

- 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.



Caution: Once wetted, the membrane should remain wet, and not be allowed to dry out to prevent irreversible damage to the membrane.

Performing the Hydraulic Test

- Fill the system [equalization tank (TNK-301) and aeration tank (TNK-501)] 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 blowers B-301/B-302/B-303/B-304/B-305/B-306 for the equalization tank (TNK-301) and blowers B-501/B-502 for the aeration tank (TNK-501), and check for:
 - Buoyancy of air diffusers and if this occurs, empty the tank and fix;
 - 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 (TNK-301) and 2- 3 mg/L for aeration tank (TNK-501); 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 tank, and record blower ON/OFF duration.

Membrane Tanks (TNK-601/TNK-602):

- Enable membrane operation.
- Start the pumps (P-501/P-502) for aeration tank and fill the membrane tank (TNK-601) with potable water.
- Start the air blowers (B-601/B-602/B-603/B-604/B-605) for membrane tank (TNK-601) and blowers (B-606/B-607/B-608/B-609/B-610) for membrane tank (TNK-602) and check for an even distribution of air across the membrane filter area and air bubble uniformity above the membrane modules/cassettes.

- Check hydraulic flow pattern through the membranes and between membrane modules/cassettes and tank wall.
- Make a clean copy of the **Clean Water Testing Sheet** presented in **Appendix K** of this O&M Manual.
- Start the permeate (vacuum) pumps P-701/P-702
- Record all checked parameters in the **Clean Water Testing Sheet**:
 - Record the vacuum (TMP) on gauges PI-701/PI-702 [for clean water could be 0.05 to 0.07 bar (20" to 29" WC)].
 - Record ambient temperature, and 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.

5.0 OPERATION of newterra MicroClear™ MBR

Membrane Bioreactor (MBR) treatment technology is an effective combination of an activated sludge biological treatment process with MicroClear™ MBR membrane filtration technology. The MBR operates at MLSS (mixed liquor suspended solids) concentrations between 8,000 to 12,000 mg/L.

This section provides a brief description of the treatment process and how it is controlled. 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. Equipment and instrumentation identification numbers are referenced from the **Process & Instrumentation Diagram** and **System Layout** presented in **Appendix A** of this O&M Manual.

Automatic Operation

The PLC-based control system is the default operation mode for the **newterra** MicroClear™ MBR. The system operates as a programmable computer that:

- Receives analog and digital input signals from the switches and transmitters being controlled;
- Processes this information using the structure and rules entered into the program;
- Generates outputs that control the equipment - turn equipment **OFF** or **ON**.

Under normal operation, all switches are set in the **AUTO** position on the **HMI**.

All alarms are visually indicated on a beacon stack on the roof of the exterior of the container:

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

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 given that the system was running when the power failed.



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

Manual Operation

The manual mode of operation is provided for maintenance purposes and for emergency operation of the plant in the unlikely event of a failure of the automatic control system (default operation mode). Operators **must be present when equipment is operated in the manual mode.**

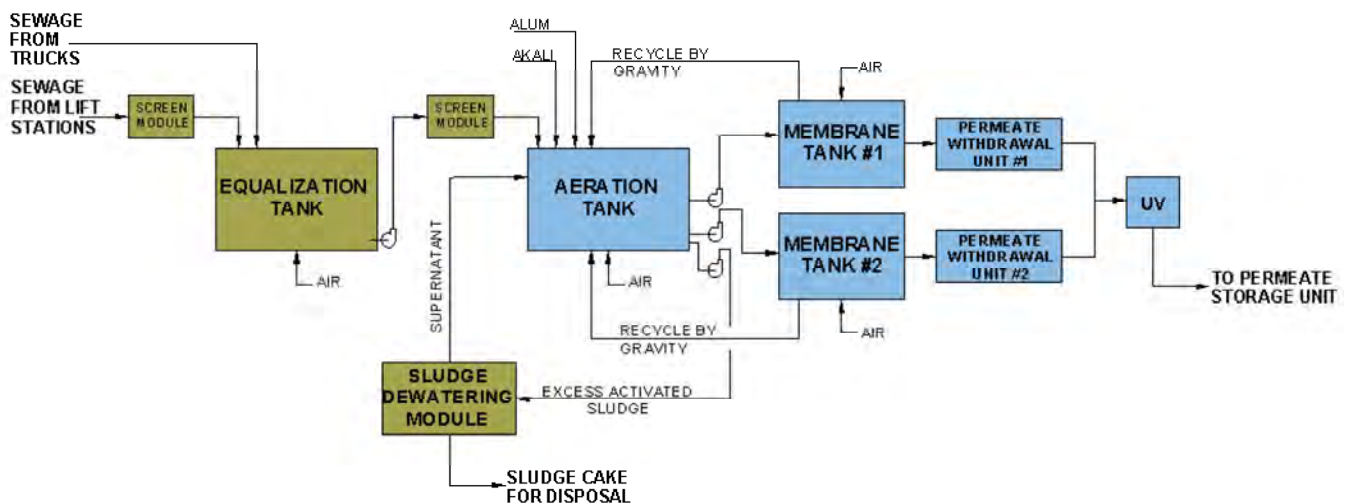
A HAND-OFF-AUTO (H-O-A) switch is provided on the touch screen of the control panel. The HAND position on the switch allows the equipment to be operated in the manual mode.



For safety reasons, a motor in the HAND position will only run for two minutes before it will be automatically stopped.

5.1 Wastewater Treatment Process Description / Control Narrative

The **newterra** MBR WWTP comprises screen modules, equalization tank, aeration tank, membrane filtration module, UV system, permeate storage tank, and sludge dewatering module.



5.1.1 Buildings/ Utilities

The newterra MBR WWTP is housed inside six (6) enclosures (buildings):

- Screen building (BLD-7903) with two (2) rooms: Room #1 (Electrical Classification – Class 1, Div 2 area), and Room #2 (GP area)
- Equalization tank building (BLD-7901)
- Aeration building (BLD-7902), GP area
- Membrane Filtration building (BLD-7900), GP area
- Effluent building (BLD-7905), GP area
- Sludge building (BLD-7904) with two (2) rooms: Room #1 (Electrical Classification – Class 1 Div 2 area), and Office Room #2 (GP area)

The main control panel is located in the Screen building (BLD-7903), Room #2 (GP area)

5.1.1.1 Wastewater Treatment Plant Power Supply



Please refer to the as-built Electrical Block Diagram presented in Appendix A of this manual.

A power monitor has been installed in the main power distribution panel to ensure proper power and phase rotation is delivered to the system. The main power distribution panel is located in the Screen BLD-7903, Room #2 (GP area).

E-STOP

There are several emergency stop buttons wired to a common system kill circuit (KILL-7901) in the plant:

- Kill Switch Emergency Stop **MCP-01** (ESD-8201) located in the control room of the BLD-7903, Room #2, (GP area)
- Emergency Stop **MCP-02** (ESD-8202) located in BLD-7900
- Emergency Stop **MCP-03** (ESD-8203) located in BLD-7905
- Emergency Stop **MCP-04** (ESD-8204) located in BLD-7904, Room #2 (GP area)
- Emergency Stop Screen (ESD-7931) located in BLD 7903, Room #1 1 (Class 1 Div 2 area)
- Emergency Stop Membrane Filtration (ESD-7911) located in BLD-7900

The following emergency stop switches are used for local shut off:

- Emergency Stop Effluent (ESD-7905) located in BLD-7905
- Emergency Stop Sludge (ESD-7941) located in BLD-7904

5.1.1.2 SCREEN BLD-7903

Ventilation

Two (2) exhaust blowers (B-7931 & B-7932) provide constant ventilation for the Screen Modules and Building BLD-7903 Room #1 (Electrical Classification – Class 1 Div 2 area). The air from the blowers is passed through a heat recovery system prior to discharging outside. The blowers run at all times at a rate of ~12 air changes per hour to ensure the requirements of the electrically classified location are met.

Alarms

If the blowers' motors stop running an alarm signal will be sent to the PLC from current switches (YI-7931/ YI-7932).

A single exhaust fan (F-7911) is located in the Room #2 (GP) of the BLD-7903 where the main control panel is located. The purpose of the fan is to prevent the building temperature from climbing higher than desired room set point temperature. The desired room temperature must be set by the operator with the building high temperature switch TSH-7911. If this switch is tripped the exhaust fan will run until the temperature drops below the set point.

Note: The fan (F-7911) is to be used primarily during the summer months - freezing cold air in to the building can lead to condensation/potential freezing risks for critical pieces of equipment.

Hydrogen Sulphide Detection

A Hydrogen Sulphide (H₂S) Detector (AIT-7931) is installed in the screen building (BLD-7903) Room #1 (Electrical Classification – Class 1 Div 2 area). This sensor allows continuous monitoring for H₂S gas. In the event the H₂S alarm level set point is exceeded an alarm will be triggered and indicated on the HMI, an internal and external audible buzzer will sound, the alarm beacon light will illuminate. The water treatment process will continue to run.

Temperature control

For building (BLD-7903), temperature is controlled manually at the local thermostats of the heaters: H-7931/H-7932 for the Room #1 (Electrical Classification - Class 1 Div 2) and H-7933 for the Room #2 (GP area). They are not linked to the PLC.

The operator is required to set the desired building temperature set point in °F at the temperature switches (TSL-7931 and TSL-7932) located in the general purpose room of this building. If the building temperature falls below the temperature switch setting the electric heaters (H-7931/H-7932) will turn on. H-7933 is locally controlled only.

CAUTION: The temperature switch units are in °F.

Alarms

If the temperature of the room #1 and room #2 in the BLD-7903 drops below the low low temperature set point, the alarm switches (TSL-7931 & TSL-7932) will trip and after 300 sec a low temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7931/H-7932) are faulty.

5.1.1.3 EQUALIZATION TANK BLD-7901

Ventilation

The Equalization Tank (TNK-301) is equipped with a ventilation exhaust blower (B-307) located in classified area of BLD-7903. The blower runs at all times providing constant ventilation of the equalization tank. The blower vents air at a rate of 12 air changes per hour and exhausts to the exterior of the building.

If the blower's motor stops running an alarm signal will be sent to the PLC from current indicator switch (YI-307).

5.1.1.4 AERATION TANK BLD-7902

Ventilation

The aeration tank head space is vented by a blower (B-503) to the aeration foam tank (see details in subsection 5.2.3).

5.1.1.5 MEMBRANE FILTRATION BLD-7900

Hydrogen Sulphide Detection

A Hydrogen Sulphide (H₂S) Detector (AIT-7911) is installed below the control panel in the permeate extraction system room of building 7900. This sensor allows continuous monitoring for H₂S gas. In the event the H₂S alarm level set point is exceeded an alarm will be triggered and indicated on the HMI, an internal and external audible buzzer will sound, the alarm beacon light will illuminate. The water treatment process will continue to run.

Temperature control

For building (BLD-7900), temperature is controlled manually at the local thermostats for the wall mounted heaters: H-7911/H-7912. They are not linked to the PLC.

The operator is required to set the desired building temperature set point in °F at the temperature switch (TSL-7912). If the building temperature falls below the temperature switch setting the wall mounted electric heaters (H-7911/H-7912) will turn on.

CAUTION: The temperature switch units are in °F.

Alarms

If the temperature in the BLD-7900 drops below the low low temperature set point, the alarm switch (TSLL-7901/TSLL-7905) will trip and after 60 sec the room's temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7911/H-7912) are faulty.

5.1.1.6 EFFLUENT STORAGE BLD-7905

Temperature control

For BLD-7905, temperature is controlled manually at the local thermostat for the wall mounted heaters (H-7951/H-7952). They are not linked to the PLC.

The operator is required to set the desired building temperature set point in °F at the temperature switch (TSL-7952). If the building temperature falls below the temperature switch setting the wall mounted electric heaters (H-7951/H-7952) will turn on.

CAUTION: The temperature switch units are in °F.

Alarms

If the temperature in the BLD-7905 drops below the low low temperature set point, the alarm switch (TSLL-7951) will trip and after 60 sec a building temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7951/H-7952) are faulty.

5.1.1.6 SLUDGE BLD-7904

Ventilation

Building (BLD-7904), Room #1, Class 1 Div 2 is equipped with an exhaust blower (B-7941). The blower runs at all times providing constant ventilation of the room. The blower vents air at a rate of 12 air changes per hour. The air from the blower (B-7941) is passed through a heat recovery system prior to discharging outside the BLD-7904.

If the blower's motor stops running an alarm signal will be sent to the PLC from current (YI-7941).

Temperature control

For BLD-7904, temperature is controlled manually at the local thermostats for the wall mounted heaters: H-7941/H-7942 for the Room #1, Class 1 Div 2 and H-7943 for the Room #2 General Purpose. They are not linked to the PLC. There are temperature switches in the BLD-7904: TSL-7941/TSL-7942 for the Room #1 (Class 1 Div 2).

Alarm

Alarm switch (TSLL-7941) is activated when the temperature falls below set point. This may indicate that heaters (H-7941/H-7942) are faulty.

Compressed air

Air compressor (C-901) supplies air to operate the filter press (FP-901). The air compressor has level switches:

- an oil level switch alarm (LSLL-901) is activated when the oil level is low
- if pressure switch (PSL-901) is activated an alarm will register on the HMI indicating the air compressor has malfunctioned.

5.1.1.7 FIRE AND EXPLOSION PROTECTION

There are some areas in the plant defined as Class 1 Div 2 according to the National Electrical Code Classification (NFPA 70). These areas are:

- Screen building (BLD-7903), Room #1
- Equalization tank zone, (BLD-7901)
- Sludge building (BLD-7904), Room #1

This classification refers to the areas with potential hazards as flammable gas which is not present under normal conditions.

Fire alarm system is implemented across the plant. The fire protection measures include fire alarm system (FAS), fire detection system (FDS), and portable fire extinguishers. Please refer to the Fire Alarm Layout Drawing presented in Appendix A of this manual.

5.1.2 Process Description

5.1.2.1 Screen Modules Building (SCREEN BLD-7903)

Function: a screening process is provided to remove hair, and fibrous materials from wastewater supplied from the lift stations and delivered by sewage trucks.

There are two (2) screen systems in the plant:

- screen module (SCR-201) for screening incoming raw sewage pumped from lift stations
- screen module (SCR-401) for screening effluent from equalization tank (TNK-301) taking into account addition of raw sewage delivered by sewage trucks and added into the equalization tank (TNK-301)

Both screen modules are located in the building (BLD-7903), Room #1 (Class 1 Div 2 area).

Screw Screen Compactor (SCR-201)/Screen Tank

The screw screen compactor module consists of:

- screw screen compactor with 2-mm opening, equipped with solids bagging
- discharge tank (TNK-202) for collection of the screened wastewater
- external discharge pumps (P-201/P-202) to transfer screened wastewater to the equalization tank (TNK-301)
- self cleaning spray nozzles set on a timer through the HMI

Screw Screen Basin Level Control

The screw screen (SCR-201) will run when the permissive signal (YC-101) to receive from the lift station is ON, and the high level in the screen tank has been reached. If the high level in the screw screen basin has been reached this indicates the screen is clogged. The screw will continue to turn for 2 minutes after the high level condition has cleared.

Screened wastewater flows by gravity from screw screen basin to the screen discharge tank (TNK-202) through 6" discharge pipe.

Alarms

If the clogged screen cannot be cleared and the high high level in the screw screen basin is reached the LSHH-201 will trip. If the LSHH-201 level switch is tripped, an alarm will be generated and will remain visible on the HMI until the alarm condition has cleared. The permissive to receive wastewater from the lift station will be lost. **Operator intervention is required in the event of this alarm!**

In the event the SCR-201 motor trips off on overload an alarm will register on the HMI and the red beacon light will flash.

Screen Tank Level Control:

The screen discharge tank (TNK-202) is equipped with:

- (2) external discharge pumps (P-201 Duty and P-202 Standby)
- discharge pressure indicator (PI-201/ PI-202) to measure the discharge pressure
- motor current switch (YA-201 /YA-202)
- variable frequency drive (VFD-201/VFD-202)
- discharge tank (TNK-202) is equipped with level transmitter (LT-202) and high high level switch (LSHH-202)

After completion of 4 cycles the standby pump will run for 1 cycle. Each time a pump starts the cycle count goes up. As long as the wastewater level in TNK-202 is between the high and low set point, the PLC will allow the operation of the pumps (P-201/P-202) to transfer wastewater to the equalization tank (TNK-301).The VFD's regulate the flow of the pumps to keep the discharge flow rate at the desired set point flow.

If current switches (YA-201/YA-202) are ON and level transmitter (LT-202) indicates the high set point, then the pumps turn on until the level transmitter (LT-202) gets to its low set point.

If the high level set point is on for more than 5 seconds, pumps (P-201/P-202) will increase speed to clear the high level condition.

Alarms

In the event the screen tank discharge pumps motor current switches (YA-201/YA-202) trip, an alarm will register on the HMI and the red beacon light will flash.

Screen Cleaning:

A potable water connection to the screw screen compactor unit (SCR-201) is used to clean the screw screen. A solenoid valve (SV-201) is controlled on a timer to open the solenoid valve for 2 seconds every 60 minutes, with the goal of removing solid build up on the screw screen. Frequency of cycle can be changed through the HMI.

5.1.2.2 Equalization Tank (TNK-301)

Function: Buffers influent variable flow to prevent concentration fluctuations in (i.e. BOD, TSS etc.) through the MBR treatment system.

The equalization tank (TNK-301) receives screened wastewater from the screen tank (TNK-202). The equalization tank (TNK-301) can also receive raw wastewater from the sewage trucks. There are two truck hook-ups from the screen building (BLD-7903) side equipped with 3" female camlocks, valves and 3" PVC pipes.

WARNING: NO CONTROLS ARE IN PLACE TO SHUT OFF TRUCK INFLUENT TO THE EQUALIZATION TANK IN THE EVENT OF A HIGH OR HIGH HIGH LEVEL CONDITION IN THE EQUALIZATION TANK. THE LEVEL OF THE EQ TANK MUST BE MANUALLY MONITORED AT ALL TIMES DURING THE OFFLOADING OF TRUCKS.

The effective volume of the EQ tank is 43.5 m³, providing a hydraulic retention time of 14.5 hours. The equalization tank is equipped with:

- level monitoring/control equipment
- 2 electric immersion heaters with local temperature control
- blowers (B-301 to B-306) supply air to the air diffusers
- 10 EDI fine-bubble air diffusers for mixing and assisting the elimination of potential odour
- 12 magnesium anodes which act as the tank ground and will be sacrificially eroded as a means of prolonging the tank life
- discharge pumps (P-301/ P-302) for transferring wastewater to the SCR-401

Air Diffusers Control

Blowers (B-301- B-306) supply air to the air diffusers installed in the bottom of the equalization tank. A pressure indicator (PI-301) and switch (PLS-301) is installed on the discharge side of the blowers.

Alarms

If the blower air pressure drops below set point, the low pressure switch (PLS-301) will trip and a low pressure alarm will be activated through the PLC. The flashing red beacon light will illuminate.

Temperature Control

The equalization tank (TNK-301) is heated via 2 electric immersion heaters (H-301/H-302). Temperature in the tank is controlled via a local thermostat. Recommended temperature setting for TSL-301/TSL-302 is 10°C to 15°C.

Alarms

If the Temperature Switch Low Low (TSLL-301) is tripped an alarm signal will register on the HMI and the flashing red beacon light will illuminate.

Note: As a low water level in the tank can cause damage to the heaters, the Level Switch Low Low (LSLL-301) is installed in the equalization tank to protect the immersion heaters and if tripped will shut the tank heaters off and initiate an alarm signal from the PLC.

Transfer Pumps/Level Control

The equalization tank (TNK-301) has two (2) external pumps (P-301, P-302) with one of the pumps acting as a standby. Pump (P-301) operates for 4 cycles, pump (P-302) for 1. This pump transfers the wastewater from the equalization tank (TNK-301) to SCR-401 screw screen basin tank.

The equalization tank discharge pumps (P-301/P-302) have local pressure indicators (PI-302/PI-303) to measure discharge pressure and motor current switches (YI-301/YI-302). The discharge pressure can be used to determine an estimation of the flow rate based on the pump curve.

A level transmitter (LT-301) is used to indicate the liquor level in the equalization tank (TNK-301). As long as the level in the tank is above set point, the PLC will allow the operation of either EQ tank discharge pump (P-301 or P-302). If the high level in the EQ tank is met the screen tank supply pumps will be turned off.

Alarms

In the event the equalization tank discharge pumps motor current switches (YI-401/YI-402) trip, an alarm will register on the HMI and the red beacon light will flash.

The Level Switch High High (LSHH-301) if tripped will send a signal to the PLC to warn of imminent overflow in the equalization tank (TNK-301).

Post EQ Screw Screen Compactor (SCR-401)

The screw screen compactor module consists of:

- screw screen compactor with 2-mm opening, equipped with solids bagging
- discharge tank (TNK-401) for collection of the screened wastewater
- external discharge pumps (P-401/P-402) to transfer screened wastewater to the aeration tank (TNK-501)
- self cleaning spray nozzles set on a timer through the HMI

Screw Screen Basin Level Control

The screw screen (SCR-401) will run when the high level in the screen tank has been reached. If the high level in the screw screen basin has been reached this indicates the screen is clogged. The screw will continue to turn for 2 minutes after the high level condition has cleared.

Screened wastewater flows by gravity from screw screen basin to the screen discharge tank (TNK-401) through 6" discharge pipe.

Alarms

If the clogged screen cannot be cleared after 5 minutes a high high level alarm (LSHH-402) will be triggered and will remain visible on the HMI until the alarm condition has cleared. The permissive to receive wastewater from the equalization tank (TNK-301) will be lost. **Operator intervention is required in the event of this alarm!**

In the event the SCR-401 motor trips off on overload an alarm will register on the HMI and the red beacon light will flash.

Screen Tank Level Control:

The screen discharge tank (TNK-401) is equipped with:

- (2) external discharge pumps (P-401 Duty and P-402 Standby)
- discharge pressure indicator (PI-401/ PI-402) to measure the discharge pressure
- motor current switch (YA-401 /YA-402)
- discharge tank (TNK-401) is equipped with a low level switch (LSL-402), high level switch (LSH-402) and a high high level switch (LSHH-202)

After completion of 4 cycles the standby pump will run for 1 cycle. Each time a pump starts the cycle count goes up. As long as the wastewater level in TNK-401 is above the low level switch level, the PLC will allow the operation of the discharge pumps (P-401/P-402) to transfer wastewater to the equalization tank (TNK-301).

Alarms

In the event the screen tank discharge pumps motor current switches (YA-201/YA-202) trip, an alarm will register on the HMI and the red beacon light will flash.

Screen Cleaning:

A potable water connection to the screw screen compactor unit (SCR-401) is used to clean the screw screen. A solenoid valve (SV-401) is controlled on a timer to open the solenoid valve for 2 seconds every 60 minutes, with the goal of removing solid build up on the screw screen. Frequency of cycle can be changed through the HMI.

5.1.2.3 Aeration Tank (AERATION BLD-7902)

Function: Oxygen is added to the wastewater to ensure microorganism concentration is at optimum levels to metabolize contaminants. (i.e. oxidation of carbonaceous BOD; nitrification (conversion of TKN to NO₃-N).

One (1) aeration tank (TNK-501) located in BLD-7902 has an overall effective volume of 48 m³, providing a hydraulic retention time of 16 hours. TNK-501 receives screened wastewater from the screen tank (TNK-401) of the post EQ screen module (SCR-401), return flow from the membrane tanks (TNK-601/ TNK-602), and supernatant from (TNK-901) of sludge dewatering module.

Blowers supply air to the submerged fine-bubble diffusers to ensure biological oxidation (aeration) and to keep solids in the water suspended. Mixed liquor is constantly re-circulated from the bottom of the tanks to the top through spray nozzles. This recirculation process is in place for foam suppression. Alum and soda ash chemical metering systems are in place to ensure regulation of aeration tank water pH and phosphorus levels.

The aeration tank (TNK-501) is equipped with:

- level, temperature, pH, and dissolved oxygen (DO) monitoring and control equipment.
- 2 electric immersion heaters (H-501/H-502) to keep the temperature of the biological process above 15-20° C.
- Blowers (B-501, B-502) equipped with VFD's to supply air to the fine-bubble air diffusers in (TNK-501)
- 30 EDI fine-bubble air diffusers
- Tank recirculation/sludge removal pump (P-503)
- Tank discharge pumps (P-501/P-502) transfer wastewater to the membrane tanks (TNK-601/TNK-602)
- Chemical Metering Systems – soda ash tank (TNK-6101) with dosing pump (P-6101) and alum tank (TNK-6102) with dosing pump (P-6102)

Temperature Control

The aeration tank (TNK-501) is heated via electric immersion heaters (H-501/H-502). Temperature in the tank is controlled via a local thermostat. Recommended temperature setting for TSL-301/TSL-302 is 15°C to 20°C.

Alarms

If the Temperature Switch Low Low (TSLL-501) is tripped an alarm signal will register on the HMI and the flashing red beacon light will illuminate.

Note: As a low water level in the tank can cause damage to the heaters, the Level Switch Low Low (LSLL-501) is installed in the equalization tank to protect the immersion heaters and if tripped will shut the tank heaters off and initiate an alarm signal from the PLC.

Discharge Pump/Level Control

The aeration tank (TNK-501) has two (2) external transfer pumps (P-501, P-502). Pump (P-501) transfers wastewater to membrane tank (TNK-601) and pump (P-502) transfers wastewater to membrane tank (TNK-602).

Level transmitter (LT-501) indicates the liquor level in the aeration tank (TNK-501). As long as the level in the tank is above set point the PLC will allow the operation of both discharge pumps (P-501 or P-502).

Alarms

If the Level Switch High High (LSHH-501) is tripped an alarm will register on the HMI, the flashing red beacon light will illuminate and the equalization discharge pumps will be shut down or disabled from running for the duration of the high high level condition.

The aeration tank discharge pumps (P-501/P-502) have pressure indicators (PI-501/PI-502) to measure discharge pressure and motor current switches (YA-P501/YA-P502). The discharge pressure can be used to determine an estimation of the flow rate based on the pump curve.

Alarms

In the event the aeration tank discharge pumps motor current switches (YA-P501/YA-P502) trip, an alarm will register on the HMI and the red beacon light will flash.

Dissolved Oxygen Control

The aeration tank (TNK-501) is equipped with a dissolved oxygen (DO-501) sensor. The PLC is programmed to ensure the level of DO remains above 2 mg/L. If the level of DO falls below the set point value a 4-20 mA signal is sent to the VFD (VFD-501) that controls the speed of the blowers (B-501, B-502). The speed of the blowers is regulated to maintain the DO at set point level.

Alarms

In the event the Dissolved Oxygen level set point cannot be achieved within 15 minutes of the detection of the level being outside of the set point range a low DO alarm will register on the HMI and the red beacon warning light will illuminate. The duty blower will run at full speed for

15 minutes to attempt to regain the oxygen level. If after 15 minutes the oxygen level has not returned to below set point the duty blower defaults to a manual speed setting until operator intervention is possible.

pH Control

A chemical dosing pump (P-6101) is provided to inject soda ash (Na_2CO_3) into the aeration tank (TNK-501) to maintain the pH at desired pH set point. If the pH measured by pH probe (PH-501) falls below set point, the PLC will turn the pump on for 30 seconds, turn the pump off for 30 seconds and repeat this cycle until tank pH has regained desired set point. The pump stroke must be set by the MBR system operator.

Alarms

In the event the pH level set point cannot be achieved a low or high pH alarm will register on the HMI and the red beacon warning light will illuminate. The system will continue to adjust to achieve set point pH throughout the duration of the alarm.

Phosphorus Concentration Control

A chemical dosing pump (P-6102) is provided to inject alum [$\text{Al}_2(\text{SO}_4)_3$]. The dosing pump will be stroked based on an influent volume set point entered on the HMI by the system user. Alum is used to remove phosphorus from the influent. The alum dosage volume is manually set locally at the metering pump by adjusting the pump stroke.

Foam Suppression

The aeration tank (TNK-501) is equipped with an external pump (P-503) and a spray nozzle system for foam suppression. The pump (P-503) has a pressure indicator (PI-503) measuring its discharge pressure. The flow is controlled by opening a manual gate valve installed in the foam suppression line. The foam suppression line is equipped with a de-ragger unit to prevent spray nozzles from plugging.

Sludge Dewatering Unit Supernatant Return

Supernatant can be returned to the aeration tank (TNK-501) if the MBR system is operating in conjunction with a sludge dewatering system. Supernatant will be returned as long as the aeration tank level is below the High Level set point. The PLC will shut down pump (P-503) for the duration of the return cycle.

Sludge Removal

A sludge removal pipeline is provided at a tee off of the aeration tank recirculation line, isolated by a manual ball valve. The manual isolation valve must remain closed at all times. To remove sludge the manual isolation valve is opened along with the manual isolation valve at the entrance of TNK-901, while P-503 is running.

5.1.2.3 Membrane Filtration (TNK-601/602)

Function: Mixed liquor filtration and supplemental biological oxidation.

Membrane filtration is comprised of a membrane tank and permeate extraction unit

Membrane unit includes:

- Two (2) membrane tanks, each tank is equipped with submersible membrane filtration module, level controls, gravity recycling line, drain, access hatch, viewing window, and sample port
- Blower unit for membrane tanks; each unit contains five (5) blowers and it is equipped with pressure indicator, pressure switch low alarm, and motorized three-way valve
- Recirculation pumps transferring mixed-liquor from the membrane tanks (TNK-601/TNK-602) to the aeration tank (TNK-501)

Permeate extraction unit includes:

- Permeate pumps (P-701/P-702) with VFD, current switches, pressure and flow rate control equipment, solenoid valves, and motorized valves
- Backwash tank (T-801) equipped with level control switches, submersible pump (P-801), and solenoid valve
- UV disinfection unit with two (2) UV lights (UV-751/UV-752)

Membrane Unit Operation

External pumps (P-501/P-502) housed in (BLD-7900) transfer mixed liquor from the aeration tank (TNK-501) to the membrane tanks (TNK-601/TNK-602). Each membrane tank contains One (1) MicroClear™ MB3-1 submerged membrane module (membrane cassettes are complete with stainless steel housing and permeate piping with header).

Each membrane tank is equipped with air diffusers for the purpose of scouring the membranes to assist in the prevention of membrane fouling.

Mixed liquor from the membrane tanks (TNK-601/TNK-602) is constantly recycled back to the aeration tank (TNK-501) by external pumps (P-601/ P-602) to maintain even biomass inventory within the aeration tank and membrane tanks.

Each of the respective pumps (P-601/P-602) are equipped with pressure indicators (PI-603/PI-604) to measure the discharge pressure of the pumps, and current switches (YA-601/YA-602). The membrane tanks are also equipped with gravity overflow lines that recycle mixed liquor back to the aeration tank (TNK-501).

Membrane Tanks Level Control

The membrane tanks (TNK-601/TNK-602) contain high level switches (LSH-601/LSH-602) which activate the permeate pumps (P-701/P-702) to start pulling permeate out of the membrane tanks (TNK-601/TNK-602).

Alarms

The level switches high high alarm (LSHH-601/LSHH-602) inform the operator of an imminent overflow. It also shuts off the aeration tank discharge pumps (P-501/P-502) to prevent more mixed liquor from entering the membrane tank (TNK-601/TNK-602).

Recycle Pump Control

Recycle (RAS) pumps (P-601/P-602) recycle mixed liquor from membrane tanks (TNK-601/TNK-602) back to the aeration tank (TNK-501) as long as the discharge pumps (P-501/P-502) are on, water level switches in the membrane tanks (LSH-601/LSH-602) are ON, and there is no High High Level in aeration tank.

Alarms

In the event the RAS pumps motor current switches (YA-601/YA-602) trip, an alarm will register on the HMI and the red beacon light will flash.

Blower Units Control

The membrane air scouring blowers (B-601 to B-605 for TNK-601 and B-606 to B-610 for TNK-602) are connected to the air diffusers in the membrane tanks (TNK-601/TNK-602) respectively. The common airlines to the membrane tanks are equipped with a discharge pressure indicators (PI-601/PI-602) and a pressure switches (PSL-601/ PSL-602).

Each blower unit is also equipped with an electrically actuated three-way valve (MV-601/ MV-602) to direct the flow of air through medium air diffusers or coarse air diffuser. The valves (MV-601/MV-602) are installed with closed position switches (ZSC-601/ZSC-602) that is monitored by the PLC.



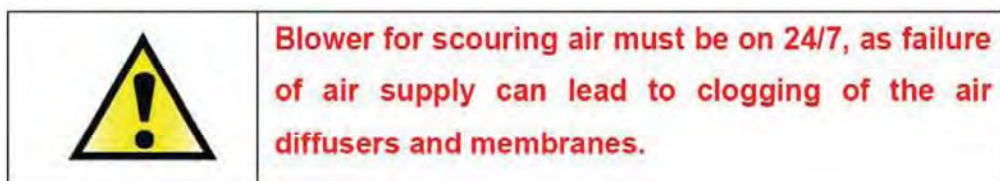
The blowers scouring the membranes:

- Operates continuously **(24/7)**
- Turned off for one minute every hour to relax the membranes

Coarse Air Diffuser Cycle

Under normal operation, air is directed through the medium air diffusers at the base of the membrane housing. If the level switch high (LSH-601) has not been reached in 30 minutes, the air is diverted to the coarse air diffusers in the membrane tank. Changing where air enters into the membrane tank (TNK-601) changes the direction of scouring, helping remove debris on the membrane modules/cassettes.

The air will be directed to the coarse air diffusers for the time interval set point entered through the HMI. The duration of the coarse air diffuser cycle time is adjustable up to 15 minutes, by changing the set point on the HMI screen to meet the particular plant operating conditions.



Alarms

If the pressure switches low alarm (PSL-601/PSL-602) are tripped, a signal will be sent to the PLC which will generate an alarm indicating a potential blowers (B-601 to B-610) malfunction which will cause the corresponding membrane permeate tank discharge pumps (P-701/P-702) to stop. This interlock is in place to prevent damaging the membranes.

Please note: At no time shall the vacuum pumps P-701/P-702 operate when the pressure switches (PSL-601/PSL-602) are active; this is to ensure that air for membrane scouring is available at all times, and to protect the membranes from fouling.

Permeate Extraction Unit Operation

Vacuum pumps (P-701/ P-702) draw the water through the membranes under a preset flow rate of 31.5 Lpm (at a design flux of 18 LMH). Permeate is run through UV system for final disinfection before entering permeate storage tank (TNK-811).

Permeate Flow Control

There are two (2) operational modes for permeate flow control, flow mode (constant flux mode) or vacuum mode (constant TMP mode). The operator has the option of selecting the permeate flow control mode on the screen. Flow transmitters (FT-701/FT-702) are installed on the permeate discharge line to measure the effluent flow from each membrane tank.

Flow Mode (default for newterra MBR)

- Normal permeate flow rate is 31.5 Lpm (corresponds to a design flux rate of 18 LMH)
- This setpoint is used for vacuum pumps (P-701/P-702) VFDs control
- The maximum permeate flow setpoint is 52.5 Lpm (corresponds to a maximum flux rate of 30 LMH)
- The operator has the option of changing the permeate flow rate on the screen, but the set point should not be greater than 31.5 Lpm under normal operating condition and cannot exceed 52.5 Lpm, at any given time

Note: If the vacuum reaches -0.250 bar the system automatically switches to Vacuum Mode.

Vacuum Mode

There are two vacuum set points for the permeate withdrawal system:

- Normal vacuum rate to pull the permeate out at a pre-set vacuum setpoint of -0.100 bar
- Higher vacuum rate (-0.120 bar) is used when the EQ tank's high level (LSH-301) is on, signalling the MBR to run at a higher vacuum to keep up with the incoming water
- The highest vacuum of the permeate extraction system is -0.300 bar

Permeate Discharge Pump Control

The permeate discharge pumps (P-701/P-702) will run continuously as long as the high level switches (LSH-601/P-602) in the membrane tanks (TNK-601/TNK-602) are activated. Permeate withdrawal is done based on the preset permeate normal flow rate or vacuum rate.

If the level switch (LSH-301) in the equalization tank (TNK-301) is active for more than 5 seconds, permeate pumps (P-701/P-702) start increasing the permeate flow rate using the variable frequency drives (VFD-701/VFD-702). The trans-membrane pressure (TMP) indicated by vacuum transmitters (VT-701/VT-702) and the calculated permeability are displayed on the touch screen. The permeability is a key indicator of membrane fouling state.

Membrane Relax Cycle

- After every 9 minutes of permeate flow the permeate discharge vacuum pumps (P-701, P-702) will stop and the electrically actuated valves SV-701/SV-702 will open to release vacuum through the membranes.
- The resulting removal of vacuum in the system allows the membranes to relax for 1 minute.

Membrane Backwash Cycle

- When necessary conditions have been met the backwash tank sump pump (P-801) will be activated, permeate pumps (P-701/P-702) shut off and the backwash supply valves (MV-701/MV-702) open, to allow the reversal of flow over the membrane surface.
- The duration of the relax and backwash time is adjustable by changing the set point on the **HMI** screen to meet the particular plant operating conditions. A combination of backwash and relaxation (no permeation) is carried out for the best performance of the membranes.



- Maximum head required for backwash is **one meter**.
- During the entire backwash cycle, the scouring of the membranes is continuous.

At design flow when the membrane discharge vacuum exceeds 0.2 bar/80" WC (transmitted by VT-701, and indicated locally at PI-701), or permeability drops rapidly to 50 LMH/bar, it is necessary to take the membrane tanks (TNK-601/TNK-602) offline for chemically enhanced backwash (**CEB**) cleaning (please refer to Section 7 of this O&M manual)..



The permeability is a key indicator of membrane fouling state. A permeability of less than 50 LMH/bar (or transmembrane pressure exceeding 0.2 bar) indicates a membrane chemical clean is required.

A chemical addition unit is provided in the building (BLD-7900) for membrane in-situ chemically enhanced backwash (CEB) and recovery cleaning. The unit includes:

- Citric acid tank (TNK-802) with chemical dosing pump (P-802)
- Sodium hypochlorite tank (TNK-803) with chemical dosing pump (P-803)

Backwash Tank

The backwash tank (TNK-801) has 3 level switches (LSL-801, LSH-801, LSHH-801). When the low level switch LSL-801 is tripped this indicates a low water level in the backwash tank. Solenoid valve (SV-801) will open to fill the tank to the high level switch (LSH-801).

Alarms

LSHH-801 indicates imminent overflow. An alarm signal will register on the HMI and the flashing red beacon light will illuminate. **Operator intervention is required.**

Disinfection System

The MBR permeate is run through UV system for final effluent disinfection. The disinfection system consists of two high intensity UVmax Lights (UV751/ UV752) installed in series. The UVmax lights provide disinfection with a UV dosage of 40 mJ/cm² and a flow rate of 303 L/min. This system is installed for protection in the event of a membrane breakthrough. The UV-Lights are connected to a solenoid safety (UVL-751, UVL-752) to restrict the flow in case the UV-Light system have been compromised.

Turbidity Meter

Turbidity transmitter (AIT-801) connected after the UV systems indicates the turbidity (solids content) in the treated effluent. High turbidity will activate an alarm as this can indicate possible breakthrough of the membranes.

5.1.2.4 Permeate /Treated Effluent Building (EFFLUENT BLD-7905)

Function: Treated effluent storage, ammonia oxidation with calcium hypochlorite followed by dechlorination.

Prior to final discharge to the receiving water body the treated effluent will be tested. In the event the biological process upset occurs, due to a toxic shock load or cold weather, it may result in a discharge of ammonia or total nitrogen into the receiving water body. Therefore, calcium hypochlorite addition system is supplied as a stand-by solution for ammonia removal in the wastewater. The sodium bisulfite dosing system is used for dechlorination.

The treated effluent from UV lights is stored in four (4) identical storage tanks (TNK-811, TNK-812, TNK-813, TNK-814). All tanks are connected with 3" PVC pipes.

Calcium Hypochlorite Concentration Control

Chemical dosing system including calcium hypochlorite tank and dosing pumps (P-813 Duty / P-814 Standby) is provided to inject calcium hypochlorite $[Ca(ClO)_2]$ to the tank (TNK-811). The calcium hypochlorite dosage rate is manually set locally at the metering pump by adjusting the pump stroke. The operator must determine what the dosage rate needs to be and manually set the stroke at the pump and enter influent flow rate set point through the HMI.

The calcium hypochlorite tank is equipped with low level switch alarm (LSLL-815) indicating if tank is empty; this is to protect dry running of the pumps (P-813/P-814).

Effluent Storage System Discharge pumps / Level control

The storage tanks have two (2) external pumps (P-811 Duty / P-812 Standby) for sending treated effluent to final discharge. Each pump is equipped with discharge pressure indicator (PI-811/ PI-812) to measure the discharge pressure and motor current switch (YA-811 /YA-812).

Tank (TNK-814) is equipped with a high level switch (LSH-814) and low level switch. As long as the water level in the tank is above the low level height, pumps (P-811/P-812) will run.

Alarms

All effluent storage tanks (TNK-811/TNK-812/TNK-813/TNK-814) are equipped with level switches alarm (LSHH-801/LSHH-802 /LSHH-803/LSHH-804) for indicating imminent overflow; an alarm signal will register on the HMI and the flashing red beacon light will illuminate, operator intervention is required.

Sodium Bisulfite Concentration Control

Chemical dosing system including sodium bisulfite tank and metering pumps (P-815 Duty / P-816 Standby) is provided to inject sodium bisulfite [$\text{Na}_2\text{S}_2\text{O}_5$] to the discharge line for effluent dechlorination. The sodium bisulfite dosage rate is manually set locally at the metering pump by adjusting the pump stroke. The operator must determine what the dosage rate needs to be and manually set the stroke at the pump and enter influent flow rate set point through the HMI.

The sodium bisulfite tank is equipped with low level switch alarm (LSLL-815/LSLL-816) indicating if tank is empty; this is to protect dry running of the pumps (P-815/P-816).

5.1.2.5 Sludge Treatment Module (SLUDGE BLD-7904)

Excess waste activated sludge (WAS) from the aeration tanks (TNK-501) is pumped to the sludge treatment module housed inside container (SLUDGE BLD-7904), Room#1 Cl1 Div 2.

Sludge treatment module includes:

- Polymer tank (TNK-902) with mixer (M-902), and polymer transferring pump (P-902)
- Sludge mixing tank (TNK-901) equipped with level control switch, mixer (M-901), and transferring pump (P-901)
- One (1) Filter Press unit equipped with air driven hydraulic pump, and sludge dumpster
- Supernatant tank (TNK-903) equipped with level control switches, and supernatant transferring pump (P-903)
- Air compressor (C-901) equipped with oil level switch and pressure switch; air compressor located in Room #2 GP of the building (SLUDGE BLD-7904)

Polymer preparation unit

The polymer unit is used for preparation and dosing polymer solution into the mixing tank (TNK-902) for sludge treatment. The batch-wise polymer preparation process includes:

- Hydration stage, when dry polymer is added to the tank for mixing with potable water
- Blending the polymer to a homogenous and activated solution, when the gentle agitation/mixing is provided
- Dosing the polymer activated solution into the sludge mixing tank (TNK-901) for sludge treatment using air diaphragm pump (P-902)

The mixer (M-902) and the pump (P-902) are driven by compressed air supplied by air compressor (C-901). Compressed air lines are equipped with pressure indicators (P-901/P902) to measure pressure in the air lines. The mixer (M-902) and the pump (P-902) are operated manually.

Sludge mixing unit

The waste activated sludge is pumped from the aeration tank (TNK-501) into the mixing tank (TNK-901) where it is mixed with the polymer solution sent by pump (P-902) from the polymer tank (TNK-902). The sludge is mixed with polymer by submersible mixer (M-911). The mixer is driven by compressed air supplied by air compressor (C-901); compressed air line is equipped with pressure indicator (P-903) to measure pressure in the air line.

Alarm

The mixing tank (TNK-901) is equipped with level switches alarm (LSHH-901) indicating imminent overflow; an alarm signal will register on the HMI and the flashing red beacon light will illuminate, operator intervention is required. If the high high condition occurs and if the sludge transfer pump is running the PLC will shut P-503 off.

Treated (flocculated) sludge is transferred from mixing tank (TNK- 901) to the filter press (FP-901) by air diaphragm pump (P-901); compressed air line is equipped with pressure indicator (P-904) for measure pressure in the air line.

Filter press

The incoming treated sludge enters the filter press (FP-901) via the center feed pipe. The center feed plates contain a recess on either side of the plates. The cylinder will be shut closed (and hence compress the plates together) with the air driven hydraulic pump and then pressurized shut with approximately 4300 PSI of pressure. When the plates are closed, a cavity is created between the plates where the sludge will be captured.

The filtered water (supernatant) exits through the filter cloth (while the solids are captured within the clothed chambers) and goes to the supernatant tank (TNK-903) by gravity.

The feed pressure of the filter press (FP-901) may start at about 25 PSI, due to the low resistance of an empty filter press. As solids accumulate in the chambers of the filter press, the feed pressure will need to be increased to maintain a stroke count of about one stroke every 1-5 seconds or until a maximum feed pressure of 100 PSI is obtained.

Once the filter press (FP-901) is filled with sludge, the feed pump (P-901) and air driven hydraulic pump are shut off and the sludge blow down process will then commence for further water removal. The air enters via air valve into the sludge chamber via the upper left hand corner of the three button plates, and exits via the bottom right hand corner of the one button plates. This process will push excess water out through the outlet manifold.

Once the sludge blown down process is complete, the filter press is ready to be opened. To open the automatic filter press, reverse the air valve on the automatic pump to allow the pump to slowly pull open the pushing plate. For opening and closing the filter press the controls are right on the hydraulics for safety reasons. It is a forward, off, reverse lever.

Now that the plates are released, index the plates one by one, and most of the sludge will fall into the sludge dumpster below the press. A sludge spatula is provided to aid in the sludge removal.

Once all plates are clean, the filter press (FP-901) is ready to be closed hydraulically. The three outlet manifold ball valves should be opened, the center feed pipe should be opened and the pump is ready to be turned on again.

Supernatant unit

The supernatant tank (TNK-903) receives supernatant from the filter press (FP-901). The tank is equipped with:

- Liquid level switches (LSL-902/LSH-902/LSHH-902)
- Pump (P-903) transferring supernatant from the supernatant tank (TNK-903) to the aeration tank (TNK-501) located in the building (AERATION BLD-7902); pump is equipped with current switch (YA-903) and pressure indicator (PI-903) for pressure control.

Level / Pump Operation and Control

The supernatant transferring pump (P-903) will run based on liquid level in the supernatant tank (TNK-903):

- Pump (P-903) run, when level switch LSL-902 is ON and YA- 903 is ON
- Pump (P-903) stops, when level switch (LSL-902) is OFF; this is to protect dry running of the pump

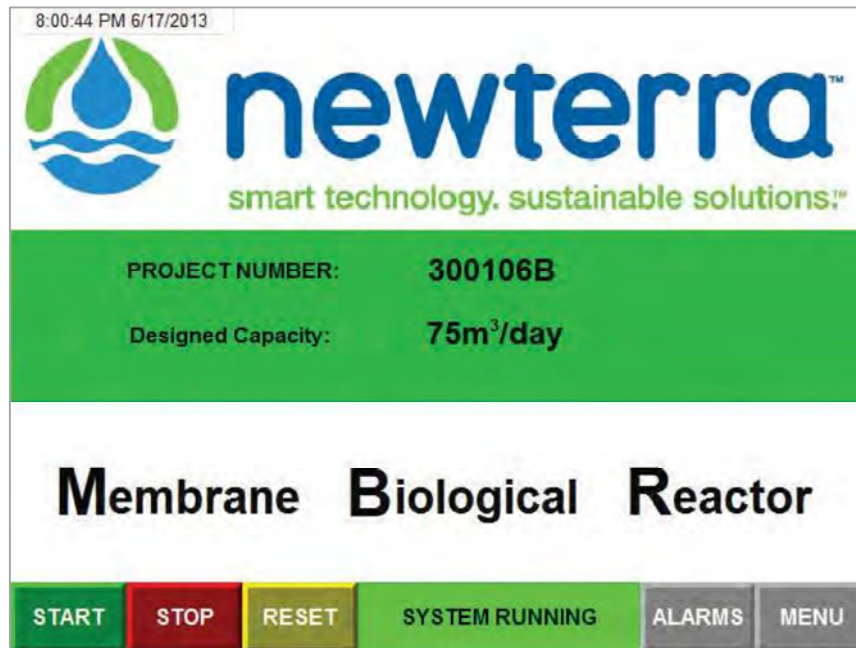
Alarms

LSHH-902 indicates the imminent overflow. Operator intervention is required.

5.2 Process Control System Touchscreen Operation

The MicroClear™ MBR system is designed to be fully automatic. Since the unit operates through a touchscreen, simply press the screen in an area where a button or text appears.

5.2.1 Main Control Screen



System Operation Commands

- **START** button puts the system in **RUN** mode
- **STOP** button stops the system operation. Some equipment continues to run even after this **STOP** button has been pressed, however the **E-STOP** button (located on the panel front) will stop all equipment
- **RESET** button is used to clear alarms after they have been addressed
- **SYSTEM ON (RUNNING) / SYSTEM OFF** indicates whether the system is currently in RUN mode or turned off
- **ALARM** button - when it is flashing red (it is on), it indicates an alarm is present in the system. Press **ALARMS** button to be routed to the alarm screen
- **MENU** button is used for screen navigation to show individual screens

5.2.2 Process Screens

The main process screens are accessed from the main menu by pressing either the “BIOLOGY” button or the “MBR SYS” button.

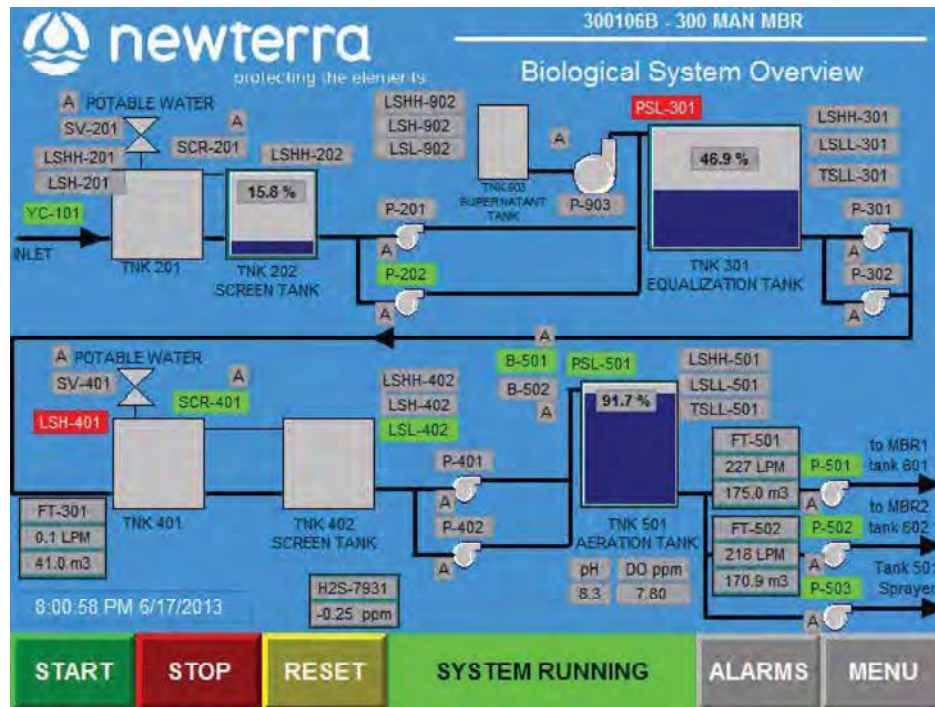
On the main process screens, switches are displayed as **Grey** when **OFF**, **Green** when **ON** and **Red** when in alarm condition.

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

Individual devices can be monitored and controlled from the process screens.

- The letter indicated beside a device shows the current operational status of that device (**H** for hand, **O** for off, **A** for automatic)
- Touching a device on the process screen will open an **HOA** popup for that device.
- Devices are shown in green if they are currently running

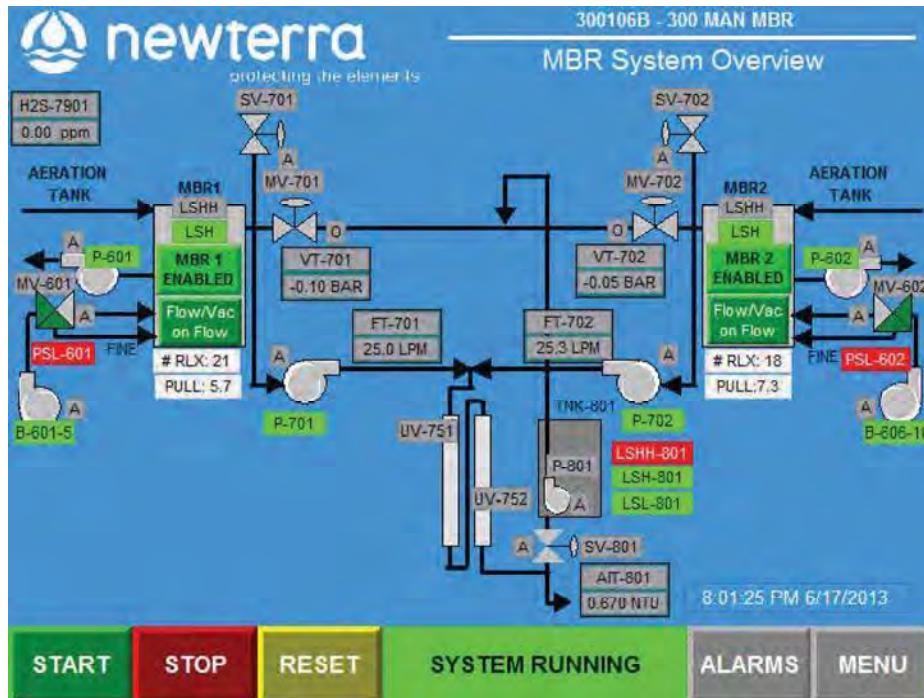
5.2.2.1 Biological System Overview Screen



On the Biological System Overview Screen the following equipment and parameters are displayed:

- Inlet screen module (SCR-201) including screen basin (TNK-201) connected with screen tank (TNK-202), pumps and controls
- Equalization module including EQ tank (TNK-301) with controls, blowers; EQ tank level is displayed in %
- The second screen module (SCR-401) including screen basin (TNK-401) connected with screen tank (TNK-402), pumps and controls
- Aeration Tank (TNK-501) with all interconnecting piping, pumps and controls. Aeration tank level is displayed in % , dissolved oxygen (DO) and pH is displayed for the tank
- Status of blowers, pumps, level switches, flow transmitters and H₂S detector are displayed

5.2.2.2 Membrane Filtration System (MBR) Overview Screen



On this screen the following equipment and parameters are displayed:

- Membrane Tanks (TNK-601 and TNK-602), and Backwash Tank (TNK-801) with all interconnecting piping
- Permeate flow and vacuum are indicated for both membrane systems
- The number of relaxes performed in the current cycle is displayed
- The time on the current pull cycle is displayed
- Status of blowers, pumps, level switches, flow transmitters and H₂S detector are displayed
- The time on the current pull cycle