CORNWALL WASTEWATER TREATMENT PLANT
ENVIRONMENTAL ASSESSMENT UPDATE

TECHNICAL MEMORANDUM NO. 4
FACILITY CONDITION ASSESSMENT

December 1, 2009

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1 INTRODUCTION

The City of Cornwall owns and operates the Cornwall Wastewater Treatment Plant (WWTP), which provides primary treatment with chemical addition for enhanced treatment and phosphorus removal as well as disinfection. The existing WWTP has an average rated capacity of 54 432 m^3/day and a peak design capacity of 108 864 m^3/day. Biosolids are treated onsite in anaerobic digesters and dewatered using centrifuges before being disposed of at the City's landfill. Sewage from the City of Cornwall is collected and transferred by gravity to a pumping station located on Montreal Road near the entrance to the WWTP and is conveyed through a forcemain and into the plant, as shown on Figure 1. Following a plant-wide evaluation in 2003 to determine required upgrades, a Schedule C Class Environmental Assessment (Class EA) was completed in 2005.

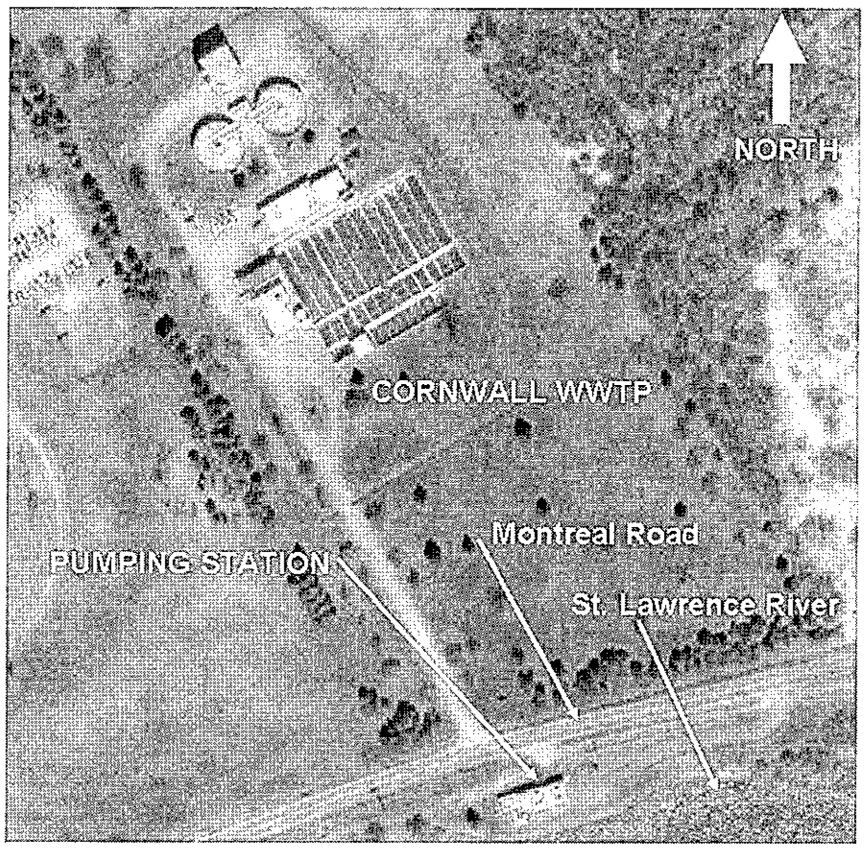

Figure 1 - Satellite photograph of the Cornwall WWTP (courtesy of GoogleMaps)

A Pollution Control Planning (PCP) study was undertaken in 1995 to address concerns raised as part of the Remedial Action Plan (RAP), which stemmed from the designation of the St. Lawrence River (Cornwall area) as an Area of Concern (AOC) by the Water Quality Board and the International Joint Commission. The PCP has recently been updated to include a hydraulic assessment of critical sewer infrastructure and to determine compliance with MOE Procedure F-5-5. In addition to other recommendations, the RAP recommended the following upgrades for the Cornwall WWTP:

- Upgrading the existing primary treatment plant to the equivalent of secondary treatment
- Achieve phosphorous removal to a compliance limit of 1.0 mg/L, with an objective of 0.5 mg/L
- Increase removal efficiency of other toxic contaminants
- Reduce bacteria levels

These requirements were considered in the 2005 Class EA, and a Biological Aerated Filter (BAF) and Ultraviolet Light (UV) disinfection system were recommended.

In May 2009, the City retained J.L. Richards & Associates Limited, in association with CH2M HILL Canada Limited and XCG Consultants Limited to update the 2005 Class EA and to update the budget for capital required upgrades, as well as life-cycle costing over the 20-year EA planning period.

The purpose of Technical Memorandum No. 4 (TM4) is to summarize the existing physical conditions of the various components of the facility based on an on-site condition assessment. Five other technical memoranda are to be prepared to summarize various elements of the overall project. These technical memoranda will form part of the Environmental Study Report Addenda (ESR Addenda), which is anticipated to be the main project deliverable for this project.

2 BACKGROUND

The Cornwall WWTP was originally constructed in 1968 and has undergone several expansions since that time. The WWTP currently serves approximately 46 000 people, numerous commercial and industrial properties, as well as the leachate from five waste disposal sites. The plant was transferred to MOE ownership in 1970, and to the City of Cornwall in 2000. An expansion completed in 1988 established the plant's current layout and the current dry weather capacity of 54 432 m^3/day.

The Cornwall WWTP is a primary wastewater treatment plant that provides phosphorus removal using chemical addition. Gravity-conveyed sewage first passes through a mechanical fine-screen located at the pumping station. Sewage is then pumped through a forcemain to the treatment plant, where grit is removed in aerated grit tanks. Following degritting, the sewage is conveyed to several primary clarifiers, and is then disinfected using chlorine and the treated effluent is discharged to the St. Lawrence River.

Solids that settle in the primary clarifiers are pumped to the two anaerobic digesters for stabilization before being dewatered by centrifugation. Dewatered solids are landfilled for final disposal.

3 LIMITATIONS AND ASSUMPTIONS

3.1 Limitations

The accuracy of discussions, conclusions, and costs presented in this Technical Memorandum are limited to the extent of the information available at the time the investigations were carried out. This information includes background information provided by the City of Cornwall and Operations Staff, regulatory codes currently in effect, and visual observations.

Site review was limited to visual observations at readily accessible locations of the exterior and interior of the WWTP and plant site. No destructive testing or inspections were carried out. A Designated Substance Survey was not undertaken.

Estimates of replacement costs have been included for various elements of the WWTP. These should be considered as order-of-magnitude approximations of what it might cost to replace existing infrastructure with comparable systems. Sizing and quality of the materials in the identified costs are similar to existing. Since the exact nature of site-wide upgrades and modifications to the existing plant are unknown at this stage, the costs presented in this

Technical Memorandum do not apply to any upgrades to be recommended at the end of the EA update phase (such as the addition of secondary treatment). Instead, these costs give an indication of what would be required to bring the relevant systems up to date using the same technologies. The costs presented do not take into consideration future expansion, constructability, phasing, and impact to the process during the implementation of any upgrades. In the final Environmental Study Report (ESR), the costs from this Technical Memorandum will be compiled with costs presented in other TMs to provide a preliminary Opinion of Probable Cost for the final recommended alternative. The intent of this Technical Memorandum is to provide order of magnitude pricing to extend the life of the plant with the existing operating criteria.

3.2 Assumptions

Due to the complexity of the existing site and the number of systems and engineering disciplines involved, some assumptions must be made when undertaking a condition assessment for obtaining available information to understand the condition of the entire site. Some of the specific assumptions made as part of this condition assessment are noted below:

- The assessment of the remaining life of a system is not exact. It is based on limited information and, in many instances, influenced by factors that may occur at some future date. Even the urgency of replacement may be determined by factors that cannot be predicted. For example, retroactive rulings by regulatory agencies may necessitate unanticipated replacement or updating of equipment within a short timeframe. By contrast, items such as paving, painting, or interior finishes might be delayed for an extended period of time, at the discretion of the City of Cornwall, subject to financial and other considerations. The actual year of replacement will be dictated by the physical condition of the system at the time of replacement. Also, certain replacements may be advanced or deferred by the City of Cornwall, subject to other considerations (e.g. financial, coordination with related work, incorporation into plant-wide upgrades, etc.).
- The assessment considers that the design life of the upgraded plant is taken as approximately 20 years.
- The estimated replacement costs noted for the various items are order of magnitude only and are based on experience and current unit prices in the construction industry.
- All costs, including those for future years, are expressed in 2009 dollars. Hence, if these costs are to be used for long-range cash-flow projection, the implications for potential future trends of inflation and interest must be applied accordingly.

It is recommended that a condition survey be undertaken approximately every five years in order to ensure that information presented in the report, including financial data, remains current and relevant.

4 CIVIL AND GENERAL REVIEW

The civil and general review of the plant consists of an assessment of roads, structures, and fencing. There are roadways and parking/loading areas for both the pumping station and main plant. These roadways generally appear to be in good condition, although they are aging. Some deterioration was noted, particularly in high-traffic areas adjacent to the Chemical and Blower Building. Asphalt roadways typically have a life expectancy of approximately 25 years. It is expected that the roadways at the WWTP may need replacement within 10 to 15 years, subject to increased wear caused by construction or other activities undertaken at the plant. An approximate replacement cost of $250 000 is estimated for this work.

A galvanized chain link fence encircles the main part of the plant. There is no fence around the pumping station. The fence is approximately 1.8 m (6') high, topped with three strands of barbed wire. A gate is located on the access road and another along the north boundary of the site, west of the dewatering building. In general, the fence is in good condition and should not need replacement within the 20 year design life, provided that it is maintained (trimming of vegetation, etc.) and no other modifications are required. The access gates were noted to be sagging and some work could be done to re-plum them. Providing a new fence complete with gates would be approximately $80 000. Replacement of the gates only could probably be undertaken for approximately $20 000.

For a discussion of the structural aspects of the buildings and tankage, refer to Section 5. The underground piping including the on-site sewers and the forcemain from the pumping station could not be inspected because they are buried. Operators did not note any issues or problems with these underground pipes. Because underground pipes such as those at the WWTP typically have extended useable service lives, it is not expected that they will need replacement within the next 20 years, unless required as part of a plant upgrade. It is recommended, however, that the City of Cornwall undertake CCTV inspections of buried piping to confirm that replacement is not warranted. This should be undertaken during the design phase.

5 STRUCTURAL AND ARCHITECTURAL REVIEW

5.1 General Methodology

Background information for the structural review was obtained during a site visit on July 7, 2009, and through discussions with current plant staff. During the visit, observations of the interior condition of Primary Settling Tanks 3 and 4 were possible since they had been dewatered for maintenance and cleaning.

Reference drawings provided by the City included:

- Basement Floor Plans
- Architectural Plans
- Ground Floor Plans
- Tank Plans
- Structural Framing Plans
- Sections and Details
- Mechanical and Electrical Plans

Reference was made during the investigation to various applicable regulatory codes, including the following:

- Ontario Building Code
- Ontario Hydro Electric Safety Code
- Ontario Plumbing Code
- NFPA Standards
- ASHRAE Standards
- SMACNA Standards
- CSA Standards

5.2 Results of Investigation

The following sections provide technical discussions on the individual structural components and/or systems of the Cornwall WWTP.

5.2.1 Retaining Walls

The reinforced concrete retaining walls near the raw sewage pumping station appear to be in good condition with no obvious signs of distress visible.

5.2.2 Substructures/Foundations

The condition of the reinforced concrete footings, piers, and walls below the level of the lower slabs on grade are unknown at this time. It has been considered in the industry that significant deterioration of below grade reinforced concrete would typically be limited. No serious problems of a structural nature were readily evident during the on-site observations, and no concerns have been reported by staff.

Minor concrete deterioration (i.e. caused by freeze-thaw effects) was evident on the top of the chlorine contact tank walls. The exterior upstand concrete curb in the Administration Building adjacent the MCCs and the concrete below the entrance door to the Screen Building are severely deteriorated and require rehabilitation. Cracks were also evident along the access stairs to the roof of the Digesters. These cracks should be injected to prevent water infiltration and freeze-thaw damage.

Assuming the substructures/foundations are maintained, the service life of the structural systems would be expected to equal or exceed and, to a certain extent, define the effective service life of the WWTP. Hence, no replacement allowance has been included in this assessment.

It is expected that the repairs to foundation walls, curbs, and cracks described above will cost in the order of $25 000 and should be undertaken in the next two years.

5.2.3 Exterior Walls

The exterior walls are typically solid brick except for the 1988 expansion buildings (Screen Facility and Sludge Dewatering Facility), which incorporate masonry cavity walls with insulation. The Digestion Tank walls also consist of exterior brick cladding and insulation within the cavity. It appears that parts of the Administration Building and Screen Building have been retrofitted with metal siding.

The exterior walls were observed to be generally in good condition considering their age. However, the solid brick walls are not energy efficient. At several locations, brick deterioration, cracks, and spalling mortar joints were observed. The cracks should be repointed to prevent water infiltration and freeze-thaw damage. Brick deterioration has been caused by water infiltration and freeze-thaw damage. Further investigation is required to determine the source of water entry, and then corrective measures can be taken before brick restoration costs become a major capital expense.

Plant staff noted that the exterior brick on the Digesters was rehabilitated in 2004 and 2006. Efflorescence on the exterior brick of the Digestion Tank No. 1 was noted during the onsite review. This is indicative of further water infiltration problems that could be related to the membrane on the interior of the tanks. Estimated costs to perform the repairs to the brick is approximately $25 000 and should be undertaken as soon as possible.

5.2.4 Roof Framing

The roof framing configuration varies (i.e. lightweight precast slabs supported by steel beams or open web steel joists and metal decking supported by open web steel joists on reinforced concrete slabs supported by reinforced concrete beams). From ground-level observations, the roof framing appears to be in good condition. No major restoration work is anticipated over at least the next ten years.

5.2.5 Roofing/Deck Membrane

Plant staff indicated that the WWTP buildings were reroofed in 2004 except for the Chlorine Building. The new roof membrane system appears to be a ballasted single-ply membrane. The typical service life of a roof membrane is 20 years, provided periodic inspections are performed every two to three years to correct any deficiencies and extend the service life. Through visual observations, it was noted that vegetation was growing on the roof of the Screen Facility. Vegetation will reduce the service life of a roof membrane. A maintenance program for the roof should be instituted to remove any vegetation and clean around all of the roof drains. Cleaning debris from around the roof drains will prevent water from ponding and will extend the service life of the membrane.

A rolled roofing membrane was noted over the service tunnel between the Primary Clarifiers. During the on-site review, it was noted that sections of the rolled roofing had debonded from the concrete slab and had blown off. The rolled roofing requires replacement. A thin polyurethane deck membrane, fully boned to the concrete, is recommended.

Cost estimates to replace the roofing on the Chlorine Building and the deck coating membrane between clarifiers are $30 000 and $20 000 respectively, and should be undertaken as soon as possible. Full roof replacement costs for the entire facility (not likely required for 15 to 20 years) would likely cost approximately $500 000 in 2009 dollars.

5.2.6 Digester Interior Membranes

The interior gas-proofing membrane in the Digesters will eventually require replacement both due to its age and as indicated by plant staff based on their experience. Replacement of such a membrane is an involved process where each digester must be taken off-line for an extended period. Material and installation costs, per digester, for replacement of the gas-proofing membrane would likely be approximately $250 000, not including costs to take the digesters out of service, for cleaning, or for process changes that might be necessary to facilitate operation with one digester at a time for an extended period.

Digester No. 1 was cleaned and visually inspected by CH2MHILL and Cornwall Staff in August 2009. The gas proofing on approximately 50% of the digester wall, going counter clock wise from the overflow box and in the liquid operating area, is the area with the most issues. The gas-proofing has bubbles in it, in the lower portion some have burst, while those in the upper portion have not yet. The bubbles are relatively small varying from an estimated 10 mm in diameter up to several centimeters across. The bubbles are most prevalent on the east side of the sludge return pipe. The maintenance port and its cover have a significant amount of delamination. The coating appears to be coal tar epoxy.

The roof appears to have one small bubble just out from the overflow box. This bubble does not appear to be collapsed at this time.

The gas relief port exhibits some delamination but the amount could not be verified as the ventilation fan is in this port. The gas withdrawal port and the gas vent port could not be inspected at this time as there was no access.

The concrete within the digester is generally in very good condition.

There is one column and one pipe support which show honey combing. However, visual observations suggest that this is a result of poor concrete placement and not deterioration caused by erosion or corrosion.

The construction joint that runs around the floor approximately 1.8 m in from the outside wall has several areas of minor liquid infiltration, as does the base at several of the columns. The construction joint has been injected at numerous locations sometime in the past as the ports are readily visible. It would appear that at some point in the past some type of concrete repair has been carried out on some areas of the joint. This appears to be sound.

As well there is evidence on the floor that concrete structures have been removed and their attachments were cut off and left exposed and the areas of disturbed concrete unfinished. There is minor deterioration of the concrete in these areas.

The piping was inspected and the attachment and supports are all in good condition.

It was suggested that a number of localized and relatively straightforward repairs be undertaken before putting this digester back in service.

Although installed approximately 40 years ago, the gas proofing was found to be in relatively good condition. Based on the visual inspection, it was concluded that gas proofing should last for another 5 years.

5.2.7 Caulking/Tank Expansion Joints

Caulking is provided to weather seal the building cladding, particularly around doors and windows and at the juncture of dissimilar materials. Caulking replacement approximately every seven to ten years is recommended due to a loss of elasticity with age and subsequent cracking and leakage. The frequency of caulking renewal is often extended up to fifteen years at the discretion of the Owner, although this is not recommended.

The caulking at most locations was observed to be brittle and cracked and is in need of immediate replacement.

Tank expansion joints were also observed to be brittle and cracked and, in some locations, missing and thus require immediate replacement.

The existing condition of the caulking and sealants will allow infiltration of water and freeze-thaw damage to occur.

It is estimated that caulking of expansion and tank joints would likely cost approximately $50 000 for the entire facility.

5.2.8 Windows

The existing windows typically consist of single glazed units in the 1968 buildings and double glazed units in the 1988 buildings. Major replacement of the windows is not anticipated over the next ten years unless the City wishes to improve the energy efficiency of the facilities.

5.2.9 Doors

The exterior doors appear to be in good condition except for one exterior tunnel door and frame, which was observed to be severely corroded and in need of replacement. Corrosion was also visible at the bottom of several doors and frames and these require repainting. With the exception of the above-noted tunnel door, the doors should provide a long service life with only minor maintenance and hardware repairs.

Costs to replace the badly rusted door and to paint other doors identified as having rust are estimated to cost approximately $10 000.

5.2.10 Miscellaneous Metals

The exterior and interior railings were observed to be in good condition. With regular painting of the steel railings and minor maintenance of the steel and aluminum railings, they should provide a long service life. It was noted, however, that the exterior tank aluminum railing posts have been cast into the walls or slabs. With very different thermal coefficients of expansion, water has infiltrated between the posts and concrete and has caused the concrete to crack, and in some locations spall, thus requiring extensive concrete repairs. The City may wish to consider cutting off the embedded posts and providing new baseplates with anchor bolts.

The access hatch covers are typically aluminum and appeared to be in good condition. With minor maintenance, the hatches should provide a long service life.

The aluminum railing and concrete repairs, that should be undertaken immediately, are estimated to cost approximately $100 000. Costs to replace other steel and aluminum railings (which is not likely required for another 10 to 15 and 15 to 25 years, respectively) is $20 000 for the steel railings and $200 000 for the aluminum railings.

6 PROCESS AND MECHANICAL REVIEW

6.1 Methodology and General Comments

A visual assessment of the mechanical systems was also completed on July 7th, 2009. This walk-through assessment was supplemented by discussions with plant staff and a review of as-built drawings. In some cases, where an equipment assessment could not be made using the methods indicated, additional investigation and/or testing is recommended.

The plant is generally in good condition due in part to an excellent maintenance and upkeep program. As previously noted, the facility was originally constructed in 1968 with a major upgrade in 1988. For the most part, equipment has been repaired on an as-needed basis and is in reasonable condition.

Cost estimates for non-mechanical and process related work, such as building modifications, have not been included in the costs listed below. All costing will need to be re-evaluated during the specific design stages for the future plant upgrade.

6.2 Condition Assessment

The plant consists of a primary wastewater treatment system that generally comprises a liquid train, solid train, gas system, chemical systems, and heating and ventilation systems.

6.2.1 Liquid Train

<u>Forcemain, Inlet Screening, and Raw Sewage Pumping</u>

A separate Technical Memorandum (TM 3) has been prepared specifically to address the Inlet Screening, Raw Sewage Pump Station, and forcemain connecting the station to the plant. Refer to that memorandum for further information.

<u>Flow Metering</u>

Plant influent metering is provided by a 30" Parshall flume complete with a Milltronics Mulitranger Plus ultrasonic level instrument. This flume was installed as part of the plant upgrades in 1988. Please refer to Section 8.2 for further discussion of the raw sewage flow metering.

Grit Removal

Grit collected in the two aerated grit tanks is removed through a clamshell bucket arrangement, complete with an overhead monorail arrangement. The grit removal system was installed as part of the 1968 construction and appears to be operating acceptably. However, the operation is labour intensive, does not usually provide consistent grit removal, requires a temporary flow and aeration shut down, and has little or no grit dewatering and washing capabilities. The removed grit is deposited in an external bin, which has the potential to cause odour issues. Operations staff has expressed interest in replacing this equipment with an automated, more modern system. A commonly used automated system would include a grit screw located at the bottom of each tank which would direct grit into a sump. Grit pumps would draw from this sump and discharge it through a grit classifier where it would be washed, dewatered, and discharged into a bin. A small building, possibly located directly over the grit tanks, would be recommended to house the mechanical equipment. A dedicated odour control unit should also be considered. The estimated replacement cost for the automatic grit removal system is in the order of $2.0 Million.

Aeration System

Three 50 hp Hoffman centrifugal blowers service the grit removal tanks and the clarifier influent channels. Minor surface corrosion was visible on the grit tank drop pipes. The submerged piping was reported to be in good condition. The blowers were installed during the 1988 upgrades and are located in an acoustically treated room within the Administration Building. The units are equipped with an intake silencer and filter. The blowers appear and are reported to be operating reliably. Typical life expectancy for centrifugal blowers of this size would be in the order of 25+ years, provided that they are sized correctly and that they are well maintained. The City should, therefore, expect to replace these units within the next 7-10 years. Several technologies are available, however a direct replacement is assumed. The estimated replacement cost is $100 000.

Chain and Flight Sludge Collectors

The clarifiers are equipped with chain and flight sludge collectors that were installed in 1968. These units are maintained annually and the wear items are regularly replaced. The collectors are reported to be in good working order. Drives for the flight and chain collectors are aging but are still in good condition. Plant staff indicated that locating parts for the drives is becoming increasingly difficult. It is recommended that the drives be replaced as part of the next major plant upgrade, at an estimated cost of $275 000.

Scum Removal

Scum is removed through a covered mechanical skimmer and routed into a scum tank through a trough, where it is pumped to the digestion process. It was installed with the original construction. Although the removal process is generally effective, during the winter months scum freezing is a reoccurring problem that hinders the operation. Investigation of alternate heating or anti-freezing solutions should be undertaken. Plant staff indicated that an automatic scum removal system could be considered if it could provide scum removal as effectively as a manual system. The clarifier dewatering pump is original, but because it has a relatively low number of operating hours, is in good working order. Replacement cost of the manual scum collection system is estimated to be $300 000.

6.2.2 Solids Train

Sludge Pumping

Sludge removal from the clarifiers is achieved using four 10 hp Moyno progressive cavity pumps. Two pumps are believed to be from the original construction, and the other two are believed to have been installed as part of the 1988 upgrades. Despite reports that performance is adequate, the City should consider the replacement of the older pumps within the next few years. The two sludge recirculation pumps are 20 hp Wemco Torque Flow pumps. One was installed originally in 1968, and the other was installed in 1988. These pumps have undergone extensive repairs over the years, primarily as a result of volute wear. Plant staff have epoxy-coated the two pumps, and the pumps are reported to be operating satisfactorily. Further investigation is recommended to determine the proper corrective action that should be taken. The use of a different pump technology or manufacture-applied coating applied to the pumps might improve their operation and permit a longer service life. Estimated replacement costs for the sludge pump, recirculation pump, and recirculation progressive cavity pump are $25 000, $50 000, and $50 000, respectively.

Scum Pumping

Scum pumping is accomplished through the use of a 5 hp Moyno progressive cavity pump installed in 2008. To date, no issues have been noted with this system. Plant staff has developed a unique method to reduce the volume of water pumped to the digesters with the scum. This system seems to work quite well. No work appears to be necessary in the foreseeable future for the scum pumping system.

Sludge Heat Exchangers

Sludge heating is currently performed through the use of two obsolete Napier Reid heat exchangers and the plant hot water system. Replacement parts are reported to be difficult to obtain. Plant staff has indicated that these units are to be replaced in the fall of 2009.

Centrifuges and Conveyors

The dewatering facility currently houses two Humbolt Wedag S3-01 hydraulically-driven centrifuges. These units were installed as part of the 1988 upgrade project and have had various rebuilds to date. Humbolt Wedag is no longer in business, making replacement parts increasingly more difficult to source. The centrifuges are reported to be performing well. Future performance will likely be affected by the introduction of secondary sludge, and will need to be considered as part of the design of such upgrades. Centrifuge cake is transported to the truck loading by shaftless screw conveyors and fed into the loading bin by a manually adjustable drop chute arrangement. Although the system does function, it requires constant operator supervision. Various methods could be implemented to provide a more user-friendly discharge system. Estimated Centrifuge budget replacement cost is $750 000. An additional cost of $10 000 to $50 000 is estimated to be required to replace the automatic cake discharge equipment.

Piping and Valving

Most process piping found on site was installed in 1968 or 1988, coinciding with the plant erection and the major upgrade projects. Piping material is generally ductile iron or stainless steel. Based on a strictly visual exterior observation, the pipes generally appear to be in reasonable condition, showing little signs of surface corrosion or joint leakage. Prior to the next major upgrade, the City may wish to have the interior and exterior of critical pipes formally inspected by a specialty company.

Specific piping concerns include the current routing of the centrate line from the holding tank in the Dewatering Facility. The centrate is currently pumped to the head of the plant through a pipe that is connected to the Digester supernatant overflow line. It is speculated that under high flows, the hydraulic losses of this centrate line exceed the elevation difference of the supernatant / overflow line, causing an undesired flow diversion. Plant staff currently limits the pumping rate to correct this shortcoming. The centrate line should be dedicated and possibly have its discharge relocated to a nearby manhole, by gravity, if possible.

Plant staff has raised concerns that the digesters only have one feed and one draw line from each tank, resulting in a lack of redundancy in the event of a plugged pipe. Provisions will need to be made to prevent the unused Tines from plugging. Estimated cost for digester line additions are $100 000.

6.2.3 Gas Systems

Digester gas is collected from each digester and routed to the boilers and/or the waste gas flare. There are no gas pressure booster pumps. Other than moisture and sediment removal, the gas is untreated. With the addition of secondary treatment, sludge production will increase, with a corresponding increase in gas production. A detailed evaluation of the existing gas piping arrangement will be required. Changes required as a result of this evaluation would form part of the plant upgrades associated with the addition of secondary treatment. Therefore, no changes to the existing gas system are recommended as part of this Technical Memorandum.

The primary digester is equipped with a gas bubble mixing system. Digester gas is re-circulated through the digester by two 20 hp Fuller gas boosters. Each booster is equipped with moisture and sediment removal as well as a Hydramotor automatic safety shut off valve. One booster was recently replaced in 2008, and the other is believed to be from the original plant construction. Although the system is functionally reliable, plant staff have noted that sludge mixing in the digesters is poor and that solids accumulate in the bottom and tend to clog piping. The implementation of a digester mixing system is recommended. A budgetary cost of approximately $300 000 is suggested, excluding costs for digester cleanout.

Automatic safety valves associated with the digester gas system, particularly with unconditioned gas, should be tested as part of a regular maintenance program. It is not uncommon for these valves to have problems seating completely after years in service. It is also recommended that a code review be completed of this room with respect to ventilation rates, explosion proof paneling, etc. TSSA is in the process of performing a province-wide review of digester gas systems.

6.2.4 Chemical Systems

Ferric Sulphate is used as a coagulant and is injected into the discharge of the grit tanks by four Pulsafeeder diaphragm metering pumps. These pumps are reported to be in good operating condition. The coagulant is stored in two large 37 800 litre Fiberglas reinforced plastic (FRP) tanks. These storage tanks do not have any form of secondary containment. Given that the tanks are 25 to 35 years of age, it is suggested that they be considered for replacement when the plant is expanded. Spatial requirements for the containment area may require the tanks to be relocated from their current location.

Polymer is used in the dewatering process. The storage, preparation, mixing, and injection systems are located in the Dewatering Facility and are original along with the building upgrades in 1988. Plant staff indicated that this system is to be replaced in the near future. Estimated Polymer tank budget replacement cost, including containment, is $ 50 000.

Disinfection is currently accomplished through chlorine injection and has apparently been operating without major problems. This system may be abandoned (i.e. if UV disinfection is added) or replaced as part of the secondary treatment upgrades, but replacement is currently not necessary.

6.2.5 Heating/Ventilation System

The heating system for the WWTP is generally accomplished through the use of two Cleaver Brooks hot water boilers, each rated at 730 kW input power. Both boilers, one installed in 1988 and the other in 2001, are dual-fuel compatible and are fitted with both biogas and natural gas valve trains. The boilers are reported to operate satisfactorily without significant problems noted to date. It was noted that digester gas piping within the Boiler Room appeared to be of carbon steel where the Digester gas code requires stainless steel 316. This should be reviewed in further detail during the detailed design phase to ensure compliance.

The raw sewage pumping station is equipped with a single Pendell hot water boiler, which is believed to have been installed when the plant was originally constructed. Although still functioning reliably, this boiler is obsolete and parts are difficult to acquire. Thus, it should be considered for replacement. Many older boilers have asbestos in their insulation. This, along with any other insulation, should be inspected as part of a designated substance survey prior to replacement. Spot heating units are generally a combination of Trane and Ruffneck hot water unit heaters and, for the most part, are still from the original construction. They are reported to be all functioning well. No issues were reported nor noted with the ventilation system. Replacement costs for the boiler would likely be in the range of $85 000.

7 ELECTRICAL REVIEW

7.1 Plant Electrical Service and Capacity

The original facility design allowed for 1 000 kVA of available power to sustain both the main sewage pumping station as well as the original sewage treatment plant. This service was delivered to the facility via a 12.6 kV hydro line, which is located south of the facility on Montreal Road.

In 1988, significant upgrades were carried out over the entire facility, including revisions to the Hydro service supplying both the pumping station and the treatment plant. This resulted in both service and capacity revisions to the original design as follows:

- The original 12 kV substation, located adjacent to the pumping station, was removed and replaced with two separate hydro services and pad-mounted transformers;
- A 500 <VA service supplied from the original 12 kV hydro circuit was added to re-feed the pumping station; and
- A new 300 kVA service, circuited from 2 Street (north of the facility), was added, to re-feed the main plant. This circuit is supplied separately from the pumping station.

Overall, the facility now appears to operate from two distinct sources of power (it is assumed the second hydro circuit on 2 Street is not directly connected to the 12 kV circuit along Montreal Road). Furthermore, the overall available plant capacity was decreased by 20% from the original design. These changes were the likely result when the aging outdoor substation needed to be replaced. Newer and stricter Hydro regulations limited the service to a value less than the original 1000 kVA supply. It is presumed that the resolution of this issue meant breaking the facility power requirements into the two separate services, as noted above.

During the on-site investigation, it was observed that the WWTP was drawing 280 Amps RMS (approximately 290 kVA) on the available 300 kVA service or 97% of its capacity. Any significant additions to this facility will require replacement of the existing 300 kVA pad-mounted transformer with a larger transformer to comply with current hydro regulations, presumably a 500 kVA, as is provided at the raw sewage pumping station.

In carrying out the 1988 hydro service revisions, the secondary service cables that were direct buried and ran from the original substation (along Montreal Road) to both the treatment plant and the raw sewage pumping station, were cut and spliced while tying in the new pad-mounted transformers. At that time, this practice would have served as a quick and cost effective solution for dealing with existing buried cables; however it is now a major weakness to the operation of either location. These cable splices are located below a small tin lid labelled 'High Voltage' in an otherwise public area. At the time of the onsite investigation, this lid was not secured and was easily opened by hand to review the six cable splices. If any of these splices are compromised by either vandalism or by rain and snow, the raw sewage pumping station will be out of service and bypassing will result. The City made arrangements to secure this lid shortly after the inspection.

Estimated costs for the service entrance duct-banks is $120 000. Note that this price does not include the cost for a new transformer.

7.2 Motor Control Centres (MCCs)

The MCCs at both the raw sewage pumping station as well as the main processing facility are all in very good condition, considering their original 1968 vintage. This equipment has been well maintained over the years, but the original manufacturer is no longer in business, and MCC maintenance will become increasingly difficult in the years to come. It was noted by plant staff that in some cases, parts can only be found on-line from third party sources such as E-bay. It is strongly recommended that this equipment be replaced during the next major upgrade. An estimate of the replacement cost is $600 000.

7.3 Branch Circuit Panels

Typical of the time of the original 1968 construction, most branch circuit panels are recessed within the concrete block walls. As a result, these panels have been difficult to service over the years. It is also difficult to track their branch circuit wiring (which runs within the walls and floor slabs). The replacement of these panels with surface-mounted panels is recommended. Phasing out problematic circuits with new surface-mounted conduit or cable is also recommended. New branch circuit panels are recommended as part of the next major upgrade, however phasing out existing panels is not necessarily required at this time. The costs for these changes is estimated at $60 000.

7.4 Lighting

The existing facility is a mix of original 1968 incandescent lamps and newer vapour-proof fluorescent lighting. Outdoor lighting at the main facility appears to be mainly provided by flood lights at a 60 degree outward angle. Some areas have high pressure sodium (yellow light), and newer locations are utilizing metal halide (white light) for the same application.

During the next major upgrade, it is recommended that the lighting be closely reviewed and that incandescent lights be upgraded to fluorescent technologies in order to benefit from their energy savings potential. High pressure sodium lamps should also be replaced with fixtures similar to their metal halide counterparts, purely for consistency in replaceable components and a more uniform working environment throughout the facility. Lastly, the outdoor flood lights have been noted to be filled with dead insects (up to 30% in one case) and should be replaced by pole mounted fixtures with 100% down light.

Costs for changes to the lights are estimated to be $85 000.

7.5 Grounding

Electrical grounding is critical for worker safety, as well as reliable operation of modern electronic equipment. The record drawings only provide grounding details for the original electrical substation, which was removed in 1985. As a result, site observations are the only basis for this review.

The WWTP appears to be well grounded back to the service entrance board, located in the Administration Building. However, from this location there does not appear to be any grounding provided for the cable that leaves this building to the outdoor pad-mounted transformer. Specifically, the bare copper ground cable exits the facility and is directly bonded to the pad-mounted transformer's neutral cable within the outdoor splicing pit. As the neutral cable is insulated, the only contact this cable has with the earth is along approximately 1.5 metres of cable.

The raw sewage pumping station is similar in that it also has a grounding cable leaving the station. However, it does not arrive into the splicing pit adjacent to this station. This indicates that there may or may not be a grounding triad for this location. The pad-mounted transformer itself, however, is not connected directly with the facility grounding.

During the next major upgrade, it is recommended that a detailed investigation of the existing pad-mounted transformer grounding be undertaken to ensure that service entrance grounding triads are provided to each building. In particular, the raw sewage pumping station appears to rely on the earth itself as a conductive pathway in the event of a phase to ground fault. This is a safety risk, as the high resistance of the earth will limit fault currents and could delay breakers or fuses from operating when required.

An estimate of the costs to upgrade the grounding system is $30 000.

7.6 Hydro Metering

The treatment plant and the raw sewage pumping station are each supplied by two separate hydro services. Standard practice is to have hydro metering provided on the secondary (low voltage) side of the main service transformer. However, for each of these locations, hydro metering is provided on the primary (high voltage) service connections. This has no direct consequence with respect to future upgrades, but it should be noted that the City is being metered and billed for transformer losses from which traditional installations are exempt. In the case of the raw sewage pumping station operating at full load, the owner would be paying for an additional load approximately equivalent to that of a 25 hp motor.

It is likely that primary metering was employed during the 1988 upgrades, as the existing MCC equipment had no available provisions for hydro metering equipment. The original facility design had its hydro metering centralized in the low voltage compartments within the original service substation on Montreal Road, which were removed during the 1988 upgrade.

Costs to reconfigure the metering would be in the order of $20 000.

7.7 Standby Power

Because of the importance and potential impact to the environment of a power outage at a WWTP, it is typical to have local standby power sources available for when the hydro grid is offline. It was noted that there is no backup power source or diesel-driven pumps available as an alternative measure for when the hydro service fails. As this facility is expected to operate well into the future, it is highly recommended that either diesel or natural gas power sources be provided in the next plant upgrade in order to avoid bypassing.

Furthermore, as this facility is divided into two separate hydro services as described previously, it is also recommended that each location be provided with its own distinct standby power generator. Doing so will fully prepare for all possible modes of hydro service failure and maximize the reliability of the treatment system.

The estimated cost of backup generation equipment is approximately $600 000.

8 INSTRUMENTATION AND CONTROLS

8.1 General Comments

A visual assessment of the existing Instrumentation and Controls (I&C) systems was completed on July 7th, 2009. This walk through assessment was supplemented by verbal discussions with Operations staff and a review of the plant's as-built drawings.

From an I&C perspective, the Cornwall Wastewater Treatment Plant is primarily limited to localized, hardwired automation and controls (with some exceptions), representing the technology and automation concepts in line with industry practice coincident with the last major upgrade in 1988. Existing Instrumentation and Controls components are generally in good operating condition due in part to an excellent maintenance and upkeep program. Where older instrumentation has failed, it has typically been replaced with more modern equivalents, providing similar levels of service to the replaced component.

Costs, where provided, are order of magnitude only and are intended only for relative comparison. These estimated costs reflect upgrade and/or replacement of old equipment with similar technology respective of both existing quantity and general arrangement. Allowances for related work, such as building modifications, have not been included herein. All costing will need to be verified prior to preparing final budgets.

8.2 Existing Systems

The subsequent commentary on the condition of existing Instrumentation and Control systems should to be considered in the perspective that unlike most other components within a wastewater treatment plant, these systems typically approach and past the date of effective obsolescence at a rate faster than any other critical component. Within this industry, obsolescence of PLC hardware typically occurs after 7 to 10 years, depending upon the specific manufacturer, commonly arising from the manufacturer ceasing production of specific product lines and/or components.

Similarly, HMI software, if not kept current with recent versions, commonly transitions from active feature development, support and maintenance by the software vendor to a point where older versions are no longer being actively supported or maintaining. HMI software longevity is further challenged by the frequent issue that older HMI software versions no longer supporting newer operating systems, combined with the issue that older operating systems are no longer compatible with or available for purchase on newer computer hardware. Resultantly, obsolescence of HMI software, and the corresponding computers on which these systems operation, typically occurs after 3 to 6 years, again depending upon the specific software vendor(s) involved.

8.2.1 Central Control and Monitoring Systems

The plant's main control room consists of a single, PC based legacy HMI software package. This software is networked serially to two remote, Texas Instruments Series 305 PLCs. A legacy Panalarm™ type panel mounted alarm annunciator provides centralized, critical visual alarm notification of key plant operating and fault conditions. This system is combined with a legacy Barnett Engineering Protalk alarm dialer for remote alarm annunciation outside the plant. Both the alarm annunciator and the alarm dialer remain operational, they represent now obsolete products. Their respective manufacturers remain in business however and are able to provide similar, modern replacements in the event of a component failure.

Plant performance data is collected and transcribed manually to paper and/or spreadsheet based logs from instrument displays for historical record and annual compliance reporting.

8.2.2 PLCs

Control of the main sewage pumps and their associated discharge valves is implemented by an obsolete Texas Instruments (TI) Series 305 PLC, located within the old MCC section of the pumps. A second TI Series 305 PLC provides control of the grit tank valves. Although these PLC remains in operation, they have reached their end-of-life. Texas Instruments sold the product line to Siemens Automation in 1991. Siemens no longer manufactures parts for, or provides support this product; however some spare parts remain available from third party sources. Furthermore, the PLC programming software is DOS based and a new Windows based version does not exist. As such, making any modifications to the existing PLC logic is becoming increasingly difficult. Similar to the screen operations, very limited monitoring and alarming of the pump operations and any adverse operating conditions are presently provided.

8.2.3 Motor Control Centres (MCCs)

Of primary concern is the age of the majority of the motor starters and variable speed drives located within the MCC sections located throughout the facility. Although these systems are well maintained and were indicated to be operating reliably, these components have reached their effective end-of-life primarily from obsolescence, resulting in non-existent or very limited access to manufacturer's service support and spare parts. This situation can place the continued operation of the pumping station plant in risk in the event hardware failures. In extension of this issue, the proposed future automation of these systems becomes increasingly difficult as extensive modifications within the motor and drive controls would likely be required.

Accordingly, existing starter control enclosures may not be suitably sized or have sufficient spare terminals to facilitate integration of the new monitoring and controls signals into the existing control circuits. Furthermore construction activities necessary during the integration of these systems often result in incidental damage to existing internal components, greatly elevating the construction risk from, as previously mentioned, the non-existent or very limited access to manufacturer's service support and spare parts. Finally, these on-site modifications would require special inspections of the modified systems to be conducted. This adds both substantial cost and again additional risk if inspectors deem certain components to be non-compliant with present day standards and codes.

Please refer to Section 7.2 for further information on this topic and an estimated cost for MCC replacement.

8.2.4 Flow Metering

Record drawings indicate the plant influent metering is performed through a 30" Parshall flume complete with a Milltronics Multiranger Plus ultrasonic level instrument. This flume was installed as part of the plant upgrades in 1988. Historical flow data is presently recorded to paper by a circular pen chart recorder of similar vintage. Parshall flumes offer reliable wastewater flow measurement over a wide range of flows and usually operate well in excess of the Ministry of the Environment's flow accuracy requirements. Typical installed Parshall Flume accuracies range from 5% to 8%, under design operating conditions when installed in accordance with the manufacturer's recommendations, which the existing installation appears to be. The effective resolution of the existing ultrasonic level instrument is approximately 3 mm. This results in a final effective flow measurement resolution varying between 500 and 650 m^3/day from average to design peak flow. No specific functional deficiencies were noted with the flume operation.

The recommended design maximum flow through a 30" Parshall flume is approximately 102 000 m^3/day, marginally less than the present raw sewage pumping capacity of 108 000 m^3/day. However flow capacities can vary by manufacturer, functionally dependent upon the throat height. Exceeding the manufacturer's recommended flow however will produce the onset of submerged flow through the flume, greatly reducing the accuracy of the flow measurement. The actual throat width of the existing flume should be confirmed prior to proceeding into preliminary design to ensure that its capacity is sufficient for the intended final capacity of the raw sewage pumping station. Please refer to Technical Memorandum No. 3 for further information regarding the sewage pumping station.

The City expressed an interest in replacing the existing Parshall Flume with alternative flow metering in an effort to achieve improved accuracy. Possible options include utilizing the existing channel and inserting a channel based magnetic flow meter (i.e. Emco ChannelMag) or a conventional full pipe magnetic flow meter installed within the raw sewage forcemain following the pumping station.

ChannelMag

A ChannelMag, given sufficient upstream clearances (x10 channel widths upstream, x5 downstream), could be installed within the existing channel, immediately upstream of the existing flume. Typical accuracies of 4% to 5% can be achieved where average channel flow velocity exceed 0.6 m/s. These measurement systems retain the requirement for accurate level measurement of the fluid within the channel, similar to a flume. Accuracies decrease quickly for channel velocities less than 0.6 m/s. Additionally, flow turn-down ratios are often lower than flumes (depending upon the channel configuration), limited by greater minimum fluid depths required over the sensor installed on the channel floor, thus limiting low flow measurements. Similar to conventional magnetic flow meters, measurement performance can vary greatly with variable wastewater conductivities, often affected by upstream chemical additions like Ferric Chloride. In all likelihood, given existing conditions, the use of a ChannelMag will not provide greatly enhanced accuracies beyond that of the existing Flume.

Magnetic Flow Meter

Another possible alternative a conventional pipe magnetic flow meter inserted into a flooded section of the raw sewage forcemain from the raw sewage pumping station, within the treatment plant's front yard. This would require the construction of a below grade chamber to house the flow meter. This work would be high cost and difficult to schedule, but would result in the highest accuracy of all other alternatives, being typically less that 1% for municipal wastewater applications. There are insufficient available free piping lengths within the existing raw sewage pumping station to install any practical form for flow metering for raw sewage.

Recommendations

The potential cost for the flume replacement with a ChannelMag would be in the order of $50 000 including demolition of the existing flume. Similarly the potential cost for the flume replacement with a conventional in-pipe magnetic meter would be in the order of $75 000, including flume demolition. Both alternatives would require careful construction sequencing, plant shutdowns, and likely involving bypass events and the provision of temporary division piping / channels while the new installations are completed. These efforts would require thorough and careful planning by the City and Contractor during both design and construction.

Comparing the cost and risk against the benefits of alternative flow metering technologies, it is our recommendation that the existing Parshall flume be retained, provided it is of sufficient capacity for the future plant upgrades. Of final comment is the issue of flow recording and records. At present, a paper based circular chart recorder is used for data collection of raw sewage flows. It is highly recommended that with the anticipated instrumentation and control system upgrades, that automated electronic data collection be adopted, utilizing the proposed new SCADA system for long term data collection, trending, storage and reporting.

8.3 Control System Upgrades/Replacement

City staff expressed a keen interest in updating the existing I&C systems to include modern PLCs and SCADA in order to provide better plant wide monitoring, controls, alarming, historical data collection and reporting of the various primary treatment processes and their respective mechanical and electrical systems.

In discussions with operations staff, they indicated a strong desire to implement a plant wide SCADA system that would include full remote monitoring and control capabilities of all process equipment within the sewage pumping station, and the remainder of the treatment plant. Their preferred approach includes the use of a modern PLC and HMI based approach in achieving this goal. Staff also requested that the PLC hardware and HMI software be compatible and/or common with that already in use at the Water Treatment Plant, specifically Allen-Bradley SLCs and Wonderware Intouch HMI software. From a future system design and cost estimate standpoint, Ethernet based Allen-Bradley CompactLogix or ControlLogix PLCs would likely be implemented.

8.3.1 Control System Areas/Costs

Control system upgrade costs were developed by grouping major plant processes into areas generally affiliated by their common proximity and process control relationship to each other. The following sections define these areas and systems, providing an opinion of probable cost for the full scale upgrades and replacement of the plant's instrumentation and controls in conjunction with the related process mechanical and electrical upgrades anticipated as part of the overall plant upgrade / expansion. Costs estimates include allowances for component supply, installation, wiring, PLC programming, factory acceptance testing, start-up / commissioning, site acceptance testing and final documentation. Per pervious discussions with the City, HMI programming is not included as it is anticipated that this work will be completed by their own forces.

Screening/Raw Sewage Pumping

City staff indicated that they are internally completing the automation of a CSO project, whereby the gate controls to be implemented at this remote facility would need to communicate with and be directly common / compatible with the future PLC to be located at the main sewage pumping station and the treatment plant itself. For the purposes of this memorandum, it is assumed the City would deploy only the minimum required networking, PLC hardware and HMI systems to achieve integration of the CSO facility with the pumping station wet well level, and that the upgrade / expansion project would include the full scale replacement of the pumping station instrumentation and controls in conjunction with related process mechanical and electrical upgrades anticipated at that time. An estimated cost of $187 000 includes replacement and upgrades to the following major components:

- Replacement of critical instrumentation (i.e. Level, Flow, Gas Detection). Addition of new security and asset monitoring systems.
- PLC control panel (x1), c/w hardwired PLC I/O to all major process equipment (pumps, valves, screen, instrumentation, new standby generator)
- Ethernet based (copper & fibre) communications systems
- PLC programming, system integration, and associated documentation for all major equipment
- HMI workstation (x1) (hardware & software) located within the pumping station

Grit Removal/Chemical Systems

An estimated cost of $426 000 includes replacement and upgrades to the following major components:

- Replacement of critical instrumentation (i.e. Level, Flow, Gas Detection, Chemical Analysers). Addition of new security and asset monitoring systems.
- PLC control panels (x2), c/w hardwired PLC I/O to all major process equipment (tanks, new grit removal system, blowers, chemical tanks, chemical pumps, chlorination system, instrumentation, new standby generator)
- Ethernet based (copper & fibre) communications systems
- PLC programming, system integration, and associated documentation for all major equipment
- HMI workstations (x2) (hardware & software) located within the control room or adjacent offices
- HMI Servers (x2) (redundant configuration, incl. hardware & software) located within the control room

Sludge/Scum

An estimated cost of $196 000 includes replacement and upgrades to the following major components:

- Replacement of critical instrumentation (i.e. Level, Flow, Gas Detection). Addition of new security and asset monitoring systems.
- PLC control panel (x1), c/w hardwired PLC I/O to all major process equipment (tanks, valving, sludge collection, pumps, instrumentation)
- Ethernet based (copper & fibre) communications systems
- PLC programming, system integration, and associated documentation for all major equipment

Digestion/Sludge Heating/Boilers/Gas Mixing/Flare

An estimated cost of $269 000 includes replacement and upgrades to the following major components:

- Replacement of critical instrumentation (i.e. Level, Flow, Pressure, Temperature, Gas Detection). Addition of new security and asset monitoring systems.
- PLC control panel (x1), c/w hardwired PLC I/O to all major process equipment (digesters, valving, pumps, heat exchangers, boilers, gas boosting / mixing, flare, instrumentation)
- Ethernet based (copper & fibre) communications systems
- PLC programming, system integration, and associated documentation for all major equipment

Dewatering Centrifuges/Centrate/Conveyors

An estimated cost of $246 000 includes replacement and upgrades to the following major components:

- Replacement of critical instrumentation (i.e. Level, Flow, Temperature). Addition of new security and asset monitoring systems.
- PLC control panel (x1), c/w hardwired PLC I/O to all major process equipment (new centrifuges, valving, pumps, tanks, mixers, conveyors, instrumentation)
- Ethernet based (copper & fibre) communications systems
- PLC programming, system integration, and associated documentation for all major equipment

Secondary Treatment Systems

At this time, the specific type of secondary treatment systems proposed for the plant upgrades has not yet fully determined. However for the purposes of this document, an estimated cost of $203 000 is provided to accommodate the installation and integration of the typical vendors designed secondary treatment system(s) into the plant's overall upgraded control systems:

- Installation only of new instrumentation (i.e. Level, Flow, Temperature). Addition of new security and asset monitoring systems.
- Installation only of PLC control panels (x2), c/w hardwired PLC I/O to all major secondary treatment process equipment
- Ethernet based (copper & fibre) communications systems
- System integration and associated documentation for a portion of the secondary treatment process equipment

9 SUMMARY AND GENERAL RECOMMENDATIONS

The purpose of this Technical Memorandum is to discuss some of the existing conditions of the Cornwall WWTP and raw sewage pumping station. Until the precise scope of a secondary treatment upgrade project is determined from the EA update, it would be premature to positively identify what changes to the existing plant will be required over and above those described in this Tech Memo. Information has been provided regarding components of the plant that require immediate attention, but, depending upon the nature and schedule of future upgrades, some of this work could be deferred, at the discretion of the City, to coincide with a main upgrade project.

A summary of the various costs (excluding Engineering and Contingency) presented in this report is included in Table 1, below. As discussed above, these costs are order-of-magnitude only figures and should be read in conjunction with the descriptions in each section. Repairs and upgrades, which should be undertaken as part of the City's ongoing annual maintenance program over the next several years, are identified in Table 1. The City's annual repair and maintenance budget is approximately $350,000. This should be continued to permit completion of the repairs identified in Table 1 over the next 7 to 10 years.

Table 1 - Repairs to Be Undertaken As Part of Ongoing Maintenance Program

Item	**Cost**
Civil	
Roads and Parking	$250 000
Fence Gate	$20 000
CCTV of Existing Sewers	$10 000
Structural and Architectural	
Foundation Walls, Curbs and Cracks	$25 000
Exterior Brick Walls	$25 000
Chlorine Building Roof	$30 000
Decking between Clarifiers	$20 000
Digester Membrane	$250 000
Caulking (Site Wide)	$50 000
Doors	$10 000
Miscellaneous Metals	$100 000
Replace Scum Collection System	$300 000
Mechanical and Process	
Existing Process Piping and Valving	$100 000
Digester Mixing	$400 000
Chemical Systems	$50 000
Raw Sewage Pumping Station Boiler	$85 000
Total	$1 725 000

Repairs and upgrades, which should be undertaken as part of the proposed Plant Upgrade and Expansion, are summarized in Table 2.

Table 2 - Repairs and Upgrades to Be Undertaken as Part of the Plant Upgrade/Expansion

Item	Cost
Mechanical and Process	
Grit Removal	$2 000 000
Aeration Blower for Influent Channels and Aerated Grit Ranks	$100 000
New Drives for Chain and Flight Sludge Collectors	$275 000
Sludge Pumping	$125 000
Centrifuges	$750 000
Automatic Cake Conveyor System	$50 000
Electrical	
Service Entrance Duct Bank	$120 000
MCCs (supply only)	$600 000
Branch Circuit Panels	$60 000
Lighting	$85 000
Grounding	$30 000
Hydro Metering	$20 000
Standby Generators (pumping station and plant)	$600 000
Instrumentation and Controls	
Screening/Raw Sewage Pumping	$187 000
Grit Removal/Chemical Systems	$426 000
Sludge/Scum	$196 000
Digestion/Sludge Heating/Boilers/Gas Mixing/Flare	$269 000
Dewatering Centrifuges/Centrate/Conveyors	$246 000
Secondary Treatment Systems	$203 000
Total	$6 342 000