SEWPCC Upgrading/Expansion
Conceptual Design Report

SECTION 8 - Primary Treatment

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8.0 Primary Treatment

8.1 PURPOSE OF UNIT PROCESS

The purpose of primary treatment is the removal of readily settleable solids and the separation of floatable solids such as fats, oils and grease, commonly referred to as scum. As a part of the existing operation, the Primary Settling Tanks (PST) also act to co-thicken the waste activated sludge (WAS) with the primary sludge. For the proposed BNR upgrade, this practice will be discontinued. A secondary purpose of primary clarification is equalizing side stream flows, such as the dissolved air floatation (DAF) supernatant.

8.2 EXISTING PRIMARY SETTLING TANKS

There are currently three (3) Primary Settling Tanks (PST) at the SEWPCC facility. Primary settling tank no. 1 (PST-1) and 2 (PST-2) each have a peak hydraulic capacity of 42 ML/d, while primary settling tank no. 3 (PST-3) has a peak hydraulic capacity of 90 ML/d; for a total peak hydraulic capacity of 174 ML/d. The components of the existing PSTs are described below.

8.2.1 Influent Flow Distribution

Screened and degritted sewage flows through a 3.0 meter wide channel from the grit removal system to the PSTs. A concrete wall divides the channel to distribute flow to either PST-1 & PST-2 or to PST-3. The channel to PST-1 & PST-2 is further divided to split flow to between PST-1 and PST-2, while the channel to PST-3 is further divided to allow for flow to be split between PST-3 and a future primary settling tank. Stop logs can be inserted into the channels to isolate any of the PSTs.

8.2.2 Primary Sludge Removal System

Primary sludge for PST-1 & PST-2 is scraped to the sludge collection trough located at the influent end of the PSTs by a traveling bridge. The sludge troughs are each equipped with an auger cross collector to convey the sludge to a common collection point. PST-1 & PST-2 are equipped with two variable speed pumps rated at 7 – 22 L/s that act in a duty/standby fashion.

Primary sludge for PST-3 is scraped to four (4) sludge hoppers located at the influent end of the PSTs by a traveling bridge. A common sludge suction line interconnects each sludge hopper to two variable speed pumps rated at 7 – 22 L/s that act in a duty/standby fashion.

The sludge pumps operate on an operator selectable time basis to maintain a primary sludge total solids concentration of 2.5 to 3%. A nuclear density meter is presently used to determine the total solids concentration. Based on feedback received from the City's operation staff, the nuclear density meter will be decommissioned. A sludge blanket meter in each of the existing PSTs is proposed for optimal operation and in maintaining the desired sludge blanket.

The travel cycle distance of the traveling bridge mechanisms is currently programmed to optimize sludge removal for the existing operation. The mechanism is programmed to perform one half-length cycle, alternating with a full-length tank sweep cycle. This pattern is programmed to address the fact that sludge particles settle and accumulate more quickly in the front half (influent half) of the PST. In addition, the resting point dwell timer are programmed to allow for a sludge blanket.

8.2.3 Primary Scum Removal System

Primary scum in PST-1 & PST-2 is swept by a blade on the traveling bridge over an inclined beach plate to a trough at the effluent end of the PSTs. In the trough, the scum flows by gravity to a three (3) cubic meter scum pit.

Primary scum in PST-3 is swept by a surface skimming blade mounted on the traveling bridge to the influent end of the PST. A motorized scum cross collector with a flight of smaller surface skimming blades push the scum along the influent end into a thirty (30) cubic meter scum hopper.

Both the scum pit for PST-1 & PST-2 and the scum hopper for PST-3 are equipped with a duty and standby transfer pump and a duty recirculation pump. The operators currently manually operate the scum pumping systems on a daily basis Monday to Friday. The scum transfer sequence of operation involves the operator manually operating the recirculation pump to create a homogeneous mixture before operating the scum transfer pump to empty the scum pit or hopper to the sludge holding tanks. In addition, the motorized cross collector for PST-3 is also operated manually on a daily basis prior to transferring scum to the sludge holding tanks.

Issues related to scum removal for the Primary Settling system include the following separate features:

- The efficiency of removal of scum from the clarifiers.
- Clogging of the piping in the downstream scum pumping system.

PST-3 has a different type of surface skimming mechanism than PST-1 and PST-2. There have been indications of differences in efficiencies. The skimming systems are discussed in detail later in this section of the report.

With the current pumping configuration, scum congeals over time in the scum line from PST-3 to the sludge holding tank. It is suspected that this is due to the longer piping run from the PST-3 scum hopper to the sludge holding tank. Over time, longer pump run times for the PST-3 transfer pumps occur as the useful pipe diameter is reduced. The City's current practice is to contact an outside company to clean the scum lines on an annual basis. The City indicated that the use of a degreasing chemical is also being investigated. Additional details about the scum handling system and options to improve the scum removal system are discussed in Section 8.6.

The collected scum is pumped along with the sludge from the sludge holding tank to be carried by tanker trucks to the NEWPCC, where it is eventually fed into the NEWPCC anaerobic sludge digestion system. Information provided by the City has indicated that periodically this program becomes congested to the point that the removal of scum from the PSTs becomes impaired.

8.3 PROPOSED PRIMARY SETTLING TANK OPERATION

The Preliminary Design Report (PDR) indicated that an additional PST would be constructed with lamella plates and chemical addition to treat wet weather flows greater than 175 ML/d. Subsequent to the PDR, it was determined that the need for the additional lamella clarifier could be eliminated by operating the existing settling tanks as a chemically enhanced primary treatment (CEPT) for flows up to 200 ML/d and diverting up to 100 ML/d of screened/degritted sewage directly to the bioreactors. The performance of the system was confirmed via process modeling. The revised flow scenarios relevant to primary treatment are summarized below. Refer to Figure 8.1 for a process flow diagram relevant to primary clarification.

- Flows less than or equal to 175 ML/d will pass through screening (12 mm), the existing aerated grit removal system and then through the existing PSTs.
- Flows greater than 175 ML/d and less than 200 ML/d will pass through screening (12 mm), the existing aerated grit removal system and then receive chemical addition (alum + polymer) prior to passing through the existing PSTs.
- Flow greater than 200 ML/d and less than 300 ML/d will pass through coarse screening (12 mm), the new vortex grit removal system, and fine screening; and will then bypass the PSTs and be conveyed directly to the bioreactors.

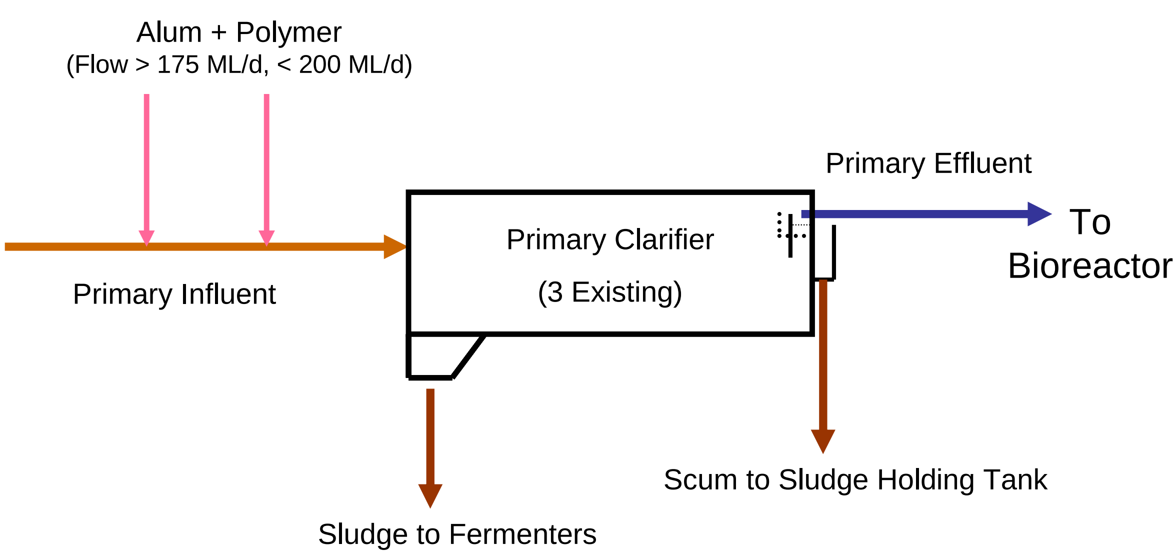


Figure 8.1: Process Flow Diagram for Proposed Primary Clarification

The sludge handling operation will be revised as follows:

- The existing PST will no longer receive WAS for co-thickening. WAS will be directed to the Dissolved Air Flotation (DAF) facility for thickening.
- The PST will be operated with a very low sludge blanket and the existing primary sludge pumps will continuously operate to waste primary sludge to the fermenter. The target solids level in the blanket is approximately 1.5% solids under normal operating conditions (including CEPT mode). Should the fermenters be out of service due to maintenance, the PSTs will operate with a thicker blanket.
- DC drives for the existing primary sludge pumps will be upgraded.

8.4 PRIMARY SETTLING TANK DESIGN

The PST design under peak hydraulic conditions with respect to rise rate with and without chemical addition is summarized in Table 8.1. Typical maximum PST rise rates are less than 4.2 m/h without chemicals and less than 5.0 m/h with chemical addition.

Table 8.1 – Rise Rates of the Existing PSTs with and Without Chemicals at Peak Hydraulic Conditions

Tank No.	1	2	3
Length (m)	51.8	51.8	51.8
Width (m)	9.1	9.1	19.2
Depth (m)	4.3	4.3	4.3
Surface Area (m^2)	472	472	995
Total Surface Area (m^2)	1939		
Rise Rate (without chemicals)	3.8 m/h @ 174 Ml/d		
Rise Rate (with chemicals)	4.3 m/h @ 200 ML/d		

8.4.1 Chemically Enhanced Primary Clarification

The primary purpose of chemically enhanced primary clarification (CEPT) is to increase the hydraulic capacity of the existing PSTs during wet weather events. This is possible due to the increase in rise rates with chemical addition. The additional benefit of CEPT is that removal treatment through the PSTs is improved during wet weather events. The influent during wet weather events is characterized by the increased quantity of fine, silty particles that enter the collection system via weeping tiles. The addition of a coagulant and polymer act to increase the particle size of the suspended material thereby increasing the ability of the PSTs to remove these fine particles. A spin off effect of increased removal of fine particles is that the ultraviolet transmissivity (UVT) of the primary effluent is also improved. This increases the effectiveness of the UV disinfection system, as a portion of the primary effluent will be blended with secondary effluent prior to UV disinfection during wet weather events greater than 125 ML/d during the spring, fall and winter.

8.4.2 Chemical Selection

Jar testing was conducted during a wet weather flow event in the summer of 2006 to evaluate alternative chemicals for CEPT. Refer to the PDR for details concerning the jar testing. Recommendations regarding chemical selection are summarized as follows:

- Alum in combination with an anionic polymer provided the best performance.
- Alum dose in the range of 40 to 60 mg/L provided the best performance with respect to Biochemical Oxygen Demand (BOD_5) and Total Suspended Solids (TSS).

8.4.3 Alum Feed System

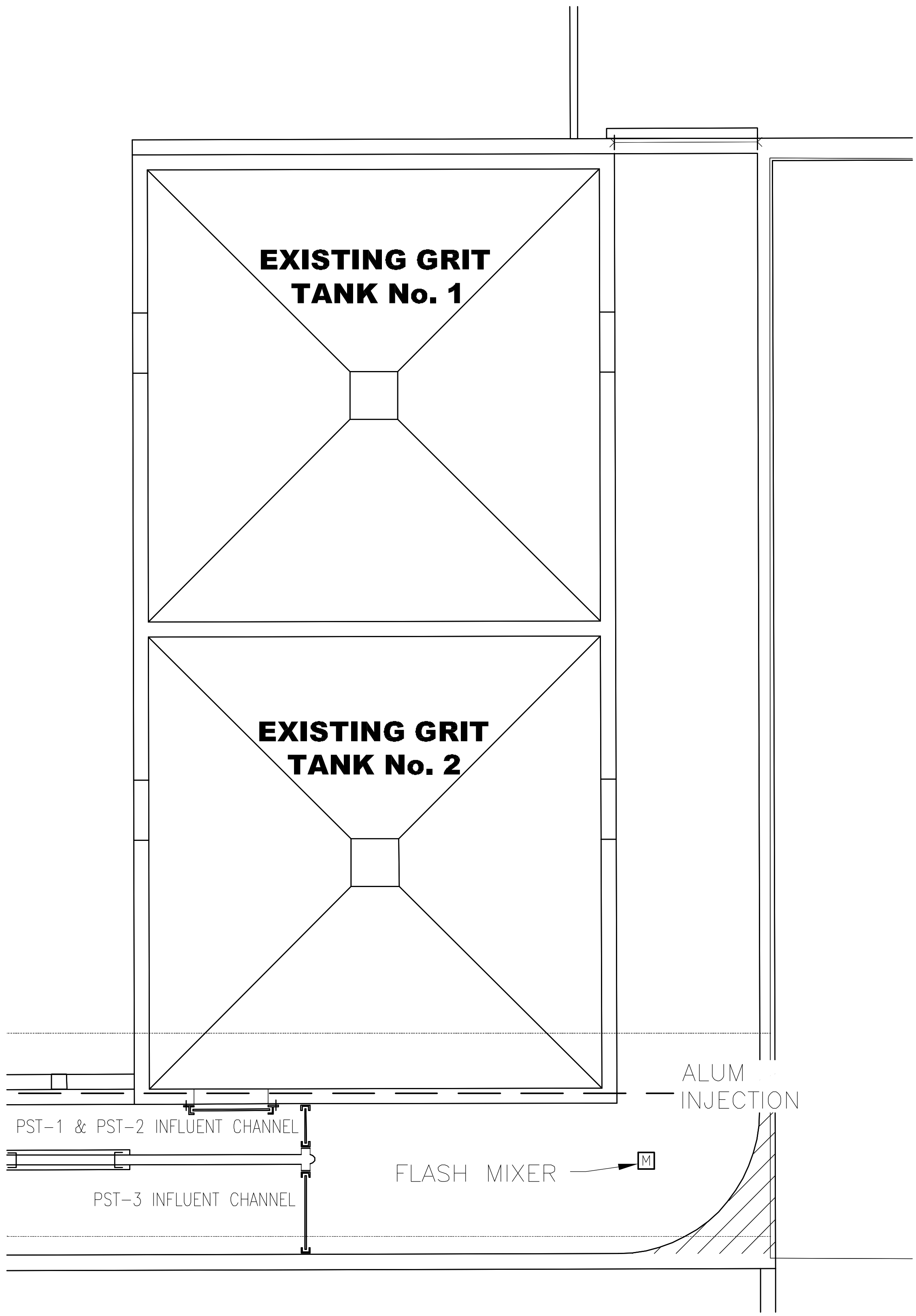
The alum feed system for CEPT is based on the following design parameters:

- Alum dose = 50 mg/L.
- Average flow over the maximum week = 181 ML/d.
- Maximum instantaneous flow = 200 ML/d.
- Alum requirement = 9050 kg/d or 14.1 m^3/d (48% strength solution).
- 7 days storage for CEPT = 99 m^3.

The alum storage tanks will also be used to feed alum to the BNR process for phosphorous trimming, if required. Assuming an alum dose of 0.5 mg/L, a flow rate of 175 ML/d, and 21 days of storage, the additional storage requirement for phosphorous trimming is 32 m^3. The total alum storage requirement is 131 m^3. Four (4) - 32.9 m^3 double walled storage tanks will be provided for alum storage.

A peristaltic pump rated at 0.18 L/s is required to satisfy the maximum pumping requirement of 50 mg/L at a flow rate of 200 ML/d. The peristaltic pump will be capable of receiving an analog signal so that it can dose based on the actual flow rate.

Alum will be pumped to and injected into the PST influent channel immediately downstream of the existing grit tanks. A flash mixer will be provided immediately following the alum injection point to mix alum into the sewage. Refer to Figure 8.2 for a plan view of the alum injection location.



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ENGINEER'S SEAL

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE

ALUM INJECTION LOCATION PLAN

DESIGNED BY	CHECKED BY
DRAWN BY	APPROVED BY
HOR. SCALE: VERTICAL:	RELEASED FOR CONSTRUCTION:
DATE JULY 29, 2008	DATE

TENDER NO.	CITY DRAWING NUMBER	SHEET OF
2007-	FIGURE 8.2	

8.4.4 Polymer Feed System

The polymer feed system for CEPT is based on the following design parameters:

- Polymer dose = 1 mg/L.
- Maximum instantaneous flow = 200 ML/d.
- Polymer requirement = 200 kg/d.

Dry polymer will be provided in 50 kg bags. The bags will be lifted using a spreader bar on a hoist and transported to the polymer makedown system via an overhead monorail. The polymer makedown system will consist of a dry polymer disperser, a mixing tank and a holding tank. The prepared polymer will be diluted and dosed to the injection points using progressive cavity pumps. Two (2) duty pumps rated at 7 L/min with a spare capable of backing up either duty pump will be required to dose to two injection points.

Polymer will be pumped to and injected into the primary influent channel to PST-1 & PST-2 and to the primary influent channel to PST-3. Flocculators will be submersed in the channels to slowly mix the polymer with the sewage to encourage the formation of floc. Refer to Figure 8.3 for a plan view of the polymer injection location.

8.5 CHEMICAL FEED ROOM LAYOUT

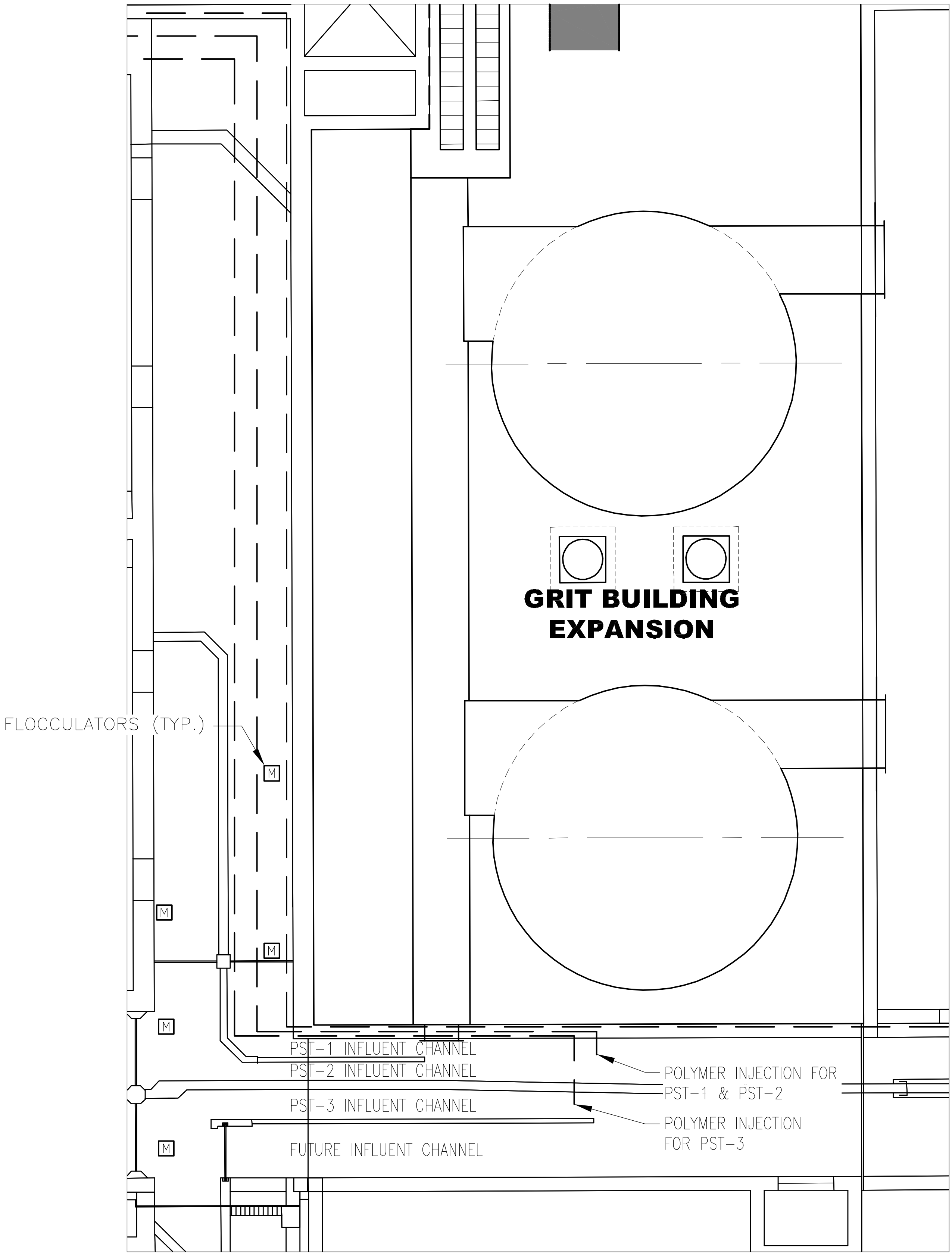
The Chemical Feed Room will be located north of the existing PSTs. The alum storage tanks will be located along the east wall of the Chemical Feed Room with an alum fill line accessible for tanker trucks along the north side of the building. The alum tanks will be interconnected with a common header that the peristaltic pumps will draw from. The polymer feed system will be located along the west wall of the Chemical Feed Room. An overhead door will be provided to allow for equipment or tank removal. Refer to Figure 8.4 for a plan view of the Chemical Feed Room.

8.6 SCUM MANAGEMENT

Scum and foam are phenomena recognized to cause a variety of problems in wastewater treatment plants.

Scum in wastewater treatment plants is considered to be the matrix of buoyant material including a thin visible film which develops and floats on the liquid surface in relatively quiet tank and channel areas. The scum matrix often includes:

- demulsified fats, oils and/or grease (FOG) compounds.
- organic and inorganic solids.
- fibers and other small particles.



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ENGINEER'S SEAL

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE

POLYMER INJECTION LOCATION PLAN

DESIGNED BY	CHECKED BY
DRAWN BY	APPROVED BY
HOR. SCALE: VERTICAL:	RELEASED FOR CONSTRUCTION:
DATE JULY 29, 2008	DATE

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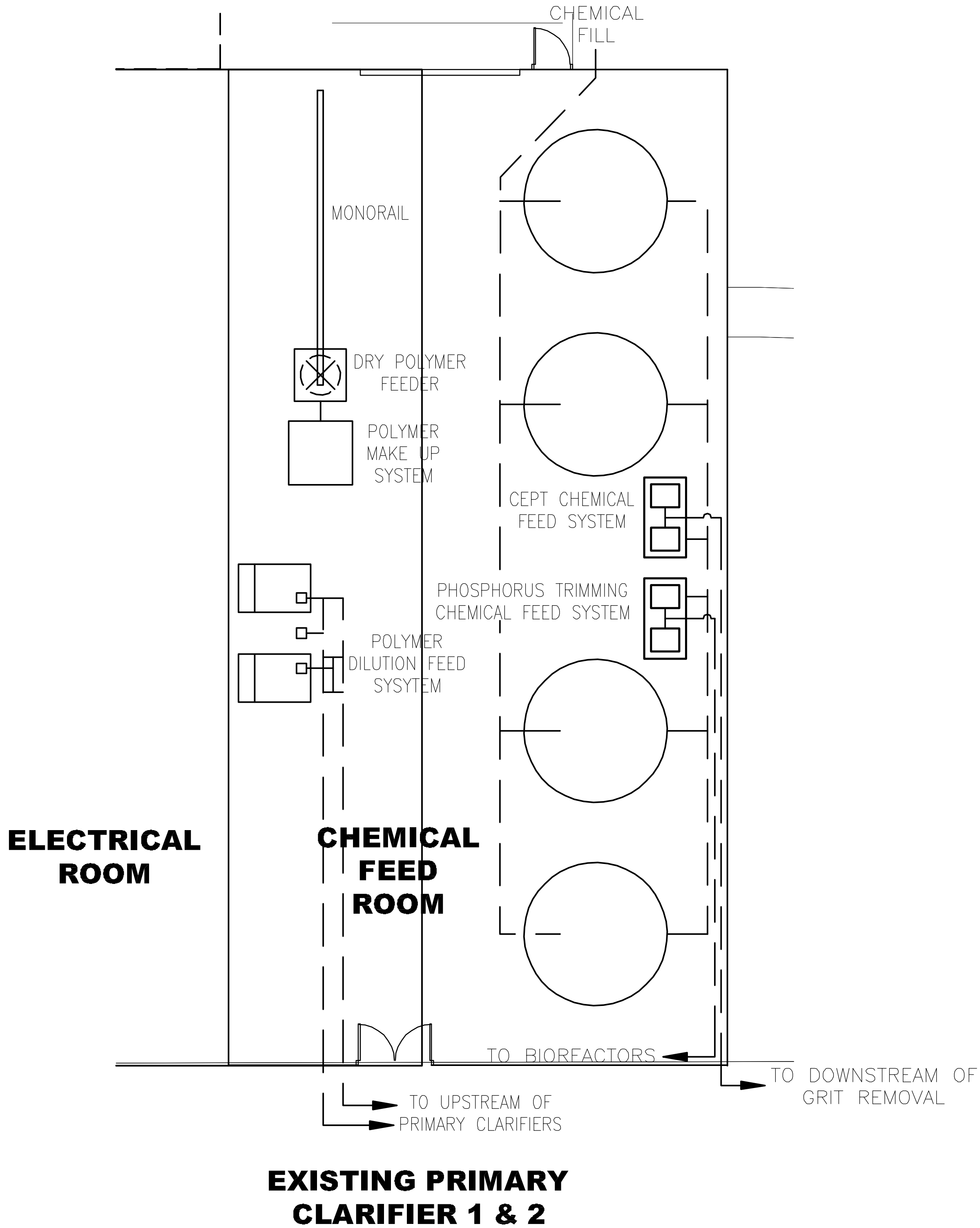

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ENGINEER'S SEAL

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
Winnipeg

SOUTH END WATER POLLUTION CONTROL CENTRE

CHEMICAL FEED ROOM PLAN

DESIGNED BY	CHECKED BY
DRAWN BY	APPROVED BY
HOR. SCALE: VERTICAL:	RELEASED FOR CONSTRUCTION:
DATE JULY 29, 2008	DATE

TENDER NO. 2007-

CITY DRAWING NUMBER FIGURE 8.4

SHEET OF

- small bits of biodegradable and non-biodegradable trash.
- either natural or manufactured polymers.

The major components of scum are demulsified FOG compounds which are initially present in the bulk liquid in dissolved or colloidal suspended form, and which under certain conditions partition to the liquid surface as non-aqueous phase liquid layers and/or congealed clumps. FOG compounds in the bulk liquid may be considered to be potential precursors of scum. Emulsified compounds become demulsified and partition to the liquid surface as a film often under conditions of decreased temperature, change in pH, or in the presence of certain coagulating chemicals in solution in the bulk liquid. The rate of accumulation of the demulsified film layer on the surface of the bulk liquid is also dependent on the liquid velocity profiles and patterns within the bulk liquid volume, in comparison with the upward velocity of the buoyant globules which come out of emulsion throughout the depth and area of the bulk liquid. Demulsified FOG may result in thin film layers and/or in clusters of larger congealed clumps.

Foam consists of a matrix of numerous gas bubbles trapped in liquid film in a surfactant mode, with other material often present in the matrix. Foam often represents a component of the scum matrix at a particular location, but the origin and nature of foam are different from scum.

Foam may develop at the following points:

- Where the bulk liquid is mixed or aerated, either intentionally by mixers or diffusers, at junctions or drop points such as weir cascade points.
- Where surfactant chemicals are present in solution in the bulk liquid.
- Where a biological treatment process is generating gas bubbles through either aerobic or anaerobic biological respiration.
- Where a tank headspace pressure is reduced below atmospheric pressure to the point where dissolved gases come out of solution.
- Where sub-atmospheric pressure develops in liquid piping.
- Where dissolved chemical compounds trap numerous fine bubbles (from whatever origin) in a surfactant mode at the bulk liquid surface, preventing those bubbles from escaping to the tank headspace and the atmosphere.

Scum and foam may exist together in a combined matrix. However, the presence of scum or scum precursors does not always also result in the formation of foam. Likewise, foam may develop in situations where there has been no scum formation and where scum precursors are not present in significant concentrations in the bulk liquid.

Engineering solutions developed to address scum and foam problems need to address each phenomenon.

8.6.1 Overview of Primary Settling Tank Scum Management

The existing PST scum management program includes several components, including the following:

- Removal of the scum from the surface of the settling tanks by skimming or sweeping the scum into collection troughs.
- Pumping of the collected scrum/water mixture from the hoppers to the sludge holding tanks.

There are currently deficiencies perceived in both of these steps.

As noted in Section 8.2.3, the existing scum piping from PST-3 to the existing sludge holding tanks plugs up over time, resulting in longer pump runs. It is believed that the problem is in part a result of the long pipe run from PST-3 to the sludge holding tank. The new sludge holding tanks will be located southeast of the existing PSTs, and the primary sludge will be re-routed to the new sludge holding tanks. If the problem is a result of the long piping run, the issue with pipe plugging would probably persist with the piping from PST-1 & PST-2, as opposed to the piping from PST-3, following the shift to the new sludge holding tanks if PST-1 and PST-2 are retained in their current configuration.

As part of the PST review, the City requested an evaluation of the existing scum collection mechanism associated with PST-1 and PST-2. The review addressed the potential relocation of the scum collection chamber from the effluent end of the settling tanks to the influent end, similar to PST-3. Information for the evaluation was obtained from review of the City's June 1993 PSTs Operating Manual, site inspection at the SEWPCC, and discussions with plant personnel. The details and exact installation dimensions of existing equipment will be confirmed during the detailed design phase, as necessary.

8.6.2 Existing Primary Settling Tank Number 1 and 2 Scum Collection System

PST-1 and PST-2 are rectangular tanks with traveling bridges. Each traveling bridge is mounted across a 30 ft wide tank. Each bridge is equipped with a single bottom blade and a top surface skimming blade. Each of these can be raised and lowered. The bottom scraper pushes the settled sludge in a counter current direction to a single sludge hopper located at the influent end of the tank. The sludge that accumulates in the hopper is removed by pumps.

The top scum skimmer blade is a single cross flight blade that pushes the floating scum in a co-current direction up an inclined beach plate and into a scum trough located at the effluent end of the settling tank. The scum trough is mounted along the entire width of the tank. The trough is mounted above the operating water level and has a small beach plate on the skimmer approach side. The collected scum flows by gravity to a single common 3 cubic meter scum pit located on the south longitudinal side of PS-2, at the southwest end. The traveling bridges were installed in 1972. Three pumps are located at the scum pit serving PST-1 and PST-2; one scum recirculation pump, and two scum removal pumps. The City's 1993 Operating Manual indicates the following:

- One scum recirculation pump serving PS-1 and PS-2: P208-SCP: Chicago Pump, Model S114, with a capacity of 15 L/s, 6.0 m head; with 5.0 hp (3.75 kW) 575V motor.
- Two scum pumps serving PST-1 and PST-2: each Hayward Gordon, Vortex Model Torus XR-10, with 5 hp (3.75 kW) 575V motors; each with a capacity of 5 L/s at a head of 3.3 m.

These pumps were installed in 1991 in an upgrade from the original 1970s pumping equipment. The pumping equipment serving PST-3 is similar to that serving PST-1 and PST-2. Flushing water lines are located in this area, designed to feed flushing water into the upstream end of the scum collection trough at the influent end of PST-1. There are both cold and hot flushing water lines in this area; however, the hot flushing water system has not been operative for a number of years. As described in the 1993 Operating Manuals, the scum discharge piping, valves, level sensors, and controls were designed to operate the scum recirculation, scum removal, and flushing cycles automatically; with periodic adjustment by the staff. However, it appears that currently the scum transfer operation and in particular the flushing are controlled manually to minimize the transfer of liquid to the scum tanks and thereby minimize the overall hauling to the NEWPCC.

In PST-1 and PST-2, scum is collected co-current with the direction of wastewater flow through the settling tanks. In PST-3, scum is collected counter-current to the wastewater flow direction, by means of a traveling bridge mechanism. In PST-3, there is no inclined scum beach plate which spans the tank and no cross-tank scum collection trough as in PST-1 and PST-2. In PST-3, the single bridge-mounted skimmer blade pushes the floating scum in a counter-current direction to a scum collection zone at the inlet end of the settling tank. Within that zone, a scum collector mechanism consisting of a series of traveling flights (short surface-skimmer blades) pushes the scum across the tank to hopper located at the southeast corner of that settling tank. Scum from PST-3 is pumped from the hopper through dedicated piping to a point of intersection with the PST-1 and PST-2 scum pump discharge piping. From that intersection point on, a single common pumped scum pipeline continues westward to the existing sludge holding tank which is located west of the aeration tanks. The controls were designed to operate the scum pumps in a manner to preclude both scum pumping systems (that serving PSTs 1 and 2 and that serving PST-3) from pumping simultaneously. In addition, valving allows the option of pumping scum through the sludge pumping line in this area, which also discharges to the sludge holding tank. The PST-3 pumped scum line runs approximately 75 m prior to the intersection with the pumped scum line of PST-1 and PST-2. There are routing valves on each branch of the pipelines.

8.6.3 Current Perceived Problems With Primary Scum Collection

Information provided by City personnel indicates that the scum pump discharge pipelines routinely get clogged over time, diminishing the pumped flowrate to the point that excessive time is required to remove scum from the collection hoppers to the sludge holding tank. The City addresses this in part by bringing in an outside contractor to clean out the scum pipelines, typically about once per year, usually in or around the month of February. This reportedly involves the use of unheated high pressure water.

Information provided to Stantec indicates that the heat exchanger for the SEWPCC hot flushing water system has not operated for many years; and that the past performance of the hot flushing water system for scum flushing is not known in detail. Detailed information has not been provided on the quantity of scum collected (differentiated from total liquid pumped by the scum pumps) nor on the status of sewer system controls such as sewer user FOG control programs. The March 26, 2008 version of the Consolidation Update, By-Law No. 7070/97 includes a restriction of 100 mg/L of synthetic or petroleum oil and grease and requires that restaurants and other commercial buildings with kitchen sink waste pipes have interceptors installed for grease, oil, and sand. However, the By-Law does not include a numerical limit for natural oil and grease.

As noted above, as part of the SEWPCC upgrade project, it is planned to construct a new sludge holding tank to the east of the existing PSTs, with the scum to be pumped eastward to that new holding tank. In that context, the City has expressed interest in consideration of changing the direction of scum collection in PSTs 1 and 2, and construction of a new scum accumulation hopper with pumps at the east (influent) end of PSTs 1 and 2. The evaluation summarized in this Section assumed that any scum collected from the PSTs would be pumped eastward to the proposed new sludge holding tank, regardless of how it is initially gathered in the settling tanks.

It is estimated that major sources of scum-forming material include fats, oil, and grease (FOG) contained in low concentrations in the sewered wastewater, and periodically at higher concentrations in septage and hauled wastewater, which is unloaded into the SEWPCC. Information provided by the City has included test data on samples from Miscellaneous Grease Traps throughout the sewer system. That data indicated high strength, but did not include analysis for oil and grease. That data spanned from April 2007 through April 2008. The City information also included tests data from sampling of raw sewage entering the SEWPCC, from March 2006 to May 2007. The highest concentration of oil and grease in those composite samples was 88 mg/L. While the City is in the process of re-writing its sewer use bylaw, no strong indications have been developed to date that forecast significant reductions in these materials being conveyed to the plant. Likewise, the currently anticipated modifications to the plant systems for receipt of septage and other hauled wastewater are not projected to significantly reduce the flux of scum-forming materials into the plant.

As noted previously, the two major features of the primary treatment scum management system; clarifier surface skimming and subsequent scum pumping, are related but separate issues. Because of that, a strict cost comparison of these actions is not used to conclusively select a unique alternative solution, but rather to prioritize recommended actions.

To address the current scum handling problems, Stantec initially developed three action solutions for consideration, as follows:

- Action 1 - Major modifications to the scum collection system, including reversing the collector direction in PST-1 and PST-2.
- Action 2 - Revisions to the hot flushing water system and related operational changes.
- Action 3 - Continuation of the current practice of periodic contractor cleaning of the scum lines.

As requested by the City, Stantec evaluated the possibility of modifying the scum collection systems in PST-1 and PST-2 to reverse the direction of collection, as part of an effort to strengthen the collection of grease (which is a component of scum). That action would result in collecting scum from west to east, or countercurrent to the wastewater flow direction through those settling tanks.

Based on the fact that the existing scum transfer piping apparently functions in a satisfactory manner after the periodic contract cleaning events, Stantec has assumed that the existing scum piping will be acceptable for continued use (at least those portions which will continue in service). The new scum piping which will be required to convey the pumped scum eastwardly to the planned new sludge holding tank would be required as a common component in any case, and is not considered in the comparison of the three action solutions.

The three actions developed are outlined below.

Based on City review comments on draft Technical Memorandum No. 32, a September 2008 site visit and related information exchange with the City operational personnel, Stantec has developed a fourth action, which is outlined subsequently.

8.6.4 Action 1 - Scum Collection Equipment Modifications

8.6.4.1 Description of Action 1 - Potential Modifications to PST-1 and PST-2 Scum Collection Equipment

As part of the settling tank review, the option of abandoning the current location of the scum collection system and constructing a new scum collection system at the influent end of the settling tanks was investigated. Modifications of the scum collection system location would require the following:

1. Modifications to the traveling bridge to change the operation of the scum scraper to pushing the scum to the influent end of the tank.
2. Installation of new stainless steel scum cross removal conveyor flights located at the influent end of each tank. The conveyor would push the scum to a scum pit located at the side of each tank. The scum pit would be connected to the scum hopper.
3. Modifications to the bridge flights to allow for the new scum removal system at the end of the tank. The bridges would stop sooner, so sludge and scum flights would need to be extended and adjusted. Controls would need to be repositioned.
4. Installation of two new scum pits inside the two settling tank tanks at each end of the scum removal units.
5. New scum hopper, to be constructed outside the settling tanks.
6. Installation of piping to new scum hopper.
7. New sludge pump and new recirculation pump.
8. New electrical service to pumps.
9. New scum removal and pump controls.
10. New valves and piping.
11. New flushing water piping connections.
12. Removal of old scum trough and patching.
13. Capping and sealing old scum hopper.
14. Removal of old pumps and piping.
15. Odor control ventilation.
16. Revisions to the DCS monitoring screens.

It should be noted that even if Action 1 were implemented, it still might be necessary to upgrade and use the hot flushing water system or to conduct periodic contractor cleaning of the scum lines, including the new lines.

8.6.4.2 Opinion of Cost for Modifications to PST-1 and PST-2

The opinion of costs based on the above works is shown in Table 8.2.

Table 8.2 - Preliminary Opinion of Probable Cost - Scum Handling Upgrade
Action 1 – Scum Collection Equipment Modifications

Item	Description	Number	Unit Cost Installed	Total Cost Installed
1	Scum cross removal system	2	$100,000	$200,000
2	Modify sludge scraper and scum skimmer	2	$40,000	$80,000
3	Scum pit concrete	2	$10,000	$20,000
4	Scum Hopper	1	$130,000	$130,000
5	Scum pump	2	$15,000	$30,000
6	Scum recirculation pump	1	$30,000	$30,000
7	Scum piping	1	$30,000	$30,000
8	Ventilation	1	$15,000	$15,000
9	Electrical	1	$15,000	$15,000
10	Controls	1	$25,000	$25,000
	Sub-total			$575,000
	Contingency	15%		$86,000
	Engineering	15%		$86,000
	Total			$750,000

8.6.4.3 Description of Work for Modifications to PST-1 and PST-2

The conversion of PST-1 and PST-2 would require that the two tanks be taken out of service to perform the modifications. One tank at a time would be taken out of service. It is preferable to remove a tank from service during the low flow period since all settling tanks are needed during the peak flow time. The work within the tank would be considered as confined entry and confined entry procedures would be required.

Once the tank is out of service the scum pit would be constructed, the traveling bridge would be modified, the old scum trough would be removed and the controls modified.

The scum pits would be constructed on the interior of the tanks at the influent end adjacent the centre divide wall between PST-1 and PST-2. One scum pit would be located on one side of the divider wall and the other scum pit would be on the opposite side of the wall. The scum pit tank walls would be constructed with reinforced concrete and would be cast to the divider wall to become an integral with the divider wall. A cored pipe opening in the settling tank wall would allow the installation of a scum pipe between the scum pit and the scum hopper.

A new concrete scum hopper would be constructed on the east exterior side of gallery no. 4 along with an area for the scum pump and recirculation pump. New piping would be required to connect to the scum pits.

New scum pump and recirculation pump would be installed.

The existing scum trough is metal and is bolted to the transverse beam at the effluent end of the settling tank. The scum trough would be removed and the beam patched. The existing concrete scum hopper that is cast integral with the south longitudinal wall of PST-2 would be capped off.

The traveling bridge would be modified to change the operating direction of the scum skimmer to operate in the same direction as the sludge flight. The skimmer would push the surface scum to the influent end of the settling tank. Modifications to the sludge flight may be required to extend the reach to compensate for the scum collection system.

A scum collection system with cross removal conveyor flights would push the scum to the scum pit. The scum collection system would be mounted transversely at the influent end of both settling tanks.

The old scum pump and recirculation pump would be removed.

Electrical work would be required to rework the traveling bridge operation and limit switches, for the scum pump and recirculation pump.

Work would be required to modify the graphics screen of the DCS system.

8.6.5 Action 2 - Hot Flushing Water System Modifications

8.6.5.1 Description of Action 2 – Modification of the Hot Flushing Water System

The fact that periodic pipeline cleaning by an outside contractor is successful at restoring the capacity of the pumped scum pipelines suggests that more frequent line cleaning would be successful and should be considered as a potential operational action. The SEWPCC has hot water flushing lines in place at the plant. Recent discussions with City personnel indicated that the heat exchanger which originally served the hot flushing water system has not been operational for many years. That heat exchanger was originally designed to draw heat from the main boiler in the service building. For planning comparison purposes, it was assumed that installation of a new heat exchanger would be a more feasible option than cleaning and renovating the old heat exchanger. Stantec has assumed that this action would also include a comprehensive cleaning, testing and renovation of the existing hot flushing water piping, valves, and control operators; and replacement of the hot flushing water recirculation pumps.

Stantec has also assumed that the sizes of the existing hot flushing water piping are sufficient to convey the required flowrate of hot water for the necessary flushing function.

8.6.5.2 Opinion of Cost for Modifications to the Hot Flushing Water System

A conceptual planning estimate of capital costs for the upgrades related to this action is summarized in Table 8.3.

Table 8.3 - Preliminary Opinion of Probable Cost - Scum Handling Upgrade
Action 2 – Hot Flushing Water System Modifications

Item	Description	Number	Unit Cost Installed	Total Cost Installed
1	Remove old heat exchanger	1	$3,000	$3,000
2	Install new heat exchanger and pumps	1	$50,000	$50,000
3	Clean, test and repair piping and valves	LS	$20,000	$20,000
4	Budget for piping and valve replacement	LS	$20,000	$20,000
	Sub-total			$93,000
	Contingency	15%		$14,000
	Engineering	15%		$14,000
	Total			$121,000

Stantec has estimated that as long as the plant boiler system has the required heating capacity, the cost of installing a new heat exchanger and any additional required hot flushing water pipelines, insulation, valving, and controls, would be substantially less than the cost for construction of the major scum collection modifications outlined above.

Assuming that the hot flushing water upgrades are feasible, operational procedures should be developed and programmed into the controls to provide for regular hot water flushing cycles for the scum lines, on the order of once per month in the cooler half of the year.

8.6.5.3 Action 2 - Implementation

If Action 2 were selected for implementation, an accurate estimate of the hot water flowrates, insulation, and heat exchange requirements would be calculated. That effort would include:

- Review of temperature patterns in the piping corridors and review of the scum pumping records to asses whether the scum pipeline clogging problem develops more quickly in colder periods.
- Inspection of the existing hot flushing water pipelines, points of application, valves and other controls; and assessment as to what if any additional hot flushing water branches are needed.

- Review of the flowrate and pressure capacity of the hot flushing water lines.
- Review of the heating capacity of the boiler and heat exchange system to heat flushing water, within the context of the overall plant heating loads on the boiler system.
- Calculation of heat losses between the heat exchanger and the points of flushing water application in the scum line system, given existing piping conditions, in cold –temperature conditions.
- Assessment of the need and benefit of changing or adding insulation to the hot flushing water pipelines to the scum handling area.

The assessment should include consideration of the proposed new easterly-pumping scum line concept.

8.6.6 Action 3 - Continued Periodic Contracted Cleaning of Scum Lines

8.6.6.1 Description of Action 3 – Continued Periodic Contracted Cleaning

This action would involve continuing the practice of periodic contractor cleaning of the scum lines, at an estimated cost of approximately $5,000 per year.

8.6.7 Action 4 - Scum Control Operational Modifications

8.6.7.1 Overview

Subsequent to the submittal of draft Technical Memorandum No. 32 in August, 2008, Stantec obtained additional information related to scum management in the PST area from the City, through review comments and through a site visit in early September, 2008. Based on evaluation of that additional information, Stantec has developed an additional action item to address scum control. This additional option is based on the procurement of more precise information on the magnitude and location of the problem and on optimizing operation of the existing equipment.

Key issues related to the scum control problems at the SEWPCC include the following:

- The magnitude and location of scum accumulation, and possible relation to foam formation in treatment units downstream of the PSTs;
- Perceived advantages of counter-current versus co-current scum collection in the PSTs;
- The impact of the settling tank bridge mechanism cycle pattern and programmed dwell times;

- Definition of the limitations on scum and scum precursors which can be allowed into the proposed new BNR bioreactor system without causing operation and performance problems.

8.6.7.2 Additional Information Obtained

In early September, 2008 Stantec personnel visited the SEWPCC and examined the PSTs. During that visit, at PST-1 and PST-2, it appeared that the skimmer blade on the traveling bridge was successfully trapping a floating scum layer on the downstream (west) side of the blade. At PST-3, the skimmer blade on the traveling bridge was trapping scum on the upstream side (east) of the blade, but the trapped scum layer was not as distinct and cohesive in PST-3 as it appeared to be in PST-1 and PST-2. At the scum collection zone at the influent end of PST-3, it appeared that while the cross-collector flights were pushing some of the scum towards the collection hopper, some portion of the scum was being swept away by currents back out into the body of the settling tank (but still behind the traveling bridge blade). One of the operators advised Stantec that the performance of scum collection in PST-1 and PST-2 with the co-current system was generally better than that of PST-3 with the counter-current system, and that conversion of PST-3 to a co-current system would improve the scum collection there. It is understood that the visual appearance and opinions conveyed during that visit are anecdotal.

Written comments provided by the City on review of the August, 2008 Technical Memorandum No. 32 included suggestions and recommendations for scum control. Several comments indicated a preference for Action 1, which would involve conversion of the scum skimmer mechanism in PST-1 and PST-2 to be counter-current. One of the comments indicated that grease removal from PST-3 is more effective than from PST-1 and PST-2. Another comment noted the presence of foam in the existing HPO bioreactors, under the cover, in relation to FOG carryover to the bioreactors and to the final clarifiers. Several comments expressed concern about the possible detrimental impact of FOG and scum on the proposed new BNR bioreactor system, with specific concern about grease clogging the IFAS exit screens and impairing the performance of the treatment process by filming on the IFAS media.

Subsequent City of Winnipeg comments noted that large FOG globules had been observed exiting PST-1 and PST-2 in the winter; and that plugs of FOG get pushed through the plant when the influent pumping wet well gets drawn down.

In September 2008, in response to a request for copies of available test data on oil and grease entering and traversing the SEWPCC, the City provided data on testing of samples of SEWPCC raw sewage and samples of miscellaneous restaurant grease traps throughout the sewer system. Copies of the data reports are included in Appendix I.

The SEWPCC raw sewage data were for 24-hour composite samples taken roughly once per week from March 2006 until May 2007, and included results for analysis of Oil and Grease. The maximum concentration was 88 mg/L. The average concentration was approximately 60 mg/L.

The miscellaneous Restaurant Grease Trap samples were collected from April 2007 through April 2008, and were analyzed for a variety of parameters including BOD, TSS, TKN, metals, and pH; but not for oil and grease. The data report suggests the restaurant grease trap samples were primarily grab samples. While these samples were not tested for oil and grease, the nature of the sources and the reported concentrations of some of the other parameters suggested that oil and grease concentrations would be fairly high. TSS results ranged from 63,400 mg/L to 214,000 mg/L; and were coded as “TSSavg” or “TSSwv.” BOD results ranged from 22,400 mg/L to 49,300 mg/L; and were coded as “BOD5 seed.” TKN results range up to 1,713 mg/L; and were coded as “nuTKN.”

Related to the cleaning of the scum transfer lines, information provided by the City indicates that this is done once per year, typically around February; and that the contractor uses only high-pressure water that is not heated. Also, the City confirmed that the hot flushing water system and related boiler operations that were included in the earlier SEWPCC design and operations have not been active for many years.

During an October 30, 2008 Project Team Meeting, City personnel reiterated the written comment concerns. The phenomenon of foam developing in the existing covered HPO reactor vessels was discussed, with some suggestion that the degree of foam present in the northern HPO reactors and scum present in the northern secondary clarifier were indicative of a higher degree of scum and/or FOG flux from PST-1 and PST-2 in comparison with the flux from PST-3. The different causes of scum and foam formation were briefly discussed, as were the variable factors affecting spatial tracking of these through the treatment units. The City’s operational procedures for programming of the PST bridge movement patterns were reviewed. It was discussed how the current partial-length bridge travel cycle patterns and dwell times were programmed in an attempt to maximum sludge removal in the front end of the settling tanks while still maintaining the desired sludge blanket for the current HPO-based treatment process. The fact that the proposed new treatment process would not have the same sludge blanket requirement was discussed. The City indicated that periodically, the process of transferring sludge and scum from the SEWPCC sludge holding tanks by tanker truck to the NEWPCC digester system became bottlenecked logistically; such that the removal of scum from the PSTs through the collection hoppers became impaired. The possibility of sending scum from PST-1 and PST-2 to the PST-3 scum hopper was discussed as a possible option for relieving the bottleneck. The possibility of sending PST scum either to the proposed DAF system or to the proposed Fermenters was discussed, in part to relieve the load on the NEWPCC digester system, and also possibly to recover some volatile fatty acids (VFAs) in the Fermenters. It was decided that these possible options would be investigated further during the detailed design phase. Stantec indicated that the IFAS supplier has advised that the IFAS process would not be impaired as long as the concentration of oil and grease entering the IFAS process does not exceed 100 mg/L.

The limited extent of available recent oil and grease test data for the SEWPCC was confirmed at the October 30, 2008 project meeting. The difficult nature of sample collection and handling for accurate oil and grease characterization was discussed. It was agreed that some additional testing of oil and grease entering and traversing the SEWPCC was appropriate and a proposal for that monitoring was subsequently drafted.

The City's current sewer use Bylaw currently contains numeric limits (100 mg/l) on the discharge of synthetic or petroleum oil and grease. However, while the Bylaw requires that commercial kitchen facilities have grease interceptors in place, it does not contain a numerical limit on total oil and grease including natural oil and grease components in discharges to the City sewer system. Stantec recommends that the City revise the sewer use Bylaw so that the limit of 100 mg/l applies to Total oil and grease. Likewise, the City currently does not have numeric limits on total oil and grease includingthe concentration or mass of total oil and grease allowed in hauled wastewater load dumps to the SEWPCC. At the September 30 meeting, it was discussed that a review of this would be appropriate if monitoring indicated that the flux of oil and grease from hauled waste sources represented a significant problem that could not be addressed by reasonable process and operational measures at the SEWPCC.

Based on the additional information summarized above, Stantec believes that another scum management action is appropriate, Action 4.

8.6.7.3 Description of Action 4 – Scum Control Operational Modifications

Action 4 involves:

a) Optimization of the removal of scum from the collection hoppers by transfer of some of the collected scum to either the DAF system or the Fermenters; as well as using the PST-3 collection hopper for temporary storage of some of the scum from PST-1 and PST-2.

b) Modifications to the programming of the traveling bridge cycle and dwell times for the proposed new treatment process.

c) Continued periodic contractor cleaning of scum transfer lines.

d) No significant modification to the scum collection mechanical equipment of the PST traveling bridge mechanisms.

e) Minor modifications to the existing scum collection system, if determined to be necessary from additional monitoring of FOG at the SEWPCC and from further review of the resilience of the proposed new BNR system; including such measures as the possible addition of addition of chemicals to promote the biodegradation of scum and scum precursors.

In conjunction with Action 4, it is recommended that a program of limited monitoring for FOG be performed at the SEWPCC. This would include collection of samples at the headworks, north and south PSTs, and secondary clarifiers. Multiple grab sample collection would be performed using glass containers with no transfer. This would include both surface samples and depth samples for comparison. An outline of the proposed monitoring program, which would only run for a limited time period of one month during the detailed design phase, is contained in Appendix J. Further detailed evaluation of the optimum transfer of scum to the DAF and/or

Fermenters will be performed during the detailed design phase. In addition, the exact limits on appropriate allowable flux limitations of FOG to the proposed new BNR treatment system will be confirmed during the final design phase, through process research and further review of the operations at other similar facilities. The detailed design phase will also include the design of all necessary maintenance and access features to allow for periodic examination and maintenance of the BNR treatment system including the IFAS media and exit screens.

The capital costs associated with Action 4 would be minimal in comparison with Actions 1 and 2. The operational costs including continued annual contractor cleaning of the scum transfer lines, would be similar to those of Action 3. The costs associated with the FOG monitoring program and changes to the PST bridge travel programming would be included in the detailed design phase costs.

8.6.8 Comparison of Actions and Recommended Solution

A comparison of costs estimated above indicates that Action 1, involving major modification to the scum collection equipment and hoppers, would have a capital cost approximately 5 times as high as Action 2, modifications to the hot flushing water system. As noted above, modifications to the hot water system or continued periodic contractor cleaning might be required even if Action 1 were implemented. In addition, recent information provided indicates some uncertainty as to whether the co-current scum collection system is inherently inferior to the counter-current system. Because of these three factors, it is not recommended that the City proceed with Action 1 immediately.

Assuming an interest rate of 5.0 % and a comparison term of 25 years, the present worth for the annual cost of Action 3 was estimated to be approximately $70,000. This value is still somewhat lower than the estimated capital cost for Action 2, modification of the hot water flushing system.

As noted above, there are a variety of causes of foam and scum formation, and the extent of a problem as it might affect the proposed new BNR treatment process has not been conclusively established from existing data.

Based on this, it is recommended that the City not implement any significant scum equipment infrastructure improvements immediately. The City should continue the current practice of periodic contracted cleaning of the scum lines. The City should maintain detailed records of the volumes of scum pumped, the temperatures in the piping corridors, and the frequency and chronology of the contracted cleaning, to optimize the cleaning benefit.

It is recommended that the City adopt Action 4 - Scum Control Operational Modifications, incorporating continued minor operational modifications. The recommended additional FOG monitoring should be undertaken as soon as possible. If the FOG monitoring additional indicates that the minor operational modifications are not sufficient to prevent problems, it may be necessary to implement major retrofit such as Action 1 in the future. It should be noted that the cost for such a major retrofit action has not been included in the total project cost estimate presented in this report.

8.6.9 Scum-control Additives

There are a number of materials available on the market that are designed to help control the formation of scum in wastewater systems. Some of these are chemicals that inhibit the formation of scum from the precursor oil, fat, and grease (FOG) compounds; but which do not necessarily degrade the precursor compounds. Others are bacterial cultures designed to accelerate the biological degradation of the precursor compounds. Each product has specific features which may affect its performance in meeting scum control goals at a particular treatment plant. In some cases, the formation of scum merely gets delayed until a later stage in the treatment process. Some of the bacterial cultures require ongoing supplementation and thus ongoing purchase of proprietary culture material. Stantec has not evaluated this approach in detail, but recommends that the City consider this approach as a possible supplemental measure for controlling scum in the future. Based on the fact that the pending SEWPCC upgrade and expansion project will involve a significant change in the activated sludge treatment biology in the conversion to the MJ BNR system with IFAS, testing of scum control additives on the current HPO activated sludge system at the SEWPCC will have only limited relevance to the upgraded plant.

8.7 CONSTRUCTABILITY

No significant construction related to scum collection is anticipated at the PSTs. However, the new sludge holding tanks will be constructed to the east, and modifications will be made to the scum transfer piping to reach the new sludge holding tank. The Chemical Feed Room will be new construction and can be constructed without impacting the operation of the existing facility. Installation of the flash mixer can be completed from outside of the channel and will not impact the operation of the existing facility. The PSTs will be required to be taken out of service one at a time to allow for installation of the flocculators in the channels to each settling tank. This work can be completed during dry weather when either PST-1 & PST-2, or PST-3 is sufficient to accommodate the flow to the SEWPCC.