3.3 Operation and Maintenance Responsibilities

The site Building and Maintenance Supervisor, under the supervision of the Project Manager, will conduct all operation and maintenance activities associated with this facility (described in section 3.4). Contact information is provided below:

- **Building and Maintenance Supervisor** Ulu Tel: (604) 759-0602
  Wayne Kirkham or Kirk Keller
- **Project Manager** Ulu Tel: (604) 759-0605
  David Stevenson Ulu Fax: (604) 759-0605
  Office: (807) 346-1668

3.4 Operation and Maintenance Procedures

Both routine and non-routine O&M procedures are described in the subsections below.

3.4.1 Routine O&M

The following procedures associated with operation and maintenance of the sewerage facilities will be performed on a ***daily*** basis while the camp is in operation:

- visual inspection of RBC unit;
- visual inspection of camp kitchen grease trap;
- visual inspection of effluent pipeline and heat trace checks along the pipeline; and
- visual inspection of the pump station at the main camp.
- field measurements of RBC effluent (pH, temperature, dissolved oxygen).

Prior to inspecting the RBC unit the operator will ensure the unit is well ventilated and appropriate personal protective gear is worn, including disposable gloves. During daily visual inspections of the RBC unit, attention will be paid to the nature of the biological growth on the disk media. The colour of the growth will typically be dark brown to black on the 1st disk stage. The growth on disks 2-4 will typically range between medium brown to tan on the final section. Unusual discolouration/texture of the disk media growth or strong sour odours could be indicative of process malfunction. A troubleshooting guide is provided in Section 3.7.

Mechanical maintenance of the RBC unit, including lubrication of the shaft bearings, will be conducted on a ***monthly*** basis.

3.4.2 Non-routine O&M

Non-routine O&M procedures will be performed associated with the following system needs:

- sewage sludge management;
- unit startup; and
- unit shutdown.

It is expected that sewage sludge will be removed from the primary and secondary settlement chambers of the RBC unit on a ***twice per year*** basis (Appendix B). The total sludge capacity of the treatment unit (both settlement chambers) is 3.47 m^3. The accumulation of sludge can be indirectly monitored by visually observing the thickness of the scum blanket on the surface of the primary settlement tank. When the scum blanket has grown to a height of approximately 25 cm, it is a good indication that sludge accumulation is near the capacity of the treatment unit, and sludge withdrawals are required.

Special startup procedures must be followed if the RBC unit has been out of operation. These procedures are outlined in detail in Appendix A and briefly summarized below:

- support bearings on shaft and coupling relubricated;
- primary settling tank should be filled with fresh water;
- while the RBC is rotating, introduce wastewater at design or less than design loading rates; and
- unit startup normally requires 2½ to 3 weeks, with 50% BOD removal often occurring after one week.

Shutdown procedures (described in detail in Appendix A) are necessary if the treatment unit is to be taken out of operation for any significant period of time. These procedures are briefly summarized below:

- remove all accumulated sewage sludge from settlement chambers;
- clean disk media and flush unit clean; and
- drain tanks and pipes and disconnect pipes.

3.5 SNP Sampling Procedures

Treated wastewater effluent will be sampled on a ***monthly*** basis at the Surveillance Network Program (SNP) location 200-1 (discharge point at East Lake) as defined in the water license. Collected samples will be analyzed for the following parameters:

- Fecal coliforms
- BOD_5
- Total suspended solids
- pH (measured at time of sampling)
- Temperature (measured at time of sampling)
- Conductivity (measured at time of sampling)
- Total Kjedahl Nitrogen
- Nitrate
- Nitrite
- Total phosphorus
- Total dissolved phosphorus

All sampling, sample preservation and analysis will be conducted in accordance with methods prescribed in the current edition of "Standard Methods for the Examination of Water and Wastewater".

3.6 Record Keeping

On-site records will be maintained incorporating the following information:

- maintenance record:
  - daily;
  - monthly;
  - non-routine (including startup, shutdown, upsets, sludge withdrawals);
- date and volume of sewage sludge removed from treatment unit;
- sampling dates and times; and
- analytical results of effluent sampling (location #200-1).

3.7 Troubleshooting

The RBC manufacturer has developed a list of potential operational problems, causes and corrective actions. This information is summarized in Table 1. Further information (including mechanical troubleshooting) is provided in Appendix A.

Table 1. 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.** Provide a larger amount of surface area for the first stage treatment by removing baffle **c.** 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, b, and c 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 overloads, remove bulkhead or baffle between stages 1 and 2
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, b, and c 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

Table 1. Rotordisk® Process – Rotordisk® Troubleshooting Guide (contimued)

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.** Move baffles to change flow patterns to reduce settling (if the problem is serious, the RBC wastewater tank may have to be pumped or cleaned out) **d.** 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 2. Stage loading too high	• Decrease organic loading **a.** Remove baffles between units to increase size of treatment stages **b.** Increase number of recycle buckets
	3. Shaft speed too low	• Increase the shaft rotational speed by adjusting drive ratio
	4. Inorganic solids accumulation because of inadequate pretreatment	• Check primary treatment and grit removal equipment for proper operation
	5. Accumulation of minerals	• Use chemical pre-treatment to eliminate minerals
	6. 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
12. Effluent quality apparently below requirements	1. Organic loading too high	**a.** Add additional operating RBCs **b.** Identify cause of additional loading and eliminate at source **c.** Add supplemental air to RBC trough
	2. Sampling or testing procedures inaccurate	**a.** In 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 **BUGS** filter after clarifier
	4. Anaerobic solids in the RBC tanks producing BOD kickback	• Flush or drain tanks
13. Snails or other nuisance organisms in RBC tanks	Nutritional environment conducive 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

3.8 Good Practices Checklist

The following list of "Do's and "Don'ts" are supplied by the RBC manufacturer to help ensure smooth operation of the treatment unit. This list will be posted in areas of the camp where the possibility of inappropriate deposit of materials exists.

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

DON'Ts

1. Do not put non-biodegradable materials down the drain, put them in the garbage; these include any plastics, rubber, disposable diapers, sanitary napkins, rubber goods, cigarettes, cellophane, etc.
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.
4. Do not connect any other electrical load to the fuse or breaker feeding the plant as it will cause damage to the controls.
5. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

4. Sludge Management and Disposal

Based on the design loadings of the treatment unit (50 camp residents) it is estimated that approximately 0.02 m^3/day of (gravity thickened) sludge will accumulate in the RBC treatment unit (Appendix B). This volume of sludge production will require pumpout twice per year based on the primary settlement chamber capacity. Assuming the Ulu camp operates eight months of the year, it is estimated that approximately 5 m^3 of gravity thickened sludge will be generated in the treatment unit on a yearly basis. The bulk of the sewage sludge will be generated in the primary settling tank at an expected solids content of up to 10% by weight. Sewage sludge settled in the final settlement tank is expected to have a lower solids content (up to 5% by weight).

As discussed in Section 3.6, records will be kept of sewage sludge volumes removed from the treatment unit and disposed of on-site. These records will be included in the annual report to the Nunavut Water Board, as specified in the water license.

Sewage sludge will be disposed of on-site in a shallow "above-ground sump". This sump will be signposted noting the potential exposure hazards and will be located within the site disturbance area, no closer than 30 metres from any waterbody. Deposited sewage sludge will be covered by waste rock.

5. Solid Waste Disposal

The Ulu exploration camp does not incorporate solid waste disposal facilities. All solid waste material generated on-site is generally incinerated on-site or stored and transported by air for off-site disposal. The names and contact phone numbers of personnel responsible for waste management at the site are listed in Section 3.3. Specific handling procedures for combustible waste, wood waste, waste metals and miscellaneous non-combustible waste are outlined below. Storage and handling procedures for hazardous wastes generated on-site are outlined in the following section.

Combustible Waste

All non-hazardous combustible waste (including food waste but excluding wood waste) is burned on-site in a diesel-fired incinerator. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by to the individuals handling these products to minimize their exposure to the materials.

Wood Waste

Very little wood is burned since it is so expensive to fly it in. Most wood waste is stored on-site for eventual reuse. Non-usable wood is burned in an on-site burn pit. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

Waste Metals

Waste metals are stored on site in one of two large steel bins, labeled “metal only” to ensure that only metals products are deposited. One is located on the waste rock pile and the other near the equipment laydown area outside the Ulu tank farm. Periodically, the metal is cut into smaller pieces and put into 45 gallon drums. In the past this waste has been flown to Yellowknife for landfill disposal. As this material is no longer accepted at the Yellowknife landfill, the waste metal stored on-site will be disposed of in the underground upon closure. A site record will be maintained of all waste metal quantities disposed underground. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

Miscellaneous Non-Combustible Waste

Non-hazardous waste materials, such as glass products, that cannot be combusted or reused will be stored onsite in 45 gallon drums. This material will be flown to Yellowknife for landfill disposal. A site record will be maintained of all wastes flown off-site for disposal. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

6. Hazardous Waste Management

All hazardous waste generated onsite will be handled, stored and disposed of, according to the Government of Nunavut's *Environmental Guideline for General Management of Hazardous Waste*. In accordance with the Guideline, Wolfden has obtained a hazardous waste generator registration number (NUG100013) from the Environmental Protection Service, Department of Environment, Government of Nunavut.

Hazardous waste transported off-site will be undertaken only with carriers registered with the Environmental Protection Service, in accordance with requirements of the appropriate transport authority: *Transportation of Dangerous Goods Regulation* (TDGR) and *International Civil Aviation Organization* (ICAO). Prior to off-site transportation of hazardous wastes, a waste manifest will be completed which will accompany the waste shipment (unless the quantities transported are below the small quantity exemption outlined in the Guideline). The waste generator registration number will be written on the manifest documents that accompany every consignment of hazardous waste.

Site records will be maintained for all hazardous wastes generated onsite, including the following information:

- Date, description and volume of waste placed in temporary storage;
- Method of storage;
- Date, description and volume of waste transported offsite for disposal;
- Name of carrier removing wastes for offsite disposal;
- Copies of waste manifests.

Specific handling procedures for hazardous wastes anticipated to be generated onsite are provided below.

Waste Batteries

Waste batteries are generally transported individually (wet) off-site for disposal to an appropriately certified facility in Yellowknife or elsewhere. People handling the old batteries will ensure the caps are on tight so there is no chance of inhaling acid fumes or spillage onto the person's body. Personal protective equipment, including gloves, coveralls, and steel-toed boots will be worn by the individuals handling these products to minimize their exposure to the materials. If necessary, waste batteries will be bulked onsite either in sealed and labeled 45 gallon drums or properly secured to pallets, prior to being flown out for proper disposal.

Used Oil and Antifreeze

Oil pans are used to collect any waste oil throughout the site in order to minimize spillage on to the ground. Used oil and waste antifreeze are stored on site in 1500 litre cubes. Containers will be labeled according to the requirements of the Work place Hazardous Materials Information System (WHMIS).

These cubes will be flown out and disposed of at a certified facility in Yellowknife or elsewhere. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

Waste paints

Waste paints are stored on site in the mechanics shop (see Figure 2). Waste oil-based paints are bulked and temporarily stored in a sealed, steel 45 gallon drum. WHIMIS sheets are displayed near this container. The sealed drum will be flown out and disposed at a certified facility in Yellowknife or elsewhere. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

Waste paint cleaners, solvents

Waste solvents are stored in their original containers and bulked within a sealed, steel 45 gallon drum, temporarily stored onsite in the mechanics shop (Figure 2). WHIMIS sheets are displayed near this container. The sealed drum will be flown out and disposed at a certified facility in Yellowknife or elsewhere. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials. In compliance with the *Environmental Guideline for Waste Solvents*, temporary onsite storage of waste paints will not exceed quantities greater than 1000 Litres for periods greater than 180 days, without first registering the site as a hazardous waste storage facility.

Petroleum contaminated soils

Procedures for managing all spills are outlined in detail in the Spill Contingency Plan (Appendix C). Soils contaminated with hydrocarbons are stored in sealed, steel 45 gallon drums and temporarily stored on wooden pallets near the equipment laydown area. The drums will be later transported offsite to an approved facility for final disposal/treatment. Personal protective equipment, including gloves, coveralls, steel-toed boots, and a hardhat will be worn by the individuals handling these products to minimize their exposure to the materials.

7. Emergency Responses

A comprehensive spill contingency plan for the Ulu Exploration Project has been completed by Wolfden Resources. This plan, which includes potential sewage-related spills, is included in Appendix C for reference purposes.

8. References

AWWA 1999. Standard methods for the examination of water and wastewater, 20th Edition. Prepared and published jointly by the American Water Works Association, American Public Health Association, and Water Environment Federation.

NWB. 2004. Water License NWB1ULU0008. Issued by the Nunavut Water Board to Echo Bay Mines Limited. Reassigned to Wolfden Resources Inc. on March 23, 2004. Expiry date of License: June 30, 2008.

NWT. 1996. Guidelines for the preparation of an operation and maintenance manual for sewage and solid waste disposal facilities in the Northwest Territories. Prepared by the Government of Northwest Territories Department of Municipal and Community Affairs, October 1996.

Wolfden Resources Inc. 2004. Spill Contingency Plan: Ulu Exploration Project. Prepared for the Nunavut Water Board, Water License NWB1ULU0008.

Appendices

Appendix A

Operations Guide

(supplied by Seprotech Incorporated)

1.5 - SUMMARY OF OPERATION

(ROTORDISK® systems designed for BOD/SS removal)

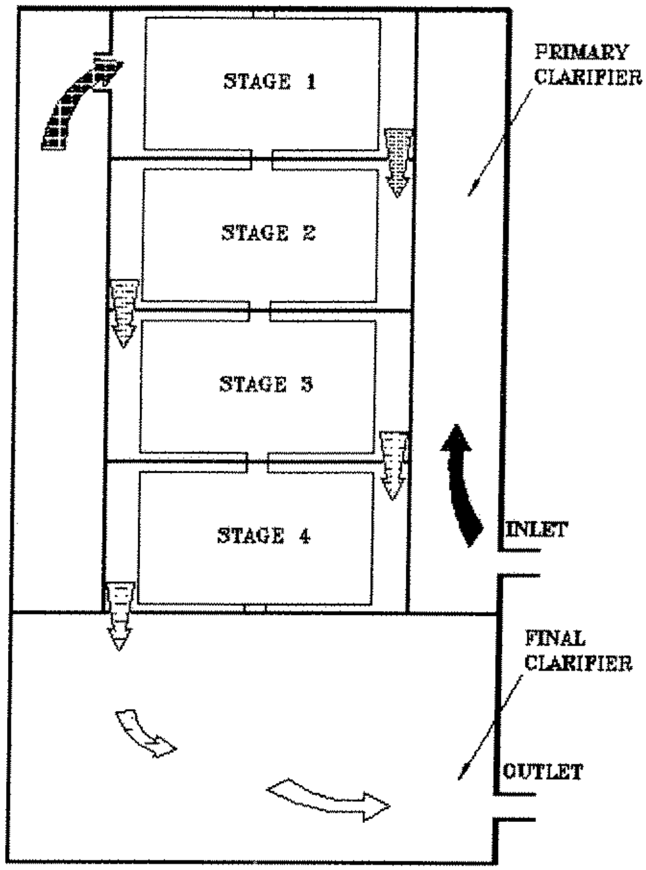
A). The sewage plant (as supplied by SEPROTECH SYSTEMS INCORPORATED) is comprised of the primary settlement tank, the RBC tank, and the secondary tank.

B). The RBC tank is the aerobic section of the treatment plant divided into four (4) stages.
Raw sewage is pumped and/or gravity flows into the primary settlement tank. Settling separates heavy solids 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) or two (2) disk banks, representing 40% of the surface area of the RBC. The normal color of the bacteria in the 1st stage is dark brown. This is the stage where most of the BOD reduction 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) disk bank each. It is in the 2nd stage that further BOD is reduced, and that nitrifying bacteria start to predominate in the 3rd and 4th stages. The 4th disk bank or last stage has recycle buckets that introduce both fresh dissolved oxygen into the primary settlement tank and nitrifying bacteria present in the recycled water.

C). Partially treated water from the RBC now enters the secondary settling tank. Sloughed off biomass from the disks and other suspended solids is further settled in this chamber. A scum weir prevents the floating scum from leaving the chamber through the effluent pipe.

2.0 - ROUTINE VISUAL CHECKS - ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK®

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



2.1 - PRIMARY SETTLEMENT CHAMBER (PRIMARY "CLARIFIER")

The accumulation of floating scum on the surface of the primary clarifier is normal. It is proportional to the accumulation of settle-able 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 a bank of disks 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 section 2, 3, and 4 before entering the final settlement chamber.

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 - FINAL SETTLEMENT CHAMBER (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.

2.4 - 'BATHTUB RING'

The flow of wastewater within a ROTORDISK® Plant is strictly by gravity and the water level 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 that 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.

2.5 - FREQUENCY OF INSPECTION

Visual checks at 3-4 month intervals should be sufficient.

There is considerable amount of money that is invested in the wastewater treatment system. Daily walk through of large treatment systems is often the preferred frequency of visit. Many owners prefer the visual and audible (look and listen) walk through.

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 the unit and its operation if they are not already familiar with it. A particular point to emphases is that the biological growth on the disks should <u>not</u> 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/1 and 50-250 mg SS/1. 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 ration.), 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/1 and 10,000 mg BOD/1, 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 ration 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 there being considerably over designed for loads anticipated in normal operation.

Clearly, these potential problems should be avoided by the removal of sludge once they reach the levels 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

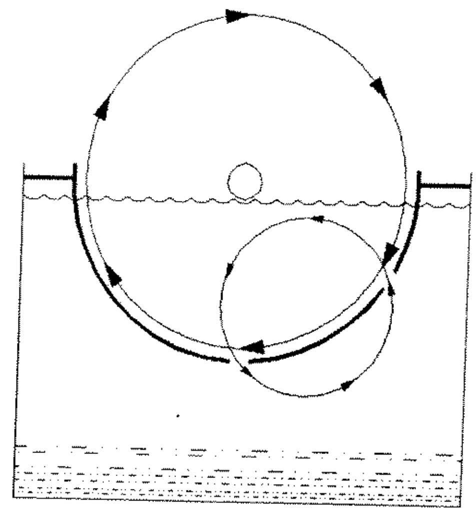


Figure a-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

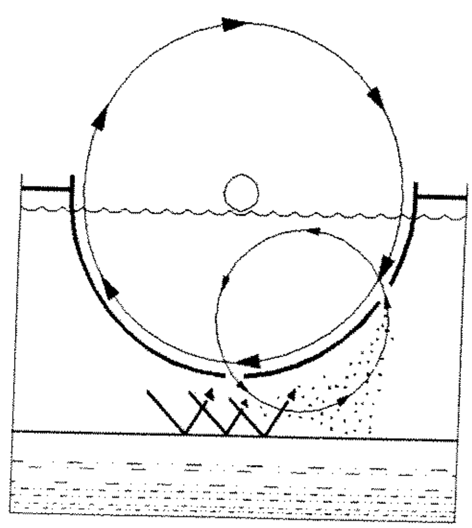


Figure b- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.