SWWTP AUDIT REPORT

March 26, 2007

INTRODUCTION

The Stage 1 construction phase for the Summerland wastewater treatment plant (SWWTP) was commissioned in 1998. The facility is a BNR WWTP producing an effluent with low concentrations of BOD_5, TSS, phosphorus and nitrogen. The effluent is discharged to Okanagan Lake via a submerged pipe and diffuser into the lower levels of the lake. The Stage 1 design plant flow capacity is 4,000m3/d based on average day flow. There is sufficient area within the site boundaries to expand the plant capacity to the Stage 2 design plant flow capacity of 8,000m3/d. In December 2005 a centrifuge dewatering facility was added to the plant process. The dewatering equipment dewaters both fermented primary sludge and waste activated sludge.

Planning for the Summerland Hills land development project has required a review of the SWWTP and the District of Summerland retained Earth Tech in March 2007 to complete a process and equipment audit for the plant. The purpose of the audit is to determine the remaining unused capacity in the facility and to identify operational issues that are hindering ongoing operations at the facility.

This audit report documents process and capacity information for the following plant components:

- Raw Sewage Mechanical Bar Screen / Compactor
- Primary Clarifier/ PS Fermenter
- Bioreactor
- Secondary Clarifier 1 / Secondary Clarifier 2
- Effluent Filter
- Effluent UV Disinfection
- Dissolved Air Flotation Thickener
- Centrifuge Dewatering
- Foul Air Biofilter

Table 1 - Process Design Data Table lists in detail the design parameters for each process component and the capacity that is available for each process component based on Year 2006 flow and load conditions.

PLANT CAPACITY

The original plant configuration was designed for a population is 9,000. The estimated contributing population for Year 2006 is 5000. However, the insertion of a dewatering centrifuge into the facility adds over 10% to the incoming load as the returning centrate is high in TSS, BOD_5, and nutrients.

The Stage 1 design hydraulic flow is

- 4,000m3/d at Average Dry Weather Flow (ADWF);
- 4,400m3/d at Maximum Month Flow (MMF); and
- 10,000m3/d for Peak Wet Weather Flow (PWWF).

For Year 2006 the typical recorded flow variations to the plant are

- 2005 m^3/d ADWF;
- 2285m^3/d MMF; and
- 2,410m^3/d PWWF.

Based on year 2006 recorded flows the raw sewage flow rate is at present approximately 50 percent of the Stage 1 design capacity.

HEADWORKS

Pretreatment - Raw sewage from the Summerland sewerage area is collected and discharged to the plant headworks. The flow into the plant is continuously measured using a magmeter. The incoming grit accumulates in a large rising chimney and requires occasional removal.

At the present time the plant operates without mechanical grit removal equipment. The existing chimney provides for a limited amount of grit removal. Often the de-sludging process within the treatment facility dictates the degree of grit removal required. With liquid sludge trucking to an off-site composting facility, limited grit removal is required. However, with the large "G" forces found within a centrifuge, grit will cause serious wear and tear and thus grit removal up stream is given a higher priority.

Without an efficient mechanical grit system, the grit is partially removed in the rising chimney and the remainder is removed with the sludge that settles out in the Primary Clarifier/ PS Fermenter. The fermented primary sludge (FPS) along with the settled grit is pumped to storage and then pumped to the centrifuge for dewatering.

The centrifuge is a recent addition to the plant process and is an essential part of the sludge dewatering process. Not only is it an expensive piece of equipment but normal annual maintenance costs associated with it are significant. Without a grit removal process accelerated and premature wear of the centrifuge will occur resulting in added maintenance costs. To protect this piece of equipment, provision should be made to incorporate an efficient mechanical grit removal process in the headworks area.

Screening - The raw sewage is then screened using a mechanically cleaned bar screen. The bar screen intercepts large solids, rags, feacal matter and pieces of debris that are typically present in raw sewage. These materials can have deleterious effects such as pump clogging, pump damage, pipe plugging, etc., on downstream processes. As material collects on the upstream side of the bar screen flow is impeded through the bar screen, resulting in increased water level upstream of the bar screen. The bar screen spacing is a 6mm gap. The cleaning cycle for the screen is initiated either by a high water set point in the upstream channel, or a timer.

The headworks bar screen is designed to process peak flow conditions of 208L/s. Year 2006 peak day flow is approximately 28L/s.

Based on Year 2006 recorded peak flow conditions the screen is at approximately 15 percent of its design capacity.

Screenings are discharged into a compactor consisting of an enclosed auger. The compactor dewaters the screenings to 40 to 50 percent solids. The compacted screenings are discharged into a plastic bag that is contained in a bin and trucked to landfill. Operation of the compactor is interlocked with the screen. The capacity of the compactor is 1m3/h.

The mechanical bar screen and compactor as installed has operated well over the years and the operators to date are satisfied with the performance of both.

PRIMARY CLARIFIER / PS FERMENTER

The primary clarifier / primary sludge (PS) fermenter serves two process functions, solids removal by settling and solids hydrolysis and fermentation by anaerobic microorganisms.

A primary clarifier removes easily settleable solids and floatable material from the incoming screened raw sewage. Typically primary sludge (PS) settles and accumulates in the primary clarifier tank and is removed in relatively dilute concentrations of 2,000mg/L to 3,000mg/L TSS. The PS retention time in a tank designed as a primary clarifier is short, normally in the range of 3 to 6 hours.

The second process function is fermentation of settled PS. Fermentation of PS produces volatile fatty acids (VFA) such as acetate and propionate which are required for the optimum performance of the plant BNR process. The VFA is concentrated in the overflow from the primary clarifier and fed continuously to the two bioreactors at a steady rate.

To initiate the fermentation process the solids retention time for PS in the primary clarifier is increased from hours to days. The increased retention time of 3 to 6 days creates a suitable anaerobic environment that allows hydrolysis and the first stage of fermentation to occur. The longer solids retention time increases the solids concentration of the fermented primary sludge (FPS) to between 40,000mg/L to 70,000mg/L.

Overflow from the primary clarifier / PS fermenter is controlled using a motorized flow control gate. The control gate is operated so that the tank overflow weir is always in a flooded state thereby minimizing aeration of and odour generation from the tank overflow.

The diameter of the tank is 15m. The collector/rake mechanism has a centre drive that runs continuously. The motor power for the mechanism is 0.5hp. Operation of the primary sludge clarifier / fermenter with a sludge blanket causes increased stresses on the rake/collector mechanism moving. The FPS rake/collector mechanism as installed is designed to be more robust than a conventional PS collector mechanism.

Fermented Primary Sludge (FPS) is withdrawn from the primary clarifier / PS fermenter and pumped to a sludge storage vault, the pump motor is 3hp. The FPS pumps are equipped with variable speed drives so that the pumping rate of FPS can be varied over a wide range as required. FPS is typically removed at a rate of 10L/s. The pump is fitted with a magmeter. The solids content of the FPS that is removed is typically over 5% Total Solilds.

A skimmer mechanism collects and discharges scum to a hopper on the side of the clarifier / fermenter and is discharged to the sludge vault.

The primary clarifier / PS fermenter has a design ADWF flow capacity of 10,000 m^3/d. Year 2006 peak day flow is 2,410m^3/d.

Based on Year 2006 recorded peak day flow conditions, the primary clarifier / PS fermenter is at approximately 24 percent of its design capacity.

The primary clarifier / PS fermenter as installed has operated well over the years and the operators to date are satisfied with its performance.

BIOREACTOR

The biological treatment train consists of 2 bioreactors configured in the 3-Stage Bardenpho process. Each bioreactor is sized for a solids retention time of 15 days for winter conditions and 10 days for summer conditions. The mass of active bacteria or "Mixed Liquor Suspended Solids" (MLSS) concentration varies between 2000 mg/L to 3500 mg/L depending on incoming load and seasonal conditions. The hydraulic retention at an ADWF of 4,000m3/d is approximately 11 hours. The volume of the bioreactor is 1840m3

The 3-Stage Bardenpho process configuration consists of 4 zones;

- pre-denitrification - 1% of volume;
- anaerobic - 10% of volume;
- anoxic - 20% of volume; and
- aerobic - 69% of volume.

Pre-denitrification Zone - The first zone of the bioreactor is the pre-denitrification zone. In this zone some of the overflow from the Primary Clarifier / PS Fermenter is mixed with return activated sludge (RAS) from the underflow of the secondary clarifier. The mixing of these two flows stimulates denitrification and minimizes the nitrate load on the downstream anaerobic zone.

Anaerobic Zone - The second zone is the anaerobic zone. In this zone primary phosphorus release occurs due to environmental conditions plus VFA concentrations. The environment within the anaerobic zone, conditions the microorganisms to absorb a greater amount of phosphorus in the subsequent zones of the bioreactor. The VFA load comes from the overflow of the Primary Clarifier / PS Fermenter.

Anoxic Zone - The third zone is the anoxic zone. In this part of the BNR process nitrates that are produced in the aerobic zone are recycled from the aerobic zone back to the anoxic zone. Sufficient nitrates are recycled from the aerobic zone to the anoxic zone to prevent onset of anaerobic conditions. If anaerobic conditions develop in this zone due to lack of nitrates, secondary release of phosphorus occurs. The secondary release will result in poorer effluent quality due to increased phosphorous concentrations.

In addition to recycled nitrates, a portion of the overflow from the Primary Clarifier / PS Fermenter is added into this zone. The VFA and COD rich overflow provides soluble biodegradable COD for the heterotrophic bacteria and during this part of the process the recycled nitrates are necessary for the metabolic requirements of the ML microorganisms.. During this process bacteria convert nitrates to nitrogen. The nitrogen comes out of solution as nitrogen gas. The nitrogen gas that is produced is vented to atmosphere.

Monitoring of nitrate concentration at the end of the anoxic zone is necessary to ensure that a residual concentration of nitrate is retained and anaerobic conditions do not develop.

Mechanical mixing is also provided in all un-aerated zones to ensure even distribution of MLSS, nitrates and COD plus to keep MLSS in suspension. The mixers operate continuously.

Recycle pumps recycle nitrate rich mixed liquor to the anoxic zone The recycle pumps are provided with variable speed drives to allow for fine tuning of the nitrified ML recycle rate as required to meet process objectives for this zone. The recycle pump is a submersible type pump with a shrouded horizontal propeller. The pump is fabricated from SS which is required for anoxic zone environment. Maximum capacity of each pump is approximately 190L/s which is equal to 8 times the design capacity of each bioreactor.

Mixers are provided for both the anaerobic and anoxic zones. Each mixer is a horizontal propeller type that is mounted mid-depth in the anaerobic and anoxic zones. The mixers operate at low revolutions to minimize the risk of shearing the ML floc but at the same time maintaining the ML floc in suspension. The mixers are designed to impart 8W/m3 of mixing energy.

Aerobic Zone - The fourth and final zone is the aerobic zone. In this zone ammonia is converted to nitrates along with COD reduction. The zone is sized to achieve nitrification due to the fact that the conversion of ammonia to nitrates is the governing reaction rate. Reduction of COD is a relatively quick reaction rate compared to nitrification. The aerobic zone is equipped with diffusers which distribute process air (PA) throughout the contents of the aerobic zone. PA provides both the oxygen to drive the biochemical reactions and the mixing energy to keep MLSS in suspension and to ensure even distribution of COD.

Dissolved oxygen (DO) concentrations are continuously measured and the information from the DO probes is used to control PA supply. As the pressure in the PA supply system varies in response to changing demand requirements, the PA blower output is modulated by the inlet valve to maintain the set point DO value.

The bioreactor has a design average flow capacity of 4,000m3/d. Year 2006 average day flow is 2,005m3/d.

Based on Year 2006 recorded average day flow conditions the bioreactor is at approximately 50 percent of their design hydraulic capacity.

The operators are currently maintaining a high MLSS concentration in the bioreactor however given some optimization of this process, the MLSS concentration is expected to decrease. At this time, due to the low flow conditions, the higher than expected MLSS concentration is not causing any process limitations, however if this continues in the future, a premature limit will be placed on the plant capacity.

However at this time, based on Year 2006 recorded average day flow conditions the bioreactor MLSS concentration is approximately 113 percent of the design value.

Centrifugal Blowers - Centrifugal blowers supply the required PA. The PA blower system is designed with enough flexibility to ensure meeting air demand variations throughout the day and year.

There are 3 fixed speed centrifugal blowers. One blower supplies enough PA to satisfy the minimum to average air demand requirements; the second blower with the lead blower is put into service to supply the peak air demand requirements. The third blower is a standby unit. The motor power for each blower is 60hp.

The blowers as installed have operated well over the years and the operators to date are satisfied with their performance.

Based on the Year 2006 load and high MLSS concentrations, the blowers are operating at approximately 66% of design.

Dissolved Air Flotation - Wasting of MLSS is required to control the bioreactor SRT requirements. To control the bioreactor SRT, waste activated sludge spills over a floating weir and is pumped to the DAF thickener. Selective wasting from the surface of each bioreactor ensures removal of filamentous microorganisms that typically cause process and foaming problems.

The motor power for the pump is 5hp. The WAS pump capacity is 5L/s and each pump is fitted with a VFD. The pumping rate is varied to maintain SRTs in the range from 10 to 15 days. The pump is fitted with a magmeter.

SECONDARY CLARIFIER 1 / SECONDARY CLARIFIER 2

There are two secondary clarifiers. MLSS and flow from the bioreactors discharges to the two secondary clarifiers. In the secondary clarifiers MLSS settles and is concentrated from typically 2,500mg/L TSS to 5,000mg/L TSS. The settled MLSS is recycled to the bioreactors as activate bacteria. The clarified effluent overflows the clarifier weir into a collection launder and flows by gravity to the effluent filter.

Each clarifier consists of a circular concrete tank 4.5m side wall depth, with a centre drive rake mechanism. The rake mechanism sweeps settled ML sludge into a central hopper. The settled ML sludge is then pumped as RAS back to pre-denitrification zone of each bioreactor. The motor power for the centre drive is 0.5hp

The RAS pumps are equipped with VFD drives to allow selection of optimum RAS pumping rates based on nitrate and phosphorus concentration measurements and the ML sludge settling characteristics. The capacity of each RAS pump is 50 L/s. The RAS pump motors are 15 hp.

For surface scum a skimmer collects the surface scum and discharges it to a collection sump. The scum is pumped to the DAF thickener. The design capacity of the scum pump is 5L/s. Approximately 2000L of scum is removed daily from the two secondary clarifiers.

Each secondary clarifier is designed for a peak overflow rate of approximately 28m3/d/m2 and a solids flux rate of 5kg/h/m2. For a peak flow condition of 10,000m3/d two clarifiers have been provided. Year 2006 peak day flow is 2,410m3/d.

Based on Year 2006 recorded peak day flow conditions the secondary clarifiers are at approximately 25 percent of their design capacity.

Secondary Clarifier 1 and Secondary Clarifier 2 as installed have operated well over the years and the operators to date are satisfied with their performance.

EFFLUENT FILTER

Effluent filtration is provided to remove solids from the clarified effluent from the secondary clarifiers. The filtration process;

- ensures compliance with effluent suspended solids permit limits;
- decreases the overall phosphorus concentration of the effluent; and
- improves the disinfection efficiency of the UV process.

The effluent filter consists of multiple horizontal cells with two layers of granular material. The filter media captures solids as the effluent drains through the filter cell. The top layer is a relatively coarse anthracite media and the bottom layer is a fine silica sand media. The total depth of the filter media is approximately 400mm. As solids accumulate in the filter media, the filter becomes hydraulically restricted, and the water depth over the filter increases. When the water level over the filter reaches a high set point the cleaning cycle is initiated.

The filter cleaning mechanism consists of a traveling bridge fitted with pumps for backwashing individual cells during the filter cleaning sequence. The pumps fluidize the filter bed and remove and carry away the solids trapped in the filter media. The cleaning cycle sequentially subjects only a portion of the entire filter to cleaning. In this way the most of the filter remains in service during a cleaning operation. Filter backwash is returned to the plant headworks.

The filter surface area is 38m2. The filter design peak hydraulic loading is 235m3/d/m2. The filter peak capacity is approximately 8,900m3/d. Year 2006 peak day flow is 2,410m3/d.

Based on Year 2006 recorded peak day flow conditions the effluent filter is at approximately 27 percent of their design capacity.

The effluent filter is heavily relied upon to ensure permit compliance for SS and phosphorus concentrations. The provision of only one filter with no standby unit has proved at times to be an operational issue. Should the unit be out of service due to mechanical problems with the bridge and/or pumps or problems related to the filter media the effluent could be out of compliance. If a second filter was provided, routine maintenance could be easily scheduled.

Overall the plant operators are not satisfied with the filter equipment and strongly recommend that a standby unit be provided.

UV DISINFECTION

The ultraviolet disinfection system consists of an array of closely spaced, parallel and horizontal lamps submerged in the filtered effluent. There are three equally sized banks that can be automatically turned ON and OFF independently in response to flow variations. At low flow conditions only one bank is ON. At average and peak flows the second and third banks are turned ON. Typically two banks are energized.

A dose of 50W-s/cm2 is effective in reducing the level of coliform to the required level of less than 5 per 100mL based on a 30 day geometric mean. The UV equipment is designed to provide the required UV dose at a peak flow of 10,000m3/d at a transmissivity of 60 percent and effluent TSS of less than 5mg/L.

The channel width is 610mm and the length is 11m. A counterweighted pivoting flap gate maintains a water depth of 600mm in the channel under all flow conditions to ensure that the lamps are submerged at all times.

The operators have operated the UV lamps well beyond there rated life cycle, thus saving on the cost of lamp replacement. However, the older a UV lamp gets, the less light it produces. Thus the

UV system has been operated at 100 % of bulbs in operation. This could be lowered if the bulbs were replaced on a more frequent basis.

DAF THICKENER

Surplus MLSS (WAS) from the bioreactor is pumped to the dissolved air flotation (DAF) thickener for thickening and removal. The MLSS solids concentration to the DAF thickener typically varies from 2,500 mg/L to 3,500 mg/L. Thickening agents such as a cationic polymber can be added to the DAF to produce thicker sludges and this system is used most of the time at the SWWTP. The DAF thickener with polymer addition can produce sludge 30,000mg/L and 50,000mg/L.

The DAF thickening equipment processes the WAS quickly and at the same time maintains the WAS in an aerobic condition. Maintaining an aerobic condition is essential to prevent the release of biologically stored phosphorus into the liquid fraction. The DAF thickener equipment is designed and sized to process WAS continuously 24h/d and 7days per week.

The design solids loading rates at average and maximum sludge wasting rates are 3kg/h/m2 and 6kg/h/m2 respectively.

Based on Year 2006 recorded peak day flow conditions the DAF is at approximately 69 percent of its design capacity.

CENTRIFUGE DEWATERING

A sludge dewatering centrifuge was added to the facility and was commissioned in late 2005. The centrifuge separates the combined WAS and FPS sludge in a high gravity spin and produces an approximate 20% Total Solids cake for disposal and returns the centrate (liquid) stream back to the treatment plant for further treatment.

The returning centrate contains TSS, BOD5, and nutrients for treatment in the facility. This "load" consumes capacity. It is estimated that current operation of the centrifuge is recycling 13% of the load for treatment a second time. If this continues, the plant design capacity will be limited to approximately 8100 population equivalents.

Two centrate issues require optimization as follows:

- Returning phosphorus that has been released in the sludge storage vault, is significantly impacting effluent phosphorus discharges and created numerous out of compliance incidents. One solution is to add lime either before the centrifuge or following the centrifuge.
- Returning BOD_5 and VFA's are being "pulsed" back into the process with no load equalization. This is causing significant upsets to the BNR process and again leading to out of compliance nitrogen and phosphorus levels. The solution to this would be to re-route the centrate to the flow and load equalization tank used for raw sewage load attenuation.

The other issue surrounding the centrifuge operation is one of odour control. To facilitate partial collection and treatment of "off-gases" from the centrifuge, air has been diverted away from the Headworks room that potentially contains explosive and hazardous gases. The Headworks room is a "rated" area under the building code and requires 12 air changes per hour. Reducing the air flow through this room is an un-safe practice and contravenes the building code.

The operation of a centrifuge requires collection of "off-gases" at source as well as room evacuation of up to 12 air changes per hour. The current HVAC design does not meet either of these conditions. During normal operations, high H_2S alarms have been activated and staff have regularly opened doors to reduce the gas concentrations. Uncontrolled releases of H_2S into the neighborhood and odour complaints have been recorded.

The centrifuge room air exhaust system needs to be reviewed and the above noted deficiencies corrected.

FOUL AIR BIOFILTER

Originally foul air (FA) was collected from the headworks / DAF area and sludge vault. The FA biofilter is designed for treating FA only from the headworks /DAF area and the sludge vault. The design is based on 12AC/h for a total air flow of approximately 7,700m3/h and an empty bed retention time of 60 seconds.

The design H_2S loading on the biofilter was for approximately 10 mg/L. The FA collection system has been expanded to include FA flows from the centrifuge dewatering and dewatered sludge storage area and an approximate 20% or more additional H_2S requires treatment.

To reduce the H_2S load on the on-site biofilter, a Ferric Chloride addition system was provided to pre-treat most of the H_2S entering the facility and reduce the H_2S generation in sludge handling processes on site. This Ferric addition system has not been fully utilized and as a result a significant increase in H_2S load has been placed on the biofilter for treatment.

The FA biofilter is designed for treating FA only from the headworks /DAF area and the sludge vault. The design is based on 12AC/h for a total air flow of approximately 7,700m3/h. The design H_2S loading on the biofilter was for approximately 10 mg/L.

With the additional load from the centrifuge and the additional load from the influent sewer, the biofilter has failed and requires replacement.

At the biofilter FA is vented through a network of perforated pipes covered by approximately 1000mm of organic bulk media such as wood chips and bark mulch. The media along with microbial activity adsorbs and oxidizes contaminants present in the FA. The biofilter produces as an end product of water vapour, carbon dioxide, sulphates and nitric acid. With high H2S loads, the amount of acid produced destroys the ability of the biofilter to work and thus media must be completely replaced.