Executive Summary

Introduction

This Conceptual Design Report summarizes the findings of a study completed to assess the requirements of the accepted Council direction for Beneficial Use of Biosolids from the Highland Creek Wastewater Treatment Plant (WWTP). This work involves the construction of a new Truck Loading Facility and the upgrade of the existing anaerobic digestion complex to the degree necessary to support this biosolids management strategy.

Truck Loading Facility

Predicted dewatered biosolids production at the Highland Creek WWTP, for the design year of 2032, totals 123 m^3/d. The anticipated maximum sustained production rate over a seven day period is approximately 210 m^3/d. Design of a new biosolids truck loading facility will be based on this 'maximum week' production rate. The total solids concentration of the dewatered biosolids is expected to be about 27 percent, in line with current experience. The truck loading facility will accommodate 5.5 days of dewatered biosolids storage at the maximum sustained production rate, resulting in a total biosolids storage volume of 1,200 m^3. The facility will enable any single truck to be loaded within a 30 minute period. Prior to discharge, odorous air will be contained and treated in a single stage biofiltration process. The odour control system will handle about 20 m^3/s of odorous air.

Four Truck Loading Facility options were assessed in the Conceptual Design Report on the basis of costs and non-monetary considerations. These options include:

- Option 1 – Master Plan Option (New Truck Loading Facility East of Existing Biosolids Management Building)
- Option 2 – Modified Master Plan Option (New Dewatering and Truck Loading Facility East of Biosolids Management Building)
- Option 3 - New Dewatering and Truck Loading Facility East of New Dechlorination Building.
- Option 4 – New Truck Loading Facility in Area of Existing Heat Treatment Building.

Table ES-1 summarizes the estimated capital, operation and maintenance (O&M), and life cycle costs for these four options.

TABLE ES-1
Summary of Life Cycle Cost Estimates Truck Loading Facility and Odour Control (Excluding Digestion Upgrades) to Accommodate Beneficial Use of Biosolids)

Description	Option 1[1]	Option 2[2]	Option 3[3]	Option 4[4]
Capital Costs	$ 93,090,000	$ 95,710,000	$ 102,011,000	$ 109,012,000
O&M Costs	$ 2,800,000	$ 2,579,000	$ 2,421,000	$ 2,800,000
Life Cycle Costs	**$ 128,760,000**	**$ 128,180,000**	**$ 132,021,000**	**$ 144,066,000**

Note:

1. Option 1 – Master Plan Option (New Truck Loading Facility east of the existing Biosolids Management Building).
2. Option 2 – Modified Master Plan Option (New Truck Loading Facility and dewatering facility east of the existing Biosolids Management Building).
3. Option 3 – New Truck Loading Facility and dewatering facility at a central location, east of the new Dechlorination Building
4. Option 4 – New Truck Loading Facility within the existing Heat Treatment area.

Estimated Option 1 and Option 2 capital costs and life cycle costs are considered equal within the accuracy of the estimates generated for this Report. Further, neither of these options exhibited operational, environmental, or aesthetic advantages or disadvantages that would differentiate one from the other. Because there were no compelling economic or non-monetary reasons for selecting either option, it is recommended that both Option 1 and Option 2 be carried forward into the next stage of project development.

Odour Control

Odour Control is an integral component of the four Truck Loading Facility options discussed in the above paragraphs. The selected approach to odour control that is incorporated in each option includes containment of all odour emitting enclosures and areas, including the truck loading bays; conveyance to an odour treatment facility; treatment of the odorous gases to remove odour causing constituents; and exhausting the treated air streams through the existing stack (Option 1, Option 2, and Option 4) or through a new dedicated stack (Option 3). The approach involves conservative sizing of the odorous air treatment units, which has purposefully been adopted to ensure reliable and effective removal of odour causing constituents. The cost associated with this odour control strategy account for 6 percent to 8 percent of the total capital cost listed in Table ES-1 above.

Anaerobic Digestion Expansion and Upgrade

Design of the Highland Creek WWTP digestion facility recognized the resiliency provided by the thermal oxidation process. The existing digesters at the Highland Creek WWTP are sized on the premise that raw sludge can bypass digestion, passing directly to the thermal oxidation units, when the digestion process is overloaded or when components are out of service for maintenance.

Changing to a beneficial use strategy for Highland Creek WWTP biosolids results in retirement of the existing thermal oxidation system. Hence, the anaerobic digestion system needs to be reinforced to provide the system reliability required to handle normal and adverse operating conditions. Ontario's biosolids management regulations mandate that the digestion process provides 15 days of solids retention time to satisfy biosolids quality requirements. This requirement translates into a need for more digestion capacity at the plant in the near and the long term. Various options for providing this capacity were considered in this study, including:

- Increasing the available digestion capacity through the addition of new digesters (different sizes and configurations were considered in 'Conventional Expansion", Conventional Option with Larger Digesters, Option 1, and Conventional Option with Larger Digesters Option 2)
- Incorporating primary solids thickening to reduce the need for additional digestion volume
- Changing the basic digestion process to an acid-gas configuration, which can achieve equivalent treatment with somewhat less additional digester volume.

The necessary expansions were assumed to occur in two stages – the first expansion would be required in the next few years and was assumed capable of handling the capacity needs until 2032. The second expansion would be undertaken during the years leading up to 2032 and would handle the plant's ultimate capacity requirements. The ultimate capacity of the plant would not be attained until well after 2032. Table ES-2 summarizes the estimated capital, O&M, and life cycle costs for the various options considered.

TABLE ES-2
Digestion Expansion Scenarios

	Option 1A[1]	**Option 1B[2]**	**Option 1C[3]**	**Option 2[4]**	**Option 3[5]**
Capital Costs	$ 82,090,000	$ 59,990,000	$ 74,630,000	$ 50,685,000	$ 56,425,000
Present value of future capital costs[6]	$ 12,700,000	$ 14,300,000	$ 0	$ 13,800,000	$ 23,700,000
Present Value of O&M Costs	$ 54,900,000	$ 50.7	$ 49,900,000	$ 54,100,000	$ 56,900,000
Life Cycle Costs	$ 149,600,000	$ 125,000,000	$ 124,500,000	$ 118,600,000	$ 136,600,000

Notes:

1. Option 1A - Expansion includes 3 new digesters by 2016 and a fourth new digester by 2032, all of the same size and configuration as the existing digesters at the Highland Creek WWTP (volume per digester - 6,610 m^3).
2. Option 1B - Expansion includes 2 new digesters by 2016 and a third new digester by 2032, all greater in size than the existing digesters (volume per digester - 7,780 m^3)
3. Option 1C - Expansion includes 2 new digesters by 2016 that are greater in size than the existing digesters (volume per digester - 15,560 m^3)
4. Option 2 - Option includes construction of primary sludge thickening and one new digester by 2016 and one additional new digester by 2032. The new digesters would be similar in size to the existing units (volume per digester - 6,610 m^3).
5. Option 3 - Option includes the construction of primary sludge thickening and two acid gas reactors by 2016, with one additional new digester by 2032 (volume per acid gas reactor – 1,575 m^3;volume per digester - 6,610 m^3).
6. Future capital costs are those incurred to expand the plant beyond 2032 to handle the ultimate capacity.

The net present value of the option that includes Primary Solids Thickening and Limited Digester Expansion was lowest. Further, primary sludge thickening complements the current on-going secondary sludge

thickening project. It allows optimization of the existing digester infrastructure and it would provide opportunities to enhance primary treatment by allowing the solids inventory to be removed from this process expeditiously. The option including primary sludge thickening exhibits a reasonable cost advantage and several process related advantages; hence, it is recommended for implementation.

Waste Gas Burners

The waste gas burners (WGBs) at the Highland Creek WWTP thermally oxidize excess biogas that cannot be used as fuel in the plant's boiler system. The current system consists of three units, each with a capacity of 513 m^3/h.

The WGBs will need to be upgraded to account for increased biogas generation due to projected biosolids increases during the design life of the plant and due to the enhanced gas production associated with longer solids retention times that occur in the expanded digestion process. The estimated peak diurnal biogas production rate at plant capacity is 54,000 m^3/d or about 2,250 m^3/h. The estimated maximum week biogas production rate is 1,500 m^3/h. This peak production rate exceeds the capacity of the existing units, even when no standby capacity is provided. Two upgrading options were considered to reconcile this shortfall, as follows:

- Option 1: Replace the existing units with three larger waste gas burners.
- Option 2: Maintain the existing units and add two additional larger units

Table ES-3 summarizes the estimated capital, O&M, and life cycle costs for the two options considered.

TABLE ES-3
Waste Gas Burner Upgrade Scenarios

	Option 1 – Three New Units[1]	**Option 2 - Maintain Existing Units and Add Two New Units[2]**
Present Value of Capital Costs	$3,905,000	$3,071,000
Present Value of O&M Costs	$2,011,000	$4,003,000
Life Cycle Costs	**$5,916,000**	**$7,074,000**

Notes:
1. Option 1 entails the replacement of existing three units with three new 1500 m^3/h units
2. Option 2 entails the extension of existing structures to accommodate two new 500 m^3/h units, in addition to existing three units. Due to their age, present value of O&M costs also included replacement of the existing units in about 10 years.

The capital cost associated with Option 1 described above are higher than those of Option 2, because all of the equipment is new. However, the O&M costs exhibited by Option 2 are much higher as the replacement of the existing units at the expected end of their design life, within the period considered for this analysis, substantially adds to the price. Further, Option 2 involves maintenance of additional equipment elements because of the number of WGBs involved.

The substantially lower net present value associated with Option 1 has led to the recommendation that this approach be implemented.

Summary

Implementing a Biosolids Management Plan that involves the Beneficial End Use of biosolids from the Highland Creek WWTP mandates that the City of Toronto undertake the construction of a Truck Loading Facility, associated odour control facility, and expansion of the current anaerobic digestion facilities (including the waste gas burners). The total project cost (not including HST) escalated to 2016 dollars, is $150,302,000. The summary of the costs associated with this recommendation is as summarized in Table ES-4.

TABLE ES-4

Summary of Truck Loading Facility and Digester Upgrade Capital Costs[1]

	Costs
Truck Loading Facility[2]	$ 95,714,000
Digester Upgrades[3]	50,585,000
Waste Gas Burner Upgrades[4]	3,905,000
Total	$ 150,302,000

Notes:

1. Costs noted in this table include direct and indirect costs, contingencies, escalation to midpoint in construction (assumed to be 2016) and engineering. They do not include internal City of Toronto costs nor HST.
2. The cost of the Truck Loading Facility is that estimated for Option 2, where the dewatering facility would be relocated to the Truck Loading Facility and the new consolidated facility would be constructed east of the existing Biosolids Management Building.
3. The cost of the Digester Upgrades is based on Option 2 - Option includes construction of primary sludge thickening and one new digester by 2016 and one additional new digester by 2032. The new digesters would be similar in size to the existing units (volume per digester - 6,610 m^3).
4. The cost of the waste gas burner upgrades is based on Option 1 where three new 1,500 m^3/h thermal oxidizing units would be installed to replace the existing units.