

Operation & Maintenance Manual Sewage Treatment Plant (STP)

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division – Whale Tail Pit Project

EXECUTIVE SUMMARY

Agnico Eagle has prepared the following document which summarizes the operational and maintenance procedures to be followed at the Sewage Treatment Plant (STP).

This report documents the stand alone Operation & Maintenance Manual – Sewage Treatment Plant, includes the following requirements:

- The manual was prepared in accordance with the “Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996”, and adapted for the use of a mechanical contact water treatment facility;
- The manual includes contingency measures in the event of a plant malfunction; and
- The manual includes sludge management procedures.

IMPLEMENTATION SCHEDULE

This Plan will be implemented upon Board approval and subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Eagle Internal:

- Energy & Infrastructures Services Superintendent
- Energy & Infrastructures Services General Foreman
- Environmental Superintendent
- Senior environmental Coordinator
- Environmental Compliance Counselor
- Sewage Treatment Plant Operator

DOCUMENT CONTROL

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1 INTRODUCTION

1.1 PURPOSE

This Sewage Treatment Plant (STP) Operation and Maintenance Manual (OMM) for the Whale Tail Gold Project (the Project) has been prepared based on the “*Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996, prepared by the Department of Municipal and Community Affairs, NWT*”. The OMM has been adapted for the use of a mechanical contact water treatment facility.

This manual is a component of the Whale Tail Environmental Management System. The objectives of this plan are summarized as follows:

1. To define the location, design and operating procedures to be used in the treatment of sewage generated at the Project; and
2. To provide monitoring requirements for the STP.

The STP purpose is to treat domestic sewage from the camp and adjacent building which are not connected to the STP directly (sucker truck will discharge sewage from this building directly into the STP).

1.2 BRIEF DESCRIPTION OF THE PROJECT

Agnico Eagle Mines Limited—Meadowbank Division (Agnico Eagle) is developing Whale Tail Pit and Haul Road Project, approximately 55 km north of the Meadowbank mine, on a satellite deposit located on the Amaruq property in the Kivalliq Region of Nunavut (65°24'25" N, 96°41'50" W), to extend mine operations and milling at Meadowbank Mine. The 99,878-hectare Amaruq property is located on Inuit-owned and federal crown land.

A conventional open pit mining operation is forecasted on the Whale Tail deposit. Access to the site is via a 64-kilometer road from Meadowbank mine. On-site facilities will include a power plant, maintenance facilities, tank farm for fuel storage, Arsenic water treatment plant, sewage treatment plant (STP), drinking water treatment plant, as well as accommodation and kitchen facilities for approximately 400 people.

Figures 1, 2 and 3 illustrate the location and general arrangement of the STP.

December 2018

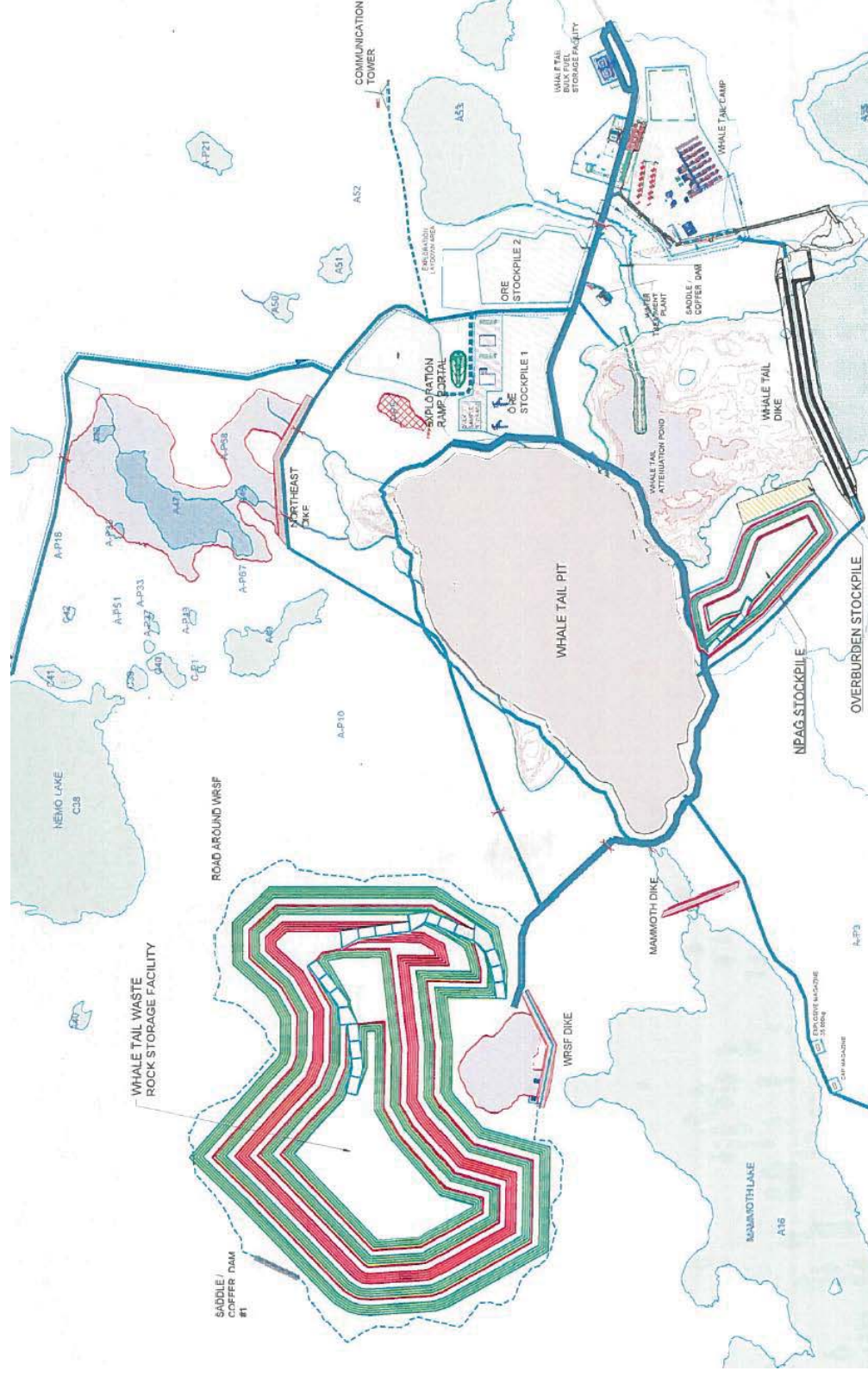


Figure 1 – Site Layout

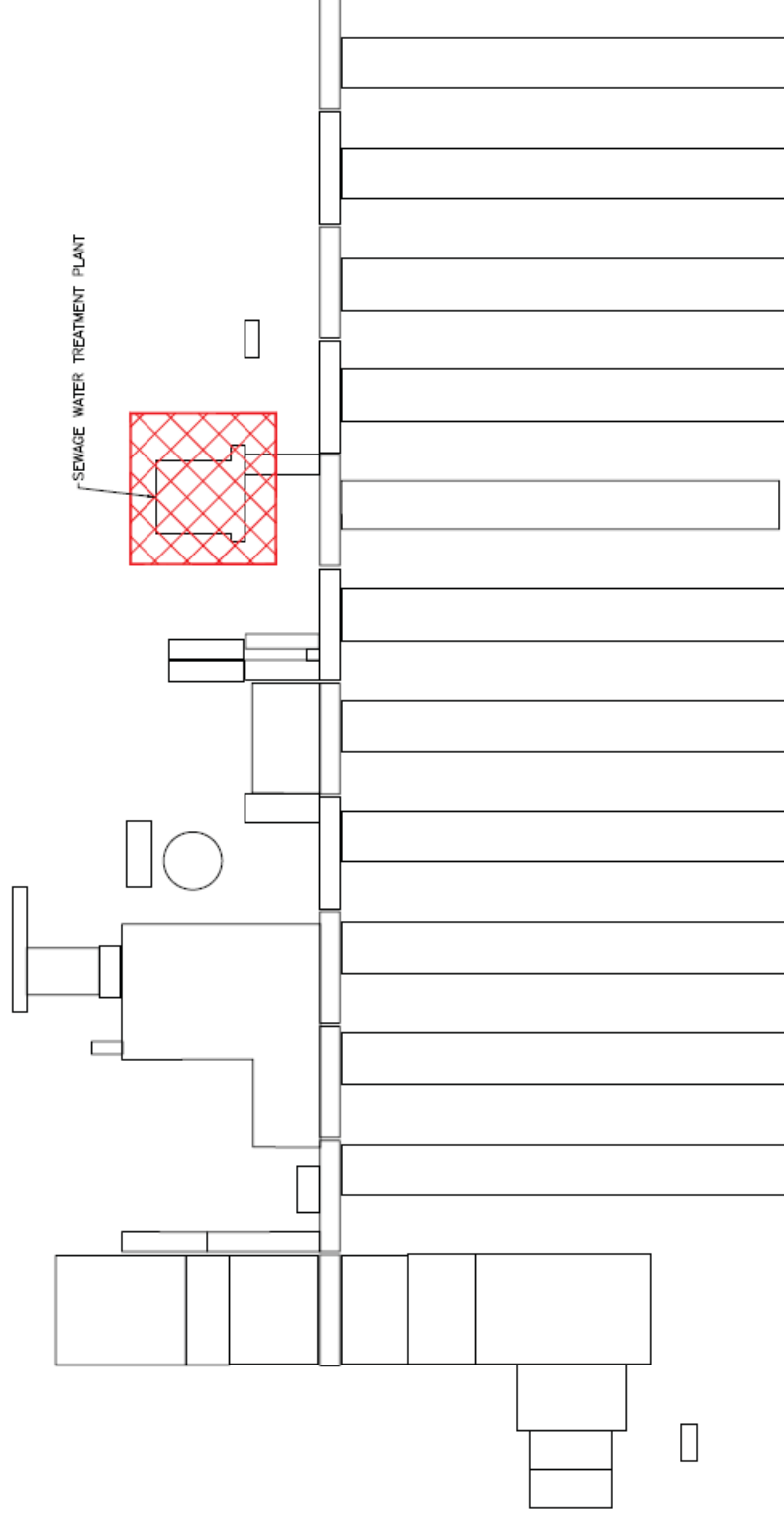


Figure 2 – Location of STP in the Whail Tail Camp

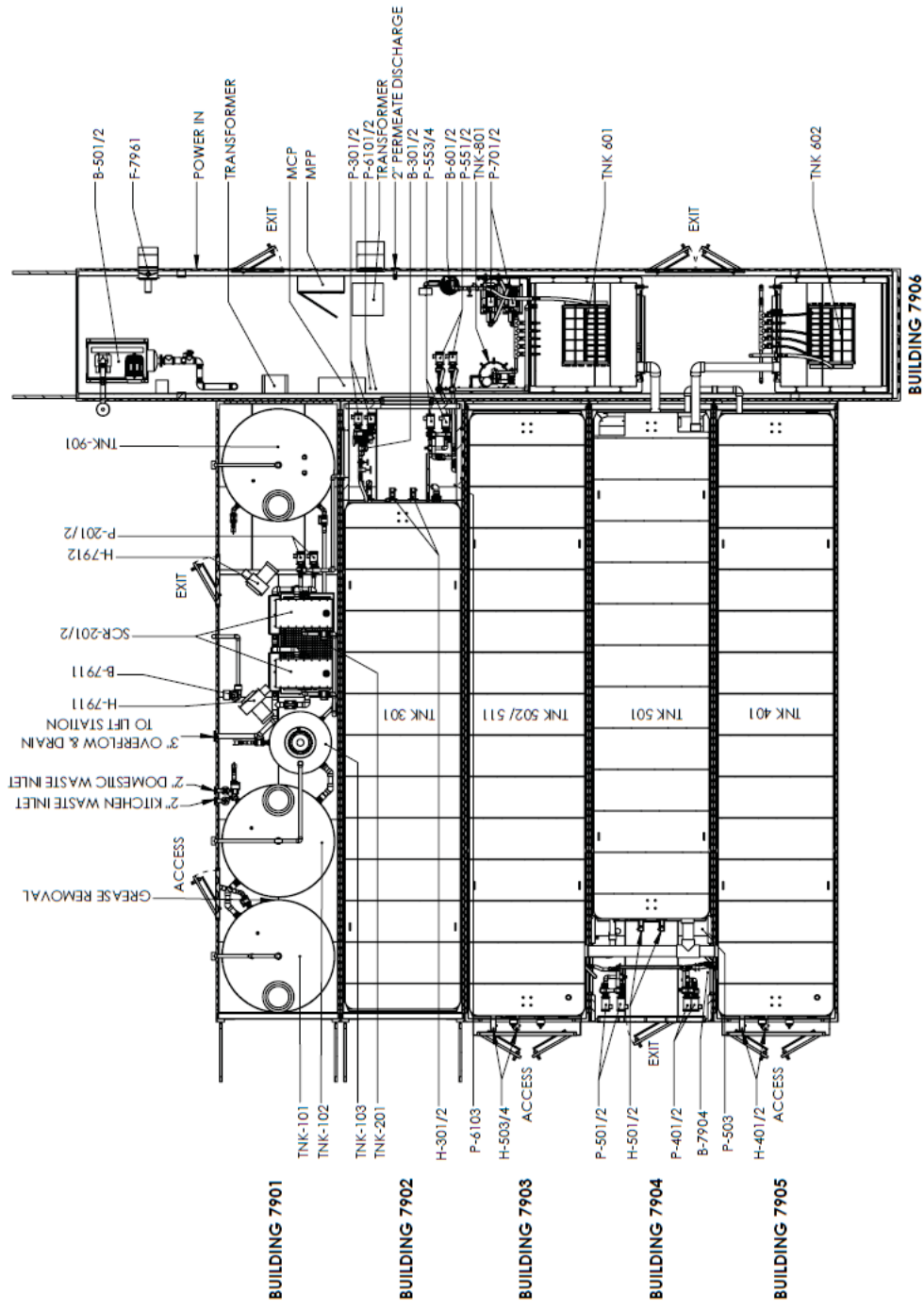


Figure 3 – General Arrangement of STP

1.3 CONTACT INFORMATION

The individuals responsible for the operation of the sewage treatment plant for the Project are the following:

Energy and Infrastructure Superintendent
Energy and Infrastructure Supervisors

819-856-3073
819 759-3555 ext 6731 or 6902

2 DESCRIPTION

2.1 SEWAGE TREATMENT PLANT (STP)

The plant is designed based on the occupation maximum of the camp for 400 persons (240L per day and per person). The design flows are presented in Table 1.

Table 1: Design flow rate

Parameters	Design Value	Unit
Per capita design flow	240	L/p/d
Number of persons	400	People
Average daily flow (ADF)	96	m ³ /d
Maximum Daily Flow (MDF)	192	m ³ /d
Peak Hourly Flow (PHF)	24	m ³ /h
Overall time for speak to occur	2	hours
Maximum number of peak events per day	2	Qty

Table 2 presents the typical sewage composition used for the design (based on Meadowbank sewage quality).

Table 2: Sewage typical chemical composition

Parameters	Unit	Design Value
Biochemical Oxygen Demand (BOD ₅)	mg/L	952
Total Suspended Solids (TSS)	mg/L	300
Total Kjeldahl Nitrogen (TKN)	mg/L	130
Ammonia nitrogen (NH ₃ -N)	mg/L	130
Oil and Grease	mg/L	30
pH	-	6 to 9.5
Water Temperature	°C	10 to 25
Alkalinity	mg/L as CaCO ₃	471.1

2.1.1 Process summary

The sewage treatment plant receives two streams of sewage as presented in Figure 4 (basic flowsheet of the STP). The first source is domestic sewage, which is fed directly to the fine screening process to remove any fibers or debris that might damage the membranes. The second source is kitchen sewage which is pre-treated in the oil and grease tanks to remove oil and grease prior to being fed into the fine

screens. The combined screened sewage is pumped to the equalization tank. The equalization tank buffers variability in the influent flow rate and concentrations of influent constituents, maintaining a consistent flow rate and sewage strength through the membrane bioreactor (MBR) system. Sewage is then pumped from the equalization tank to the pre-anoxic tank for denitrification.

In the pre-anoxic tank, screened sewage containing organics is combined with recycled mixed liquor from the aeration tank containing nitrates. Bacteria use some of the organics to drive the denitrification process, converting nitrate into nitrogen gas. This process occurs in an anoxic environment where there is minimal oxygen. As such a pump and eductors are used to mix the tank to prevent addition of oxygen. The denitrification process is used to meet the effluent nitrate operational target, reduce oxygen requirements and to recover alkalinity, thus reducing chemical consumption.

Mixed liquor from the anoxic tank flows by gravity to the first aerobic tank followed by the second aeration tank for aerobic biological degradation of the influent constituents (organics and ammonia). In the aerobic tanks, the nitrification process converts ammonia to nitrate in order to meet the effluent ammonia operational target. This process consumes alkalinity, so a caustic soda or soda ash dosing pump is used to control the pH. Additionally, liquid alum is dosed into the anoxic zone to precipitate phosphorus in order to meet the effluent phosphorus operational target. Mixed liquor flows by gravity from the second aeration tank to the post-anoxic tank for final denitrification polishing. In the post-anoxic tank there are minimal dissolved influent organics to drive the denitrification process. As such, an external carbon source in the form of MicroC is dosed to supplement the organics and drive the denitrification process.

Mixed liquor is pumped from the post-anoxic tank to the membrane tanks. The membrane tanks serve as additional volume for aerobic biological treatment to remove any excess MicroC (which would otherwise increase BOD in the effluent) and house the membrane filters used for solid-liquid separation. A treated effluent is drawn through the membranes by vacuum pumps.

Since the solid-liquid separation process results in an accumulation of solids in the membrane tank, the mixed liquor (containing both solids and filtrate) is continuously recycled to the first aeration tank. This prevents excessive solids build-up in the membrane tank, and maintains sufficient biomass in the anoxic and aeration tanks. The solids that accumulate in the system consist of biomass that has grown from the influent organics and ammonia, as well as non-biodegradable solids from the influent sewage. In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank to the sludge holding tank. Wasted sludge in the sludge holding tank is thickened by decanting supernatant back to the screen tank. Thickened sludge accumulates in the sludge holding tanks until it is eventually pumped out for disposal.

The STP general flow diagram is illustrated in Figure 4 and Piping and Instrumentation Diagram (PID) in Figures 5 to 8. The following sections describe the STP components.



AGNICO EAGLE

Operation & Maintenance Manual Sewage treatment plant

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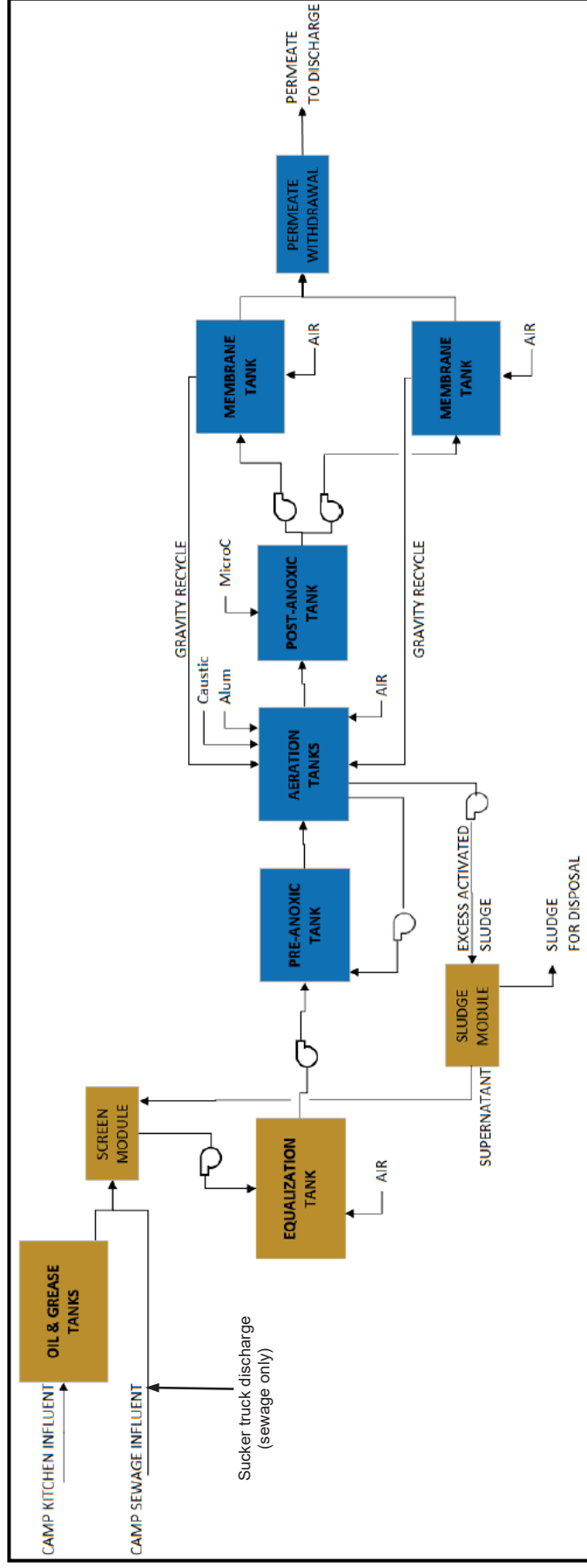


Figure 4 – Flowsheet

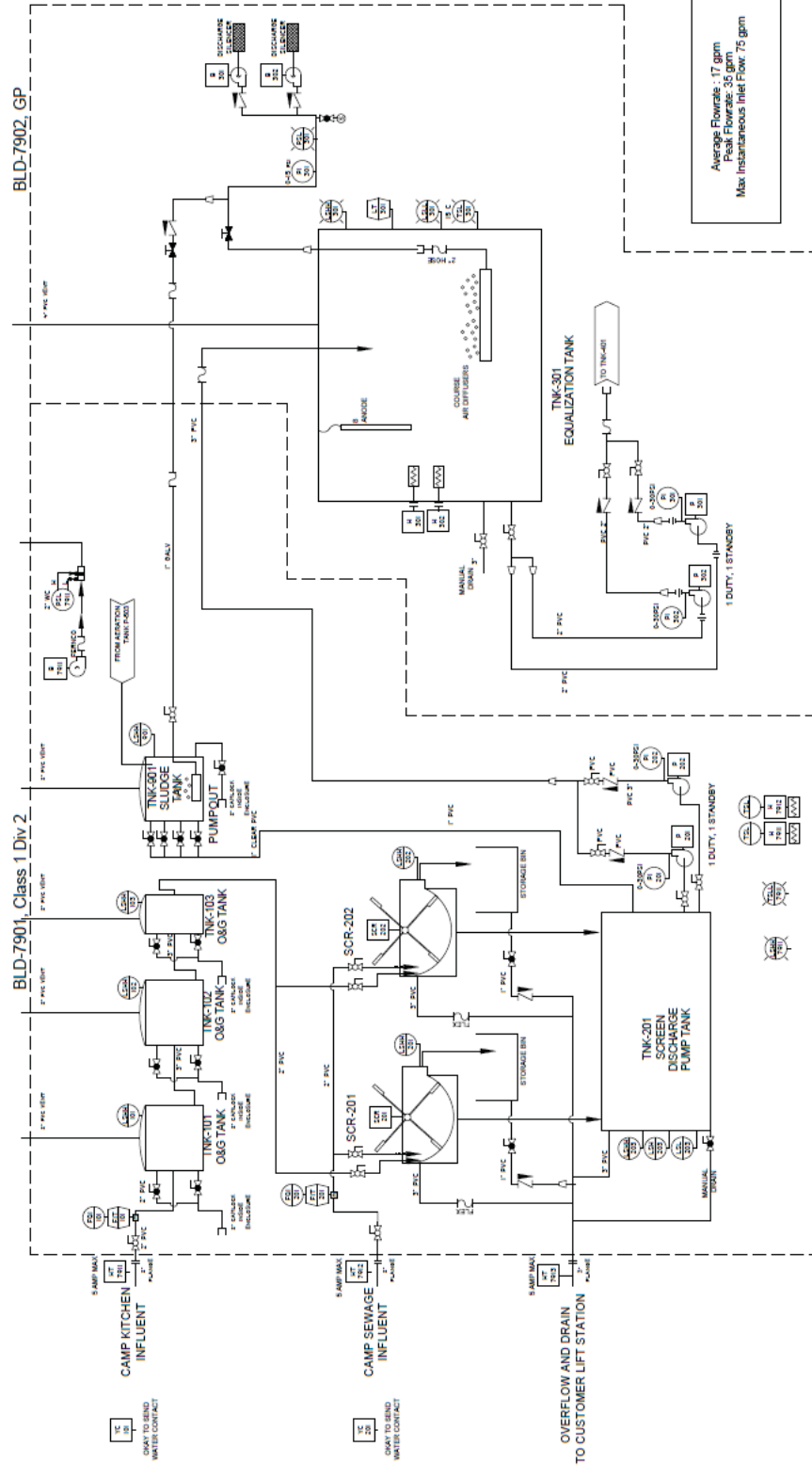


Figure 5 – Oils and grease removal, screening and equalization's tank

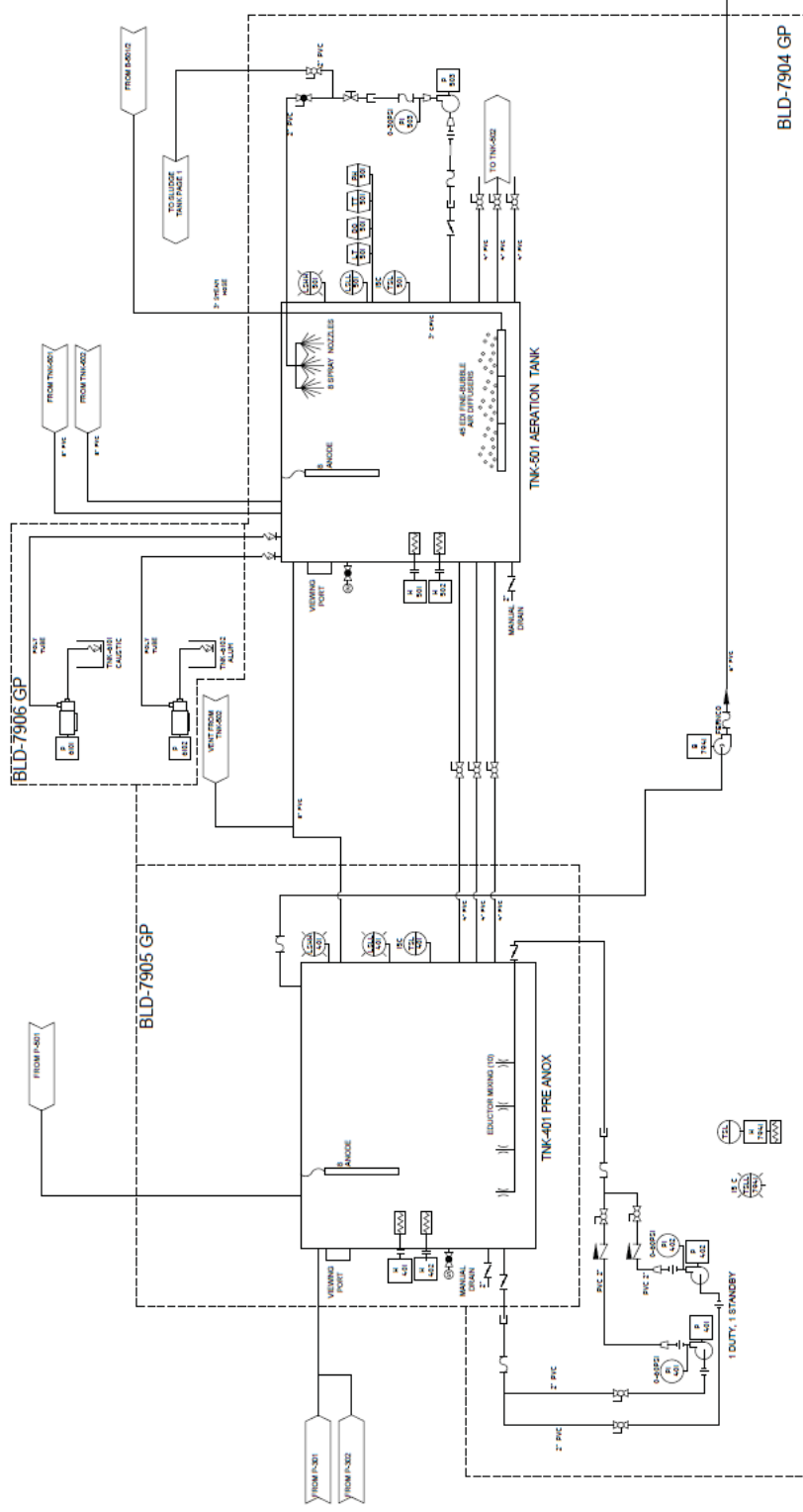


Figure 6 – Biological treatment

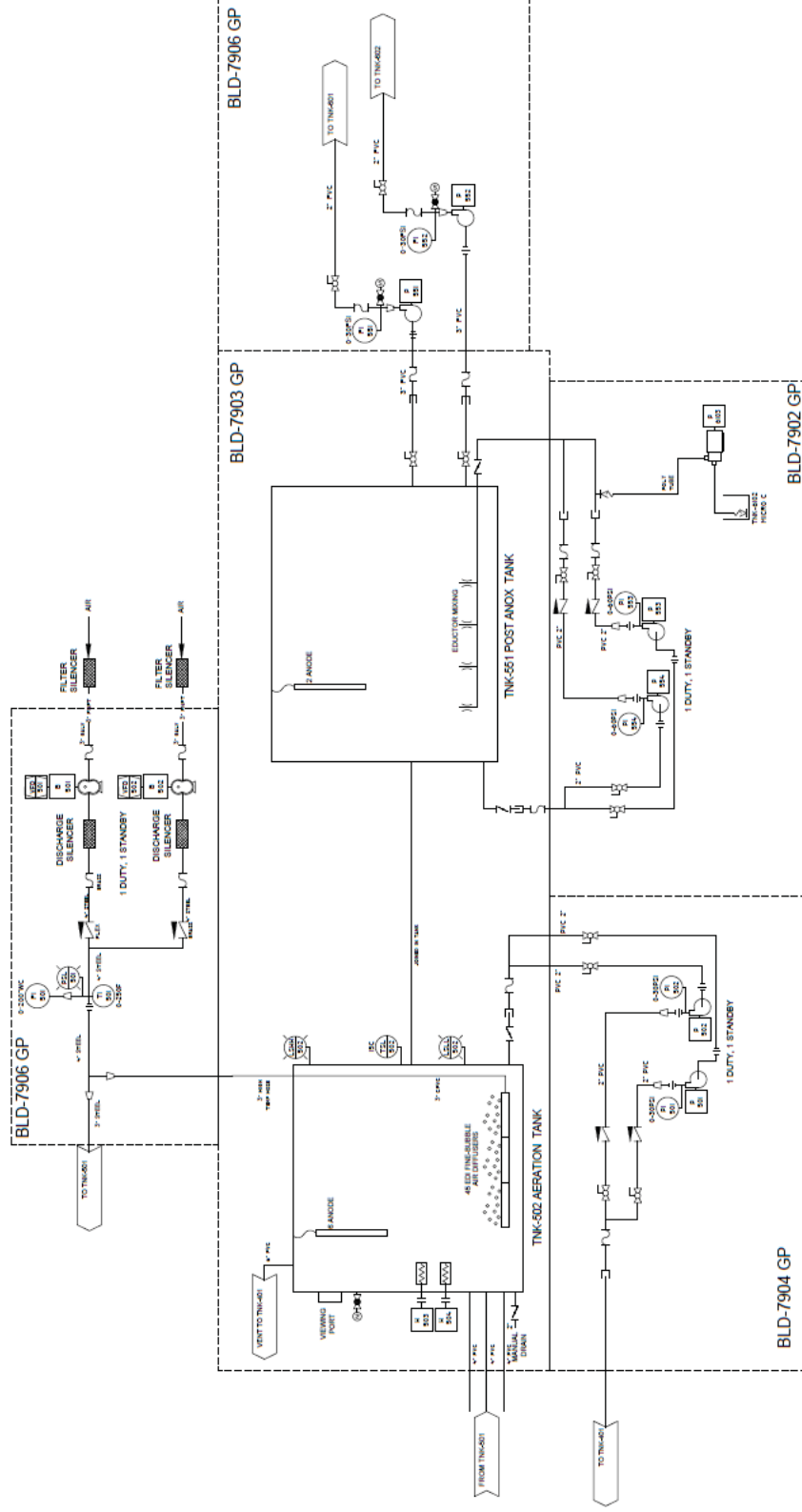


Figure 7 – Post Biological treatment



2.1.2 Process description

Oil and Grease (O/G) removal

Raw sewage from the kitchens entering the system can contain high levels of fats, oils and grease that can damage equipment and membranes downstream. To remove the oil and grease from the system a double trap grease interceptor is installed prior to the kitchen sewage entering the fine screen. Floating grease is removed via a vacuum truck hookup that will be used when the sludge tank is emptied. A pipe and vacuum truck hookup are also used to remove any debris that sunk to the bottom of the tanks. Vacuumed debris, oil and grease are to be disposed at the Meadowbank's tailings storage facility (TSF).

Fine Screening

Raw sewage entering the MBR system contains particulates and solids that could damage the equipment and membranes downstream. 0.5mm wedge wire fine screening protects the downstream equipment by removing large solids and fibrous material. Two screens are used for redundancy so that no unscreened influent enters the EQ tank. Redundant pumps are used to move the screened influent to the equalization tank.

Flow-Equalization

Throughout the day the flow and strength of the sewage will vary. To accommodate this, an equalization tank will buffer the flow and homogenize the loading. The equalization tank is aerated to maintain an aerobic environment to reduce odors and to maintain suspension of solids and pumps transfer sewage to biological treatment. This tank is provided with tank heaters. All wetted materials in this tank are either stainless steel or polypropylene to eliminate the possibility of corrosion. In addition, the tank has two liners, one primary, one secondary, with interstitial monitoring, providing the protection of a double wall tank.

Biological Treatment

In the anoxic zone, the pre-treated sewage is combined with return activated sludge from the aerobic tank and is kept mixed while maintaining a low level of dissolved oxygen (DO). Denitrification occurs as specific microorganisms convert nitrates to nitrogen gas – reducing the total nitrogen (TN) in the mixed liquor. Additionally, the anoxic stage optimizes the biological treatment process, which recovers alkalinity, aids in stabilizing pH, and improves energy efficiency by reducing overall aeration demand. In the aerobic zone, fine bubble diffusers create an aerobic environment where the organics contributing to biological oxygen demand (BOD) and ammonia are oxidized by the biology. Dissolved oxygen is continuously measured and aeration blowers controlled to maintain it in the range of 2 to 3 mg/L for process optimization and energy savings. In the post-anoxic zone, return activated sludge from the aerobic tank is kept mixed while maintaining a low level of dissolved oxygen (DO). The denitrification process continues in the post anoxic zone to reduce the TN even further.

Phosphorous Reduction

Chemical precipitation is used to remove inorganic phosphate. An aluminum sulphate or "Alum" solution is dosed into the mixed liquor causing dissolved phosphate to precipitate and coagulate. The suspended phosphate cannot pass through the Newterra MicroClearUltra Filtration membrane (UF), and the phosphate is eventually removed from the system as a solid with the waste activated sludge (WAS).

Membrane Filtration

After being treated biologically, the treated effluent is separated from the mixed liquor and solids by the Newterra MicroClear membrane modules and the permeate extraction system. The membrane

modules are continually air scoured to induce flow of mixed liquor over the flat sheet membrane surface and prevent fouling and buildup of solids on the membrane surface without the use of chemicals. The mixed liquor is then transferred to the inlet of the biological treatment to maintain even distribution of solids throughout the system and to introduce activated biology to the raw sewage. Newterra MicroClear membranes are produced with true ultrafiltration membrane material with 0.04 μm pore size, which blocks all bacteria and most viruses. Secondary disinfection is not required to exceed effluent requirements. Figure 9 presents a schematic view of the UF process.

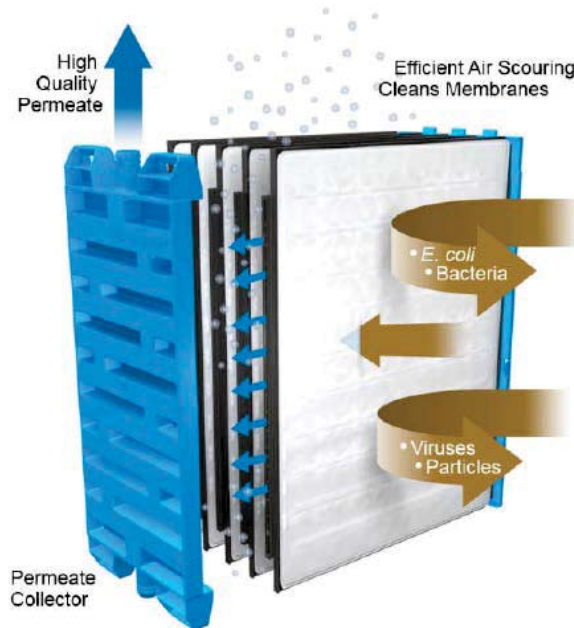


Figure 9 – Membrane filtration concept

2.1.3 Sludge Management Strategy

As solid-laden sewage enters the system and solid-free effluent is discharged, the suspended solids concentration in the mixed liquor suspended solids (MLSS) will increase. To maintain the proper level of MLSS, solids must be removed from the system as Waste Activated Sludge (WAS) which is mixed liquor discharged from the aerobic tank at approximately 0.8% dry. WAS is discharged to a tank for holding and decanting. The holding tank is aerated to maintain an aerobic environment to reduce odors. In the decanting process the WAS is allowed to settle and supernatant is pumped off, and returned to the MBR, thickening the sludge in the holding tank. By thickening the sludge to approximately 2% dry solids by weight, the total volume that must be disposed of is decreased, extending holding time and reducing operational costs. Level control in the tank indicates when the tank should be decanted or a vacuum truck should be scheduled to dispose of the WAS.

3 OPERATION AND MAINTENANCE

3.1 PUMPING

The system includes several pumps for the operation of the STP. All pumps are regularly inspected by the Operator who will ensure the pumps continue to operate efficiently and will address any deficiencies. If the pumps require maintenance, the Operator will report the situation and take appropriate action. Some of the pumps are installed with a standby unit that allows the Operator to switch from one pump to the other if necessary. In some specific situations, it may be necessary to temporarily shutdown the STP for servicing of the equipment.

A preventative maintenance program, as recommended by the pump supplier, will be followed to ensure the pumps are always kept in good working order.

3.2 SEWAGE COLLECTION

The sewage from the kitchen must pass through a grease trap (or similar facility for grease/fat removal). The large amount of oil and fat can harm treatment facility (e.g., clogging pumps and piping and cause foaming in the aeration tank). To avoid premature membrane fouling, maximum O/G concentrations should not exceed 30 mg/L.

The raw wastewater should not contain any of the following substances:

- Hydrocarbons – lubricants, gasoline, diesel, etc.;
- Paints, solvents, silica, silicon and polymers;
- Antibacterial solutions and products with quaternary ammonia;
- Large quantities of chemicals such as water softener, disinfectants, strong acids & alkalis, pesticides or photographic chemicals;
- Silicone based defoamers;
- Non-biodegradable solid waste (plastic, rubber products, disposable diapers, etc.);
- High amount of metals, such as iron, magnesium, calcium, barium and strontium.

3.3 SLUDGE DISPOSAL

Excess sludge from the STP will be trucked to Meadowbank and disposed of in the Tailings Storage Facility (TSF) or shipped south for disposal.

3.4 CONTROL

MBR (Membrane Bioreactor) treatment technology is an effective combination of an activated sludge biological treatment process with MBR membrane filtration technology. The STP can be operated in either manual or automatic mode. The system is designed to always run in auto mode. The manual option is provided mainly for maintenance purposes.

STP's control and automation system is based on several instruments measuring key parameter of the process, combined with a PLC. The STP don't require continuous operator intervention except for daily inspection and maintenance. The user interface can be accessed on-site from the control panel mounted touch-screen HMIs or remotely from a computer. Alarm messages can be set up to alert operators to issues.

The STP PLC is programmed to:

- Receive analogue and digital input signals from the switches and transmitters being controlled;
- Process the information using the structure and rules entered into the program;
- Generate outputs that control the equipment - turn equipment OFF or ON.
- Generate alarms if critical conditions are present
- Provide a HMI (Human Machine Interface) touch-screen for use of operator process monitoring and control.

More information are provided in the Operation and Maintenance Manual in Appendix.

3.5 REAGENTS

Some chemicals are required for treatment operation and also for Membrane cleaning. Chemicals will be used according to the MSDS recommendation. MSDS are provided in Appendix. Table 3 presents the estimated chemical consumption per year.

Table 3: Chemical consumption

Consumable		Usage Rate			
Purpose	Name	Value	Unit	Value	Unit
Supplemental Alkalinity	Dry Soda Ash	6.28	kg/d	2292	Kg/year
Phosphorus Removal	Liquid Alum, 48%	14.6	L/d	5346	L/year
Nitrate Removal	MicroC 2000	16.5	L/d	6025	L/year
Membrane Cleaning	Sodium Hypochlorite, 12%	-	L/d	150	L/year

Sodium Carbonate (Soda Ash) is used for pH adjustment in case there is a deficiency in alkalinity in influent sewage and pH drops. It is hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).

Sodium hypochlorite (NaOCl) and **Citric Acid** (C₆H₈O₇) are used for cleaning the membranes.

- Sodium hypochlorite is a common disinfectant, which can be an irritant or corrosive, depending on its concentration. It cannot be mixed with organics, ammonia compounds or acids. Contact with acids produces highly toxic chlorine gas. It has to be mixed only with pure water.
- Citric Acid is hazardous in case of skin contact (irritant, sensitizers), or ingestion, eye contact (irritant) and inhalation (lung irritants).

Aluminum Sulfate (Al₂(SO₄)₃) is used for Phosphorus Removal. Mild to moderate irritation can occur from unprotected contact. Aluminum is very poorly absorbed through the skin and toxic effects would not be expected following short-term skin contact. Inhalation of mists can be irritating to the respiratory tract and lungs.

MicroC 2000 is used for nitrate removal. Exposure to eyes may cause slight irritation. Exposure to Skin may cause slight irritation. Inhalation of high mist concentrations may cause irritation of respiratory tract.

3.6 BIOLOGICAL OPERATION

The following table presents target parameters required for a good operation of the STP.

Table 4: Biological system targets operational parameters

Parameter	Recommended	Range	Notes
MLSS (mg/L): Mixed Liquor Suspended Solids	10,000	8,000 – 15,000	Never operate the membranes if MLSS < 3,000 mg/l. Sludge wasting should be undertaken as required to maintain target MLSS
Temperature (°C)	15 - 35	10 – 35	Avoid sudden changes in temperature. Minimum operating temperature is 15 °C
pH	6.8 - 8.5	6.0 – 9.0	Membrane module can handle a change in pH. However it is recommended to keep pH between 6.8 - 8.5
Aeration Tank, DO (mg/L)	≥ 2.0	1.0 – 8.0	This can be maintained by adjusting the volume of air supplied to the aeration tank
Viscosity (mPa-s)	Not applicable	0 – 300	
Aeration Tank to Anoxic Tank Recirculation	400%	200 – 500%	
Membrane Tank to Aeration Tank Recirculation	400%	200 – 600%	
F:M (kg BOD/kg MLSS/d)	0.1	0.03 – 0.2	$F:M = \frac{\text{Flow (m}^3/\text{d)} \times \text{BOD conc (mg/l)}}{\text{Process volume (m}^3) \times \text{MLSS conc (mg/l)}}$
F:M (kg COD/kg MLSS/d)	0.15	0.05 – 0.3	$F:M = \frac{\text{Flow (m}^3/\text{d)} \times \text{COD conc (mg/l)}}{\text{Process volume (m}^3) \times \text{MLSS conc (mg/l)}}$
SRT : sludge retention time (days)	> 15	12 – 50	

3.7 MEMBRANE OPERATION

This section outlines the operating conditions that are required for proper sewage treatment, and longevity of the membranes.

Generally, the following points can be used to operate the MBR system properly:

- The MBR system is designed to treat wastewater with specified influent characteristics.
- Never operate the MBR tank below the minimum membrane submerged level. It is necessary to maintain a minimum of 250 mm liquid level above the membrane modules to ensure they are wet at all times and to allow for proper filtration.
- Always supply the required amount of air for scouring to the membrane module.
- Always filter sewage at or below design flow rate.
- Periodically, relax the membranes by ending filtration while allowing the membrane aeration scour to operate continuously and initiate backwash operation during membrane relaxation (default relaxation mode preset in PLC - permeation continues for 9 min and stops for 1 min).
- Always operate the MBR in accordance with the parameters listed in the supplier O&M Manual.
- Clean the membranes in-place with a dilute chemical in accordance with the supplier O&M Manual.

3.8 MEMBRANE CLEANING

In order to enhance life duration of the membrane, several cleaning are required as presented below.

In-situ Chemically Enhanced Backflush (CEB)

It is recommended that in-situ CEB be carried out before the trans membrane pressure (TMP) exceeds 0.25 bar (or permeability drops rapidly to 50 LMH/bar) This is typically done once every couple weeks/months depending on biomass characteristics and system operating condition. On certain occasions, membrane module/cassette may need to be physically inspected for membrane integrity if membrane permeability performance is not recovered after the cleaning (i.e., suspect of membrane deterioration). Hypochlorite is used for organic fouling and citric acid for inorganic acid.

Membrane Recovery Cleaning

The membrane recovery cleaning is to be done once a year at a minimum. On certain occasions, membrane cassette may need to be inspected for membrane integrity (suspect of membrane deterioration, membrane permeability performance does not recover after the cleaning, etc.).

- **Cleaning with High pH Solution:** This step is to be done if membrane fouling is a result of high fat, oil and grease. Sodium hydroxide can be used for this cleaning (400 mg/L, pH 12, 1 to 2 hours).
- **Cleaning with Sodium Hypochlorite** (500 mg/L free Cl_2 , 12 hours)
- **Cleaning with Citric Acid** only in case of inorganic fouling (2 to 20 g/L during 2 h).
- **Checking Permeability.**

3.9 SERVICE WATER

For better cleaning performance, it is recommended to use:

- Potable water (permeate is acceptable if potable water is unavailable for the CEB cleaning),
- Water temperature is above 20°C.

3.10 OPERATIONNAL PERFORMANCE TARGETS

The plant is designed to meet the following criteria presented in Table 5. Note that the treated water from STP is not directly discharged to the environment. The target concentrations presented in the following table for the treated water from STP, are set to limit effect on the receiving Environment after mixing with surface water into the Whale Tail attenuation pond and treatment in the AsWTP. There are no Water Licence criteria for the STP treated water. Reaching these values assure Agnico Eagle to operate the STP at a highest level of efficiency.

Table 5: STP treated water quality operational target

Parameters	Unit	Effluent
pH	s.u.	6.5 – 9.5
Oil, Grease	mg/L	<5
Biological Oxygen Demand (BOD)	mg/L	<25
Total Suspended Solids (TSS)	mg/L	<25
Total Kjeldahl Nitrogen (TKN)	mgN/L	-
Unionized Ammonia Nitrogen (NH ₃ -N)	mgN/L	<1.25
Nitrate Nitrogen (NO ₃ -N)	mgN/L	<5
Total Phosphorus (TP)	mgP/L	<0.5
Fecal Coliform	CFU/100 ml	<200
Total Residual Chlorine	mg/L	<0.02

3.11 GENERAL OPERATION & MAINTENANCE, SAMPLING PROCEDURES AND FREQUENCY

To ensure efficiency of STP, samples of water must be collected periodically. Table 6 presents sampling schedule to assess that STP performance comply with operational target values.

More samples can be taken at different locations in the plant to assess any default on STP operation.

Visual inspection is also important to verify STP operation. The following sign must be reported as soon as possible:

- Plant Visual Checks Noise**
 During normal operation, there is a uniform humming sound at the plant. In case of an unusual noise, it could be an indication that the blower needs maintenance or repairs
- Smell**
 The MBR is an aerobic system. During normal operation, the system has an earthy smell similar to that of a well-maintained compost pile. If other odors are noticed, the aeration process may not be operating or the system has been overloaded. Check the DO manually and the blower to verify the proper operation.
- Effluent Aspect**
 Normally, the effluent is reasonably clear, colorless, and odorless. If the effluent becomes turbid, there is a pin hole in the membrane or a leakage in the piping. Take the unit out of operation and investigate. Check uniformity of membrane air distribution periodically to ensure air scouring is effective across all membrane plates.

Table 6: Monitoring program for operational efficiency assessment.

Parameters	Sewage	Aeration tank	Membrane tank	Effluent
Flow	daily			daily
Oil and Grease	As required			As required
Alkalinity	As required			
Biological Oxygen Demand	Weekly			Weekly
Total Suspended Solids	Weekly			Weekly
Total Kjeldahl Nitrogen / Total Nitrogen	Monthly			As required
Ammonia Nitrogen				As required
Nitrate				As required
Total Phosphorus	Weekly			Weekly
Mixed Liquor Suspended Solids (MLSS)			Weekly	
Mixed Liquor Volatile Suspended Solids (MLVSS)			As required	
Temperature		daily		
pH	As required	daily		Weekly
Dissolved Oxygen		daily		
Filterability			3 times weekly	
Turbidity				As required
Fecal Coliform / E-Coli				Weekly

Table 7 summarizes also Routine Operation and Maintenance Checkups. More details are provided in the supplier O&M Manual.

According to the water licence, Group 1 Parameters should be analyzed four times per calendar year during operation and closure. The parameters are presented herein:

- pH, turbidity, hardness, alkalinity, chloride, fluoride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), ammonia nitrogen, nitrite, nitrate, Total Metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium and zinc).

Table 7: Routine Operation and Maintenance Checkups

Location	Item	Action	Comments
Grease trap	Periodic cleaning	As needed	Waste sent to Meadowbank TSF
Process	Visual check	Daily	Performance evaluation
	Flow rate in and out	Daily	
	Sampling	Daily / as requested	For water quality and performance evaluation
	Vacuum pressure on membrane	Daily	Evaluate Membrane fouling
	Inspect Membrane	Weekly	
Mechanical & process	Sensor cleaning and calibration	Weekly / yearly	
	Valves, fittings	Weekly	Prevent spill
	Membrane Cleaning	Quarterly/Yearly	Permeability recovery
	Aeration diffuser	Yearly	Process efficiency
	Pumps	Quarterly	Prevent spill
	Blower	Monthly	Process efficiency
	Screening device	Daily/ Weekly/ Quarterly	Prevent clogging, remove solid waste and dispose it
	Dosing pumps	Quarterly	Prevent spill
	Fan and heaters	Yearly	Health and safety of operator
	Leads	Quarterly	Health and safety of operator and Process efficiency
Electrical	Panel fan filter, inspection breaker, fuses, motor bold, clean dust	Monthly	Health and safety of operator Process efficiency
	PLC functionality	Weekly	Process efficiency

3.12 TROUBLESHOOTING AND MAINTENANCE PROCEDURES

MBR operation relies critically on the ability of the membrane unit to pass all flow incoming to the plant. If membrane permeability is impaired, the MBR plant cannot process all flow with potentially negative results even though effluent quality remains consistently high. Membrane fouling (and associated reduction of flux or increase of TMP) remains as an operational challenge.

Membrane fouling in MBR is a result of the interaction between the incoming water quality, mixed liquor filterability, system operation condition, and membrane material. There are four categories of membrane fouling.

Microbial/Biological Fouling

Microbial fouling is a result of the formation of biofilms on membrane surfaces. This structure protects bacterial cells from hydraulic shearing and from chemical attacks of biocides such as chlorine. Chemical cleaning would be required to restore permeability.

Particulate/Colloid Fouling

This type of fouling may be associated with high concentrations of colloidal solids present in mixed liquor. In most cases, particles and colloids do not really foul the membrane because the flux decline caused by their accumulation on the membrane surface is largely reversible by hydraulic cleaning measures such as backwash and air scouring. However, the accumulation of solids between the membranes can create increased membrane resistance to permeation and permanent physical membrane damage.

Inorganic Fouling

Inorganic fouling or precipitative fouling is caused by the accumulation of inorganic precipitates such as metal hydroxides, and “scales” on membrane surface or within pore structure. Chemical cleaning will be required in that case.

Organic Fouling

Organic fouling is the attachment of materials such as oil or grease to the membrane surface. Oil and grease trap will prevent this type of fouling and chemical cleaning is also achievable to restore permeability.

Excessive foaming (white foam accumulating over the liquid surface) in aeration and/or membrane tanks could also reduce performance of the STP. Remediation should be taken to eliminate foaming agent or restore design parameters of the plant.

Permeate bad quality can also indicate default in MBR membrane and operation.

Finally, biological system can also indicate default in operation.

- Black color of biomass indicates a lack of aeration,
- Increase of bacteria quantity in the reactor indicates a low sludge wasting,
- Unpleasant odor can indicate overload of the system, blower failure, etc.
- Water quality not achieved: Mixed liquor characteristics are not within proper operating standards.

Further details are available in the manufacturer’ operating manuals in Appendix.

3.13 RECORD KEEPING

Records of the operational, maintenance and sampling procedures will be kept daily in order to assist in the evaluation of the effectiveness of the STP.

The following will be recorded on a daily basis:

- Volume of effluent discharged to the whale tail attenuation pond;
- Sewage volume collected;
- Details of any maintenance undertaken at site;
- Volume of sewage sludge removed from the STP;
- Locations and methods of sewage sludge disposal;
- Water quality parameter results required to follow the STP performance.

The record sheets will be kept in the STP office.

3.14 SAFETY PROCEDURES FOR OPERATORS

Operators working in the STP facility must be trained prior to work so that they are aware of the health and safety risks as well as the operational procedures associated with the STP. The following are important safety considerations:

- The wastewater contains a mixture of viable bacteria and other biological organisms. A wastewater treatment plant poses a number of bacterial hazards and consequently potential health risk. Immunization protects operator against infection. The use of proper hygiene measures, protective equipment, good housekeeping and common sense prevent contact with pathogens. Ensure that hands are washed with an antibacterial soap and warm water and dried by disposable towels on a regular basis, especially prior eating. Do not expose cuts or open sores to wastewater. Any concern about possible infection should be brought to the attention of medical physician immediately.
- Follow local laws and regulations with respect to entering a confined space.
- Working within the plant, especially with chemicals, requires adequate personal protective equipment (PPE) for Operators. This includes wearing steel toed boots, hard hat, rubber aprons, safety glasses with side shields and gloves.
- Operators are required to conduct good housekeeping of the working area to minimize the risk of incidents.
- Lock-out/tag-out procedures must be applied when servicing equipment.
- The MSDS for reagents used in the STP will be readily available for the operator at all times.
- Eyewash stations are located within proximity of reagent systems in the STP.

3.15 CONTROLLING ACCESS TO THE STP

Access to the STP will be restricted to authorized personnel only. Signs will be posted at the STP entrance.

4 EMERGENCY RESPONSE

4.1 FIRE

In case of fire at the STP, the on-site emergency response team (ERT) will be notified as per Agnico Eagle's protocol. Instructions from the on-site emergency response team will be followed by all personnel at the STP. Further details of fire response are provided in the "*Risk Management & Emergency Response Plan*". The STP will include the necessary fire safety protection measures in accordance with the Nunavut and North West Territories Mine Act.

4.2 SPILL

In the event of a spill at the STP, the Environment Department will be notified immediately and provide support, as required. In the event of a large spill, the on-site ERT will be notified as per Agnico Eagle's protocol. Instructions from the ERT will be followed by all personnel at the STP. All spill will be reported and treated according to the "*Spill Contingency Plan*".

4.3 PLANT MALFUNCTION

If there is a major problem or failure in the STP it would be most likely due to changes in the influent (raw sewage) (i.e. high strength sewage (BOD high) killing bacteria in the STP) or membrane failure. In this case, there would be visible effluent problems (part of daily operational checks), poor water quality, and increased odours that the operator would note. If this occurs, a sample will be taken to try to determine the source of the problem.

The following other contingent measures can be applied by Agnico Eagle in the event of a malfunction at the STP:

- Cut back on allowable camp water until the malfunction is corrected and use the equalization tank to retard the peak flow;
- Shut down the malfunctioning unit until the malfunction is repaired and use only one of the two parallel units until repairs are completed (for equipment in parallel);
- Shut down temporarily all water use in the camp until the repairs are completed;
- Bypassing untreated STP influent around the malfunctioning unit and holding this untreated influent in a holding tank or lined pond on site until the repairs are complete is another contingent measure that could be applied. The untreated sewage would then be pumped back to the STP when the unit is repaired.

Appendix A: Reagent MSDS Sheets



SAFETY DATA SHEET

NC00525
MICROC 2000

Preparation Date: 09/Mar/2018

Version: 1

1. IDENTIFICATION

Product identifier

Product Name MICROC 2000

Other means of identification

Product Code(s) NC00525

Synonyms none

Recommended use of the chemical and restrictions on use

Recommended Use Reducing agent for biological purposes

Restricted Uses No information available

Initial Supplier Identifier

Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC V6X 1W5
Telephone: 1-866-686-4827

Emergency telephone number

24 Hour Emergency Phone Number (CANUTEC): 1-888-226-8832 (1-888-CAN-UTEC)

2. HAZARD IDENTIFICATION

Hazardous Classification of the substance or mixture

none

Label elements

Hazard pictograms None

Hazard statements



SAFETY DATA SHEET

SDS00221
Sodium Hypochlorite 12%

Preparation Date: 09/Feb/2018

Version: 4

1. IDENTIFICATION

Product identifier

Product Name Sodium Hypochlorite 12%

Other means of identification

Product Code(s) SDS00221

Synonyms Sodium oxychloride; Soda bleach liquor; Javel water; Clorox; Javex.

Recommended use of the chemical and restrictions on use

Recommended Use Chemical intermediate Bleaching agent Laboratory reagent. Pulp and paper. Water treatment. Disinfectant

Restricted Uses No information available

Initial Supplier Identifier

Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC V6X 1W5
Telephone: 1-866-686-4827

Emergency telephone number

24 Hour Emergency Phone Number (CANUTEC): 1-888-226-8832 (1-888-CAN-UTEC)

2. HAZARD IDENTIFICATION

Hazardous Classification of the substance or mixture

Corrosive to metals	Category 1
Skin corrosion/irritation	Category 1
Sub-category B	
Serious eye damage/eye irritation	Category 1

Label elements

Hazard pictograms**Signal Word: Danger****Hazard statements**

May be corrosive to metals

Causes severe skin burns and eye damage

Precautionary Statements**Prevention**

Do not breathe dust/fume/gas/mist/vapors/spray

Wash face, hands and any exposed skin thoroughly after handling

Wear protective gloves/protective clothing/eye protection/face protection

Immediately call a POISON CENTER or doctor

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do.

Continue rinsing

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower

Wash contaminated clothing before reuse

IF INHALED: Remove person to fresh air and keep comfortable for breathing

IF SWALLOWED: Rinse mouth. DO NOT induce vomiting

Storage

Store locked up

Store in a well-ventilated place. Keep container tightly closed

Disposal

Dispose of contents/container to an approved waste disposal plant

Very toxic to aquatic life with long lasting effects

3. COMPOSITION/INFORMATION ON INGREDIENTS**Substance**

Not applicable.

Mixture

Chemical Name	CAS No	Weight-%	Synonyms
Water	7732-18-5	80 - 90%	Water
Sodium Hypochlorite, Solution	7681-52-9	10 - 20%	Sodium Hypochlorite, Solution

4. FIRST AID

Description of first aid measures

General advice

Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Inhalation

Remove to fresh air. If breathing has stopped, give artificial respiration. Get medical attention immediately. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur.

Eye contact

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Do not rub affected area. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact

Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention.

Ingestion

Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Get immediate medical advice/attention.

Self-protection of the first aider

Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed:

Causes irritation of the mouth, nose and throat. Corrosive Causes burns to the mouth, throat and stomach. May cause severe skin irritation. Corrosive to the respiratory passage. Corrosive to eye tissue and may cause severe damage and blindness. Causes vomiting, nausea, and diarrhea. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary edema (fluid build-up in lungs) and reduction of pulmonary function. Coma, shock and death may occur. May cause whitening or bleaching of the skin. If mixed with acids or warmed to temperatures greater than 40 °Celsius, Sodium hypochlorite solutions release chlorine gas. This gas can cause severe irritation of the nose and throat. Exposures to high levels of chlorine gas may result in severe lung damage. Prolonged contact may lead to burns and blisters and may aggravate dermatitis.

Indication of any immediate medical attention and special treatment needed:

Note to physicians

Due to the severely irritating or corrosive nature of the material, swallowing may lead to ulceration and inflammation of the upper alimentary tract with hemorrhage and fluid loss. Also, perforation of the esophagus or stomach may occur, leading to mediastinitis or peritonitis and the resultant complications.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media

Use extinguishing media appropriate for surrounding fire.

Specific hazards arising from the substance or mixture

Closed containers may explode in fire. Keep containers cool to prevent rupture and release of material. Spilled material may cause floors and contact surfaces to become slippery.

Hazardous combustion products

Chlorine. Oxides of sodium. Oxygen. When heated to decomposition, it emits acrid smoke and irritating fumes.

Special protective equipment for fire-fighters

Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES**Personal precautions, protective equipment and emergency procedures**

Attention! Corrosive material. Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Should not be released into the environment. Do not allow to enter into soil/subsoil. Prevent product from entering drains.

Methods and materials for containment and cleaning up

Prevent further leakage or spillage if safe to do so.

7. HANDLING AND STORAGE**Precautions for safe handling**

For industrial use only. Handle and open containers with care. Avoid contact with eyes, skin and clothing. Do not ingest. Avoid inhalation of chemical. Empty containers may contain hazardous product residues. Keep the containers closed when not in use. Protect against physical damage. Use appropriate personnel protective equipment. When diluting, add this product to water in small amounts to avoid spattering. Never add water to this material.

Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area, away from heat and ignition sources. Keep away from direct sunlight. Do not freeze. Store away from organic chemicals, strong bases, metal powders, carbides, sulfides, and any readily oxidizable material. Storage area should be equipped with corrosion-resistant floors, sumps and should have controlled drainage to a recovery tank. Store below 29 °C. Store in a sealed polyethylene lined container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION**Control parameters****Exposure Limits**

This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Chemical Name	Alberta OEL	British Columbia OEL	Ontario	Quebec OEL	Exposure Limit - ACGIH	Immediately Dangerous to Life or Health - IDLH
Water	Not available	Not available	Not available	Not available	Not available	Not available
7732-18-5	Not available	Not available	Not available	Not available	Not available	Not available
Sodium	Not available	Not available	Not available	Not available	Not available	Not available

Hypochlorite, Solution 7681-52-9						
--	--	--	--	--	--	--

Consult local authorities for recommended exposure limits

Appropriate engineering controls

Engineering controls

Local exhaust ventilation as necessary to maintain exposures to within applicable limits. Make up air should always be supplied to balance air exhausted (either generally or locally). Ventilation required when spraying or applying in a confined area. Ventilation should be explosion proof. Eliminate ignition sources.

Individual protection measures, such as personal protective equipment

Eye/face protection

Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes.

Hand protection

Nitrile gloves. Neoprene gloves. Impervious gloves. Rubber gloves.

Skin and body protection

Neoprene coated apron or chemical resistant clothing. Impervious boots.

Respiratory protection

NIOSH approved supplied air respirator when airborne concentrations exceed exposure limits. Wear a NIOAH approved full facepiece respirator for acid gases or a self-contained breathing apparatus for air concentration levels up to 5 ppm.

General hygiene considerations

Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance

Physical state	Liquid
Color	Clear Green to yellow.
Odor	Chlorine
Odor threshold	No information available

<u>PROPERTIES</u>	<u>Values</u>	<u>Remarks • Method</u>
pH	11.5 - 13	
Melting point / freezing point	-25 °C / -13 °F	
Initial boiling point/boiling range	No data available	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		
Upper flammability limit:	No data available	
Lower flammability limit:	No data available	
Vapor pressure	17.5 mmHg	
Relative vapor density	No data available	None known

Specific Gravity	1.175	
Water solubility	Soluble in water	
Solubility in other solvents	No data available	
Partition coefficient	No data available	
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known
Explosive properties	No information available.	
Oxidizing properties	No information available.	
Molecular weight	No information available	
VOC Percentage Volatility	No information available	
Liquid Density	No information available	
Bulk density	No information available	

10. STABILITY AND REACTIVITY

Reactivity/Chemical Stability

Unstable above 40°C / 104 °F.

Possibility of hazardous reactions

Hypochlorites may react with primary amines to form nitrogen trichloride which explodes spontaneously in air. Hypochlorite bleach reacts with urea to form nitrogen trichloride which explodes spontaneously in air. Some metals accelerate the decomposition of Sodium Hypochlorite. Nickel. Copper. Tin. Iron and its alloys. Manganese.

Hazardous polymerization

Will not occur.

Conditions to avoid

High temperatures. Exposure to light.

Incompatible materials

Strong oxidizers. Acids. Reducing agents. Ammonia. Metals.

Hazardous decomposition products

Chlorine. Oxides of sodium. Oxygen. When heated to decomposition, it emits acrid smoke and irritating fumes.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation

Causes irritation of the mouth, nose and throat. Corrosive to the respiratory passage. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary edema (fluid build-up in lungs) and reduction of pulmonary function. If mixed with acids or warmed to temperatures greater than 40 °Celsius, Sodium hypochlorite solutions release chlorine gas. This gas can cause severe irritation of the nose and throat. Exposures to high levels of chlorine gas may result in severe lung damage.

Eye contact

Corrosive to eye tissue and may cause severe damage and blindness.

Skin contact

Corrosive. May cause severe skin irritation. May cause whitening or bleaching of the skin. Prolonged contact may lead to burns and blisters and may aggravate dermatitis.

Ingestion

Causes burns to the mouth, throat and stomach. Corrosive. Causes vomiting, nausea, and diarrhea. Coma, shock and death may occur.

Information on toxicological effects**Symptoms**

Corrosive effects on the skin and eyes may be delayed, and damage may occur without the sensation or onset of pain. Aspiration may cause lung damage.

Numerical measures of toxicity**Acute toxicity**

The following values are calculated based on chapter 3.1 of the GHS document .

ATEmix (oral)	68,333.00 mg/kg
ATEmix (dermal)	83,417.00 mg/kg

Unknown acute toxicity No information available

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Water 7732-18-5	> 90 mL/kg (Rat)	Not available	Not available
Sodium Hypochlorite, Solution 7681-52-9	= 8.91 g/kg (Rat)	> 10000 mg/kg (Rabbit)	Not available

Delayed and immediate effects as well as chronic effects from short and long-term exposure**Skin corrosion/irritation**

Corrosive. May cause severe skin irritation. May cause whitening or bleaching of the skin. Prolonged contact may lead to burns and blisters and may aggravate dermatitis.

Serious eye damage/eye irritation

Corrosive to eye tissue and may cause severe damage and blindness.

Respiratory or skin sensitization

No information available.

Germ cell mutagenicity

No information available.

Carcinogenicity

No information available.

The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
Water 7732-18-5	Not available	Not available	Not available	Not available
Sodium Hypochlorite, Solution 7681-52-9	Not available	Group 3	Not available	Not available

Legend

IARC (International Agency for Research on Cancer)
Group 3 - Not Classifiable as to Carcinogenicity in Humans

Reproductive toxicity

No information available.

Specific target organ systemic toxicity - single exposure

No information available.

Specific target organ systemic toxicity - repeated exposure

No information available.

Aspiration hazard

No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Chemical Name	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Fish Species Data	Toxicity to microorganisms	Crustacea
Water 7732-18-5	Not available	Not available	Not available	Not available
Sodium Hypochlorite, Solution 7681-52-9	Not available	0.06 - 0.11 mg/L LC50 (Pimephales promelas) 96 h flow-through 4.5 - 7.6 mg/L LC50 (Pimephales promelas) 96 h static 0.4 - 0.8 mg/L LC50 (Lepomis macrochirus) 96 h static 0.28 - 1 mg/L LC50 (Lepomis macrochirus) 96 h flow-through 0.05 - 0.771 mg/L LC50 (Oncorhynchus mykiss) 96 h flow-through 0.03 - 0.19 mg/L LC50 (Oncorhynchus mykiss) 96 h semi-static 0.18 - 0.22 mg/L LC50 (Oncorhynchus mykiss) 96 h static	Not available	EC50: 0.033 - 0.044mg/L (48h, Daphnia magna)

Persistence and degradability No information available.

Bioaccumulation No information available.

Chemical Name	Partition coefficient
Water 7732-18-5	Not available
Sodium Hypochlorite, Solution 7681-52-9	Not available

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Do not reuse empty containers.

14. TRANSPORT INFORMATION

TDG (Canada):

UN Number	UN1791
Shipping name	HYPOCHLORITE SOLUTION
Class	8
Packing Group	III
Marine pollutant	Not available.

DOT (U.S.)

UN Number	UN1791
Shipping name	HYPOCHLORITE SOLUTION
Class	8
Packing Group	III
Marine pollutant	Not available

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

NSF International



Additional information

Maximum use for potable water 95 mg/L. Only products bearing the NSF Mark on the product, product packaging, and/or documentation shipped with the product are Certified.

U.S. Regulatory Rules

Chemical Name	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Water - 7732-18-5	Not Listed	Not Listed	Not Listed
Sodium Hypochlorite, Solution - 7681-52-9	Not Listed	Listed	Not Listed

International Inventories

TSCA	Complies
DSL/NDSL	Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

16. OTHER INFORMATION, INCLUDING DATE OF PREPARATION OF THE LAST REVISION

NFPA:	Health hazards 3	Flammability 0	Instability 0	Physical and chemical properties - Personal protection X
HMIS Health Rating:	Health hazards 3	Flammability 0	Physical hazards 0	

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Prepared By: The Environment, Health and Safety Department of Univar Canada Ltd.

Preparation Date: 09/Feb/2018

Revision Date: 09/Feb/2018

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End of Safety Data Sheet

The mixture does not meet the criteria for classification.

Prevention

Wash hands thoroughly after handling

Wear protective gloves/protective clothing/eye protection/face protection

In case of inadequate ventilation wear respiratory protection

Response

Read the label and safety data sheet before use.

Flush eyes with plenty amounts of water.

If eye irritation persists: Get medical advice/attention

Wash skin with plenty of water.

If skin irritation occurs: Get medical advice/attention

Move person to fresh air.

Do NOT induce vomiting. Never give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs.

Storage

Store in accordance with good industrial practices.

Disposal

Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance

Not applicable.

Mixture

Chemical Name	CAS No	Weight-%	Synonyms
Glycerine	56-81-5	70 - 80%	Glycerine
Water	7732-18-5	20 - 30%	Water
Sodium Chloride	7647-14-5	0 - 10%	Sodium Chloride
Methanol	67-56-1	0 - 10%	Methanol

4. FIRST AID

Description of first aid measures**Inhalation**

Remove to fresh air.

Eye contact

Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact

Wash skin with soap and water.

Ingestion

Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed:

May cause slight eye irritation Symptoms include pain, redness and tearing. May cause slight skin irritation. Prolonged or repeated contact may cause discomfort and local redness. High concentrations of mist or vapor may cause irritation of the respiratory tract. May be harmful if swallowed

Indication of any immediate medical attention and special treatment needed:**Note to physicians**

Treatment based on sound judgment of physician and individual reactions of patient.

5. FIRE-FIGHTING MEASURES**Suitable Extinguishing Media**

Use extinguishing agent suitable for type of surrounding fire. Water spray. Alcohol foam. Dry chemical or CO2. Water or Foam may cause frothing.

Specific hazards arising from the substance or mixture

No information available.

Hazardous combustion products

See section 10 for more information.

Special protective equipment for fire-fighters

Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES**Personal precautions, protective equipment and emergency procedures**

Ensure adequate ventilation. Avoid breathing vapors or mists.

Environmental precautions

See Section 12 for additional Ecological Information.

Methods and materials for containment and cleaning up

Prevent further leakage or spillage if safe to do so. Eliminate all ignition sources.

7. HANDLING AND STORAGE**Precautions for safe handling**

Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes or clothing. Avoid breathing vapors or mists. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

Conditions for safe storage, including any incompatibilities

Keep containers tightly closed in a cool, well-ventilated place. Keep away from sources of ignition.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits

Chemical Name	Alberta OEL	British Columbia OEL	Ontario	Quebec OEL	Exposure Limit - ACGIH	Immediately Dangerous to Life or Health - IDLH
Glycerine 56-81-5	TWA: 10 mg/m ³	TWA: 10 mg/m ³ TWA: 3 mg/m ³	Not available	TWA: 10 mg/m ³	Not available	Not available
Water 7732-18-5	Not available	Not available	Not available	Not available	Not available	Not available
Sodium Chloride 7647-14-5	Not available	Not available	Not available	Not available	Not available	Not available
Methanol 67-56-1	TWA: 200 ppm TWA: 262 mg/m ³ STEL: 250 ppm STEL: 328 mg/m ³ Skin	TWA: 200 ppm STEL: 250 ppm Skin	TWA: 200 ppm STEL: 250 ppm Skin	TWA: 200 ppm TWA: 262 mg/m ³ STEL: 250 ppm STEL: 328 mg/m ³ Skin	250 ppm STEL 200 ppm TLV-TWA	6000 ppm

Consult local authorities for recommended exposure limits

Appropriate engineering controls

Engineering controls

Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection

Chemical goggles; also wear a face shield if splashing hazard exists.

Hand protection

Use gloves chemically resistant to this material, examples of preferred glove barrier materials include: Nitrile gloves.

Skin and body protection

Skin contact should be prevented through the use of suitable protective clothing, gloves and footwear, selected for conditions of use and exposure potential. Consideration must be given both to durability as well as permeation resistance.

Respiratory protection

If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator.

General hygiene considerations

Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance

Physical state	Liquid
Color	Light brown

Odor MUSTY to Sweet
Odor threshold No information available

PROPERTIES	Values	Remarks • Method
pH	4 - 11	
Melting point / freezing point	No data available	None known
Initial boiling point/boiling range	No data available	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		
Upper flammability limit:	No data available	
Lower flammability limit:	No data available	
Vapor pressure	No data available	None known
Relative vapor density	No data available	None known
Specific Gravity	1.225@ 20°C	
Water solubility	Soluble in water	
Solubility in other solvents	No data available	None known
Partition coefficient	No data available	
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	45 cPs @ 20C	
Dynamic viscosity	No data available	None known
Explosive properties	No information available.	
Oxidizing properties	No information available.	
Molecular weight	No information available	
VOC Percentage Volatility	No information available	
Liquid Density	No information available	
Bulk density	10.22 lbs/gal	

10. STABILITY AND REACTIVITY

Reactivity/Chemical Stability

Stable under normal conditions

Possibility of hazardous reactions

None under normal processing.

Conditions to avoid

Heat, flames and sparks.

Incompatible materials

Oxidizing agents. Nitric acid. Peroxides. Chromates.

Hazardous decomposition products

Oxides of carbon.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation

High concentrations of mist or vapor may cause irritation of the respiratory tract.

Eye contact

May cause slight eye irritation.

Skin contact

May cause slight skin irritation.

Ingestion

May be harmful if swallowed.

Information on toxicological effects**Symptoms**

Prolonged exposure may cause headaches, nausea, dizziness, eye, skin and respiratory irritation.

Numerical measures of toxicity**Acute toxicity**

The following values are calculated based on chapter 3.1 of the GHS document .

ATEmix (oral) 13,548.00 mg/kg

ATEmix (dermal) 13,903.00 mg/kg

Unknown acute toxicity No information available

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Glycerine 56-81-5	= 12600 mg/kg (Rat)	> 10 g/kg (Rabbit)	> 570 mg/m ³ (Rat) 1 h
Water 7732-18-5	> 90 mL/kg (Rat)	Not available	Not available
Sodium Chloride 7647-14-5	= 3 g/kg (Rat)	Not available	> 42 g/m ³ (Rat) 1 h
Methanol 67-56-1	= 6200 mg/kg (Rat)	= 15840 mg/kg (Rabbit)	= 22500 ppm (Rat) 8 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure**Skin corrosion/irritation**

May cause slight irritation with discomfort and local redness.

Serious eye damage/eye irritation

Symptoms include pain, redness and tearing.

Respiratory or skin sensitization

No information available.

Germ cell mutagenicity

No information available.

Carcinogenicity

No information available.

Chemical Name	ACGIH	IARC	NTP	OSHA
Glycerine 56-81-5	Not available	Not available	Not available	Not available
Water 7732-18-5	Not available	Not available	Not available	Not available
Sodium Chloride 7647-14-5	Not available	Not available	Not available	Not available
Methanol 67-56-1	Not available	Not available	Not available	Not available

Reproductive toxicity

No information available.

Specific target organ systemic toxicity - single exposure

No information available.

Specific target organ systemic toxicity - repeated exposure

No information available.

Aspiration hazard

No information available.

12. ECOLOGICAL INFORMATION**Ecotoxicity**

Chemical Name	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Fish Species Data	Toxicity to microorganisms	Crustacea
Glycerine 56-81-5	Not available	51 - 57 mL/L LC50 (Oncorhynchus mykiss) 96 h static	Not available	Not available
Water 7732-18-5	Not available	Not available	Not available	Not available
Sodium Chloride 7647-14-5	Not available	5560 - 6080 mg/L LC50 (Lepomis macrochirus) 96 h flow-through 12946 mg/L LC50 (Lepomis macrochirus) 96 h static 6020 - 7070 mg/L LC50 (Pimephales promelas) 96 h static 7050 mg/L LC50 (Pimephales promelas) 96 h semi-static 6420 - 6700 mg/L LC50 (Pimephales promelas) 96 h static 4747 - 7824 mg/L LC50 (Oncorhynchus mykiss) 96 h flow-through	Not available	EC50: =1000mg/L (48h, Daphnia magna) EC50: 340.7 - 469.2mg/L (48h, Daphnia magna)
Methanol 67-56-1	Not available	28200 mg/L LC50 (Pimephales promelas) 96 h flow-through 100 mg/L LC50 (Pimephales promelas) 96 h static 19500 - 20700 mg/L LC50 (Oncorhynchus mykiss) 96 h flow-through 18 - 20 mL/L LC50 (Oncorhynchus mykiss) 96 h static 13500 - 17600 mg/L LC50 (Lepomis macrochirus) 96 h flow-through	Not available	Not available

Persistence and degradability No information available.**Bioaccumulation** No information available.

Component Information

Chemical Name	Partition coefficient
Glycerine 56-81-5	-1.76
Water 7732-18-5	Not available
Sodium Chloride 7647-14-5	Not available
Methanol 67-56-1	-0.77

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Do not reuse empty containers.

14. TRANSPORT INFORMATION

TDG (Canada):

UN Number	Not applicable
Shipping name	Not regulated
Class	Not applicable
Packing Group	Not applicable
Marine pollutant	Not available.

DOT (U.S.)

UN Number	Not applicable
Shipping name	Not regulated
Class	Not applicable
Packing Group	Not applicable
Marine pollutant	Not available

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

U.S. Regulatory Rules

Chemical Name	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Glycerine - 56-81-5	Not Listed	Not Listed	Not Listed
Water - 7732-18-5	Not Listed	Not Listed	Not Listed
Sodium Chloride - 7647-14-5	Not Listed	Not Listed	Not Listed
Methanol - 67-56-1	Not Listed	Listed	Listed

International Inventories

TSCA	Complies
DSL/NDL	Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

16. OTHER INFORMATION, INCLUDING DATE OF PREPARATION OF THE LAST REVISION

NFPA:	Health hazards 0	Flammability 0	Instability 0	Physical and chemical properties -
HMIS Health Rating:	Health hazards 0	Flammability 0	Physical hazards 0	Personal protection X

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Prepared By: The Environment, Health and Safety Department of Univar Canada Ltd.**Preparation Date:** 09/Mar/2018**Revision Date:** 09/Mar/2018**Disclaimer****NOTICE TO READER:**

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End of Safety Data Sheet



SAFETY DATA SHEET

SDS00404
ALS Aluminum Sulphate

Preparation Date: 07/Nov/2017

Version: 3

1. IDENTIFICATION

Product identifier

Product Name ALS Aluminum Sulphate

Other means of identification

Product Code(s) SDS00404

Synonyms none

Recommended use of the chemical and restrictions on use

Recommended Use Water treatment (potable and waste water). Paper applications.

Restricted Uses No information available

Initial Supplier Identifier

Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC V6X 1W5
Telephone: 1-866-686-4827

Emergency telephone number

24 Hour Emergency Phone Number (CANUTEC): 1-888-226-8832 (1-888-CAN-UTEC)

2. HAZARD IDENTIFICATION

Hazardous Classification of the substance or mixture

Corrosive to metals	Category 1
Serious eye damage/eye irritation	Category 1

Label elements

Hazard pictograms



Signal Word: Danger

Hazard statements

May be corrosive to metals
Causes serious eye damage

Precautionary Statements

Prevention

Wash face, hands and any exposed skin thoroughly after handling
Keep only in original container
Wear eye/face protection

Response

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
IF SWALLOWED: Call a POISON CENTER or doctor if you feel unwell
Rinse mouth

In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish

Storage

Store locked up
Store in a well-ventilated place. Keep container tightly closed

Disposal

Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations

Other Information

Unknown acute toxicity No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance

Chemical Name	CAS No	Weight-%	Synonyms
Sulfuric acid, aluminum salt	10043-01-3	20 - 30%	Sulfuric acid, aluminum salt

4. FIRST AID

Description of first aid measures

General advice

Show this safety data sheet to the doctor in attendance.

Inhalation

Remove to fresh air.

Eye contact

Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact

Wash with soap and water. Take off contaminated clothing and wash before reuse. Get medical attention if irritation develops and persists.

Ingestion

Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Call a physician.

Most important symptoms and effects, both acute and delayed:

May cause digestive tract irritation. May cause respiratory tract irritation May cause moderate skin irritation. Direct contact may cause moderate irritation.

Indication of any immediate medical attention and special treatment needed:**Note to physicians**

Treatment based on sound judgment of physician and individual reactions of patient.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media

Use extinguishing media appropriate for surrounding fire.

Specific hazards arising from the substance or mixture

Use water spray to cool fire-exposed containers and structures. Under fire conditions, toxic, corrosive fumes are emitted.

Hazardous combustion products

Thermal decomposition: after completely dry and heated to decomposition will produce sulphur oxides and aluminum oxides.

Special protective equipment for fire-fighters

Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Use personal protective equipment as required. Wash thoroughly after handling.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. Consult local authorities.

Methods and materials for containment and cleaning up

Small spills: soak up with absorbent material and scoop into containers. Large spills : prevent contamination of waterways. Dike and pump into suitable containers. Clean up residual with absorbent material, place in appropriate container and flush with water. Neutralize with lime or limestone powder.

7. HANDLING AND STORAGE

Precautions for safe handling

Empty containers may contain hazardous product residues. Use appropriate personnel protective equipment. Wash thoroughly after handling. Avoid contact with eyes, skin and clothing.

Conditions for safe storage, including any incompatibilities

Place away from incompatible materials. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid). Suitable material: Stainless steel, rubber-coated steel, plastic, plastic with fiberglass reinforcement. Unsuitable material: Common metal. Do not store in aluminum, copper, copper alloys and galvanized containers. Shelf life: 12 months in original, sealed container. Keep at temperatures between 0 and 30 °C. Reason: Quality.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits

Chemical Name	Alberta OEL	British Columbia OEL	Ontario	Quebec OEL	Exposure Limit - ACGIH	Immediately Dangerous to Life or Health - IDLH
Sulfuric acid, aluminum salt 10043-01-3	TWA: 2 mg/m ³	Not available	Not available	TWA: 2 mg/m ³	Not available	Not available

Consult local authorities for recommended exposure limits

Appropriate engineering controls

Engineering controls

Local exhaust ventilation as necessary to maintain exposures to within applicable limits.

Individual protection measures, such as personal protective equipment

Eye/face protection

Chemical goggles; also wear a face shield if splashing hazard exists.

Hand protection

Appropriate chemical resistant gloves should be worn.

Skin and body protection

Skin contact should be prevented through the use of suitable protective clothing, gloves and footwear, selected for conditions of use and exposure potential. Consideration must be given both to durability as well as permeation resistance.

Respiratory protection

If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator.

General hygiene considerations

Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES**Information on basic physical and chemical properties****Appearance**

Physical state	Liquid
Color	Colorless Clear
Odor	Slight ACIDIC
Odor threshold	No information available

PROPERTIES	Values	Remarks • Method
pH	<2.5	
Melting point / freezing point	-13 °C / 9 °F	
Initial boiling point/boiling range	110 °C / 230 °F	None known
Flash point	No data available	None known
Evaporation rate	similar to water	
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability limit:	No data available	
Lower flammability limit:	No data available	
Vapor pressure	40 mmHg @ 35°C	
Relative vapor density	No data available	None known
Specific Gravity	1.2 - 1.36	
Water solubility	Completely soluble	
Solubility in other solvents	No data available	
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known
Explosive properties	No information available.	
Oxidizing properties	Not oxidizing.	
Molecular weight	No information available	
VOC Percentage Volatility	No information available	
Liquid Density	No information available	
Bulk density	No information available	

10. STABILITY AND REACTIVITY**Reactivity/Chemical Stability**

Stable under normal conditions

Possibility of hazardous reactions

No additional remark.

Conditions to avoid

Avoid contact with mineral acids, excessive heat and bases/alkalis.

Incompatible materials

Metals such as iron or steel which are subject to corrosion. Carbon steel, aluminum, carbon, brasses and nylon.

Hazardous decomposition products

Thermal decomposition: after completely dry and heated to decomposition will produce sulphur oxides and aluminum oxides. Decomposition : 650 °C/ 1202 °F.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation

May cause respiratory tract irritation.

Eye contact

Direct contact may cause moderate irritation.

Skin contact

May cause moderate skin irritation.

Ingestion

May cause digestive tract irritation.

Information on toxicological effects

Symptoms

No additional information available.

Numerical measures of toxicity

Acute toxicity

The following values are calculated based on chapter 3.1 of the GHS document .

ATEmix (oral) 1,930.00 mg/kg

Unknown acute toxicity No information available

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Sulfuric acid, aluminum salt 10043-01-3	= 1930 mg/kg (Rat)	Not available	Not available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation

May cause moderate skin irritation.

Serious eye damage/eye irritation

Direct contact may cause moderate irritation.

Respiratory or skin sensitization

No information available.

Germ cell mutagenicity

No information available.

Carcinogenicity

No information available.

Chemical Name	ACGIH	IARC	NTP	OSHA
Sulfuric acid, aluminum salt 10043-01-3	Not available	Not available	Not available	Not available

Reproductive toxicity

No information available.

Specific target organ systemic toxicity - single exposure

No information available.

Specific target organ systemic toxicity - repeated exposure

No information available.

Aspiration hazard

No information available.

12. ECOLOGICAL INFORMATION**Ecotoxicity**

May lower pH of waterways and adversely effect aquatic life.

Chemical Name	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Fish Species Data	Toxicity to microorganisms	Crustacea
Sulfuric acid, aluminum salt 10043-01-3	Not available	Not available	Not available	Not available

Persistence and degradability No information available.**Bioaccumulation** No information available.

Chemical Name	Partition coefficient
Sulfuric acid, aluminum salt 10043-01-3	Not available

Other adverse effects No information available.**13. DISPOSAL CONSIDERATIONS****Waste treatment methods**

Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Do not reuse empty containers.

14. TRANSPORT INFORMATION**TDG (Canada):**

UN Number	UN3264
Shipping name	CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (ALUMINUM SULPHATE)
Class	8
Packing Group	III
Marine pollutant	Not available.

DOT (U.S.):

UN Number	UN3264
Shipping name	CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (ALUMINUM SULPHATE)
Class	8

Packing Group
Marine pollutant

III
Not available

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

NSF International



Additional information

Maximum use for potable water 400 mg/L. Only products bearing the NSF Mark on the product, product packaging, and/or documentation shipped with the product are Certified.

U.S. Regulatory Rules

Chemical Name	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Sulfuric acid, aluminum salt - 10043-01-3	Not Listed	Listed	Not Listed

International Inventories

TSCA Complies
DSL/NDSL Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

16. OTHER INFORMATION, INCLUDING DATE OF PREPARATION OF THE LAST REVISION

NFPA: Health hazards 1 Flammability 0 Instability 0 Physical and chemical properties -
HMIS Health Rating: Health hazards 1 Flammability 0 Physical hazards 0 Personal protection X

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA TWA (time-weighted average) STEL STEL (Short Term Exposure Limit)
Ceiling Maximum limit value * Skin designation

Prepared By: The Environment, Health and Safety Department of Univar Canada Ltd.

Preparation Date: 07/Nov/2017

Revision Date: 07/Nov/2017

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End of Safety Data Sheet



SAFETY DATA SHEET

SDS00256
SODA ASH 58% DENSE

Preparation Date: 10/Jan/2018

Version: 2

1. IDENTIFICATION

Product identifier

Product Name SODA ASH 58% DENSE

Other means of identification

Product Code(s) SDS00256

Synonyms Sodium carbonate, anhydrous. Carbonic acid, disodium salt; Disodium carbonate; Soda ash

Recommended use of the chemical and restrictions on use

Recommended Use Soda salts. Manufacture of glass. Soap Cleaners and water softeners. Pulp and paper. Photographical agent. Water treatment. pH adjustment

Restricted Uses No information available

Initial Supplier Identifier

Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC V6X 1W5
Telephone: 1-866-686-4827

Emergency telephone number

24 Hour Emergency Phone Number (CANUTEC): 1-888-226-8832 (1-888-CAN-UTEC)

2. HAZARD IDENTIFICATION

Hazardous Classification of the substance or mixture

Serious eye damage/eye irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3

Label elements

Hazard pictograms**Signal Word: Danger****Hazard statements**

Causes serious eye damage
May cause respiratory irritation

Precautionary Statements**Prevention**

Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower
IF INHALED: Remove person to fresh air and keep comfortable for breathing
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting

Storage

Store locked up
Store in a well-ventilated place. Keep container tightly closed

Disposal

Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations

Direct skin contact may cause slight or mild, transient irritation. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Unknown acute toxicity No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS**Substance**

Chemical Name	CAS No	Weight-%	Synonyms
Sodium Carbonate	497-19-8	90 - 100%	Sodium Carbonate

4. FIRST AID**Description of first aid measures****General advice**

Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Inhalation

Remove to fresh air. If breathing has stopped, give artificial respiration. Get medical attention immediately. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur.

Eye contact

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Do not rub affected area. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact

Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention.

Ingestion

Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Get immediate medical advice/attention.

Self-protection of the first aider

Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed:

May cause gastrointestinal irritation, nausea, vomiting and diarrhea. May cause severe eye irritation. Symptoms include redness, swelling, itching and pain. Material is irritating to mucous membrane and upper respiratory tract. Exposure can cause coughing, chest pains and difficulty in breathing. Effects may include pain, marked redness and swelling.

Indication of any immediate medical attention and special treatment needed:**Note to physicians**

Treatment based on sound judgment of physician and individual reactions of patient.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media

Use extinguishing media appropriate for surrounding fire. Does not burn.

Specific hazards arising from the substance or mixture

Not flammable.

Hazardous combustion products

Carbon dioxide. Decomposition temperature: >400°C / 752 °F.

Special protective equipment for fire-fighters

Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Attention! Corrosive material. Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Should not be released into the environment. Do not allow to enter into soil/subsoil. Prevent product from entering drains.

Methods and materials for containment and cleaning up

Stop leak if you can do it without risk. Shovel, sweep up or use industrial vacuum cleaner to pick up. Sweep up and place in an appropriate closed container. Avoid raising dust.

7. HANDLING AND STORAGE

Precautions for safe handling

Use good personal hygiene. Avoid prolonged contact with eyes or prolonged skin contact. Avoid breathing in dust. When dissolving, add to water cautiously while stirring; solutions can get hot.

Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area. Prolonged storage may cause product to cake and become damp from atmospheric moisture. Store away from acids.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits

This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Chemical Name	Alberta OEL	British Columbia OEL	Ontario	Quebec OEL	Exposure Limit - ACGIH	Immediately Dangerous to Life or Health - IDLH
Sodium Carbonate 497-19-8	Not available	Not available	Not available	Not available	Not available	Not available

Consult local authorities for recommended exposure limits

Appropriate engineering controls

Engineering controls

Local exhaust ventilation as necessary to maintain exposures to within applicable limits.

Individual protection measures, such as personal protective equipment

Eye/face protection

Safety glasses with side shields or chemical goggles.

Hand protection

Appropriate chemical resistant gloves should be worn. Break through time >8 hours. Butyl rubber gloves. Natural rubber gloves. Neoprene gloves. Nitrile gloves. Polyvinylchloride (PVC) gloves. Viton gloves. Silver Shield (R). NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials as well as the instructions/specifications provided by the glove supplier.

Skin and body protection

As a minimum, wear long-sleeve shirts, trousers, and gloves for routine product use.

Respiratory protection

For dusty or misty conditions, wear NIOSH-approved dust or mist respirator.

General hygiene considerations

Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties**Appearance**

Physical state	Solid
Color	White
Odor	Odorless
Odor threshold	No information available

PROPERTIES**Values****Remarks • Method**

pH	11.3-11.4 (1% solution), 11.6 (5% solution), 11.7 (10% solution) @ 20°C	
Melting point / freezing point	851 °C / 1563.8 °F	
Initial boiling point/boiling range	No data available	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		
Upper flammability limit:	No data available	
Lower flammability limit:	No data available	
Vapor pressure	No data available	None known
Relative vapor density	No data available	None known
Specific Gravity	2.533 @ 20°C	
Water solubility	Soluble in water	
Solubility in other solvents	No data available	
Partition coefficient	No data available	
Autoignition temperature	No data available	None known
Decomposition temperature	>400°C/752°F	
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known
Explosive properties	No information available.	
Oxidizing properties	No information available.	
Molecular weight	105.99	
VOC Percentage Volatility	No information available	
Liquid Density	No information available	
Bulk density	No information available	

10. STABILITY AND REACTIVITY

Reactivity/Chemical Stability

Stable

Possibility of hazardous reactions

Contact with acids will release carbon dioxide gas. Can react violently with red hot aluminum metal; fluorine gas; lithium; and 2,4,6-trinitrotoluene.

Hazardous polymerization

Will not occur.

Conditions to avoid

Hygroscopic (absorbs moisture from the air). Simultaneous exposure to soda ash and lime dusts (CaO). In the presence of moisture (i.e. perspiration) the two materials combine to form corrosive caustic soda (NaOH) which may cause burns.

Incompatible materials

Acids. Soda Ash is corrosive to aluminum, lead, and zinc and zinc brasses when in solution and to aluminum when high humidity is present. Silver nitrate. Magnesium. Fluorine. Lithium. Calcium hypochlorite.

Hazardous decomposition products

Carbon dioxide. Decomposition temperature: >400°C / 752 °F.

11. TOXICOLOGICAL INFORMATION**Information on likely routes of exposure****Inhalation**

Material is irritating to mucous membrane and upper respiratory tract. Exposure can cause coughing, chest pains and difficulty in breathing.

Eye contact

Causes serious eye damage. Effects may include pain, marked redness and swelling.

Skin contact

Symptoms include redness, swelling, itching and pain.

Ingestion

May cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Information on toxicological effects**Symptoms**

Excessive contact may produce "soda ulcers" on hands and perforation of the nasal septum. Sensitivity reactions may occur from prolonged and repeated exposure.

Numerical measures of toxicity**Acute toxicity**

The following values are calculated based on chapter 3.1 of the GHS document .

ATEmix (oral) 4,098.00 mg/kg

Unknown acute toxicity No information available

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Sodium Carbonate 497-19-8	= 4090 mg/kg (Rat)	Not available	= 2300 mg/m ³ (Rat) 2 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure**Skin corrosion/irritation**

Symptoms include redness, swelling, itching and pain.

Serious eye damage/eye irritation

Causes serious eye damage. Effects may include pain, marked redness and swelling.

Respiratory or skin sensitization

No information available.

Germ cell mutagenicity

No information available.

Carcinogenicity

No information available.

Chemical Name	ACGIH	IARC	NTP	OSHA
Sodium Carbonate 497-19-8	Not available	Not available	Not available	Not available

Reproductive toxicity

No information available.

Specific target organ systemic toxicity - single exposure

May cause respiratory irritation.

Specific target organ systemic toxicity - repeated exposure

No information available.

Aspiration hazard

No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Chemical Name	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Fish Species Data	Toxicity to microorganisms	Crustacea
Sodium Carbonate 497-19-8	Not available	310 - 1220 mg/L LC50 (Pimephales promelas) 96 h static 300 mg/L LC50 (Lepomis macrochirus) 96 h static	Not available	EC50: =265mg/L (48h, Daphnia magna)

Persistence and degradability No information available.

Bioaccumulation No information available.

Chemical Name	Partition coefficient
Sodium Carbonate 497-19-8	Not available

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations.

Do not reuse empty containers.

14. TRANSPORT INFORMATION

TDG (Canada):

UN Number	Not applicable
Shipping name	Not regulated
Class	Not applicable
Packing Group	Not applicable
Marine pollutant	Not available.

DOT (U.S.)

UN Number	Not applicable
Shipping name	Not regulated
Class	Not applicable
Packing Group	Not applicable
Marine pollutant	Not available

15. REGULATORY INFORMATION**Safety, health and environmental regulations/legislation specific for the substance or mixture**

NSF International

**Additional information**

Only products bearing the NSF Mark on the product, product packaging, and/or documentation shipped with the product are Certified. Maximum use of potable water 100 mg/L.

U.S. Regulatory Rules

Chemical Name	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Sodium Carbonate - 497-19-8	Not Listed	Not Listed	Not Listed

International Inventories

TSCA	Complies
DSL/NDSL	Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

16. OTHER INFORMATION, INCLUDING DATE OF PREPARATION OF THE LAST REVISION

NFPA:	Health hazards 3	Flammability 0	Instability 0	Physical and chemical properties -
HMIS Health Rating:	Health hazards 3	Flammability 0	Physical hazards 0	Personal protection X

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Prepared By: The Environment, Health and Safety Department of Univar Canada Ltd.

Preparation Date: 10/Jan/2018

Revision Date: 10/Jan/2018

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End of Safety Data Sheet



MATERIAL SAFETY DATA SHEET

Revision date: 06/15/2011

Revision number: 3

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name BioRemove 5895

Contact Manufacturer Novozymes Biologicals Inc.
5400 Corporate Circle
Salem, VA, USA 24153

Information Telephone Number 1-540-389-9361

Emergency Telephone Number 1-800-424-9300 (Chemtrec) 24 hours every day

Health Hazard	1
Fire Hazard	0
Reactivity	0

2. HAZARDS IDENTIFICATION

CAUTION

Emergency Overview

Contact may cause eye and skin irritation

Appearance Opaque

Physical State Liquid

Odor Slight fermentation odor

Potential Health Effects

Principle Routes of Exposure Eye contact, Skin contact, Inhalation

Acute Effects

Eyes

May cause slight irritation

Skin

Substance may cause slight skin irritation

Inhalation

May cause irritation of respiratory tract

Ingestion

Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea

Chronic Effects

Chronic Toxicity No information available

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions No information available

Potential Environmental Effects There is no known ecological information for this product
See Section 12 for additional Ecological information

3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous Components

Chemical Name	CAS-No	Weight %
Water	7732-18-5	95-100%
Viable Bacteria Cultures	Not Applicable	1-5%

Ingredients not listed are either non-hazardous or under reportable concentrations

4. FIRST AID MEASURES

Eye Contact	Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician
Skin Contact	Wash off immediately with soap and plenty of water
Inhalation	Move to fresh air
Ingestion	Clean mouth with water and afterwards drink plenty of water
Notes to Physician	Treat symptomatically

5. FIRE-FIGHTING MEASURES

Flammable Properties	Slightly flammable according to HMIS criteria
Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	None
Hazardous Combustion Products	None
Specific Hazards Arising from the Chemical	May cause allergic respiratory reaction.
Protective Equipment and Precautions for Firefighters	Self-contained breathing apparatus and standard turn-out apparel

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	For personal protection see section 8
Environmental Precautions	Spilled preparation should be removed immediately to avoid formation of dust from dried preparation. Take up by mechanical means preferably by a vacuum cleaner equipped with a high efficiency filter. Flush remainder carefully with plenty of water. Avoid splashing and high pressure washing (avoid formation of aerosols). Ensure sufficient ventilation. Wash contaminated clothing. .
Methods for cleaning up	Avoid formation of dust and aerosols Spilled preparation should be removed immediately to avoid formation of dust from dried preparation. Take up by mechanical means preferably by a vacuum cleaner equipped with a HEPA (High Efficiency Particulate Air) filter. Flush remainder carefully with plenty of water. Avoid splashing, high pressure washing or compressed air cleaning to avoid formation of aerosols. Ensure sufficient ventilation. Wash contaminated clothing.
For personal protection see section 8	

7. HANDLING AND STORAGE

Handling	Avoid formation of dust and aerosols Ensure adequate ventilation
General Precautions	The Substance should be handled under conditions of good industrial hygiene and in conformity with any local regulations in order to avoid unnecessary exposure..
Storage	Keep tightly closed in a dry and cool place.
Temperature	Keep in a dry, cool and well-ventilated place.
Storage Conditions	In unbroken packaging - dry and protect from the sun. The product has been formulated for optimal stability. Extended storage or adverse conditions such as higher temperatures or higher humidity may lead to a higher dosage requirement.
Conditions To Avoid	Avoid Temperatures above 45 C to preserve biological stability. Avoid freezing temperatures. Strong Acids or alkali compounds may inactivate biological cultures. Avoid strong oxidizing agents.
Incompatible Materials	Strong acids or alkali compounds may inactivate biological cultures

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure controls

Engineering Controls	Ensure adequate ventilation, especially in confined areas Maintain good conditions of industrial hygiene. Some processes may require enclosures, local exhaust ventilation, or other engineering controls to control airborne levels. Additional handling and healthy/safety information is available upon request
-----------------------------	---

Personal Protective Equipment

Respiratory Protection	In case of insufficient ventilation wear suitable respiratory equipment that meets HEPA/P100 specifications
Eye Protection	Safety glasses with side-shields
Skin Protection	Long sleeved clothing
Hand Protection	Protective gloves
General Hygiene Considerations	Handle in accordance with good industrial hygiene and safety practices
Environmental exposure controls	Local authorities should be advised if significant spillages cannot be contained

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Opaque
Physical State	Liquid
Odor	Slight fermentation odor
pH	7.0-8.0
Boiling Point/Range	No information available
Melting Point/Range	No information available
Flash Point	No information available
Flammability (solid, gas)	No information available
Explosive Properties	No information available
Oxidizing Properties	No information available
Vapor Pressure	No information available
Relative density	No data available
Solubility	No information available
Partition Coefficient (n-octanol/water)	No information available

The physical data presented above are typical values and should not be construed as a specification

10. STABILITY AND REACTIVITY

Chemical stability	Stable under recommended storage conditions
Conditions to Avoid	Stable under normal conditions Excessive temperature variations below 32F or above 155F
Materials to avoid	None
Hazardous Decomposition Products	None
Possibility of Hazardous Reactions	None

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Ingestion, LD50 Rat Oral (mg/kg):	Not Determined
Inhalation, LC50 Rat inhalation (mg/l/4hr)	Not Determined
Skin, LD50 Rat Dermal (mg/kg)	Not Determined
Eye Irritation	Not Determined

Chronic Toxicity

Sensitization	According to our experience and to the information provided to us, the product does not have any harmful effects if it is used and handled as specified
---------------	---

This product is formulated using a range of microorganisms specially selected from the natural environment

12. ECOLOGICAL INFORMATION

Ecotoxicity

This product is not expected to pose an environmental hazard. No Toxicity Data is available specifically for soil organisms, plants and terrestrial animals.

Environmental Effects	The data available do not support any environmental hazard
Persistence/Degradability	The organic components of the product are biodegradable.
Bioaccumulative Potential	According to experience not expected
Mobility	Not available
Other adverse effects	No known effect

13. DISPOSAL CONSIDERATIONS

Waste Disposal Method	Dispose of contents/container in accordance with local regulation.
Contaminated Packaging	Dispose of wastes in an approved waste disposal facility.

14. TRANSPORT INFORMATION

Transport Regulations	Not dangerous goods
IMDG/IMO	Not regulated
RID	Not regulated
ADR	Not regulated
ICAO	Not regulated
IATA	Not regulated
DOT	Not regulated

15. REGULATORY INFORMATION

International Inventories

TSCA	Complies
PICCS	Complies
KECL	Complies
ENCS	Complies
CHINA	Complies
AICS	Complies
DSL/NDSL	Complies

USA, Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and 40 CFR Part 372.

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

USA, State Regulations

California Proposition 65

This product contains the following Proposition 65 chemicals:

Canada

WHMIS Hazard Class

Controlled product hazard class D2 A (respiratory sensitizer)

WHMIS Statement

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the SDS contains all the information required by the CPR.

16. OTHER INFORMATION

Disclaimer

The information provided on this MSDS is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text. Furthermore, as the conditions of use are beyond the control of Novozymes, it is the responsibility of the customer to determine the conditions of safe use of these products.

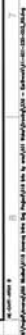


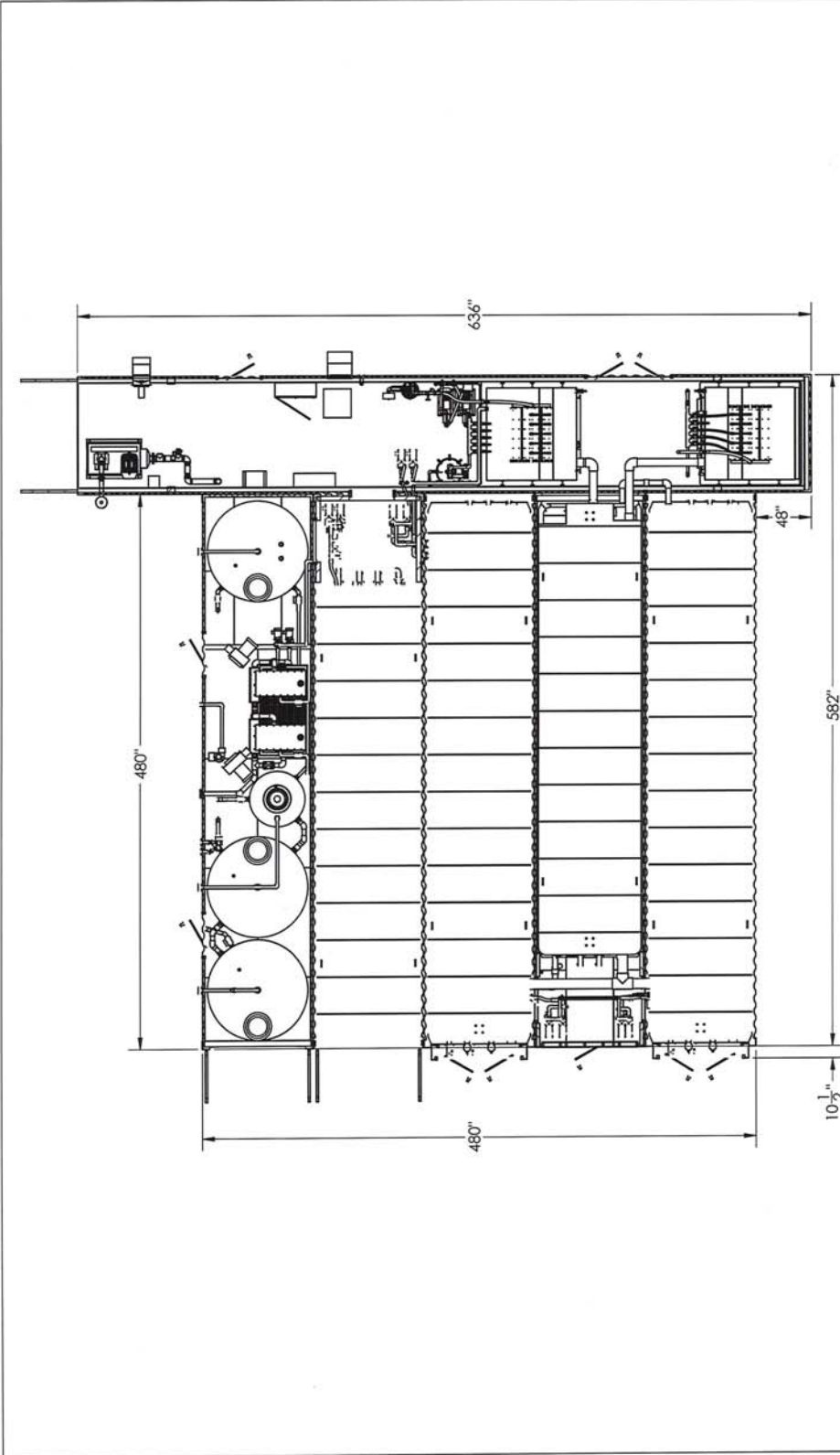
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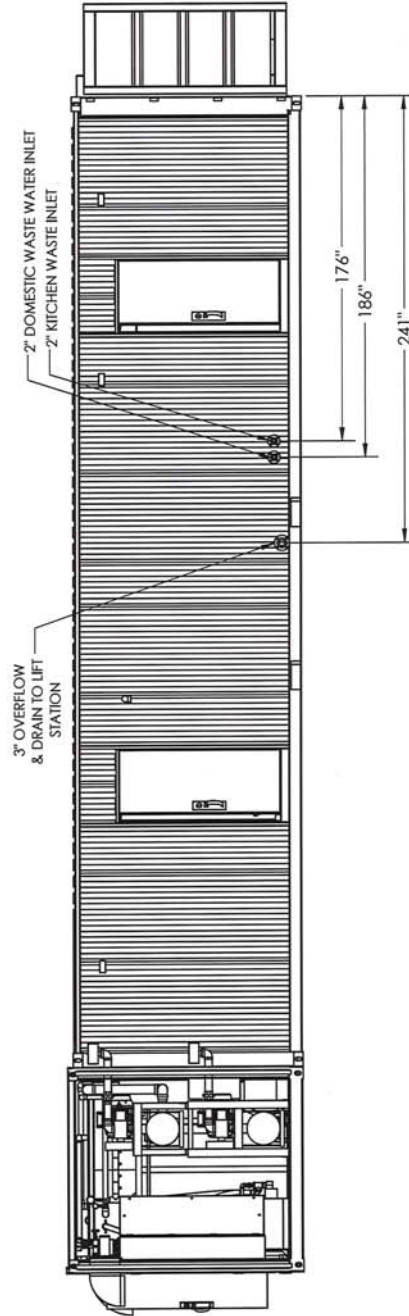
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Appendix B: Drawings

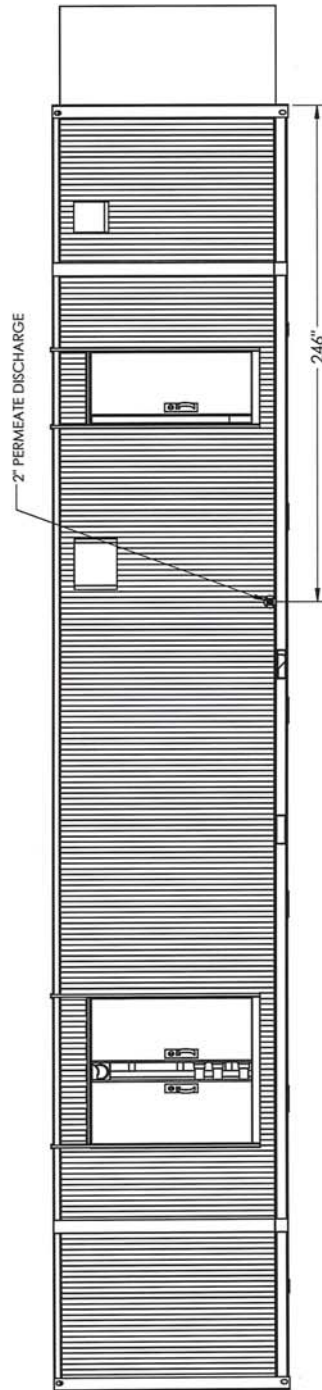




GENERAL TOLERANCES		DWG. NO:		PROJECT NUMBER	
XX 1/4"	XX 1/2"	TITLE		1704432	
XX 3/8"	XX 1"	CUSTOMER:		AGNICO EAGLE	
UNLESS OTHERWISE SPECIFIED		BY		GH	
DIMENSIONS ARE IN INCHES		DATE		19/05/17	
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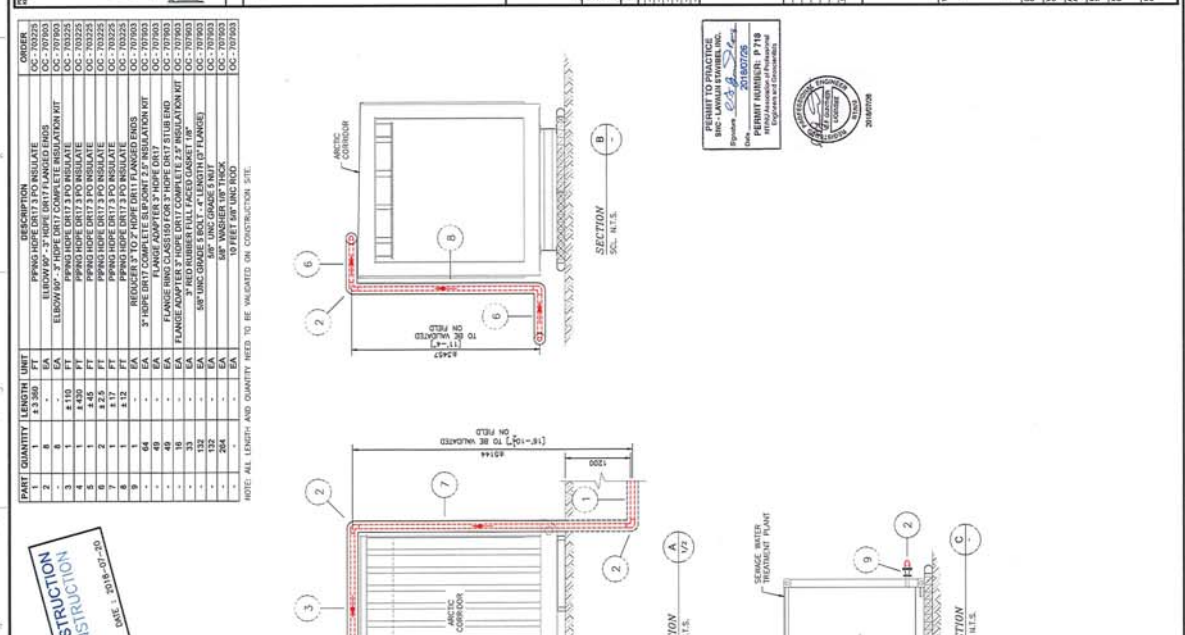


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GENERAL TOLERANCES XX ± 1/8" XXX ± 1/16"		DWG. NO: 1704432	
newterra THIS INFORMATION IS THE PROPERTY OF NEWTERRA. IT IS TO BE USED ONLY FOR THE PROJECT AND SITE SPECIFICALLY IDENTIFIED. NO REPRODUCTION OR REPRODUCTION WITHOUT WRITTEN CONSENT.		TITLE: SYSTEM LAYOUT	
C1 1/18/17 C2 1/18/17 C3 1/18/17 C4 1/18/17 C5 1/18/17 C6 1/18/17 C7 1/18/17 C8 1/18/17 C9 1/18/17 C10 1/18/17 C11 1/18/17 C12 1/18/17 C13 1/18/17 C14 1/18/17 C15 1/18/17 C16 1/18/17 C17 1/18/17 C18 1/18/17 C19 1/18/17 C20 1/18/17 C21 1/18/17 C22 1/18/17 C23 1/18/17 C24 1/18/17 C25 1/18/17 C26 1/18/17 C27 1/18/17 C28 1/18/17 C29 1/18/17 C30 1/18/17 C31 1/18/17 C32 1/18/17 C33 1/18/17 C34 1/18/17 C35 1/18/17 C36 1/18/17 C37 1/18/17 C38 1/18/17 C39 1/18/17 C40 1/18/17 C41 1/18/17 C42 1/18/17 C43 1/18/17 C44 1/18/17 C45 1/18/17 C46 1/18/17 C47 1/18/17 C48 1/18/17 C49 1/18/17 C50 1/18/17 C51 1/18/17 C52 1/18/17 C53 1/18/17 C54 1/18/17 C55 1/18/17 C56 1/18/17 C57 1/18/17 C58 1/18/17 C59 1/18/17 C60 1/18/17 C61 1/18/17 C62 1/18/17 C63 1/18/17 C64 1/18/17 C65 1/18/17 C66 1/18/17 C67 1/18/17 C68 1/18/17 C69 1/18/17 C70 1/18/17 C71 1/18/17 C72 1/18/17 C73 1/18/17 C74 1/18/17 C75 1/18/17 C76 1/18/17 C77 1/18/17 C78 1/18/17 C79 1/18/17 C80 1/18/17 C81 1/18/17 C82 1/18/17 C83 1/18/17 C84 1/18/17 C85 1/18/17 C86 1/18/17 C87 1/18/17 C88 1/18/17 C89 1/18/17 C90 1/18/17 C91 1/18/17 C92 1/18/17 C93 1/18/17 C94 1/18/17 C95 1/18/17 C96 1/18/17 C97 1/18/17 C98 1/18/17 C99 1/18/17 C100 1/18/17		CUSTOMER: AGNICO EAGLE	
REVISION BY: REVISION		SHEET 4 OF 4	





PROSIDENT BETA 4
 FLOWMETER & PRESSURE - 45 GPM @ 10 FT
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - N/A

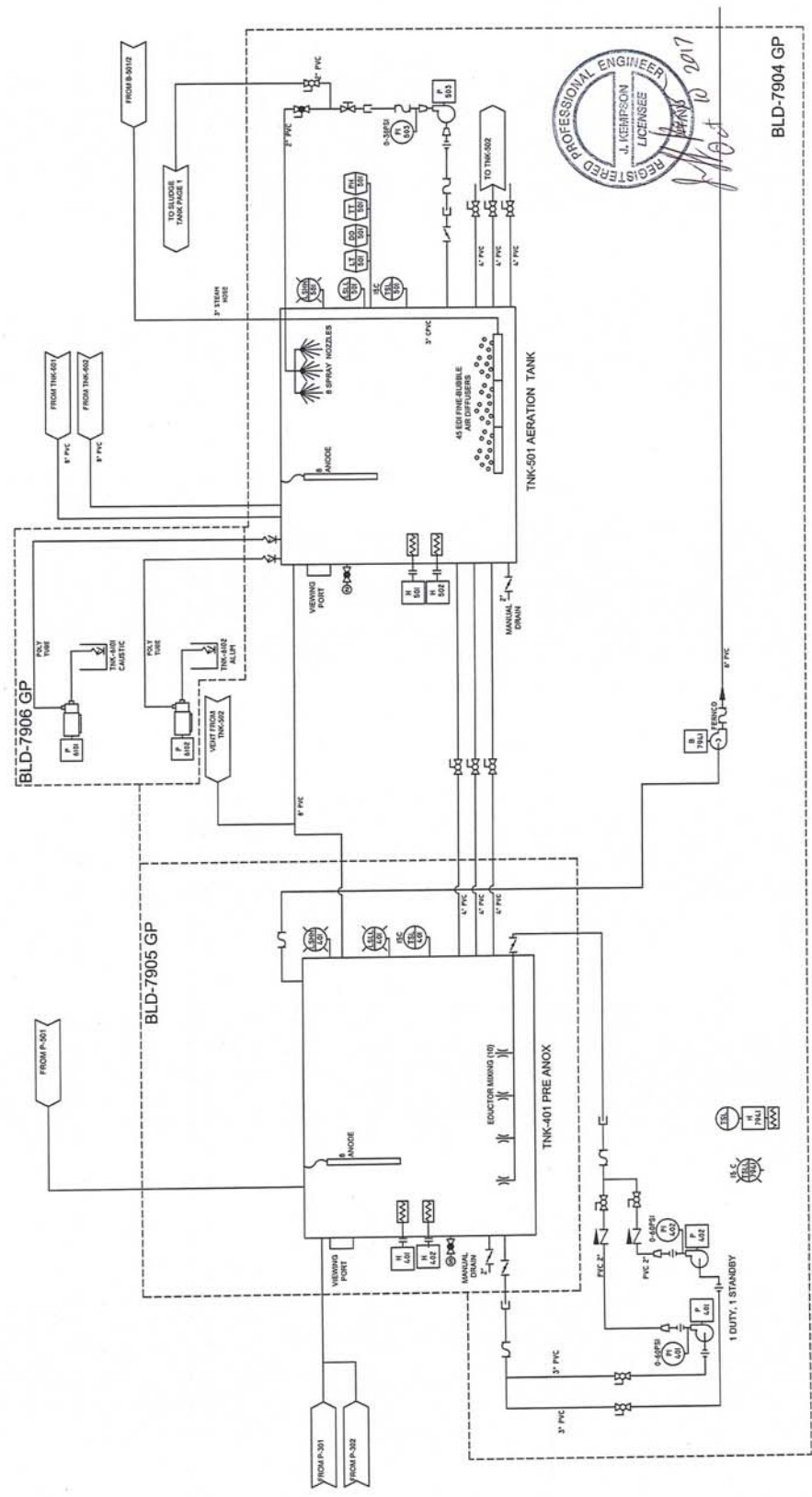
PRICE PUMPS BC-250
 FLOWMETER & PRESSURE - 45 GPM @ 10 FT
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - N/A

OUTLET OACALABE
 FLOWMETER & PRESSURE - N/A
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - 2.5 A

CINCINNATI LUG
 FLOWMETER & PRESSURE - 45 GPM @ 10 FT
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - 2.5 A

CALORTEC COT 1200-AL-103
 FLOWMETER & PRESSURE - N/A
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - 10.2 A

PRICE PUMPS BC-100
 FLOWMETER & PRESSURE - 45 GPM @ 10 FT
 VOLTAGE & PHASE - 240V 3 PH, 480V 3 PH, 208V 3 PH
 FULL-LOAD AMPS - 2.5 A

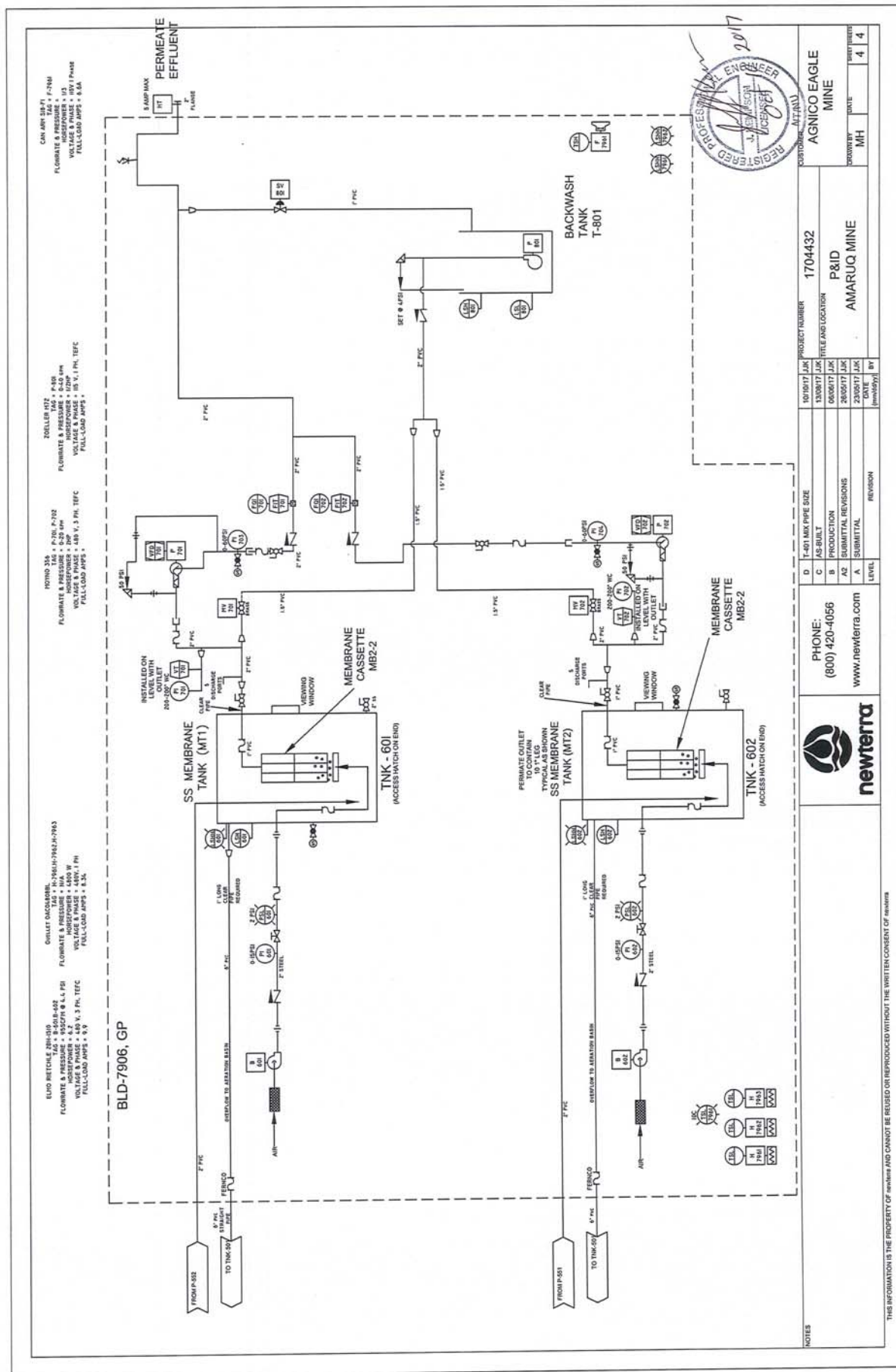


NOTES		PROJECT NUMBER		CUSTOMER	
1-401 MAX PIPE SIZE		1704432		AGNICO EAGLE MINE	
AS-BUILT		P&ID		AMARUQ MINE	
PRODUCTION		SUBMITTAL REVISIONS		DATE	
A2		SUBMITTAL		BY	
LEVEL		REVISION		DATE	
A		SUBMITTAL		BY	
1		SUBMITTAL		DATE	
2		SUBMITTAL		DATE	
3		SUBMITTAL		DATE	
4		SUBMITTAL		DATE	



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AGNICO EAGLE

Operation & Maintenance Manual
Sewage Treatment Plant

December 2018

Appendix C: Newterra Operation and Maintenance Manual



newterra MBR Wastewater Treatment Plant OPERATION AND MAINTENANCE MANUAL

System:	newterra MBR WWTP
Location:	Amaruq mine, Kivalliq District of Nunavut
Client:	Agnico Eagle
Project:	1704432
Rev.:	1
Date:	August 2017



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1.0 INTRODUCTION

The purpose of this manual is to provide necessary information for the Installation, Operation and Maintenance of the Wastewater Treatment Plant equipment.

	The newterra MicroClear™ MBR wastewater treatment plant (WWTP) functions optimally if the operating procedures described in this manual are followed. If you have any questions after reading through this manual, please contact newterra ltd.
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- This O&M Manual must be kept on-site and available to employees at all time.
- It is **IMPERATIVE** that employees read the manual **BEFORE** working in the plant.
- Employees must read **Section 2** – Health and Safety.
- Technical Support Department contacts are provided in **Section 9**.



WARNING: Failure to comply with the instructions provided in this manual can cause equipment & property damage or severe personal injury, and will render the warranty null and void.

2.0 SAFETY

2.1 Introduction

This section provides general personal and environmental safety information for newterra MBR WWTP operators.

Always refer to local codes and regulations.

Specific equipment and parts safety information can be found in Appendix E. Material Safety Data Sheets (MSDSs) include detailed information regarding health & safety of chemicals used in wastewater treatment process and are presented in Appendix F. These are sample MSDS sheets and need to be replaced by the actual vendor MSDS sheets.

Information and guidelines outlined in this manual **must** be followed at all times prior to system installation and during operation and maintenance.

ESSENTIAL FOR SAFE OPERATION:

- Installation and operation of the newterra system must only be carried out by **trained and qualified** personnel.
- All necessary **safety precautions must** be carefully exercised, including but not limited to proper use of personal protective equipment considering given working environment and conditions.
- All **electrical installations and troubleshooting must** only be carried out by licensed electricians.
- All **plumbing work must** only be carried out by licensed plumbers or qualified personnel.
- Please keep in mind that trees and shrubs taller than two meters located in close proximity to the newterra system may become a safety concern at the time of installation or service.

DEFINITION OF SAFETY AND WARNING SIGNS USED IN THE MANUAL



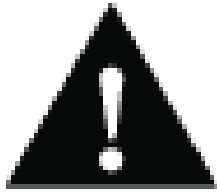
ATTENTION SYMBOL

Special attention is required to ensure compliance with instructions concerning correct operating sequences to prevent damage to the plant or its function.



GENERAL WARNING SIGN

This symbol accompanies all important instructions or warnings associated with risks of injury as well as possible equipment damage.



WARNING

CRITICAL WARNING SIGN

Warns against an unsafe situation or practice associated with severe injury as well as major equipment damage.

2.2 Personal Protective Equipment (PPE)

Personal protective equipment (PPE) refers to protective clothing, gloves, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, masks, and others.

The purpose of personal protective equipment is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels. PPE is needed when there are hazards present. PPE has the serious limitation that it does not eliminate the hazard at source and may result in employees being exposed to the hazard if the equipment fails.

The following list includes the minimum scope of PPE that should be available to system operators:

2.2.1 Head protection

Hard hats, bump caps, or helmets are types of protection that should be considered if there is a hazard of head injury. Head injuries can occur under various circumstances including as the result of a slip or fall, working in confined areas or where there are low ceilings, where there may be falling objects. Hard hats should be worn at all times when overhead work is being conducted.

2.2.2 Eye and Face Protection

Eye protection with side shields should be used at all times while inside the newterra system as there may be a danger of flying objects, particles, liquids, sprays or other matter entering the eyes. Protection can take many forms including:

- safety glasses,
- goggles, or
- full face protection. This should be used if handling chemicals, waste product or working around pressurized lines (air of liquid).

2.2.3 Foot Protection

Foot protection should be used at all times within the newterra system. Foot protection is usually in the form of steel-toed work boots, with a steel shank to protect the bottom of the foot from puncture wounds. In wet environments, steel-toed boots that are waterproof and slip-resistant may be necessary.

2.2.4 Hand Protection

Hand protection should be worn within the newterra system. The workplace can create many hazards for hands, whether from chemicals, cuts or burns. No single glove can provide appropriate protection for every work situation, so it is important to assess the risk for each task and select a glove that provides specialized protection.

The following is a list of gloves and their suggested appropriate application:

- Coated fabric gloves: This type of glove can provide protection against some moderate concentrated chemicals. They can be used in laboratory work provided they are strong enough to protect against the specific chemical being handled.
- Rubber, plastic or synthetic gloves: These types of glove can be used when cleaning or working with oils, solvents and other chemicals.
- Leather gloves: These should be used when welding, as the leather can resist sparks and moderate heat. The risk of cuts and abrasions also can be minimized by wearing leather gloves.
- Kevlar gloves: These have a wide variety of industrial applications. They are cut- and abrasion-resistant and provide protection against both heat and cold.
- Chemical/liquid-resistant gloves: Several types of gloves help protect against specific chemicals:
 - o Butyl rubber gloves: nitric acid, sulfuric acid, hydrochloric acid and peroxide
 - o Natural latex/rubber gloves: water solutions or acids, alkalis, salts, and ketones
 - o Neoprene gloves: hydraulic fluids, gasoline, alcohols and organic acids
 - o Nitrile rubber gloves: chlorinated solvents

2.2.5 Body Protection

Body protection may be required in various situations including dusty environments or when spraying liquid pesticides or handling dangerous chemicals. The hazard to be controlled will determine the type of protection that is most appropriate, for example, an apron, coveralls or a full rain suit. As a minimum, the operator should be wearing work coveralls.

2.2.6 Hearing Protection

Hearing protection should be worn in work environments where noise levels exceed 85 decibels – such as around blowers and air compressors. There are many types of hearing protection, including earplugs or muffs. Hearing protection that is suitable for the work environment and provides adequate noise reduction should be chosen. Disposable ear plugs or headset style are acceptable.

2.3 Bacterial Safety

The wastewater contains a mixture of viable bacteria and other biological organisms. A wastewater treatment plant poses a number of bacterial hazards and consequently potential health risk. Immunization protects operator against infection. The use of proper hygiene measures, protective equipment, good housekeeping and common sense prevent contact with pathogens.

These measures prevent infection!



Ensure that hands are washed with an antibacterial soap and warm water and dried by disposable towels on a regular basis, especially prior eating!

Do not expose cuts or open sores to wastewater!

Use personal protective equipment (PPE) at all times in wastewater treatment facility!

Any concern about possible infection should be brought to the attention of medical physician immediately!

2.4 Chemical Safety

The following chemicals are used in operation of newterra MBR WWTP:

- **Sodium Carbonate (Soda Ash)** is used for pH adjustment, in case there is a deficiency in alkalinity in influent sewage and pH drops. It is hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).
- **Sodium hypochlorite (NaOCl)** and **Citric Acid (C₆H₈O₇)** are used for cleaning the membranes.
 - o **Sodium hypochlorite (NaOCl)** is a common disinfectant, which can be an irritant or corrosive, depending on its concentration. It cannot be mixed with organics, ammonia compounds or acids. **Contact with acids produces highly toxic chlorine gas. It has to be mixed only with pure water.**
 - o **Citric Acid (C₆H₈O₇)** is hazardous in case of skin contact (irritant, sensitizer), or ingestion, eye contact (irritant) and inhalation (lung irritant).

- **Aluminium Sulphate ($\text{Al}_2(\text{SO}_4)_3$)** is used for Phosphorus Removal. Mild to moderate irritation can occur from unprotected contact. Aluminum is very poorly absorbed through the skin and toxic effects would not be expected following short-term skin contact. Inhalation of mists can be irritating to the respiratory tract and lungs.
- **MicroC 2000** is used for nitrate removal.
 - o Exposure to eyes may cause slight irritation
 - o Exposure to Skin may cause slight irritation
 - o Inhalation of high mist concentrations may cause irritation of respiratory tract.

When handling chemicals, it is important to wear proper personal protective equipment such as chemical goggles with combination full face shield, protective clothing with chemical splash apron and chemical-resistant rubber gloves.



The above descriptions are preliminary warnings only. The MSDSs for each of the chemicals should be consulted prior to using or handling any of the chemicals. Sample MSDSs for chemicals used in the PWTP process can be found in Appendix F of this Manual.



WARNING

Mixing chemicals can result in dangerous reactions, including violent splashing, fires, explosions and release of toxic gases!
Chemicals should only be used for their intended uses!

2.5 Electrical Safety

Power may be supplied to control panels from various sources. Even if the disconnect is in the OFF position, certain electrical components inside the panel may be energized and servicing should not be conducted unless all incoming power is disconnected. Refer to the electrical drawings in Appendix A of this manual.

Ensure that the system is properly grounded before applying power to the system. Installation and servicing is only to be performed by **qualified authorized personnel**.

2.5.1 Lockout Procedures

Lockout procedures must be followed prior to performing mechanical or electrical maintenance to ensure that equipment has been de-energized. All relevant local guidelines and procedures must be applied. The person who locked out the device, should be the only person to remove the lockout.

When equipment is to be locked out, employers, supervisors and workers should follow accepted lockout principles, including:

- Pre-planning for the lockout by identifying all energy sources, switches, etc.
- Where lockout is complex, a written sequence in checklist form should be prepared for equipment access, lockout/tagout, clearance, release and start-up.
- All workers affected by the lockout should be notified.
- Equipment should be shut down by normal means by turning of switches and closing valves etc.
- Equipment should be isolated from energy sources by disconnecting or blocking the sources of energy.
- Lockout and tag the energy isolating devices by padlock or some other locking device that the worker has control over as well as a tag indicating that the equipment has been shut down.
- Verify that all energy sources have been isolated by attempting to cycle the equipment prior to working on it.
- When work is completed, release equipment from lockout.
- Test equipment

2.6 Confined Spaces

"confined space" means a fully or partially enclosed space:

- that is not both designed and constructed for continuous human occupancy, and
- in which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.

If you have a space that is fully or partially enclosed, the two conditions – (a) and (b) above – must both apply before the space can be considered a "confined space".

"atmospheric hazards" means:

- the accumulation of flammable, combustible or explosive agents,
- an oxygen content in the atmosphere that is less than 19.5 per cent or more than 23 per cent by volume, or
- the accumulation of atmospheric contaminants, including gases, vapours, fumes, dusts or mists, that could,
 - o result in acute health effects that pose an immediate threat to life, or
 - o interfere with a person's ability to escape unaided from a confined space.

Follow local laws and regulations with respect to entering a confined space.

If a workplace includes a confined space that workers may enter to perform work, it is highly recommended that written program for the confined space is developed and maintained in accordance with this local regulations and policies before a worker enters the confined space. A confined space program is a written document that would include: a method for recognizing each confined space to which the program applies; a method for assessing the hazards to which workers may be exposed; a method for the development of confined space entry plans; a method for training workers; and, an entry permit system.

2.7 Fire Safety

Exposed hot surfaces can create potential burn/ignition hazards. Blowers and air compressors compress ambient air, causing heat to be generated. This heat can bring the temperature of the air compressor head and blower piping to a level that can cause burns to exposed flesh.

Follow local laws and regulations with respect to Fire Safety and regulations.

2.8 Responsibility for Safety

2.8.1 Management

Management is responsible for providing a safe working environment. This is accomplished partly by:

- Ensuring that all facilities and equipment are built and maintained in accordance with the appropriate safety standards
- Providing adequate funds for equipment and plant maintenance
- Establishing, promoting, and enforcing a **safety policy**
- Establishing a safety training program
- Supplying easy accessible eyewash and first-aid stations and proper personal protective equipment (PPE) for personnel servicing wastewater treatment facility.

2.8.2 Worker

- To develop a positive and professional attitude towards safety.
- To avoid mistakes caused by indifference to safety, poor work habits, lack of attentiveness, rushing the job, failure to observe established safety procedures and poor physical condition.



**Remember the “ABC” of accident prevention:
ALWAYS BE CAREFUL!!!**

In addition to **“being careful”**, it is the responsibility of all workers to:

- Work in accordance with established safety procedures
- Follow the established safety rules
- Wear appropriate personal protective equipment (PPE)
- Report all accidents, no matter how minor
- Report potential safety hazards
- Participate in safety programs

2.8.3 Plant Safety – Simple Rules to Follow



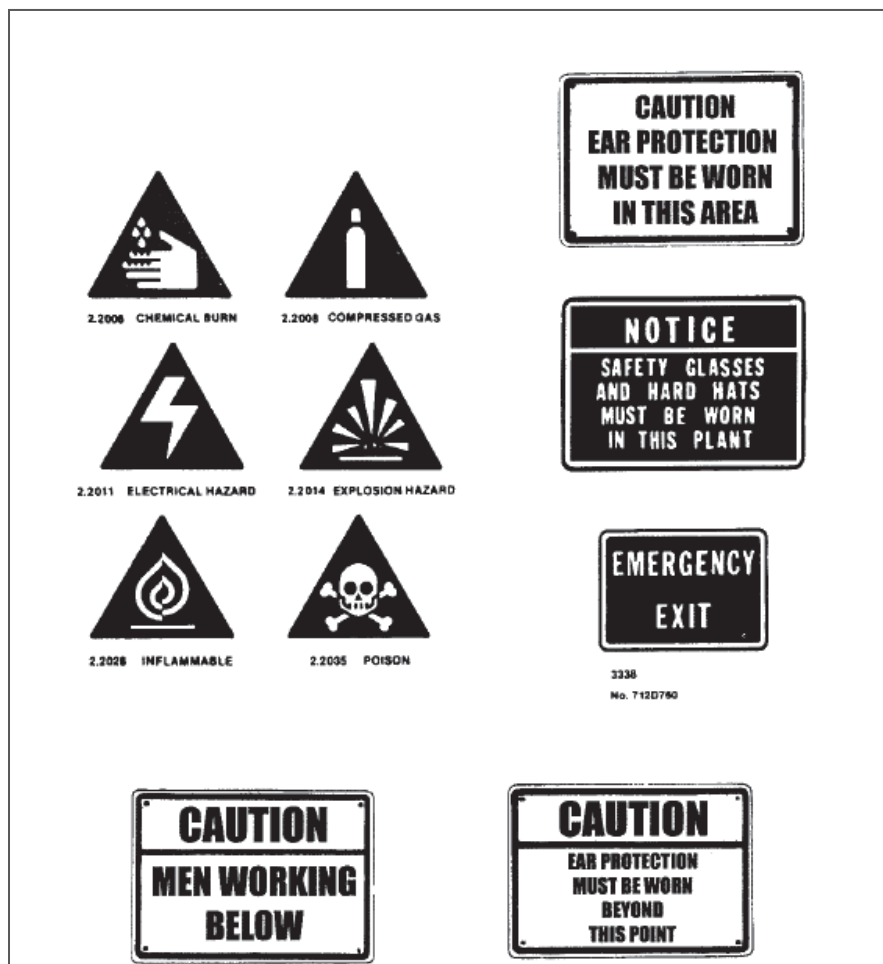
ATTENTION

Common sense plays a very important part in the safe operation of any type of plant!

- Wear the appropriate personal protective equipment at all times.
- Keep walkways clear of snow and ice, and loose objects such as pails, shovels, tools, etc.
- Clean up spills of oil, grease, chemicals, or other substances immediately.
- Keep all tools and similar equipment clean, in good condition, and properly stored when not in use.
- Replace all manhole covers, access trap doors, etc. as soon as possible. Erect a safety barrier if it is necessary to leave the opening uncovered.
- Wear a safety belt whenever there is the possibility of falling even a short distance, or when working over water.
- Lock out and tag electrical equipment before working on it or the associated equipment.
- Ensure that moving machinery is properly guarded. Wear ear protection in noisy environments.
- Ensure that fire-fighting equipment is in good working condition.

2.9 Hazard Warning Signs/Symbols

Below is a sample of possible hazard warning signs/symbols that may be provided with the newterra system. It is recommended that the operator become familiar with the warning signs in the system.



2.10 First aid

First aid is emergency care given immediately to an injured person. The purpose of first aid is to minimize injury and future disability. In serious cases, first aid may be necessary to keep the victim alive.

It often consists of a one-time, short-term treatment and requires little technology or training to administer. First aid can include cleaning minor cuts, scrapes, or scratches; treating a minor burn; applying bandages and dressings; drinking fluids to relieve heat stress, etc.

Operators must know the location of emergency telephone number(s), First Aid Kits, emergency eye wash stations and first aid attendant(s).

In over 98% of locations in the United States and Canada, dialing "9-1-1" from any telephone will link the caller to an emergency dispatch office—called a Public-Safety Answering Point (PSAP) by the telecom industry—which can send emergency responders to the caller's location in an emergency. In approximately 96 percent of the U.S., the Enhanced 9-1-1 system automatically pairs caller numbers with a physical address.

Follow local laws and regulations with respect to First Aid procedures and reporting.

2.10.1 CPR Poster

CPR for an Adult or Child

1

- Check the scene to ensure it is safe. If it is safe to do so, check the person and the person's ABCs (Airway, Breathing, Circulation).
- Call EMS/9-1-1 and get an AED or have someone else do this.



2

- Place the heel of one hand on the middle of the chest. Place the other hand on top.
- Do 30 compressions. Push hard, push fast.



3

- Open the airway by tilting the head back and lifting the chin. Pinch the nostrils closed and give 2 breaths.
- Repeat the cycle of 30 compressions and 2 breaths.
- Continue CPR until an AED arrives or more advanced care takes over.





The information on this poster does not replace formal First Aid & CPR training.

To find a Red Cross First Aid course in your area scan the QR code, or:

redcross.ca/firstaid | 1.877.356.3226



3.0 WASTEWATER TREATMENT PLANT DESIGN BASIS

This section presents the design basis of the newterra MicroClear™ Membrane Bioreactor (MBR) Wastewater Treatment Plant (WWTP), including the influent constituent loading rates, hydraulic capacity and specifications for the membrane module and cassettes used. This section also includes a list of prohibited chemicals that should not be added to the influent wastewater and chemicals that should not come in contact with the membranes. The system is designed to meet effluent discharge criteria presented in this section below.

3.1 newterra MicroClear™ MBR Process Specification

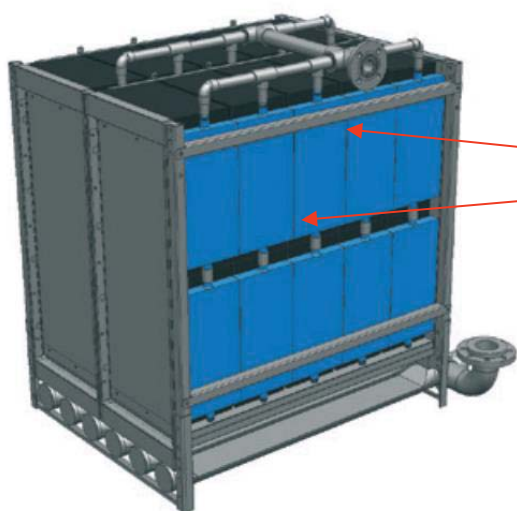
Design loading	SI Units
Design Hydraulic Load	96 m ³ /d
Organic Load	87.1 kgBOD/d
TKN Load	12.5 kgTKN/d
Phosphorus Load	1.15 kgTP/d
Process Tanks	SI Units
Three (3) Oil & Grease Tanks (TNK-101/TNK-102/TNK-103) with a total volume	12 m ³
One (1) Equalization Tank (TNK-301) with effective volume	40 m ³
One (1) Pre-Anoxic Tank (TNK-401) with effective volume	46 m ³
Two (2) Aeration Tanks (TNK-501/TNK-502) with total effective volume	76.5 m ³
One (1) Post-Anoxic Tank (TNK-401) with effective volume	8.6 m ³
Two (2) Membrane Tanks (TNK-601/TNK-602) each with effective volume	8.0 m ³
Two (2) Sludge Holding Tank (TNK-901) each with effective volume	7.0 m ³
Membrane Bioreactor (MBR) including anoxic tanks, aeration tanks and membrane tanks - total effective volume	147.1 m³
Design Hydraulic Retention Time (HRT)	36.8 h
Sludge Age	26.5 d
Mixed Liquor Return Ratio - from Membrane Tank to Aerobic Tanks	5 x
Mixed Liquor Return Ratio - from Aerobic Tanks to Pre-Anoxic Tank	8 x
Design net flux (average)	13 LMH
Design Sludge Wasting Rate	5.36 m ³ /d
Minimum design operating temp	10 °C

3.2 MicroClear™ MB2-2 Membrane Module Characteristics

MicroClear™ MB2-2 membrane module	SI Units
MB2-2 modules in MBR	2
MCXL cassettes in MB2-2 module	20
Total Area of MB2-2 module	160 m ²
MB2-2 Module Dimensions (L x W x H)	1.302 m x 1.124 m x 1.379 m
Housing materials	Stainless steel

3.3 MicroClear™ MCXL Membrane Cassette Characteristics

MicroClear™ MCXL membrane cassette	
Membrane Material	Polyethersulfone (PES)
Individual Cassette Area	8 m ²
Pore Size	0.04 µm
Cut Off	150 kDalton
Filtration Pressure	0.1 – 0.25 bar
Backwash Pressure	0.07 – 0.1 bar
Cassette Dimension	0.416 m x 0.209 m x 0.490 m



**MicroClear™ MB2-2
membrane module**



**MicroClear™ MCXL
membrane cassette**

3.4 Influent/Effluent Wastewater Characteristics

The newterra MBR shall treat wastewater from the mine camp with the following characteristics upon entering the newterra MBR.

Parameters	Unit	Influent*	Effluent
pH	s.u.	6 - 9	6.5 – 8.5
Fat, Oil, Grease (FOG)	mg/L	< 30	< 5
Biological Oxygen Demand (BOD)	mg/L	907.5	< 25
Total Suspended Solids (TSS)	mg/L	262.5	< 25
Total Kjeldahl Nitrogen (TKN)	mgN/L	130	-
Unionized Ammonia Nitrogen (NH ₃ -N)	mgN/L	-	< 1.25
Nitrate Nitrogen (NO ₃ -N)	mgN/L	-	< 5
Total Phosphorus (TP)	mgP/L	12	< 0.5
Fecal Coliform	CFU/100mL	-	< 200**
Total Residual Chlorine	mg/L	-	< 0.02
Alkalinity (assumed)	mg/L as CaCO ₃	471	-
Total Dissolved Solids(TDS)	mg/L	< 1,200	-

3.5 Estimated Chemical Consumption

Consumable		Usage Rate			
Purpose	Name	Value	Unit	Value	Unit
Supplemental Alkalinity	Dry Soda Ash	6.28	kg/d	2292	kg/year
Phosphorus Removal	Liquid Alum, 48%	14.6	L/d	5346	L/year
Nitrate Removal	MicroC 2000	16.5	L/d	6025	L/year
Membrane Cleaning	Sodium Hypochlorite, 12%	-	L/d	150	L/year

3.6 Prohibited Items

The raw wastewater should not contain any of the following substances:

- Hydrocarbons – lubricants, gasoline, diesel, etc.;
- Paints, solvents, silica, silicones and polymers;
- Antibacterial solutions, and products with quaternary ammonia;
- Large quantities of chemicals such as water softener, disinfectants, strong acids & alkalis, pesticides or photographic chemicals;
- Silicone based defoamers;
- Non-biodegradable solid waste (plastic, rubber products, disposable diapers, etc.);
- High amount of metals, such as iron, magnesium, calcium, barium and strontium.



TOXIC MATERIALS SHOULD NOT BE THROWN INTO THE DRAIN!

3.7 Removal of Oily Materials

The wastewater must pass through a grease trap (or similar facility for grease/fat removal), if there is kitchen usage onsite. The large amount of oil and fat can harm treatment facility (e.g., clogging pumps and piping and cause foaming in the aeration tank). To avoid premature membrane fouling, maximum FOG concentrations should not exceed 30 mg/L.



Fats, oils and grease (FOG) must be removed prior to MBR. Removing of FOG significantly reduces membrane fouling, foaming potential and increases aeration efficiency.

The raw wastewater should also comply with the following compatibility chart. The lipophilic substances concentration must be lower than **50 mg/L**.

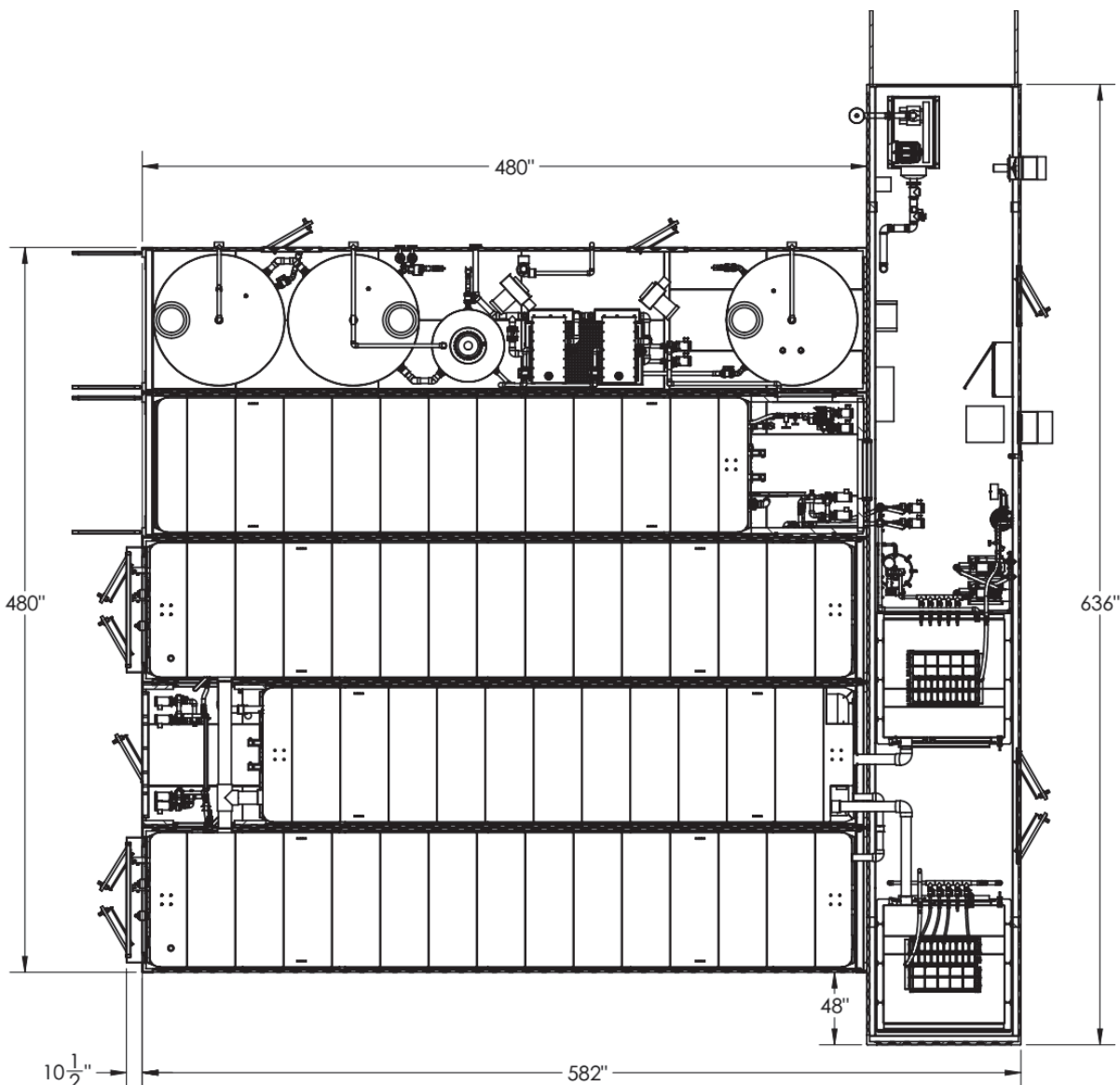
3.8 MicroClear™ Membrane Compatibility Chart

Group	Substances	Compatibility
Chlorinated solvents	Methylene Chloride, Chloroform, Carbon Tetrachloride, Chlorobezene, Trichloroethane (<1%)	Not recommended
Esters	Ethyl Acetate, Butyl Acetate, Butyl Acrylate (<1%)	Not recommended
Ethers	Ethyl Ether, Polyethylene Oxide (<1%)	Not recommended
H ₂ O ₂	<2000 ppm	Very good
Inorganic acids	HF, HCl, H ₂ SO ₄	pH 0 - 14
Ketones	Acetone, Methyl Ethyl Ketone	Not recommended
NaOCl	100,000 ppm x h	Very good
Organic acids	Sulfamic Acid, Formic Acid, Oleic Acid, Sulfonic Acid, Acetic Acid, Acrylic Acid, Lactic Acid	pH 0 - 14
Phenols		Not recommended
Silicones		Not recommended
Alcohols	Ethanol, Butanol, Isopropanol (<50%)	Good
Aldehydes	Formaldehyde (<1%)	Very good
Alkali		pH 0 - 14
	Dimethyl Formamide, Dimethyl, Acetamid Dioxane, N-Methyl, Pyrrolidone, Tetramethyl Acetamide	Not recommended
Aprotic Solvents	Benzene, Toluene, Xylene, Anthracene, Naphatalene, Gasoline	Not recommended
Aromatic hydrocarbon	Methoxyethanol, Ethoxyethanol, Buthoxyethanol	unknown

4.0 PLANT INSTALLATION, INSPECTION, AND TESTING

4.1 System Overview

The **newterra** MicroClear™ MBR WWTP is 96m³/day MBR for for the Amaruq Mine located in Nunavut. The system consists of five (5) modified 40 foot High Cube ISO shipping containers and one (1) modified 53 foot High Cube ISO shipping container. See below. .



4.2 Site Conditions Requirements

- Installation site for the **newterra** MicroClear™ MBR WWTP should be close to the sewer drain and have a sufficient power source (refer to Electrical Drawings in Appendices B-F).
- Location must permit easy access for equipment capable of transporting, offloading, and handling of the designed loads.
- There should be adequate space around the containers for safe operation and maintenance.
- The firm base (foundation) must be built to support the full operating weight of the plant to prevent buildings from shifting and pipe/electrical conduit connection failure – pilings are recommended.



The firm base for the container must be level and must be capable of supporting the operating weight.



WARNING: *Always check with the local utility companies for the location of water lines, electrical and telephone cables, or any additional hazards below grade, prior to excavation. Failure to do so could result in severe bodily injury or death.*

4.3 Inspection upon Delivery

The **newterra** MicroClear™ MBR WWTP is carefully manufactured, checked, and tested at the manufacturing plant. All equipment is pre-wired, pre-piped, mounted inside the enclosures and factory tested. Upon receiving the system, please perform the following:

- Place the container onto the prepared firm base to avoid sagging, equipment vibration, and shifting. When lifting the containers, ensure that lifting equipment is clear of overhead obstructions such as power lines, trees or rooftops. Be careful during this procedure!
- Be careful when offloading the containers to prevent damage to the internal pipe work.
- Check the containers for any signs of shipping damages.

- Inspect the containers to ensure that no components or parts are missing (refer to the Packing List – see Appendix B). Also, inspect for visual damage of the tanks, pumps, blowers, piping, and control panel.
- If the containers, equipment inside and any parts shipped loose are free of damage, proceed with the installation.

For any damages or loss of equipment, **please notify newterra ltd. at (800) 420-4056 immediately.**

4.4 Plant Initial Set up



WARNING: *The installer must ensure that the installation site is safe from hazards. These could include excavations left open overnight, debris left lying around, and tanks & equipment not properly blocked. Provisions must be made to eliminate the potential hazards by roping off and proper shoring around the excavations, cleaning up at the end of each workday, and proper storage of equipment. Failure to do so could result in severe injury or death.*

4.4.1 Installation Checklist

At Appendix C is the installation and commissioning checklist for the system. Below is a summary of installation activities.

4.4.1.1 Customer's Scope List

- Placement and anchoring (if required) of equipment
- Interconnecting piping supply and installation
- Interconnecting electrical and controls supply and installation including connection inside newterra's control panel
- Electrical power supply to our electrical panel, lightning, grounding, etc.
- Permitting
- Potable water supply to the plant site for plant hydraulic test during startup
- Seed sludge
- Wastewater testing
- Chemicals supply and storage
- Treated effluent and waste sludge disposal
- All site civil work including design

4.4.1.2 Civil Checklist

- Ensure that a potable water supply is available (used for hydraulic testing during start-up, membrane cleaning, washing hands and for performing onsite testing).
- Ensure availability of on-site emergency eyewash station and personal protection equipment.
- Remove hatch covers from the interconnecting ports.
- All doors are closing, latching and locking
- Weather stripping has been installed around each door
- Door sweeps have been installed on each door
- Louvers and hoods have been installed and sealed
- Install Liquid Rubber Container Seal as per drawing at Appendix C.

4.4.1.2 Electrical Checklist

- Connect electrical power to the Main Disconnect from available source ensuring correct phase rotation (See Electrical Drawings at Appendix A for power source specifications).
- Connect electrical power to the Control Panel (See System Layout drawing in Appendices A for locations)
- Ensure that proper electrical grounding and lightning protection is available.
- Switch Main Switch Panel's isolator to the ON position.
- Check all internal lighting and heating for correct operation.
- Install packed external lighting into brackets above the doorways.
- All internal electrical connections have been terminated
- Confirm Phase Monitor is not in alarm
- Site voltage measured:
 - L1/L2 - L2/L3 - L3/L1 - L1/GRD - L2/GRD - L3/GRD:
- Check field wiring and piping as per drawings
- Check panel for loose wiring, Correct as required
- Check voltage on AC transformer
- Check voltage on DC transformer
- Check I.S. barrier is grounded as per input drawing

4.4.1.3 Mechanical Checklist

- All hoses and mechanical connections have been hooked up
- Ensure all unions and fittings are tight, as some are loosened to prevent stress in shipping
- Check alignment of motors, Correct as required
- Check all motor belt tensions, Correct as required
- Check alignment of pulleys for all belt driven blowers
- Verify membrane modules are secure within the membrane tanks – i.e. verify wheel chocks are in the correct location and that there is no lateral movement (less than an inch) of the membrane modules on the wheel tracks in the tanks.
- Confirm Tank Diffusers and Educators have not moved during shipping
- Calibrate pH sensor

4.4.2 System Electrical Specifications

Verify site power per system design criteria. Additional detail is at Appendix A.

ELECTRICAL SPECIFICATIONS	
VOLTAGE	600V
PHASE	3Ø
FREQUENCY	60 Hz
FULL LOAD AMPS	172A
MAIN DISCONNECT SIZE	400A - FUSED @ 250A
SCCR SYMMETRICAL (kAMPS)	10
SYSTEM APPROVAL AND CLASSIFICATION	cMET - CL1Div2
PANEL APPROVAL AND CLASSIFICATION	cMETus to UL698A

Please refer to the as-built electrical drawings in Appendices A of this manual.

	Only trained and certified electricians should make the electrical connections.
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4.5 Plant Initial Testing

The newterra MicroClear™ MBR WWTP (except the membrane modules) undergoes electrical and leakage tests in our manufacturing facility prior to shipment; however, fittings could shift during shipment, so it is our standard practice to perform initial testing on the plant after installation, including **dry and hydraulic tests**.

The following subsection is presented for one single process train; if multiple trains are provided, performing the dry test and hydraulic test for each train is identical.

4.5.1 Dry Test

The following tasks have to be performed **before** potable water is introduced into the system:

- Ensure that all tanks are clean and free of any dirt or debris (this is to prevent obstruction or damage to the piping, pumps, and membranes).
- Ensure that all connections have been provided and joints have been tightened.
- Check the placement of the air diffusers in the equalization tank(s) and the aeration tank(s) if incorrectly positioned, proper adjustment has to be performed.
- Ensure that a functional check of the electrical and control system has been performed (please refer to the newterra Commissioning Checklist presented in Appendix H).
- Confirm heater/fan and air conditioner operations

4.5.2 Hydraulic Test

The hydraulic test is performed using potable water to:

- Check for and fix any leakage;
- Check the setting of level switches/transmitters;
- Check the hydraulic flow through the plant;
- Check if all the ancillary equipment and controls of the plant function as per design;
- Recalibrate instruments (if applicable);
- Perform clean water test on membranes.
- Perform clean water test on the chemical distribution system.

4.5.2.1 EQ, Anox and Aeration Tanks

- Fill the tanks in order - TNK-301, 401, 501, 502, 551, 601, 602 with potable water, run the pumps and check for any signs of leakage.
- Perform electrical and instrumentation (E&I) functional checks and adjustment of level switches.
- Turn on the air blower(s) for the blower(s) for aeration tank(s), and check for:
 - o Buoyancy of air diffusers and if this occurs, empty the tank and fix;
 - o Air leakages: if this occurs, tighten up the fittings;
- Manually check water temperature and DO (dissolved oxygen): with a hand-held DO meter and adjust air flow to keep it up to 0.5 – 1 mg/L for equalization tank(s) and 2 - 3 mg/L for aeration tank(s); check the DO readings on the touch screen.
- DO Control System: check automatic ON/OFF of Aeration Tank air blowers at low and high settings of DO without the return of aerated water from the membrane tanks to aeration tanks (i.e. turn off transfer pump(s) from aeration tank(s) to membrane tank(s) and turn of recirculation pump(s) from membrane tank(s) to aeration tank(s), if included), and record blower ON/OFF duration.

4.5.2.2 Membrane Tank

- Enable membrane operation using the HMI
- Start the transfer pump(s) from the aeration tank(s) to the membrane tank(s) and fill the membrane tank(s) with potable water.
- Start the air blowers for the membrane tank(s) and check for an even distribution of air across the membrane filter area and air bubble uniformity above the membrane module/cassette.
- Check hydraulic flow pattern through the membranes and between membrane module/ cassette and tank wall.
- Make a clean copy of the **Clean Water Testing Sheet** presented in **Appendix J** of this O&M Manual.
- Record all checked parameters in the **Clean Water Testing Sheet**.
- Start the permeate (vacuum) pumps.
- Record the vacuum (TMP) on the gauge(s) on the permeate line [for clean water could be 0.05 to 0.07 bar (20" to 29" WC)].
- Record water temperature and DO with a hand-held DO meter.
- Gradually increase the permeate flow while recording the vacuum (TMP) on the gauges up to the anticipated peak wastewater flow.

Forward a complete **Clean Water Testing Sheet** to **newterra** for analysis.

4.5.2.3 O&G and 901 Tanks

- Fill the tanks in order - TNK-101, 102, 103 and 901 with potable water, run the pumps and check for any signs of leakage.
- Confirm diffuser operation in TNK-901. Adjust as necessary.

5.0 OPERATION of newterra MicroClear™ MBR

MBR (Membrane Bioreactor) treatment technology is an effective combination of an activated sludge biological treatment process with MicroClear MBR membrane filtration technology.

This section provides a description of the treatment process and how it is controlled. For a more complete understanding, review the **Process & Instrumentation Diagram** and **System Layout** provided in **Appendix A** of this manual as well. The detailed Control Narrative with factory setpoints, alarms and logic, please see **Appendix K**.

Most of the equipment in the **newterra** WWTP can be operated in either manual or automatic mode. The system is designed to always run in auto mode. The manual option is provided mainly for maintenance purposes.

5.1 Control System – Main SCADA Control, PLCs and HMIs

The **newterra** MicroClear™ MBR is controlled by a PLC (Programmable Logic Controller). The system is programmed to:

- Receive analog and digital input signals from the switches and transmitters being controlled;
- Process the information using the structure and rules entered into the program;
- Generate outputs that control the equipment - turn equipment OFF or ON.
- Generate alarms if critical conditions are present
- Provide a HMI (Human Machine Interface) touch-screen for ease of operator process monitoring and control.

5.1.2 HMI Control Screen

An example of an HMI Control Screen is provided below:



System Operation

- (RUNNING/STOPPED) Indicates whether the system is currently in the **RUN** mode or turned off
- **START** button puts the system in **RUN** mode as long as there are no alarms preventing the start up of the system
- **STOP** button stops the system operation
- **RESET** button is used to clear alarms after they have been addressed
- Clarifier blowers, equalization tank blowers and the building fan if on, continue to run even after the **STOP** button has been pressed

The MBR will always remain in auto run mode, unless the kill switch is pressed or power is down.

The MBR will automatically restart after power failure.

A menu to navigate through the process and data information screens is provided at the bottom right corner of the HMI screen.

When the **MENU** button is pressed, it shows a list of individual screens with a scroll bar.

- To go to any of the listed screens, touch the icon.
- To go back to the main screen, touch the **X** button.



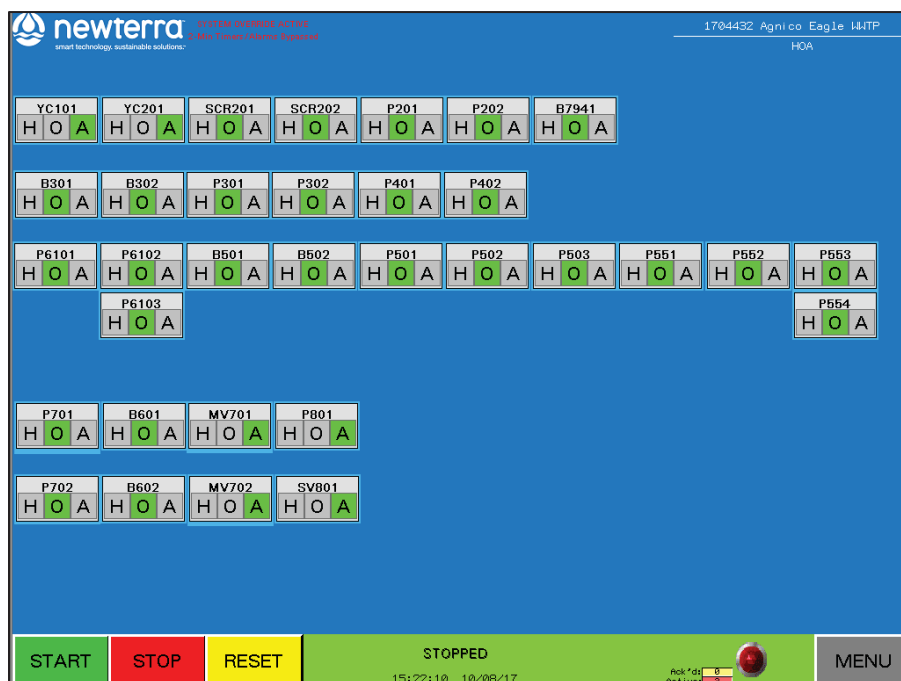
ATTENTION

Screen-shots presented in this manual are for example only and may not be representative of ideal operation.

5.1.3 HOA (Hand/Off/Auto) Screen

This screen displays all devices controlled by the PLC. Under normal operation (auto mode), all devices are set in the AUTO position.

- Each PLC controlled motor or valve in the system has a Hand/Off/Auto (HOA) Switch to control its operation.
- The HAND (H) position of a switch is used for testing and troubleshooting of the system. As a safety precaution to prevent damage to equipment, the equipment will operate for two minutes in hand mode and will then turn OFF and revert to the (O) position. Operators must be present when equipment is operated in the manual mode.



5.1.4 Process Screens

The main process screens are accessed from the main menu of the HMI control screen. These process screens are:

- Inlet
- EQ & Anox
- Aeration
- MBR

Note: In the following sections are the detailed descriptions of the main processes.



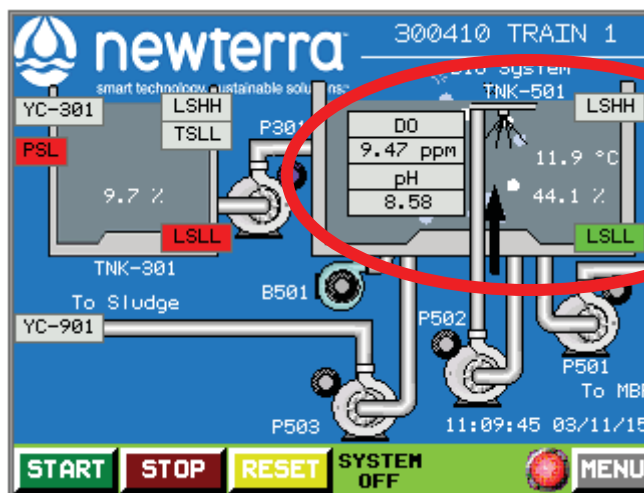
Switches are indicated on the HMI as follows:

- LSHH – level switch high high
- LSH – level switch high
- LSL – level switch low
- LSL – level switch low
- TSLL – temperature switch low low
- PSL – pressure switch low

Status of the switches are indicated as follows:

Grey when **OFF**
Green when **ON**
RED when in Alarm

Tank levels are indicated by level switch positions and percent full values where level transmitters are provided. For example, the following screen shows LSHH as green, LSHH as grey and the percent full as 44.1% in TNK-501. This indicates that the tank is 44.1% full, and the water level is above LSHH and below LSHH.



NOTE: Touching a device on the process screen will open an HOA popup for that device.

- The device status indicator color coding is as follows:

Indicator Color	Operational Status
Yellow	Manual operation
Orange	Interlock
Red	Failure
Green	ON / OK
Purple	Interlock / Communication failure
Pink	Unknown
Black	Faulty contactor
Grey	Off

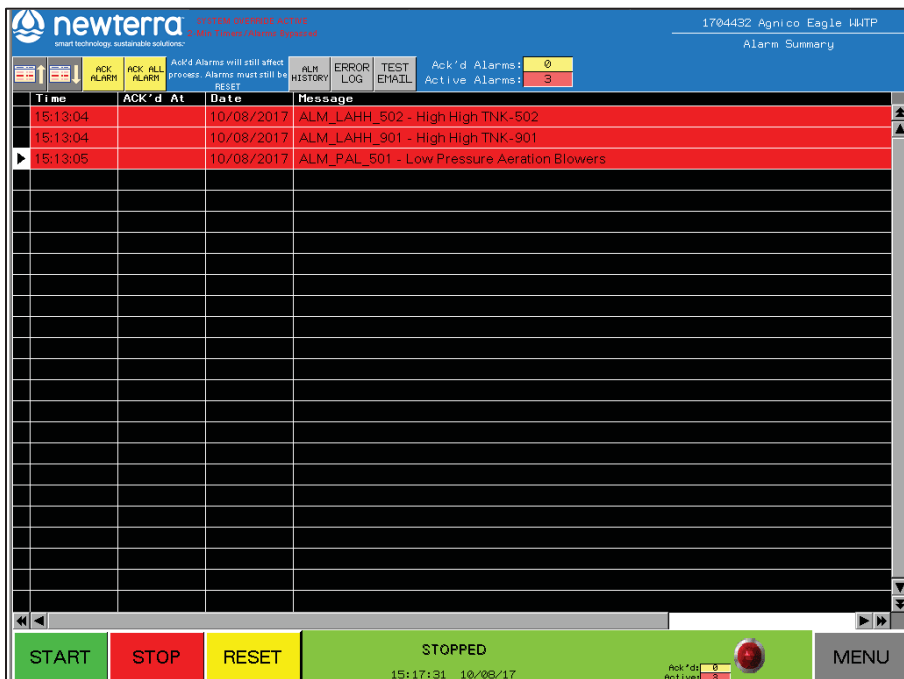
5.1.5 HMI Alarm Screen

- When the **ALARMS** button is flashing red, it indicates an alarm is present in the system. Press the **ALARMS** button to be routed to the Active Alarms Screen.
- To clear alarms, first press the yellow **RESET** button then press the flashing **ALARMS** button to verify that the condition causing the alarm has been cleared.

All alarms are visually indicated on a beacon stack on the roof of the exterior of the container and an alarm light on the system control panel:

- Green – System OK
- Red Solid – Warning Alarm
- Red Flashing – Critical Alarm
- No Light – Loss of Power





newterra smart technology. sustainable solutions. 1704432 Agnico Eagle WHTP
Alarm Summary

ACK'd Alarms: 0
Active Alarms: 3

Time	ACK'd	At	Date	Message
15:13:04			10/08/2017	ALM_LAHH_502 - High High TNK-502
15:13:04			10/08/2017	ALM_LAHH_901 - High High TNK-901
15:13:05			10/08/2017	ALM_PAL_501 - Low Pressure Aeration Blowers

START STOP RESET STOPPED 15:17:31 10/08/17 MENU



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Alarm History

Save to USB

Time	ACK'd	At	Date	Message
15:13:04			10/08/2017	ALM_LAHH_502 - High High TNK-502
15:13:04			10/08/2017	ALM_LAHH_901 - High High TNK-901
15:13:05			10/08/2017	ALM_PAL_501 - Low Pressure Aeration Blowers

START STOP RESET STOPPED 15:17:52 10/08/17 MENU

NOTE: All high level alarms (identified as LSHH on P&ID and HMI) indicate a critical situation for imminent tank overflow and could result in pump(s) shutting off to avoid overflow situations.

5.2 WWTP Buildings/Utilities

5.2.1 Power Supply

A power monitor has been installed in the main power distribution panel to ensure proper power and phase rotation is delivered to the system.

Alarms

<u>Alarm</u>	<u>Alarm Description</u>	<u>Actuation Control</u>	<u>Delay</u>	<u>Self Resetting (Y)</u>
ESA-8201	Emergency Stop Alarm	ESA-8201 = Active	Immediate	Y
PWR-FAIL	Power Failure		Immediate	Y
PLC FLT	PLC Fault Detected		Immediate	Y
PWR FLT	Phase Monitor Fault	JA-8201 = Active	Immediate	Y

5.2.2 E-Stop

Emergency stop buttons are located:



- On the Main Control Panel in each of the Screen Buildings
- On the Control Panel installed in each process train
- On the Main Control Panel in the Sludge Building
- Main Control Panel in each of the Receiving Stations
- There is an E-Stop PLC alarm if pressed.

5.2.3 Building Temperature Control

The electric heaters respond to the temperature set point set on the individual heater TSL temperature switches. If the building temperature falls below the temperature switch settings, electric heaters will turn on.

5.2.3.1 Logic

<u>TAG</u>	<u>Description</u>	<u>Control Logic</u>	<u>Output Type</u>
H-7911	Building Heater	Always on internally controlled	Direct (not PLC controlled)
H-7912	Building Heater	Always on internally controlled	Direct (not PLC controlled)
H-7941	Building Heater	Always on internally controlled	Direct (not PLC controlled)
H-7961	Building Heater	Always on internally controlled	Direct (not PLC controlled)
H-7962	Building Heater	Always on internally controlled	Direct (not PLC controlled)
H-7963	Building Heater	Always on internally controlled	Direct (not PLC controlled)

5.2.3.2 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
TALL-7911	Temperature Alarm Low Low	TSLL-7911 = Active	5s	Y
TALL-7941	Temperature Alarm Low Low	TSLL-7941 = Active	5s	Y
TALL-7961	Low Low Temp Alarm	LSLL-7961 = Active		

5.2.4 Ventilation

A single fan (F-7963) located in the MBR Process container acts to exhaust the container during the warmer months. Temperature is monitored by the temperature sensor and a high setpoint turns the exhaust fan on. There are also exhaust blowers to de-rate classified areas.

5.2.4.1 Logic

Tag / Mode	Description	Control Logic	Output Type	HOA Control
B-7911	Ventilation Blower	The continuous ventilation blower will always be ON. This blower is used as means to de-rate the screen building to a Class 1 Division 2 area. Air exchanges must be a minimum of 12 per hour,	Direct (not PLC controlled)	
B-7941	Aeration Exhaust Blower	On when B-501/502 is on OR B-601/602 is on	Discrete	Auto
F-7963	Building Fan	Always on controlled by Wall Mount Thermostat	Direct (not PLC controlled)	

5.2.4.2 Alarms

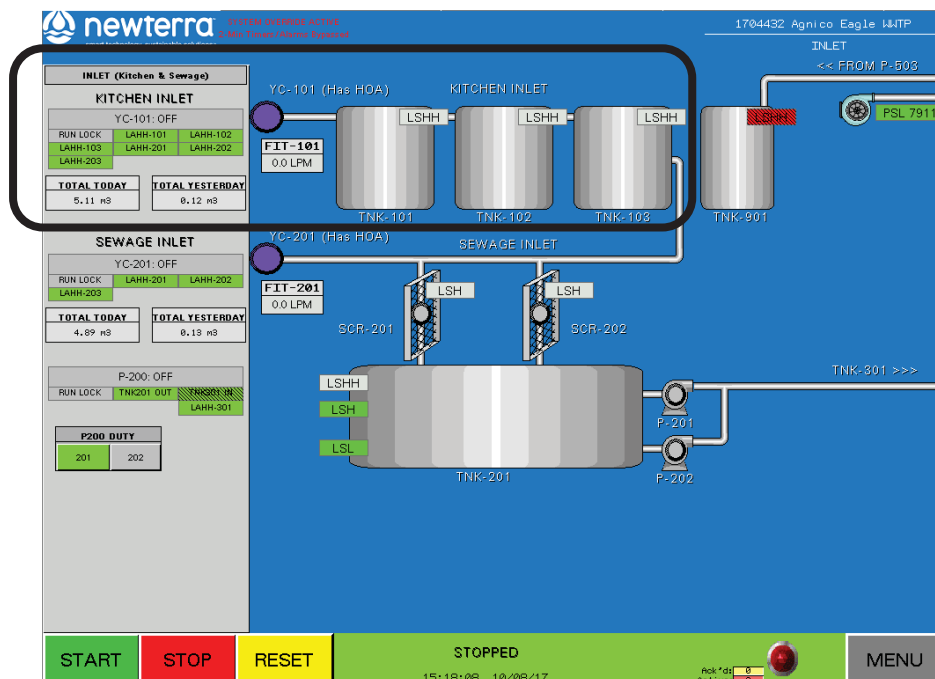
Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)	Notes
PAL-7911	Pressure Alarm Low	PSL-7911 = InActive	5s	Y	Alarm indicates possible continuous ventilation failure, indicating risk that the room may become Class 1 Division 1 rated.

Mixed liquor is pumped from the post-anoxic tank to the membrane tanks (TNK-601 and TNK-602). The membrane tanks serve as additional volume for aerobic biological treatment to remove any excess MicroC (which would otherwise cause BOD in the effluent) and house the membrane filters used for solid-liquid separation. Treated effluent is drawn through the membranes by vacuum pumps.

Since the solid-liquid separation process results in an accumulation of solids in the membrane tank, the mixed liquor (containing both solids and filtrate) is continuously recycled to the first aeration tank (TNK-501). This prevents excessive solids build-up in the membrane tank, and maintains sufficient biomass in the anoxic and aeration tanks. The solids that accumulate in the system consist of biomass that have grown from the influent organics and ammonia, as well as non-biodegradable solids from the influent wastewater. In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank (TNK-501) to the sludge holding tank (TNK-901). Wasted sludge in the sludge holding tank is thickened by decanting supernatant back to the screen tank. Thickened sludge accumulates in the sludge holding tanks until it is eventually pumped out for disposal.

5.4 Kitchen Inlet Module (TNK-101/2/3) Module

A schematic of the Kitchen Inlet Module is located on the INLET HMI screen and shown below.



5.4.1 Function

The Waste Water Treatment Plant accepts waste water from the local kitchen which contains kitchen oils and greases. These need to be removed prior to being fed into the fine screens. This is done by using TNK-101/2/3 as grease traps. The kitchen waste water enters TNK-101, the solid food particles sink to the bottom, while lighter grease and oil floats to the top. The relatively grease-free water is then fed into TNK-102 where the process is repeated to further separate the oils and greases from the waste water. The same applies to TNK-103. The waste water is then fed to the fine screens.

5.4.2 Inputs

TAG	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)
FIT-101	Flow Indicating Transmitter	Analog	GPM	0-760lpm	0-760lpm	Y	Y
FQI-101	Flow Totalizer	Discrete N.O.	Pulse/Gal	1 liter/Pulse			
LSHH-101	Level Switch High High	Discrete N.C.					
LSHH-102	Level Switch High High	Discrete N.C.					
LSHH-103	Level Switch High High	Discrete N.C.					

5.4.3 Setpoints

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)
FTAH-101-SP	Flow Transmitter Alarm High Setpoint	75	0-200 GPM	Open	Y

5.4.4 Logic

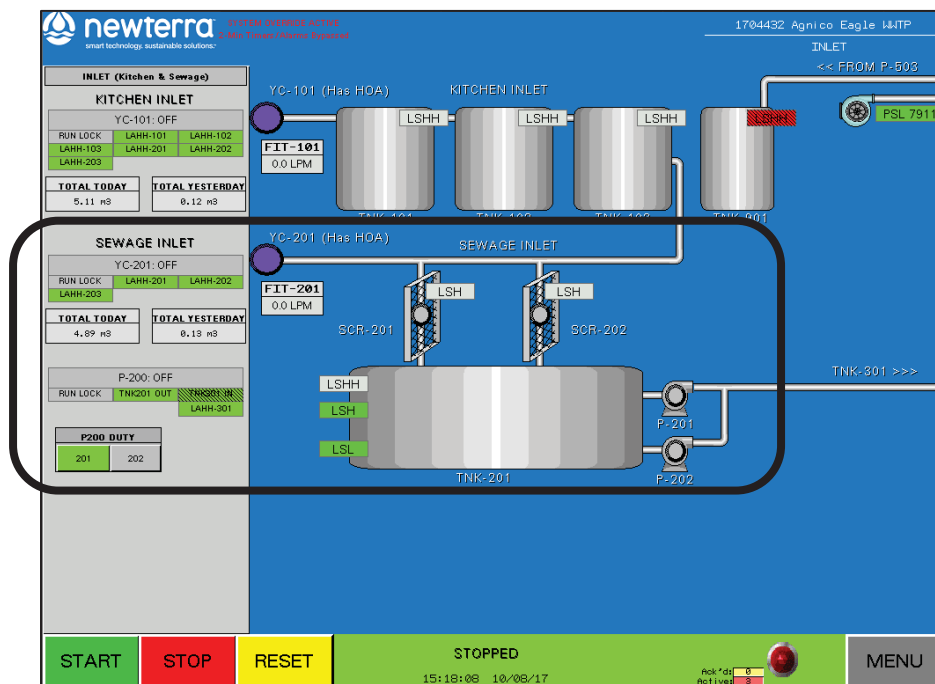
TAG	Description	Control Logic	Alarm Interactions	HOA Control
YC-101	Ready Contact	On when LSHH-101 / 102 / 103 and LSHH-201 / 202 and LSHH-203 are not ON	All LSHH's in the inlet area	HOA

5.4.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
FTAH-101	Flow Transmitter Alarm High	FIT-101 > FTAH-101-SP	60s	
LAHH-101	Level Alarm High High	LSHH-101 = Active	5s	Y
LAHH-102	Level Alarm High High	LSHH-102 = Active	5s	Y
LAHH-103	Level Alarm High High	LSHH-103 = Active	5s	Y

5.5 Fine Screens (SCR-201/202) Module

A schematic of the Fine Screens are located on the INLET HMI screen and shown below.



5.5.1 Function

Camp domestic and kitchen wastewater is into the fine screens (SCR-201/202). The screening process is provided to remove hair, and fibrous materials from the supplied wastewater that might damage the membranes. The screening are collected in burlap bags that need to be removed daily. The waste water is then pumped to the EQ Tank.

5.5.2 Inputs

TAG	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)
FIT-201	Flow Indicating Transmitter	Analog	GPM	0-760lpm	0-760lpm	Y	Y
FQI-201	Flow Totalizer	Discrete N.O.	Pulse/Gal	1 liter/Pulse			
LSHH-201	Level Switch High High	Discrete N.C.					
LSHH-202	Level Switch High High	Discrete N.C.					
LSHH-203	Level Switch High High	Discrete N.C.					
LSH-203	Level Switch High	Discrete N.C.					
LSL-203	Level Switch Low Low	Discrete N.O.					

5.5.3 Setpoints

TAG	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)
FTAH-201-SP	Flow Transmitter Alarm High Setpoint	75	0-200 GPM	Open	Y

5.5.4 Logic

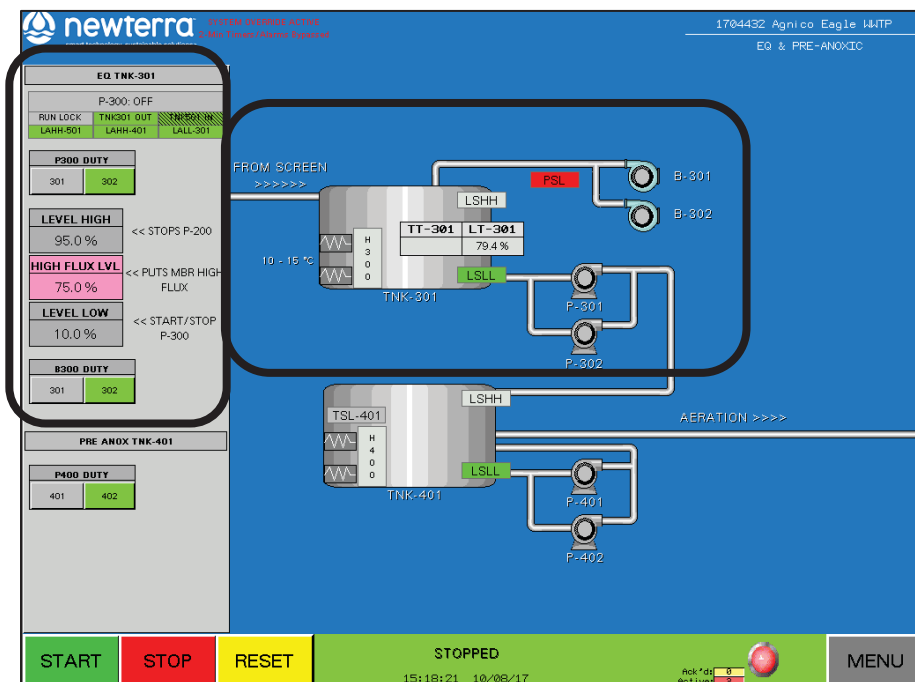
TAG	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
YC-201	Ready Contact	On when LSH-201 / 202 and LSHH-203 are not ON				HOA
SCR-201	Inlet Screen	The inlet screen will be ON when influent flow is detected via flow transmitter FIT-201. The screen will run for 1 minute after influent flow has stopped via flow transmitter FIT-201. If the high high level switch LSHH-201 on the screen is ON then the inlet screen SCR-201 will be ON.		Discrete	Y	HOA
SCR-202	Inlet Screen	Same as SCR-201		Discrete	Y	HOA
P-201	Screen Transfer Pump	The pump will be ON when the LSH-203 turn on as long as LT-301 < LTH-301-sp setpoint the pump will turn off when the LSL-201 turns off	LAHH-301	Discrete	Y	HOA
P-202	Screen Transfer Pump	This pump runs duty standby with P-201 with a 5:1 ratio	LAHH-301	Discrete	Y	HOA

5.5.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
FTAH-201	Flow Transmitter Alarm High	FIT-201 > FTAL-201-SP	60s	
LAHH-201	Level Alarm High High	LSHH-201 = Active	5s	Y
LAHH-202	Level Alarm High High	LSHH-202 = Active	5s	Y
LAHH-203	Level Alarm High High	LSHH-203 = Active	5s	Y

5.6 Equalization Tank (TNK-301) Module

A schematic of the Equalization Tank (TNK-301) is located on the EQ & PRE-ANOXIC HMI screen and shown below.



5.6.1 Function

The EQ Tank (TNK-301) buffers variability in the influent flow rate to maintain a consistent flow rate through the membranes and to reduce concentration fluctuations of influent constituents (i.e. BOD, TSS etc.) through the MBR treatment system. Wastewater entering the newterra MBR will first have undergone pre-treatment by fine screens and grease traps (kitchen waste). The waste water is then pumped to the Pre-Anox Tank.

5.6.2 Inputs

Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes
LSHH-301	Level Switch High High	Discrete N.C.						
LT-301	Level Transmitter	Analog	%	0-10 ftWC	0-10 ftWC	Y	Y	
TT-301	Temperature Transmitter	Analog	°C	0-100c	0-100c	n	n	Added to System
LSLL-301	Level Switch Low Low	Discrete N.O.						Must be above all immersion heaters in Tank
PSL-301	Pressure Switch Low	Discrete N.C.		9-85"WC				

5.6.3 Setpoints

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes
LTL-301-SP	Level Transmitter Low Setpoint	10%	0-100%	Open		
LTHFLUX-301-SP	High Flux Level Setting	50%	0-100%			Puts the MBR Permeate pumps into High Flux Mode
LTH-301-SP	Level Transmitter High Setpoint	80%	50-100%	Open		

5.6.4 Logic

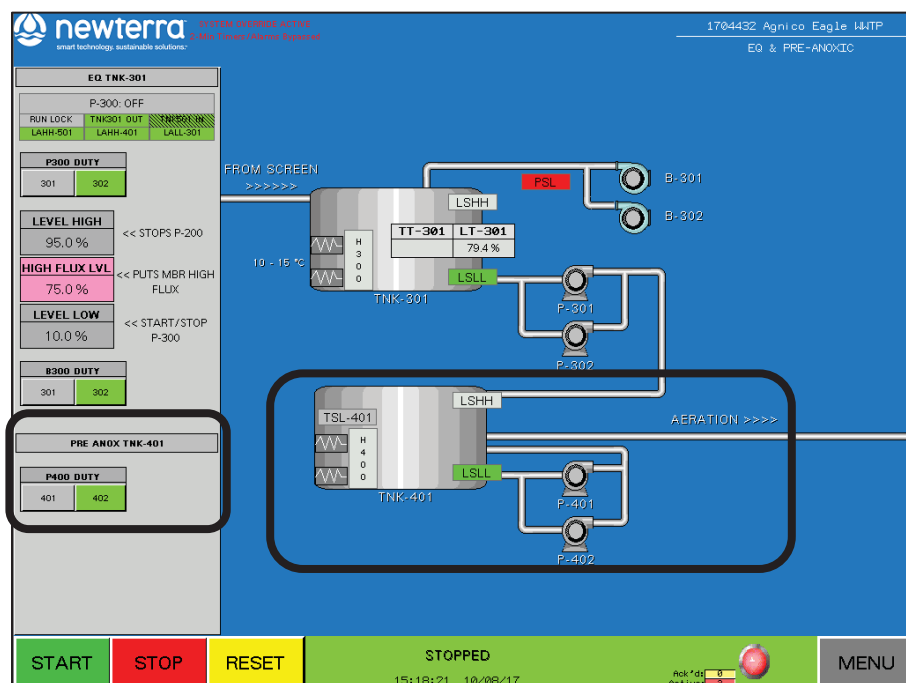
Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
H-301	Tank Heater	On when TT-301 < 10C Off when TT-301 > 15C	LALL-301	Discrete		
H-302	Tank Heater	Same as H-301	LALL-301	Discrete		
P-301	EQ Transfer Pump	The EQ pump will be ON when the EQ level transmitter LT-301 > LTL-301-SP and the aeration tank level transmitter LT-501 < LTH-501-SP The EQ pump will be OFF when the EQ level transmitter LT-301 < LTL-301-SP OR LSLL-301 = InActive OR the aeration tank level transmitter LT-501 > LTH-501-SP OR LSHH-401 is active Runs Duty with P-302 as Standby	Turns OFF LAHH-501 LAHH-401 LALL-301	Discrete	Y	HOA
P-302	EQ Transfer Pump	This pump runs duty standby with P-201 with a 5:1 ratio		Discrete	Y	HOA
B-301	EQ Blower	The EQ blower will be ON when the System is in Run & LSLL-301 is active.		Discrete	Y	HOA
B-302	EQ Blower	Runs Duty standby with B-301 switching every 120 hours		Discrete	Y	HOA

5.6.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
LAHH-301	Level Alarm High High	LSHH-301 = Active	5s	Y
LALL-301	Level Alarm Low Low	LSLL-301 = Off	5s	Y

5.7 Pre-Anox Tank (TNK-401) Module

A schematic of the Pre-Anox Tank (TNK-401) is located on the EQ & PRE-ANOXIC HMI screen and shown below.



5.7.1 Function

In the pre-anoxic tank (TNK-401), the wastewater containing organics is combined with recycled mixed liquor from the aeration tank containing nitrates. Bacteria use some of the organics to drive the denitrification process, converting nitrate into nitrogen gas. This process occurs in an anoxic environment where there is minimal oxygen. As such, a pump and eductors are used to mix the tank to prevent addition of oxygen. The denitrification process is used to meet the effluent nitrate limit, reduce oxygen requirements and to recover alkalinity, thus reducing chemical consumption.

5.7.2 Inputs

Tag	Description	Input Type
LSHH-401	Level Switch High High	Discrete N.C.
TSL-401	Temperature Switch Low	Discrete N.C.
LSLL-401	Level Switch Low Low	Discrete N.O.

5.7.3 Setpoints

None

5.7.4 Logic

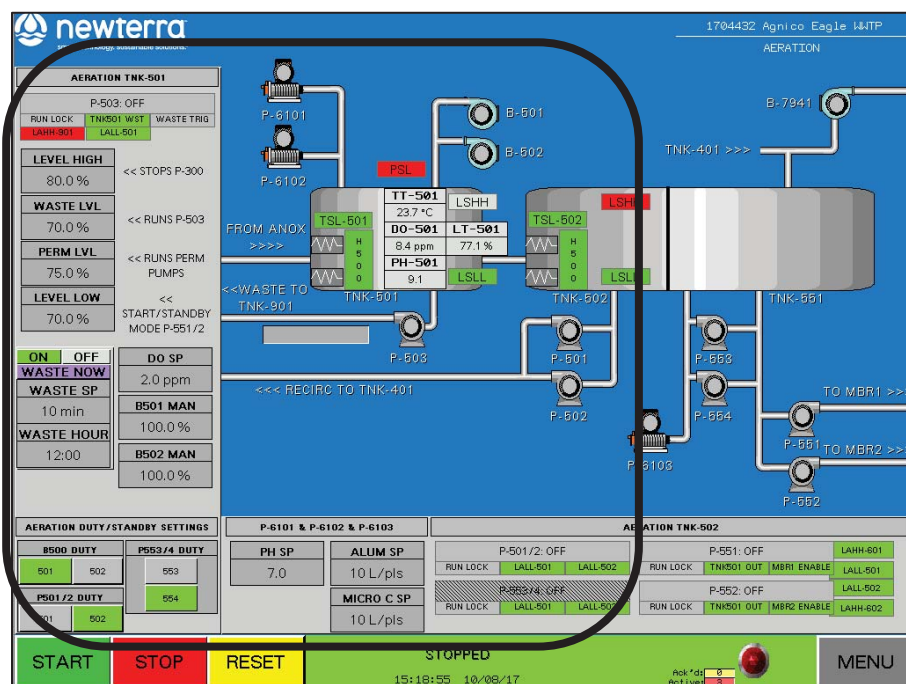
Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
P-401	Pre-Anox Mixing Pump	The pump will be ON when the System is in Run & LSSL-401 is active.	LALL-401 PUMP IS OFF	Discrete	Y	HOA
P-402	Pre-Anox Mixing Pump	Runs Duty standby with P-401 switching every 120 hours		Discrete	Y	HOA
H-401	Tank Heater	On when TSL-401 is OFF	LALL-401	Discrete		
H-402	Tank Heater	On when TSL-401 is OFF	LALL-401	Discrete		

5.7.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
LAHH-401	Level Alarm High High	LSHH-401 = Active	5s	Y
LALL-401	Level Alarm Low Low	LSSL-401 = OFF	5s	Y

5.8 Aeration Tanks (TNK-501/502) - Biological Treatment Module

The schematic of the Aeration Tanks (TNK-501/502) is located on the AERATION HMI screen and shown below.



5.8.1 Function

Mixed liquor from the anoxic tank (TNK-401) flows by gravity to the first aerobic tank (TNK-501) followed by the second aeration tank (TNK-502) for aerobic biological degradation of the influent constituents (organics and ammonia). In the aerobic tanks (TNK-501/502), the nitrification process converts ammonia to nitrate in order to meet the effluent ammonia limit. This process consumes alkalinity, so caustic is dosed into TNK-501 (by pump P-6101) to control the pH. Additionally, liquid alum is dosed (by pump P-6102) into the anoxic zone to precipitate phosphorus in order to meet the effluent phosphorus limit.

pH measured by a pH probe (PH-501) in TNK-501.

Blowers (B-501/502) supply air to the submerged fine-bubble diffusers to ensure sufficient dissolved oxygen (DO) is available for biological oxidation and to keep solids in the water suspended. Dissolved Oxygen (DO) is measured by a DO Probe (DO-501) in TNK-501.

In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank (TNK-501) to the sludge holding tank (TNK-901) by P-503.

5.8.2 Inputs

Tag	Description	Input Type	HMI Display Units	Device Range and Units	Datalog (Y)	Trending (Y)
LSHH-501	Level Switch High High	Discrete N.C.				
LSLL-501	Level Switch Low Low	Discrete N.O.				
PH-501	pH Transmitter	Analog		0-14 pH	Y	Y
DO-501	Dissolved Oxygen Transmitter	Modbus	ppm	0-10	Y	Y
TT-501	Temperature Transmitter	Modbus	°C	0-100		
LT-501	Level Transmitter	Analog	%	0-10 ft	Y	Y
PSL-501	Pressure Switch Low	Discrete N.C.		9-85"WC		
LSHH-502	Level Switch High High	Discrete N.C.				
LSLL-502	Level Switch Low Low	Discrete N.O.				
TSL-502	Temperature Switch Low	Discrete N.C.				

5.8.3 Setpoints

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)
LTL-501-SP	Level Transmitter Low Setpoint	70%	0-100%	Open	
LTH-501-SP	Level Transmitter High Setpoint	80%	0-100%	Open	
LT501-SLUDGE-SP	Waste Level for P-503	75%	0-100%	Open	
LT501-PERM-SP	Level Control for Permeate Pumps	75%	0-100%	Open	
P503 WASTE HOUR	When P-503 will waste	12pm	0-23		
P503 WASTE SP	Time that P-503 wastes for	10min	0-99		
PH-501-SP	pH Normal Setpoint	7 pH	6-8pH	Open	
PHAH-501-SP	pH Alarm High Setpoint	8 pH	7 - 14 pH	Open	Y

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)
PHAL-501-SP	pH Alarm Low Setpoint	6 pH	0-7 pH	Open	Y
DO-501-SP	Dissolved Oxygen Normal Setpoint	2 ppm	0-6 ppm	Open	
B500 I SP	Integral Gain setting DO PID Loop	10s	0-99		
B500 P SP	Proportional Gain setting DO PID Loop	100%	0-99		
B501 MAN SP	Manual Speed B-501	50%	0-100		
B502 MAN SP	Manual Speed B-502	50%	0-100		
DOAL-501-SP	Dissolved Oxygen Alarm Low Setpoint	0.5 ppm	0-6 ppm	Open	Y
ALUM DOSE	Alum Dose setting (xGal per Pulse)	10 Gallons	0-99 Gallons	Open	
MICROC DOSE	Micro C Dose setting (xGal per Pulse)	10 Gallons	0-99 Gallons	Open	
TALL-501-SP	Temperature Alarm Low Low	10 deg C	5 - 25 deg C	Password	Y
TTL-501-SP	Temperature Transmitter Low Setpoint	15 deg C	5-25 deg C	Open	
PAL-501-SP	Pressure Alarm Low Setpoint	28"WC (1PSIG)		On Device	Y
TALL-502-SP	Temperature Alarm Low Low	10 deg C	5 - 25 deg C	Password	Y

5.8.4 Logic

Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
P-6102	Alum Dosing Pump	Alum Dosing Pump P-6102 be ON when FIT-701 has reached a user adjustable volume of permeate via FT-701-DOSE setpoint. P-6102 will be ON for one pulse.		Discrete		HOA
P-6101	Caustic Dosing Pump	Caustic Dosing Pump P-6101 will be ON when PH-501 < PH-501-SP. The pump will be ON for 30s and OFF for 30s and will operate in pause mode		Discrete		HOA
H-501	Tank Heater	On when TSL-501 is OFF	LALL-501	Discrete		

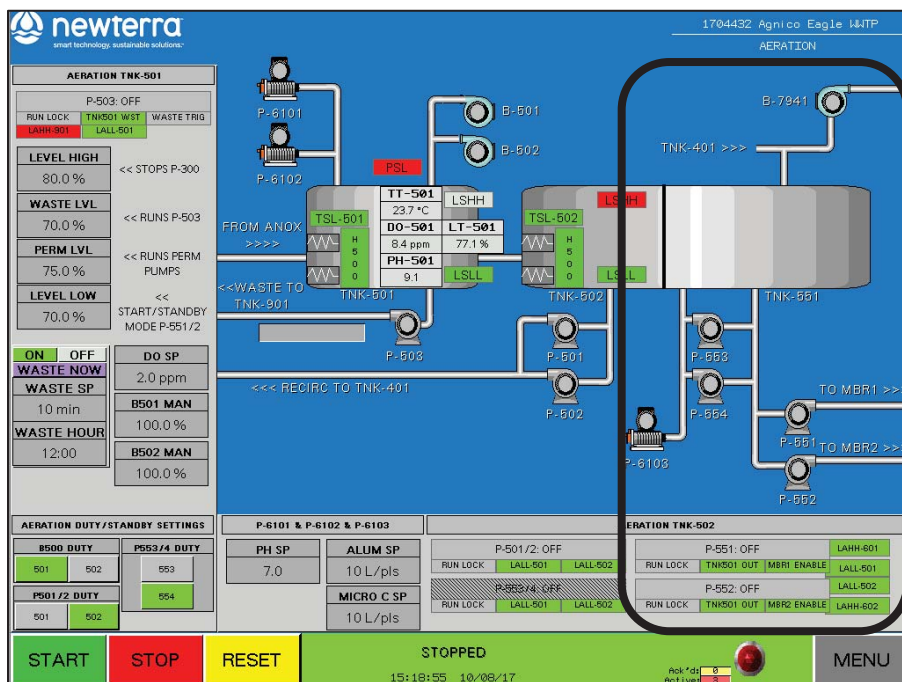
Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
H-502	Tank Heater	On when TSL-501 is OFF	LALL-501	Discrete		
P-503	Waste Activated Sludge Pump	The waste activated sludge pump will be ON at time of day setting SLUDGE-WASTE-TOD IF level switch LT501-SLUDGE-SP	LAHH-901: Pump will be OFF	Discrete		HOA
H-503	Tank Heater	On when TSL-502 is OFF	LALL-502	Discrete		
H-504	Tank Heater	On when TSL-502 is OFF	LALL-502	Discrete		
P-501	Aeration Recirc Pump	The pump will run as long as LSSL-501 is Active	LALL-502: Pump will be OFF	Discrete	Y	HOA
P-502	Aeration Recirc Pump	Runs Duty standby with p-501 switching every 120 hours		Discrete	Y	HOA
B-501	Aeration Tank Aeration Blower	ON - AlwaysRuns via PID loop to maintain DO-501-SPRuns Duty/Standby 120 hours with B-502.		Direct	Y	HOA
B-502	Aeration Tank Aeration Blower	Runs via same logic as B-501. Runs Duty/Standby every 120 hours with B-501.		Direct	Y	HOA

5.8.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
LAHH-501	Level Alarm High High	LSHH-501 = Active	5s	Y
LAHH-502	Level Alarm High High	LSHH-501 = Active	5s	Y
PHAH-501	pH Alarm High	pH-501 > PHAH-501-SP	60s	
PHAL-501	pH Alarm Low	pH-501 < PHAL-501-SP	60s	
DOAL-501	Dissolved Oxygen Alarm Low	DO-501 < DOAL-501-SP	15m	
DOALL-501	Dissolved Oxygen Alarm Low Low	DO-501 < DOAL-501-SP	4hrs	
TTAL-501	Low Temp TNK-501	TT-501 < TTAL-501-SP		
PAL-501	Pressure Alarm Low	PSL-501 = InActive	5s	Y
VFDA-501	VFD Fault			
VFDA-502	VFD Fault			
LALL-501	Low Low Level TNK-501	LSLL-501 = OFF		
LALL-502	Low Low Level TNK-502	LSLL-502 = OFF		

5.9 Post-Anox Tank (TNK-551) Module

The schematic of the Post-Anox Tank (TNK-551) is located on the AERATION HMI screen and shown below.



5.9.1 Function

Mixed liquor flows by gravity from the second aeration tank (TNK-502) to the post-anoxic tank (TNK-551) for final denitrification polishing. In the post-anoxic tank, there are minimal dissolved influent organics to drive the denitrification process. As such, an external carbon source in the form of Micro C is dosed (by P-6103) to supplement the organics and drive the denitrification process.

5.9.2 Inputs

None

5.9.3 Setpoints

None

5.9.4 Logic

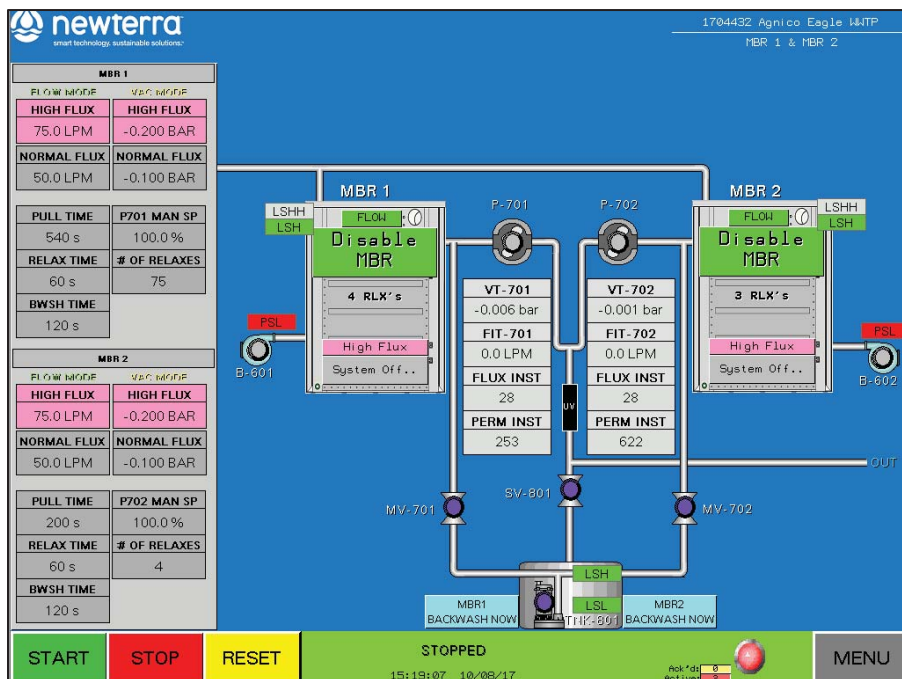
Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
P-553	Post Anox Mix Pump	The pump will run as long as LSLL-501 is Active	LALL-501: Pump will be OFF	Discrete	Y	HOA
P-554	Post Anox Mix Pump	Runs Duty standby with p-501 switching every 120 hours		Discrete	Y	HOA
P-6103	Micro C Dosing Pump	Dosing Pump will be ON when FIT-701 or FT-702 has reached a user adjustable volume of permeate via DOSE setpoint.		Discrete		HOA
P-551	Aeration Transfer Pump Feed to MBR-1	The aeration pump will feed MBR tank T-601. The pump will be ON when level transmitter LT-501 > LTL-501-SP and LSLL-501 = Active and LSLL-502 = Active and MBR-1 is Enabled. The aeration pump will be cycle ON/OFF when LT-501 < LTL-501-SP and be OFF if LSLL-501 = InActive OR LSLL-502 = InActive	LAHH-601: Pump will be OFF MBR-1 Disabled	Discrete	Y	HOA
P-552	Aeration Transfer Pump Feed to MBR-2	The aeration pump will feed MBR tank T-602. The pump will be ON when level transmitter LT-501 > LTL-501-SP and LSLL-501 = Active and LSLL-502 = Active and MBR-2 is Enabled. The aeration pump will cycle ON/OFF when LT-501 < LTL-501-SP and be OFF if LSLL-501 = InActive OR LSLL-502 = InActive	LAHH-602: Pump will be OFF MBR-2 Disabled	Discrete	Y	HOA

5.9.5 Alarms

None

5.10 Membrane and Permeate Module

The schematic of the Membrane (TNK-601/602) and Permeate (P-701/702) Module is located on the MBR 1 & MBR 2 HMI screen and shown below.



5.10.1 Function

Mixed liquor filtration and supplemental biological oxidation.

Since the solid-liquid separation process results in an accumulation of solids in the membrane tank, the mixed liquor (containing both solids and filtrate) is continuously recycled to the first aeration tank (TNK-501). This prevents excessive solids build-up in the membrane tank, and maintains sufficient biomass in the anoxic and aeration tanks. The solids that accumulate in the system consist of biomass that have grown from the influent organics and ammonia, as well as non-biodegradable solids from the influent wastewater.

Vacuum pumps (P-701 and P-702) draw the water through the membranes under a low vacuum of 0.07 to 0.25 bar.

5.10.2 Inputs

Tag	Description	Input Type	HMI Display Units	Device Range and Units	Datalog (Y)	Trending (Y)
LSHH-601	Level Switch High High	Discrete N.C.				
LSH-601	Level Switch High	Discrete N.O.				
LSHH-602	Level Switch High High	Discrete N.C.				
LSH-602	Level Switch High	Discrete N.O.				
PSL-601	Pressure Switch Low	Discrete N.C.		9-85"WC		
PSL-602	Pressure Switch Low	Discrete N.C.		9-85"WC		
VT-701	Vacuum Transmitter	Analog	Bar	-1.0 - 1.0 Bar	Y	Y
VT-702	Vacuum Transmitter	Analog	Bar	-1.0 - 1.0 Bar	Y	Y
VFD-701	VFD Status	Communcation				
VFD-702	VFD Status	Communcation				
FIT-701	Flow Indicating Transmitter	Analog	GPM	0-300lpm	Y	Y
FQI-701	Flow Totalizer	Discrete N.O.	Pulse/Gal	1liter / Pulse		
FIT-702	Flow Indicating Transmitter	Analog	GPM	0-300lpm	Y	Y
FQI-702	Flow Totalizer	Discrete N.O.	Pulse/Gal	1liter / Pulse		
LSH-801	Level Switch High	Discrete N.C.				
LSL-801	Level Switch Low Low	Discrete N.O.				

5.10.3 Setpoints

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes
VT-701-SP	MBR-1 Vac Mode Permeate Setpoint	-0.1 bar	-0.2 - 0 bar	Open		
VT-701-HFSP	MBR-1 Vac Mode Permeate High Flux Setpoint	-0.15 bar	-0.2 - 0 bar	Open		
VTAH-701-SP	MBR-1 Vacuum Transmitter Alarm High	-0.3 bar	-0.3 - 0 bar	Open	Y	
VT-702-SP	MBR-2 Vac Mode Permeate Setpoint	-0.1 bar	-0.2 - 0 bar	Open		
VT-702-HFSP	MBR-2 Vac Mode Permeate High Flux Setpoint	-0.15 bar	-0.2 - 0 bar	Open		

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes
VTAH-702-SP	MBR-2 Vacuum Transmitter Alarm High	-0.3 bar	-0.3 - 0 bar	Open	Y	
FT-701-SP	MBR-1 Flow Mode Permeate Setpoint	60 GPM	0-200	Open		
FT-701-HFSP	MBR-1 Flow Mode Permeate High Flux Setpoint	75%	0-200	Open		
FTAH-701-SP	MBR-1 Flow Transmitter Alarm High Setpoint	100	0-200	Open	Y	
FTAL-701-SP	MBR-1 Flow Transmitter Alarm Low Setpoint	10	0-200	Open	Y	
FT-702-SP	MBR-2 Flow Mode Permeate Setpoint	60 GPM	0-200	Open		
FT-702-HFSP	MBR-2 Flow Mode Permeate High Flux Setpoint	75GPM	0-200	Open		
FTAH-702-SP	MBR-2 Flow Transmitter Alarm High Setpoint	100	0-200	Open	Y	
FTAL-702-SP	MBR-2 Flow Transmitter Alarm Low Setpoint	10	0-200	Open	Y	
BKWSH-TIME-SP	Backwash Time Setpoint	120s	0-999 s	Open		
RELAX-SP	Number of Relaxes Before Backwash	6	0-999	Open		
PERM-PULL-TIME	Permeate Pull Time	9m	0-30m	Open		
RELAX-TIME	Membrane Relax Time	60s	0-999 s	Open		
FLUX-SP	High Flux Setpoint	75%	50-100%	Open		Reading based on LT-301
SLUDGE-WASTE-TOD	Time of Day to Start Sludge Wasting	23hr	0-23 hr	Open		
SLUDGE-WASTE-TIME	Duration of Sludge Wasting	60m	0-1000m	Open		

5.10.4 Logic

Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter
B-601	MBR Tank Blower	The membrane tank blower will be ON when the System is in Run. And the MBR 1 is enabled	MBR-1 Disabled	Discrete	Y
B-602	MBR Tank Blower	The membrane tank blower will be ON when the System is in Run. And the MBR 2 is enabled	MBR-2 Disabled	Discrete	Y
P-701	Permeate Transfer Pump	The permeate pump will be ON when MBR-1 is Enabled & level switch LSH-601 = Active & LT-501 > LT501-PERM-SP The Pump will perform a PULL/RELAX Cycle. The pump will be ON for the duration specified by the PERM-PULL-TIME setpoint and then be OFF for the duration of the RELAX-TIME setpoint. This will generate one PULL/RELAX Cycle. The VFD Speed of the pump will operate based on the following: In FLOW MODE: The VFD Speed will operate based on a PID loop to maintain the flowrate setpoint FT-701-SP. IF the vacuum transmitter VT-701 > -0.25 bar then the pump will switch to VAC MODE. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint FT-701-HFSP In VAC MODE: The VFD Speed will operate based on a PID loop to maintain the vacuum setpoint VT-701-SP. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint VT-701-HFSP P-701 will be OFF if P-501 is OFF.	VFDA-701: Pump Will be Off	Communication	Y

Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter
P-702	Permeate Transfer Pump	The permeate pump will be ON when MBR-2 is Enabled & level switch LSH-602 = Active & LT-501 > LT501-PERM-SP The Pump will perform a PULL/RELAX Cycle. The pump will be ON for the duration specified by the PERM-PULL-TIME setpoint and then be OFF for the duration of the RELAX-TIME setpoint. This will generate one PULL/RELAX Cycle. The VFD Speed of the pump will operate based on the following: In FLOW MODE: The VFD Speed will operate based on a PID loop to maintain the flowrate setpoint FT-702-SP. IF the vacuum transmitter VT-702 > -0.25 bar then the pump will switch to VAC MODE. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint FT-702-HFSP In VAC MODE: The VFD Speed will operate based on a PID loop to maintain the vacuum setpoint VT-702-SP. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint VT-702-HFSP P-702 will be OFF if P-502 is OFF.	VFDA-703: Pump Will be Off	Communication	Y
SV-801	Clean In Place Tank Fill Solenoid Valve	The Solenoid Valve SV-801 will be Open (Energized) when level switch LSH-801 is InActive and MBR-1 OR MBR-2 are not in Backwash. The Solenoid Valve SV-801 will be Closed (De-Energized) when LSH-801 is Active or IF MBR-1 OR MBR-2 are in Backwash.		Discrete	
MV-701	Backwash Actuated Valve	A Backwash is enabled once the permeate pumps for MBR-1 reach the number of PULL/RELAX cycles designated by the RELAX-SP on the HMI. The actuated valve will be OPEN when MBR-1 is in Backwash and level switch LSH-801 is Active. If MBR-2 is already in backwash, MBR-1 will complete 1 additional PULL/RELAX Cycle before starting a Backwash Cycle.		Discrete	
MV-702	Backwash Actuated Valve	A Backwash is enabled once the permeate pumps for MBR-2 reach the number of PULL/RELAX cycles designated by the RELAX-SP on the HMI. The actuated valve will be OPEN when MBR-2 is in Backwash and level switch LSH-801 is Active. If MBR-2 is already in backwash, MBR-1 will complete 1 additional PULL/RELAX Cycle before starting a Backwash Cycle.		Discrete	

Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter
P-801	Backwash Transfer Pump	The backwash transfer pump will be ON when MBR-1 OR MBR-2 are in Backwash and level switch LSH-801 is Active The backwash transfer pump will be OFF after the duration of BKWSH-TIME-SP OR level switch LSL-801 becomes InActive.		Discrete	

5.10.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)
LAHH-601	Level Alarm High High	LSHH-601 = Active	5s		Y
LAHH-602	Level Alarm High High	LSHH-602 = Active	5s		Y
PAL-601	Pressure Alarm Low	PSL-601 = InActive	5s		Y
PAL-602	Pressure Alarm Low	PSL-602 = InActive	5s		Y
VTAH-701	Vacuum Transmitter Alarm High	VT-701 < VTAH-701-SP	5s		Y
VTAH-702	Vacuum Transmitter Alarm High	VT-702 < VTAH-702-SP	5s		Y
VFDA-701	VFD Fault				
VFDA-702	VFD Fault				
FTAH-701	Flow Transmitter Alarm High	FIT-701 > FTAH-701-SP	60s		
FTAL-701	Flow Transmitter Alarm Low	FIT-701 < FTAL-701-SP	60s		
FTAH-702	Flow Transmitter Alarm High	FIT-702 > FTAH-702-SP	60s		
FTAL-702	Flow Transmitter Alarm Low	FIT-702 < FTAL-702-SP	60s		

5.10.6 Blower Control

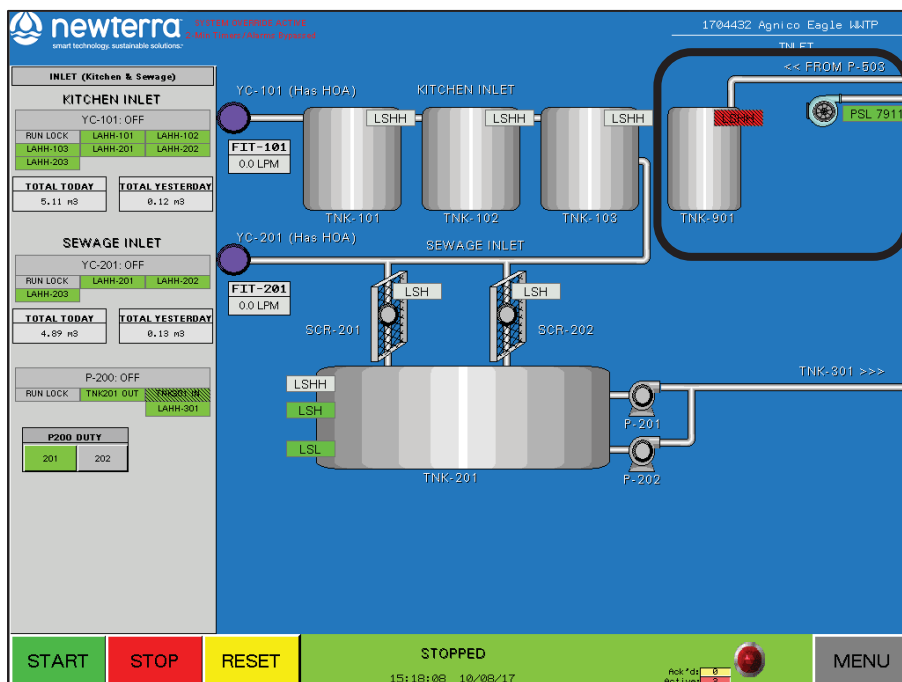
	Blower for scouring air must be on 24/7, as failure of air supply can lead to clogging of the air diffusers and membranes.
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5.10.7 CIP Cleaning

Note: At design flow when the membrane discharge vacuum exceeds 0.2 bar (80" WC), as transmitted by VT-701, VT-702 and indicated locally at PI-701, PI-702, it is necessary to take the membrane tank offline for CIP cleaning. See **Section 7** for instructions on CIP cleaning.

5.11 Sludge Holding Tank Module (TNK-901)

A schematic of the Sludge Holding Tanks is located on the INLET HMI screen is shown below.



5.11.1 Function

To store and thicken waste activated sludge for later disposal off site.

In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank (TNK-501) to the sludge holding tank (TNK-901). Wasted sludge in the sludge holding tank is thickened by decanting supernatant back to the screen tank. Thickened sludge accumulates in the sludge holding tanks until it is eventually pumped out for disposal.

5.11.2 Inputs

Tag	Description	Input Type
LSHH-901	Level Switch High High	Discrete N.C.

5.11.3 Setpoints

Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)
P503 WASTE HOUR	When P-503 will waste	12pm	0-23		
P503 WASTE SP	Time that P-503 wastes for	10min	0-99		

5.11.4 Logic

Tag	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	HOA Control
P-503	Waste Activated Sludge Pump	The waste activated sludge pump will be ON at time of day setting SLUDGE-WASTE-TOD IF level switch LT501-SLUDGE-SP	LAHH-901: Pump will be OFF	Discrete		HOA

5.11.5 Alarms

Alarm	Alarm Description	Actuation Control	Delay	Self Resetting (Y)
LAHH-901	Level Alarm High High	LSHH-901 = Active	5s	Y

5.12 Setpoints

The system Setpoints can be accessed from the SETPOINTS menu option.

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SETPOINTS

INLET		EQ TNK-301		ANOX TNK-401		AERATION							
P200 DUTY		P300 DUTY		B300 DUTY		P400 DUTY		LEVEL HIGH	<< STOPS P-300	B500 DUTY	P553/4 DUTY	P550 STDBY ON	
201	202	301	302	301	302	401	402	80.0 %		501	502	553	5 min
HIGH FLOW 101		LEVEL HIGH		<< STOPS P-200		WASTE LVL		70.0 %	<< RUNS P-503	P501/2 DUTY		P550 STDBY OFF	
300.0 LPM		95.0 %				70.0 %				501	502	554	30 min
HIGH FLOW 201		HIGH FLUX LVL		<< PUTS MBR HIGH FLUX		PERM LVL		75.0 %	<< RUNS PERM PUMPS				
300.0 LPM		75.0 %				75.0 %							
		LEVEL LOW		<< START/STOP P-300		LEVEL LOW		70.0 %	<< START/STOP P-551/2	DO SP			B500 (P)
		10.0 %				70.0 %				2.0 ppm			1.0
						ON OFF				B501 MAN			B500 (I)
						WASTE NOW				100.0 %			25 s
						WASTE SP		WASTE HOUR		B502 MAN			LOW TEMP
						10 min		12:00		100.0 %			10.0 °C
													10 L/pls
													10 L/pls
													0.5 ppm
													pH LOW
													6.0
MBR 1				MBR 2				pH HIGH				LOW DO	
FLOW MODE	VAC MODE	FLOW MODE	VAC MODE	FLOW MODE	VAC MODE	FLOW MODE	VAC MODE	FLOW MODE	VAC MODE	FLOW MODE	VAC MODE	FLOW MODE	VAC MODE
HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX	HIGH FLUX
75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR	75.0 LPM	-0.200 BAR
NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX	NORMAL FLUX
50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR	50.0 LPM	-0.100 BAR
PULL TIME				P701 MAN SP				P701 (P)				HIGH FLOW	
540 s				100.0 %				3.0				280.0 LPM	
RELAX TIME				# OF RELAXES				P701 (I)				LOW FLOW	
60 s				75				10 s				10.0 LPM	
BWSH TIME								HIGH VAC					
120 s								-0.300 BAR					
PULL TIME				P702 MAN SP				P702 (P)				HIGH FLOW	
200 s				100.0 %				3.0				280.0 LPM	
RELAX TIME				# OF RELAXES				P702 (I)				LOW FLOW	
60 s				4				10 s				10.0 LPM	
BWSH TIME								HIGH VAC					
120 s								-0.300 BAR					
START				STOP				RESET				STOPPED	
15:21:55				10/08/17				ack'd 0				MENU	

Date & Time

Factory Defaults

5.12.1 PLC Date & Time

The PLC Time and Date can be adjusted from the SETPOINTS HMI screen. Below is an example of the screen that will appear for the operator.

SET PLC DATE/TIME

Day
Month
Year
0
0
0

Hour
Minute
Second
0
0
0

Read PLC
Set & Exit
Exit

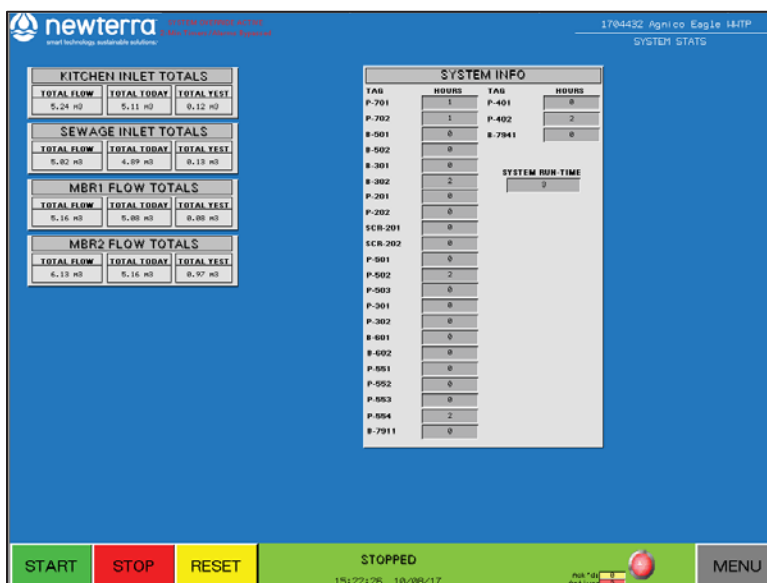
5.12.2 Factory Defaults

The Factory Defaults (setpoints) can be restored to the WWTP by pressing the Factory Default button from the SETPOINTS HMI screen. A confirmation screen will appear to the operator. See below. A listing of WWTP Factory Default values (setpoints) are at Appendix K.



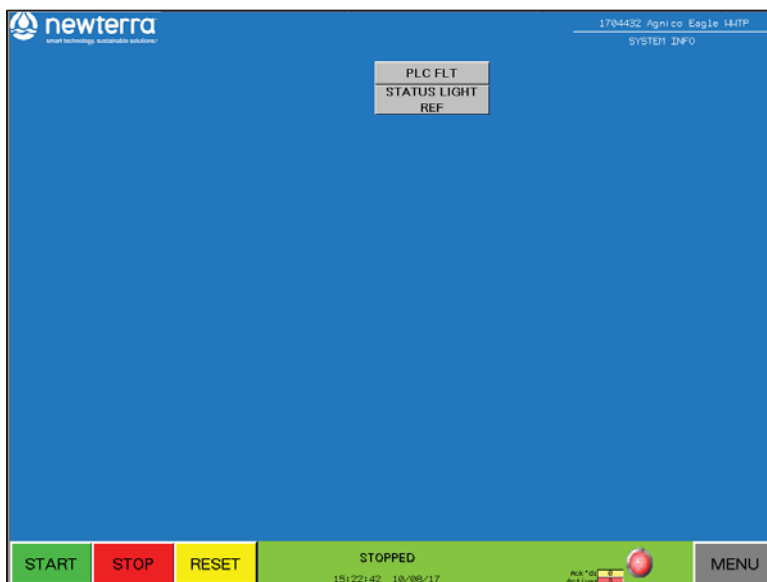
5.13 Statistics

The system statistics can be accessed from the STATS menu option. Influent and Process Flow totals as well as motor run times are provided at this screen.



5.14 PLC Status

The system PLC status can be accessed from the SYSTEM INFO menu option.



6.0 PLANT START-UP, OPERATING GUIDELINES AND MONITORING

6.1 MBR Plant Start-Up

6.1.1 Mechanical & Electrical Start-up Procedure

- If the system is being started for the first time, work your way through the **newterra Commissioning Checklist** presented in **Appendix C** of this O&M Manual.
- If the kill switch on the panel (red mushroom shaped button) is pulled out, then push it in to confirm that the MBR system is off.
- Push the reset button on the operator interface to reset all alarms.
- Make sure there are no obstructions over any moving parts, for example a jacket laying on a belt drive.
- Put all HAND/OFF/AUTO switches to AUTO (**A**) mode.
- Pull the kill Button (red button on panel) out to start the process.
- Push the start button on the Operator Interface.

6.1.2 Process Start-up

NOTE: Sludge from a nearby wastewater treatment plant can be used to start up another system if the treatment process is similar (i.e. nitrification, de-nitrification etc.).

1. Introduce the seed bacteria and fill the aeration tank according to one of the following two methods specific to the type of seed used:

Sludge Seed

- a. Calculate the volume of seed sludge required to ensure that there is a minimum of 3,000 mg/L MLSS in the MBR system. The volume of seed sludge required can be calculated with the following formula.

$$V_s = \frac{3000 \times V_t}{MLSS_s}$$

Vs: Total volume of seed sludge for MBR system (m3)

Vt: Total effective volume of process tanks in MBR system (see section 3 of the manual) (m3)

MLSSs: MLSS concentration of seed sludge from a treatment system with similar processes (nitrification, de-nitrification etc.) (mg/L)

Arrange for delivery of fresh seed sludge from an activated sludge system employing a suspended growth type process. If it is possible, obtain seed sludge from a facility treating similar wastewater and operated with similar processes (nitrification etc).

- b. If possible drain the water used for clean water testing from the aeration tank. This will minimize dilution of the seed bacteria.
- c. Pump seed sludge through the screen module to remove any debris that might damage the membranes. This can usually be done by slowly dumping the seed into the closest lift station. Ensure screen process and feed pumps to aeration tank are in "AUTO" mode.
- d. If a primary clarifier is included and there is a screen between the aeration tank and membrane tank: Add seed sludge directly to the aeration tank.
- e. Once aeration tank liquid level has filled above 30% with seed sludge, turn aeration tank blowers to "AUTO" mode.
- f. Continue adding remaining seed sludge.
- g. Once all seed sludge has been pumped into the aeration tank take note of the liquid level. If the aeration tank is full then continue to Step 2. If the aeration tank is not full then continue to fill the aeration tank 15% of its total volume per day using raw wastewater. This is to avoid shocking the bacteria with excess BOD, reducing the risk of forming foam causing bacteria and reducing the impact of un-metabolized BOD on the membranes.

Dry Seed

- a. If possible drain the water in the aeration tank used for clean water test. This will minimize dilution of the seed bacteria.
- b. Turn screen module and feed pump(s) to aeration tank to "AUTO".
- c. Allow aeration tank to fill to 30% with raw wastewater, and then turn off screen module and feed pump(s).
- d. Remove the access cover from the aeration tank.
- e. Adjust the DO probe and pH probe positioning in the aeration tank until both probes are submerged in the wastewater.
- f. Turn aeration tank blowers to "HAND" to ensure vigorous mixing when adding dry seed bacteria. Note: When set to "HAND" the blowers will only run for 2 minutes. If this time runs out before all the dry bacteria have been added, then the blowers must be set to "OFF" and then back to "HAND".

- g. Slowly add 25% of the supplied heterotrophic dry seed bacteria through the view port). The following quantities in Table 1 are typically shipped with standard camp systems, if the current system is not on this list please consult with a Process Engineer:

Table 1 - Seed bacteria quantities per standard camp model

Standard Camp Model	Dry Bacteria (Bioremove 5190) (lbs)	Nitrifying Bacteria (Bioremove 5895) (lbs)
50 Man	50	10
100 Man	50	10
300 Man	75	20
600 Man	75	20
1000 Man	100	30

- h. Turn aeration tank blowers to “AUTO”.
- i. Continue adding raw wastewater and dry seed bacteria according to the schedule outlined in Table 2 below:

Table 2 - Dry seed and wastewater dosing schedule

Day	Daily Wastewater Flowrate (% of Aeration Tank Volume)	Aeration Tank Fill Level (%)	Dry (heterotrophic) Seed to be Added (% of Total Supplied)
1	30%	30%	25%
2	10%	40%	20%
3	10%	50%	15%
4	15%	65%	10%
5	15%	80%	10%
6	15%	95%	10%
7	5%	100%	10%

- j. As the aeration tank fills, continue to adjust the positioning of the DO and pH probes accordingly.
2. Once the aeration tank is full (liquid level >80%) the remaining equipment in the system can be started. Turn all equipment (except sludge wasting/processing equipment) to “AUTO”. Set the permeate flow rate at a value to achieve a flux of 6.5 lmh initially.

Convert flux (lmh) to flow rate (lpm) as follows:

$$\text{Flow rate (lpm)} = \frac{\text{Flux (lmh)} * \text{membrane surface area (m}^2\text{)}}{60 \left(\frac{\text{min}}{\text{h}} \right)}$$

**** Verify the membrane cassette model – MCXL2 = 8 m² of surface area

3. Continue increasing the flux rate everyday according to the schedule in below.

NOTE: Day 1 refers to the day that the aeration tank is full. If dry seed was used this will be day 7. If nitrifying bacteria were provided begin dosing into the aeration tank according to the schedule in below.

Flux and nitrifying bacteria dosing schedule

Day	Flux (lmh)	Nitrifying Bacteria to be Added (% of Total Provided) [If Provided]
1	6.5	20%
2	6.9	20%
3	7.4	20%
4	7.9	20%
5	8.4	20%
6	9.0	-
7	9.6	-
8	10.2	-
9	10.9	-
10	11.6	-
11	12.4	-
12	13.2	-
13	14.1	-
14	15.1	-
15	16.1	-
16	17.1	-
17	18.0	-
18	18.0	-
19	18.0	-
20	18.0	-
21	18.0	-
22	18.0	-
23	18.0	-

4. Foaming may occur during start-up, which is normal. Foaming can be caused by a number of factors. Typically during start-up foaming is a result of a high food (BOD) to microorganism (F/M) ratio. This promotes the growth of long chained filamentous bacteria that increases the surface tension resulting in strong, long lasting foam. As the quantity of biomass builds, and the sludge age increases the normal non-filamentous bacteria will dominate, and the foam should subside. In the meantime foaming can be addressed by spraying water, food based defoamer (silicone based defoamer is strictly prohibited) addition, or aeration minimization in the aeration tank. Check for signs of toxicity and excessive fat, oil and grease.
5. If a defoamer is required, consult with a process engineer for recommendation of an acceptable antifoaming agent and dosing quantities.

6. Monitor the pH throughout the start-up process. An observed decline in pH is an indication that the nitrifying bacteria are beginning to remove ammonia. It is important, however, that the pH does not drop too low, as this can cause biological activity to be inhibited, which can then result in severe membrane fouling. During start-up it is beneficial to operate at a pH between 7.0 and 7.5 to ensure optimal performance and growth of bacteria.

The pH should be maintained between 6.5 and 8.0 during normal operation.

ATTENTION

It is advisable to start the MBR system with a minimum MLSS concentration of 3,000 mg/L to minimize foaming. The seed sludge should come from a plant which has a screen of 2 mm. It is critical to screen the seed sludge with 2 mm perforated screen prior to seeding for membrane protection.

ATTENTION

No untreated wastewater should enter the membrane tank. Make sure wastewater is completely biologically treated before it gets to the membrane tank

6.2 MBR System Operating Guidelines and Monitoring

6.2.1 Operating Guidelines

This section outlines the operating conditions that are required for proper wastewater treatment, and longevity of the membranes. For instructions on how to control the system using the touch screen HMI, see **Section 5**. The operators are expected to run the MBR system at all times in accordance with the maintenance, operational procedures and details specified in this manual. The following two tables provide operating parameters that can be easily maintained, and define the range of operating values.

There may be situations where the system needs to operate outside of the conditions covered in this manual. If these conditions develop, please consult newterra ltd. to discuss operation and methods to optimize performance.

Generally, the following points can be used to operate the MBR system properly:

- The MBR system is designed to treat wastewater with specified influent characteristics.
- Never operate the MBR tank below the minimum membrane submerged level. It is necessary to maintain a minimum of 250 mm liquid level above the membrane modules to ensure they are wet at all times and to allow for proper filtration.
- Always supply the required amount of air for scouring to the membrane module.
- Always filter wastewater at or below design flow rate.
- Periodically, relax the membranes by ending filtration while allowing the membrane aeration scour to operate continuously and initiate backwash operation during membrane relaxation (default relaxation mode preset in PLC - permeation continues for 9 min and stops for 1 min).
- Always operate the MBR in accordance with the parameters listed in the following tables.
- Clean the membranes in-place with a dilute chemical in accordance with **Section 7** of the O&M Manual.

6.2.1.1 Membrane Filtration Operational Conditions

Parameter	Recommended Value	Notes
Diffuser Relaxation	10 minutes/day	Effluent filtration must be turned off, blower shuts down for 10 mins/day
Relax Time	1 min/10 min	Filtration must be off and blower are operating continuously
Backwashing	48 cycles	Built-in backwash mode during relaxation mode
In-situ Chemically Enhanced Backwash (CEB)	500 ppm as NaOCl	Requires 3 L to fully backwash one MCXL cassette. Frequency of CEB may vary. Refer to Membrane Cleaning Section 7.3 for cleaning procedure.
TMP	< 0.2 bar (2.9 psi)	Membranes to be cleaned once the TMP exceeds 0.2 bar (2.9 psi)

6.2.1.2 MBR – Recommended Biological Operational Conditions

Parameter	Recommended	Range	Notes
MLSS (mg/L)	10,000	8,000 – 15,000	Never operate the membranes if MLSS < 3,000 mg/l. Sludge wasting should be undertaken as required to maintain target MLSS
Temperature (°C)	15 - 35	10 – 35	Avoid sudden changes in temperature. Minimum operating temperature is 15 °C
pH (s.u.)	6.8 - 8.5	6.0 – 9.0	Membrane module can handle a change in pH, however it is recommended to keep pH between 6.8 - 8.5
Aeration Tank, DO (mg/L)	≥ 2.0	1.0 – 8.0	This can be maintained by adjusting the volume of air supplied to the aeration tank
Viscosity (mPa-s)	Not applicable	0 – 300	–
Aeration Tank to Anoxic Tank Recirculation	400%	200 – 500%*	Only applies if an anoxic tank is included. *The recycle ratio is a function of effluent NO ₃ -N/TN limit
Membrane Tank to Aeration Tank Recirculation	400%	200 – 600%	–
F:M (kg BOD/kg MLSS/d)	0.1	0.03 – 0.2	$F:M = [\text{Flow (m}^3/\text{d)} \times \text{BOD conc (mg/l)}] / [\text{Process volume (m}^3) \times \text{MLSS conc (mg/l)}]$
F:M (kg COD/kg MLSS/d)	0.15	0.05 – 0.3	$F:M = [\text{Flow (m}^3/\text{d)} \times \text{BOD conc (mg/l)}] / [\text{Process volume (m}^3) \times \text{MLSS conc (mg/l)}]$
SRT	> 15	12 – 50	

Process Troubleshooting Guide is presented in Section 7 of this O&M Manual.

6.2.2 Sampling

To ensure accurate system monitoring and the validity of laboratory test data, samples must be collected as outlined below. These are only recommended guidelines. It is imperative that scheduled testing protocols are performed in compliance with local regulatory agency requirements. Composite samples of the MBR systems may need to be sent out to a certified laboratory for testing, based on the local regulatory requirements.

Monitoring and Testing Requirements

Parameter***	Influent	Aeration Tank	Membrane Tank	MBR Effluent
Flow rate	D (PLC)			D (PLC)
Fat, Oil and Grease (FOG)	AR			AR
Alkalinity	AR			
Biological Oxygen Demand (BOD)	W			W
Total Suspended Solids (TSS)	W			W
Total Kjeldahl Nitrogen / Total Nitrogen (TKN / TN)	M			AR
Ammonia Nitrogen(NH ₄ -N)				AR
Nitrate Nitrogen (NO ₃ -N)				AR
Total Phosphorus (TP)	W			W
Mixed Liquor Suspended Solids (MLSS)			W	
Mixed Liquor Volatile Suspended Solids (MLVSS)			AR*	
Temperature		D (PLC)		
pH	AR	D (PLC)		W
Dissolved Oxygen (DO)		D (PLC)		
Filterability			TW	
Turbidity				AR**
Fecal Coliform / <i>E-Coli</i>				W

Legend: D = daily; W = weekly; TW = three times weekly; M = monthly; AR = as required.

* If MLVSS /MLSS ratio of a minimum of 0.7 is detected, MLVSS testing can be done periodically, on an “as required” basis.

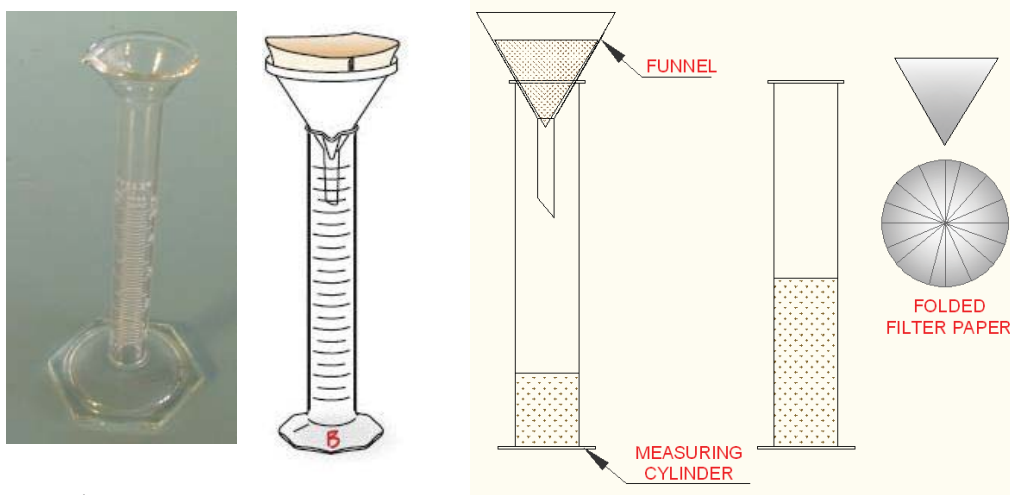
**The effluent should be routinely checked for any signs of problem. Normally, the effluent is reasonably clear, colourless, and odourless. If the effluent becomes turbid, testing should be carried out required.

*** Explanation and definition of abbreviations, acronyms and terms used in the manual are presented in **Appendix G – Glossary & Terms** and **Appendix H – Biological Treatment & Monitoring Parameters**.

6.2.2.1 Filterability Test

The objective of the filterability test is to evaluate the condition of the working biomass. This is assessed by measuring the volume of filtrate passing through the filter paper. If filtrate is greater than 10 mL/10 min, then biomass filterability is acceptable; however, if it is less than 10 mL/10 min, modifications to the plant operating condition are required to prevent premature membrane fouling. See the Membrane Fouling Troubleshooting Guidelines table in Section 7.6.1 to determine the cause of the low filterability and how to correct operation to improve the filterability.

Laboratory Glassware and Filter Paper



Apparatus:

Filterability Kit is distributed by **newterra ltd (Part # 24146)**.

Measurement Procedure:

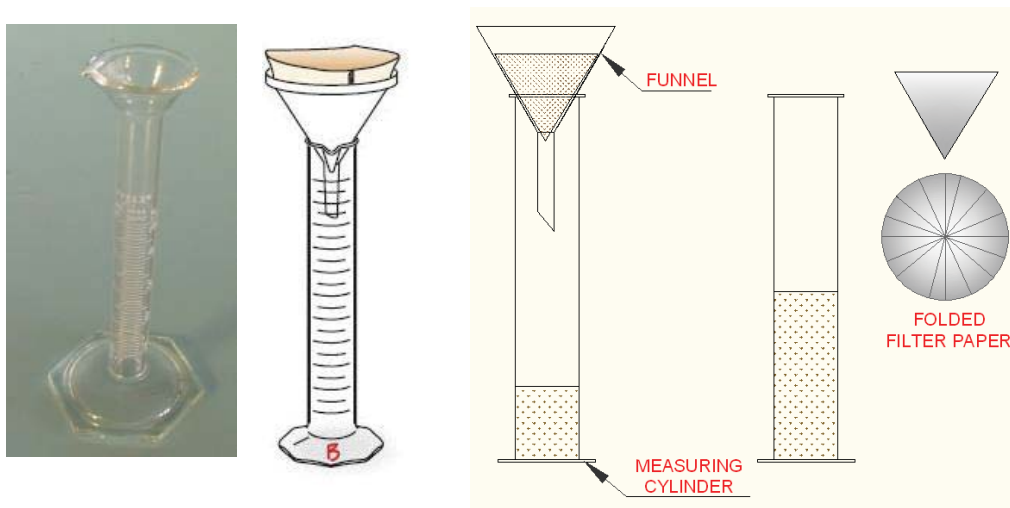
1. Pleat filter paper by folding in half, quarters etc.
2. Line the funnel with pleated filter paper and place the funnel in the graduated cylinder.
3. Collect 50 mL of activated sludge sample in a beaker and stir.
4. Pour the 50 mL sample into the funnel.
5. Start timer when the first drop of water filtered through the filter paper.
6. After 10 minutes of filtration, record the level of filtrate in the graduated cylinder.

Filterability (FT)	Action	State of urgency
> 10 ml	Excellent, no action req'	
5 - 10 ml	Tweak process operation	
< 5 ml	Process adjustment req	Contact newterra ltd.

6.2.3 Suggested Test Equipment for Monitoring

The following test equipment's will assist in the monitoring of the MWWTP but are not provided with the system.

6.2.3.1 Filterability - Laboratory Glassware and Filter Paper



Apparatus:

- Filter paper - AMD Manufacturing, Part Number NO5C 18.5CM or equivalent;
- Funnel (75 mm diameter recommended);
- 50 mL graduated cylinder - Cole-Parmer Graduated Cylinder, Part Number RK-06134-67 or equivalent;
- Beaker (min 100 ml size) and stir rod
- Watch with seconds display or equivalent

6.2.3.2 Turbidity, Phosphorus - Hach DR900 (and reagents)



The hand-held DR 900 allows quick and easy access to most-used testing methods. This colorimeter is waterproof, dustproof and field durable. With an intuitive user interface, easy data transfer abilities, and the ability to test up to 90 of the most commonly tested water methods.

6.2.3.3 DO and pH - Hach HQ40d with probe or Equivalent



Designed for water applications, the Hach HQ40d portable meter is an advanced meter. HQd[™] meters connect with smart probes that automatically recognize the testing parameter, calibration history, and method settings to minimize errors and setup time.

Portable meter measures critical water quality parameters - without the need for multiple instruments.

Intuitive user interface for simple operation and accurate results.

Meter kit includes field case, 4 AA batteries, protective meter glove, power adapter, USB/DC power adapter for data transfer, quick-start guide, user manual, and documentation CD.

DO and pH probes required.

6.2.3.4 Sludge Settling - Settleometer



The ability to observe and measure the rate and characteristics of solids separation is essential to control biological treatment processes that produce sludge.

6.2.3.5 TSS - Aysix model 3150 hand held TSS meter or Equivalent



Portable Suspended Solids Analyser

6.2.3.6 Hach CEL Advanced Wastewater Laboratory



Includes the DR 900 Colorimeter, HQd multi-meter with pH probe, reagent sets, apparatus, illustrated instrument and procedures manuals, and a rugged carrying case

6.2.4 Record Keeping

An essential component of quality control in any facility is sound record keeping. A log book covering the entire treatment system performance should be maintained, updated, and readily accessible to all operators. The log book should be used to record observations, set point alterations, and unusual conditions.

For each wet chemistry parameter analysis, a separate work-sheet has to be prepared. Work-sheet data for at least the previous year should be kept for possible consultation.

The second step in quality control is to train all operators to follow an established procedure for each test. Identical samples should be periodically tested for any parameter by different operators, and the variability among results should be compared. Consistent variability in results may lead to the technique improvement of operators.

Duplicate analysis of a sample should also regularly be done. And, split samples should regularly be sent to an outside accredited laboratory and analysis results should be compared with those done in-house.

In addition to summary sheets, it is highly recommended that data should be entered into prepared Excel spread-sheets. Spread-sheets greatly aid in the data presentation and manipulation, and would be of immeasurable value when report writing is required.

6.2.5 Process Trending

Other than pre-planned process changes or major upsets, process modifications should be based on trends shown in the process data. A trend is nothing more than an indication of real change in a process parameter over time. A trend chart is simply a graph of data being trended.

As the graph changes, upward or downward trends are detectable. Smoothing trends by graphing the 3-, 7-, or 30-day average of the data allows the trend to be shown more clearly. Because the individual data point may be questionable, the actual value of data point are less important compared with the trend regarding the process monitoring.

Trend graphs are a part of the Excel data spread-sheet; the operator can trend and analyse many parameters in just a few minutes in order to assess process performance. When a trend is identified, its indication to the process can be evaluated, and corrective action may be carried out, if needed. Statistically, the more data points there are in a trend chart, the more reliable the trend.

7.0 SYSTEM MAINTENANCE

 ATTENTION	ATTENTION: MAINTENANCE SHOULD BE PERFORMED ONLY BY TRAINED PERSONNEL! When providing maintenance or cleaning the plant, avoid direct contact with wastewater, organic materials, etc. Always wear protective clothing, e.g. waterproof, protective gear, boots, and gloves to keep these materials from body. Wear face and eye protection as required by health & safety protocols and standards, especially when handling chemicals.
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CAUTION: Shut off all electrical power before working on the mechanical or electrical equipment.

The system should be routinely checked for any signs of operational problems. Such problems could include, but are not necessarily limited to, abnormally high peak flows, unpleasant odour, and diffuser clogging, and so on.

7.1 Plant Visual Checks

Noise	During normal operation, there is a uniform humming sound at the plant. In case of an unusual noise, it could be an indication that the blower needs maintenance or repairs.
Smell	The MicroClear™ MBR is an aerobic system. During normal operation, the system has an earthy smell similar to that of a well-maintained compost pile. If other odours are noticed, the aeration process may not be operating or the system has been overloaded. Check the DO manually and the blower to verify proper operation.
Sight	Normally, the effluent is reasonably clear, colourless, and odourless. If the effluent becomes turbid, there is a pin hole in the membrane or a leakage in the piping. Take the unit out of operation and investigate. <u>Check uniformity of membrane air distribution periodically to ensure air scouring is effective across all membrane plates.</u>

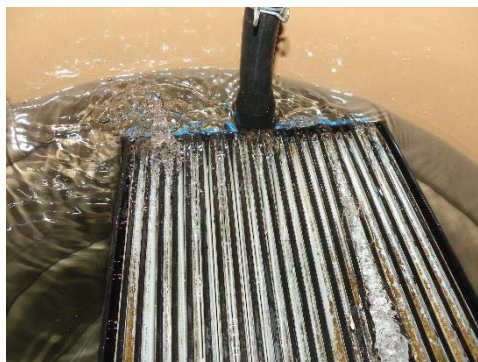
7.1.1 Air Scouring Patterns in Membrane Tanks

Membrane air scouring check is an essential routine maintenance procedure for **newterra** MBR WWTP to ensure membranes are receiving effective physical cleaning. Air scouring has to be observed for uniformity of bubbling action all across the membrane module/cassette on regular basis.

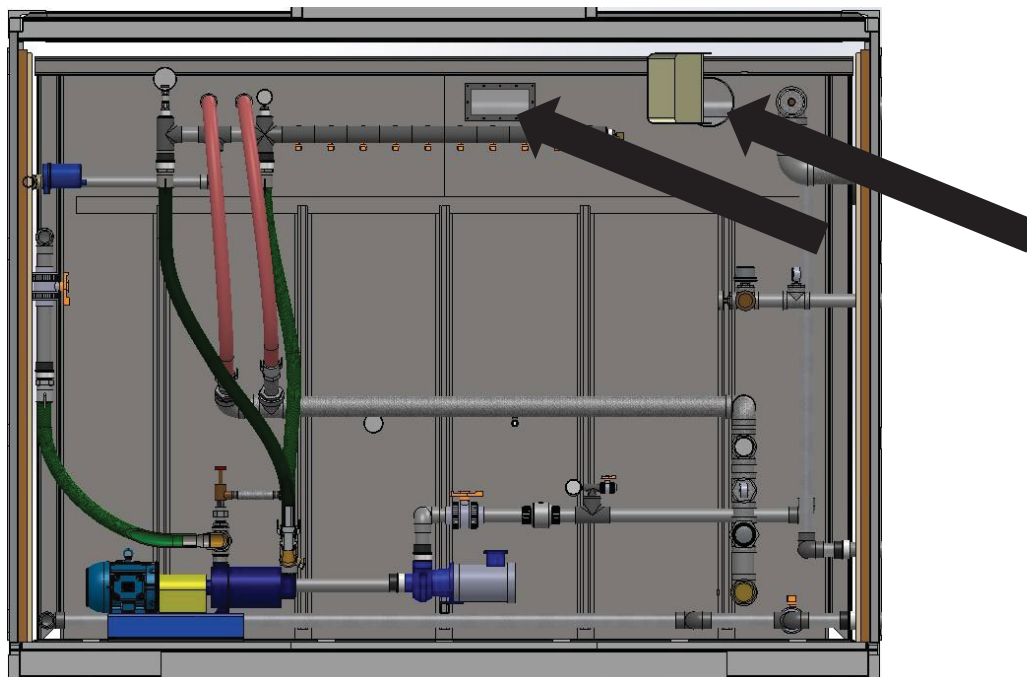
A visual inspection of the aeration patterns should be performed with the liquid level 2-3" (5 – 7.5 cm) above the top row of membranes and looking thru the tank viewport or inspection opening (see below).



**Proper air scouring in
membrane tank**



**Uneven aeration in
membrane tank**



It is easy to observe aeration patterns through the clear window in the membrane tank(s). Operator should note any unusual patterns of air distribution. The visual inspection should also be performed before any membrane cassettes are removed from the membrane tank(s). Operator has to check for:

- damage of air diffusers - if this occurs, empty the tank and fix the diffuser;
- air leakages - if this occurs, tighten up the fittings.

If there is insufficient air scouring, localized dewatering (**clogging, sludging, caking and plugging**) may occur and may in turn lead to membrane fouling.

7.2 Schedule for Routine Operation and Maintenance Checkups

Location	Item	Day	Week	Month	Quarter	Year	Comments
Grease Traps	TNK-101/102/103 Grease traps must be cleaned whenever the grease film is approx. 1 foot thick in any tank. An unmaintained grease trap does not stop any grease waste from entering the WWTP system.						Remove vac out grease film from top of tanks and any food particles from the bottom of tanks.
PROCESS	Perform visual check	X					Refer to Plant Visual Checks
	Record permeate flow rate	X					
	Record DO in the aeration tank	X					
	Record pH in the aeration tank	X					
	Record vacuum pressure at the membranes	X					Normal range: 0.07 – 0.25 bar (28" -100" WC)
Note: When the vacuum at the membranes reaches 0.25 bar/3.5 psig/100" WC, it may be necessary to stop the permeation and perform recovery cleaning (please see Section 7.6.1 for membrane fouling troubleshooting and subsection 7.3 for membrane cleaning procedures)							
MECHANICAL & PROCESS	Inspect membranes and permeate withdrawal system		X				1 hour
	Clean the DO sensor – DO-501 Replace DO probe every second year in accordance with vendor manual.		X				In accordance with vendor manual in Appendix E
	Clean and calibration (as required) PH-501					X	In accordance with vendor manual in Appendix E

Location	Item	Day	Week	Month	Quarter	Year	Comments
MECHANICAL & PROCESS	Inspect and maintain valves & fittings for leaks.		X				
	Membrane in-situ cleaning				X		2-4 hours
	Remove membrane module for mechanical cleaning and inspection					X	Drain membrane tank. Roll out membrane cassette. Remove membranes and inspect. (1 -2 days)
	Remove, inspect and maintain diffusers in aeration and membrane tanks					X	This involves a complete draining of tanks (1-2 days). In accordance with vendor manual in Appendix E
	P-201/202, 301/302, 401/402, 501/502, 553/554, 551/552 – Price Pumps -General Condition (Temperature, Unusual Noises or Vibrations, Cracks, Leaks, Loose Hardware, Etc.) - Pump Performance (Gauges, Speed, Flow) -Clean electrical motor and keep ventilation openings clear				X		See vendor manual at Appendix E.
	P-701/702 – Permeate Pumps -General Condition (Temperature, Unusual Noises or Vibrations, Cracks, Leaks, Loose Hardware, Etc.) - Pump Performance (Gauges, Speed, Flow) -Clean electrical motor and keep ventilation openings clear -Do Not let the pump run dry!				X		See vendor manual at Appendix E.

Location	Item	Day	Week	Month	Quarter	Year	Comments
MECHANICAL & PROCESS	P-801 – Backwash Pump -General Condition (Temperature, Unusual Noises or Vibrations, Cracks, Leaks, Loose Hardware, Etc.) - Pump Performance (Gauges, Speed, Flow)						Submersible pumps contain oils which becomes pressurized and hot under operating conditions - allow 2½ hours after disconnecting before attempting service.
	B-301/302 , 601/602 – EQ and Membrane Tank Blowers -Clean electrical motor and keep ventilation openings clear -Check inlet filter. Clean or replace as necessary.			X X			In accordance with vendor manual in Appendix E
	B-501/502 – Aeration Tank Blowers -Clean electrical motor and keep ventilation openings clear - Check V-belts for tightness - Check and add fresh oil as required to maintain proper level. - Change blower oil. -Check inlet filter. Clean or replace as necessary.		X X	X X		X	In accordance with vendor manual in Appendix E Semi-annual
	SCR-101/102 -Inspect inspecting the unit for blockages and general cleaning. Inspection doors are located on the cover guard and screen body. Washing the screen with high water pressure may be necessary.	X					

Location	Item	Day	Week	Month	Quarter	Year	Comments
	-Check for wear on the brushes and give the unit a thorough cleaning each week will ensure maximum efficiency. -Check the oil level in the motor. Grease the bearings with the appropriate grease. Making adjustments to the brushes to maximize contact with perforated sheet.		X	X			
	P-6101/6102/6103 – Dosing Pumps -Check the metering diaphragm for damage -Check that the hydraulic lines are fixed firmly to the liquid end. -Check that the suction valve and discharge valve are fitted tightly. -Check the tightness of the entire liquid end - particularly around the leakage hole -Check that the flow is correct: Allow the pump to prime briefly - turn the multifunctional switch briefly to "Test" -Check that the electrical connections are intact. -Check the integrity of the housing. -Check that the dosing head screws are tight.				X		In accordance with vendor manual in Appendix E
	Container Fans -Dust and dirt on the exterior surface of the motor, fan panel and the entire fan wheel should be removed. -Inspect of all fasteners to ensure they have not loosened due to vibration.					X	In accordance with vendor manual in Appendix E

Location	Item	Day	Week	Month	Quarter	Year	Comments
	Container Heaters Once a year, remove the dust accumulation inside the heater using a vacuum cleaner or compressed air. Cleaning should be done while the heater is disconnected from the supply circuit.					X	In accordance with vendor manual in Appendix E
ELECTRICAL	Check electrical leads				X		
	Check panel fan filter and replace/clean as necessary.			X			
	Inspect and maintain breakers, fuses, resets and anodes			X			
	Check motor mounting bolts			X			
	Clean dust away from electric motor			X			
	Check PLC and control panel functionality		X				



All connections (hoses, hose clamps, camlocks) have to be checked periodically (on a monthly basis) to make sure all of them are in good condition with no leaks.

7.3 MBR Membrane Cleaning

7.3.1 Membrane In-situ Chemically Enhanced Backflush (CEB)



Chemical cleaning is only to be carried out by qualified and trained personnel! Chemicals can lead to serious injuries. Always wear personal protective equipment (PPE) when handling chemicals! Obey the chemical safety handling procedure as listed in the Material Safety Data Sheets.

It is recommended that in-situ CEB be carried out before the TMP exceeds 0.25 bar (or permeability drops rapidly to 50 LMH/bar) This is typically done once every couple weeks/months depending on biomass characteristics and system operating condition.

On certain occasions, membrane module/cassette may need to be physically inspected for membrane integrity if membrane permeability performance is not recovered after the cleaning (i.e., suspect of membrane deterioration); please refer to subsection 7.3.3.



The maximum backflush pressure of MicroClear[™] MCXL filter is 0.1 bar or equivalent to a 100 cm water line. Only use gravity force to perform the backflush.

Note: Membrane have a maximum active chlorine tolerance of 100,000 ppm.h.

For better cleaning performance, it is recommended:

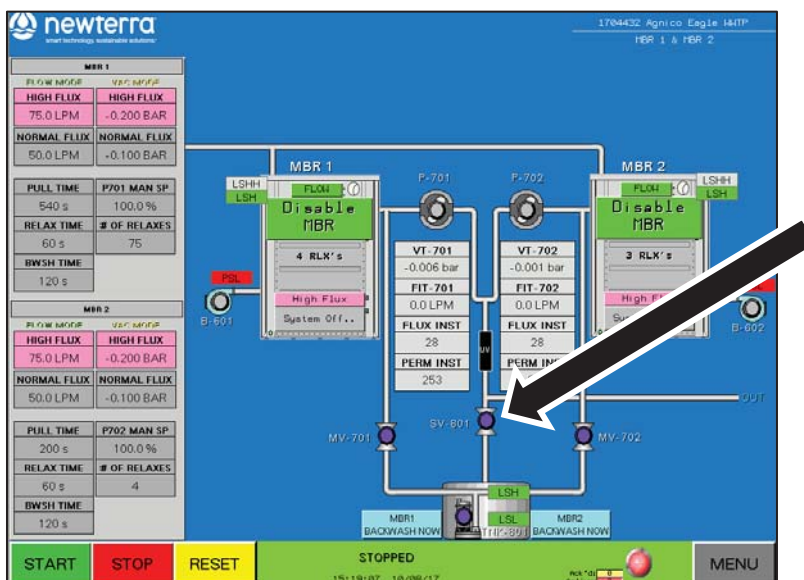
- Potable water (permeate is acceptable if potable water is unavailable)
- Water temperature is above 20 °C (better cleaning efficiency if water temperature ranges from 20 to 30 °C)

7.3.1.1 Procedure – Backwash Solution Preparation

Note: It is recommended that only one membrane module at a time be cleaned (backwash).

Prepare the backwash solution as follows:

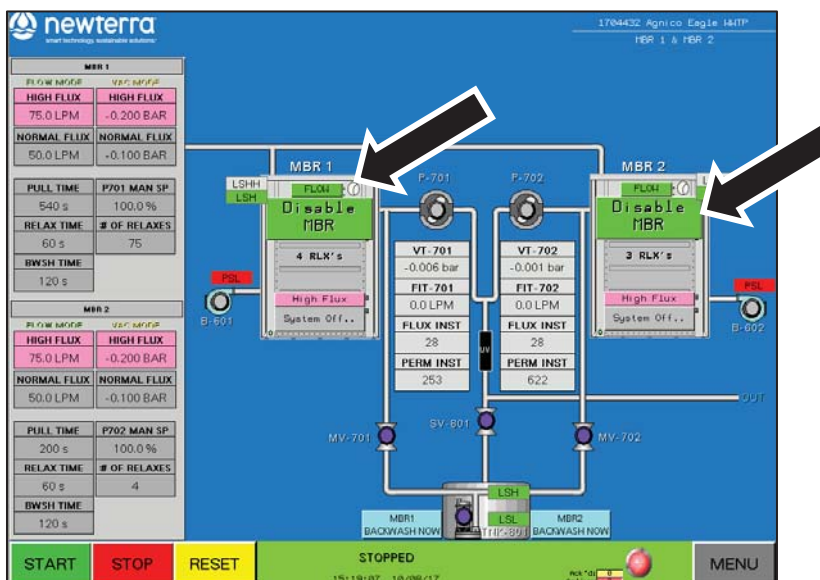
- 1) If backwash tank TNK-801 is empty:
 - a. Ensure membrane is enabled and pulling, and turn SV-801 solenoid valves on hand (“H”) until backwash tank is filled with required volume for chemical backwash (3L per cassette X 20 cassettes per module = 60 L OR approx. 1/4 capacity of TNK-801). Note TNK-801 capacity is 272L.
 - b. Turn SV-801 series solenoid valves off (“O”)



- c. Skip to step 3

2) If backwash tank TNK-801 is full:

- a. Disable membrane by holding down the disable membrane button for about 5 seconds



- b. Turn SV-801 solenoid valves to off ("O")
- c. Turn MV-701/702 (depending on the membranes to be cleaned) motorized valves to hand ("H")
- d. Turn pump P-801 to hand ("H") until the backwash tank has drained to the required volume for chemical backwash (3L per cassette X 20 cassettes per module = 60 L OR approx. 1/4 capacity of TNK-801) – the exact volume can be determined by backwash tank level drop. Note TNK-801 capacity is 272L.
- e. Turn P-801 to off ("O")

7.3.1.2 Procedure – Organic Fouling Solution

Organic Fouling - NaOCl: 500 mg/L solution (acceptable range of 200 to 1000 mg/L). Used for removal of organic fouling, which is the most common type of fouling in MBRs.

Volume of concentrated NaOCl required can be calculated with the following formula,

$$V_x = \frac{V_m \times 0.05}{C_s}$$

V_m : Volume of the solution (Gallon, or Litre), equal to 3 L multiplying the number of MCXL cassettes 20 (60L per module);

C_s : Concentrated NaOCl concentration (%)

V_x : Volume of concentrated NaOCl required (Gallon, or Litre)

7.3.1.3 Procedure – Organic Fouling Solution

Inorganic Fouling - Citric Acid: 2 g/L solution (up to 20 g/L). Used for removal of inorganic fouling. This is typically only required for systems treating water with a high hardness.



Rinse membrane filter and backwash tank thoroughly with potable water to completely remove NaOCl solution before treatment with citric acid. Mixing NaOCl with citric acid releases toxic chlorine gas!

7.3.1.4 Procedure

- 1) Ensure MV-701/2 series motorized valves and SV-801 solenoid valve are set to off (“O”). The system is now ready for a chemical backwash. Note: only one membrane module should be backwashed at a time. The modules can be isolated by closing the permeate valves (there are valves per module)



- 2) Turn off all blowers in the membrane tank to be backwashed (B-601)
- 3) Turn the MV-701/702 motorized valve to hand (“H”) then turn pump P-801 to hand (“H”) until the backwash tank has drained.
- 4) Turn pump P-801 to off (“O”) and then turn the MV-701/702 motorized valve to off (“O”).
- 5) Let membranes soak for 45 mins or so.
- 6) After soaking membranes, turn the blowers back on (B-601) and allow blowers to scour for - 15 minutes.
- 7) After the 15 minute scour turn all valves and pump back to auto (“A”)
- 8) Turn SV-801 solenoid valves to off (“O”)

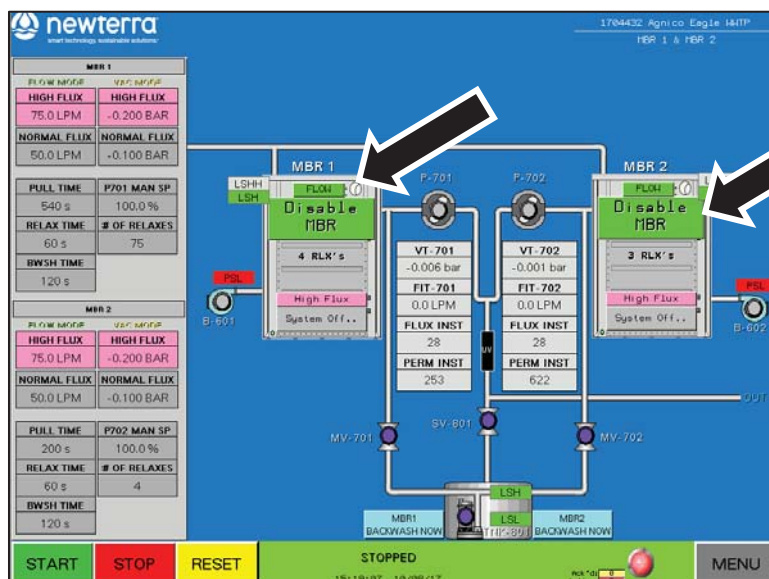
- 9) Enable membranes by holding down the enable membrane button for about 5 seconds
- 10) Allow membranes to permeate for 5 minutes, and then turn SV-801 solenoid valves back to auto ("A")
- 11) Record TMP and flux, and ensure that the permeability has recovered
- 12) Repeat procedure for the second membrane module.

7.3.2 Membrane Recovery Cleaning

The membrane recovery cleaning is to be done once a year at a minimum. On certain occasions, membrane cassette may need to be inspected for membrane integrity (suspect of membrane deterioration, membrane permeability performance does not recover after the cleaning, etc.).



Disable operation of the membrane tank by pressing the disable membrane button on the screen.

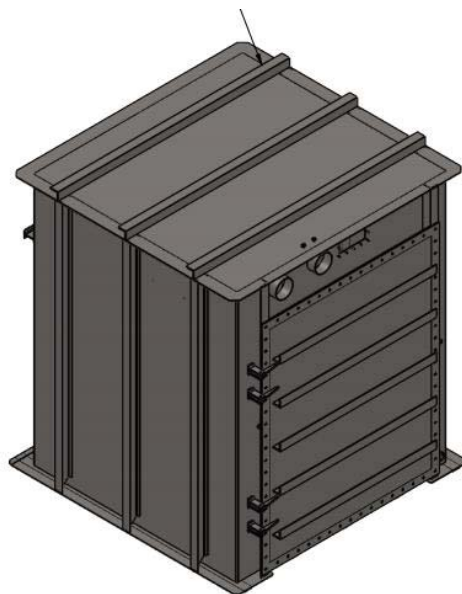


For better cleaning performance, it is recommended:

- Potable water is used
- Water temperature is above 20 °C (better cleaning efficiency if water temperature ranges from 20 to 30 °C)

7.3.2.1 Step 1 - Preparation

1. Turn off air scour – B-601/602
2. Drain all mixed liquor from the membrane.
3. Open the MBR tank hatch. Clean (wash down) the membrane tank with water and vacuum out the dirty liquid. Close the MBR tank hatch.



4. Fill the membrane tank with potable water until the membranes are completely covered. The membrane tank (TNK-601/2) holds approx. 8.0 m³ / 6000L.

7.3.2.2 Step 2 – Cleaning with High pH Solution

This step is to be done if membrane fouling is a result of high FOG. Note: FOG in influent wastewater should be maintained below 30 mg/L.

5. Confirm that the membrane tank (TNK-601/2) has been cleaned and refilled with water (Section 7.3.2.1).
6. Add a suitable chemical – normally caustic soda (Sodium hydroxide (NaOH)) - to the membrane tank to raise the pH to 12.
 - a. Volume of NaOH required can be calculated as follows. A starting dose for NaOH would be 400 mg/L. For example: if using a 50% solution of sodium hydroxide, approximately 0.5 L of solution would be required per m³ of membrane tank. Additional NaOH may be required depending on the alkalinity of the water. The operator should measure pH after addition of 400 mg/L and add more until the pH is 12.

b. TNK-601 holds approx. 8 m³ or 8000L.

7. Turn on air scour for 2 min to mix the solution and turn it off during membrane soak.
8. Allow membranes to soak for 1 to 2 hours.
9. Drain spent solution.

7.3.2.3 Step 3 - Cleaning with Sodium Hypochlorite (NaOCl)

1. Turn off air scour
2. Confirm that the membrane tank (TNK-601) has been cleaned and refilled with water (Section 7.3.2.1).
3. Add NaOCl into the membrane tank to a concentration of 500 mg/L as free chlorine (max. 1,000 mg/L). Turn on air scour for 2 min to mix the solution and turn it off during membrane soak.

Volume of NaOCl required can be calculated with the following formula:

$$V_x = \frac{V_m \times 0.05}{C_s}$$

V_m : Volume of membrane tank - TNK-601 holds approx. 8.0 m³ / 8000L.

C_s : NaOCl concentration (%)

V_x : Volume of NaOCl required (m³ or Litre)

4. Keep the membranes soaked for 8 to 12 hours in the NaOCl solution (longer soak time required if severe fouling is evident).
5. Drain spent NaOCl solution.
6. Rinse membrane filter thoroughly with potable water by filling and draining the entire tank. Rinse waters are drained to the sump/recycle back to the headwork.
7. Repeat step 6 to ensure all NaOCl has been thoroughly removed.

7.3.2.4 Step 4 - Cleaning with Citric Acid

This step is only required in case of inorganic fouling caused by the high hardness. The recommended concentration is 2 g/L solution (up to 20 g/L).



Rinse membrane filter thoroughly with potable water to completely remove NaOCl solution before treatment with citric acid. Mixing NaOCl with citric acid releases toxic chlorine gas!

1. Turn off air scour
2. Confirm that the membrane tank (TNK-601) has been cleaned and refilled with water (Section 7.3.2.1).
3. Add Citric Acid into the membrane tank to a concentration of 2 g/L solution (up to 20 g/L) – reducing the membrane tank to a pH of 2.0.
 - a. Volume of Citric Acid required can be calculated as follows. A starting dose for Citric Acid would be 2g/L (up to 20g/L). For example: if using a 50% solution of Citric Acid, approximately 3.2 L of solution would be required per m³ of membrane tank. Additional Citric Acid may be required depending on the alkalinity of the water. The operator should measure pH after addition of 2g/L and add more until the pH is 2.
 - b. TNK-601 holds approx. 8 m³ or 6000L.
4. Keep the membranes soaked in the citric acid solution for 2 hours (longer soak time required if severe fouling is evident).
5. Drain spent citric acid solution, rinse membranes thoroughly with potable water and drain all the rinse waters. Spent citric acid solution and rinse waters are drained.

7.3.2.5 Step 5 - Resume normal operation

Turn all equipment back to Automatic mode “A”, and enable the membranes.

7.3.2.6 Step 6 - Checking Permeability

Normal permeability after cleaning: 200 to 300 LMH/bar.

Repeat the cleaning procedures If normal permeability is not achieved.

Note: Membrane maintenance (CEB) and recovery cleaning has to be recorded according to Membrane Cleaning Log Sheet presented in Appendix J of the manual.

7.3.3 Membrane Physical Check



WARNING: A membrane cassette that has been in operation weighs more than dry membrane cassette before installation. Failure to comply with the instructions provided in this manual can cause equipment & property damage or severe personal injury, and will render the warranty null and void.

To removing membrane module from membrane tank

This procedure is required if the membranes are being inspected as part of routine maintenance for physical check or being replaced.

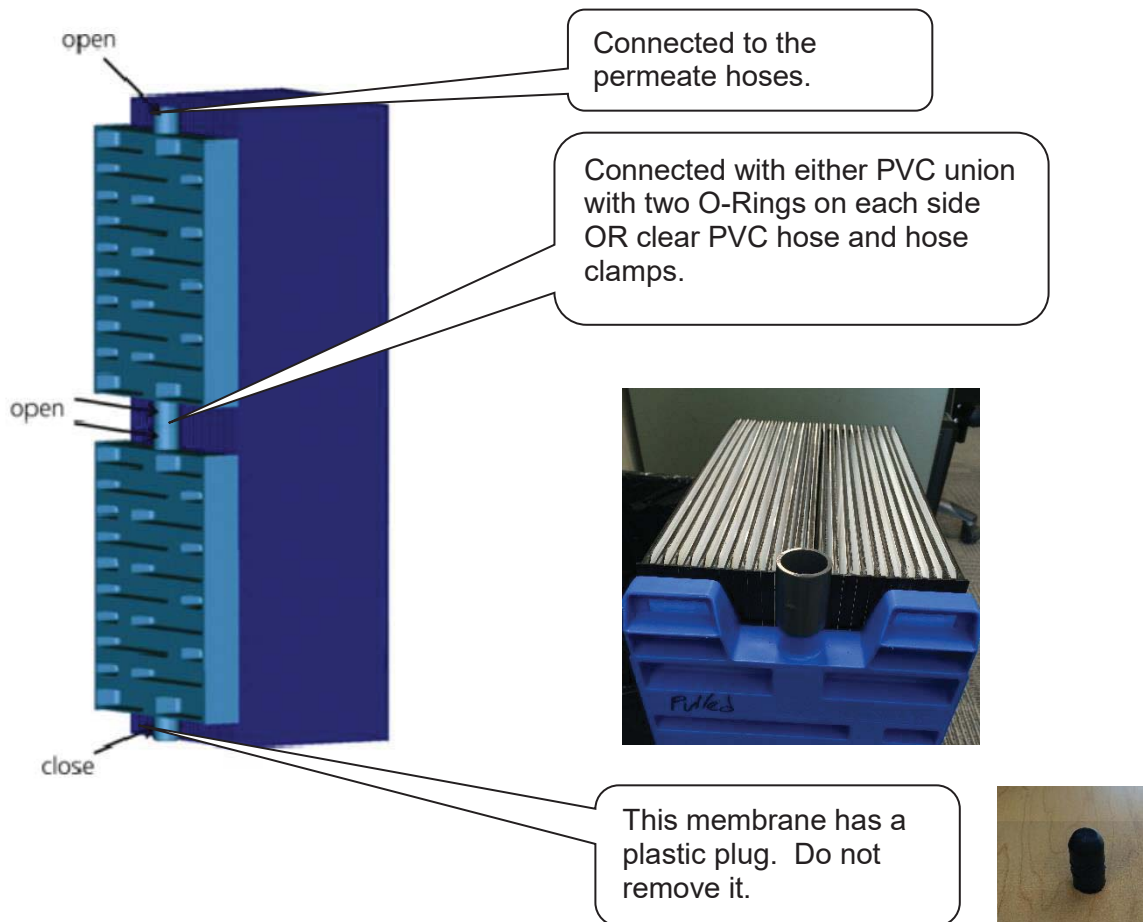


Once membrane inspection or replacement has begun, it must be completed promptly. It is important that the membranes DO NOT DRY OUT OR FREEZE during this procedure.

1. Confirm that the eStop switch on the main panel is pushed in. Confirm that the Main Disconnect is ON. Stop the system operations by using the HMI screen button.
2. Empty the MBR tank (TNK-601) via the tank drain valve or recycle back to Aeration Tank using P-601.
3. Open the MBR tank hatch.
4. Wash remainder of waste water in the tank with reuse water and vacuum out.
5. Install the cassette rails and Disconnect the permeate hoses from the top of the membranes.
6. Slide out the cassette and further clean the membranes.

Membrane module replacement - If membranes require changing verify membrane modules are secured within the membrane tanks after re-installing the new modules – i.e. verify wheel chocks are in the correct location and that there is no lateral movement (less than an inch) of the membrane modules on the wheel tracks in the tank.

7. Remove the membranes from the cassette. NOTE. The membranes are triple stacked. The bottom membrane has a plug in the bottom opening. Do not remove this plug. Note the membrane orientations for re-installation. The membranes are joined together with either a PVC union with two O-Rings on each side OR clear PVC hose and hose clamps.



8. After membranes are separated, wash with clean water. Remove the blue backing plate and gently separate the membrane plates and clean with water to remove any debris. Replace backing plate.



9. Place bottom membrane cassettes in the MBR tank and then integrate top membranes into the triple stack configuration. Slide in the cassette and reconnect the permeate hoses. Close the MBR tank door and start system operation.

7.4 Sludge Decanting (TNK-901)

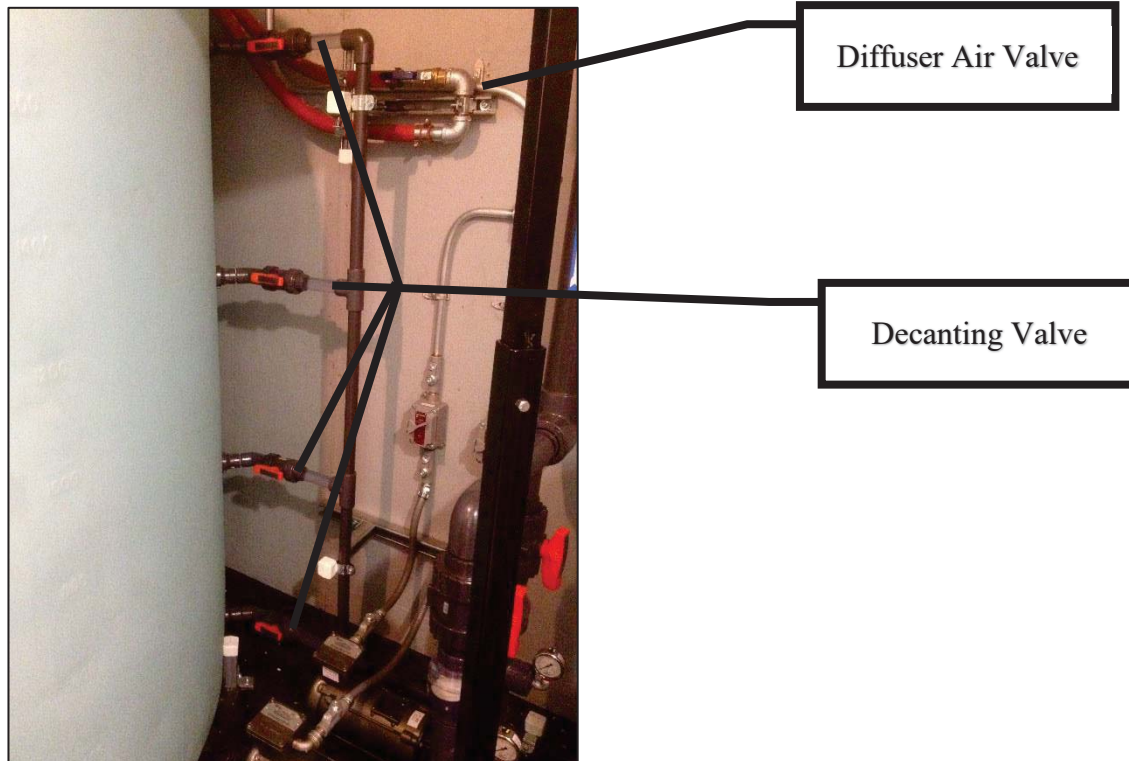
In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank (TNK-501) to the sludge holding tank (TNK-901). Wasted sludge in the sludge holding tank is thickened by decanting supernatant back to the screen tank. Thickened sludge accumulates in the sludge holding tanks until it is eventually pumped out for disposal.

Excess sludge will be wasted by P-503 from the Aeration Tank (TNK-501) every 10 mins at noon. See below.

Tag	Description	Factory Setpoint	Setpoint Range and Units
P503 WASTE HOUR	When P-503 will waste	12pm	0-23
P503 WASTE SP	Time that P-503 wastes for	10min	0-99

In order to decant the water from the sludge, the air to TNK-901 diffuser must be turned off. See valve location below.

After the sludge has settled, that the operator would open the appropriate valve on TNK-901 to decent off the water.



7.5 Trouble Shooting

7.5.1 MBR Membrane Fouling

Introduction

MBR operation relies critically on the ability of the membrane unit to pass all flow incoming to the plant. If membrane permeability is impaired, the MBR plant cannot process all flow with potentially catastrophic results even though effluent quality remains consistently high. This contrasts with typical operation of activated sludge system where the plant hydraulic capacity is rarely exceeded but effluent quality is much more variable. Hence, membrane fouling (and associated reduction of flux or increase of TMP) remains as an operational challenge.

Membrane Fouling in MBR is a result of the interaction between the incoming water quality, mixed liquor filterability, system operation condition, and membrane material. There are four categories of membrane fouling. They are microbial fouling, particle/colloids fouling, inorganic fouling, and organic fouling. A brief description on the nature of fouling and control measures is summarized below.

7.5.1.1 Microbial/Biological Fouling

Microbial fouling is a result of formation of biofilms on membrane surfaces. Living materials, such as bacteria, fungus and algae, or soluble microbial products (SMP) and extracellular polymeric substances (EPS) bound to the activated sludge attach to the membrane; they start to multiply and produce EPS to form a viscous, slimy, hydrated gel. EPS typically consists of heteropolysaccharides and have high negative charge density. This gel structure protects bacterial cells from hydraulic shearing and from chemical attacks of biocides such as chlorine.

7.5.1.2 Particulate/colloid Fouling

This type of fouling may be associated with high concentrations of colloidal solids present in mixed liquor. In most cases, particles and colloids do not really foul the membrane because the flux decline caused by their accumulation on the membrane surface is largely reversible by hydraulic cleaning measures such as backwash and air scouring. However, the accumulation of solids between the membranes can create increased membrane resistance to permeation and permanent physical membrane damage.

To distinguish the different fouling phenomena, particles and colloids here are referred to biologically inert particles and colloids that are inorganic in nature.

7.5.1.3 Inorganic Fouling

Inorganic fouling or precipitative fouling is caused by the accumulation of inorganic precipitates such as metal hydroxides, and “scales” on membrane surface or within pore structure. Precipitates are formed when the concentration of chemical species exceeding their saturation concentrations. Scale can be caused by high pH and extremely hard feed water. For the ultrafiltration (UF) membranes in our MBR system, inorganic fouling can exist most likely due to interactions between ions and other fouling materials (i.e., organic polymers) via chemical bonding.

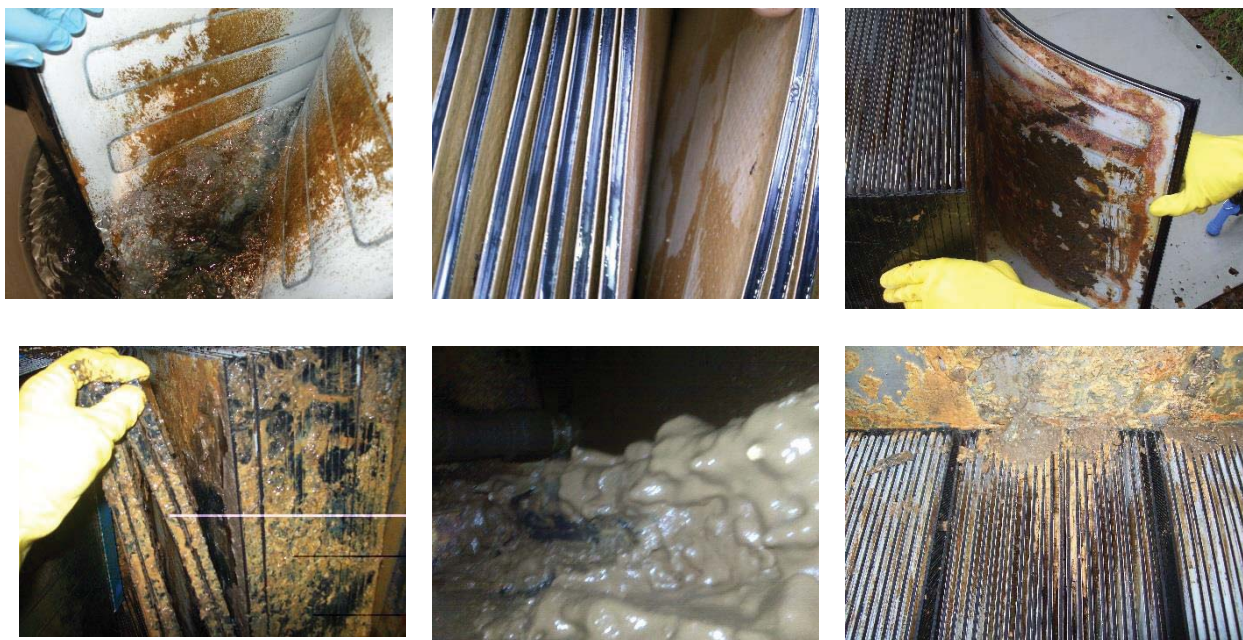
7.5.1.4 Organic Fouling

Organic fouling is the attachment of materials such as oil or grease to the membrane surface. It is common in MBR systems used for treating industrial effluent. Organic fouling often leads to surface and internal pore fouling. More importantly, organic fouling progressively leads to biological fouling (i.e., biofilm growth/build up on membrane surface). Sometimes the adsorption process is irreversible when the organic substances are hydrophobic or positively charged polymers with high molecular weight. Such organic substances including organics present as an emulsion must be removed in the pretreatment.

The following pictures are examples of clean membranes



The following pictures are examples of fouled membranes



7.5.1.5 Fouling Prevention

Control of fouling and clogging in practice is generally limited to six main strategies:

1. Applying appropriate pretreatment to the feed water. Fine screen helps to eliminate the build-up of trash, hair, lint and other fibrous materials, and decrease the risk of solids accumulation.
2. Maintaining operation within the design conditions, such as HRT, SRT, MLSS, temp, BOD/COD loading, pH, DO, F/ M ratio. Sludge wasting is a key in controlling the target operating SRT (typically ≥ 15 day) in the system. Table F.1 shows some examples.

Relationship between various operating parameters and their effect on membrane fouling

Parameter	Effect on membrane fouling
MLSS concentration $\uparrow$ or $\downarrow$	Fouling potential $\uparrow$
SRT $\uparrow$ or $\downarrow$	Fouling potential $\uparrow$
HRT $\downarrow$	Fouling potential $\uparrow$
Temperature $\downarrow$	Viscosity $\uparrow \Rightarrow$ membrane permeability $\downarrow$
Filamentous bacteria $\uparrow$	Viscosity $\uparrow \Rightarrow$ membrane permeability $\downarrow$
Air scour intensity $\uparrow$	membrane permeability $\uparrow$
EPS $\uparrow$	Fouling rate $\uparrow$
SMP $\uparrow$	Fouling potential $\uparrow$

3. Employing appropriate physical or chemical cleaning protocols. For example, sodium hypochlorite and citric acid solutions are used to remove organic and inorganic foulants respectively.
4. Chemically or biochemically modifying the mixed liquor, such as addition of coagulants and powdered activated carbon (mostly in industrial effluent).
5. Reducing the flux. Particulate/colloid fouling is "reversible" in the sense that a reduction of the forward flux (through lowering of the membrane flux or solids concentration) or an increase of backwash intensity restores membrane permeability.
6. Ensure sufficient air scouring is being maintained to slough off excessive biofilm layer on the membrane surface.

7.5.1.5 MBR WWTP Fouling Control & Troubleshooting Chart

Combination of membrane physical cleaning operations as air **scouring**, **backwashing** and **relaxation** are efficient in membrane fouling control.

7.5.1.5.1 Air Scouring

Aeration generates a shear stress at the membrane surface, which provides a scouring action and reduces membrane cake fouling.

Membrane air scouring check is essential procedure for newterra MBR WWTP. Air scour has to be observed for uniformity of bubbling action all across the membrane module/cassette on regular basis. It is easy to observe through clear window in membrane tank. Operator should note any unusual patterns of air distribution. Operator has to check for:

- damage of air diffusers and if this occurs, empty the tank and fix the diffuser;
- air leakages: if this occurs, tighten up the fittings.

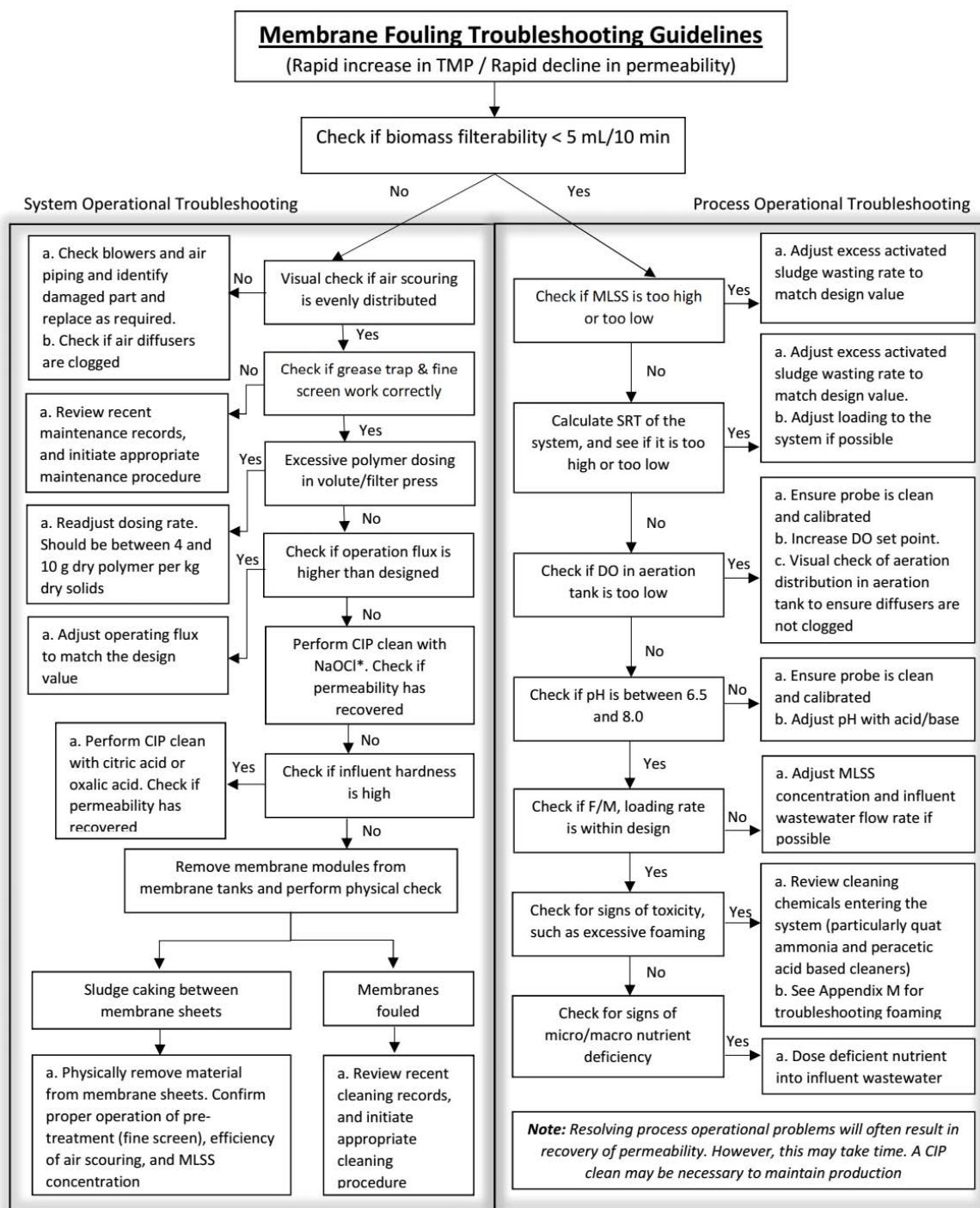
If there is insufficient air scouring, localized dewatering (**clogging**, **sludging**, **caking** and **plugging**) may occur and as a result, membrane fouling occurs.



**Proper air scouring
in membrane tank**



**Uneven aeration in
membrane tank**



7.5.2 MBR Alarm Trouble Shooting

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
PLC ALM	CP	SHUTDOWN PLC Fault	FLASH	Turn off entire system. Wait 10 seconds before restoring power.	Please contact newterra -PLC problem
PWR FAIL ALM	CP	WARNING , Power Fail	SOLID	Power has failed to the unit	Press Reset
ESTOP ALM	Panel	E-Stop	FLASH	Check all locations of E-Stop Buttons to ensure they are not pushed in.	Pull out E-Stop
TALL-201	Clarifier	Temperature alarm low	FLASH	Check for building heater malfunction. Assess influent water temperature	Replace heater. Take action to increase influent water temperature.
B-201/ B-202 Fail	Clarifier	Blower B-201/B-202 has potentially failed	FLASH	Check blower for failure. Check breaker	Replace blower B-201/B-202.
LAHH-401	SCREEN DISCHARGE	High high level alarm in Screen Module discharge tank	FLASH	Potential discharge tank pump P-401/P-402 failure Check Breaker	Replace pump
P-401 or P-402 FAIL	SCREEN PUMP	P-401/P-402 has potentially failed	FLASH	P-401/P-402 for failure. Check Breaker	Replace pump P-401/P-402

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
SCN-401 Or SCN-402 FAIL	SCREEN	Potential screen paddle wheel motor failure.	FLASH	Check screen motor for failure. Check Breaker	Replace motor
LAHH-301	EQ Tank	Level Alarm High High, EQ Tank	FLASH	Investigate if pump P-301, P-302 has failed, or system is receiving higher than design flow, or membrane is fouling.	Replace pump, divert flow, perform membrane chemical cleaning.
LALL-301	EQ TANK	Low Low Level Alarm	WARN	Check for level transmitter operation or upstream pipe obstruction or pump failure.	Clear obstruction or repair/replace faulty equipment.
P-301 or P-302 FAIL	EQ PUMP	Pump P-301 has potentially failed	FLASH	Check pump P-301 or P-302 for failure or if it is unplugged. Check Breaker	Plug in or replace pump P-301 or P-302.
PAL-301	EQ TANK	Pressure Alarm low on air inlet to EQ Tanks	FLASH	Check if blower B-301 or B-302 have failed. Check Breaker	Replace blowers if required.
LAHH-501 or LAHH-502	AERATION TANK	High High level alarm in Aeration Tank	FLASH	Check pump P-501/P-502 for failure	Replace faulty pump
LALL-501	AERATION TANK	Low Low Level Alarm	WARN	Check level in the tank and ensure Level switch or transmitter is functioning correctly.	Clear obstruction or repair/replace faulty equipment

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
PHAL-501	AERATION TANKAERATION TANK	Low pH AlarmLow low in Aeration Tank	WARN WARN	Check if caustic injection system is working and or needs refill Check if the pH probe is fouled or if the probe requires calibration. Check setpoint temperature.	Replace caustic injection system or refill. Clean pH probe. Calibrate pH probe. Adjust set point temperature.
PHAH-501	AERATION TANKAERATION TANK	High pH alarm	WARN WARN	Check if caustic injection system is malfunctioning or if PH probe is calibrated or fouled.	Replace caustic soda injection. Calibrate pH probe or clean sensor
DOAL-501	AERATION TANKAERATION TANK	Dissolved Oxygen Alarm low	WARN WARN	Investigate if there is septic smell & check the mixing pattern. If system smells septic with no uniform mixing, air diffuser might be clogged, blowers may not work or plant is overloaded. Ensure DO probe is calibrated and clean.	Increase aeration rate to maintain DO above 1.5 mg/L, or replace clogged diffuser, or change blower, or calibrate or clean DO probe. Replace caustic soda injection. Calibrate pH probe or clean sensor
P-501 or P-502 FAIL	AERATION TANK	Pump P-501 or P-502 has potentially failed	FLASH WARN	Check pump P-501 or P-502 for failure. Check Breaker	Replace pump P-501 or P-502.

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
P-503 FAIL	AERATION TANK	Pump P-503 has potentially failed	FLASH FLASH	Check pump P-503 for failure. Check Breaker	Replace pump P-503
PAL-501	AERATION	Blower motor tripped off on overload Pressure	WARN FLASH FLASH	Check blower air line equipment and blower motor Check if 500 series blowers have failed	Replace faulty equipment Replace blowers if required
PAL-601 or PAL-602	MEMBRANE TANK	Pressure Alarm low on air inlet to corresponding Membrane Tank. Blower motor tripped off on overload	FLASH WARN	Check if blower B-601 or B-602 has failed. Check blower air line equipment and blower motor	Replace blower if required. Replace faulty equipment.
LAHH-601 or LAHH-602	MEMBRANE TANK	High High level alarm in Membrane	FLASH WARN	Check pump P-601 for failure	Replace pump P-601 Replace faulty equipment
FLT-701 or 702	PERM VFD 1 or 2	VFD Fault	FLASH WARN	Check VFD fault	Replace pump and VFD Replace faulty equipment
VTAL-701 or 702	MEMBRANE 1 or TANK 2	Low vacuum alarm on permeate line from MBR1 or MBR2	FLASH WARN	Check for vacuum leak and membrane or pump fail	Repair and replace as required

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
VTAH-701 or 702	MEMBRANE 1 or TANK 2	High vacuum alarm on permeate line from MBR1 or MBR2	FLASH WARN	Check for closed valve on permeate side or check membranes for severe fouling	Open valve or clean membranes Repair and replace as required
FTAL-701 or 702	MEMBRANE 1 or TANK 2	Low permeate flow alarm on permeate line from MBR1 or MBR2	FLASH WARN	Check for closed valve or permeate pump failure Check for closed valve on permeate side or check membranes for severe fouling	Open valve or repair/replace permeate pump Open valve or clean membranes Repair and replace as required
FTAH-701 or 702	MEMBRANE 1 or TANK 2	High permeate flow alarm on permeate line from MBR1 or MBR2	FLASH WARN	Check for vacuum leak or membrane failure and operation of permeate pump	Repair and replace as required Open valve or repair/replace permeate pump Open valve or clean membranes
UVA-811 or 812	PERM	UV-811 or UV-812 has failed.	FLASH WARN	Check if UV lamp has failed	Change UV lamp
UVA-BOTH	PERMEATE	UV-light 811 and UV-812 have failed	FLASH WARN	Check if UV lamp has failed Check if UV lamp has failed Check if UV lamp has failed	Change UV lamp Change UV lamp Change UV lamp Repair and replace as required
BACKWASH1 or BACKWASH2 FAILED	BACKWASH PERM1 or PERM2	Backwash to TNK-601 or TNK-602 failed	FLASH WARN	Backwash did not complete – system skipped backwash	Check function of back-wash pump and valve

Alarm Name	Alarm Location	Alarm Description	Beacon Status	Troubleshooting Recommendation	Remedy Action
P-901 FAIL	MEMBRANE PERM 1	Pump P-901 has potentially failed	FLASH WARN	Check pump P-901 for failure Check for vacuum leak or membrane failure and operation of permeate pump	Replace pump P-901 Repair and replace as required
TALL-7901	BLDG-7901	Low low Temperature alarm for building	FLASH WARN	Check if electric heaters have failed or if BLDG door is open	Repair or replace heater(s) if required. Repair and replace as required
B-7901 FAIL	AIR EXCHANGE BLDG-7901	Potential blower failure	FLASH WARN	Check motor breaker	Turn breaker on

7.5.3 MBR Process Trouble Shooting

The following **newterra MicroClear™ MBR WWTP troubleshooting guide** can be used as a quick reference. If any of the problems discussed in this section or other difficulties persist, consult **newterra** Ltd.

7.5.3.1 Biological System

Condition	Possible Cause	Potential Remedies
Mixed liquor is black or dark brown	Insufficient aeration is supplied for mixed liquor and/or plant is under-loading	Increase aeration rate and keep it above 1 mg/L Waste more sludge Increase influent feed rate if required
Mixed liquor concentration is too high or too low	Sludge wasting rates are incorrect	Review operation of the activated sludge process and revise the sludge wasting rates as necessary
No mixing in tanks	Blowers failure	Check for electrical/blower failure, and replace blowers as necessary

Condition	Possible Cause	Potential Remedies
Unpleasant odour from tanks	Mechanical/electrical failure, e.g. blower and air piping are not operating correctly System is overloading	Ensure good order of mechanical/electrical components Check the maximum flow and BOD loading rate to the MBR unit to see whether it is within the limits as per design specification Check the quality and contents of the flow into the MBR unit for any abnormal or prohibited substances
Effluent quality does not meet discharge criteria	Mixed liquor characteristics are not within proper operating standards	Improve the process operating conditions of the activated sludge system (confirm operating SRT and loading is within design and no present of toxic compounds)

7.5.3.2 Foaming

Condition	Possible Cause	Potential Remedies
Excessive foaming (white foam accumulating over the liquid surface) in aeration and/or membrane tanks	Influent inhibition/biomass toxicity occurs	Check the quality and contents of the flow into the MBR system for any abnormal or prohibited substances
	MBR system is overloading	Check the flow rates, BOD/COD loading and F:M ratio and then reduce flow/loading and/or increases MLSS concentration accordingly
	Mixed liquor characteristics are not within proper operating standards	Improve the operating conditions of the activated sludge system
	Membrane air scour system is over aerating	Review operation of the membrane scour system
	Foam control strategies are not operating correctly	Review foam removal equipment, anti-foam chemical dosing system (if applicable)
	MBR system are undergoing start-up	Remove foam and use approved defoamer as necessary (consult newterra Ltd); Control foam and ensure sprayer pump is running at all time during start-up, Ensure that MLSS concentration is increased, after start-up is completed

7.5.3.3 Permeate

Condition	Possible Cause	Potential Remedies
Cloudy permeate (The permeate turbidity or TSS is above the specific setpoint)	Faulty operation of instrumentation	Confirm proper operation of control systems and instrumentation, clean, replace, recalibrate as required
	Membrane cassette sheets are damaged	Take out membranes and visually inspect the individual membrane sheets, and repair or replace the membrane sheets as necessary
	Membrane module assembly are damaged	Identify damaged part, e.g. leaking tube, pipe, O-ring, gasket, and replace as required
	Permeate piping leak	Identify the leak and repair as required, e.g. tighten connections
Lower permeate flow than expected	Mechanical equipment failure	Ensure proper operation of permeate pumps
	Incorrect operation of permeate piping and valves	Check permeate piping for leaks
High TMP and lower permeability than expected	Membrane sludging	Confirm proper operation of pretreatment Take out membranes and visually inspect the individual membrane sheet. Remove sludge material from membrane sheets**
	Mixed liquor characteristics are contributing to poor filterability	Test the filterability of the mixed liquor; review and improve operating conditions of the activated sludge system as necessary
	Desired operating flux or flowrate is higher than design	Adjust operational flux or flowrate to match the design flux or flowrate

Condition	Possible Cause	Potential Remedies
	Membrane surface is fouled MLSS is too high, SRT is too low or insufficient dissolved oxygen in aerobic zone	Review recent cleaning records, and initiate appropriate cleaning procedure Improve the characteristics of sludge by adjusting the activated sludge process operation
Uneven permeate and/or MLSS flow between membrane tanks	More recent completion of maintenance or recovery cleanings for one of the membrane tank Uneven flow distribution to each membrane tank	Review membrane cleaning records Confirm proper operation of flow distribution system (pumps/control valves, etc)

7.5.3.4 Membrane air system

Condition	Possible Cause	Potential Remedies
Uneven aeration of membrane module	Membrane diffuser clogging;	Wash or clean the diffusers
	Loose air piping connections	Tighten pipe connections
Uneven aeration in membrane tank	Membrane diffusers or membrane modules are not level	Level the equipment
Air scour rate fails to reach the specified values	Improper operation of membrane blowers and/or air scour system, malfunctioning diffusers	Repair or replace the blowers Review and repair air piping as necessary Repair the diffusers

7.5.3.5 Membrane Cleaning

Condition	Possible Cause	Potential Remedies
Increased frequency of cleaning	Mixed liquor characteristics are contributing to poor filterability	Test the filterability of the mixed liquor Review and improve operating conditions of the activated sludge system as necessary
	Improper operation of membrane cleaning	Confirm cleaning is done correctly, such as controls, cleaning cycles or durations, chemical concentration, and dosing system
	Membrane operate at higher flux than designed	Review MBR flow records
Cleaning fails to recover flux, permeability of membranes	Improper operation of membrane cleaning	Confirm cleaning is operated correctly, such as controls, cleaning cycles or durations, and chemical concentration etc.
	Improper operation of permeate pumps, piping, and control valves	Repair equipment as necessary
	Irrecoverable fouling of membranes	Review operating history with the goal of identifying contributing factors to fouling;

Condition	Possible Cause	Potential Remedies
		Perform membrane autopsy on membrane cassettes

7.5.3.6 Mechanical / Electrical Issues

Condition	Possible Cause	Potential Remedies
Indicator light at the control panel is on.	Air intake is blocked Air discharge or vent line is blocked MBR is flooded Blower failed	Clean intake screens on blower housing Check air filter on blower for blockage Check discharge line and vent line visually or with drain cleaning equipment for obstructions Determine the cause of flooding, e.g., line obstruction, high flows, etc., and fix it Determine if blower failure was caused by an obstructed intake or discharge line Investigate overheating (i.e. internal thermal overload protection), short-circuiting, or other electrical failure, and mechanical failure (i.e. bearing failure) and correct it
Wastewater is backing up	Obstruction in the incoming sewer Obstruction in the discharge piping Pumps failed Flow rate to the MBR is too high	Check the inlet pipe leading to the MBR visually or with drain-cleaning equipment Check the permeate piping and later field piping visually or with drain-cleaning equipment Check the operation of pumps as per pump manufacturer's specifications Check if the maximum flow rate to the MBR is within the limits as per design specification
Blower/pump not working	Fuse blown Motor is overloading Power failed	Electrician to check Electrician to check Electrician to check
System not in run mode	Kill switches are mistakenly pushed in Power failure/outage	Ensure kill switches (on control panel/wall) are not pressed; Electrician to check

7.5.4 P-201/2, 301/2, 401/2, 501/2, 553/4, 551/2 - Trouble Shooting

TROUBLESHOOTING		
1. Pump fails to build head pressure: Check for: a. Pump not primed. b. In correct pump rotation. c. Driver speed too low. d. Suction line restricted. e. Driver failure. f. Plugged or damaged impeller. g. Pump or impeller undersized. h. Pump cavitation. i. Improper impeller clearance.	3. Excessive noise or vibration during operation. Check for: a. Motor bearing failing. b. Pump cavitation. c. Improper impeller clearance. 4. Leaking mechanical seal. Check for: a. Improper assembly. b. Worn or cracked seal faces. c. Abrasive material in fluid. d. Liquid flashing at seal faces (Fluid temperature too high). e. Seal pressure rating too low for the service. f. Chemical attack of seal components. g. Seal operated dry or with a liquid having poor lubricating properties.	5. Pump gradually loses pressure and head. Check for: a. Increasing temperature causing cavitation or liquid vaporization. b. Driver failure. c. Suction lift too high. d. Air entering suction line. 6. Motor overheating. Check for: a. Excessive flow and amp draw (Throttle discharge). b. Low voltage or frequency. c. Flow rate too low with resulting heat rise. d. Bearing failure. e. System temperature too high.
2. Pump fails to provide enough flow rate. Check for: a. System resistance too high. b. Pump undersized. c. Pump not primed. d. Driver speed too low. e. Poor suction conditions. f. Improper impeller clearance.		

7.5.5 P-701/702 Trouble Shooting

TROUBLESHOOTING

WARNING: Before making adjustments, disconnect power source and thoroughly bleed pressure from system prior to disassembly. Failure to do so could lead to electric shock or serious bodily harm.

Failure To Pump.

1. Motor will not start: Check power supply. Voltage must be $\pm 10\%$ of nameplate rating when motor is in locked rotor condition. Check for faulty capacitor on 1 phase Models.
2. Motor runs and thermally kicks out: Check for excessive discharge pressure. Check for defective centrifugal switch on 1 phase Models. Increase ventilation to motor. Do not use less than #14 wire size.
3. Stator torn; possible excessive pressure: Replace stator, check pressure at discharge port.
4. Flexible joint broken; possible excessive pressure: Replace joint, check pressure at discharge port.
5. Wrong rotation (3 phase only): Rotation must be clockwise when facing pump from motor end. Reverse the connections of any two line leads to the motor.
6. Excessive suction lift or vacuum.

Pump Overloads.

1. Excessive discharge pressure: Check pressure at discharge port for maximum ratings given in Table 1.
2. Fluid viscosity too high: Limit fluid viscosity to 100 CP or 500 SSU.

Noisy Operation.

1. Excessive suction lift or vacuum: Maximum suction lift is 25 feet for water.
2. Suction line too small: Check pipe size. Be sure lines are free from obstructions.
3. Pump Cavitates: Pump speed is 1725 rpm. Viscosity of fluid should not exceed 100 CP or 500 SSU.
4. Flexible joint worn: Replace joint. Check pressure at discharge port.
5. Insufficient mounting: Mount to be secure to a firm base. Vibration induced noise can be reduced by using mount pads and short sections of hose on suction and discharge ports.

Seal Leakage.

1. Leakage at startup: If leakage is slight, allow pump to run several hours to let faces run in.
2. Persistent seal leakage: Faces may be cracked from freezing or thermal shock. Replace seal.

Pump Will Not Prime.

1. Air leak on suction side: Check pipe connections.

7.5.6 P-801 Trouble Shooting

CONDITION	COMMON CAUSES
A. Pump will not start or run.	Check fuse, low voltage, overload open, open or incorrect wiring, open switch, impeller or seal bound mechanically, defective capacitor or relay when used, motor or wiring shorted. Float assembly held down. Switch defective, damaged, or out of adjustment.
B. Motor overheats and trips overload or blows fuse.	Incorrect voltage, negative head (discharge open lower than normal) impeller or seal bound mechanically, defective capacitor or relay, motor shorted.
C. Pump starts and stops too often.	Float tight on rod, check valve stuck or none installed in long distance line, overload open, level switch(s) defective, sump pit too small.
D. Pump will not shut off.	Debris under float assembly, float or float rod bound by pit sides or other, switch defective, damaged or out of adjustment.
E. Pump operates but delivers little or no water.	Check strainer housing, discharge pipe, or if check valve is used vent hole must be clear. Discharge head exceeds pump capacity. Low or incorrect voltage. Incorrect motor rotation. Capacitor defective. Incoming water containing air or causing air to enter pumping chamber.
F. Drop in head and/or capacity after a period of use.	Increased pipe friction, clogged line or check valve. Abrasive material and adverse chemicals could possibly deteriorate impeller and pump housing. Check line. Remove base and inspect.

7.5.7 B-501/502 - Trouble Shooting

PROBLEM	POSSIBLE CAUSES	SOLUTION
Knocking	- Unit out of time. - Distortion due to improper mounting or pipe strains. - Excessive pressure differential. - Worn gears. - Worn bearings.	- Re-time impellers - Check mounting alignment and relieve pipe strains. - Reduce to manufacturer's recommended pressure. Examine relief valve, re-set if necessary. - Replace timing gears. - Replace bearings..
Excessive blower temperature.	- Too much oil in gear case. - Too low operating speed. - Dirty air Filter. - Clogged filter or muffler. - Excessive pressure differential. - Worn impeller clearances. - Internal contact.	- Reduce oil level. - Increase blower speed. - Clean or replace air filter - Remove cause of obstruction. - Reduce pressure differential across the blower. - Replace impeller. - Correct clearances.
Impeller end or tip drag.	- Insufficient assembled clearances. - Case or frame distortion. - Excessive operating pressure. - Excessive operating temperature.	- Correct clearances. - Check mounting and pipe strain. - Remove cause. - Remove cause
Lack of volume.	- Slipping belts. - Worn clearances. - Dirty air filter	- Tighten belts. - Re-establish proper clearances. - Clean or replace air filter.
Excessive bearing or gear wear.	Improper lubrication.	Correct lubrication level. Replace dirty oil.
Loss of oil.	- Headplate, gear case or drive cover vents plugged. - Worn Seal.	- Clean vents. - Replace seals.

7.5.8 B-301/302, B-601/602 - Trouble Shooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise..	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service ^{*)}
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service ^{*)}
	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service ^{*)}
Protective motor switch trips when motor is switched on. Power consumption too high.	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service ^{*)}
		Clean filters, mufflers and connection pipes if necessary.	Service ^{*)}
	Compressor is jammed.	See fault: "Motor does not start; humming noise." with cause: "Impeller is jammed.".	Service ^{*)}
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service ^{*)}
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service ^{*)}
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service ^{*)}
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service ^{*)}
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service ^{*)}
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

^{*)} Only when the maintenance manual is at hand: rectification by the operator.

7.5.9 LT-301/501 - Trouble Shooting

1. **Symptom:** *Transducer fails to give output of any kind.*

Procedure: Isolate the problem to either the transducer or the power supply/readout. See the Quick Check Procedures (above) for this check. If it can be determined that the transducer is no longer operable, remove it from service for further analysis. If the transducer output falls within the limits described above, the fault lies somewhere else in your system.

2. **Symptom:** *Transducer has failed and has been removed for analysis.*

Procedure: Inspect the cable for physical damage. Cuts in the cable jacket can result in liquid incursion into the transducer housing, which can cause permanent damage. If operational, the cable can be repaired by using a splice kit (P/N 830) supplied by Pressure Systems.

Inspect the transducer housing. It should be intact and free of corrosion. If the outer surface of the transducer is pitted, this could be an indication of galvanic corrosion caused by stray ground currents. If this is the case, the transducer will probably require replacement. If the external case exhibits none of these characteristics, carefully unscrew the nosepiece and look into the pressure sensing end of the transducer. The concentric rings of the sensing diaphragm should be visible. If they are not, it could be that residue has accumulated on the diaphragm, preventing it from responding properly to pressure changes. The transducer can be cleaned by gently swishing the transducer back and forth in a bucket of warm, soapy water until the residue softens and washes off. (See **Cleaning Your Transducer**, page 8.) ***Under no circumstances should any object or tool be used to remove residue from the sensing diaphragm or else permanent damage will be done.*** If cleaning the diaphragm does not solve the problem, the transducer should be returned to the factory for repair or replacement.

3. **Symptom:** *Transducer develops a negative offset and gets worse over time (actual level exceeds specified level).*

Procedure: This may be a sign that moisture has entered the reference (vent) tube in the cable and is inside the transducer housing. This is usually the result of not maintaining the desiccant vent filter or of operating the transducer without a desiccant filter or aneroid bellows. If caught early enough, the transducer can be saved by coiling the cable and transducer in a pan and baking it in an oven at 50°C (122°F) for a minimum of 2 hours. ***Be careful that the oven temperature does not exceed 50°C (122°F) or both the transducer and the cable can be damaged.*** Alternatively, suspend both the cable and transducer in a vertical position (with vent tube down), overnight to allow water to drain from the transducer and vent tube.



4. Symptom: *Transducer suddenly fails during or just after a nearby lightning event.*

Procedure: This failure is usually caused by overvoltage due to ground transients resulting from a direct or indirect lightning event. These transients can travel

distances of a mile or more. The transducer may be returned to the factory for repair and optional retrofit of our **lightning protection system**. This system carries a lifetime warranty against transducer damage due to lightning.

5. Symptom: *Transducer response to pressure/level input changes becomes sluggish.*

Procedure: This is usually a sign that the sensing end of the transducer has become fouled with residue. The transducer must be removed from service and the sensing diaphragm cleaned as described in Item 2, (warm, soapy water). If fouling persists, the transducer may be replaced with a Series 705 or Series 750 (non-fouling) transducer, which is specifically designed for trouble-free operation in a high residue environment.

6. Symptom: *Output reading is within limits but "freezes" at one point.*

Procedure: In certain environments "crust" may form over the sensing diaphragm, preventing the sensor from identifying change in level. Removing the transducer from service and cleaning it (as described in Item 2) will generally solve the problem. To combat marine growth, you might try wrapping the transducer with copper wire similar to that found in wire scouring pads for cleaning dishes. Marine growth occurs on the copper and eventually erodes the copper and drops off or the copper is manually removed during routine maintenance. Alternatively, there are various companies that will impregnate/coat the 316 stainless steel with anti-fouling chemicals of coatings. Level transducers temporarily removed from the well or sump should not be stored dry, but should be stored in a bucket of fresh water in order to prevent "crust" formation.

7. Symptom: *Readings increase very slowly over time.*

Procedure: Our cable is shipped coiled and consequently takes time to straighten when installed. Attaching a weight to the transducer (e.g., one of our sacrificial anodes) will help. To prevent cable stretch with lengths greater than 200 feet (60 m), secure the Kevlar fibers (just under the cable jacket) to your junction box or other secure object.

8. Symptom: *No electrical output from your transducer.*

Procedure: Check all electrical connections to ensure they are correct and secure. Double check your power supply or use a battery (as described previously) to ensure the transducer is getting power. If all checks OK, the problem could be a circuit board or the sensor in your transducer. The unit must be returned to the factory for evaluation. The most probable cause of this type of failure is damage to the submersible cable jacket allowing water to leak down the cable and into the transducer housing or lightning damage.

9. Symptom: *Formation of marine growth on a submersible transducer.*

Procedure: Certain transducer construction materials, for example, 316 stainless steel, attract marine life (snails) and algae. Clean the transducer diaphragm by

soaking it in a bucket of warm water with a non-aggressive cleaning solution. You can also coat the transducer with marine grease. This may be the most effective and inexpensive way to protect your transducer.

10. Symptom: *Submersible transducer exhibits corrosion or pitting on body or diaphragm*

Procedure: Dissimilar metals (for example, your transducer housing and your pump housing) in an electrolytic environment (fluid in your well) can lead to *galvanic corrosion* of the metal that is nearer the anodic end of the galvanic series. Likewise, a voltage potential between the ground wire of the transducer and the ground of other equipment in the well can lead to *galvanic corrosion*. Installation of a P/N 820 or 825 sacrificial anode will help protect your transducer from *galvanic corrosion*. Our sacrificial anodes are made of a zinc alloy that, being nearer the anodic end of the galvanic series than the 316 stainless steel or titanium housing of the transducer, will corrode before the transducer.

11. Symptom: *The transducer is buried in dirt or silt and the readings seem to be erroneous.*

Procedure: Use of a piezometer nosepiece in this application would help. This nosepiece can be easily installed in the field and features a very fine screen to keep dirt from fouling the diaphragm, but allows the diaphragm to sense moisture levels.

12. Symptom: *Transducer has an offset error.*

Procedure: Our submersible transducers perform best when the sensing end is pointing in a downward manner. Keep in mind that you can experience offset error due to the position sensitivity or orientation change of the sensor. Offset errors are more prominent in low pressure applications with the sensing end of the transducer lying flat or pointing upward.

- 13. Symptom:** *I am testing a Series 700 4-20mA sensor for use with our data logger. On page A-2 of the KPSI Level and Pressure Transducers User's Manual, I see the standard 4-20mA configuration. Does the recording channel of my data logger become the mA meter?*

Procedure: Most data loggers cannot measure current (mA) directly. When this is the case a load resistor must be used to convert the current (mA) output into an appropriate voltage. If the User's Manual for your particular instrument does not illustrate a preferred method for recording current (mA) data then you should attach your transducer signal wires to your data logger in the following manner.

Transducer red wire - Data Logger Excitation Terminal
(The minimum excitation for a Series 700 Transducer is 9VDC)
Transducer black wire – Data Logger signal input (+) terminal

Attach a Load resistor between the Data Logger signal input (+) terminal and the Data Logger signal input (-) terminal.

Attach a separate piece of wire between the Data Logger signal input (-) and analog ground.

In this configuration you will turn your data logger into a milliammeter. The size of your load resistor can be calculated in the following manner.

$$D/0.02=R$$

Where:

Data logger input range = D
Full scale output of transducer = 0.02 A (20 mA)
Load Resistor Value = R

Pick an appropriate standard value

250 Ohms results in 1 to 5 VDC at 4 and 20 mADC
125 Ohms results in 0.5 to 2.5 VDC (500 to 2500 mVDC) at 4 and 20 mADC

At this point the discussion needs to address IR loss (voltage drop) in series circuits. Note that Series 700 transducers need a minimum of 9 VDC to operate correctly. When the transducer is operating correctly it will output a current which, when driven through a resistor, will generate some amount of voltage drop. If the resistor value is 250 Ohms then the voltage measured across that resistor will be $0.004 \text{ A} \times 250 \text{ Ohms} = 1.000 \text{ VDC}$ and $0.020 \text{ A} \times 250 \text{ Ohms} = 5 \text{ VDC}$. Notice that, if the available voltage from the data logger is 12 VDC then $12 \text{ VDC} - 5 \text{ VDC} = 7 \text{ VDC}$ which is less than the voltage required by the transducer to operate. If this scenario were to occur the transducer would actually stop functioning correctly when its output reached 12 mADC (50% of transducer full scale range). In this case the appropriate choice for a load resistor value is 125 Ohms.



- 14. Symptom:** *I have a Series 700 4-20mA transducer rated for 7.5 PSIG attached to a pressure source that is outputting 7.5 PSIG. With 20VDC being supplied I am getting 19.94 mA. I can't find the upper range allowance for the sensor, but this seems low to me. Does this mA reading fall into the acceptable range for the transducer with the settings I've specified?*

Procedure: When evaluating a transducer it is sometimes convenient to make some broad generalizations in order to rapidly determine the condition of the unit. In general, transducers that output a 4-20 mADC signal have a 16 mADC span ($4 - 20 = 16$). If the transducers accuracy is reported as being some percentage of its full-scale range then the following table could be used in conjunction with the instructional notations to determine whether a more detailed analysis of data quality is required.

Model	Accuracy	Accuracy in mADC
700	1.00%FS	± 0.16 ma
710	0.50%FS	± 0.08 ma
720	0.25%FS	± 0.05 ma
730	0.10%FS	± 0.016 ma
735	0.05%FS	± 0.008 ma

In order to approximately determine how many milliamps a transducer should output at a given depth.

1. Determine the depth (in feet) at which the transducer is sited.
2. Divide the depth value (from step 1) by the transducer full-scale range (in feet). - Record the value.
3. Multiply the value calculated in step 2 by 16 (the transducer span in milliamps).
4. Add 4 to the product of step 3. This is the approximate value in milliamps that should be output by the transducer at its current depth.

In order to approximately determine the depth of a transducer (in feet) using a given value of milliamps.

1. Divide the full-scale range of the transducer (in feet) by 16.
Record this value.
2. Subtract 4 from the milliamp output of the transducer.
Record this value
3. Multiply the result of step one by the result of step 2.
This is the approximate depth at which the transducer is sited.

If the resulting numbers are reasonably close to some verified value for current water depth, then the unit is functioning. In order to determine the quality of measurement, additional steps need to be performed.

7.5.10 PH-501 - Trouble Shooting

Fault reporting and troubleshooting					
Display	Description / cause	Status ¹	Mode ²	Measured variable output ³	Correction variable output ⁴
pH/mV RANGE ↓	Input voltage too low	Error	Basic load	Fault current	-
pH/mV RANGE ↑	Input voltage too high	Error	Basic load	Fault current	-
T RANGE ↓	Measured temperature beneath measuring range	Error	Basic load	Fault current	Fault current
T RANGE ↑	Measured temperature above measuring range	Error	Basic load	Fault current	Fault current
CAL ERROR	No valid user calibration exists	Error	-	-	-
NO PROBE	If activated: pH sensor monitoring outputs: no sensor	Error	Basic load	Fault current	-
PROBE ERR	If activated: pH sensor monitoring outputs: sensor break	Error	Basic load	Fault current	-
CHECK-TIME	Control checkout time elapsed	Error	Basic load	Fault current	-
mA RANGE ↑	mA output current has an upper limit	Error	-	-	-

Display	Description / cause	Status ¹	Mode ²	Measured variable output ³	Correction variable output ⁴
mA RANGE ↓	mA output current has a lower limit	Error	-	-	-
LIMIT ↑	Measured variable exceeds upper set limit	Warning	-	-	-
LIMIT ↓	Measured variable falls below lower set limit	Warning	-	-	-
T LIMIT ↑	Correction variable exceeds upper set limit	Warning	-	-	-
T LIMIT ↓	Correction variable falls below lower set limit	Warning	-	-	-
LIMIT ERR	Set checkout time for monitoring the measurement variable limits has elapsed	Error	Stop	Fault current	-
TLIMITERR	Set checkout time for monitoring the correction variable limits has elapsed	Error	Stop	Fault current	Fault current
NO CAL	No valid user calibration exists	Warning	-	-	-
CONTACTIN	If activated: Power relay is activated in 'PAUSE/HOLD'	Error	-	-	-

1 = [Status] Error status after occurrence of the fault (error means: alarm relay deactivates, "E" is displayed before the error message, can be acknowledged with OK)