AGNICO EAGLE

MEADOWBANK GOLD PROJECT

Operation & Maintenance Manual
Sewage Treatment Plant

In Accordance with Water License 2AM-MEA1525 & 8BC-TEH0809

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 6
March 2017

EXECUTIVE SUMMARY

The Nunavut Water Board (NWB) has issued Type A Water License 2AM-MEA0815 to Agnico Eagle Mines Limited (Agnico) for the Meadowbank Gold Project site authorizing the use of water and the disposal of waste required by mining and milling and associated uses. In September 2015, Agnico received the renewed Type A Water License 2AM-MEA1525.

Agnico has prepared the following document which summarizes the operational and maintenance procedures to be followed at the sewage treatment plant.

This report documents the stand alone Operation & Maintenance Manual – Sewage Treatment Plant, as specified under Water License 2AM-MEA0815 Part D, Item 19 and 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 sewage treatment facility;
- The manual includes contingency measures in the event of a plant malfunction;
- The manual includes sludge management procedures; and
- The manual incorporates the Operation and Maintenance Manual requirements of 8BC-TEH0809, Part D, Item 10.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA1525, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (September 2015) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Internal:

- Site Services Superintendent
- Site Services General Foreman
- Environmental Superintendent
- Environmental Coordinator
- STP Operator

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	08/11/07			Operation and Maintenance manual
2	July 2012			Complete review of Operation and Maintenance Manual
3	February 2013			Complete review of Operation and Maintenance Manual
4	April 2013			Change in sampling frequency and parameters of analysis
5	September 2015	3.4	13	Remove option of incinerating food and kitchen grease
6	March 2017			Complete review of Operation and Maintenance Manual

Version 6

Prepared By: 
Environmental Department

Approved by: 
_____
Erika Voyer
Environment General Supervisor

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1 INTRODUCTION

1.1 PURPOSE

This sewage treatment plant (STP) operation and maintenance (O&M) manual for the Meadowbank Gold Project has been prepared in accordance with the Nunavut Water Board Type A Water License 2AM-MEA1525 and is 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 manual has been adapted for the use of a mechanical sewage treatment facility.

This manual is a component of the Meadowbank 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 Meadowbank Mine; and
2. To provide monitoring requirements for the STP.

1.2 BRIEF DESCRIPTION OF THE PROJECT

The Meadowbank Gold Project, operated by Agnico Eagle Mines Ltd. (Agnico), is located approximately 70 kilometres north of the Hamlet of Baker Lake, in the Kivalliq Region of Nunavut. The center of operations is situated at 65^{o} 01' 9.12''N latitude and 96^{o} 04' 1.91''W longitude on NTS map sheet 66H/1. The site has been actively mining since March 2010.

Gold will be extracted using traditional open pit mining methods during the roughly two year remaining mine life (2018 Q3). Access to the site is via an airstrip at Meadowbank and via an all-weather access road from the Hamlet of Baker Lake. On-site facilities will include a mill, power plant, maintenance facilities, tank farm for fuel storage, water treatment plant, sewage treatment plant, and accommodation and kitchen facilities for 550 people.

1.3 CONTACT INFORMATION

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

Site services Superintendent	819-759-3555 ext 6803
STP Operator	819-759-3555 ext 6758
Environmental coordinator	819-759-3555 ext 6747/6744

2 BACKGROUND AND DESCRIPTION

2.1 HISTORY OF SEWAGE TREATMENT AT MEADOWBANK

The sewage treatment plant (STP) at Meadowbank first went into operation on May 15, 2008. It is located on the northern end of the mine site in a prefabricated structure adjacent to the accommodations camp. The proximity of the system to the camp optimizes the wastewater inputs. The treated wastewater is discharged into a small attenuation pond (formerly known as Teardrop Lake – now as the Stormwater Management Pond). It is less than 2m deep, and fishless. This water body is located between the plant site and Portage Pit, within the mine footprint, and is also used as a storm water management pond for the Meadowbank site. This wastewater is pumped periodically (when near capacity of the pond) with mill tailings or directly to the Tailings Storage Facility (TSF). There is no discharge of treatment effluent to the natural environment.

2.2 DESCRIPTION OF TREATMENT PLANT

A Rotary Biological Contactor (RBC) sewage treatment system has been installed at Meadowbank. Four RBC units are installed at site; the Seprotech L333 Rotordisk model, and three Biodisk LJ100 units. These units are designed to remove solids, organic material a limited amount of nutrients from the wastewater (sewage and grey water).

The main unit, the Seprotech L333, and two (plus one backup) Biodisk LJ100 units, run in a parallel series. An 80 m^3 capacity equalization tank is utilized prior to the treatment units and serves as an equalization tank to manage peak flows of influent (morning and evenings). The treated effluent from both systems passes through a U.V. disinfection system and flows to a common lift station (station 3) prior to discharge.

The operation of the RBC system is based on a continuous flow of wastewater through a series of stages. As wastewater flows through the RBC system, each successive RBC stage receives influent with lower contaminant concentrations than the previous. In general, treatment of wastewater by an RBC system includes the following processes:

- Aeration and mixing via rotating disks;
- Biological reactions on disk surfaces; and
- Sloughing of solids from rotating disks.

Prior to entering the RBC, untreated wastewater, as a pretreatment, passes through a screen system to provide for course solids removal prior to primary clarification. Wastewater can then flow into the RBC units, where it comes in contact with disks attached to a rotating shaft. The disks can be configured and corrugated in various patterns to provide increased surface area and enhanced structural stability as they rotate through the wastewater. Aeration and mixing occurs as the shaft and associated disks rotate through the wastewater. The disks provide surfaces on which microorganisms can react with ambient air and wastewater to convert ammonia to nitrate (termed nitrification) and reduce the Biological Oxygen Demand (BOD). As wastewater flows through the disks, sloughing of solids accumulated on the disks occurs by displacement and gravity. After the treatment process within the RBC is complete, the resulting wastewater is directed to settling tanks. These tanks are necessary for secondary clarification. The settled solids remaining after secondary clarification is termed sewage sludge.

The Meadowbank RBC units are housed within an insulated tank with an insulated cover and are equipped with immersion heaters to ensure efficient operation under Northern adverse weather conditions. See below for Photographs of the system and Figure 1 for a flow diagram of the system.

Photo 1 – RBC units

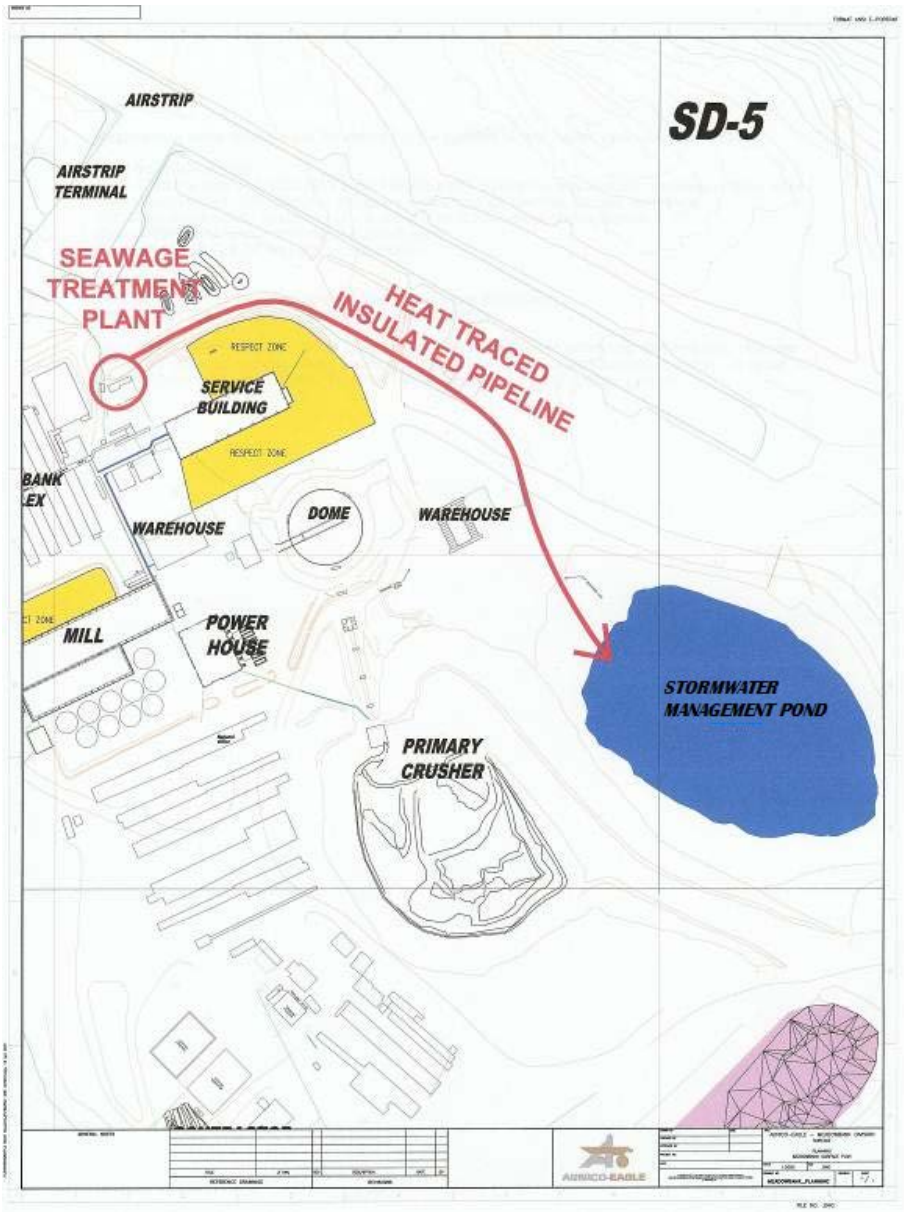

Figure 1 – Flow Diagram

2.3 SEWAGE GENERATION AND COMPOSITION

The STP at Meadowbank is capable of handling 188 m^3 per day. With a biological oxygen demand (BOD) of approximately 350 mg/L, the L333 has a capacity up to 105 m^3, and the two Biodisks, operating in a series, another 27.5 m^3 each. These units provide primary and secondary treatment.

On average between 100 m^3 and 120 m^3 of sewage and grey water is generated at site each day. Daily records are maintained of the amount of sewage and grey water generated.

The composition of the sewage and grey water entering the plant and the composition water exiting the units are monitored monthly (to determine plant efficiencies). Initially, STP Operations and Maintenance Manual stated that samples were taken weekly to make sure the units are operating correctly. In February 2013, Agnico reduced sampling frequency to once every two weeks and to once per month in May 2013. The reasons for this sampling frequency reduction are;

- Sampling data from the last three years certainly indicates that units are operating as designed and show little variability in the results;
- Raw sewage stream basically doesn't change;
- Operators do daily operational inspection and perform weekly maintenance and repairs, if necessary. The daily operational inspections identify problems efficiently and quickly and have proven to be as effective as sampling;
- If there is major problem or failure in the RBC it would be most likely due to changes in the influent (raw sewage) i.e. high strength sewage (BOD high) killing bacteria in the RBC. In this case, there would be visible effluent problems (part of daily operational checks), low dissolved Oxygen (part of daily operational checks) 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;
- RBC effluent is not discharged to the environment; and
- Sampling weekly or bi-weekly at this point is not necessarily and does not provide any more useful data than a monthly sampling and the daily operational checks provide.

Average results for 2012 are presented in Table 1 to provide an example of the characteristics of the raw sewage (influent) and the effluent discharged from the RBC treatment units. Sludge generated as a result of the treatment process is collected and disposed of with mill tailings in the TSF. All monitoring results are contained in Agrico's Annual Reports submitted to the Nunavut Impact Review Board and the Nunavut Water Board.

Table 1: Untreated and treated Water Quality from the STP (Influent and Effluent) – average for 2012

Parameter	Units	STP-IN (Influent)	STP-LJMIX (Effluent from combined LJ)	STP-SEP (Effluent from Seprotech)
BOD-5	mg/L	230	18	11
COD	mg/L	500	80	71
TSS	mg/L	161	27	21
Nitrate	mg N/L	0.02	24.17	22.12
Nitrite	mg N/L	0.01	1.29	0.45
pH		7.72	5.65	5.07
Total Phosphorus	mg/L	11.6	10.6	10.8
Ammonia	mg N/L	93	13.9	8.2
NTK	mg N/L	112	19.36	12.16
Fecal Coliforms	cfu/100 ml	4 846 666	721	84
Total Coliforms	cfu/100 ml	15 875 000	2458	1236

3 OPERATION AND MAINTENANCE

3.1 WASTEWATER COLLECTION

All sewage and grey water generated at Meadowbank is drained by gravity pipelines to a specific lifting station, then pumped through a heat traced insulated pipeline to the STP equalization tank. The number of lifting stations, and the building they service, is provided below.

- Lifting station 1 services the grey water generated from the kitchen grease trap, laundry room; this is strictly a grey water line that connects to lifting station 3;
- Lifting station 2 services the dormitory accommodations in trailer units # 1 to 11; this is the main sewage line;
- Lifting station 3 services the discharge line to the storm water management pond;
- Lifting station 4 services the service building; this line connects to the main line;
- Lifting station 5 services the mine operation office; this line connects to the main line;
- Lifting station 6 services the power plant; this line connects to the main line;
- Lifting station 7 services the mill; this line connects to the main line;
- Lifting station 8 services the assay laboratory; this line connects to the main line;
- Lifting station 9 services the dormitory accommodation in trailer unit # 12 and Site services building; this line connects to the main line;
- Lifting station 10 services the nova camp sewage;
- Lifting station 11 services the nova camp grey water; and
- Lifting station 12 services the gym and construction/training area.

In addition to the sewage generated from the buildings above, a sewage holding truck picks up sewage three times per week from storage tanks at the Exploration Camp, the Emulsion Plant, the old Nahanni lunch room, the north gate washroom, the primary crusher washroom, and the airport washroom. This material is deposited into Lift Station # 2 which flows to the treatment plant.

3.2 SLUDGE MANAGEMENT

Sludge from the STP treatment units is pumped and transferred to the TSF as required. Sludge and other settled solids is also removed from Lifting Station # 2 and deposited at the TSF as required.

3.3 STORMWATER MANAGEMENT POND

Agnico has built up the depth of this pond through construction of low permeability roadways around the perimeter of the pond. These roadways operate as dikes to increase capacity of the pond to better manage storm water and STP discharge flows. The treated sewage from the STP is pumped through a heat traced insulated pipeline to lifting station # 3 and then into the storm water management pond. The Stormwater pond is pumped to the TSF during the summer period.

3.4 NORMAL OPERATIONAL AND MAINTENANCE PROCEDURES

The sections below outline the general operational and maintenance procedures at the plant; further details are available in the manufacturers' operating manuals in Appendix A (Seprotech), Appendix B (Biodisk) and in the Site Services protocols and Procedures - Appendix D.

Agnico recognizes that in order to keep a properly functioning STP, certain material must be kept out of the influent raw sewage. These items are:

- Food and other kitchen grease are removed from the sewage in the kitchen via a grease trap. The grease trap is manually cleaned to keep this material out of the sewage treatment plant influent and the recovered grease is co-disposed with the mill tailings in the TSF.
- Camp rules and purchasing practices prohibit anti-bacterial soap products from being used on site to protect the biological activity in the RBC units.

3.4.1 Chemicals used in the Treatment Process

The dry bacteria product, BEC105, is used in the treatment process to stimulate biological activity when needed.

3.4.2 General Operation & Maintenance and Sampling Procedures and Frequency

The STP at Meadowbank went into operation in May 2008. The following are the general Operation & Maintenance and sampling procedures that have been employed since the plant's start up. Further details of Operation & Maintenance procedures are provided in the equipment operating manuals and in Site Services Protocols and Procedures (Appendix A, B, and D).

Daily

A daily inspection of the sewage collection system, heat traced pipelines, and treatment plant is conducted to ensure there are no spills or incidents to report.

Inspection and sampling sheets are completed every second day for each of the RBC units; these forms include:

- Daily weather observations;
- Discharge volumes;
- Turbidity;
- Dissolved Oxygen and pH measurements in the final discharge of the treatment units; and
- Visual observations of the final discharge.

Example daily/monthly record sheets are provided in Appendix C.

Weekly

Maintenance inspections and repairs, if necessary, of bearings, pumps and hoses in the STP are conducted weekly.

Monthly

Influent (sewage and grey water) and effluent sampling of the final discharge from the Seprotech and Biodisk RBC units is conducted monthly. Parameters include:

- Ammonia
- Ammonia-nitrogen
- Total Kjeldahl Nitrogen
- Biological Oxygen Demand (BOD_5)
- COD
- Nitrate
- Nitrite
- Faecal Coliforms
- Total Coliforms
- pH
- Total Suspended Solids
- Total Phosphorus

Sample monitoring for Phosphorus in the treated effluent has been discontinued because the units do not have Phosphorus removal capability. Agnico will continue to monitor Phosphorus in the influent sewage.

Every 6 Months

An inspection of the chain linkage in the RBC units will be conducted every 6 months and the gear oil is changed.

Annually

On an annual basis, each of the tanks will be pumped out for maintenance and cleaning purposes. Depending on the accumulation of sludge in the tanks it may be done more often or as required.

3.5 RECORD KEEPING

Records of the operational and maintenance and sampling procedures are kept daily in order to assist in the evaluation of the effectiveness of the sewage treatment plant.

The following is recorded on a daily basis:

- Volume of any effluent discharged to the Stormwater Pond;
- Sewage volume collected; and
- Details of any maintenance undertaken at site.

The record sheets are kept in the Sewage Treatment Plant office.

3.6 SAFETY PROCEDURES FOR OPERATORS

Employees working in the STP facility must be trained prior to commencement of 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 two very important safety rules:

- No person shall drink the water in the plant or the water that is discharged from it;
- Working with sewage requires adequate protection for operators. This includes wearing steel toed boots, hard hat, safety vest, protective glasses and protective gloves; and
- All authorized personnel working in the STP must have received Hepatitis A and B vaccine.

Eye and hand wash are located in the plant for use in the event of accidental contact with unprotected hands or face due to splashing or other causes.

3.7 CONTROLLING ACCESS TO STP

Access to the STP at Meadowbank is restricted to authorized personnel only. All doors to the plant are locked, with only authorized persons having keys. Signs are posted on the STP entrance doors notifying all people that the entrance to the STP is for authorized personnel only.

No fencing is used to control access to the STP. Due to the remote nature of Meadowbank, there is no concern of non-mine personnel attempting to access the site.

4 EMERGENCY RESPONSE

4.1 FIRE

In case of fire at the STP, the on-site emergency response team would be notified as per Agnico protocol. Instructions from the on-site emergency response team would be followed by all personnel at the STP. Further details of fire response are provided in the "*Emergency Response Plan*".

4.2 SPILL

In the event of a spill at the STP, the on-site emergency response team would be notified as per Agnico protocol. Instructions from the on-site emergency response team would be followed by all personnel at the STP. Further details of spill response are provided in the "*Spill Contingency Plan*".

4.3 PLANT MALFUNCTION

In the event of a failure of one of the three operating RBC's (i.e. Seprotech and 2 LJ100's) there is a backup LJ100 unit available at all times.

The following other contingent measures can be applied by Agnico in the event of an RBC malfunction at the Meadowbank Sewage Treatment Plant for more than 24 hours:

- Cut back on allowable camp water until the malfunction is corrected and use the equalization tank to retard the peak flow to the remaining RBC unit;
- Shut down the malfunctioning RBC unit until the malfunction is repaired and use only one of the two parallel units until repairs are completed;
- Shut down all water use in the camp until the repairs are complete; and
- Bypassing untreated STP influent around the malfunctioning RBC 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. This will require the coincidental restriction of water use to minimize the volume of untreated influent being bypassed.

Appendix A: Seprotech Operation and Maintenance Manual

Seprotech Systems Incorporated
2378 Holly Lane, K1V 7P1
Ottawa, Ontario, Canada
Telephone (613) 523-1641
Fax (613) 731-0851

INSTALLATION, OPERATION AND MAINTENANCE

MANUAL

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IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.0 SITE INSTALLATION OF ROTORDISK® SEWAGE TREATMENT PLANTS:

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.1 - Concrete Tankage for ROTORDISK®

If the ROTORDISK® unit supplied is to be encased in concrete tankage, the site preparation is as follows:

The unit is lowered into the concrete tankage, the pipe at the end of the unit is placed into the opening of the intermediate wall between the primary and final settlement chambers and lowered onto the anchor bolts (contractors supply).

Unit is to be lifted only at lifting points by use of hooks and spreader bars.

All anchor bolts (contractors supply) should be correctly located in concrete in a vertical position. In addition, all bolts should include a levelling nut.

All anchoring and levelling of ROTORDISK® unit on site is to be done by customer/contractor. When the unit is set onto the anchor bolts in the concrete tank, it must be levelled to a slope of no more than 3/4" in 20' along the length. The unit is then centred in the tank and completely bolted down.

After the unit has been bolted down, check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied. (As shown)

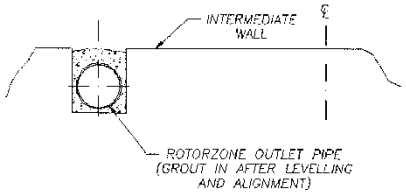


Figure a - **ROTORDISK®** tank outlet through intermediate wall between settlement tank chambers.

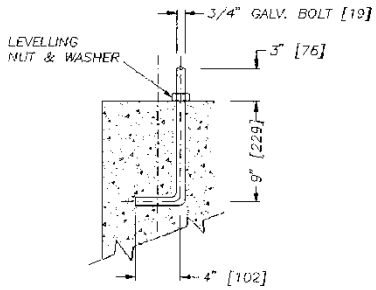
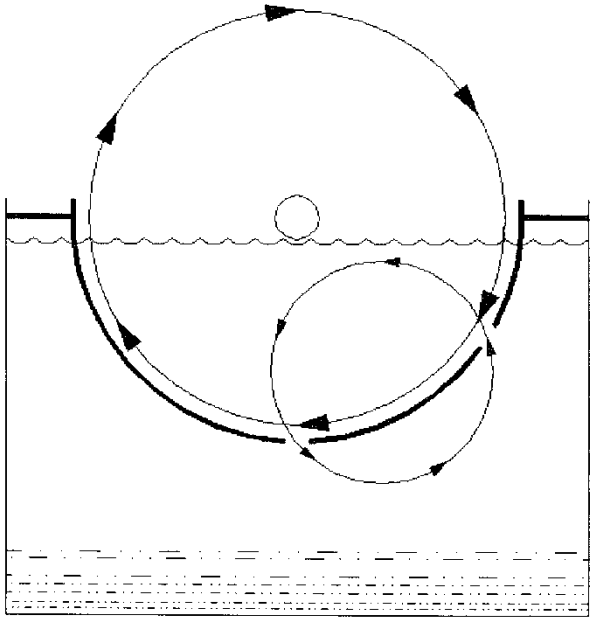


Figure b - anchor bolt detail for **ROTORDISK®** tank.

1.2 - DIRECTION OF SHAFT ROTATION



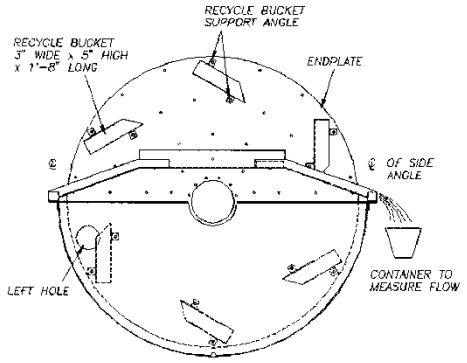
The direction of shaft rotation should be such that disks mounted on shaft will enter water on the side where inlet to "Rotorzone" is located. The electric motor driving the shaft should be wired accordingly.

1.3 - RECYCLE for ROTORDISK®

1.4.1 Recycle buckets are mounted on the last stage of the ROTORDISK®. These buckets rotate at the same speed as the disks. See the attached elevation view of the recycle buckets and trough on the Rotorzone tank.

1.4.2 As the disks rotate, the buckets scoop-up treated wastewater. As this wastewater falls into the recycle trough, it is exposed to the atmosphere, where it absorbs fresh oxygen. The wastewater then cascades on one side of the trough through a narrow steel channel and mixes back with the contents of the Primary Clarifier, thereby introducing fresh dissolved oxygen in the Primary Clarifier. See the section of diskbank assembly showing buckets and recycle trough.

1.4.3 The set-up described above is comprised of the recycle buckets and recycle trough, is what we term as our D.O. re-circulation device. This is especially advantageous to preventing septic conditions from occurring in the Primary Clarifier in small flow or low flow situations.



SECTION OF DISKBANK ASSEMBLY SHOWING 8 BUCKETS AND RECYCLE TROUGH

1.4 - SUMMARY OF OPERATION

(ROTORDISK® systems designed for BOD/SS/Ammonia/Nitrate removal)

The sewage plant (as supplied by SEPROTECH SYSTEMS INCORPORATED) is comprised of three (3) main components: the primary settling tank, the RBC tank, and the secondary settling tank.

Raw sewage is pumped and/or gravity flows into the primary settling tank (PST). When the sewage is pumped into the plant, pumping must simulate conditions encountered in gravity fed systems. Indeed, over a 24-hour period, the plant is designed to handle a flow rate corresponding to the Average Daily Flow (ADF) and can accommodate for two Peak Daily Flow (PDF) periods of two (2) hours per day. Each PDF event can be at a maximum of three times ADF.

In the PST, sedimentation separates heavy solids from the bulk of the liquid and the supernatant enters the aerobic section through the inlet slot located at the front section of the RBC tank.

The aerobic section is made up of four stages. The 1st stage is mounted on one common shaft. This 1st stage is comprised of one (1) to three (3) disk banks. The normal colour of the bacteria in the 1st stage is dark brown. This is the stage where most of the BOD removal by biological oxidation occurs. The succeeding 2nd, 3rd, and 4th stages are mounted on the rest of the shaft or another common shaft. Each stage has one (1) to three (3) disk banks. It is in the 2nd stage that further BOD is removed, and if the BOD is removed to approximately 30 mg/l, nitrification will follow. As such, in the 3rd stage, nitrifying bacteria (those which convert ammonia (NH_3) in the form of ammonium ions (NH_4^+) into nitrite (NO_2^-) and, ultimately, nitrate (NO_3^-) predominate in the 3rd and 4th stages. The 4th and last aerobic stage has recycle buckets that introduce both fresh dissolved oxygen into the primary settling tank and nitrifying bacteria present in the recycled water.

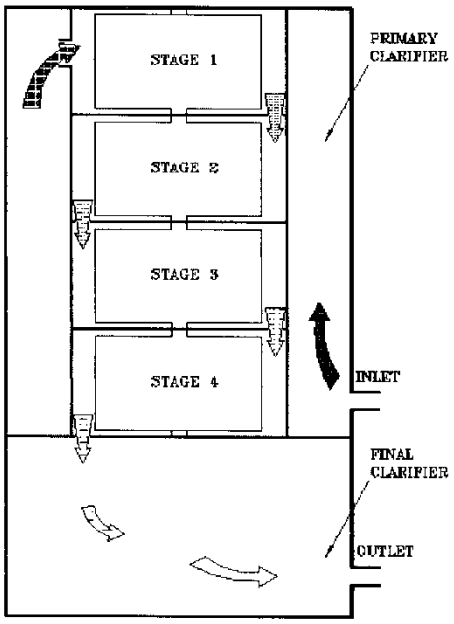
The rotation of the disks in and out of the water provides a mean of air and heat transfer from the ambient air to the water. The transfer of air to the water is important for aerobic bacteria to remove BOD and ammonia. The transfer of heat to the water is important to maintain the water at an optimum temperature of 15 °C and above such that BOD and ammonia removal rates by the bacteria are maximized (removal rates are a function of the water temperature). Because maintaining a temperature that provides acceptable removal rates is important to the process, RBC's are installed indoors and ambient air is maintained at 15 °C and above.

In the secondary settling tank, remaining suspended solids as well as sloughed off biomass from the disks settles and is pumped to the primary settling tank via sludge return pumps.

Chemical dosing of alum facilitates the coagulation and flocculation of aluminium phosphate resulting in the removal of phosphorus. Sodium bicarbonate can be used to maintain the pH balance throughout the process.

2.0 - ROUTINE VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS

ROTORDISK® sewage treatment plants have three major steps in the purification process. In the primary settling tank, gross solids separate from the flow by either sinking or floating. In the Rotorzone, dissolved pollutants are broken down to simple, non-pollutant compounds by the bacteria ("biomass"), which grows on the rotating disks. The final settling tank permits gravity separation of spent biological growth, which continually sloughs off the disks in the Rotorzone preceding it.



2.1 - PRIMARY SETTLING TANK (PST OR PRIMARY "CLARIFIER")

The accumulation of floating scum on the surface of the primary clarifier is normal. It is proportional to the accumulation of settleable solids at the bottom of the tank. Periodic (9-12 months) removal of sludge at the bottom of the tank is required for proper operation of the Unit.

If no sludge, measuring device is available; the accumulation of 9"-12" depth of scum on the surface is a good indication that it is time to remove the accumulated deposits of sludge from the bottom of the tank(s).

2.2 - ROTORZONE

The Rotorzone is subdivided into four sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the final settling tank.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the unit. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

2.3 - 'BATHTUB RING'

The wastewater flows by gravity within a ROTORDISK® Plant thus the water level is relatively constant. Changes in water level of 1" to 2" are not unusual due to surge flows entering the unit. The evidence of this is a 'bathtub ring' 1" - 2" above the normal level. A 'bathtub ring' higher than this, suggests partial or complete flooding of the unit has occurred since the last check. If so, the (gravity or pump) discharge system should be checked for blockages or mechanical malfunction. Another condition, which can lead to the level of water rising to levels greater than 1" – 2"; is if the plant is fed by pumps, which exceed, the design limits of the plant (i.e., ADF over a period of 24 hours including a maximum of two (2) PDF events no longer than 2 hours each).

2.4 - FINAL SETTLING TANK (FST OR FINAL "CLARIFIER")

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. Clarity can best be judged by scooping a small volume of the final effluent into a clear glass container. This is particularly true of larger units where the depth and dark colour of the tank walls may make clarity hard to determine. (Note: Although the risk of infection is very small, the wearing of rubber gloves is a rational safety precaution when hand-scooping the effluent for a clarity check. This is particularly true if there are open cuts on the hands.)

Although the final effluent itself should be relatively clear, some floating matter may accumulate on the surface of the final clarifier. This is normal, and will typically be much less than the accumulation of floating scum in the primary clarifier.

2.5 - MONITORING OF DISCHARGE FLOW RATE

The plant is equipped with a flow meter located on the influent pipe. This instrument is equipped with a counter that allows tracking of the total volume of clean effluent discharged by the plant.

2.6 - OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL

Sludge pumps should be set to operate for 15s every 3h. Making changes and adjustments to the default plant's operating parameters requires a good understanding of the wastewater treatment process and should therefore only be performed by qualified and trained staff. Please contact SEPROTECH SYSTEMS INCORPORATED if assistance is needed to optimise the operation of the plant.

2.7 - FREQUENCY OF INSPECTION

Visual checks every week should be sufficient. However, for better preventative maintenance of the wastewater treatment plant and thus the capital investment, a daily walk through is often the preferred frequency of visit. Many owners prefer the visual and audible (look and listen) walk through. A standard operator checklist should be prepared and used by the person responsible for periodic maintenance of the plant at every visit. SEPROTECH SYSTEMS INCORPORATED can assist in preparing such checklist upon request.

3.0 - STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL

3.1 - STORAGE CAPACITIES

A design feature of ROTORDISK®, which contributes greatly to overall simplicity of the process, is the sizing of clarifiers to accommodate static internal sludge storage for extended periods. Depending on such factors as raw wastewater solids concentrations, and design organic loading in a given application, maximum sludge storage levels will typically be reached in 6-9 months of operation.

This period is based on calculated rates of initial decomposition of raw and biological solids, and, upon operating experience, indicating the degree of auto-digestion/compacting, which proceeds during the storage period. The 6-9 month period will be shortened to the extent that design hydraulic and waste loads are exceeded. It will be lengthened to the extent that flows and waste load are less than those designed for.

3.2 - DETERMINATION OF ACCUMULATED SLUDGE VOLUMES

The accumulation of maximum storage capacities can be indirectly monitored through visual observation of the thickness of the scum blanket on the surface of the primary clarifier. When the scum blanket has matured to a height of approximately 7"-10", this is a good indication that sludge accumulations at the bottom of both clarifiers are at or near maximum levels, and that sludge withdrawal is indicated.

A more accurate procedure of determining sludge levels is to directly measure actual accumulations, and compare these to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the ROTORDISK® model in question.

A variety of sludge measuring devices is commercially available. The two most common are the weighted hollow tube type, and, the (electronic) turbidity-change detector type. The former is less

costly, relatively easy to use, and more appropriate because of the low frequency with which measurements need to be made in a ROTORDISK® unit.

Whatever means of measuring the sludge may be selected; it must be kept in mind that the sludge is not a firm solids substance. Domestic wastewater sludge is mostly trapped water and other liquids. Only to determine sludge levels by "feeling" for a solid layer with a stick or pole. The settled sludge is far more liquid than the surface scum, which is perhaps 30-40% solids, by volume.

Irrespective of the type of device used, sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone trough.

Once an average sludge height has been determined, multiply by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

3.3 - SLUDGE REMOVAL

A pump-out truck of the same type that pumps out septic tanks normally does the sludge removal. For smaller ROTORDISK® units, the entire liquid contents of the treatment plant can be withdrawn. For larger installations, the haulage contractor should be instructed to get the suction hose directly to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible. Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank to expose the secondary sludge. The suction hose should be placed down at a multiple number of points to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed. Haulage contractors should be given a brief description of the unit and its operation if they are not already familiar with it. A particular point to emphasise is that the biological growth on the disks should not be washed off, but should be left in place. The exception to this is if the disks have accumulated excess biomass due to sludge pump out being delayed past the indicated intervals.

Sludge removed from the unit is normally hauled away by the pumping truck and disposed of at municipal facilities, or, by controlled spreading on farmland. On-site disposal in shallow trenches and/or some form of on-site volume reduction (prior to export) may be feasible or desirable depending on the specific opportunities and limitations afforded by the site of a given installation.

3.4 - POTENTIAL CONSEQUENCES OF OPERATING ROTORDISK® UNITS PAST DESIGNATED MAXIMUM SLUDGE STORAGE LEVELS

Sludge accumulations should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. The potential for problems is as described below and depicted in the attached sketches.

Figure (c) shows a unit operating with sludge build-ups at or near maximum storage levels. This will cause no problem since the storage heights are designated so that flows through the primary clarifier will not disturb the sludge layer. Characteristics of wastewater reaching the Rotorzone at this time (and since start-up) will be in the range of 180-200 mg BOD/l and 50-250 mg SS/l. The

supporting structure of the rotating assembly is over designed for the amount of biological build-up which will occur on the disks under this operating condition, and the shear force of the rotation through the trough water will limit the thickness of growth.

However, if sludge is allowed to accumulate past designated storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone which are not anticipated in the design of the unit (Figure d). The pollutant load reaching the biomass on the first stage of disks will overload that biomass (in terms of F:M ratio), and force a change in its activity and growth. The biomass becomes more gelatinous, and does not shear off as well with disk rotation. Additionally, the biomass will readily adsorb and entrap the extra solids with the sum effect being an increase in weight on the rotating assembly that considerably exceeds that which its design is based on.

This tendency reaches its extreme if sludge is allowed to accumulate to the point where it will be disturbed by-, and caught up in -, the re-circulation pattern created by the two slots in the trough on the first section of the Rotorzone (see Figure e).

The sludge will have characteristics in the order of 20,000 mg TSS/l and 10,000 mg BOD/l, so it is obvious that even a minor amount of this material caught up in the re-circulation flow will significantly increase the concentration of the waste stream entering the Rotorzone. If, for example, the sludge was caught up in the recycle flow at a ratio of as little as 1:10 or 1:15, the resulting concentration would be sufficient to produce a considerable first-stage overload on an amount of disk area selected based on normal concentrations.

The resulting build-up of poorly-shearing gelatinous biomass and trapped solids would pose a serious potential for strain on the drive unit, and for structural damage to disk bank assemblies and shaft, in spite of them being considerably over designed for loads anticipated in normal operation.

Clearly, these potential problems should be avoided by the removal of sludge once it reaches the level specified as maximum for the ROTORDISK® unit in question.

3.5 - FRONT VIEW SCHEMATIC OF ROTORDISK®

UNIT OPERATING AT-, AND ABOVE-,
RECOMMENDED MAXIMUM SLUDGE STORAGE LEVELS

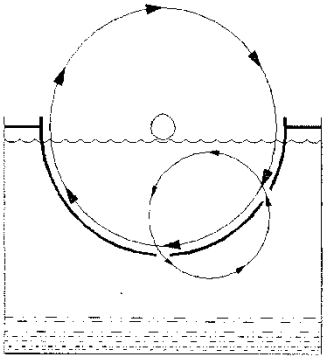


Figure c-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

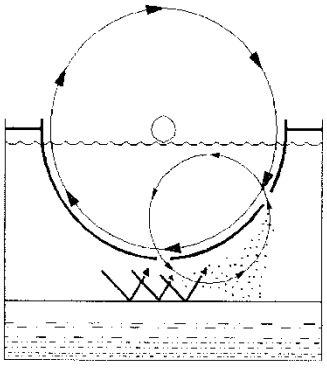


Figure d- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.

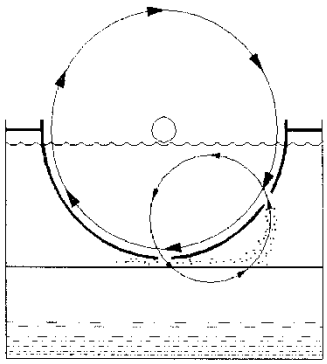


Figure e-Unit operating with excess sludge accumulated to base of Rotorzone. Both influent flows and re-circulation flows will disturb and carry sludge solids. Increase in BOD and solids loads entering Rotorzone will be substantially above design treatment levels, increase accumulated masses on rotating assembly, produce potential for damage to structure and drive unit.

3.6 - PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS (summary)

Using suction hose, floating or surface scum should be removed first. Place the suction hose directly to the bottom of the tank and withdraw sludge only, while taking as little as possible of the volume of waste liquid above the sludge blanket (supernatant).

Move the hose at a multiple number of points along the bottom of the settlement tanks. Do not wash off biological growth (biomass) on the disks. The exception to this is excess accumulated biomass on the disks due to an overdue sludge pump-out. Excess accumulated biomass is when a disk bank is 100% fully covered with biomass and the colour is grey with a slight odour.

Keep a record of all pump-outs to arrive at an actual normal operating interval for sludge pump-outs. For systems with several flow meters, it is also beneficial to note the total flow generated between pump-outs.

3.7 - START-UP PROCEDURES OF ROTORDISK®

WARNING: A VALVE LOCATED AT THE BOTTOM OF THE DENITRIFICATION TANK AND EQUIPPED WITH A REMOTE ACTUATION MECHANISM WAS PROVIDED WITH YOUR UNIT. THIS VALVE:

- Needs to be OPEN: when the plant is first filled with water, during draining if the plant ever requires such operation and during subsequent refilling operations. FAILURE TO OPEN THIS VALVE DURING FILLING AND DRAINING WILL RESULT IN SERIOUS DAMAGE TO THE PLANT. This is because, during a filling operation, the water rising in the PST would push the denitrification tank upwards while it is empty (this tank wouldn't have had a chance to fill with water until the water level reaches the inlet slot between the PST and the aerobic ROTORDISK®. Th open valves provide a mean of filling the PST and the through (denitrification tank included) at the same time.

- Needs to be CLOSED: during normal operation of the plant. Indeed, the denitrification section contains water already partly treatment thus this water and that contained in the PST shouldn't mix. FAILURE TO CLOSING THIS VALVE DURING NORMAL OPERATION OF THE PLANT WILL RESULT IN A POOR QUALITY EFFLUENT.

The ROTORDISK® sewage treatment plant is based on a fixed film treatment process referred to as the Rotating Biological Contactor (RBC). In this process, micro-organisms or bugs are attached and grown on the surface of a media, the quantity of bugs being directly proportional to the amount of food in the wastewater. When starting up a new system, it will normally take about two weeks to get organic removal from the wastewater and three to four weeks to establish the nitrification process at normal domestic sewage temperatures. The method of and effluent discharge during system start-up should be discussed and thoroughly communicated with the environmental authority. The primary sedimentation tank and RBC of the system should, preferably, be filled with fresh water before admitting wastewater to the system. A flow less than design is not a problem. The biomass will develop themselves on the media. If there is a small flow only a portion of the disk will have biomass. As the flow increases the amount of biomass will increase.

Seeding a ROTORDISK® with activated sludge, although not required, can be accomplished. The activated sludge should be at the same temperature as the influent. Sudden changes in wastewater temperature cause biomass sloughing. In most cases, the use of domestic waste as a seed culture has provided the required biomass for continuous operation. When seeding the ROTORDISK® with activated sludge is decided, the primary sedimentation tank and RBC of the system should first be filled with fresh water (preferably) and the activated sludge added to the RBC. The RBC should be rotating at all times. The wastewater introduced to the tank needs to have only 20% of the disks covered with waste. This can already provide the needed wetting and still provide some time to reach normal operating levels when source flow is introduced. The final clarifier does not need to be filled with anything.

Alternately, seeding can be accomplished using dry bacteria and a source of organic carbon such as raw molasses or sugar. This can be done, for example, in situations where wastewater or activated sludge are not available and the plant needs to be ready to treat wastewater very shortly after it begins receiving it. By simulating the conditions encountered in wastewater (where large amounts of organic carbon and bacteria are present), biomass will establish on the ROTORDISK® and the plant can thus be prepared to work under actual conditions before these are actually encountered. SEPROTECH SYSTEMS INCORPORATED can help find appropriate supplies of both dry bacteria and raw molasses.

The preferred start up is the introduction of source wastewater at design or less than design loading. The disks need to be rotating at all times. When the disks are rotating and wastewater is introduced the biomass will develop and the pollutants will be removed.

The practice of starting up a sewage plant with a charge of septage or activated sludge may be appropriate for suspended growth systems where sludge return is an essential and necessary part of the process. However, start-up with septage is not an appropriate practice for fixed film systems such as the Rotating Biological Contactor process and is not recommended. This is especially true of the ROTORDISK® process and its static, internal storage of sludge.

Studies have shown that the natural start-up time for a ROTORDISK® is 2 1/2 – 3 weeks (normal temperatures and BOD reduction only), and that it has already developed sufficient biomass for 50% removals in only 1 week. These are time frames significantly shorter than respective ones for suspended growth systems. Thus there is little rationale for "pre-starting" a ROTORDISK® unit with septage.

Further, septage contains solids that are already well digested, and therefore not subject to further digestion-compaction in the storage zones. This contrasts to the fresh solids, which will undergo considerable digestion-compaction in the 6 – 9 months after initial settlement. Therefore, a charge of septage would contribute disproportionately to the accumulation of sludge levels, and necessitate a shorter interval to the first pump-out of the unit.

The ROTORDISK® concept of static sludge storage contributes greatly to its overall operation and maintenance simplicity. Following the above guidelines and recommendations will help ensure that the trouble-free simplicity of ROTORDISK® is maintained.

4.0 - STORAGE OF ROTORDISK® SEWAGE TREATMENT EQUIPMENT

If the unit is not to be operated for an extended period, then the motor-reducer assembly (drive unit) should be removed from its mound and stored at room temperature in a reasonably dry area (unless the whole unit is being stored in such an area).

Additionally:

1. Reducer: The input shaft should be given several turns once a month to re-lubricate the upper bearings.

NOTE: Some reducers are shipped to site filled with synthetic lubrication. Otherwise, fill the reducer with the lubricant (see reducer section of installation & maintenance instructions).

2. Motor: The motor has a tendency to take on moisture when not in operation. It requires no attention during storage, but before it goes into operation the insulation should be measured using a Meger. It should be at least 1.0 mega-ohm. If below 1.0 mega-ohm, it has taken on excessive condensation, and must be dried out before being operated. (Note: any electrical contractor or repair shop commonly understands these terms and procedures).

3. Support bearings on main ROTORDISK® shaft(s) should be re-lubricated prior to start-up.

4. The system should not be installed and operated in water. In the absence of sewage inputs and normal biological activity, freezing and consequent mechanical damage would be a distinct possibility. Water level in the primary settlement tank to be dropped to below the bottom of the Rotorzone tank level, if freezing of the tank contents is possible.

5.0 - ASSEMBLY PROCEDURE OF ROTORDISK® COMPONENTS SUPPLIED BY SEPROTECH SYSTEMS INCORPORATED

1. Upon receipt of mechanical components:

   a. Check packing list for any missing items on delivery.

   b. Motor/Reducer is shipped loose, for assembly on the reducer flange. The reducer is shipped completely filled with synthetic lubricant.

   c. Bearing components are shipped as a set. Open only when ready for assembly to avoid moisture contamination.

   d. Chain and sprockets are shipped as a set. Check for the following:

   -Large sprocket bushing (O.D.) fits into the large sprocket bore.
   -Large sprocket bushing bore (I.D.) fits the Rotordisk® shaft drive end.
   -Small sprocket bore (I.D.) fits on the reducer output shaft.
   -Cottered chain fits or matches the teeth on the sprockets.

   e. Coupling (applicable only to split-shaft ROTORDISK® is shipped as a set. Check the coupling hubs to ensure they fit the center stub ends of the ROTORDISK®shafts.

f. Disk banks are shipped pre-assembled on the shaft by SEPROTECH SYSTEMS INCORPORATED and are shipped on A-frames. Handle with care, as the Fiberglass of the disk banks is brittle.

g. Hardware (bolts, nuts, washers) for mounting the following items are provided:

-Bearings
-Reducer
-Recycle trough

2. If, for any reason, the diskbanks must be removed from the shaft, the procedure for remounting them is as follows:

If disk banks are 5 ft. in diameter or larger (supplied in semicircular sections)

Mount them on shaft(s) as shown on Dwg.# GL-28D, with 1/2-20NFX1-1/2 Bolts. Connect two half sections with two connecting plates (see sketch of typical mounting details) Remove outer nuts on required tie rods, fit connecting plate on tie rods over the end plates, then fasten them together with nuts and washers.

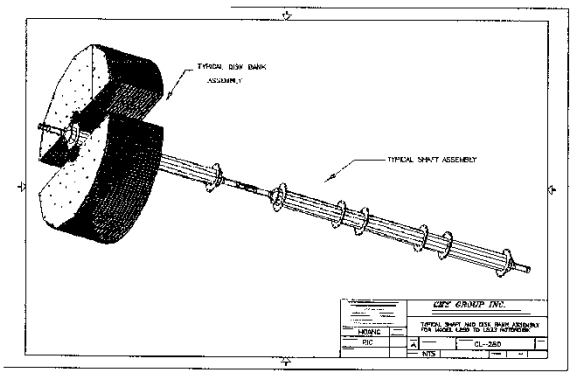


Figure f - typical mounting of disk banks on the shaft(s).

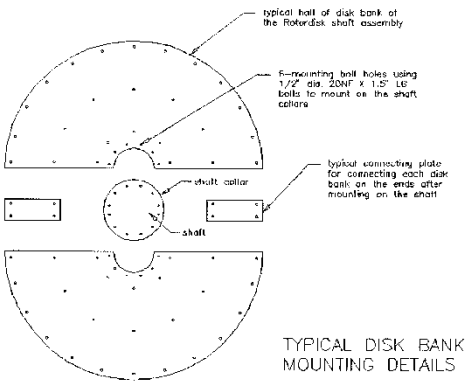


Figure g - exploded view of disk bank mounting parts.

3. Mount Bearings on Shaft(s).

   a) Bearing should be mounted at the centre of stub end. Follow bearing manufacturer's installation instructions.
   b) Use of the bearing fixing rings: one bearing of each pair is "fixed", the other "floating". Install the fixed bearing on the drive end of the shaft and the floating bearing on the non-drive end.

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in the manual, using a bearing locking tool or equal. See installation, operation and maintenance instructions section of this manual regarding bearings.

4. Mount coupling hubs on their respective shafts (if applicable) so that hub face is flush with the end of its shaft (for direct drive and 'L' models). See installation, operation and maintenance instructions section of this manual regarding couplings.

5. Install shaft(s) in ROTORDISK® tank.

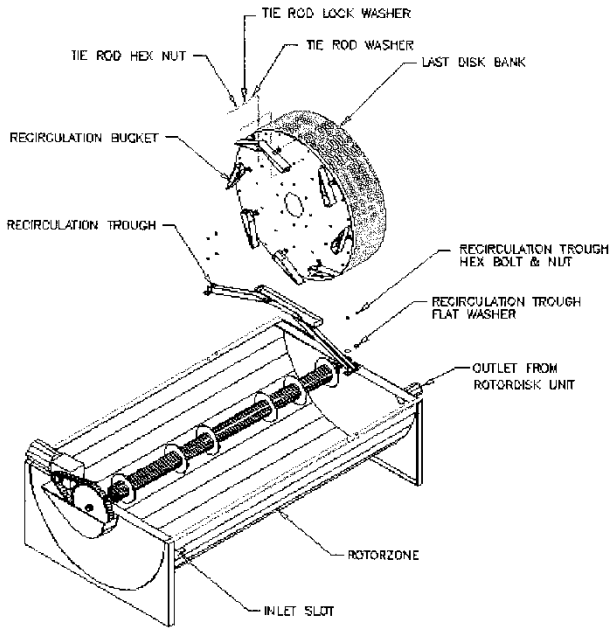
6. Mount small sprocket/coupling hubs on reducer output shaft (whichever is applicable).

7. Install Reducer-Motor Assembly in place. The reducer comes completely filled with synthetic lubricant. Ensure that the breather plug (mounted on top of one of the reducer oil intake ports) is installed on the reducer, after it is mounted on the ROTORDISK®. It is recommended that the motor be mounted into the reducer prior to assembly into the ROTORDISK® tank. Allow for some play in the reducer mounting bolt tightness so the chain tightness can be adjusted later.

8. Connect sprockets with chain. Check the axial alignment of the sprockets while tightening the chain. Tighten the previously loosened reducer mounting bolts after the sprockets are aligned and set in place. See installation, operation and maintenance instructions section of this manual regarding roller chain drives.

9. Connect two coupling hubs, grease, and fit coupling cover (if applicable). Before mounting, check bore on both hubs to match the shaft diameter. See installation, operation and maintenance instructions section of this manual regarding couplings.

10. Mount the stainless steel recycle trough on the ROTORDISK® tank with the bucket opening points to the proper rotation of the shaft.



NOTES:

1. Follow manufacturers instructions in the "Installation, Operation & Maintenance Manuals" included by SEPROTECH SYSTEMS INCORPORATED for mounting bearings, couplings (if applicable), reducer, sprockets and chain (if applicable).

2. Make sure all setscrews on sprockets and coupling hubs; bolts on reducer and bearings, are all well tightened before machine goes into operation.

6.0 - ROUTINE MECHANICAL MAINTENANCE OF ROTORDISK® SEWAGE TREATMENT PLANTS

6.1 - MOTOR:

If motor is equipped with grease fittings and relief plugs, it should be re-lubricated using a low-pressure gun once a year with Shell Alvenia R2" grease (DO NOT OVER-LUBRICATE). There is no lubrication required for motors without grease fittings and relief plugs

6.2 - REDUCER:

Reduction gear on ROTORDISK® units is filled with synthetic long life lubricant. No inspection or maintenance outside of periodic visual inspection is normally required. If there are no evidence of oil leaks on the seals, the synthetic lubricant must be changed every five (5) years for ROTORDISK® units running 24 hours a day.

Reduction Gear on medium and large ROTORDISK® size units are filled with Shell Tivela 75 oil and does not require oil changes (permanent lubrication). Periodic visual inspection is required. Check oil level and top up to required level with same oil, if necessary.

6.3 - BEARINGS:

Lubricant will deteriorate in time and rate of deterioration is a function of the operating conditions encountered. Lubrication cycle can be determined by analysing the samples taken near the bearing. See bearing manufacturer's maintenance instructions.

6.4 - SPROCKETS AND CHAIN:

(Applicable to non-direct drive ROTORDISK® units)

Chain drive should be inspected every six- (6) months for following points:
- If Chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated.
- Inspect oil for contamination, such as chips, dirt or grit. Replace oil if necessary (Oil with viscosity of SAE30 at ambient temperature 40° to 100° F is recommended).
- Milky white colour of the oil is indicative of flooding. Replace oil and determine the cause of the flood.
-Check Chain tension and adjust if required.

6.5 - COUPLING:

(Applicable for direct drive ROTORDISK®)

Coupling should be checked for lubricant level. Lubricant is to be added if required. Re-lubrication with NLGI#2 or LTG Grease once a year is usually adequate.

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. Bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. Chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

7.2 - ROTORDISK® PROCESS

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
1. Slime on media appears shaggy with a brown colour	PROPER OPERATION	NO PROBLEM. NORMAL CONDITION
2. Black slime growing on disks	Solids and/or BOD overloading	a. Pre-aerate RBC influent b. For severe organic overloads, increase recycle rate c. De-sludge unit d. Place another RBC unit in parallel
3. Rotten egg or other obnoxious odors	Solids or BOD overloading	See Problem 2, solutions a, b, c and d, above
4. Development of odors and white biomass over most of the media surface	1. Septic influent wastewater or high hydrogen sulfide or sulfate concentration	a. Determine the cause of the problem and correct it at source. For example, aerate equalization tank b. Pre-aerate influent wastewater c. Determine the cause of the problem, possibly with the addition of chlorine or hydrogen peroxide; potassium permanganate has also been used
	2. Overload first stage	a. Check dissolved oxygen levels to confirm overload problem b. Increase number of recycle buckets
5. White slime	1. Bacteria that feed on sulfur compounds. Also, industrial discharges containing sulfur compounds may cause an overload	▪ See Problem 2, solutions a and b above
	2. Grease on the disks	a. Remove grease at source b. Install grease traps
6. Sloughing or loss of slime (biomass)	1. Toxic or inhibitory substances in influent, including abrupt pH changes	a. Eliminate source of toxic or inhibitory substances b. Reduce peaks of toxic or inhibitory substances by carefully regulating inflow to plant c. Dilute influent using plant effluent or any other source of water d. See Problem 7.4
	2. Variation in flow or organic loading	a. During low flow or loading periods, pump from secondary clarifier or 4th stage RBC unit effluent to recycle water with food and dissolved oxygen through the RBC unit b. During high flow or loading conditions, attempt to throttle plant inflow during peak periods c. For severe organic under loads, add a cheap source of soluble carbon in the PST such as molasses

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
7. Decrease in process efficiency	1. Reduced wastewater temperature	a. Decrease air opening in RBC building b. Heat air inside RBC unit cover or building
	2. Unusual variations in flow or organic loading	▪ See Problem 6, cause 2, solutions a and b above
	3. Sustained flows or loads above design levels	▪ Install additional treatment units
	4. High or low pH values	▪ Adjust pH to near neutral
	5. Improper rotation of media	▪ Inspect chain tension and adjust
8. Accumulation of solids and clogging in the RBC system	Solids removal in pre-treatment steps is not adequate	a. Improve pre-treatment efficiencies b. Provide supplemental aeration to help prevent solids from settling c. De-sludge primary tank
9. Floating or rising sludge in the secondary clarifier	Removal of sludge from the clarifier is inadequate	a. Increase the duration of pumping sludge from the clarifier b. Remove sludge from the clarifier more often
10. Excess shaft weight or biomass thickness	1. Organic loading too high	▪ Decrease organic loading
	2. Stage loading too high	a. Increase number of recycle buckets
	3. Inorganic solids accumulation because of inadequate pre-treatment	▪ Check primary treatment and grit removal equipment for proper operation
	4. Accumulation of minerals	▪ Use chemical pre-treatment to eliminate minerals
	5. Digester supernatant adding excessive BOD or sulfides	▪ Modify supernatant pumping frequency
11. Shaft rotation non-uniform or "jerky"	1. Normal variations in balance	▪ Time rotation by quarters. A difference of less than 3 seconds in quarter rotation time is normal
	2. Uneven biomass weight due to power outage	a. If severe, shut unit down and wash down disks b. Turn off the unit temporarily and rotate manually to uniformly wet biomass growth before restarting c. Decrease or stop flow of wastewater to affected units d. Contact manufacturer for assistance

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
12. Effluent quality apparently below requirements	1. Organic loading too high	a. Add additional operating RBC's b. Identify cause of additional loading and eliminate at source c. Add supplemental air to RBC trough
	2. Sampling or testing procedures inaccurate	a. If nitrification is occurring, analyze for carbon BOD only by using nitrification inhibitor b. Check for contaminated dilution water, sampler lines, or improper sampling storage
	3. Inadequate secondary clarifier operation	a. Clean and de-sludge clarifier b. Modify sludge removal procedures to eliminate BOD kickback c. Install filters after clarifier d. Increase alum dose to enhance flocculation
	4. Anaerobic solids in the RBC tanks producing BOD kickback	▪ Flush or drain tanks
13. Snails or other nuisance organisms in RBC tanks	Nutritional and conducive environment for reproduction of hard-bodied shell snails ($^1/_8$" - $^1/_2$" in size)	a. Addition of controlled dosages of chlorine. Physical removal may be required with taking units out of service temporarily b. Contact manufacturer

Contact SEPROTECH SYSTEMS INCORPORATED for advice on how to resolve problems related to the process before making changes to the process or equipment.

Adapted from Water Pollution Control Federation "Manual of Practice OM-10", 1988.

8.0 - MAINTENANCE PROGRAM – Do's and Don'ts

8.1 - DO'S

1. Do use biodegradable soap if at all possible. The system will, however, handle a certain amount of normal soap. When laundering clothes, please follow manufacturer's instructions regarding quantity of detergent. Excessive use of detergent can cause odour in the system.

2. Do put large amounts of grease in a container and dump in garbage. The system will handle a certain amount of fat and grease. If a tile bed is used and if fats and grease get into it, they may plug the pores of the soil and seal up the bed. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

3. Have your system pumped out a minimum of once a year to remove sludge and scum to maintain top operating treatment in your system and filter bed.

4. For small systems equipped with a service hatch, keep the service hatch above the ground. Do not let run-off water enter system, as this will cause hydraulic overload.

5. If a tile bed is used, do keep traffic such as cars, snowmobiles, etc., away from the system bed areas as they will break pipes and seal the soil over the bed.

6. If a tile bed is used, do leave the raised filter in place without disturbing it. The filter is specifically designed to provide maximum dispersal of the water. Altering it by adding fill, covering it up or changing in any way may destroy its water dispersal characteristics and result in bed failure.

7. If a tile bed is used, do encourage a growth of ground cover over the filter bed as it helps disperse water by evaporation and transpiration.

8.2 - DON'Ts

1. Do not put non-biodegradable materials downs the drain, put them in the garbage, these include any plastics, rubber, disposable diapers, sanitary napkins, rubber goods, cigarettes, children's toys, cellophane, etc. They will plug the system, and a pump out will be needed.

2. Do not put harsh chemicals down the drain. They will kill the bacteria necessary for efficient treatment. These include acid or caustic cleaners, gasoline, oil, turpentine, photographic chemicals, etc. Disinfectant and chlorine bleaches should be kept to domestic uses.

3. Do not leave taps running or faulty toilets. The excess water may overload the system and, if used, tile field causing breakout and poor treatment.

4. If you do not have access to workers with appropriate training, do not attempt to fix the mechanical parts yourself. Your dealer is trained to repair your plant and work safely with electrical and mechanical components. Call him if you have a problem or concerns.

5. Do not connect any other electrical load to the fuse or breaker feeding the plant as it will cause damage to the controls.

6. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

YOUR CO-OPERATION WITH RESPECT TO THE ABOVE POINTS SHOULD ENSURE TROUBLE-FREE OPERATION OF YOUR TREATMENT PLANT AND WILL BE GREATLY APPRECIATED.

9.0 - INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE ROTORDISK® AND OTHER EQUIPMENT SUPPLIED

9.1 - INSTALLATION & MAINTENANCE DETAILS FOR ROLLER CHAIN DRIVES

CHAIN TENSIONING:
The proper fit of a chain may be obtained by adjusting the sprocket centres. When a chain is correctly tensioned, the total mid-span movement (double amplitude) in the slack span should be 4-6% of the span length for normal drives.

Where there is no adjustment means, adjustment may be made by removing links to compensate for elongation due to wear (Drives with fixed centres). Proper lubrication and proper drive maintenance may minimize chain wear.

LUBRICATION:
Although many slow-speed drives operate successfully with little or no lubrication beyond the initial factory lubrication, proper lubrication will greatly extend the useful life of every chain drive.

A good grade of clean petroleum oil without additives, free from flowing at the prevailing temperatures should be used.

Chain drives should be protected from abrasive and corrosive conditions, and the oil supply kept free of contamination. Periodic oil change is desirable. The lubricant viscosity recommended for ambient temperature 40° - 100°F is SAE 30.

OIL BATH:
With bath lubrication, the lower strand of chain runs through a sump of oil in the drive housing. The oil level should reach the pitch line of the chain at its lowest point while operating. Only a short length of chain should run through oil.

INSTALLATION RECOMMENDATIONS:
Shafting, bearings and foundations should be supported rigidly to maintain the initial alignment. Roller chain should be free of grit and dirt. Wash the chain in kerosene when required. Re-lubricate!

Misalignment results in uneven loading across the width of the chain and may cause roller link-plate and sprocket tooth wear. Drive alignment involves two things:

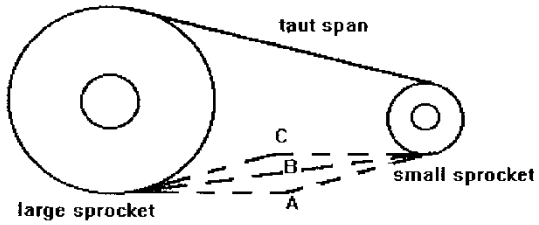
a) Parallel shaft alignment: Shafts should be parallel and level.
b) Axial sprocket alignment: Sprocket axial alignment can be checked with a straight edge, which will extend across the finished sides of the two sprockets.

Normally, it is good practice to align sprockets as close to the shaft bearings as possible.

Installing the Chain: Recheck all preceding adjustments for alignment and make sure all setscrews, bolts and nuts are tight. Fit chain around both sprockets and bring free ends together around one sprocket for connection.

Chain Tension: Check chain tension to be sure that the slack span has 4-6% mid-span movement in horizontal drives.

Recommended Possible Mid-Span Movement AC									
Drive	Tangent Length Between Sprockets								
Center-Line									
	5"	10"	15"	20"	30"	40"	60"	80"	100"
Horizontal to 45	.25"	.5"	.75"	1"	1.5"	2"	3"	4"	5"
Vertical to 45	.12"	.25"	.38"	.5"	.75"	1"	1.5"	2"	2.5"



AC = Total Possible Mid-Span Movement
Depth of Free Sag = .866 AB, approximately

MAINTENANCE RECOMMENDATIONS:

Regular maintenance schedules should be followed for all chain drives. Each drive should be inspected every six months. At each inspection period the following points should be checked:

a) Check Lubrication: If chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated before reinstalling. With bath lubrication, oil should be maintained at the proper level, as shown in lubrication instructions. Add oil if necessary. At each inspection, oil should be checked for contamination, such as chips, dirt or grit.

b) Check sprocket alignment: If the chain is properly aligned, no wear will show on the inner surfaces of the chain roller link-plates. If wear is apparent, this is evidence that sprockets are misalign and should be realigned as outlined in the installation instructions to prevent further chain and sprocket wear.

c) Check sprocket tooth wear: If sprocket shows evidence of wear high on the sprocket teeth, this is evidence of excessive wear in the chain and the chain should be replaced. If the sprocket teeth are severely worn, the sprocket should be replaced. Do not run new chain on worn sprockets.

d) Check chain tension: At each inspection period, the chain tension should be adjusted. If excessive slack has accumulated which cannot be removed by available shaft centre adjustment (i.e. by moving reducer away from large sprocket using chain tensioning bolts), two or more pitches of chain should be removed and chain reconnected.

9.2 - PROCEDURE FOR ASSEMBLING BEARINGS AND PILLOW BLOCKS

Shaft Preparation
Clean shaft and remove any burrs or sharp edges. Check the shaft diameter to given specifications.

Seal Installation
Place seal, which consists of: Double lip 'G' type seal

9.2.1 - MOUNTING OF BEARING ON SHAFT

Adapter Sleeve Mounting
Position adapter sleeve on the shaft to correct location with respect to required bearing centerline. A smear of lubricating oil (SAE 10 or 20) applied to the sleeve outside diameter surface results in easier bearing mounting and removal. (For pillow blocks mounted close to a pulley hub or similar obstruction, mount the adapter sleeve with threads inboard for easy removal. Remember to slide lock-nut, lock-washer and bearing onto the shaft before positioning the sleeve.)

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in SKF tables, to ensure correct fits. Spherical roller bearings can be measured between the unloaded rollers and the outer ring sphere surface.

Un-mounted Clearance, Spherical Roller Bearings
Measure the un-mounted internal clearance in the bearing by inserting and sliding progressively larger feeler blades the full length of the roller between the most vertical unloaded rollers and the outer ring sphere. Never run the rollers over the feeler blade, as the wrong value will be obtained. Record the measurement of the largest size blade that will slide through. This is the un-mounted internal clearance.

Bearing
Mount the bearing hand tight on the adapter sleeve. Be sure the large end of the bore of the inner ring matches the taper of the adapter. To avoid damage to the bearing it is most important during this and subsequent operation that the shaft is blocked up so the bearing is unloaded. Do not apply lock-washer. Drive up procedure may damage it.

Bearing Drive Up, Spherical Roller Bearings
Lubricate the face and thread of the lock nut and apply to sleeve with chamfered face toward the bearing. Tighten the lock nut. Do not attempt to tighten the lock nut with a hammer and drift (use proper wrenches), the lock nut can be damaged and chips can enter the bearing. Further tighten the lock nut and measure the internal clearance until the internal clearance is less than the un-mounted clearance figure by the amount shown in the attached table (see last page). Finally, remove lock nut, position lock washer with outer tangs facing away from the bearing, and inner tang properly seated in the slot provided in the adapter. Replace lock nut and tighten until firmly seated.

9.2.2 - PREPARATION OF PILLOW BLOCK HOUSING

Check to be sure all pillow block parts are free of burrs and are completely clean. Internal surfaces should be removed. Apply a thin coat of grease to the bearing seat in the base. Fit the bearing and seal inserts into the pillow block base, being careful not to damage to O-rings. For assembling larger sizes where hoists must be used, it may be convenient to seat both bearings into their housing bases simultaneously.

FIXING RINGS

On each shaft one bearing is generally "Held" and other bearings are "Free", to permit shaft expansion. For "Held" bearing housings, use two fixing rings. Place one on each side of bearing.

CAPPING THE PILLOW BLOCK

Place the cap on the base so that the dowel pins in the base align with the holes in the cap, being careful not to damage the O-rings. Caps and bases are not manufactured for interchangeable assembly. They must be kept together. Install cap-bolts with lock washers and tighten securely.

GREASE LUBRICATED BLOCKS

Lubrication Notes

Grease Lubrication

If grease is used as a lubricant, it should be smeared between the rolling elements and worked in. The lower half of the housing should be packaged $^{1}/_{2}$ to $^{3}/_{4}$ full.

9.2.3 - PROCEDURE FOR APPLYING LUBRICANT TO BEARINGS AND PILLOW BLOCKS

Pack each bearing as completely full of the specified grease as possible by swiveling the outer ring open and rotating it as necessary to inject the grease. Then, swivel the outer ring closed being careful not to use force in the event a roller end catch the corner of the outer ring sphere.

B) Before assembling the pillow block cap to the base, and after completing bearing and base assembly, fill $^{1}/_{2}$ to $^{3}/_{4}$ of the pillow block base with the same lubricant that was used to pack the bearing.

9.2.3.1 - LUBRICATION PROCEDURE TO BE USED AT START-UP

A) All pillow block assemblies that have not been prepared for stage are ready for use, assuming the installation procedures have been correctly followed.

B) While shaft is rotating, lubricate each seal through the outside lubricant fittings until grease is seen emerging from the labyrinth areas. Make sure the outside of the lubricant fitting is clean before applying grease.

9.2.3.2 - RE LUBRICATION

Lubricants deteriorate in time, and the rate of deterioration is a function of the lubricant used at the operating conditions encountered. Determining the re-lubrication cycle depends on sampling the grease and analysis of the samples. Provisions must be made to adequately evaluate the contamination by solids. Samples for grease evaluation should be taken from near the bearing, and evaluation of the samples should dictate the re-lubrication cycle.

Remove caps once a-year and re-apply new grease.

Each seal assembly should be lubricated once a month, while the bearing is rotating, with the same grease that is used in the bearing.

9.3 - GREASE CLASSIFICATION

		Oil Viscosity Saybolt Second (approx. SSU)		
Class	Type of Base (1)	@ 100 F	@ 210 F	NLGI (2) Grade
A	Lithium or Equal	200 - 500	48 – 55	0
B	Lithium or Equal	400 - 600	58 – 68	1
C	Lithium or Equal	800 - 1,000	75 – 82	1
D	Lithium only	800 - 1,000	75 – 82	2

	Grease requirement from above			
Operating temperature of bearing (4)	Low (5)	Medium	High	Suggested Re-lube cycle
0 – 70	A or B			6 – 12 months
70 – 120	B or C			6 – 12 months
120 – 160	B or C	C or D (6)	D (7)	2 - 3 weeks
160 – 200	C	C or D (6)	D (7)	1 - 4 weeks

1) Calcium Complex Greases NOT recommended for spherical roller bearings.

2) National Lubricating Grease Institute Consistency Code.

3) Definition of speed categories:
Low: up to 1/4 of catalog speed limit for static oil lubrication.
Medium: 1/4 to 1/2 catalog speed limit for static oil lubrication.
High: 1/2 to full catalog speed limit for static oil lubrication.

4) Consult SKF Engineering if temperature is below 0° or above 200°F.

5) Extremely slow speed will require special consideration if loads are high.

* Under all conditions, application should be checked using the SKF lubricant film parameter found in the Engineer Data Catalog.

6) Use type "C" where load is heavy, 15,000 hours-rating life or less and/or speed are less than RPM.

7) Consult SKF Engineering - Grease lube not normally recommended under this combination of operating conditions.

8) Dry clean applications only. For moderate conditions of dirt and/or moisture, use cycle of 1 to 2 months. For extreme conditions of dirt and/or moisture, use cycle of 1 week. Vertical applications normally require shorter than normal re-lube cycle.

9) Never mix greases with unlike bases.

10) Remove old grease at least once a year.

10 - LIMITED WARRANTY

SEPROTECH SYSTEMS INCORPORATED warrants the parts in each treatment plant to be free from defects in material and workmanship; for a period of 15 months from shipment or 12 months from start-up, whichever occurs first, in the treatment of domestic wastewater. Sole obligation under this warranty is as follows:

SEPROTECH SYSTEMS INCORPORATED shall fulfil this warranty by repairing or exchanging any component part, F.O.B. our factory, that in SEPROTECH SYSTEMS' judgement, shows evidence of defects, provided said component part has been paid for and is returned through an authorized dealer, transportation prepaid. The warranty must also specify the nature of the defect to the manufacturer. New placed parts are under warranty for one year.

The warranty does not cover treatment plants that have been flooded, by external means, or that have been disassembled by unauthorized persons, improperly installed, subjected to external damage or damage due to altered or improper wiring or overload protection.

This warranty applies only to the treatment plant and does not include any other electrical wiring, plumbing, drainage, or disposal system. SEPROTECH SYSTEMS INCORPORATED is not responsible for any delay or damages caused by defective components or material, or for loss incurred because of interruption of service, or for any other special or consequential damages or incidental expenses arising from the manufacture, sale, or use of this plant.

SEPROTECH SYSTEMS INCORPORATED reserves the right to revise, change, or modify the construction and design of the treatment plant for domestic wastewater or any component part or parts thereof without incurring any obligation to make such changes for modifications in previously sold equipment. SEPROTECH SYSTEMS INCORPORATED also reserves the right, in making replacements of component parts under this warranty, to furnish a component part, which, in its judgement is equivalent to the Company part replaced.

Under no circumstance will SEPROTECH SYSTEMS INCORPORATED, be responsible to the warrantee for any other direct or consequential damages. Including but not limited to; lost profits, lost income, labour charges, delays in production, and/or idle production, which damages are caused by a defect in material and/or workmanship in its parts.

This warranty is expressly in lieu of any other expressed or implied warranty, excluding any warranty of merchantability or fitness, and of any other obligation on the part of SEPROTECH SYSTEMS INCORPORATED.

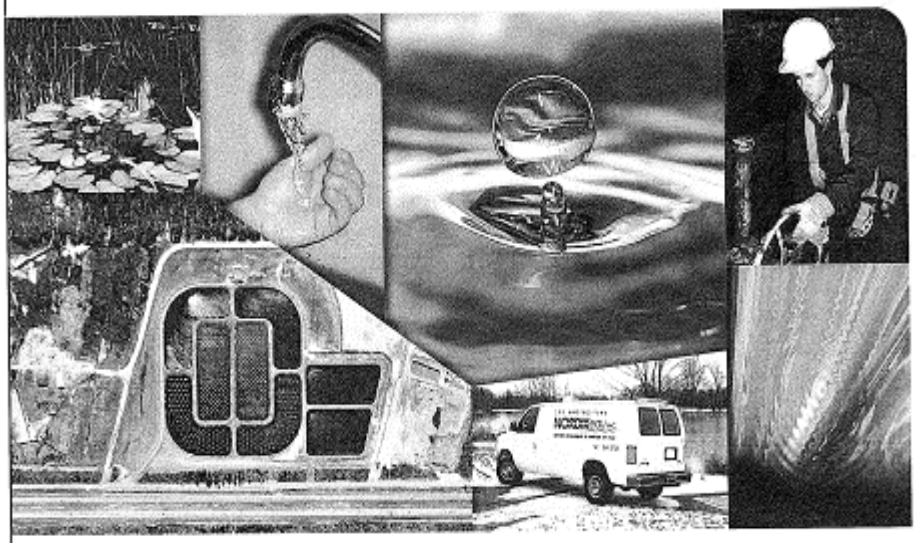
Appendix B: NORDIKeau Technical Support Manual

ORIGINAL

AEM

Agnico-Eagle Mines

TECHNICAL SUPPORT
SECTION 2



NORDIKeau INC.

EXPERTS TECHNIQUES EN GESTION DE L'EAU

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50255 / JUNE 2010

ORIGINAL

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AGNICO EAGLE

TECHNICAL SUPPORT
SECTION 2

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Frédéric Rubin-Delanchy, assistant general manager

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June 30th, 2010
(N/Réf. : 50255)

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

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APPENDIX

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

1. INTRODUCTION

The operations manual is a practical guide for the operation and maintenance of the wastewater treatment system, Rotating Biological Contactors type, installed on the Meadowbank mine site to treat domestic effluents from the Main Camp and Nova Camp.

This manual is intended both to the operator and technical supervisor. It aims to collect and condense specific data of works in place. Whenever possible, information available on previous works has also been collected and grouped together to present the most coherent overall.

Typically the operations manual contains the main works components, and described its function, its characteristics and its operation. The equipments mechanical maintenance is briefly discussed, most often in reference with documents provided by the supplier. Finally, it also includes a method and tools to follow and document the works' functioning, including information that must appear in the Daily Operation Logbook.

The operations manual has been prepared assuming that the staff assigned to the building installations has a basic knowledge in wastewater treatment and possesses the necessary qualities and skills to plan and carry out all operating tasks, process control, and maintenance grouped in this manual.

The operator plays a key role and represents a factor in:

- The quality of treated water, in connection with the disposal requirements to be met, among others;
- the optimization of the operation that can significantly reduce costs (electricity, chemicals);
- the quality of equipment maintenance which, in turn, directly affects both short-term costs (repairs) and the medium and long term (parts or equipment replacement).

2. PROCESS DESCRIPTION & DESIGN CHARACTERISTICS

2.1 Process description

Rotating biological contactors (RBC) were originally developed in Europe and recently accepted by America and Asia. The process system is primarily a fixed-film biological reactor consisting of a synthetic medium mounted on a horizontal shaft and place in a contour-bottomed tank. The general concept of rotating biological contactors is to let wastewater flow through the tank, and to rotate the medium in the wastewater to be treated, alternatively exposing the medium (and the attached biological growth) to air and the wastewater. The slowly rotated media are 40% immersed in the wastewater for aerobic removal of organic waste by the biological film developing on the media. The lattice-structured medium, and to a lesser extent the disc structure, is fragile and should be protected from direct exposure to wind, sun, and weather fluctuation. Therefore, the media are usually enclosed in a superstructure or individual shaft covers.

Media rotation can be provided by either mechanical drives or air-motivated rotation. Rotation not only results in exposure of the film to the atmosphere as a means of aeration, but also provides rotational shear forces for stripping off the excess biomass on the medium. The stripped biological solids are maintained in suspension by the mechanical mixing action of the rotation medium or by supplemental diffused air, depending on the driving force of rotation. The air-driven system, in rotating the media by diffused air generated near the thank bottom, alleviates the development of undesirable anaerobic conditions, and also reduces the oxygen limitation, which often is the limiting factor in biological oxidation.

The most important factor affecting performance of the rotating biological contactors is the biological slime of those microorganisms that grow on a series of thin media, such as disc, mounted side by side on a shaft. When the process is first started, the microorganisms in the wastewater begin to stick to the medium surfaces and grow there until all the media are covered with a 1/16 to 1/8 in layer of biological slime. The attached biomass is similar to the biofilm in a trickling filter, except that the microorganisms are passed through the wastewater rather than the wastewater being passed over the microorganisms. As with all biological units, alkalinity, pH, nutrients, temperature, oxygen, biomass population balance, concentrations of pollutants, and so on, must be acceptable for efficient operation.

Most organisms cannot tolerate pH levels above 9.5 or below 4.0. In general, the optimum pH for biological growth lies between 6.5 and 7.8 for carbonaceous oxidation, between 8.2 and 8.6 for nitrification (12), and between 7.2 and 7.8 for denitrification. An alkalinity deficit can result from nitrification; thus a supplemental alkalinity source may be required. The inorganic nutrients normally present in domestic wastewater are sufficient to assure maximum biological growth, provided that all other environmental conditions are optimum. The nutrient needs should be checked when there is a significant industrial waste contribution. A suggested ratio of BOD_5:N:P is 100:5:1. Wastewater temperatures between 13 and 32 °C have no significant effect on process performance. The treatment efficiency, however, decreases with decreasing wastewater temperature below 13 °C. For year-round operation in warm climates, a simple sun roof is sufficient protection; whereas for year-round operation in cold climates, rotating biological contactor plants should be weatherproofed.

To achieve high treatment efficiency, the wastewater should be maintained under aerobic conditions throughout the entire treatment system for carbonaceous and nitrification. It is suggested that a minimum of 1 to 2 mg/L of dissolved residual oxygen be maintained in the tank to prevent oxygen deficiencies from limiting the substrate removal rate.

Each shaft of medium operates as completely mixed, fixed-film reactor, I which the biological growth rate and the excess biomass stripping rate are at dynamic equilibrium. As the treated wastewater and the stripped biomass pass from stage to stage, the wastewater undergoes a progressively increased degree of treatment by the specific biomass found in each stage, which in turn adapt to the changing wastewater. Microorganisms in the initial stages of a medium, which receive the highest concentration of organic wastes, are mainly ordinary bacteria responsible for carbonaceous oxidation. Higher life forms, such as nitrifying bacteria, protozoa, rotifers, and other predators, begin to appear in subsequent stages, where the concentration of organic substances gradually decreases form stage to stage.

2.2 Design characteristics

The sewage treatment plant (STP) has been designed to meet environmental requirements and site conditions.

The STP design includes two (2) parallel biodisks units and has been based on the following characteristics:

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

DESCRIPTION	L 333	LJ 100	Total
Number of unit	1	3	4
Average Daily Flow	105 m³/d	3 x 27,5 m³/d	188 m³/d
Peak Hour Flow	4 x design	4 x design	4 x design
Influent BOD_5			250 mg/L
Total Suspended Solids (TSS)			250 mg/L
Total Ammonia			35 mg/L
Outdoor temperature			-40 to +40 °C
Indoor temperature			10 to 25 °C
Operating			24 hr / 365 day
Process details			
Hydraulic loading	105 m³/d	3 x 22,62 m³/d	173 m³/d
Bio support media area	3390 m²	3 x 487 m²	4851 m²
Bio support media diameter	2,44 m	1,63 m	
Primary clarifier capacity	73,09 m³	3 x 6,82 m³	93,55 m³
Final clarifier capacity	24,72 m³	3 x 3,88 m³	36,36 m³
Biozone capacity	18,12 m³	3 x 3,43 m³	28,41 m³

2.3 Effluent characteristics and performance guarantee

The STP has been designed to meet the effluent characteristics shown in table 2.1 below.

Prior to the construction of the Tailing Storage Facility, the License shall direct the effluent from Stormwater Management Pound to the monitoring station ST-35, to the northwest arm of Second Portage Lake and not exceed the government quality limits shown in table 2.1.

TABLE 2.1 EFFLUENT CHARACTERISTICS AND PERFORMANCE GUARANTEE

PARAMETER	STP Design	Government effluent quality limits	
	Monthly average	Monthly average	Grab sample
BOD_5	15 mg/L	25 mg/L	50 mg/L
TSS	15 mg/L	25 mg/L	50 mg/L
Fecal Coliforms	200 / 100 mL	1000 / 100 mL	2000 / 100 mL
Temperature	10 °C		
pH		6,0 to 9,5	6,0 to 9,5

3. DESCRIPTION AND OPERATION OF THE SEWAGE TREATMENT

3.1 Basic description of the sewage treatment plant

The sewage treatment plant has been designed to treat domestic wastewaters coming from the Main Camp and Nova Camp. As shown in Figure 1, treatment works include the following components:

- **Lifting station n° 1**

  Pumping station n° 1 is adjacent to the Main Camp. It receives grey waters coming from the kitchens and the laundry. A screen basket is installed in front of the inlet pipe to hold the unrefined wastes. These waters are currently pumped downstream to the STP, directly in pumping station n° 3 (LS-3), which insures the pumping of all effluent (treated or not) toward the Tailing Storage Facility.

- **Lifting station n° 2**

  Pumping station no 2 (LS-2) is adjacent to the STP. It receives sanitary wastewaters (washbasins, toilets, showers) coming from dormitories of Main Camp and, still to confirm, Nova Camp. These waters are pumped in the Equalization Tank (EQT) to be processed.

- **Equalization tank**

  The equalization tank (EQT) allows lopping flow peaks of the day. Wastewaters accumulated in this tank are pumped in constant flow towards the rotating biological contactors (RBC). The EQT is currently equipped with four (4) pumps. Pumps P-1 and P-2 send wastewaters towards LJ-1 and LJ-2 RBC, while pumps n° 5 and n° 6 are pumping wastewaters toward RBC L333.

- **Rotating biological contactors (RBC)**

  The RBC secondary treatment system is a fixed culture treatment process. The biological contactor (Rotorzone) is made of several thin plastic disks assembled around a horizontal axis. Microorganisms responsible for the degradation are naturally fixed to the disks and form a biofilm of about 1 to 4 mm of thickness. Approximately 40% of the disks surface is immersed. The disks' rotary movement around the axis alternately exposes the biomass to the atmosphere and the wastewaters, allowing the aeration and wastewaters mixing. The shearing forces created by the rotary movement limit the biofilm's thickness and lead to a

detachment of the excess biomass, which is then separated from the effluent with the help of a secondary settling tank (*final clarifier*).

A primary treatment system composed of a settling tank (*Primary tank*) is located under the biological contactor to hold fibrous solids, greases, scum, and other unwanted waste subjected to hang on to the disks.

The treatment system is composed of four (4) biodisks:

- One (1) unit SEPROTECH L333 designed to treat a 105 m^3/d daily flow.
- Three (3) units LJ-100 (one is not started yet) designed to treat an 83 m^3/d daily flow (27, 5 m^3/d per unit).

- **UV disinfection**

The wastewaters disinfection by ultraviolet radiation is the last stage of treatment before the treated waters is discharged towards the Tailing Storage Facility. It consists of sending wastewaters through a reactor composed of mercury vapor lamps emitting UV radiations. The radiations have the characteristic to inactivate the microorganisms.

The treatment system is composed of three (3) UV lamps:

- One (1) unit TROJAN, UV3000 PTP model, installed at the exit of biodisk L333
- Two (2) units SEVERN TRENT, ULTRADYNAMICS model, currently installed at the outlet of biodisks LJ-1 and LJ-2. Currently, these units are not in service.

- **Lifting station n° 3**

Pumping station n° 3 is located inside the WTS. It currently receives the final effluent of the STP and untreated grey waters from Main Camp and Nova Camp. Two (2) submersible pumps assure the pumping of these waters towards the Tailing Storage Facility.

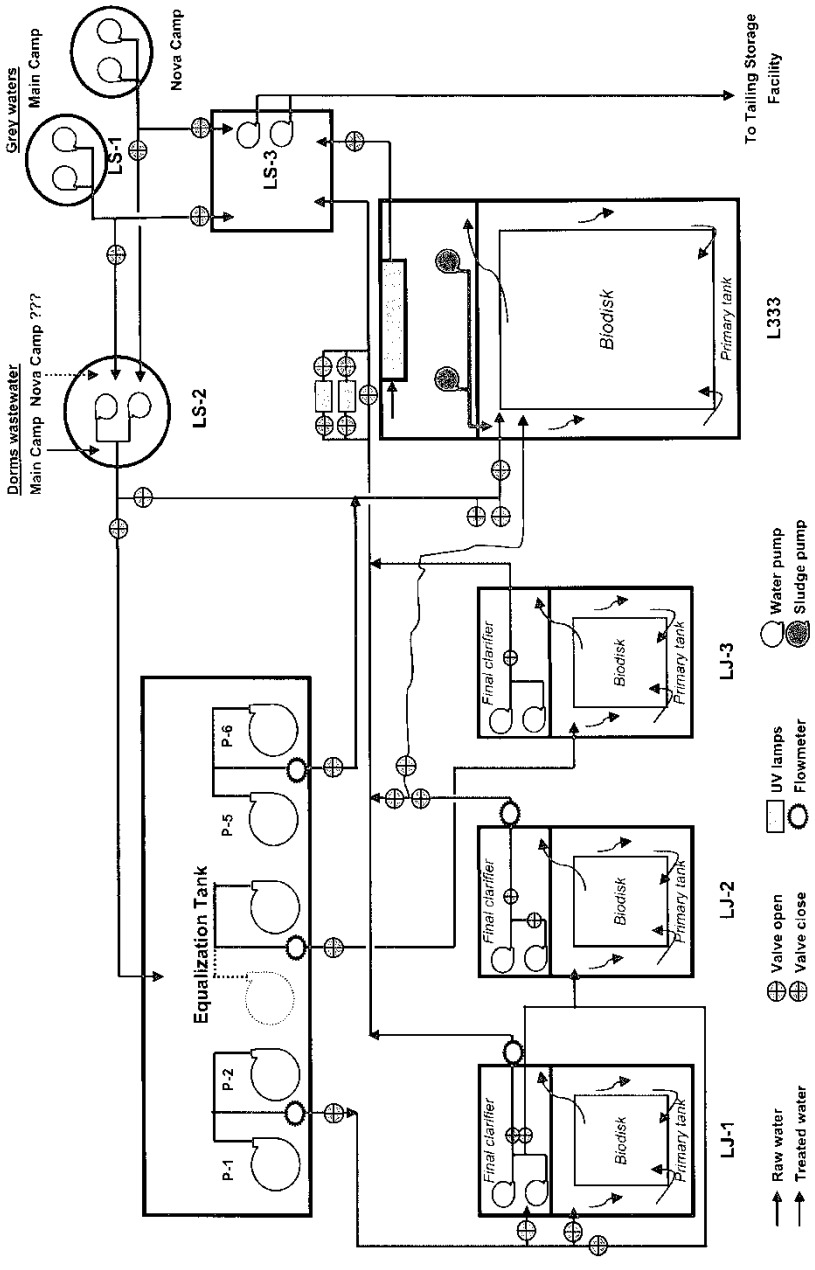


FIGURE 3.1: FLOWSHEET

3.2 Operation procedure

3.2.1 Lifting station n° 1

Pumping station n° 1 is adjacent to the Main Camp. It receives grey waters coming from the kitchens and the laundry. A screen basket is installed in front of the inlet pipe to hold the unrefined wastes. These waters are currently pumped downstream to the STP, directly in pumping station n° 3 (LS-3), which insures the pumping of all effluent (treated or not) toward the Tailing Storage Facility.

The lifting station is equipped with two (2) MYERS submersible pumps. There are level floats to control stop, and start cycles of pumps. Each pump has a check valve on their discharge pipe.

Starts and stops levels of the pumps are voluntarily set-up at close intervals to avoid prolonged operations, which could lead to an overflow of pumping station LS-3. It is also for this reason that the ball valve on the pumps' force main (just before LS-3) is maintained partially closed.

The cleaning operation of the screen basket, which requires the presence of two employees, is required approximately once a week.

No overflow pipe is present. In case of defaults of the pumping station, overflowing of the station and sewer system can occur.

3.2.2 Lifting station n° 2

Pumping station LS-2 receives wastewaters (washbasins, showers and toilets), of Main Camp dormitories and, still to confirm, Nova Camp. Pumping station n° 2 (LS-2) is adjacent to the STP. It receives sanitary wastewaters (washbasins, toilets, showers) coming from dormitories of Main Camp and, still to confirm, Nova Camp. These waters are pumped in the equalization tank (EQT).

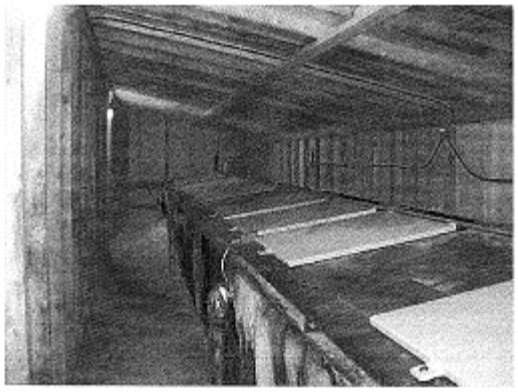
This station is equipped with two (2) MYERS submersible pumps that discharge the wastewater in the EQT. There are level floats to control stop, and start cycles of pumps. Each pump has a check valve on their discharge pipe.

3.2.3 Equalization tank

The equalization tank (EQT) allows lopping flow peaks of the day. Wastewaters accumulated in this tank are pumped in constant flow towards the rotating biological contactors (RBC). The EQT is currently (May 2010) equipped with four (4) pumps, but two (2) more pumps will be installed soon to feed the LJ-3 biodisk:

- Pumps P-1 and P-2 are pumping wastewaters towards LJ-1 and LJ-2;
- Pumps P-3 and P-4 (future) will pump wastewaters towards LJ-3;
- Pumps no. 5 and no. 6 are pumping wastewaters toward L333.

Each pair of pumps are equipped with a Doppler Flowmeter *GREYLINE*, model DFM 4.0. The sensor is fixed to the pipe with coupling material between the sensor face and the pipe. Sensor installation with excessive coupling compound can result in gaps or voids in the coupling and cause errors or signal loss. Insufficient coupling compound will create similar conditions. Over time, temporary coupling compounds (e.g. Petroleum Gel) may gradually sag away from the sensor resulting in reduced signal strength and, finally, complete loss of signal. Warm temperatures, moisture and vibration will accelerate this process. Dow Corning Silicone Compound # 4, as supplied with the DFM 4.0 (and available from Greyline Instruments) is recommended for semi-permanent installations. For more information, refer to the GREYLINE instruction manual.



The equalization tank (EQT) has the following dimensions, approximately: 14,3 m x 2,3m x 2,5 m, for a total volume of 80 m^3. The stabilization of the flow is done with the help of five (5) liquid level floats switches.

Four (4) 10 kW heating elements are installed at the bottom of the EQT to heat wastewater if required. The number of heating elements to put in service must be set to maintain a temperature between 20 and 25 °C. Temperature below 15 °C will probably cause a decrease in microbiological growth on biodisk media and reduce efficiency of the biological process. Temperature over 30 °C increases the nitrification reactions and the anaerobic fermentation which can lead to an important pH and alkalinity decrease and also can, under certain conditions, increase the formation of H_2S gas.

A control unit allow to adjust the running pumps cycles for pumps n° 1 and n° 2 (towards LJ-100), and for pumps n° 5 and n° 6 (towards L333).

The current position of the level floats and pumps on/off cycles' settings ensures an appropriate storage capacity of about 50 m^3.

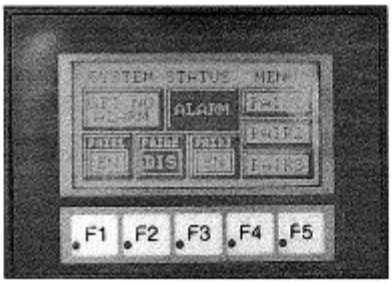
In automatic mode, the control sequence is currently the following:

Float 1 (low level):	low level alarm
Float 2 (stop):	stop pumping
Float 3 (start):	Pumps 1 and 2 (54 sec ON, 306 sec OFF) Pumps 5 and 6 (95 sec ON, 265 sec OFF)
Float 4 (high flow):	Pumps 1 and 2 (162 sec ON, 198 sec OFF) Pumps 5 and 6 (285 sec ON, 75 sec OFF)
Float 5 (high level):	High level alarm and simultaneous start of the four (4) pumps as long as the float stays in horizontal position.

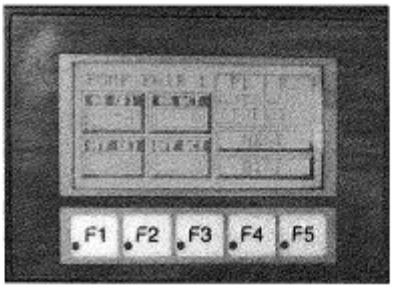
If the water level in the EQT remains low, it indicates that the current controls of the pumps operating time are too high and, consequently, the tank's equalization function is useless.

If the water level in the EQT remains very high, it indicates that the current controls of the pumps operating time are too low and, consequently, the tank's equalization can reach the level 4 «High Flow» which, obviously, would cause overflowing of station LS-3.

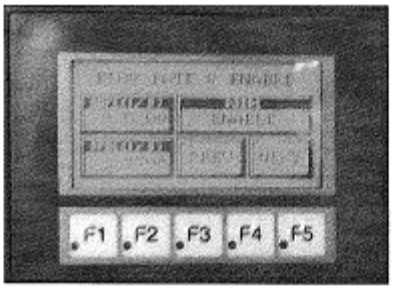
To change the ON/OFF setting cycles of each pair of pumps, you need to follow the step below. The example is for pumps 1 and 2.



Press on **PAIR 1**. A new screen (below) will appear.



Press on **NEXT**. A new screen (below) will appear



Press on **ADF1 (l/s).** Increase or decrease the value in the pop-menu to increase or decrease the running time of the pumps (in seconds) during the 360 seconds ON/OFF cycles.

The five (5) floats level switches must be inspected periodically (once a month). It is very important to keep the floats as clean as possible. Grease can potentially accumulate around the floats and impede operation.

In order to reduce deposits accumulation in the EQT, the level float n° 2 (stop pump) must be kept approximately at mid-level of the motor's pumps.

The depth of solids at the bottom of the EQT must be monitored once a month with the *RAVEN* slude interface detector.

It is possible to bypass the EQT for cleaning, maintenance, or repairs by closing valve V-__ and opening valve V-__. In this situation, Lifting Station n° 2 wastewaters will be all pumped in unit L333. A decreasing of the final effluent quality could be observed.

3.2.4 Rotating biological contactors (RBC)

The treatment system is composed of four (4) biodisks:

- One (1) SEPROTECH L333 UNIT
- Three (3) LJ-100 units

3.2.4.1 Operation summary

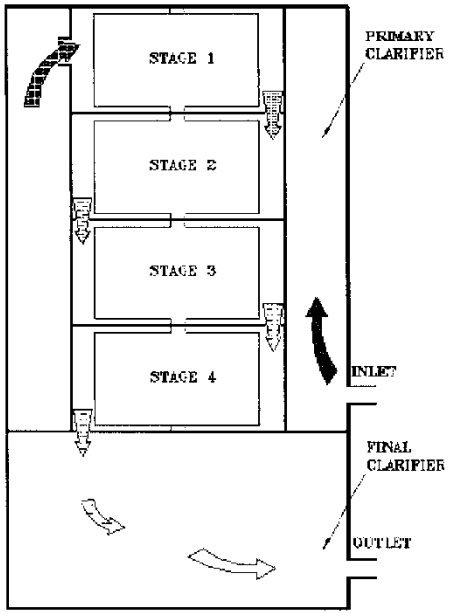
Rotating Biological Contactors (RBC) is a secondary treatment plant designed to remove organic material. It is composed of the primary settling tank (PST), the Biozone tank, and the final clarifier.

Raw sewage is pumped into the PST. Fats, oils and greases (FOG) will float to the top of the PST. The Biozone location concentrates the scum in the area along the side walls of the tank. Settling separates the heavy solids. The clarified water enters the Biozone tank section through the inlet slot located at the bottom of the non-drive end section of the Biozone.

This is the first section of four stages in the RBC aeration process. The normal color of the bacteria in the first stage is dark brown. This is the stage where most of the BOD reduction occurs. The succeeding stages are mounted on the same shaft. The fourth disk bank has recycle buckets that introduce both fresh dissolved oxygen into the PST and nitrifying bacteria present in the recycled water.

Partially treated water from the RBC now enters the final clarifier which allows gravity separation of spent biological growth. Spent biomass settles in this chamber. Sludge is

pumped to the primary clarifier and the supernatant (final effluent) is evacuated to the Lifting Station n° 3.



3.2.4.2 Biodisk LJ-100

A) Equipment characteristics

Supplier		:	Biodisk Corporation
Capacity (each unit)		:	27 500 L/d at a strength of 250 mg/L BOD Effluent BOD and TSS 20 mg/L
Drive motor and gear		:	Nord Gear Limited SK9043.1-80LH/4 Helical Bevel Gear Motor 208 volts, 1 ph, 60 Hz, 1 HP Rotation speed of the shaft is 4,8 rpm
Bearings	(fixed)	:	SKF SNL22518/3.3/16 TG
	(free)	:	SKF22518/3,3/16 THL Bearings are permanently lubricated

Effluent (2) and sludge (1) pumps	:	MYERS, Model ME50S-53 0,5 HP, 575 V, 3ph, 60 Hz
Flowmeter (LJ-1 and LJ-2 only)	:	ENDRESS & HAUSER, Promag 10W
Recorder (LJ-1, LJ-2 and LJ-3)	:	ENDRESS & HAUSER, Echograph RSG 30

B) Electrical controls

The detailed wiring diagram is provided on the inside of the panel and in the operation manual. All of the electrical power requirements pass through the panel. The panel has been designed for a 600/120v, 60 HZ.

The panel has a 200 watt forced air panel heater.

Breaker protection has been provided for all components.

The panel lights will show which equipment is running. Pumps and heaters are normally left in the AUTO position and the RBC runs 24h/365d in the ON position.

Duplex alternating effluent pump controls are provided with HAND-OFF-AUTO switches and high water alarm. The floats in the final clarifier start and stop the pumps. The fourth and highest float allows two pumps to operate at the same time for high flows. This feature will also start the stand by pump when the primary pump failed. The third float is for a high water level alarm.

A flashing red light mounted on the top of the control panel is activated by the RBC drive motor when the motor amps are too high or too low, or high water and effluent pump malfunction. The control panel lights will indicate the component that triggered the alarm.

The tank is heat traced. One additional heat tracing contact has been provided.

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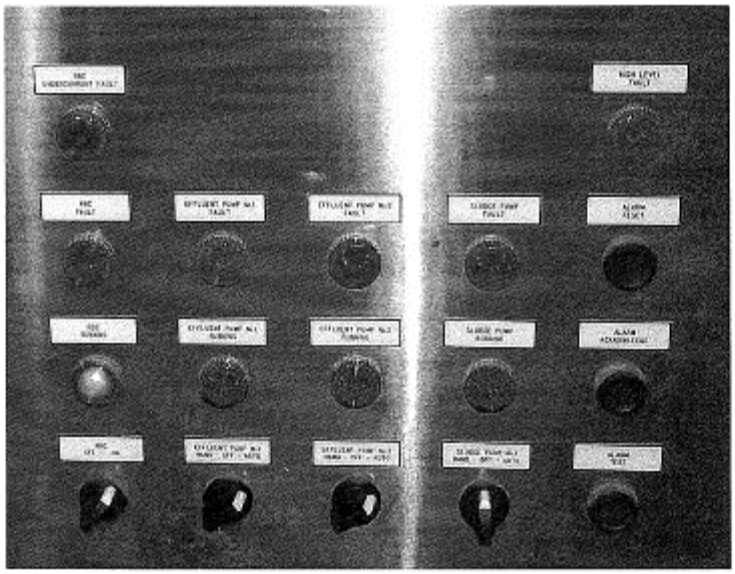
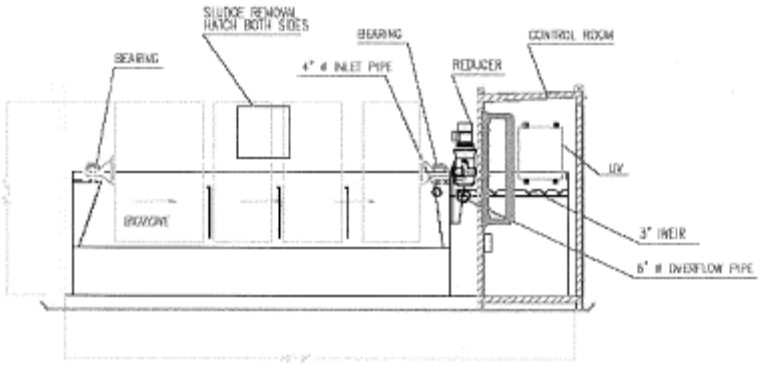


LJ-100 Electrical Panel



SECTION VIEW

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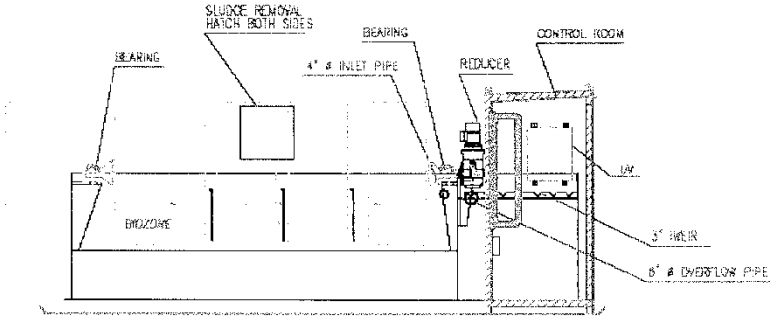
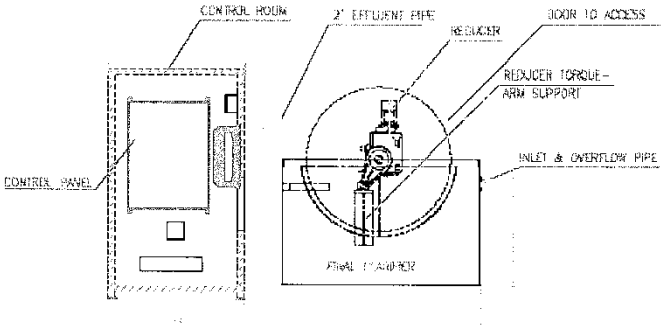


SECTION VIEW



END VIEW

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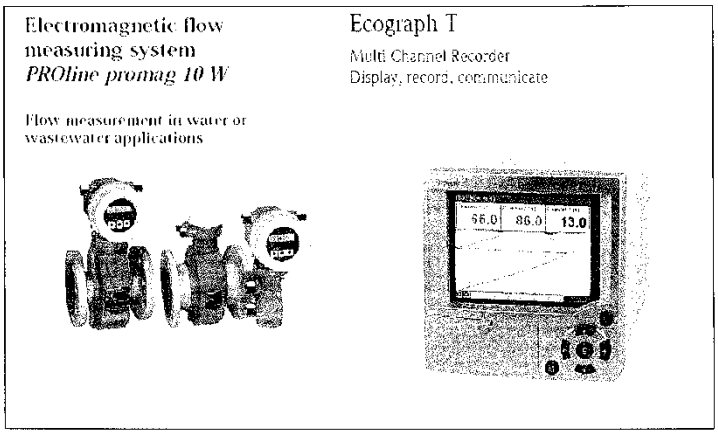

3.2.4.3 Rotordisk L333

A) Equipment characteristics

Supplier		:	Seprotech Systems inc.
Capacity (each unit)		:	105 000 L/d at a strength of 250 mg/L BOD Effluent BOD and TSS 20 mg/L
Drive motor and gear		:	Nord Gear Limited SK9062185TC Motor TEFC 185 TC Frame 575 volts, 3 ph, 60 Hz, 3 HP
Bearings	(2)	:	SKF SNH22524, 4 3/16 inches diameter
	(2)	:	SKF SNH 22526 4 7/16 inches diameter
Coupling	(1)	:	
Sludge pumps	(2)	:	MYERS, Model

B) Electrical controls

Refer to section 10 of the « *Seprotech L33 Installation, operation and maintenance manual* » for the detailed wiring diagram. All of the electrical power requirements pass through the panel. The panel has been designed for a 600/120v, 60 HZ.

Breaker protection has been provided for all components.

The panel lights will show which equipment is running. Pumps, heaters are normally left in the AUTO position and the RBC runs 24h/365d in the ON position.

Duplex alternating sludge pump controls are provided with HAND-OFF-AUTO switches. In automatic mode, pumps are controlled by an « ON-OFF » timer located inside the panel. Sludge pumps have been initially set to operate for 15 sec every 3 hours.

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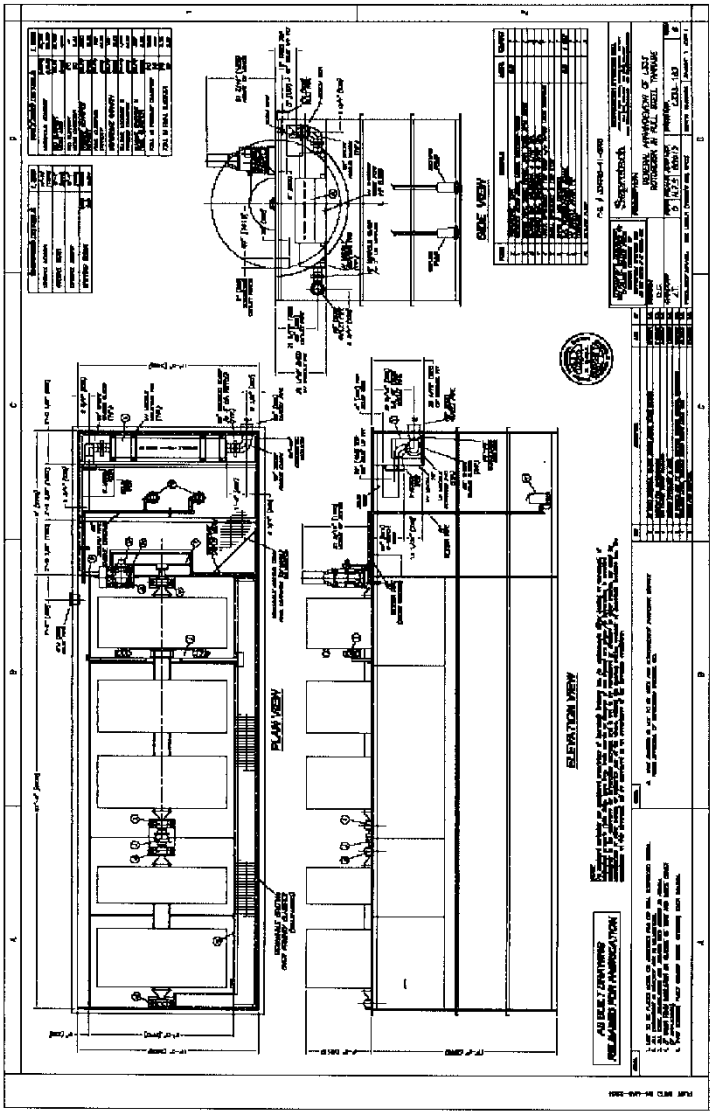


C) What to check

✓ **Abnormal Noise (1 / day)**

The Biodisk does not have any noisy components. Check valves are the only noisy (clunk) component. The splash of the disk going through the water is as constant as the humming of the motor is. Noises should be at a low level and constant. There are three sources of noise to listen for: the drive, the bearings and the rotating assembly. The drive motor makes a constant humming. High speed noises are generally associated with motor bearings or reducer input bearings. Low speed noises are reducer output noises.

Bearing noises are often cyclical. The rotation speed of the shaft is 4.8 rpm. Bearing can also squeak continuously. This type of noise needs to be investigated.

The rotating assembly consists of the shaft and the disk banks. The disk banks are bolted to the shaft. Lock Tight is used on the disk collar bolts. Movement in the collar bolts will loosen the disk bank and allow it to move. This movement will be evident on every revolution and may be accompanied by a thud. If left unattended, the loose components will eventual break down. Tighten all components that have any movement.

✓ **Visual inspection (1 / day)**

An experienced operator can tell if the Biodisk is working properly by looking at the process. The amount of scum, biomass thickness, coverage, texture, colour, odour, final clarifier scum and time are visual indicators of process efficiency.

Scum will float in the primary clarifier. Scum formation is normal. Fats, oils and grease (FOG) are not beneficial to biological growth and needs to be removed from the wastewater flow before the RBC process. The removal happens in the primary clarifier of the Biodisk. When the scum blanket completely covers the primary tank and has a depth of about 8", the primary tank may need pumping.

The amount of **scum in the final clarifier is an indicator**. A small amount of scum is an indicator that nitrogen gas has being released. Nitrogen gas is liberated in anoxic environments when a carbon source and nitrates are present. This process is called denitrification. When more than 50% of the final clarifier is covered with scum, it is an indicator that the Biodisk may need to have the biosolids and scum removed.

Sludge storage time is directly related to the organic load per day. Lightly loaded systems have long term sludge storage. Scum, biomass thickness, coverage, texture, colour, odour and time are all indicators to tell the sludge's thickness. The removal of

biosolids needs to be addressed. A pump-out truck normally does the sludge removal. A particular point to emphasize is that the biological growth (biomass) on the disks should **not** be washed off.

The thickness and distribution of the biomass is an indicator of plant capacity. When the flow is close to or at design, the biomass will be 1/8" in the first stage and progressively less on the following stages. When the treatment is at capacity, biomass will be evident on the last stage. As the flow is reduced, the amount of biomass on the disks will be proportional to the loading. At 50% of design, the organic removal biomass will occupy 50% of the shaft's length. Light brown nitrification bacteria on the last stage are a good sign. Nitrification does not occur in the Biodisk until the BOD is less than 30 mg/L. If the last stage is without obvious biomass, it is a good indicator of complete nitrification.

Biomass colour is a process indicator to the operator. The biomass in the lead stages will be a medium brown colour. In the lag stages, the disks will be lighter brown when the system is lightly loaded and heavier colour shows when designed for nitrification. Colorless or no biomass is a sign of an under loaded system. The appearance of black and grey patches biomass is not good. Black and grey biomass is an indicator of organic overload and or excessive FOG. This will appear first on the lead stage. It may be time to have the system pumped out.

Often, black and grey spots are accompanied by gelatinous material. These unhealthy bacteria hang on the ends of the tie rods. This is also a sign of organic over load, FOG and excessive use of detergents or cleaners.

The **effluent** near the outlet at the backside of the final clarifier should be relatively clear, colourless and relatively free of suspended solids. Clarity can test rapidly by performing turbidity analysis.

The bearing, gear box and motor have been lubricated with long life synthetic lubricants. **Look for oil and grease leaks.**

✓ **Odour (1 / day)**

Odour is evident when dissolved oxygen (DO) levels are low in the RBC. Low DO in the first stage is an indicator of organic overload. If the problem causing the black, grey and gelatinous biomass is not addressed, it will lead to increased odour and process breakdown. The indicators will appear on the first stage and eventually progress down the full shaft.

Odour under the RBC cover is normally not offensive. A healthy biomass smells like rich earth or loam. In some application, the RBC has been used as an odour eater. If the RBC is producing odour, it is an indicator of poor effluent, organic overload or excessive FOG.

✓ **Water sampling and on site analysis (1 / day)**

Dissolved Oxygen (D.O), pH, and temperature analysis must be performed in the first and last stage of the Biodisk.

The same analysis must be performed on the effluent of the final clarifier. Alkalinity analysis must also be performed, if required.

For more information regarding procedures and interpretations analysis, please refer to Section 4 Control Process.

✓ **Monitoring the flow rate (1 / day)**

The plant is equipped with three Doppler (3) flowmeters located on the force main of the EQT pumps. There is also two (2) magnetic flowmeters install on the force main of the effluent pumps of LJ-1 and LJ-2 units.

These instruments are equipped with a counter that allows tracking of the total volume (m^3) and pumps flowrate (m^3/h).

✓ **Determination of accumulated sludge blanket (periodically)**

The sludge blanket in the PST and in the final clarifier must be measure periodically with the « Sludge Interface Detector ». The sludge accumulation must be compare to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the Biodisk model in question.

Sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone. Once an average sludge height has been determined, multiply it by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

Sludge accumulations in PST should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. If sludge is allowed to accumulate past storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone, which are not anticipated in the design of the unit.

✓ **Sludge removal (periodically)**

L333

A pump-out truck (same type that pumps out septic tanks) normally does the sludge removal. For the L333 primary settling tank, it is preferable to connect the suction hose directly to the three (3) PVC pipes connected to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible.

Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank, to expose the secondary sludge. The suction hose should be placed down at a multiple number of points of the final clarifier (particularly in the corners) to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed.

LJ-100

Before withdrawing the sludge of the LJ-100 primary settling tank, it is recommended to transfer the supernatant at the inlet of other LJ-100 units before connecting the suction hose directly to the bottom of the tanks and withdraw the sludge only.

The same operation is recommended for the LJ-100 final clarifier.

3.2.5 U.V. Disinfection system

3.2.5.1 Summary

Another step in the STP process is to disinfect the wastewater. This ensures that any harmful bacteria are destroyed before wastewater is released from the plant. The most common method for disinfecting treated wastewater for small treatment plants is to use ultraviolet (UV) disinfection. UV disinfection relies on the high energy contained in UV light to destroy the ability of bacteria and other microorganisms to reproduce, thereby,

effectively killing them. In wastewater treatment, UV lamps are typically installed in a shallow contact channel, so as the wastewater passes through the channel, UV light is shone through the water. The UV lamps are submerged in the wastewater. When submerged UV lamps are used, they must be encased in quartz tubes to prevent excessive cooling and protected from breakage by a metal grid.

UV disinfection has been proven to be very effective in destroying bacteria in drinking water and some wastewaters. However, because the UV light must reach the bacteria in wastewater in order to be effective, wastewater must be relatively clear and free of turbidity (have few suspended solid particles that give the wastewater a cloudy appearance). In turbid or very cloudy wastewater, the suspended solid particles will reflect and scatter much of the UV light, shielding some bacteria in the wastewater from the light and leaving them unharmed. This will result in inadequate disinfection. For this reason, UV light should not be used as the sole disinfectant on wastewaters with high suspended solids concentrations. It should also be noted that, unlike chlorination, UV disinfection provides no residual disinfection of wastewater. Since wastewater can easily be contaminated again, it should not be stored for a significant length of time before its release back into receiving waters from the treatment facility.

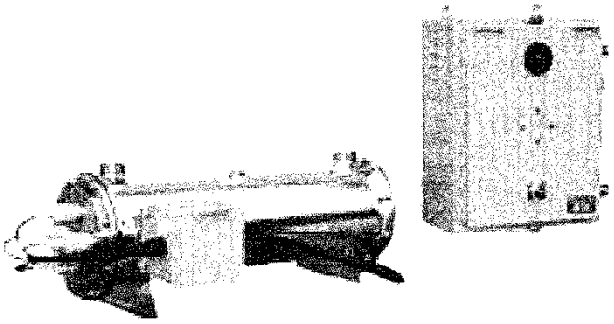
The UV disinfection system must not exceed the following effluent quality limits:

- Fecal Coliforms : 1000 CFU / 100 mL (monthly average)
  2000 CFU / 100 mL (grab sample)

The treatment system is composed of three (3) UV lamps:

- One (1) unit TROJAN, UV3000 PTP model, installed at the outlet of biodisk L333
- Two (2) units SEVERN TRENT, ULTRADYNAMICS model, currently installed at the outlet of LJ-1 and LJ-2 biodisks. Currently, these units are not in service.

3.2.5.2 Ultradynamics UV system



A) Equipment characteristics

Supplier	:	SEVERN TRENT SERVICES
Model – UV Intensity Monitor	:	8102-DM
Model – UV Reaction Chamber	:	8102-HO-60
Number of lamps	:	6
UV lamps rate	:	9000 hours or 1 year
Capacity	:	30 m³/h (clear wastewater, 65 % T)
Maximum operating pressure	:	150 psi
Power requirements	:	240 V, 1,3 kW, 5,6 amps
Maximum water temperature	:	38° C
Ambient temperature	:	2 to 43° C
Maximum start/stop cycles	:	4 per 24 hours
Minimum flowrate (to avoid heat)	:	0,7 m³/h (3 us gal/min)

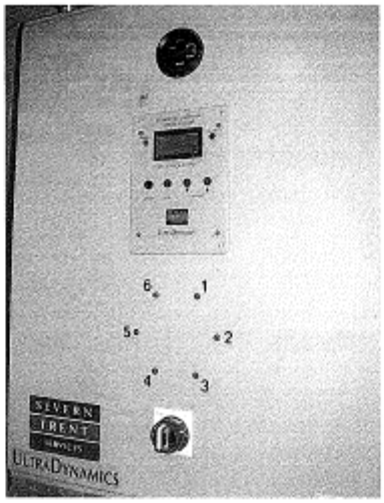
B) Equipment description

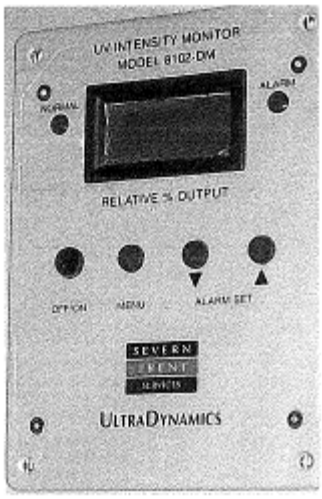
Ultraviolet disinfection performance is monitored with the UV Intensity Monitoring System. The Ultraviolet Intensity Monitoring System includes a monitor with digital display and indicator alarms mounted in a remote cabinet and a sensor assembly located at the lamp source.

Ultraviolet light intensity is monitored with a submersible UV Sensor designed for reliability in a water environment. The sensor transmits an electrical signal proportional to the UV intensity in the channel to the UV intensity monitor. The system is set to accurately indicate relative UV light intensity on a scale of 0 to 100%, with 100% representing the UV intensity in normal process effluent with clean quartz sleeves and new lamps in the UV system. Indicator lights and alarms on the UV intensity monitor keep the operator informed of UV system performance. The sensor is positioned in a UV reactor to measure the relative UV energy. Since the rate of quartz sleeve fouling and the water quality are consistent within the reactor, the readings from the UV intensity monitor are a good indication of performance.

UV Intensity Monitoring Systems measure relative UV intensity, not actual UV intensity. A reading of 100% represents the UV intensity registered with clean quartz sleeves, new lamps and normal water quality. Reductions in UV intensity are due to lamp aging, fouling of quartz sleeves, fouling of the diffuser on the sensor, and/or changes in water quality (suspended solids and percent transmission).

When cleaning the UV system quartz sleeve, it is also necessary to clean the UV sensor probe. Shut off water, relieve the system pressure and/or isolate (valve out) the UV chamber. Remove the monitor by unscrewing the white retaining nut and sliding the probe out of the sensor port. Deposits on the sensor probe are mostly caused by suspended and dissolved solids and minerals naturally occurring in the water. This coating can be easily removed by applying a small amount of lemon juice on a soft dry cloth and gently rubbing the sensor probe until clean, rinsing with hot water.





Ultraviolet lamps must be replaced every 10 to 12 months of continuous use, after every two (2) years of intermittent use, or when the monitor reads 60% of the new lamp output. **DO NOT WAIT** for the monitor to cut-off. Always stock spare lamps.

C) Operation and maintenance

Inspecting the Quartz Jackets:

As water passes through the UV unit, minerals, debris and other matter in the water will settle and deposit onto the quartz jackets. This will impair the ability of the UV rays to penetrate into the water. Therefore, it is necessary to determine a cleaning schedule for the quartz jackets, and the frequency will depend on the specific type of water used at your facility.

If the water has been processed through deionization, reverse osmosis, or distillation, the cleaning frequency can be set at once a year. If clear, fresh water is used, the probable cleaning frequency will be anywhere from once every thirty (30) days to once every six (6) months. You can determine the cleaning frequency by visually inspecting any quartz jacket to see if any debris or film has settled on the outside of the quartz jacket.

Severn Trent Services suggest to initially scheduling your first inspection after thirty (30) days of use and after the first month. If the quartz jacket is noticeably dirty, your cleaning frequency should be shortened; if the jacket is clean, the frequency can be lengthened.

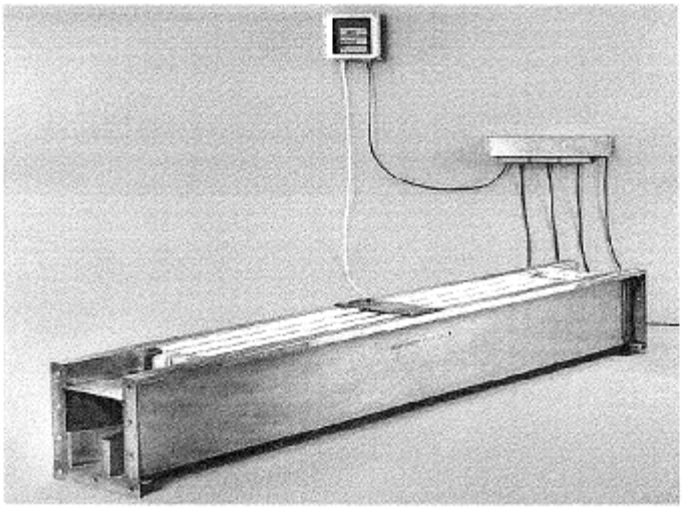
Cleaning the Quartz Jacket:

To clean the quartz jackets, first turn off the water, disconnect the electrical service and drain the UV chamber. Next, remove the UV lamps. Then loosen the compression nut and carefully remove the quartz jackets. The quartz jackets may be washed with a mild soap and hot water and rinsed clean with hot water. Should this be insufficient to clean the quartz jackets, use a mild abrasive cleaning agent. Be careful when cleaning the quartz jacket. It is fragile. Should a quartz jacket be damaged, it must be replaced.

Other Periodic Maintenance :

- ✓ Operate the quartz jacket wiper system regularly on manual models (push/pull stroke). You cannot overclean the quartz jacket(s).
- ✓ The exterior surfaces of the UV unit should be kept clean as part of routine maintenance. Use a soft cloth and water or any commercial stainless steel cleaner.
- ✓ Inspect for overhead piping leaks and correct as necessary to protect UV equipment.
- ✓ Measure the performance of the UV unit at sufficient intervals to ensure the effluent meets your requirements.

3.2.5.3 Trojan UV system



A) Equipment characteristics

Supplier	:	TROJAN TECHNOLOGIES
Model	:	UV3000 PTP
Model – UV Reaction Chamber	:	8102-HO-60
Number of lamps	:	
Number of module	:	
UV lamps rate	:	8 760 hours (1 year)
Capacity	:	
Power requirements	:	
Maximum water temperature	:	
Ambient temperature	:	
Maximum start/stop cycles	:	
Minimum flowrate (to avoid heat)	:	

B) Equipment description

The Trojan UV3000TMPTP is made of several components (some of which are optional):

- UV Module
- UV Lamps
- Quartz Sleeves, Springs, Spacers
- Lamp Holder Seal Assembly
- Effluent Channel
- Transition Boxes
- Power Distribution Receptacle
- Monitoring System UV Sensor
- Level Control Weir
- UV Module rack

UV Module

The UV module is the basic unit of the flowthrough UV bank. A bank is made up of UV modules placed in parallel within a single channel.

UV Lamps

Trojan supplied __ inch long UV lamps. The UV output after one year of use is approximately 80% of the output after the 100 - hour burn-in period. It should also be noted that frequent cycling shortens the life of the lamps.

Quartz Sleeves, Springs, Spacers

The quartz sleeves are made of Type 214 clear fused quartz circular tubing. They are rated 89% for UV transmittance and are not subject to solarisation. The sleeves protect the lamps from breakage and in conjunction with the spacer rings, they provide insulation. This assures minimum lamp temperature variations, which could affect the lamps performance.

Lamp Holder Seal Assembly

The open end of the lamp sleeve is sealed with a type 316 stainless steel sleeve nut which threads onto a sleeve cup and compresses the sleeve o-ring. The knurled surface of the sleeve nut allows a positive handgrip for tightening; it does not require any tools for removal. The lamp is held in place with a moulded lamp holder, which incorporates a triple seal. The lamp holder seals against the inside of the quartz sleeve to act as a second seal in series with the external o-ring seals.

Another seal on the lamp holder isolates and seals the lamp from the module frame and all other lamps in the module. If a quartz sleeve fracture happens, the seals of the lamp holder prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

Effluent Channel (Type K)

The effluent channel is typically made of 14 Type 304 stainless steel gauges, and comes complete with drain, UV module support rack and downstream serpentine weir.

Transition Boxes (optional)

Transition boxes are conceived to provide transition between the UV channel and flanged inlet and outlet pipes. The inlet transition box helps to ensure a plug flow condition that is conducive to more efficient disinfections.

Power Distribution Receptacle

The PDR consists of duplex ground fault interrupter receptacle that can be mounted in a location which allows convenient hook-up of UV Modules. The PDR is provided with a weatherproof cover. However, direct water sprays should be avoided.

Monitoring System UV Sensor

The submersible UV Sensor measures the UV intensity within each bank of UV lamp modules. The UV Sensor is mounted on a representative UV lamp module. The UV Sensor is calibrated in the factory and should not be altered, or its calibration changed. The monitoring system offers the main following features:

- A UV Sensor that continuously monitors the UV intensity produced in each bank of UV lamp modules.
- A 3 character display that indicates UV intensity in milliwatt per square centimeter (mW/cm2). This display will flash when the intensity drops below the Low UV Intensity Alarm setpoint.
- A 5 character display that indicates elapsed time in hours. The Elapsed Time display will flash when lamps will need to be changed in a near future.

Level Control Weir (optional)

A water level control weir controls the effluent level within the UV channel.

UV Module Rack

The UV Module Rack is a stainless steel support frame, which supports each bank of UV modules.

D) Operation and maintenance

To ensure maximum performance, it is essential that the quartz sleeves containing the UV lamps are kept clean. If coating is to building up on the sleeves, the amount of UV light transmitted to water is reduced. The cleaning interval for the UV modules depends on the effluent quality. Often, a hosing off of foreign matter clinging to the unit may be all that is required. Over a period of time, however, a coating will build up on the quartz sleeves and it will be necessary to clean them thoroughly.

Always clean quartz sleeves when intensity falls below 2,8 mW/cm2. Clean the UV Sensor at the same time.

CAUTION : ***Wear cotton gloves when handling quartz sleeves and lamps.***

The Trojan UV3000TMPTP sleeves' cleaning method is to manually hand wipe the quartz sleeves using a Trojan approved cleaning agent. The cleaning agent is applied using a cleaning cloth or sprayed on the quartz sleeves, then wiped off. See the Trojan Instruction Manual for the complete maintenance procedure.

The crest of the Level Control Weir and the channel must be clean periodically.

Lamps must be typically replaced every 8760 hours of operation (1 year), although the actual time varies according to the following factors: effluent temperature, power levels of lamps, and frequency of switching lamps ON and OFF. To ensure lamps are replaces at the proper time, it is best to replace all lamps in a scheduled operation, and to maintain a record of lamp replacement dates and elapsed timing on all lamps.

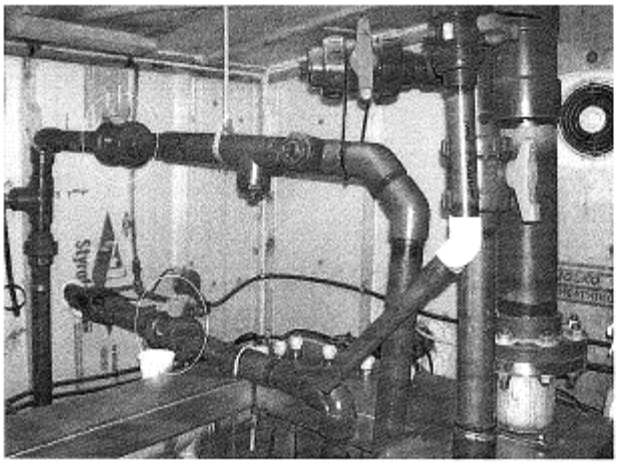
3.2.6 Lifting station n° 3

Pumping station LS-3 received the final effluent of the STP and grey waters (untreated) of Main Camp and Nova Camp wastewaters.

This station is equipped with two (2) MYERS submersible pumps and forces back waters towards the Tailing Storage Facility. Pumps control is ensured by four (4) level switch floats. Both pumps run simultaneously when the water level in the station reaches the level switch n° 3. Timers for the pumps' running time figured on the control panel.

The dimensions of the wet well are very limited (1,20 m x 0,9 m x 0,9 m), as well as the pumping flowrate capacity of the station. **No overflow pipe is present.** Overflowing can

thus occur, particularly when pumps upstream are manually started for more than a few minutes. For that reason, the ball valves installed on both grey waters 2 inches inlet pipes must be maintained partially closed (see photo below). Furthermore, Nova Camp's grey waters are pumped during the night, a low flow period.



4. PROCESS CONTROL

4.1 Summary

Operation of the RBC system is more than "just turning it on and letting run itself". The operator has a number of options even in plants with limited flexibility if he is willing to use his ingenuity.

Certain visual indicators, such as the appearance of different biomass colors, presence of odours and amounts of solids in the effluent of clarifiers and RBC overflow points, give and indication of how the process is working. These have been described in the lesson; however, they have to be related to the individual plant before they have true significance to the operator. They are valuable and should not be overlooked or discounted.

Additionally, certain lab tests are also described to tell whether the first stage is overloaded, whether nitrification might be expected in later stages, whether nitrification is occurring and reducing pH, how much DO is present, etc. Test results should be used to

make process control decisions, not simply to satisfy some regulatory requirement. Use of this information has been described.

Maintenance must be performed routinely and preventive steps taken to keep the process healthy. Lubrification of bearings, maintenance of other moving parts such as shafts, belts, chains, and media are all part of standard operation duties. The importance of this has been mentioned above.

Finally, the RBC units are depending on the correct functioning of the other processes. When all the parts of the process reviewed as tools needed to produce the final products, namely disposable solids and acceptable effluent, the operator can be proud of his job.

4.2 Sampling procedures

The analytical results of a sample are only as accurate as the quality of the sample taken. If your technique for collecting the samples is poor, then no matter how accurate your lab procedures are, the results will be poor. Buy sampling according to set procedures, you reduce the chance of error and increase the accuracy of your samples results.

Wastewater sampling is generally performed by one of two methods:

- grab sampling
- composite sampling

Grab sampling is just what it sounds like; all of the test material is collected at one time. As such, a grab sample reflects performance only at the point in time when the sample was collected, and only if the sample was properly collected.

Composite sampling consists of a collection of numerous individual discrete samples taken at regular intervals over a period of time, usually 24 hours. The material being sampled is collected in a common container over the sampling period. The analysis of this material, collected over a period of time, will therefore represent the average performance of a wastewater treatment plant during the collection period.

Numerous industry references list various parameters for wastewater testing and whether samples should be collected using grab sampling or composite sampling methods. For example, grab sampling allows the analysis of specific types of unstable parameters such as pH, dissolved oxygen, chlorine residual, and temperature.

However, the most widely used indicators of treatment plant performance, including BOD_5 (biochemical oxygen demand), TSS (total suspended solids) normally require the use of a 24 hours composite sampling techniques because routine variations in the volume and

strength characteristics of incoming wastewater create fluctuations in the quality of treatment plant effluent. Therefore, an effluent grab sample taken at one specific time throughout the daily flow pattern will not be representative of the system performance over the entire day.

In the absence of an automatic composite sampler on Meadowbank site, all the water samples collected to control and monitor the process are taken using grab samples.

Once a sample is taken, the constituents of the sample should be maintained in the same condition as when collected. When it is not possible to analyze collected samples immediately, samples should be preserved properly. Biological activity such as microbial respiration, chemical activity such as precipitation or pH change, and physical activity such as aeration or high temperature must be kept to a minimum. Methods of preservation include cooling, pH control, and chemical addition. Freezing is usually not recommended. The length of time that a constituent in wastewater will remain stable is related to the character of the constituent and the preservation method used.

4.3 Sampling points location

In order to make appropriate adjustments to the treatment plant, the operator should be able to take representative water sample at the following location of the STP as shown on Table 4.1.

Table 4.1 Sampling points location

Sampling point	Location	Test to perform		Comments
		On site by operator (each day)	Independant laboratory (each week)	
STP Influent		pH temperature	BOD5 COD TSS NH3-NH4 P tot	
Biodisks (First stage)		pH Temperature D.O. Media observation		
Biodisks (Last stage)		pH Temperature D.O. Media observation		
STP Effluent		pH Temperature D.O. Turbidity	BOD5 COD TSS NH3-NH4 P tot NO2-NO3 Fecal coliform	

4.4 Analysis results interpretation

There are a number of parameters and analyses that should be tested and tracked, beyond those required by the Government. This chapter is intended to introduce the reader to laboratory tests interpretation.

4.4.1 Independent laboratory analysis results

Biochemical Oxygen Demand (BOD) is the rate at which micro-organisms use the dissolved oxygen in the wastewater while stabilizing or breaking down decomposable organic matter. In decomposition, the organic matter serves as food for the bacteria.

The BOD is an index of the amount of oxygen that will be consumed by the decomposition of the organic matter in a wastewater.

The analysis consists of measuring the initial dissolved oxygen concentration in a water sample, and measuring the final dissolved oxygen after incubation for five (5) days (BOD_5) at 20 °C.

The STP has been designed to reduce total BOD of the effluent to approximately 15 mg/L.

The organic loading apply on a RBC must generally not exceed 5 g BOD / m² of Bio support media / day.

An increase of BOD on the effluent treated water is a sign of deterioration of the treatment process.

Chemical Oxygen Demand (COD) is a measure of the water capacity to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. Chemical Oxygen Demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific temperature conditions and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

Generally, COD is preferred to BOD in process control applications because results are more reproducible and are available in just a few hours rather than five (5) days.

The COD test is not a direct substitute for the BOD test; however, a ratio usually can be correlated between the two (2) tests. This requires COD versus BOD testing over a specified period of time.

On typical domestic wastewater, a ratio COD/BOD between 2 and 3 is usual. On treated effluent a ratio COD/BOD between 4 and 6 is usual.

Total Suspended Solids (TSS) are the particles which are either suspended in solution or slowly settled to the bottom. Wastewater treatment plants are designed to remove TSS from wastewater.

TSS of a water sample is determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size, then weighing the filter again after drying to remove all water. The gain in weight is a dry weight measure of the particulates

present in the water sample expressed in units derived or calculated from the volume of water filtered (typically milligrams per litre or mg/L).

Although turbidity purpose is to measure approximately the same water quality property as TSS, the latter is more useful because it provides an actual weight of the particulate material present in the sample. In water quality monitoring situations, a series of more labor intensive TSS measurements will be paired with relatively quick and easy turbidity measurements to develop a site-specific correlation.

The STP has been designed to reduce TSS of the effluent to approximately 15 mg/L.

An increase of TSS on the effluent treated water is probably a sign of insufficient sludge extraction in the biodisks's final clarifier.

Ammonia nitrogen (NH_3 and NH_4^+) is a form of nitrogen, which is a nutrient necessary for both plant and animal life. The Nitrogen Cycle is the natural conversion of nitrogen from one form to another through various biological processes. Wastewater treatment plants are generally designed to remove NH_3 from wastewater.

Large concentrations of ammonia create a large oxygen demand due to the conversion of ammonia to nitrate (NO_3) by nitrifying bacteria. Approximately 4.3 mg O_2 are consumed for every mg of ammonia-nitrogen oxidised to nitrate-nitrogen.

Nitrification is possible if sufficient detention time is created. There are two (2) bacterial species involved. *Nitrosomonas sp.* bacteria which oxidize ammonia to nitrite, while Nitrobacter bacteria convert nitrite to nitrate, with both species utilising the energy released by the reactions.

Between 7 to 8 mg of alkalinity in the form of HCO_3^- are consumed per mg of ammonia-nitrogen oxidised. This is quite a substantial amount of alkalinity and it will over a period of time dramatically change the character of the water during the treatment process, affecting pH stability. Nitrification process is the main reason of the pH water drop during the RBC treatment process.

The increase of nitrites (NO_2) and nitrates (NO_3) during the treatment process, and the decrease of ammonia nitrogen (NH_3 and NH_4^+) and pH is also an indication of the rate of nitrification during the treatment process.

Even if the STP system has been designed for ammonia/nitrate removal, there is no Government effluent quality limits for these parameters.

Controlling **phosphorus** discharged from municipal wastewater treatment plants is a key factor in preventing eutrophication of surface waters. The overall total phosphorus

removal obtained in a conventional biological wastewater treatment like the Meadowbank STP is generally very low, less than 20%.

4.4.2 On site analysis results

Temperature is an important factor for the treatment process. Settling properties are more effective at higher temperatures whereas colder conditions reduce the biological activity and organic removal efficiency decreases at wastewater temperatures below 15 °C.

Water will hold more dissolved oxygen at colder temperatures as compared to warmer temperatures. Water in the winter can hold almost twice as much Dissolved Oxygen (DO) as in the summer.

Biological activity and nitrification process decreases, however, as temperature decreases.

Covers on RBC provide protection against drop of water temperature and protect equipment and media from freezing during winter.

The term **pH** is a measure of the acidity or alkalinity of a liquid. The pH scale ranges from 0 to 14, with the acceptable range for wastewater typically being 6.0 to 8.5.

The microbiological organisms begin to become stressed at higher and lower pH which in turn results in lower treatment efficiencies.

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in the air. The measurement of turbidity is a key test of water quality.

A property of the particles —they will scatter a light beam focused on them — is considered a more meaningful measure of turbidity in water. Turbidity measured this way uses an instrument called a nephelometer with the detector setup to the side of the light beam. More light reaches the detector if there are lots of small particles scattering the source beam than if there are few. The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units (**NTU**). To some extent, how much light reflects for a given amount of particulates depends on properties of the particles like their shape, color, and reflectivity.

For this reason (and that heavier particles settle quickly and do not contribute to a turbidity reading), a correlation between turbidity and total suspended solids (TSS) is somewhat unique for each location or situation.

Dissolved Oxygen (DO)

In an aerobic RBC system, a biofilm is allowed to form on the medium, which is partly submerged in the wastewater and partly exposed to the air. The rotation alternately exposes this biofilm to atmospheric oxygen and wastewater. Oxygen transfers from the air to the RBC unit in three (3) ways: by oxygen absorption of the liquid film over the biofilm surface when the biofilm is in the air; by direct oxygen transfer to the air-water interface; and by direct oxygen absorption by the microorganisms during the air exposures.

Usually, as a consequence of an active respiration in the initial stages, the oxygen concentration reaches minimal levels, increasing along the reactor where substrate concentration is low.

During operation oxygen levels must be properly controlled and, to prevent from becoming a limiting factor, initial stages should have at least 1 mg/L of D.O.

Oxygen demand is the amount of DO required by bacteria and microorganisms to oxidize the influent organic waste. It is directly proportional to the organic strength of the influent waste. Therefore, oxygen requirements are dependent on BOD loading as well as the degree of treatment.

Alkalinity

Alkalinity is an indication of the acid neutralizing wastewater capacity. It is a measure of wastewater's resistance to changes in pH. The major components of alkalinity are carbonate (CO_3) and bicarbonate (HCO_3) species.

BOD removal causes a slight decrease in alkalinity. Ammonia (NH_3) removal, also known as nitrification, causes a significant decrease in alkalinity. During nitrification, NH_3 is converted to NO_3. Theoretically, 7.14 mg of alkalinity is consumed during the oxidation of 1 mg of NH_3.

When DO is not available, nitrate (NO_3) is used as an oxygen source. NO_3 removal, also known as denitrification, causes a slight increase in alkalinity. NO_3 is converted to N2 gas. Theoretically, 3.57 mg of alkalinity is created during the reduction of 1.0 mg of NO3.

When DO and NO_3 are not available, sulfate (SO_4) is used as an oxygen source. Organic nitrogen is used as a food source, which causes a significant increase in alkalinity. This leads to the generation of ammonia (NH_3).

4.5 Other process interpretations

4.5.1 Observing the media

Rotating biological contactors use bacteria and other living organisms growing on the media to treat waste. Because of this, you can use your senses of sight and smell to identify problems. The slime growth or biomass should have a brown to gray color, no algae present, a shaggy appearance with a fairly uniform coverage, and very few or no bare spots. The odour should not be offensive, and certainly there should be no sulfide (rotten egg) smells.

During operation, observations of the RBC movement, slime color and appearance are helpful in determining system performance; that is, they can indicate process conditions. If the unit is covered, observations are usually limited to that portion of the media that can be viewed through the access door.

A gray, shaggy appearing biological slime is indicative of a system designed strictly for BOD removal. A brown, thinner, less shaggy biological slime is indicative of a nitrifying system.

The Rotorzone is subdivided into four (4) sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the final settling tank.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

Black appearance

If the appearance becomes black and odours, which are not normal to occur, then this could be an indication of solids or BOD overloading. These conditions would probably be accompanied by low DO in the plant effluent. Compare previous influent suspended solids and BOD values with current test results to determine if there is an increase. To solve this problem, place another rotating biological contactor unit in service, if possible,

or try to pre-aerate the influent to the RBC unit. Also review the operation of the primary clarifiers and sludge digesters to be sure they are not the source of the overload.

White appearance

A white appearance on the disc surface also might be present during high loading conditions. This might be due to a type of bacteria which feeds itself on sulfur compounds. The overloading could result from industrial discharges containing sulfur compounds upon which certain sulfur loving bacteria thrive and produce a white slime biomass. Corrective action consists of placing another RBC unit in service or trying to pre-aerate the influent to the unit. During periods of severe organic or sulfur overloading, remove the bulkhead or baffle between stages one and two.

Another cause of overloading may be sludge deposits that have been accumulating in the bottom of the bays. To remove these deposits, drain the bays, wash the sludge deposits out and return the unit to service. Be sure the orifices in the baffles between the bays are clear.

Sloughing

Sloughing is the term used to refer to the process in which excess microbrial growth separates from the media and is washed to the secondary clarifiers with the treated wastewater. The excess slime will settle out in the secondary clarifiers and be removed from the system. Natural biological sloughing will occur from any fixed film reactor. It is a normal consequence of media growth.

If severe sloughing or low growth of biomass occurs after the start-up period and process difficulty arises, the causes may be due to the influent wastewater containing toxic or inhibitory substances that kill the organisms in the biomass or restrict their ability to treat wastes. To solve this problem, steps must be taken to eliminate the toxic substance even though this may be very difficult and costly. Biological processes will never operate properly as long as they attempt to treat toxic wastes. Until the toxic substance can be located and eliminated, loading peaks should be dampened (reduced) and a diluted uniform concentration of the toxic substance allowed reaching the media in order to minimize harm to the biological culture.

Another problem which could cause low biomass growth is an unusual variation in flow and/or organic loading. In small communities, one cause may be high flow during the day and near zero flow at night. During the day, the biomass is receiving food and oxygen and starts growing; then the night flow drops to near zero, available food is reduced and nearly stops. The biomass starts sloughing off again due to lack of food. Considering the presence of the Equalization tank, this problem should not occur.

4.5.2 Smell

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the Biodisks. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

When undesirable septic conditions appear, a classic "rotten egg" odour is noticeable. It results from the bacterial breakdown of organic matter in the absence of oxygen (anaerobic digestion). Remember that Hydrogen sulfide is a toxic gas.

4.5.3 Observing the clarifiers and final effluent

Clarification in the secondary clarifier is another major factor that affects performance. For example, shallow clarifier, as installed in Meadowbank, normally have difficulty containing the typically low density sludges. Low density sludge blanket are also easily disturbed by hydraulic (flow) fluctuations, and such disturbances can cause the loss of sludge particles (TSS) in the final effluent.

Rising sludge ('pop-ups') are particles or chunks of sludge floating to the surface of the clarifier. The sludge can be carried over the effluent weir, which results in elevated effluent TSS levels. The sludge is carried to the surface by bubbles of gas formed in the sludge blanket at the bottom of the clarifier or from sludge hung up on the walls of the clarifier. The gas may be either nitrogen or hydrogen sulfide gas (H_2S) formed from the biological decomposition of the sludge.

Some differences of the gas can be used to determine if the sludge is denitrifying or going septic at the bottom of the tank. Pop-ups caused by nitrogen are usually light brown to brown in color, and have no odour when broken up by a hose or cleaning brush. When pop-ups are caused by septic conditions, a classic "rotten egg" odour is noticeable when the sludge is hosed down or otherwise broken up, due to release of the hydrogen sulfide gas. The pop-ups are usually dark brown to black.

If sludge extraction frequency is too low, sludge can accumulate and be washed into the effluent or the sludge may remain in the clarifier but have no DO, causing the higher microorganisms to die or the bacteria to denitrify or go anaerobic and cause gas bubbles and rising sludge.

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. The turbidity measurement of the final effluent is a quick and easy method of checking the operation and performance of the RBC process. An increasing effluent turbidity indicates an unfavourable trend in process operation which should be promptly investigated and corrected.

Turbidity in the final effluent is chiefly due to biological floc that has carried out over in the clarifier effluent. Monitoring the sludge blanket in the clarifier is the most direct method available for determining when sludge extraction must be done.

4.5.4 Determination of the sludge blanket

The sludge levels accumulation can be directly measure with the Sludge Interface Detector supplied on site. The Raven SID-10200 utilizes the infrared light dispersion technology sensor probe to accurately determines the sludge blanket solid/liquid interface depth in primary tanks and clarifiers.

Sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone.

If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

4.6 Process parameters

4.6.1 Percent Removal Calculations

BOD, TSS, and NH_3 are all pollutants, which are present in large concentrations in the influent wastewater coming into a treatment plant. Through the treatment process, the concentrations of BOD, TSS and NH_3 are reduced.

The Percent Removal Calculation is used to determine the percentage of the incoming concentration of a particular pollutant (BOD, TSS or NH_3) that was removed through the treatment process. It is calculated as follows:

$$\text{Percent Removal (\%)} = \frac{(\text{Influent Concentration, mg/L}) - (\text{Effluent Concentration, mg/L})}{(\text{Influent Concentration, mg/L})} \times 100$$

Example

Influent BOD = 250 mg/L
Effluent BOD = 15 mg/L

$$\text{Percent Removal (\%)} = \frac{(\text{Influent Concentration, mg/L}) - (\text{Effluent Concentration, mg/L})}{(\text{Influent Concentration, mg/L})} \times 100$$

$$\text{Percent Removal (\%)} = \frac{(250\ \text{mg/L}) - (15\ \text{mg/L})}{250\ \text{mg/L}} \times 100$$

Percent Removal (%) = 94%

4.6.2 Organic loading

Organic loading is defined as the grams of Biochemical Oxygen Demand (BOD) introduced into the RBC basin per square meter of media surface area per day. The design of the media optimizes its available surface with the use of ridges and void spaces. Consequently, the media surface can not be accurately calculated by an operator and is provided by the manufacturer. See table in section 2.2.

Typical organic loading of a RBC is 4 to 6 grams BOD/day/m².

Increased organic loadings lead to increased biological slime thickness where dissolved oxygen becomes depleted. With higher organic loadings sulfur reducing filamentous bacteria (*Beggiatoa*) become abundant due to DO deficient conditions. This phenomenon is indicated by a white/gray colored biomass

Organic Load is calculated as follows:

$$\text{Organic Load (g BOD/day/m}^2\text{)} = \frac{\text{(BOD, mg/L) x (Flow, m}^3\text{/d)}}{\text{(Area, ft2)}}$$

Example 1

Calculate the organic loading on L333 Biodisks if the operation data are the following:

- Media Surface Area of L333 = 3390 m² (see table on Section 2.2)
- Influent Flow = 55 m³/d (flowmeter on P5 and P6 pumps of the EQT)
- Influent BOD = 240 mg/L (last result from independant laboratory)

$$\text{Organic Load} = \frac{\text{(240 mg/L) x (55 m}^3\text{/d)}}{\text{(3390 m}^2\text{)}}$$

$$\text{Organic Load} = 3{,}9 \text{ g BOD/day/m}^2$$

Example 2

Calculate the organic loading on the four (4) Biodisks if the operation data are the following:

- Media Surface Area of L333 = 3390 m² (see table on Section 2.2)
- Media Surface Area of each LJ-100 = 487 m² (see table on Section 2.2)
- Influent Flow = 78 m³/d (flowmeter on P5 and P6 pumps of the EQT)
- Influent BOD = 280 mg/L (last result from independent laboratory)

$$\text{Organic Load} = \frac{\text{(280 mg/L) x (78 m}^3\text{/d)}}{\text{(4851m}^2\text{)}}$$

$$\text{Organic Load} = 4{,}5 \text{ g BOD/day/m}^2$$

4.7 Process troubleshooting guide

This section of the manual presents troubleshooting procedures for solving common operating problems experienced in the Rotating Biological Contactors (RBC) process.

With each problem or observation, a list is included for the probable causes, checks to determine the cause, and the suggested corrective measures. You, the operator, must determine and select one or more of the corrective measures that will restore the process to its full efficiency with the least adverse effect on the final effluent quality.

There are different problems presented that frequently occur in operating the RBC process. In all of the guides presented, the probable cause given for the observation should be looked at concurrently because many times one problem may have several causes.

Table 7.3 – Troubleshooting Guide — Rotating Biological Contactors

(Adapted from *PERFORMANCE EVALUATION AND TROUBLESHOOTING AT MUNICIPAL WASTEWATER TREATMENT FACILITIES*, Office of Water Program Operations, US EPA, Washington, DC.)

INDICATOR/OBSERVATION	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTION
1. Decreased treatment efficiency.	1a. Organic overload.	1a. Check peak organic loads — BOD, SS, DO, pH, temperature.	1a. 1. Improve pretreatment of plant. 2. Place another RBC in service if available. 3. Remove bulkhead between stages 1 and 2 for larger first stage. 4. Recycle effluent as a possible short-term solution.
	1b. Hydraulic overload.	1b. Check peak hydraulic loads — if less than twice the daily average, should not be the cause.	1b. 1. Flow equalization; eliminate source of excessive flow. 2. Balance flows between reactors. 3. Store peak flows in collection system, monitor possible overflows of collection system.
	1c. pH too high or too low.	1c. Desired range is 6.5 - 8.5 for secondary treatment; 8 - 8.5 for nitrification.	1c. 1. Eliminate source of undesirable pH or add acid or base to adjust pH. When nitrifying, maintain alkalinity at 7 times the influent NH_3 concentration. 2. Sodium bicarbonate can be used to increase both pH and alkalinity.
	1d. Low wastewater temperatures.	1d. Temperatures less than 55°F will reduce efficiency.	1d. 1. Cover RBC to contain heat of wastewater. 2. Heat influent to unit or building.
2. Excessive sloughing of biomass from discs.	2a. Toxic materials in influent.	2a. Determine material and its source.	2a. 1. Eliminate toxic material if possible — if not, use flow equalization to reduce variations in concentration so biomass can acclimate. 2. Recycle effluent for dilution.
	2b. Excessive pH variations.	2b. pH below 5 or above 10 can cause sloughing.	2b. Eliminate source of pH variations or maintain control of influent pH.
	2c. Unusual variation in flow and/or organic loading.	2c. Influent flow rate(s) and organic strength.	2c. Eliminate/reduce variations by throttling peak conditions and recycling from the secondary clarifier or RBC effluent during low flows. 2d. Monitor industrial contributors for flow variations.
3. Development of white biomass over most of disc area.	3a. Septic influent or high H_2S concentrations.	3a. Influent odor.	3a. Pre-aerate wastewater or add sodium nitrate or hydrogen peroxide or place another RBC unit in service. Prechlorination of influent will also control sulfur-loving bacteria.
	3b. First stage is overloaded organically.	3b. Organic loading on first stage.	3b. 1. Improve pretreatment of plant. 2. Place another RBC in service, if available. 3. Adjust baffles between first and second stages to increase total surface area in first stage.
4. Solids accumulating in reactors.	4a. Inadequate pretreatment.	4a. Determine if solids are grit or organic.	4a. Remove solids from reactors and provide improved grit removal or primary settling.

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ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING SOLIDS

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Localized clouds of homogenous sludge solids rising in certain areas of the clarifier. Mixed liquor in settleability test settles fairly well with a clear supernatant.	A. Equipment malfunction.	1. Refer to Troubleshooting Guide No. 1, Observations 1-A, 2-A, and 2-B.		
		2. Check the following equipment for abnormal operation. a. Calibration of flow meters. b. Plugged or partially plugged RAS or WAS pumps and transfer lines. c. Sludge collection mechanisms, such as broken or worn out flights, chains, sprockets, squeegees, plugged sludge withdrawal tubes.	2) Repair or replace abnormal operating equipment.	pg II-77
		3. Check sludge removal rate and sludge blanket depth in clarifier.	3) Adjust RAS rates and sludge collector mechanism speed to maintain sludge blanket depth at 1 to 3 feet from clarifier floor.	pg II-29

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING SOLIDS (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
	B. Air or gas entrapment in sludge floc or denitrification occurring.	1. Perform sludge settleability test and gently stir sludge when settling to see if bubbles are released.	1) If the process is not nitrifying, refer to Probable Cause A above, and Troubleshooting Guide No. 7, Observation 2.	pg II-90
		2. If bubbles are released, check nitrate mg/l in secondary effluent to see if the process is nitrifying.	2) If the process is nitrifying, refer to Troubleshooting Guide No. 5, Probable Cause A.	
	C. Temperature currents.	1. Perform temperature and D.O. profiles in clarifier.	1) If temperatures exceed 1 to 2 degrees between top and bottom of clarifier, use an additional aeration tank and clarifier if possible.	pg II-81
		2. Check inlet and outlet baffling for proper solids distribution in clarifier.	2) Modify or install additional baffling in clarifiers.	pg II-81
			3) Refer to Probable Cause A-1, and A-2 above.	
	D. Solids washout due to hydraulic overloading.	1. Check hydraulic detention time in aeration tank and clarifier, and surface overflow rate in clarifier.	1) If hydraulic loadings exceed design capability, use additional aeration tanks and clarifiers if possible.	pg II-78
			2) Reduce RAS rate to maintain high sludge blanket depth in clarifier.	pg II-29
			3) If possible, change process operation to sludge reaeration or contact stabilization mode.	pg III-15
			4) Refer to Probable Causes B-1, B-2, and C-2 above.	

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ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING SOLIDS (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
2. Localized clouds of fluffy homogenous sludge rising in certain areas of the clarifier. Mixed liquor in settleability test settles slowly, leaving stragglers in supernatant.	A. Overloaded aeration tank (low MLSS) resulting in a young, low density sludge.	1. Check and monitor trend changes which occur in the following: a. Decrease in MLVSS, mg/l. b. Decrease in MCRT, Gould Sludge Age. c. Increase in F/M ratio. d. Lower air SCFM rate to maintain D.O. level.	1) Decrease WAS rates by not more than 10% per day to bring process back to optimum parameters.	pg II-97 & II-36

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 5 — SLUDGE CLUMPING

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Sludge clumps (from size of a golf ball to as large as a basketball) rising to and dispersing on clarifier surface. Bubbles noticed on clarifier surface. Mixed liquor in settleability test settles fairly well, however a portion of and /or all of the settled sludge rises to the surface within four hours after test is started.	A. Denitrification in clarifier.	1. Check for increase in secondary effluent nitrate level.	1) Increase WAS rate by not more than 10% per day to reduce or eliminate level of nitrification. If nitrification is required, reduce to allowable minimum.	pg II-90 & II-36
		2. Check loading parameters.	2) Maintain WAS rates to keep process within proper MCRT, Gould Sludge Age, and F/M ratio.	pg II-36
		3. Check D.O. and temperature levels in the aeration tank.	3) Maintain D.O. at minimum level (1.0 mg/l). Be sure adequate mixing is provided in the aeration tank.	pg II-24
		4. Check RAS rates and sludge blanket depth in clarifier.	4) Adjust RAS rate to maintain sludge blanket depth of 1 to 3 feet in clarifier.	pg II-29
	B. Septicity occurring in clarifier.	1. Refer to Troubleshooting Guide No. 1, Observation No. 2.		
		2. See 3 and 4 above.		

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 6 — CLOUDY SECONDARY EFFLUENT

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Secondary effluent from clarifier is cloudy and contains suspended matter. Mixed liquor in settleability test settles poorly, leaving a cloudy supernatant.	A. MLSS in aeration tank low due to process start-up.	1. Refer to Troubleshooting Guide No. 2, Observation No. 1.		
	B. Increase in organic loading.	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of protozoa.	1) If no protozoa are present, possible shock organic loading has occurred.	pg II-93 & IV-18
		2. Check organic loading on process.	2) Reduce WAS rate by not more than 10% per day to bring process back to proper loading parameters and increase RAS rates to maintain 1 to 3 foot sludge blanket in clarifier.	pg II-42 & II-36
		3. Check D.O. level in aeration tank.	3) Adjust air SCFM rate to maintain D.O. level within 1.0 to 3.0 mg/l.	pg II-24
	C. Toxic shock loading.	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of inactive protozoa.	1) If protozoa are inactive, possibility of recent toxic load on process.	pg II-93
			2) Refer to Troubleshooting Guide No. 2, Observation No. 1-C.	

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ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 6 — CLOUDY SECONDARY EFFLUENT (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
	D. Overaeration causing mixed liquor floc to shear.	1. Perform microscopic examination on mixed liquor. Check for dispersed or fragmented floc and presence of active protozoa.	1) Refer to Troubleshooting Guide No. 1, Observation No. 1-A.	pg IV-18
	E. Improper D.O. levels maintained in aeration tank.	1. Refer to Troubleshooting Guide No. 1, Observation No. 2.		

5. TROUBLESHOOTING GUIDES

This section presents a summary of Troubleshooting Guides gathered in the available Operation and Maintenance Manuals.

The Troubleshooting Guide in this section only applies to trouble, probable cause, and corrective solution that can occur on mechanical equipment. The problems and solutions related to the process are in Section 4.

For more information, refer to Operation and Maintenance Manual before working on equipment.

5.1 MOTOR AND GEARBOX – BIODISK L333

See appendix A

5.2 TROJAN UV 3000 – BIODISK L333

See appendix B

5.3 PYROTENAX INDUSTRIAL HEAT TRACING – BIODISK LJ-100

See appendix C

5.4 SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100

See appendix D

5.5 GREY LINE FLOWMETER DFM 4.0 - EQT

See appendix E

5.6 YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER

See appendix F

5.7 HACH – SENSION 6 DISSOLVED OXYGEN METER

See appendix G

6. RECORD KEEPING

The operators of the Sewage Treatment Plant (STP) are important players behind any effluent treatment successful story. In successful organizations, the operators are typically tasked with specific responsibilities that include daily chores such as general daily inspection of the STP to ensure that there is no effluent pipe leakages or equipment breakdown, preventive maintenance and performance monitoring, sampling, record keeping, etc. These activities need to be conducted in a coordinated manner to ensure proper functioning of all the STP components.

Monitoring, recording, and reporting of the STP performance are required to demonstrate that the treatment system is functioning correctly and the effluent standards are being complied with.

A successful effluent treatment depends on all components of the STP being operational and in optimal condition. Problems with any system components will affect the overall efficiency of the STP, resulting in poor effluent quality. To ensure a successful treatment and regulatory compliance, each of the treatment processes (unit processes and unit operations) needs close monitoring on a regular basis.

It is recommended to maintain the performance monitoring data and corrective actions taken record to address problems encountered in the STP daily operation. The tables recommended to use are shown in the next pages. The record should be kept in a log or in a file and should be available on demand.

SECTION 7 TROUBLESHOOTING

7.1 Error Codes

Error codes inform the user of an out-of-range value or meter problem. *Table 6* outlines the operator assistance codes available in the meter series.

Table 6

Error Code	Error Type	Possible Remedy
E-1	Data error in the non-volatile memory.	Turn off the meter, then turn it on again.
E-3	Failure to correctly store a reading.	Call Service. Meter cannot store data in at least one location, but is otherwise functional.
E-9	Failure to correctly retrieve a reading that was stored earlier.	Call Service.
E-10	Sample temperature is out of range (0 to 50 °C).	

Note: *To display the electric current coming from the dissolved oxygen electrode, press the* **READ** *and* **CONC** *% keys simultaneously.*

Appendix A

MOTOR AND GEARBOX – BIODISK L333

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. Bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. Chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

Motor Trouble Shooting Chart

Problem	Likely Causes	What To Do
Motor fails to start upon initial installation.	Motor miswired.	Verify motor is wired correctly.
	Motor damaged and rotor is striking stator.	May be able to reassemble; otherwise, motor should be replaced.
	Fan guard bent and contacting fan.	Replace fan guard.
Excessive humming	High voltage.	Check input line connections
Motor had been running, then fails to start.	Fuse or circuit breaker tripped.	Replace fuse or reset breaker.
	Stator is shorted or went to ground. Motor will make a humming noise and the circuit breaker or fuse will trip.	Contact NORD for assistance
	Motor overloaded or load jammed.	Inspect to see that the load is free. Verify amp draw of motor versus nameplate rating.
Motor runs but dies down.	Voltage drop.	If voltage is less than 10% of the motor's rating contact power company or check if some other equipment is taking power away from the motor.
	Load increased.	Verify the load has not changed. Verify equipment hasn't got tighter. If fan application verify the airflow hasn't changed.
	Bad bearings.	Noisy or rough feeling bearings should be replaced.
	Voltage too low.	Make sure that the voltage is within 10% of the motor's nameplate rating. If not, contact power company or check if some other equipment is taking power away from the motor.
Motor runs in the wrong rotation.	Incorrect wiring.	Disconnect from power source and interchange any two of the three line leads from the three-phase motor.
Vibration	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Resonance.	Tune system or contact NORD for assistance.
Motor overload protector continually trips.	Load too high.	Verify that the load is not jammed. If motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a stock motor may not be able to duplicate the performance. Remove the load from the motor and inspect the amp draw of the motor unloaded. It should be less than the full load rating stamped on the nameplate.
	Ambient temperature too high.	Verify that the motor is getting enough air for proper cooling. Most motors are designed to run in an ambient temperature of less than 40° C. (Note: A properly operating motor may be hot to the touch.)
	Winding shorted or grounded.	Inspect stator for defects, or loose, cut wires that may cause it to go to ground.

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TROUBLE SHOOTING

PROBLEM WITH THE REDUCER		POSSIBLE CAUSES	SUGGESTED REMEDY
Runs Hot	Overloading	Load exceeds the capacity of the reducer	Check rated capacity of reducer, replace with unit of sufficient capacity or reduce load
	Improper lubrication	Insufficient lubrication	Check lubricant level and adjust up to recommended levels
		Excessive lubrication	Check lubricant level and adjust down to recommended levels
		Wrong lubrication	Flush out and refill with correct lubricant as recommended
Runs Noisy	Loose foundation bolts	Weak mounting structure	Inspect mounting of reducer. Tighten loose bolts and/ or reinforce mounting and structure
		Loose hold down bolts	Tighten bolts
	Worn RV Disc	Overloading unit may result in damage to disc	Disassemble and replace disc. Recheck rated capacity of reducer.
	Failure of Bearings	May be due to lack of lubricant	Replace bearing. Clean and flush reducer and fill with recommended lubricant.
		Overload	Check rated capacity of reducer.
	Insufficient Lubricant	Level of lubricant in the reducer not properly maintained.	Check lubricant level and adjust to factory recommended level.
Output Shaft Does Not Turn	Internal parts are broken	Overloading of reducer can cause damage.	Replace broken parts. Check rated capacity of reducer.
		Key missing or sheared off on input shaft.	Replace key.
		Coupling loose or disconnected.	Properly align reducer and coupling. Tighten coupling.
Oil Leakage	Worn Seals	Caused by dirt or grit entering seal.	Replace seals. Autovent may be clogged. Replace or clean.
		Overfilled reducer.	Check lubricant level and adjust to recommended level.
		Autovent clogged.	Clean or replace, being sure to prevent any dirt from falling into the reducer.
		Improper mounting position, such as wall or ceiling mount of horizontal reducer.	Check mounting position. Name tag & verify with mounting chart in manual.

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Appendix B

TROJAN UV 3000 – BIODISK L333

13.1 Basic System Troubleshooting

UV module (UVM) troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. One UV lamp status LED is off	Corresponding lamp is off	Lamp failure	Replace lamp
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
	Corresponding lamp is on	Module Board (MCB)	Replace module board
2. Two UV lamp status LEDs are off (lamps 1&2 or lamps 3&4)	Corresponding lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	Both LEDs are off in a two-lamp module	No power to the module	Inspect module power cable – is it plugged-in or damaged? Reset ground fault of PDR or reset PDR supply breaker
	Corresponding lamps are on	Module Board (MCB)	Replace module board
3. All UV lamp status LEDs are off	All lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	All lamps are on	Module Board (MCB)	Replace module board
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Power Distribution Receptacle (PDR) Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Ground Fault (GFI) trips	GFI trips for a specific module only	Cracked sleeve causing water intrusion	Replace sleeve
		Faulty o-ring causing water intrusion	Replace o-ring
		End-cap assembly causing water intrusion	Inspect and repair or replace end-cap assembly
		Faulty or cut wiring	Inspect and repair or replace faulty wiring
	GFI trips for any module	Faulty wiring at GFI	Inspect and repair or replace wiring as necessary
		Faulty GFI receptacle	Replace GFI receptacle
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Monitoring System Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Elapsed Time display flashing		Elapsed time displays 9500-10,000, 19,500-20,000… hours	Replace lamps. Display will stop flashing after 10,000, 20,000… hours
2. UV intensity display is flashing and displaying 0.0mW/cm^2		Sensor cable is not connected to monitoring system	Reconnect UV sensor to monitoring system
		Fouled sleeve and/or sensor	Clean sleeve and sensor as required
		Loose or no connection at TB5 terminal in monitoring system enclosure	Tighten or reconnect wiring at terminal
3. UV intensity display is flashing and displaying value less than alarm set point (1.6 mW/cm^2)		Fouled sleeve and/or sensor	Clean sleeve and sensor as required
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Appendix C

PYROTENAX INDUSTRIAL HEAT TRACING
BIODISK LJ-100

10 Troubleshooting Guide

Symptom	Probable Causes	Corrective Action
Insulation resistance less than expected	1. Rainy or high humidity.	(1) Dry tails and face of seal.
	2. Nicks or cuts in heating cable sheath, with moisture present.	(2, 3, 4) Visually inspect cable for damage, especially at elbows, flanges, and around valves. If damaged, repair or replace heating cable. Inspect power connection box for moisture or signs or tracking. Dry out connections and retest.
	3. Kinked or crushed heating cable.	
	4. Arcing created by damage to the heating cable.	
	5. Physical damage to heating cable is causing a direct short.	(5) Check for visual indications of damage around the valves, pump, and any area where there may have been maintenance work. Look for crushed or damaged insulation along the pipe. Replace damaged sections of heating cable.
	6. Presence of moisture in terminations or connections.	(6) Dry out cold lead and/or connections and replace termination if necessary.
	7. Damaged termination.	(7) Replace termination

Symptom	Probable Causes	Corrective Action
Circuit breaker trips	1. Circuit breaker undersized.	(1) Recalculate circuit load current. Resize breaker as required.
	2. Defective circuit breaker.	(2) Repair or replace breaker.
	3. Short circuit in electrical connections.	(3, 4) Eliminate short circuit. Thoroughly dry connections. Install conduit drains as required.
	4. Excessive moisture in connection boxes.	(5, 6) Repair damaged section or replace heating cable.
	5. Nicks or cuts in heating cable sheath, moisture present.	(7) Replace undersized GFPD with 30mA GFPD. Check the GFPD wiring instructions.
	6. Kinked or crushed heating cable.	
	7. Ground-fault protection device (GFPD) is undersized (5mA used instead of 30mA) or miswired.	

Note: *If the corrective actions above do not resolve the problem, verify that the installation is as per design.*

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10 Troubleshooting Guide

Symptom	Probable Causes	Corrective Action
Power output appears correct but pipe temperature is below design maintain temperature.	1. Wet or missing insulation.	(1) Remove wet insulation and replace with dry insulation and secure it with proper weather-proofing.
	2. Insufficient heating cable on valves, flanges, supports, pumps, and other heat sinks.	(2) Confirm compliance with system design. (If valve, flange, and pipe support types and quantities have changed, additional heating cable may be required.)
	3. Temperature controller set incorrectly.	(3) Reset temperature controller.
	4. Improper thermal design used.	(4) Contact your Tyco Thermal Controls representative to confirm the design and modify as recommended.
	5. Temperature sensor in wrong location.	(5) Confirm that sensor is in the correct location.
	6. Low fluid temperature entering pipe.	(6) Verify temperature of fluid entering pipe.

Symptom	Probable Causes	Corrective Action
Power output is zero or incorrect	1. No input voltage.	(1) Repair electrical supply lines and equipment.
	2. Temperature controller wired in the normally open (N.O) position.	(2) Confirm wiring using the normally closed (N.C.) terminals so that contacts close with falling temperature.
	3. Broken or damaged heating element, hot-cold joint, end cap, or broken tail.	(3) Repair or replace heating cable.
	4. Wrong cable used.	(4) Verify installation as per design and replace cable if necessary.
	5. Improper voltage used.	(5) Verify voltage and connect to proper voltage if necessary.

Note: *If the corrective actions above do not resolve the problem, verify that the installation is as per design.*

Appendix D

SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100

6 TROUBLESHOOTING CHART

Trouble	Probable Cause	Corrective Action
1. Low UV Output	a. Dirty quartz jacket b.Old or broken quartz jacket c.Old Uv lamps d.Water or condensation inside quartz jacket	a.Remove and clean quartz jacket b.Replace quartz jacket c.Replace UV Lamps d.Remove jacket and dry internal quartz
2.Low voltage output	a.Bad regulator	a.Replace regulator
3.Lamp out	a.Bad lamp b.Bad ballast	a.Replace lamp b.Replace ballast
4.Low UV transmission	a.dirty, cloudy or high mineral count	a.Install pre-filter or de-mineralizer
5.Sensor inoperative	a.Dirty sensor lens	a.Remove and clean lens
6.Sensor malfunctioning	a.Water or condensation inside sensor b.Sensor calbe not connected	a.Remove and dry inside sensor b.Verify that the sensor cable is connected to the monitor
7.Monitor not operating	a.Sensor cable not connected b.Monitor switch in the OFF position c.No power to monitor d.Incorrect power supply to monitor.	a.Verify that the sensor cable is connected to the monitor b.Verify that the monitor switch is in the ON position c.Verify power to monitor. d.Verify power supply voltage to monitor, either 120 Vac or 240 Vac.

Design improvements may be made without notice.
Represented by:

SEVERN TRENT SERVICES

Severn Trent Services
3000 Advance Lane Colmar, PA 18915
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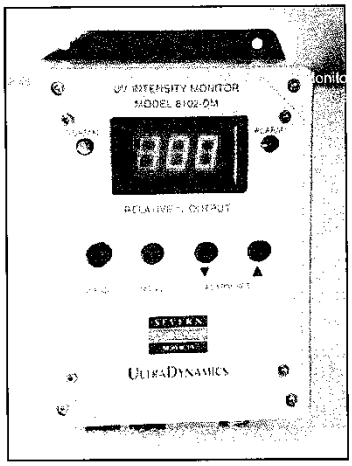
E-mail: marketing@severntrentservices.com

Maintenance:
(Reference Figure 1 & 3)
Listed in the below table are possible causes for a reduced reading of UV intensity.

Indication	Cause	Corrective Action
Gradual loss of UV intensity over several weeks or months	Fouled quartz sleeve	Follow UV System instruction manual for quartz sleeve cleaning procedure
Gradual loss of UV intensity over a 1 year period	Lamp degradation	Replace UV lamp - lamps last for 1 year Refer to UV system instruction manual
Total loss of UV intensity Check lamp status alarm	Lamp failure	Replace UV lamp Refer to UV system instruction manual
Gradual or total loss of intensity after the above have been ruled out	Change in water quality	Increase in suspended or dissolved solids may require installation of pre-filter

When cleaning the UV system quartz sleeve it is also necessary to clean the UV sensor probe. Shut off water, relieve the system pressure and/or isolate (valve out) the UV chamber. Remove the monitor by unscrewing the white retaining nut and sliding the probe out of the sensor port.

Deposits on the sensor probe are mostly caused by suspended and dissolved solids and minerals naturally occurring in the water. This coating can be easily removed by applying a small amount of lemon juice to a soft dry cloth and gently rubbing the sensor probe until clean, rinsing with hot water.



Detailed Menu Level Description

L01 Press the menu key once. L01 will be displayed. Press the menu key again. The preset alarm level will be displayed. Use the up and down keys to select the new alarm level. Press the menu key return to return to the Relative % Output display. The new alarm level will be set. If the up or down keys are not activated for longer then two seconds, the unit will default to the Relative % Output display.

L02 This function is not used on the Series 8102–DM /P. Changing this value will have no affect on the unit's operation.

L03 Press the menu key once. Press the up key twice to display L03. Press the menu key once. The absolute detector current will be displayed in milliamperes. Press the menu key again to return to the Relative % Output display.

L04 Press the menu key once. Press the up key three times to display L04. Press the menu key once. The absolute detector voltage will be displayed in Volts. Press the menu key again to return to the Relative % Output display

L05 Consult Factory, not for customer use.

Appendix E

GREYLINE FLOWMETER DFM 4.0 EQT

FIELD TROUBLESHOOTING

Possible Causes:	*Corrective Action:*
METER READING LOWER THAN EXPECTED	
Calibration Error	• Review UNITS/MODE menu and Pipe ID
Lower flow rate than expected	• Investigate pump/valves. Compare velocity with alternate instrument
Signal not penetrating far enough into the flow stream	• Relocate sensor closer to elbows or flow disturbances
Improper mounting of sensor	• Reinstall Sensor with careful application of Coupling Compound
Pipe is not full	• Remount Sensor on vertical pipe
METER READING WHEN THERE IS NO FLOW	
Vibration on pipe	• Install in another location
Local electrical noise	• Ensure all Flowmeter wiring is in METAL conduit and sensor shield is properly grounded. • Ensure correct power input Ground connection (<1 ohm resistance). • Ensure 4-20mA Shield connected to Instrument Ground stud.
Cross talk between two or more DFM 4.0 flowmeters on same pipe	• Turn OFF one flowmeter or relocate the second flowmeter at a greater distance.
Variable Speed Drive interference	• Follow Drive manufacturers wiring and Grounding instructions • Relocate Flowmeter electronics, Sensor and wiring away from VSD
Valve leak or Reverse flow	• Test Valve. Relocate Sensor farther from valve • Use Backflow Rejection
Sensor connections incorrect	• Refer to Connections diagram

Possible Causes:	*Corrective Action:*
METER READING ERRATIC	
Sensor mounted too close to valve, pump or elbow	• Change sensor placement. Recommended 6-10 diameters from elbows, and 30 diameters from pumps, controlling valves, orifice plates, nozzles or open pipe discharge
NO FLOW INDICATION	
Not enough suspended particles or gases in the fluid	• Relocate sensor in more turbulent pipe section. Mount sensor at 12 o'clock position on horizontal pipe
Coupling compound washed out, or sensor loose on pipe	• Remount sensor • Use Dow Corning Silicone #4
`Slave` selected in `SPECIAL FUNCTIONS` menu with no Synchronization input from Master.	• Select `Master` in `SPECIAL FUNCTIONS` menu.
Power interruption. No flow.	• Check fuse/breaker. Confirm flow
METER READING TOO HIGH	
Calibration error	• Review UNITS/MODE menu and Pipe ID
Vibration or noise on the pipeline	• Install in another location.
Pipe is not full	• Remount Sensor on vertical pipe
Nearby velocity increasing device (pump, valve, orifice plate)	• Relocate sensor >30 pipe diameters from velocity increasing device
Local electrical noise	• Ensure all Flowmeter wiring is in METAL conduit and sensor cable shield is connected to Ground stud
Variable Speed Drive interference	• Follow Drive manufacturers wiring and Grounding instructions • Relocate Flowmeter electronics, Sensor and wiring away from VSD

Possible Causes:	*Corrective Action:*
METER READING DOES NOT TRACK FLOW	
Sensor and GND wires reversed or not properly connected	• Check Sensor connections
Improper AC power input Ground	• Use direct connection with 12 AWG wire to nearest Ground pole (<1 ohm resistance).

Appendix F

YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER

TROUBLESHOOTING

NOTE: An error displayed briefly during the first few seconds after turning the instrument on does NOT indicate a problem.

SYMPTOM	POSSIBLE SOLUTION
1. Instrument will not turn on, LCD displays "LO BAT", or Main display flashes "OFF"	A. Low battery voltage, replace batteries B. Batteries installed incorrectly, check battery polarity C. Return system for service
2. Instrument will not calibrate.	A. Replace membrane and electrolyte B. Clean probe electrodes C. Return system for service
3. Instrument "locks up".	A. Remove batteries, wait 15 seconds for reset, replace batteries B. Replace batteries C. Return system for service
4. Instrument readings are inaccurate.	A. Verify calibration altitude and salinity settings are correct and recalibrate. B. Probe may not have been in 100% water saturated air during calibration procedure. Moisten sponge in calibration chamber and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
5. Main display reads "Over" or "Undr".	A. Sample O_2 concentration is more than 60 mg/L or 500%, or less than –0.02 mg/L or -0.3%. B. Verify calibration altitude and salinity settings are correct and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
6. Main display reads "Over" or "Undr" during calibration.	A. Replace membrane and electrolyte. Recalibrate. B. Clean probe electrodes. C. Return system for service.
7. Secondary display reads "Ovr" or "Undr".	A. Sample temperature is less than -5° C (23°F) or more than +45°C (122°F). Increase or decrease the sample temperature to bring within the allowable range. B. Return system for service.

Appendix C: STP Sample Sheets

MEADOWBANK STP - MONTHLY REPORT

Month: **February 2010** **Average flow:**

PARAMETER	INFLUENT	EFFLUENT	EFFICIENCY	COMMENTS
Independant laboratory				
BOD (mg/L)				
COD (mg/L)				
TSS				
TKN				
NH3-NH4				
NO2-NO3				
P tot				
Fecal Coliform				
On site				
pH				
Alkalinity				
D.O.				
Turbidity				
Temperature		22		

Sludge extractions (m^3)	Primary tanks	Final Clarifier	Comments
LJ-1			
LJ-2			
LJ-3			
L-333			
Total			

MEADOWBANK STP - WEEKLY ANALYSIS

Month: ____________

DATE:						Average
STP - INFLUENT						
BOD_5 (mg O_2/L)						
COD (mg O_2/L)						
TSS (mg/L)						
TKN (mg N/L)						
NH_3-NH_4 (mg N/L)						
P tot (mg/L-P)						
STP - FINAL EFFLUENT						
BOD_5 (mg O_2/L)						
COD (mg O_2/L)						
TSS (mg/L)						
TKN (mg N/L)						
NH_3-NH_4 (mg N/L)						
NO_2-NO_3 (mg N/L)						
P tot (mg/L-P)						
Fecal Coliform (UFC/100 mL)						

Comments :

MEADOWBANK MINE - SEWAGE TREATMENT PLANT

Month: ____________________ 201____

Date	Time	Operator	Concentration of gaz at L-333				COMMENTS
			CO Level (ppm)	O_2 Level (%)	Comb/Ex	H_2S (ppm)	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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31							

MEADOWBANK MINE - SEWAGE TREATMENT PLANT

Month: ____________________ **201** ____

			LJ -1				LJ -2				L 333			FINAL EFFLUENT				Grey Water LS-3	
Date	Time	Operator	D.O		pH	Temp	D.O		pH	Temp	D.O	pH	Temp	D.O	pH	Temp.	Colour	pH	Temp
			In (mg/L)	Out (mg/L)	Out	Out (°C)	In (mg/L)	Out (mg/L)	Out	Out (°C)	Out (mg/L)	Out	Out (°C)	(mg/L)		(°C)			(°C)
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Appendix D: Site Services Protocols and Procedures

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

PROCEDURE NUMBER:			MBK-SIT-0025
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

To

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓

Impacts			
Health & Safety	Process/Quality	Costs	Environment

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

Procedure	Risks/ Impacts
The screen in the top left corner of the panel is what is used for controlling the pumps	
1. Start at the screen "SYSTEM STATUS MENU"	Prevent incident and /or accident; health issues
2. If the screen is not at "SYSTEM STATUS MENU" press "DISP" (DISPLAY)	Prevent incident and /or accident; health issues
3. If the "DISP" is not showing but a "PREV" is, press the "PREV" until you come to "DISP"	
4. Press the "DISP" key and that will take you to the "SYSTEM STATUS MENU"	
5. For pumps 1 & 2 which currently feed LJ #1 press PAIR 1 , "ON & OFF SCREEN"	
6. For pumps 3 & 4 which currently feed LJ #3 press PAIR 2 , "ON & OFF SCREEN"	
7. For pumps 5 & 6 which currently feed L333 press PAIR 3 , "ON & OFF SCREEN"	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

8. After pressing the pair of pumps you want to change press NEXT (middle right)	
9. You will see the "PUMP PAIR " screen	
10. Press Next	
11. You will now be at the "FLOW RATE & ENABLE " screen	
12. Press ADFI(l/s) (top left corner)	
13. Curser will be flashing on the last number on right	
14. Using the BS (Back space key) press until you are at the number you would like to change	
15. i.e. +0.4500 on the screen presently	
16. Each time you press the BS key you will remove a number from the left	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

17. Pressing BS 4 times will bring you to +0	
18. If you want to change it to +0.5150 , press the 5 , then the 1 , and the 5, not necessary to press 0	
19. After you have done this press "ENT" (bottom left)	
20. The ADF(Average Daily Flow) on the pump has now been changed	
21. To get back to the main menu	
22. Press "PREV"(bottom middle)	
23. Then press "DISP"	
24. You are now back to the main menu	
25. The above instructions are for pairs #1 & #3	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

26. **Pair # 2 is a little different**	
27. **You will notice that in pairs #1 & #3 the number you have programmed into the" ADFl (l/s)" screen of the "FLOW RATE & ENABLE" screen is the same as in the "PUMP PAIR " screen**	
28. **Pump #2 will have a lower number in the "FLOW RATE & ENABLE" screen than in the "PUMP PAIR" screen *(It is just the way it has been programmed)***	
29. **i.e. in order to get 45 seconds on the "PUMP PAIR " screen you have to enter +0.2800 in the ADFl(l/s) screen of the "FLOW RATE & ENABLE" screen**	
30. **The ADFl(l/s) number is approx. 63% of the seconds (not including the decimal point)**	
31. **You will just need to play with it a bit to get the number you want**	
32. **Important:** If you happen to press "ENABLE" in the "FLOW RATE & ENABLE" screen by mistake and it is now at "DISABLE" just press the "DISABLE" and it will go back to "ENABLE"	
33. **When you are at the first menu ("SYSTEM STATUS MENU") ensure that the pairs 1 , 2 & 3 all have an "EN" displayed if all pumps are being used**	
34. If not , go to the pair that has a "DIS" on it , press that pair	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

35. Press "NEXT" to get to the "FLOW RATE & ENABLE" screen	
36. Press on "DISABLE" to change it back to "ENABLE"	
37. Press "PREV"	
38. Press DISP"	
39. You should be back at the Main Menu	

Personal Hygiene at STP

Personal Hygiene Protocol to follow when working at the Sewage Treatment Plant and Lift Stations

Daily Inspection and readings

Lab coat

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Testing - every second day

Lab coat

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Cleaning Lift Station #3

Tyvek suit

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Cleaning/Changing U.V. lamps - Little Johns/L333

Tyvek suit

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Personal Hygiene Protocol to follow when working at the Sewage Treatment Plant and Lift Stations

Sludge measurement

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Sludge removal

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses with full face shield/full face respirator

- Shower required

Changing Pumps in influent lift stations/working on pipes - raw sewage (plumbers?)

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses

- Shower required

Changing Pumps in effluent lift stations/working on pipes (plumbers?)

Tyvek suit

Boot covers

Nitrile gloves - rubber gloves if required

Safety glasses

- Shower required

SAMPLING AND TESTING

TARGET ANALYSIS RESULTS

	TARGET	ACCEPTABLE
pH	6.5 - 8.0	6.0 - 8.5
D.O. in	> 1.0 ppm	> .3 ppm
D.O. out	> 4.0 ppm	> 2.0 ppm
Temperature	20 - 25 C	15 - 30 C
Turbidity	< 20 NTU	< 40 NTU

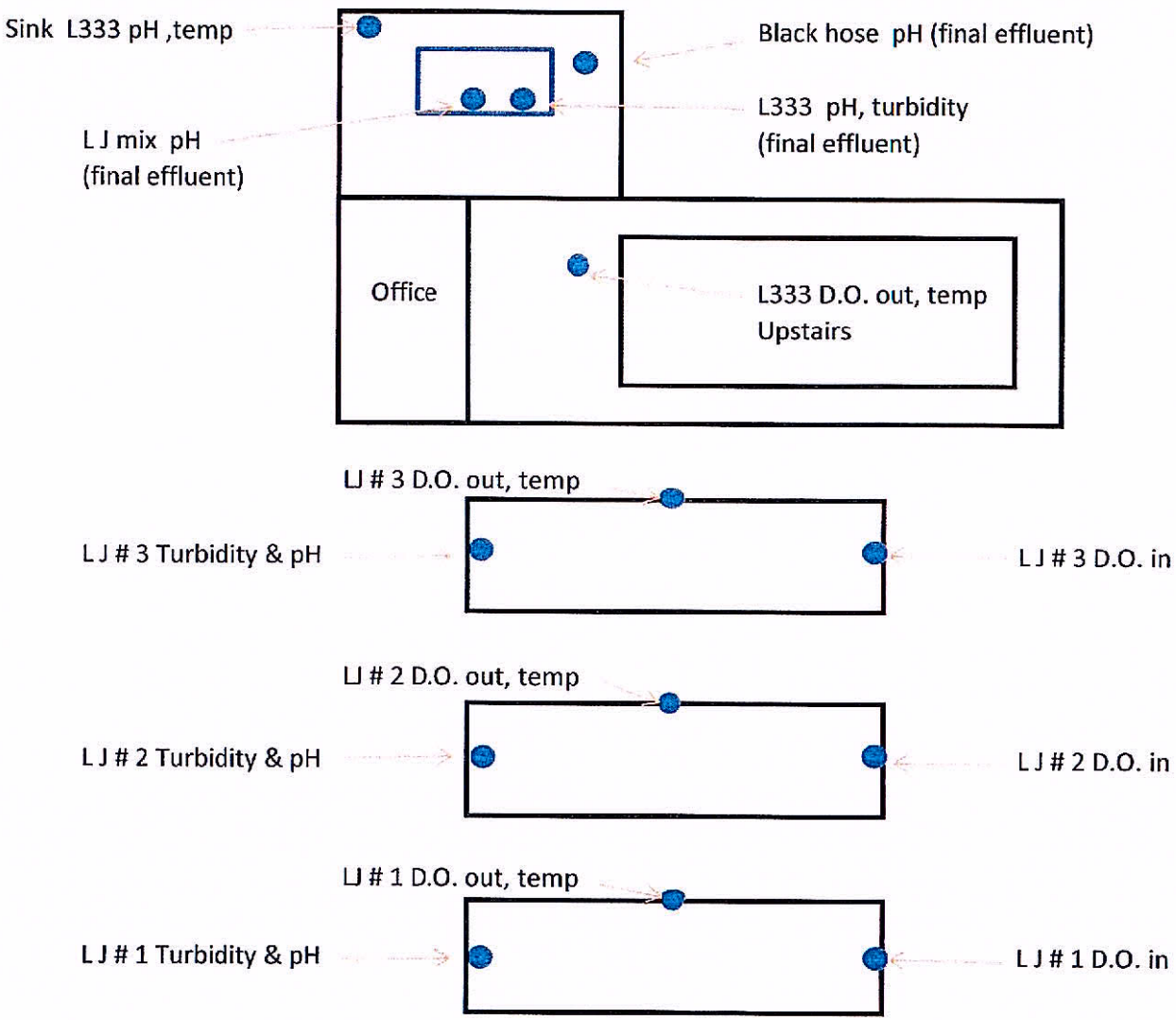
L J = Little Joh. S = Lift Station

STP SAMPLING POINTS

Location	Sampling Points	Frequency	Parameters	pH for Environment
Lift station #3 room	STP IN (Sink close to LS #3)	Every second day	pH temperature	Every Monday or whenever requested by environment department
L J back door	L J # 1 & # 3 IN	Every second day	D.O.	
L J side door	L J # 1 & # 3 OUT	Every second day	D.O. temperature	
L J double doors	L J #1 & # 3 FINAL EFFLUENT (Sample line in LJ close to the flowmeter above the clarifier)	Every second day	pH turbidity	Every Monday or whenever requested by environment department
L333 upstairs	L333 OUT (D.O. is marked on sample point)	Every second day	D.O. temperature	
Lift station #3 room	L333 FINAL EFFLUENT (3/8 " sample line above LS #3)	Every second day	pH turbidity	Every Monday or whenever requested by environment department
Lift station #3 room	L J MIX FINAL EFFLUENT (1" sample line above LS #3)		pH	Every Monday or whenever requested by environment department
Lift station #3 room	FINAL EFFLUENT (black hose from pipe beside flowmeter at LS #3)		pH	Every Monday or whenever requested by environment department

Note: Mondays pH tests done for the Environment Dept must be given to them that day

Sample points at the STP



L J = Little John L333 = Big Bertha

Calibration of pH meter

PROCEDURE NUMBER:			MBK-SIT-0023
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

To

Concerned departments:	Required equipment
Site services	

Impacts			
Health & Safety	Process/Quality	Costs	Environment

Calibration of pH meter

Procedure	Risks/ Impacts
For better accuracy, frequent calibration of the instrument is recommended	Prevent incident and /or accident; health issues
Calibrate once a week and record on calibration report	Prevent incident and /or accident; health issues
1. From the normal measuring mode, **press and hold** the MODE button until OFF and until the secondary LCD is replaced by CAL	
2. Release the button. The LCD enters the calibration mode displaying "pH 7.01 USE"	
3. After 1 second the meter activates the automatic buffer recognition feature	
4. For a two point calibration, place the electrode in pH 7.01 buffer solution. After the first calibration point has been accepted, the "pH 4.01 USE" message appears	
5. If no valid buffer is recognized, then the "WRNG" message is shown. It may be time to change the buffer solutions	
6. If a valid buffer (4.01) is detected, then the meter completes the calibration procedure	

Calibration of pH meter

7. When the buffer is accepted, the LCD shows the accepted value with the "OK 2" message and then the meter returns to the normal measuring procedure mode	
8. ***THE ELECTRODE MUST STAY WET DURING STORAGE. ENSURE THAT THERE IS ALWAYS WATER IN THE STORAGE CAPSULE***	
9. ***Taking pH Measurements***	
10. **Submerge** the electrode **in the solution** to be tested while **stirring it gently**	
11. The **measurement** should be **taken when** the stability symbol **(clock)** on the top left of LCD **disappears**	

Testing at the STP

PROCEDURE NUMBER:		MBK-SIT-0022	
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

To

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

Required equipment

- ✓ PPE : Safety glasses , hard hat, nitrile gloves, gas detector

Impacts			
			
Health & Safety	Process/Quality	Costs	Environment

Testing at the STP

Procedure	Risks/ Impacts
1. Turn on the D.O and calibrate before testing	Prevent incident and /or accident; health issues
2. Turn on the pH meter and calibrate if necessary(once a week)	Prevent incident and /or accident; health issues
3. Turn on the turbidity meter and calibrate if necessary(once a month)	
4. Check the chart on the wall for schedule and locations of sampling points	
5. Procedures for each sampling point are posted at each location	
6. Record all test results and enter into computer	

Procedures For Little John's

Procedures for Changing U.V. Lamps and

Changing/Cleaning Tubes in Little John U.V. Lamp Units

Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓ **Warning : Do not look at the U.V. lamps when they are on**

There are 2 sealed U.V. lamp units , both have 6 U.V. lamps inside each unit

✓ **PPE: Tyvek suit, boot covers, nitrile gloves, safety glasses, hard hat, locks for locking out electrical panel**

1) Check for gases with gas detector before entering the U.V. lamp area
2) Shut off and lock out one of the U.V. lamps units
3) Using a step ladder close the valves on both sides of the unit being cleaned
4) Place a pail under the drain hose and open the valve
5) Crack the outlet valve a bit to allow the unit to drain
6) Once the unit has been drained remove the sensor
7) The sensor is located on the side of each unit and is threaded in
8) With the 50% Lime Away solution spray bottle clean the sensor by spraying it and then wiping it down with a soft paper towel/kleenex
9) Take another dry paper towel/kleenex and wipe the sensor dry
10) Take the water hose and spray water into the sensor hole and let it drain to remove some of the dirt inside the unit
11) Thread sensor unit back into chamber
12) Close the valve on the drain hose
13) Remove the wiring harness from the U.V. lamps
14) Remove the U.V. lamps being very careful not to break them
15) Some end caps may need to be removed to get the lamps out(very tight spot)
16) These will need to be disposed of as HAZMAT
17) Remove the threaded end caps from the unit if removing the tubes
18) If the tubes are not being taken out the end caps do not need to be removed
19) If the tubes are being cleaned or replaced remove them as well by pulling them out
20) Be careful not to lose the o rings and stainless steel washers
21) Clean the tubes with Lime away if they are going to be cleaned
22) Install cleaned or new tubes

23) Install the U.V. lamps being careful not to get them dirty
24) Thread the end caps back into place
25) Put the wiring back on the lamps taking note that the wires are numbered to match with the unit
26) Unlock the Unit
27) Turn the unit back on for approximately 2 minutes
28) Open up the inlet and outlet valves
29) Wait for a few minutes to ensure that the lamps are working properly by checking the reading on the monitor.
30) The unit will now need to be calibrated
31) See the manual for calibrating
32) After calibrating the unit % will be at 100
33) The % will fluctuate at times as the effluent flows and particles of dirt get on the sensor
34) Enter the date the U.V lamps/tubes were changed in the back of the daily log book

Procedures for Cleaning Little John U.V. Lamp Sensor (downstairs)

Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓ **Warning : Do not look at the U.V. lamps when they are on**

There are 2 sealed U.V. lamp units , both have 6 U.V. lamps inside each unit

✓ **PPE: Tyvek suit, boot covers, nitrile gloves, safety glasses, hard hat, locks for locking out electrical panel**

1) Check for gases with gas detector before entering the U.V. lamp area
2) Shut off and lock out the U.V. lamp unit that is being cleaned
3) Using a step ladder close the valves on both sides of the unit being cleaned
4) Place a pail under the drain hose and open the valve
5) Crack the outlet valve a bit to allow the unit to drain
6) Once the unit has been drained remove the sensor
7) The sensor is located on the side of each unit and is threaded in
8) With the 50% Lime Away solution spray bottle clean the sensor by spraying it and then wiping it down with a soft paper towel/kleenex
9) Take another dry paper towel/kleenex and wipe the sensor dry
10) Take the water hose and spray water into the sensor hole and let it drain to remove some of the dirt inside the unit
11) Thread sensor unit back into chamber
12) Close the valve on the drain hose
13) Unlock the Unit
14) Turn the unit back on for approximately 2 minutes
15) Open up the inlet and outlet valves
16) Wait for a few minutes to ensure that the lamps are working properly by checking the reading on the monitor.
17) When all is working well the number should be around 100% after a cleaning
18) The % will fluctuate at times as the effluent flows and particles of dirt get on the sensor
19) Record the date the sensor was cleaned in the daily log book

Procedures for dumping sewage into and removing solids/sludge from lift station #2 at the STP

Workers are required to have Hepatitis A & B and Tetanus shots before doing any work that will bring them in contact with contaminants i.e. sludge, effluent, influent,sewage etc.

All sewage from bathroom facilities around the Meadowbank site including the Exploration and Emulsion plants must be dumped into lift station #2 at the Sewage Treatment Plant.

All other liquids including the liquids from the grease traps should be off loaded at the tailings pond.

Twice a week, Wednesdays and Sundays 1 load of solids should be removed from lift station #2 and unloaded at the tailings pond.

If other jobs or poor weather come up and the solids cannot be done during these days removing solids can be done on other days.

There is a sheet at the STP just inside the door of the decontamination unit which is to be filled out by the vacuum truck operator.

The operator will fill in the date, initials of driver of vacuum truck, size of sewage load in or size of solids load out. This size of the load will be entered in the appropriate column , example *¾ S or 75% S.*
(S for small truck, B for big truck)

Also on this sheet under comments enter why the solids were not able to be done if it happens example, " *blizzard , truck broke* down, *too busy*" or any other information the driver may need to enter example "*broken paddle needs to be repaired*"

Occasionally the STP operator will also ask for the sludge to be removed from the bottom of lift station #2 but this will come as a formal request.

Measuring Sludge in the Little Johns

	PROCEDURE NUMBER:		**MBK-SIT-0004**
People concerned	**Site Services**	**Prepared by**	Site Services
		Approved by	Roger Sauvé Services General Supervisor
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and everyone also have to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

Sludge is required to be measured every 2 weeks in the primary and clarifier tanks(final stage)

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

Required equipment

- Gas detector , safety glasses ,hard hat, Tyvek suit and boot covers, nitrile/rubber gloves, locks for locking out bio-disk

Impacts				Location	
Health & Safety	Process/Quality	Costs	Environment	Control Room	Field

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Procedure	Risks/ Impacts
1. Ensure proper PPE is worn	 Prevent incident and /or accident; health issues
2. Two (2) people to be present when measuring sludge	
3. Shut off and lock out the bio-disk	
4. Keep gas tester on person or close at hand	
5. Little Johns primary tank measurement : side door/opening on the left side when facing the Little Johns from the big double doors – 1 measurement	
6. Turn the sludge meter on	
7. Turn the alarm on the sludge meter	
8. Slowly drop the sensor into the effluent allowing in to go to the bottom	

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9. The alarm will sound as it starts to hit the sludge	
10. Take note of the depth of the tank by reading the numbers on the cord (measured in 6" intervals)	
11. Slowly lift the sensor/cord until the alarm goes off	
12. Record the difference on the cord from when the alarm is on at the bottom to when the alarm goes off	
13. This difference is the depth of the sludge	
14. Follow the same procedures in the Little Johns clarifier tank	
15. Little Johns clarifier tank measurement : open double doors and take measurements on both sides of the tank	
16. Once the sludge measurements have been taken and recorded, the bio-disk can be unlocked and restarted	
17. Clean up tools and put things away where they belong	