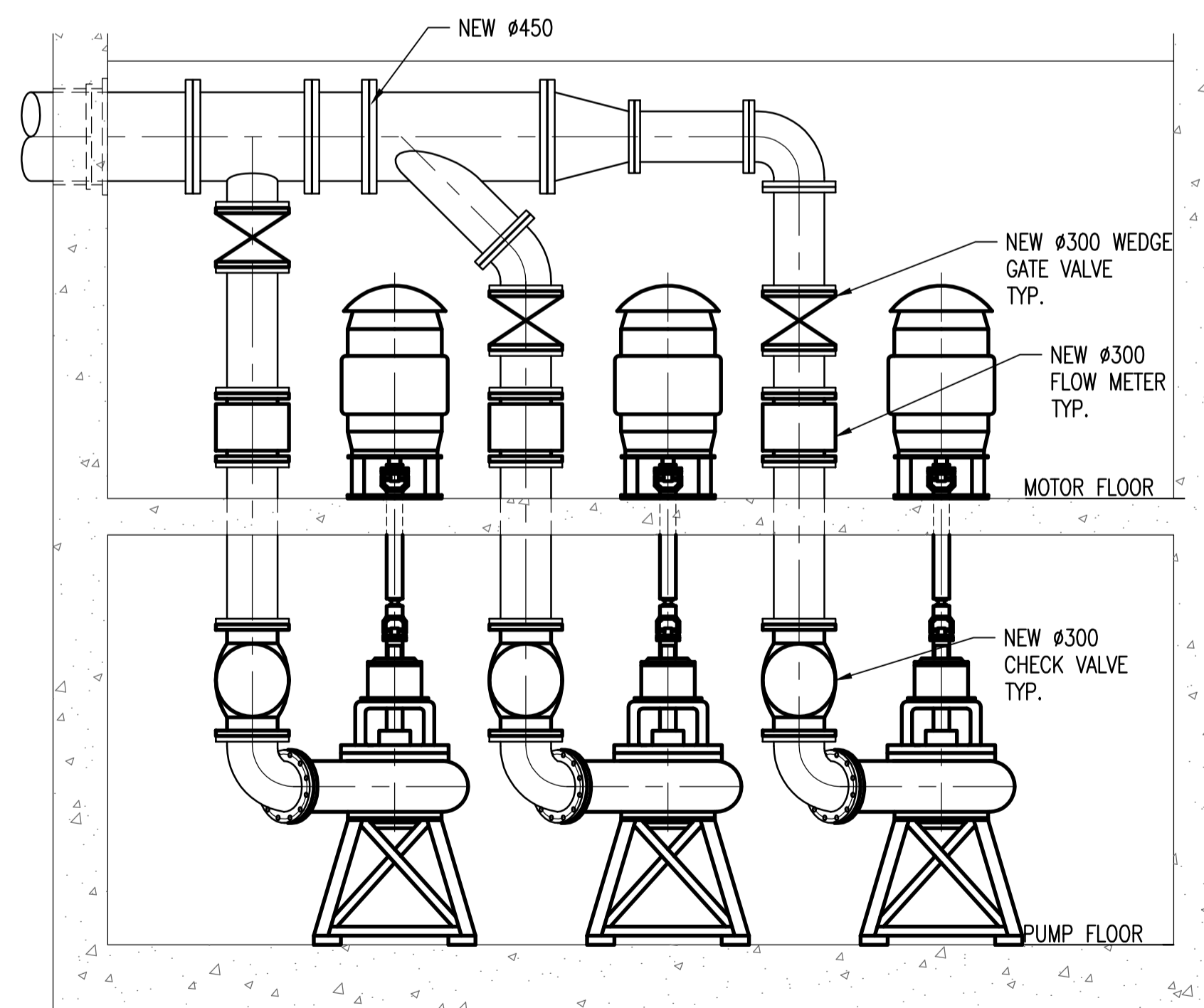
<p>THE CITY OF WINNIPEG WATER AND WASTE DEPARTMENT</p>			
AUBREY WASTEWATER LIFT STATION			
ELECTRICAL PLAN LAYOUT MAIN FLOOR PRELIMINARY DESIGN			
CITY DRAWING NUMBER SK-E02	SHEET 001	REV. 00	SIZE A1



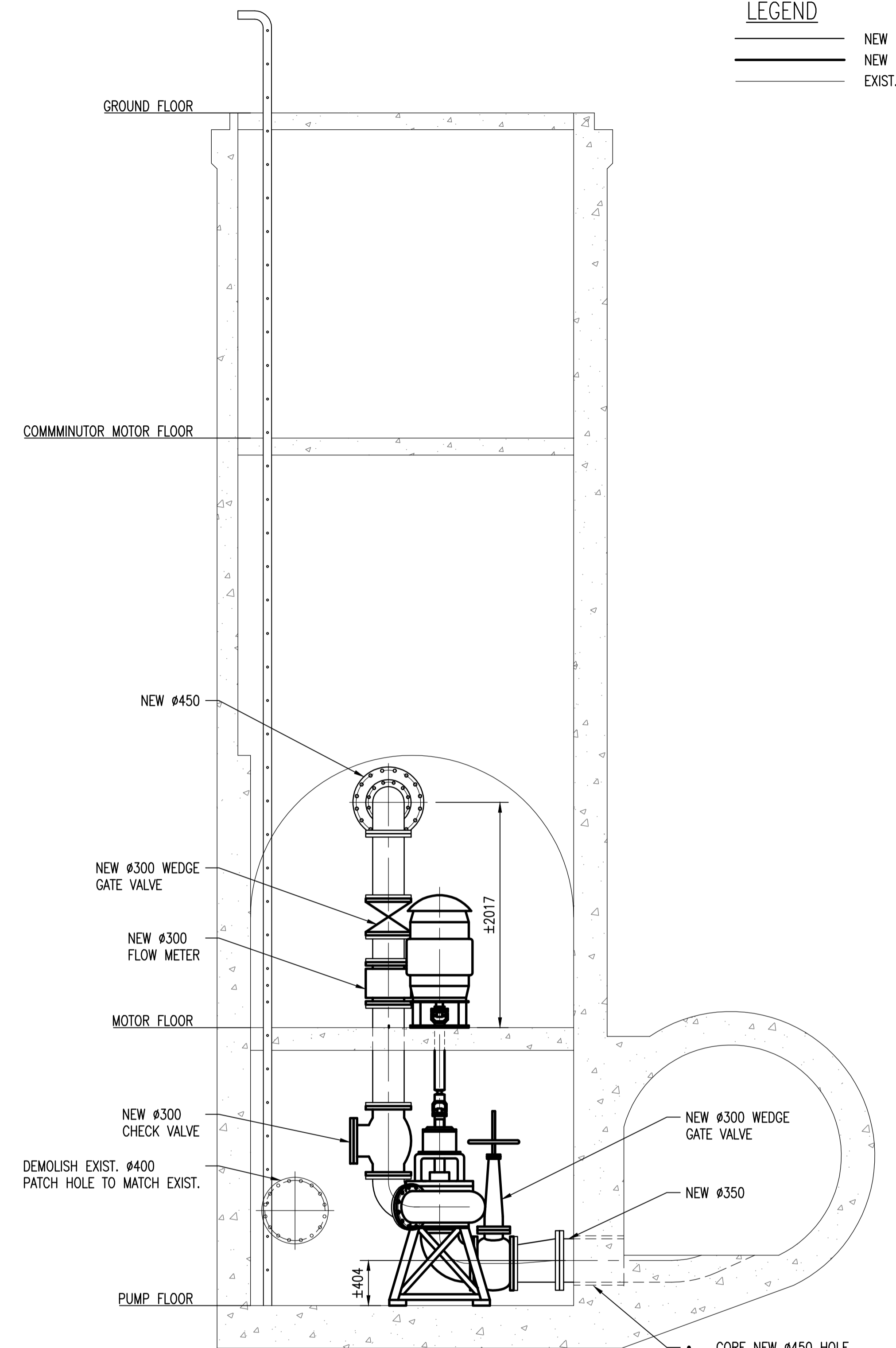
PLAN @ MOTOR FLOOR
SCALE: 1:30



PLAN @ PUMP FLOOR
SCALE: 1:30



ELEV. LOOKING EAST
SCALE: 1:30



ELEV. LOOKING NORTH
SCALE: 1:30

LEGEND

- NEW LINE
- NEW EQUIPMENT
- EXIST. LINE

- CORE NEW #450 HOLE
- NEW #400 SLEEVE
- NEW LINK SEAL

NOTES:

1. THIS PIPING ARRANGEMENT IS PROVIDED AS A CONCEPT ONLY. CONFIRMATION OF PUMP SIZING, HYDRAULICS AND PIPE SPECIFICATIONS TO BE COMPLETED AT DETAILED DESIGN.



DESIGNED BY:	C. FETTERLY	CHECKED BY:	J. REMPEL
DRAWN BY:	C. FETTERLY	APPROVED BY:	C. REIMER
SCALE:	1:30	RELEASED FOR CONSTRUCTION BY:	
DATE:	2012/03/26	DATE:	
ISSUED WITH REPORT NO.:	2013/04/25	DATE:	CAF JNR
REVISIONS:		DESIGN:	CHECK

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204-786-8080

CONSULTANT NO.: 509869-0000-45DD-0001

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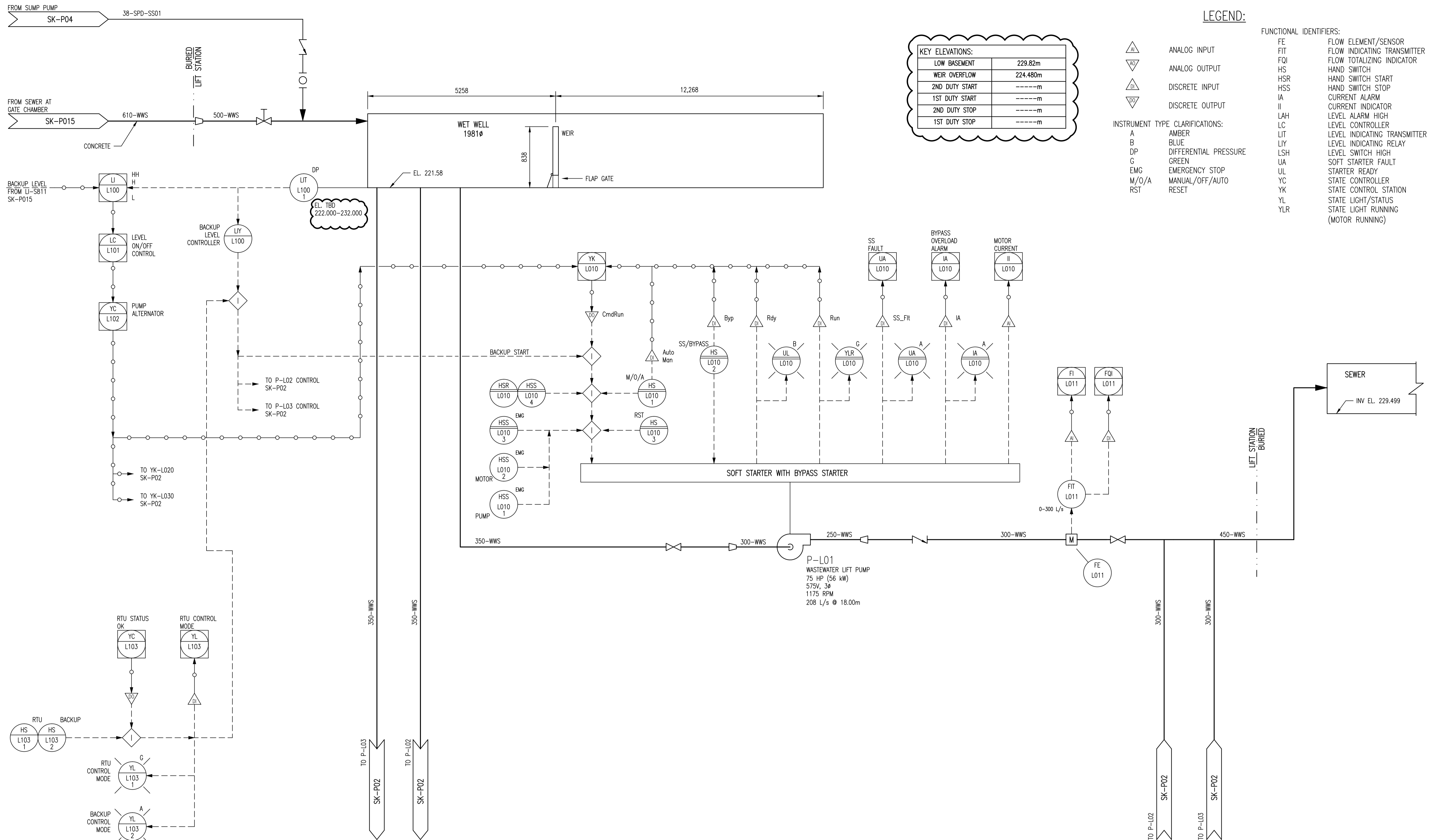
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

AUBREY WASTEWATER PUMPING STATION
PIPING ARRANGEMENT
COMMUNOTOR CHAMBER, PUMP ROOM, MOTOR ROOM
PRELIMINARY VERSION

CITY DRAWING NUMBER: SK-M01

SHEET: 001 REV: 00 SIZE: A1

DRAWING NUMBER	REFERENCE DRAWINGS
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KEY ELEVATIONS:

LOW BASEMENT	229.82m
WEIR OVERFLOW	224.480m
2ND DUTY START	-----m
1ST DUTY START	-----m
2ND DUTY STOP	-----m
1ST DUTY STOP	-----m

LEGEND:

	ANALOG INPUT		FLOW ELEMENT/SENSOR
	ANALOG OUTPUT		FLOW INDICATING TRANSMITTER
	DISCRETE INPUT		FLOW TOTALIZING INDICATOR
	DISCRETE OUTPUT		HAND SWITCH
			HAND SWITCH START
			HAND SWITCH STOP
			CURRENT ALARM
			CURRENT INDICATOR
			LEVEL ALARM HIGH
			LEVEL CONTROLLER
			LEVEL INDICATING TRANSMITTER
			LEVEL INDICATING RELAY
			LEVEL SWITCH HIGH
			SOFT STARTER FAULT
			STARTER READY
			STATE CONTROLLER
			STATE CONTROL STATION
			STATE LIGHT/STATUS
			STATE LIGHT RUNNING (MOTOR RUNNING)

INSTRUMENT TYPE CLARIFICATIONS:

A	AMBER
B	BLUE
DP	DIFFERENTIAL PRESSURE
G	GREEN
EMG	EMERGENCY STOP
M/O/A	MANUAL/OFF/AUTO
RST	RESET

FUNCTIONAL IDENTIFIERS:

FE	FLOW ELEMENT/SENSOR
FIT	FLOW INDICATING TRANSMITTER
FQI	FLOW TOTALIZING INDICATOR
HS	HAND SWITCH
HSR	HAND SWITCH START
HSS	HAND SWITCH STOP
IA	CURRENT ALARM
II	CURRENT INDICATOR
LAH	LEVEL ALARM HIGH
LC	LEVEL CONTROLLER
LI	LEVEL INDICATING TRANSMITTER
LIY	LEVEL INDICATING RELAY
LSH	LEVEL SWITCH HIGH
UA	SOFT STARTER FAULT
UL	STARTER READY
YC	STATE CONTROLLER
YK	STATE CONTROL STATION
YL	STATE LIGHT/STATUS
YLR	STATE LIGHT RUNNING (MOTOR RUNNING)

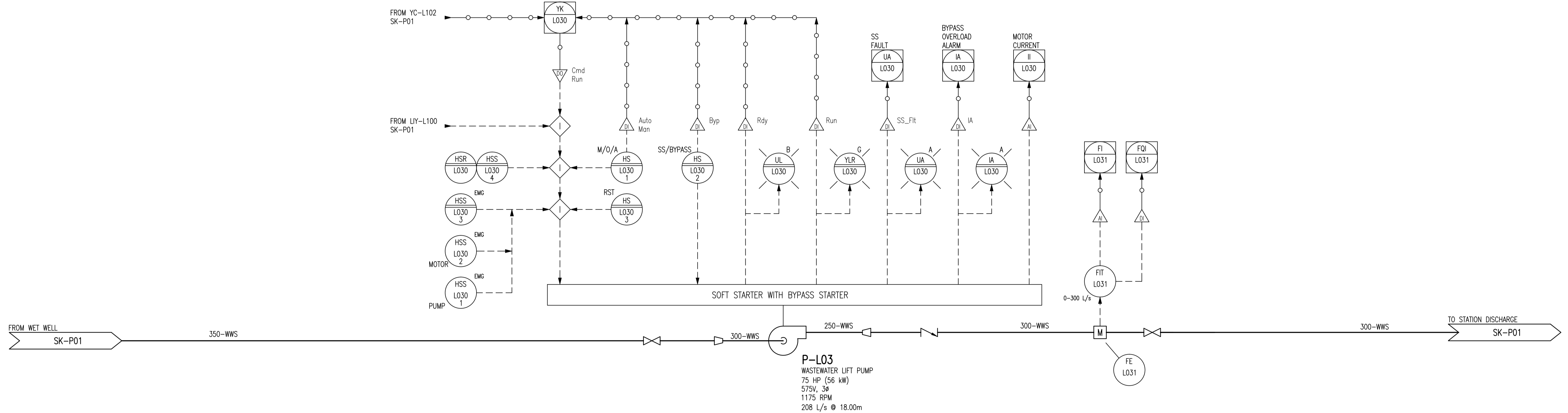
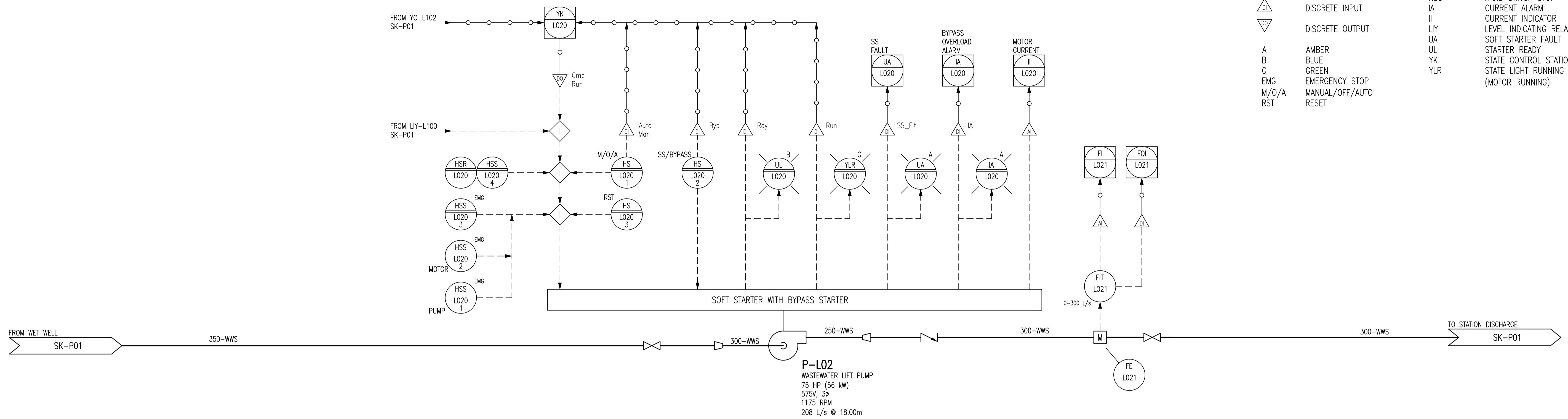
NOTES:
 1. ALL INSTRUMENTS SHOWN IN AN AUXILIARY LOCATION ARE IN THE CORRESPONDING MCC STARTER.



 SNC-LAVALIN INC. 148 Nature Park Way Winnipeg, MB, Canada R3P 0X7 204-786-8080		ENGINEER'S SEAL PRELIMINARY NOT TO BE USED FOR CONSTRUCTION	 THE CITY OF WINNIPEG WATER AND WASTE DEPARTMENT AUBREY WASTEWATER PUMPING STATION PROCESS & INSTRUMENTATION DIAGRAM WET WELL AND PUMP P-L01 PRELIMINARY DESIGN
DESIGNED BY: C. REIMER	CHECKED BY: C. REIMER	CITY DRAWING NUMBER: SK-P01	
DRAWN BY: M.J. PERSSON	APPROVED BY: C. REIMER	SHEET: 001 REV: 00 SIZE: A1	
SCALE: NTS	RELEASED FOR CONSTRUCTION BY: DATE: 2012/03/23	SK-P01.dwg	
DATE: 2013/04/25	CONSULTANT NO.:	001 00 A1	
ISSUED WITH REPORT	2013/04/25	001 00 A1	
NO. REVISIONS	DATE DESIGN CHECK	001 00 A1	

LEGEND:

DEVICE DESCRIPTORS:		FUNCTIONAL IDENTIFIERS:	
	ANALOG INPUT	FIT	FLOW INDICATING TRANSMITTER
	ANALOG OUTPUT	FQI	FLOW TOTALIZING INDICATOR
	DISCRETE INPUT	HS	HAND SWITCH
	DISCRETE OUTPUT	HSR	HAND SWITCH START
		HSS	HAND SWITCH STOP
		IA	CURRENT ALARM
		II	CURRENT INDICATOR
		LIY	LEVEL INDICATING RELAY
		UA	SOFT STARTER FAULT
A	AMBER	UL	STARTER READY
B	BLUE	YK	STATE CONTROL STATION
G	GREEN	YLR	STATE LIGHT RUNNING (MOTOR RUNNING)
EMG	EMERGENCY STOP		
M/O/A	MANUAL/OFF/AUTO		
RST	RESET		



NOTES:

- ALL INSTRUMENTS SHOWN IN AN AUXILIARY LOCATION ARE IN THE CORRESPONDING MCC STARTER.



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00	ISSUED WITH REPORT	2013/04/25	CJR	CJR

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DRAWN BY: M.J. PERSSON	APPROVED BY: C. REIMER
SCALE: NTS	RELEASED FOR CONSTRUCTION BY: DATE:
DATE: 2013/04/18	DATE:
CONSULTANT NO.:	

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THE CITY OF WINNIPEG
 WATER AND WASTE DEPARTMENT

AUBREY WASTEWATER PUMPING STATION

PROCESS & INSTRUMENTATION DIAGRAM
 PUMPS P-L02 AND P-L03
 PRELIMINARY DESIGN

CITY DRAWING NUMBER SK-P02	SHEET 001	REV. 00	SIZE A1
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SK-P02.dwg

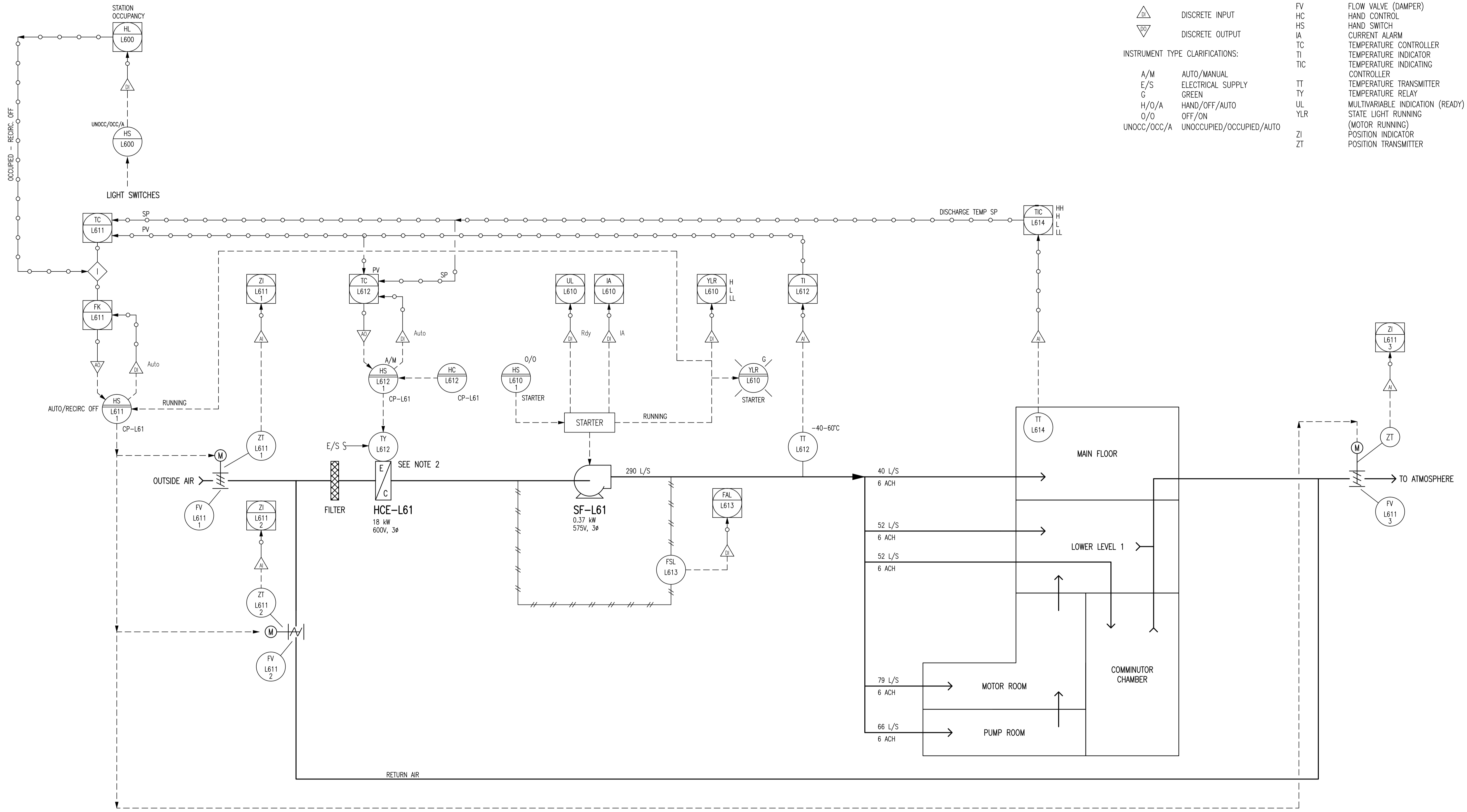
DRAWING NUMBER	REFERENCE DRAWINGS
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LEGEND:

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	ANALOG OUTPUT	FK	FLOW CONTROL STATION
	DISCRETE INPUT	FSL	FLOW SWITCH LOW
	DISCRETE OUTPUT	FV	FLOW VALVE (DAMPER)
		HC	HAND CONTROL
		HS	HAND SWITCH
		IA	CURRENT ALARM
		TC	TEMPERATURE CONTROLLER
		TI	TEMPERATURE INDICATOR
		TIC	TEMPERATURE INDICATING CONTROLLER
		TT	TEMPERATURE TRANSMITTER
		TY	TEMPERATURE RELAY
		UL	MULTIVARIABLE INDICATION (READY)
		YLR	STATE LIGHT RUNNING (MOTOR RUNNING)
		ZI	POSITION INDICATOR
		ZT	POSITION TRANSMITTER

INSTRUMENT TYPE CLARIFICATIONS:

A/M	AUTO/MANUAL
E/S	ELECTRICAL SUPPLY
G	GREEN
H/O/A	HAND/OFF/AUTO
O/O	OFF/ON
UNOCC/OCC/A	UNOCCUPIED/OCCUPIED/AUTO



- NOTES:**
- VENTILATION RATE:
 SUMMER: 6 ACH, 0% RECIRC
 WINTER UNOCCUPIED: 6 ACH, 75% RECIRC
 WINTER OCCUPIED: 6 ACH, 0% RECIRC
 - HCE-L1 CONTAINS INTEGRAL HIGH TEMPERATURE AND LOW AIR FLOW CUTOUTS.



DESIGNED BY:	C. REIMER	CHECKED BY:	C. REIMER
DRAWN BY:	M.J. PERSSON	APPROVED BY:	C. REIMER
SCALE:	NTS	RELEASED FOR CONSTRUCTION BY:	
DATE:	2012/03/23	DATE:	
ISSUED WITH REPORT	2013/04/25	DESIGN	CJR
NO. REVISIONS	DATE	DESIGN	CJR

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 WATER AND WASTE DEPARTMENT





AUBREY WASTEWATER PUMPING STATION

PROCESS & INSTRUMENTATION DIAGRAM
 VENTILATION
 PRELIMINARY DESIGN

CITY DRAWING NUMBER	SK-P03	SHEET	001	REV.	00	SIZE	A1
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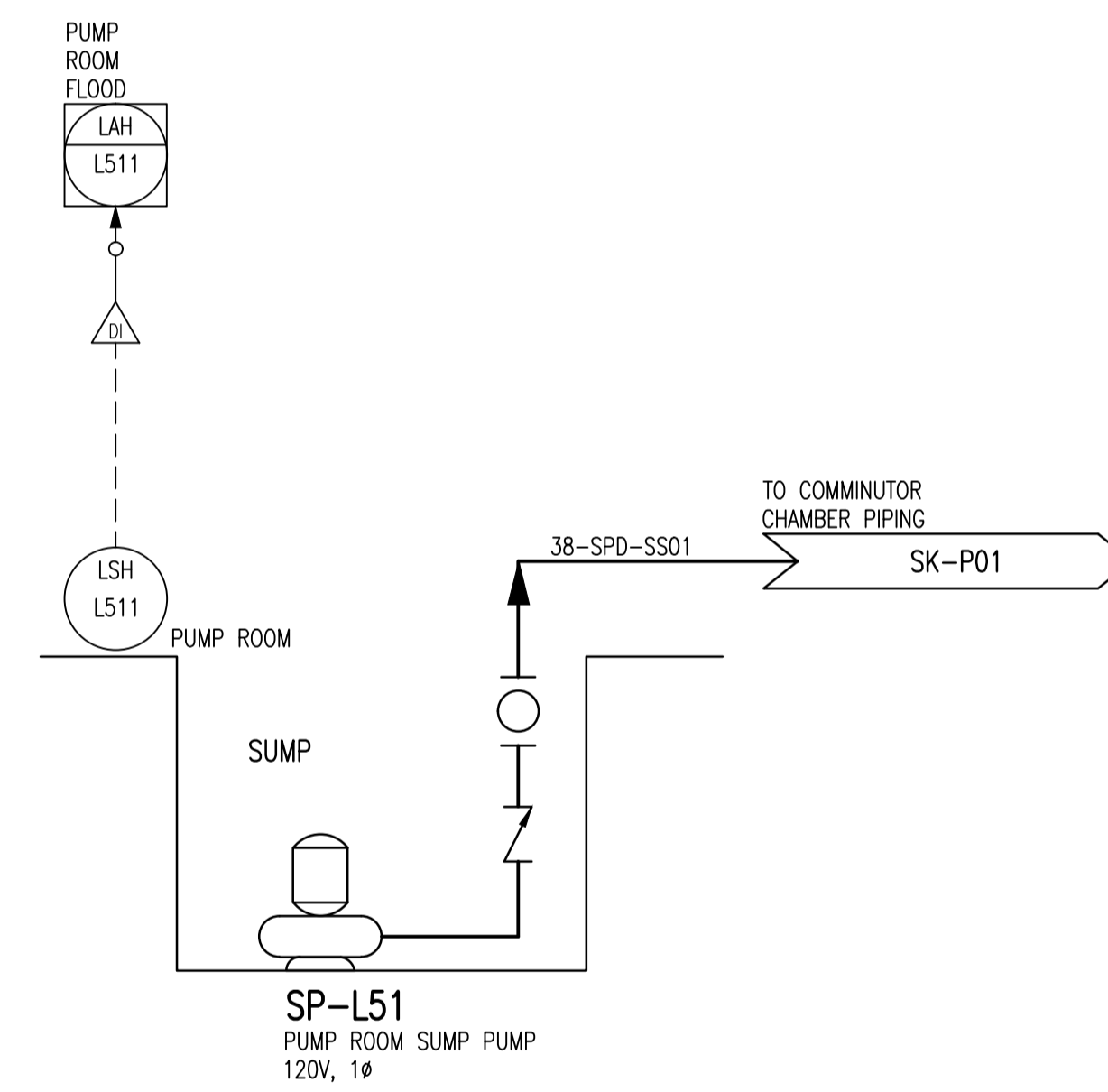
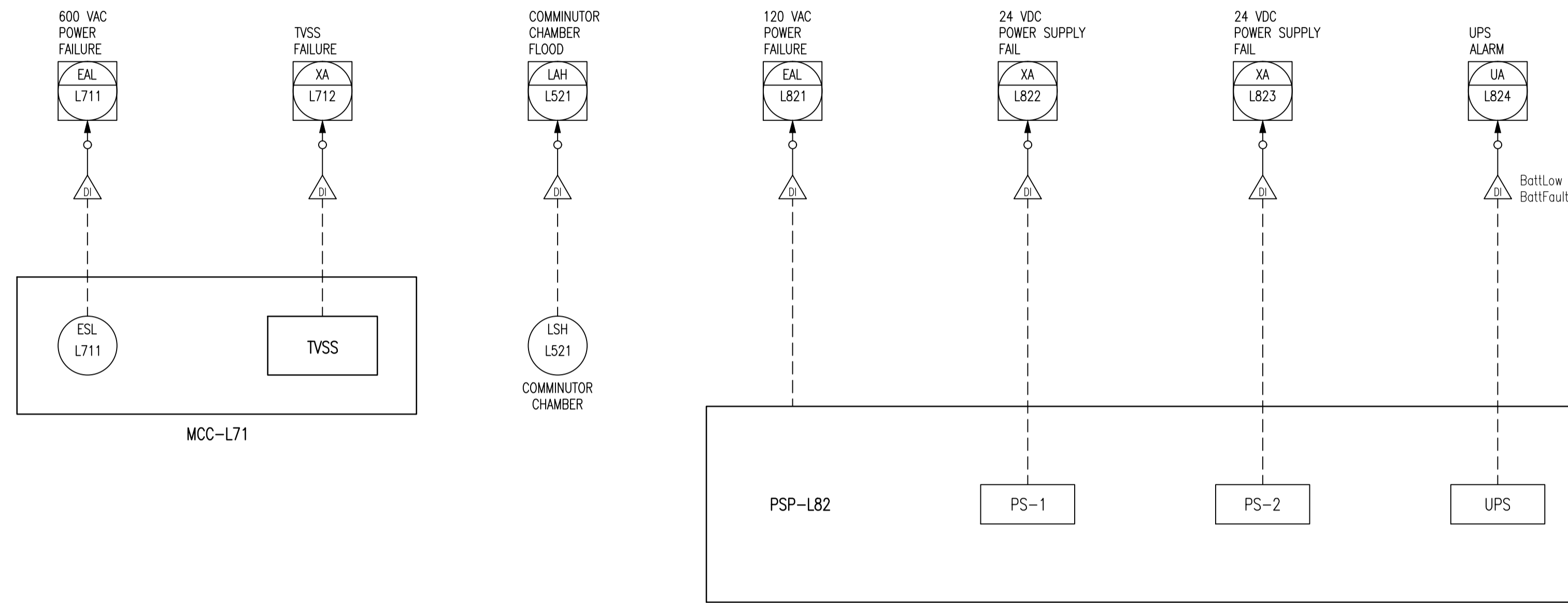
LEGEND:

DEVICE DESCRIPTORS:

-  ANALOG INPUT
-  ANALOG OUTPUT
-  DISCRETE INPUT
-  DISCRETE OUTPUT

FUNCTIONAL IDENTIFIERS:


- EAL VOLTAGE ALARM LOW
- ESL VOLTAGE SWITCH LOW
- LAH LEVEL ALARM HIGH
- LSH LEVEL SWITCH HIGH
- UA MULTIVARIABLE ALARM
- XA UNDEFINED (MISC.) ALARM



DRAWING NUMBER	REFERENCE DRAWINGS




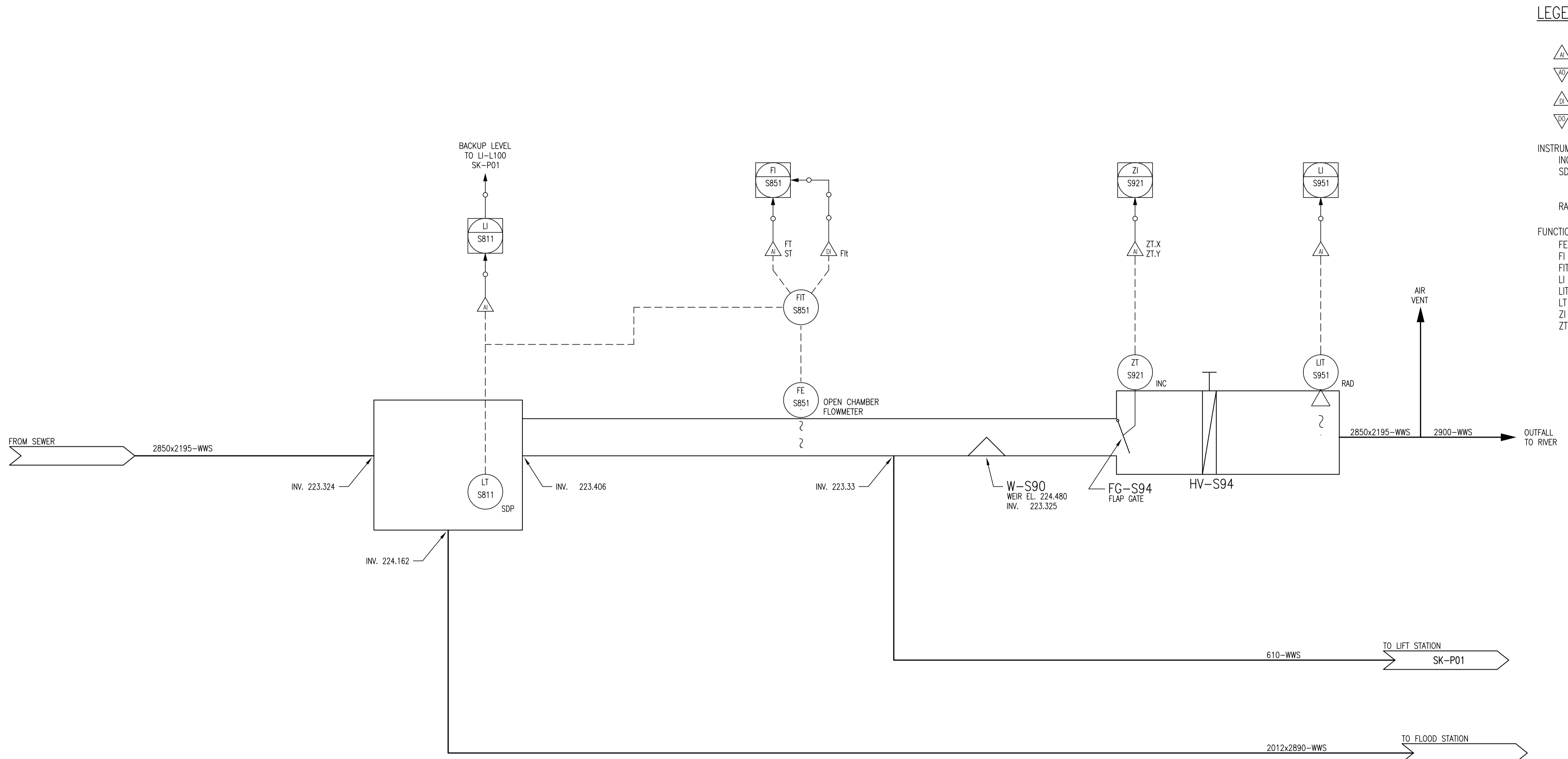
NO.	REVISIONS	DATE	DESIGN	CHECK
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 SNC-LAVALIN INC. 148 Nature Park Way Winnipeg, MB, Canada R3P 0X7 204-786-8080	
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DRAWN BY: M.J. PERSSON	APPROVED BY: C. REIMER
SCALE: NTS	RELEASED FOR CONSTRUCTION BY:
DATE: 2012/03/23	DATE:
CONSULTANT NO.:	

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 THE CITY OF WINNIPEG WATER AND WASTE DEPARTMENT		
AUBREY WASTEWATER PUMPING STATION PROCESS & INSTRUMENTATION DIAGRAM MISCELLANEOUS PRELIMINARY DESIGN		
CITY DRAWING NUMBER SK-P04	SHEET 001	REV. 00
		SIZE A1



- LEGEND:**
- ANALOG INPUT
 - ANALOG OUTPUT
 - DISCRETE INPUT
 - DISCRETE OUTPUT
- INSTRUMENT TYPE CLARIFICATIONS:**
- INC INCLINATION
 - SDP SUBMERSIBLE
 - DIFFERENTIAL
 - PRESSURE
 - RAD RADAR
- FUNCTIONAL IDENTIFIERS:**
- FE FLOW ELEMENT/SENSOR
 - FI FLOW INDICATOR
 - FIT FLOW INDICATING TRANSMITTER
 - LI LEVEL INDICATOR
 - LIT LEVEL INDICATING TRANSMITTER
 - LT LEVEL TRANSMITTER
 - ZI POSITION INDICATOR
 - ZT POSITION TRANSMITTER

NOTES:

1. THIS P&ID IS BASED UPON AN EXISTING INSTALLATION.



NO.	REVISIONS	DATE	DESIGN	CJR	CJR	CHECK
00	ISSUED WITH REPORT	2013/04/25				

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DESIGNED BY: C. REIMER	CHECKED BY: C. REIMER
DRAWN BY: K. MOHAMMED	APPROVED BY: C. REIMER
SCALE: NTS	RELEASED FOR CONSTRUCTION BY: DATE:
DATE: 2013/04/19	DATE:
CONSULTANT NO.:	

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THE CITY OF WINNIPEG
 WATER AND WASTE DEPARTMENT

AUBREY WASTEWATER PUMPING STATION

PROCESS & INSTRUMENTATION DIAGRAM
 SEWER AND OUTFALL
 PRELIMINARY DESIGN

CITY DRAWING NUMBER	SHEET	REV.	SIZE
SK-P015	001	00	A1

DRAWING NUMBER	REFERENCE DRAWINGS
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