Lions Gate Wastewater Treatment Plant Site Investigation Feasibility Report

Prepared for:

Greater Vancouver Sewerage and Drainage District

Prepared by:

Stantec Consulting Ltd.
#1007 – 7445 132 Street
Surrey, BC V3W 1J8

Contact:

Reno Fiorante, P.Eng.
Tel: 604-597-0422

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Executive Summary

In August 2005 the Greater Vancouver Sewerage and Drainage District (GVS & DD) completed a Facility Plan Report to outline options for upgrading of the Iona and Lions Gate Wastewater Treatment Plants (WWTP) from primary to secondary treatment. The report outlined a plan for upgrading the Lions Gate WWTP at the current location just west of the Lions Gate Bridge. There is sufficient available land at the current site to expand the plant to the 2046 design population at 275,000.

The 2005 Facility Plan report reviewed a number of wastewater treatment technologies which would fit on the existing site which has limited land availability of approximately 3.5 hectares. The recommended technology chosen for secondary treatment at existing Lions Gate site was a biological aerated filter (BAF) system. This technology was selected because it had a low space requirement, it would easily fit on the current site for the 2046 design flow and the technology would satisfy the Provincial Municipal Sewage Regulation (MSR) discharge objectives. It could also be upgraded for more stringent requirements in the future should regulations change.

In April 2007, the GVS & DD commissioned Stantec Consulting to review the feasibility of constructing new secondary wastewater treatment plants at four other locations within the North Shore Sewerage Area in addition to the current Lions Gate site. For some of the sites below ground construction options were also investigated. A below ground option is an option where most of the plant would be constructed entirely below grade. The sites evaluated for new plant construction are shown on **Figure E.1,** and summarized in **Table E.1**.

Table E.1
Sites Evaluated for WWTP Construction

Site	Options Evaluated
Lions Gate Site	Above ground / below ground
Pacific Environment Centre (PEC) Site	Above ground / below ground
Vancouver Wharves Site	Above ground / below ground
BC Rail Passenger Lands Site	Above ground site
Klahanie Park Site	Below ground only

The design criteria established for evaluation of all plant options is summarized in **Table E.2.**

Table E.2
Wastewater Treatment Plant Design Criteria

Parameter	Existing (2007)	2046 Design Case Build-out
Population	_	275,000
Flow		
• ADWF (ML/d)	96	111
• AAF (ML/d)	115	133
• PWWF (ML/d)	324	356
Max. Month Load		
• BOD_5 (t/d)	19	28
• TSS (t/d)	23	32

The plant will be designed to meet BOD_5 and TSS of 45 mg/L to satisfy the Provincial Municipal Sewage Regulation discharge objectives.

All plant sites were evaluated to determine if it would be possible to expand in the future to a 100 year planning horizon.

Conceptual designs were prepared for all site locations using the BAF secondary treatment process. Other emerging technologies including high rate primary treatment and membrane bioreactor technology (MBR) were also reviewed as part of this study. All sites included cost allowances for odour control. A discussion of the sites is provided below.

Existing Lions Gate Site

The existing Lions Gate site is approximately 3.5 hectares. Construction of an above ground plant would be preferred at this site because underground facilities would be very costly and it is possible below ground construction with shoring and dewatering could impact the existing plant. There would also be significant implementation and operational challenges for construction of an underground plant at the existing site. From a risk and cost perspective an underground plant option would present significant challenges and is not recommended.

PEC Site

The PEC site is located approximately 0.5 km east of the existing Lions Gate WWTP, adjacent to Burrard Inlet. This site is contaminated and would require clean up as part of the construction. This site has ample space, for construction of above or below ground options with 11.3 hectares of available land. A below ground construction option at this site would be costly because of shoring and dewatering requirements.

Vancouver Wharves Site

The Vancouver Wharves site, approximately 1.5 km east of the Lions Gate site, is presently used as a bulk materials container loading terminal. The available construction area is 10.0 hectares. An above ground facility could be accommodated at this site. Underground facilities would have to be designed to accommodate the significant structural loads from a container storage facility. Construction in a working terminal adjacent to railway tracks would also be difficult.

BC Rail Passenger Lands Site

The BC Rail Passenger Lands site is situated on West 1st Street and has an available site area of 2.9 hectares. This site is adequate for the 2046 design population flows and could be expanded beyond this horizon if high rate primary sedimentation tanks are utilized and higher rate sludge digestion processes are considered. This site is favourable for construction of an above ground treatment plant.

Klahanie Park Site

The Klahanie Park site is located approximately 1.0 km north of the existing Lions Gate plant. The available site is 3.5 hectares. The park is used for soccer and baseball. An underground facility could be constructed at this site but costs are significant. A high level of odour control would have to be incorporated into the design.

Cost estimates were prepared for all sites to assess the feasibility of plant construction. Underground plant options were found to have a cost premium of up to 70% over above ground options. Construction costs in the Lower Mainland have increased by approximately 30 – 35% since the preparation of the 2005 Facility Plan Report. These escalation factors have been included in the costs presented in this report.

Table E.3 provides a summary of costs for the options investigated.

Table E.3
Treatment Plant Costs

Plant Site / Option	Cost
Lions Gate Above Ground	$ 254,111,900
Lions Gate Below Ground	$ 443,283,600
PEC Site Above Ground	$ 318,458,520
PEC Site Below Ground	$ 483,882,520
Vancouver Wharves Above Ground	$ 321,560,520
Vancouver Wharves Below Ground	$ 533,186,620
BC Rail Passenger Lands Above Ground with Digestion	$ 335,185,000
BC Rail Passenger Lands Above Ground without Digestion	$ 277,972,200
Klahanie Park Below Ground	$ 464,180,420

The most feasible option is an above ground option at the existing Lions Gate site. Of the alternate sites investigated for above ground options, the PEC, BC Rail Passenger Lands site and Vancouver Wharves site have similar costs. However, the BC Rail Passenger Lands site offers the least construction, environmental and cost risk. Below ground options are significantly more costly and come with increased construction cost risk due to underground construction.

METRIC

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W IJ8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com
www.stantec.com

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Manager

LIONS GATE WASTEWATER TREATMENT PLANT

OVERALL SITE LOCATIONS MAP

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1.0 Introduction

1.1 Background

The Greater Vancouver Sewerage and Drainage District (GVS & DD) is evaluating upgrading options for the Lions Gate Wastewater Treatment Plant (LGWWTP). The plant is currently a primary treatment plant and is regulated by Operational Certificate ME – 00030. The plant is located just west of the Lions Gate Bridge in West Vancouver. The existing site is small with limited capacity for long term expansion beyond 2046. The Liquid Waste Management Plan calls for the Lions Gate plant to be upgraded to secondary treatment by 2031.

In 2005 a Facility Plan (Stantec / D & K) was prepared for the long term upgrading strategy for the LGWWTP. The report outlined a plan for upgrading the plant at the existing location using biological aerated filter (BAF) secondary treatment technology. The major advantage of BAF technology was its small footprint and its ability to handle significant fluctuations in wet weather flows as experienced in the North Shore sanitary catchment. The Facility Plan Report focused on upgrading opportunities at the existing Lions Gate Site and provided a preliminary overview serving the North Shore Sewerage Area. From a cost perspective, development of the existing Lions Gate site was the preferred option because of the significant investment in infrastructure at the existing site. The multiple plant option was discounted because it had significant disadvantages including higher capital, operational and maintenance costs over a single plant option at the existing site.

Since the completion of the 2005 Facility Plan, the GVS & DD has decided to assess the potential of building a single new plant at several alternative sites in close proximity to the existing Lions Gate site. The evaluation will include investigations of above ground and below ground options at the existing Lions Gate and alternative sites in the North Shore Sewerage Area. The main focus of the evaluation will be to provide conceptual level technical feasibility and preliminary cost comparisons for each option.

Stantec Consulting was engaged to assist the GVS & DD with this project in April 2007. This report provides a summary of the technical issues and estimated costs for the development of secondary treatment at the existing Lions Gate site and alternative treatment plant sites in the North Shore Sewerage Area.

1.2 Location Options for Development

The GVS & DD is considering several locations and alternatives for evaluation of secondary treatment. The sites are illustrated in **Figure 1.1** and are described in **Table 1.1**.

Table 1.1
Lions Gate WWTP Siting Options

Site	Options for Evaluation
Existing Lions Gate WWTP	Above ground option Below ground option
Pacific Environmental Centre (PEC) Site	Above ground option Below ground option
Vancouver Wharves	Above ground option Below ground – container storage above
BC Rail Passenger Lands Site	Above ground option
Klahanie Park Site	Below grade option

A total of nine alternatives are to be evaluated to enable GVS & DD to review the technical considerations and cost feasibility of plant construction at each site. For sites remote from the existing LGWWTP site it was assumed a new pump station and forcemain would convey raw sewage to the new plant location and treated effluent would be pumped back to the existing plant outfall. All alternatives will have odour control facilities to mitigate odour emissions using best available technology.

1.3 Relevant Background Information

Since the study is a conceptual level feasibility study, a significant amount of previously prepared reference material was used in the preparation of this report. Reference material included:

- Iona Island and Lions Gate WWTP Facility Plan Summary Report – August 2005, Stantec Consulting Ltd. and Dayton and Knight Ltd.
- Geotechnical Assessment, Facility Plans for Iona Island and Lions Gate WWTP, December 2004, Trow Associates.
- Internal Cost Data for Wastewater Treatment Plant and heavy civil construction, Stantec Consulting Ltd.
- Record Drawings of Lions Gate WWTP.

- Population and Flow Data provided by GVRD Policy and Planning.
- Internal cost data for construction of the City of Windsor BAF plant.
- Vancouver Market Intelligence, BTY Group.
- Hanscomb, Escalation Watch – Fourth Quarter 2006.
- Statistics Canada, Non-Residential Construction Cost Indexes.

It is noted that the only geotechnical information available was for the existing Lions Gate WWTP site. For the purpose of this report, the sites adjacent to Burrard Inlet including the PEC and Vancouver Wharves site were assumed to have similar geotechnical conditions to the existing LGWWTP site. As more detailed work is completed, geotechnical investigations should be completed at all sites. More detailed work should be completed prior to purchase or long term lease of any site.

1.4 List of Acronyms

AAF	-	Average Annual Flow
ADWF	-	Average Dry Weather Flow
BAF	-	Biological Aerated Filter
BOD_5	-	Biochemical Oxygen Demand
LGWWTP	-	Lions Gate Wastewater Treatment Plant
LWMP	-	Liquid Waste Management Plan
MBR	-	Membrane Bioreactor
mg/L	-	Milligrams per Litre
ML/d	-	Million Litres per Day
MSR	-	Municipal Sewage Regulation
PWWF	-	Peak Wet Weather Flow
TSS	-	Total Suspended Solids
WWTP	-	Wastewater Treatment Plant

2.0 Design Criteria

2.1 Design Population

The sewerage catchment design population is used to establish design flows for the LGWWTP upgrading. The Facility Plan projected a 2046 design case build out population of 275,000 which represented a median between the lower population envelope of 250,000 and the upper limit of 300,000 people. In planning new wastewater treatment plant sites, it is prudent to look at a 100 year horizon because concrete structures have a design life exceeding 50 years and a significant investment in onsite and offsite infrastructure makes plant relocation costly. For the purposes of this study a year 2101 planning population of 373,400 was provided by GVRD for use in projecting long term flows beyond 2046. Ideally sites should be selected to enable expansion to support the 100 year planning population. All sites were evaluated to determine if there was sufficient space for the 100 year planning horizon.

For the costing of the options evaluated in this report, the year 2046 design case population from the 2005 Facility Plan has been used to project design flows and loads.

2.2 Design Flows and Loads

The design flows and loads for the 2046 build out design case scenario are summarized in **Table 2.1**

Table 2.1
Design Case Flows and Loads

Parameter	Existing (2007)	2046 Design Case Build-out
Population		275,000
Flow		
• ADWF (ML/d)	96	111
• AAF (ML/d)	115	133
• PWWF (ML/d)	324	356
Max. Month Load		
• BOD_5 (t/d)	19	28
• TSS (t/d)	23	32

For sizing the secondary treatment process, the design case maximum month BOD_5 load of 28 tonnes/day and TSS load of 32 tonnes / day have been selected.

The projected design flows and loads extracted from the 2005 Facility Plan Report are illustrated in **Figures 2.1 – 2.3**.

Figure 2.1
LGWWTP Lower, Upper Envelopes and the Design Case Scenarios for ADWF (MLD)

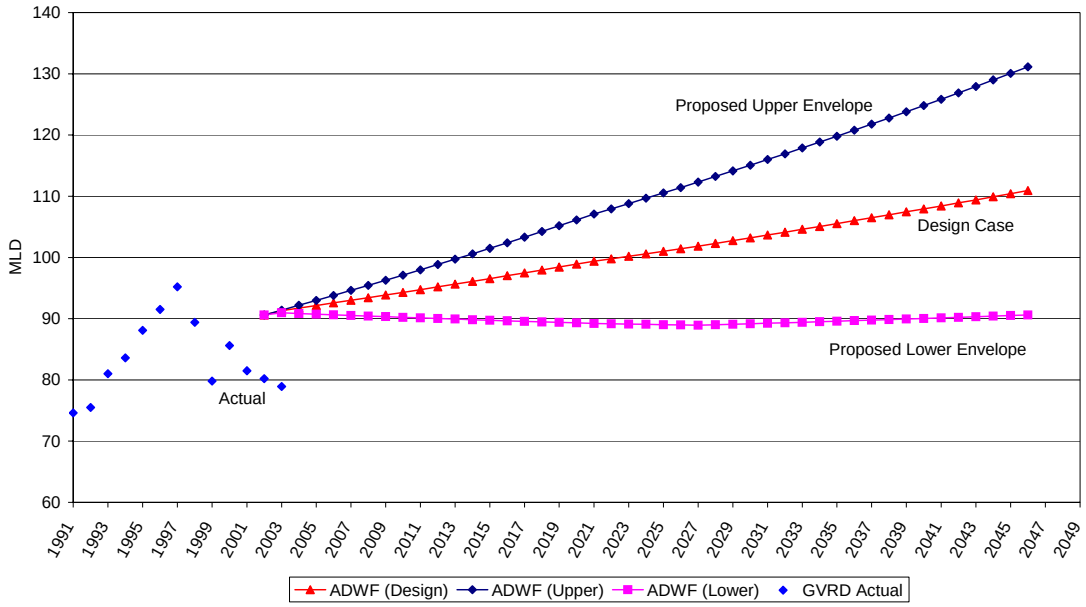


Figure 2.2
LGWWTP Lower, Upper Envelopes and the Design Case for BOD_5 (Max. Month)

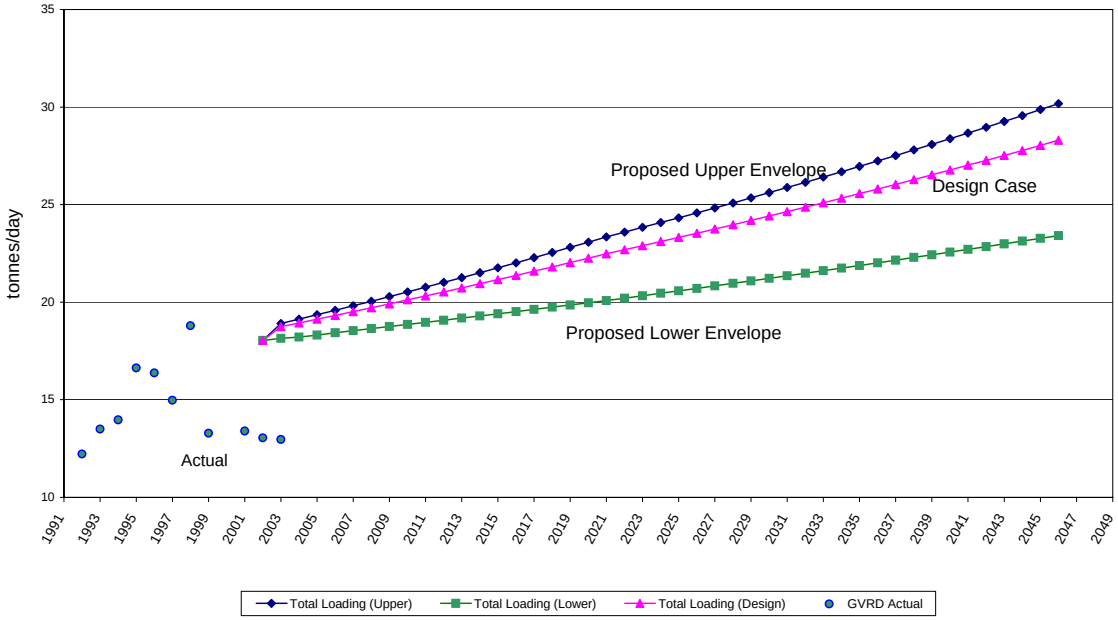
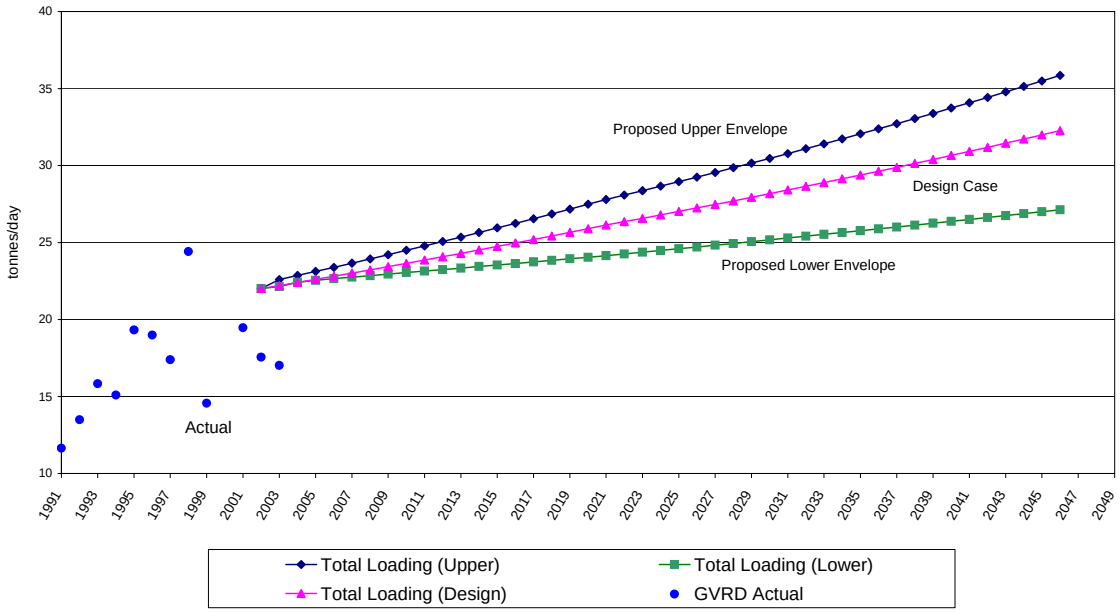


Figure 2.3
LGWWTP Lower, Upper Envelopes and the Design Case
For TSS (Max. Month)



2.3 Future Flows and Loads Beyond 2046 Build-out Horizon

The GVRD has projected a 100 year – 2101 planning population of 373,400. The 2005 Facility Plan Report predicted that there would be a reduction in sewerage flows due to water conservation initiatives and infiltration and inflow reduction. The 2046 design case residential and commercial flows of 243 L/C/d and 55 L/C/d, respectively were used for projections. Extrapolating between 2046 and 2101 populations, the flows and loads are estimated as shown in **Table 2.2**.

Table 2.2
100 Year Horizon Flows and Loads

Parameter	2101 Planning Values
Population	373,400
Flow	
• ADWF (ML/d)	151
• AAF (ML/d)	181
• PWWF (ML/d)	481
Load	
• BOD (t/d)	38
• TSS (t/d)	43

It is noted that PWWF may be reduced as I & I initiatives are completed. In designing conveyance and pumping substructure facilities, it may be prudent to consider planning horizons beyond the 2046 horizon.

2.4 Effluent Treatment Objectives

The Liquid Waste Management Plan (LWMP) does not include secondary treatment criteria for the LGWWTP. For this report, the objectives outlined in the Province of British Columbia *Municipal Sewage Regulation* (MSR) have been utilized.

The MSR requires that secondary treatment provide an effluent quality of 45 mg/L TSS and 45 mg/L BOD_5 for flows up to 2.0 times average dry weather flow which for the Lions Gate 2046 design case would be 222 ML/d. The BAF has been sized using these criteria. Hydraulically the process must be capable of passing the PWWF of 356 ML/d.

For costing purposes it has been assumed that there is no requirement for nitrification since there is no current requirement in the MSR for nitrification.

2.5 Sludge Management Objectives

The GVRD currently has a biosolids management plan which uses anaerobically digested sludge to produce a land amendment product known as Nutrifor. The GVRD is also currently investigating use of biosolids as a fuel for energy production. The strategy for the purpose of costing assumes two options, one option involves no sludge stabilization where sludge would be thickened, dewatered and hauled offsite to another site for processing or combustion.

A second and the base option assumes the use of extended thermophilic digesters and continuation with the current use of stabilized biosolids in the Nutrifor program. For stabilization purposes the biosolids would have to meet the requirement of the Provincial Organic Matter Recycling Regulation for pathogen and vector reduction as well as metals. Thermophilic digesters are capable of producing a Class A or near Class A sludge depending on the metals concentration. **Table 2.3** provides a summary of estimated future sludge quality as outlined in the 2005 Facility Plan.

Table 2.3
Biosolids Quality Criteria

Chemicals/Nutrients (mg/kg dry)	Primary Sludge	Secondary Sludge*	Organic Matter Recycling Regulation Class A Compost
Arsenic Total	1~3	5~10	13
Cadmium Total	1~3	5~10	3
Chromium Total	30~70	100~150	100
Cobalt Total	2~5	5~10	34
Copper Total	1,000~1,800	2,000~3,000	400
Lead Total	60~90	150~200	150
Mercury Total	5~8	5~8	2
Nickel Total	30~50	50~100	62
Zinc Total	400~700	700~1,500	500
Total Nitrogen	25,000~40,000	30,000~50,000	-
Total Phosphorus	10,000~20,000	20,000~30,000	-

* In part based on Bonnybrook WWTP, Calgary, 1998

Provincial regulations also require that fecal coliforms be less than 1000 MPN per gram of total dry solids.

With the exception of copper, all parameters will meet the current provincial regulations for Class A compost.

2.6 Seismic and Structural Design Considerations

Structures will be designed in accordance with National Building Code of Canada (NBCC) 2005 for structural and seismic requirements. ACI 350, Design of Liquid Retaining Structures, will be used for the design requirements for liquid retention and ACI 350.3,

Seismic Design of Liquid Retaining Structures, will be used for the seismic design loads for the contained liquid.

The Maximum Credible Earthquake (MCE) will be used for the design. Stantec was involved at the Capilano Pump Station Project a short distance north of the proposed site, and a Peak Ground Acceleration (PGA) of 0.5g was determined for that site, based on the 1995 NBCC design criterion. As there was no indication of potential MCE in the Trow Assessment, the same magnification of PGA (NBCC 1995 1/475 design earthquake PGA to MCE PGA) will be used for design by NBCC 2005. A site specific assessment should be completed when GVS & DD selects a preferred plant site.

As noted in the Facility Plan Report, it is unlikely that the existing facilities at the Lions Gate plant would meet the present day seismic code. Most of the concrete structures on the plant site were designed between 1960 and 1980 when building codes were not as stringent as they are today. For this report it is assumed that these structures would have to be replaced to meet the current standards if the existing Lions Gate site were maintained.

Underground treatment options have a considerable impact on the structural requirements for new treatment works. Two underground design scenarios have been considered; one with a park setting at grade (Klahanie Park site, PEC site, Lions Gate site) and one with container storage at grade (Vancouver Wharves site). Superimposed loading for the underground structures with container storage is assumed at 60 kPa localized loading for 12 m (40 ft.) containers stacked 6 high. For average loading a 40% reduction is applied for consideration of aisle ways. This option also incorporates a 100mm asphalt wearing surface over a 100mm protective concrete layer, overtop of a membrane on the structural slab. For the park setting, a membrane and protection board on the structural slab is overlain by 600mm of growing medium.

Bulk sulphur storage was also considered at Vancouver Wharves site for a 14.6 m high sulphur stockpile. The loads imposed by this stockpile are 4 to 5 times the loading for container storage and it would not be practical to consider this usage on the underground option. In order to maintain the equivalent loading for the container storage option, the pile height would have to be limited to about 3m, likely an unacceptable operational situation.

Design for uplift of the underground options will be dealt with as explained in Section 3.7.4. All of the sites under consideration will likely require design provisions for uplift as they are situated adjacent to major water bodies which will most probably influence water table conditions at the proposed plant sites. The extent of dewatering can be determined once detailed geotechnical investigations are completed at the preferred sites.

3.0 Plant Siting Options

3.1 Existing Lions Gate WWTP Site

The existing Lions Gate WWTP site is shown in **Figure 3.1** along with other candidate sites under consideration. The site is situated just west of the north approach to the Lions Gate Bridge. The original plant construction dates back to the early 1960's. The primary tankage is elevated to avoid water table conditions. The site has a limited area of approximately 3.5 hectares. The 2005 Facility Plan outlined an option of upgrading to BAF secondary treatment technology at the existing site.

The current site is confined by a railway track to the north and the Lions Gate Bridge to the east. The capacity for expansion beyond 2046 is limited, but if sludge digestion was moved to another site or if it was no longer required, it would likely be possible to meet the 100 year flows at the current site if the facility was constructed above ground and with high rate primary sedimentation facilities. Construction of an underground facility at the current site would be costly with significant constructability and risk issues.

3.2 PEC Site

The Pacific Environmental Centre (PEC) site is located approximately 0.5km east of the existing Lions Gate plant site. Similar to the Lions Gate Site, this is a foreshore site and it has some marshy areas. The site has an approximate area of 11.3 hectares. From discussions with GVRD we understand that this site has contaminated soils and groundwater which will require remediation as part of any new plant construction. The PEC site is registered as a contaminated site and some clean up work has been completed. It is also highly probable that below ground options will require significant dewatering as the site is adjacent to Burrard Inlet. This site would be better suited to an above ground construction option.

Access to the site will require construction of a major overpass crossing of the CNR rail tracks. In addition, since the site is located adjacent to a major active railway line, construction logistics would have to be carefully coordinated so as not to interfere with railway operations.

The PEC site is a good treatment plant site in that construction could be implemented with no disruption to existing Lions Gate operations. The PEC site has sufficient space for buffer and long term expansion beyond the 2046 design horizon.

METRIC

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W IJ8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com
www.stantec.com

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Manager

LIONS GATE WASTEWATER TREATMENT PLANT

OVERALL SITE LOCATIONS MAP

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3.3 Vancouver Wharves

The Vancouver Wharves site is situated approximately 1.5 km east of the existing Lions Gate site. The site has an approximate area of 10 hectares within the inner oval yard. The plant would be located in the inner core of a working container port yard which is surrounded by railway tracks. This site also has silo storage and marine loading and unloading facilities for major sulphur stockpiles. Stockpiling of sulphur above underground treatment options would not be feasible as there would be significant structural implications. Because of its proximity to Burrard Inlet, it is highly likely that shoring and dewatering would be required.

There is sufficient space to develop an above or underground plant within the inner core of the yard. There is also sufficient space for expansion beyond the 2046 design horizon.

3.4 BC Rail Passenger Lands Site

The BC Rail Passenger Lands site is situated on West 1 Street between Philip and Pemberton Avenue. It is bounded by a railway track on the south. This site is a long narrow site occupying approximately 2.9 hectares. An above grade treatment plant could be constructed at this site but it would be confined if sludge digestion facilities were to be located on the site. A revised digester design with fewer but larger digesters would enable construction of digesters on site. If high rate primary clarification is incorporated in the design, the BC Rail Passenger Lands site would have room for expansion beyond 2046.

3.5 Klahanie Park Site

The Klahanie Park site is situated approximately 1 kilometre north of the Lions Gate Bridge, adjacent to the Capilano River. The available site area is 3.5 hectares. It is a developed park site that has playing fields and is a candidate for an underground treatment plant site. The location of the site adjacent to the Capilano River will likely require dewatering for major underground construction. Other construction projects adjacent to Capilano have encountered rock. Access to the site would be via existing roadways or a new roadway constructed adjacent to the interchange off ramp.

3.6 Plant Siting Issues and Considerations

3.6.1 Existing Lions Gate Site

The existing plant was constructed in the early 1960s when seismic design standards were less stringent than they are today. The 2005 Facility Plan Report identified that many of existing structures at the site would suffer damage in a major seismic event. It was also identified that post-liquefaction movements could result in fractures and settlements in yard piping.

As part of the 2005 Facility Plan Report, a geotechnical assessment was completed by Trow Associates. The report indicated that groundwater was high and potential liquefiable zones of soils were scattered sporadically throughout the site with several areas where liquefaction could be significant. It was postulated in the Trow report that earthquake shaking together with subsoil liquefaction will cause the ground to move towards Burrard Inlet. Ground improvement along a 15 metre wide densified berm along the water front was recommended. A ground densification program using dynamic compaction or stone columns using vibro replacement was considered.

To provide resistance to uplift, soil anchors were recommended for all structures in the Trow report. For the proposed BAF secondary treatment process the underground structures will be situated below the groundwater table and will require the use of soil anchors or mini piles. Deep excavations would require a shoring and dewatering system to facilitate construction.

Because of the difficulty in constructing deep excavations in wet conditions adjacent to existing structures, the Lions Gate site would be better suited to development of an above grade plant expansion. This was the option carried forward in the 2005 Facility Plan. It would be very difficult if not almost possible to construct an underground plant at the existing site while continuing to maintain the plant in operation. There is concern that installation of shoring and dewatering could damage the existing structures as the new structures will have to be located in close proximity to the existing plant structures.

3.7 Geotechnical Considerations

3.7.1 General

The Preliminary Geotechnical Report entitled *"Facility Plans for Iona Island and Lions Gate Wastewater Treatment Plant – Geotechnical Assessment" by Trow Associates dated December 20, 2004, forming a part of "GVRD Iona Island and Lions Gate WWTP Project No. RFP 03-005"* was used as a basis for the geotechnical parameters for initial costing investigation.

The geotechnical data in the report for the Lions Gate site was used for the PEC, Vancouver Wharves and BC Rail Passenger Lands sites. As there was no information on the Klahanie Park site, the same data was used as for Lions Gate for this exercise. It is likely the site will be more favorable geotechnically and ground densification may not be required, and for the purpose of this report, the associated costs will be the same as for the other two sites, with the ground densification assumed as not being required, pending further site geotechnical assessment. The Klahanie site may be underlain by rock which will alter the excavation costs. It is recommended that detailed geotechnical investigation be completed for sites selected for further evaluation by GVS & DD.

3.7.2 Seismic Considerations

All structures should be designed to withstand the Maximum Credible Earthquake (MCE) based on the NBCC 2005 criteria for seismic design. There was no indication in the Geotechnical Assessment by Trow as to the possible magnitude of the MCE Peak Ground Acceleration (PGA) at the Lions Gate site, so the MCE will be in accordance with the procedure outlined in Section 2.6.

The Geotechnical Assessment by Trow provides lateral seismic earth loadings for the normal design earthquake. For the MCE loading, the lateral seismic pressure is increased by a factor proportional to the PGA given in the Trow report (section 3.2) of 0.23g to the assumed MCE of 0.5g.

3.7.3 Soil Liquefaction

The Trow Geotechnical Assessment indicates there is liquefaction potential at the Lions Gate site with potential differential settlement of a suggested design difference of 125 mm over 5m for the 1/475 design earthquake. This would be significantly more for the MCE. As this differential settlement would be severe for a liquid retaining structure, soil densification would have to be completed. On past projects Stantec has been involved in, the liquefaction issue was mitigated with the use of stone columns installed over the footprint of the site. For preliminary costing, stone columns of 1m diameter by 15m deep with spacing of 2.3m on centers were used. As noted in the previous section, soil densification may not be required at the Klahanie Park site but this would have to be confirmed by geotechnical investigation. The specific liquefaction issues for each site under consideration will have to be determined by geotechnical investigation.

3.7.4 Dewatering and Uplift Considerations

For the conventional above-ground options, it is assumed there will only be minor dewatering required. For the underground options, it is anticipated a shoring perimeter wall will be installed to provide adequate depth for installation of the structure bases and a well point dewatering system would be installed outside this shoring wall. The wall would have to be tied back using a soil anchor system.

Uplift will be resisted by either adequate weight of the structure or supplementing with uplift anchors, as suggested in the Trow Assessment. For the uplift design, as the site will have the soil densified to mitigate liquefaction, the uplift pressure due to hydrostatic pressure will be used in assessing the design of uplift anchors, rather than the larger uplift buoyancy due to liquefied soil.

3.7.5 Underground Construction Constraints

For the above underground sites, the Trow Report indicates fill to a depth of about 1.8m. It is assumed the areas for the structures will be excavated to a depth of 2m average to provide a bearing surface for structure foundations which will be of suitable native material instead of fill.

Construction of an underground site will require shoring of an excavation for the site. As the heights and required depth of bury vary, design height will be investigated for final design to provide the most economical shoring system in conjunction with dewatering requirements. In discussions with contractors, because of the likelihood of boulders on the three sites near the Burrard inlet, the choice for shoring would be shotcreted concrete wall with soil anchor tie-backs. Driving of steel sheet piles would be very difficult if not impossible due to the presence of boulders. At the existing Lions Gate site, when the shoring wall is close to existing structures, the wall may have to be supplemented with steel beams between soil anchors spaced to miss existing structures and utilities.

The Vancouver Wharves site is constrained by the perimeter rail lines in an oval configuration. Access to the interior oval of the rail lines or working yard is currently provided by an overpass in the northeast corner of the site. This overpass location may not be conducive to being able to provide the required access to the site without relocation. If it cannot be utilized, a new overpass will be required.

The PEC site will require an overpass crossing at the rail yards. For the purpose of this report, it is assumed the existing at grade crossing alignment on Lower Capilano Road will be utilized for an overpass. There is significant trackage at the location so a major overpass would be required.

The existing Lions Gate site underground expansion provides a difficult challenge because of the proximity to the waters edge, keeping the existing plant in service during construction and coordination of construction to avoid existing underground services. Most of the structures are assumed to be constructed within shoring walls. Because of the proximity to the existing structures, it may be difficult to locate the tie-backs for the wall, so alternative methods of shoring stability may have to be considered for final design.

Due to the extreme closeness to the existing structures, the influent pump station and thickeners would be best constructed as caisson type structures. Stantec was involved in the recent construction of the screenings building adjacent to the proposed effluent pump station, which was successfully completed as a caisson structure. Uplift resistance for these structures would be provided by dead weight of the structure. Soil densification will not be possible with this type of construction.

The costs for underground construction at the PEC, Vancouver Wharves sites, and Klahanie Park will be considerable because of the dewatering and shoring requirements. It is also possible that boulders and large rocks may impact the installation of shoring. During

preliminary design it will be necessary to optimize the depth of excavation and the hydraulic profile for the selected site. It may be desirable to consider intermediate pumping part way through the treatment process to reduce excavation depths and shoring requirements.

The design concept for all underground options assumes that an underground tunnel with adequate width for large trucks for sludge hauling is constructed underground and adjacent to all process tankage. The circulation tunnel roadway would be located at elevation of 6 metres below grade to maintain reasonable grades on ramps. All process tankage is developed in a compact arrangement to minimize facility footprint. Some of the area between structures will have a structural slab above, leaving an open area for circulation and access to all of the facilities.

To reduce underground construction, sewage and screenings could be conveyed to an enclosed at grade utility building via a pump or conveyor system.

If possible the GVS & DD should avoid the construction of major underground facilities as it will significantly impact construction costs.

3.8 Forcemain to the New Site

The site locations remote from the existing site will require construction of a large 1.8 metre diameter forcemain to convey raw sewage to the new treatment works. Construction of this pipe could present some challenges depending on the final route selection. The shortest route to the new plant sites will be along the edge of the rail right of ways or along adjacent roadways. There will also be large diameter rail crossings for several of the sites which could present some challenges given the width of the rail right-of-way. Specialized jacking or tunneling may be necessary for these crossings.

3.9 Construction Scheduling Considerations

There will be significant construction scheduling differences depending on whether above ground or below ground options are constructed. Based on experience with other wastewater treatment plant projects we anticipate the construction duration for above grade options would be 4 years while below grade options would be 5 – 6 years.

3.10 Preliminary Site Risk Assessment

Risk assessment techniques are often used to quantify the severity of risk factors for a particular technical or siting option. There are a number of factors that are considered in risk assessment and these factors and the criticality of these factors are developed specifically for each project.

A high level screening risk assessment was completed for each of the sites and is shown on **Table 3.1** below.

Table 3.1
Lions Gate WWTP – Relocation Summary Risk Assessment of Alternative Sites

Risk	Lions Gate Above Ground	Lions Gate Below Ground	PEC Above Ground	PEC Below Ground	Vancouver Wharves Above Ground	Vancouver Wharves Below Ground	BC Rail Passenger Lands Above Ground	Klahanie Park Below Ground
First Nations Land	In	In	C	C	N	N	N	N
Land Acquisition Private / Public	N	N	S	S	C	C	S	Im
Contaminated Site Clean Up	N	N	S	S	S	S	N	N
Constructability	A	C	S	C	S	C	A	C
Land Use Alienation	C	A	A	A	S	S	A	S
Public Acceptance	A	A	A	A	A	A	Im	In
Construction Cost Risk	S	In	Im	C	S	C	Im	C
Operational Issues	Im	C	A	Im	Im	Im	A	Im
Aesthetics	Im	Im	Im	A	A	A	Im	Im
Seismic Risk	S	Im	Im	Im	Im	Im	Im	Im
Approximate Severity	27,000	34,000	13,000	26,500	39,000	57,000	10,000	31,000

In	-	Intolerable	> 10,000	-	Must eliminate or transfer
C	-	Critical	5,000 – 10,000	-	Risk unacceptable eliminate – mitigate
S	-	Serious	1,000 – 5,000	-	Large impact work to mitigate
Im	-	Important	200 – 1,000	-	Mitigate / manage
A	-	Acceptable	26 – 200	-	Accept and manage
N	-	Negligible	0 – 26	-	Small don't worry

The results of the screening level risk assessment indicate that the BC Rail Passenger Lands above ground option would be the preferred option for the new plant construction.

4.0 Secondary Treatment Process – Liquid Train

4.1 Influent Pumping

A new influent pumping station is proposed for all options being considered. The new station will lift raw sewage from the Hollyburn interceptor and will pump wastewater to the new headworks. The new pumping station would be located completely underground at the existing Lions Gate site. Depending on the final site selection it is possible that flows to the new plant could be conveyed partially by gravity and partially by pumping.

The pumping station would be designed as a wetwell / drywell configuration with 4 pumps, (3 duty, 1 standby) to convey the PWWF of 356 ML/d. It is suggested that it may be desirable to size the pump combined capacity at 400 ML/d. Because of high groundwater conditions at the Lions Gate site and the deep excavation required to intercept flows from the Hollyburn and North Shore interceptors, the wetwell / drywell substructure would be sunk as a caisson. The screening facility upstream of the existing pumps at Lions Gate would remain in operation to protect the new influent pumps.

The PEC, Vancouver Wharves, BC Rail Passenger Lands Sites are all at approximately the same elevation so the static component of the pumping head will be similar. The Klahanie Park site is approximately 10 metres higher than the Lions Gate site so the influent pumps will be higher horsepower than for the lower sites.

Depending on the final hydraulic profile for the Klahanie Park site, it may be possible to return flows back to the existing Lions Gate plant by gravity. However for the purpose of this evaluation we have assumed that effluent pumping would be necessary.

Table 4.1 provides the approximate influent pumping heads and pump horsepower for various sites.

Table 4.1
Influent Pumping Characteristics

Site	Total Flow ML/d	Approx. TDH (m)	No. of Pumps	Horsepower Each Pump
Existing LGWWTP Site	356	13.6	4	300
PEC Site	356	15.0	4	350
Vancouver Wharves Site	356	17.0	4	400
BC Rail Passenger Lands Site	356	17.8	4	400
Klahanie Park Site	356	26.4	4	600

4.2 Screening

Wastewater will pass through existing screens located at the existing Lions gate WWTP upstream of the influent pumps. These screens protect the influent pumps and are required to protect the fine screens proposed for this upgrade. From the existing LGWWTP site, the wastewater will be pumped to any of the sites under consideration. Upon entry to the site, all waste will be screened for removal of solids and inorganic material. The captured materials are then washed and compacted to reduce both the organic content and volume. The captured materials will discharge to disposal bins for transport off site to a disposal facility.

The screening systems must treat the peak wet weather flow of 356 ML/day. The proposed secondary treatment of Biologically Aerated Filters (BAF's) requires a high level of screening to prevent clogging of plenum nozzles.

For the purpose of costing we have assumed existing screen substructure upstream of the Lions Gate pumping station can be used and have provided for 3 step screens.

The selected fine screen assumes the use of a perforated screen with 3 mm openings. The perforated screens provide a higher level of removal over bar or wedge wire screens. The screening system would include three (3) 2.5 metre wide screens each capable of screening 135 ML/day. One (1) screen can treat the ADWF. Three (3) screens would treat the PWWF. While a 60 degree incline is preferred by the vendors, the units can be installed up to a 75 degree incline. We propose the steeper arrangement to reduce overall footprint.

All screens will include isolation gates upstream and downstream of the screens. Each unit requires a float level switch installed upstream to measure differential level across the screen. The differential level will trigger a cleaning cycle. Each screen will include an explosion proof local panel to permit local operation plus an emergency shut-off switch.

Screenings from the coarse bar screen will discharge directly to a disposal container and be removed per current operations. The screenings would discharge to a dumpster since the material will be large non-compressible solids with limited volatile organic content. Based on typical capture (per Metcalf and Eddy), roughly 2.5 to 4.5 cubic metres of screenings would be captured per day during peak wet weather flow conditions.

Screenings from the fine screens can be conveyed by screw conveyors or via a sluice trough. The screenings from the fine screen proposed are discharged with a high volume of water – almost a slurry. For the proposed layout, we assume the material will be conveyed via a sluice trough. The trough arrangement provides the additional benefit of fewer mechanical parts and some passive washing of the screened solids prior to compaction. The washing reduces organic content of the compacted material and thus limits odours emitted from the screening disposal container. **Figure 4.1** provides a typical layout for fine screens.

The screenings will discharge into a compactor then gravity discharge into a disposal bin. The discharge chute of the compactor will include a bagging unit. The screenings will fill the bags that are then tied into "sausages" to reduce odours emitted from the captured solids. An ultrasonic level probe will monitor the screenings height in the bin and alert operation staff to remove the full bin and replace. The bins will then be transported off-site for disposal of the materials.

All screens will include integral covers for direct connection to the foul air collection system. The front of the screen is covered from the top of channel to the top of the unit. Air intake dampers can be installed around the base of the screen to create a down draft around the screen and thus further limit odours from the screening process. The screen will include stainless covers on the discharge chute that will connect to the screening conveyor or discharge bin.

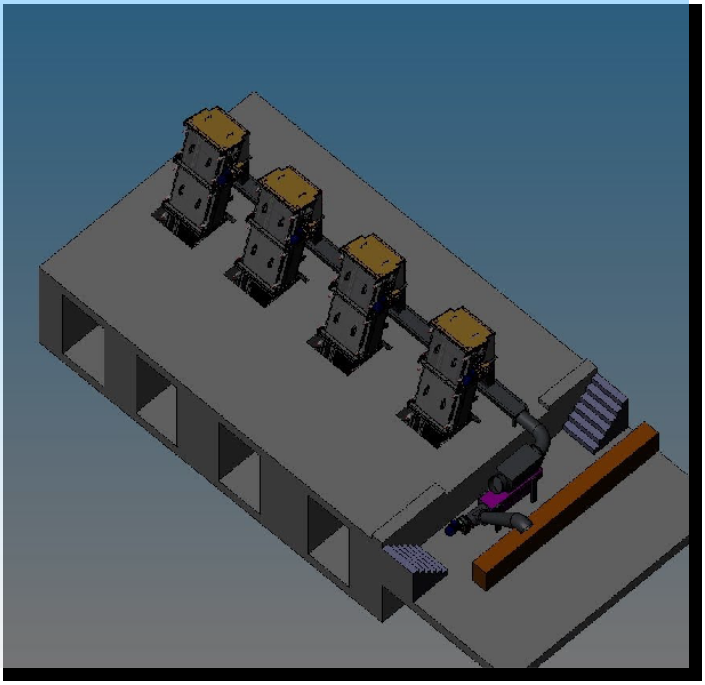


Figure 4.1 – Typical Screening Arrangement

For below grade treatment plant locations, the cost estimate allows for a pneumatic conveyor system for the screened material. This is a similar system used at the Annacis Island WWTP. The conveyor would collect compacted screenings in a pressure vessel. A level indicator in the vessel will detect a high solids level within the pressure vessel. On high level the vessel inlet valve will close. The vessel would then be pressurized. Once conveyor pressure is reached, the lower valve opens resulting in a plug of product squeezed into a transport line. This line can convey the screened material both horizontally and vertically and takes a limited amount of room for installation. At the discharge end, a receiving hopper separates the air from the screenings and gravity discharges into a disposal container.

This conveyance system is assumed as a worst case scenario for solids disposal. It provides the greatest degree of flexibility for plant design and would permit strategic location of the disposal bin access to truck for hauling offsite. At preliminary design, a more simple approach may suffice but at this stage this system provides the most probable cost of the upgrade requirements.

4.3 Grit Removal

After screening, all flow is directed to a vortex grit removal system. This system will remove grit consisting of sand, gravel and other heavy solids not captured by the screening system. The system must treat the full PWWF of 356 ML/day. The grit system includes 3-6 metre diameter grit chambers to pass the design flow of 356 ML/d. Flow enters the units in a 1.5 metre wide concrete channel. The layout will also include a bypass channel. Each channel will include isolation gate valves.

Typical Vortex Grit Removal System

The vortex units would be installed in a concrete structure and include an internal turbine to maintain constant velocity and promote separation of grit from the flow. The separated grit drops to the lower grit storage chamber. The dimensions of the unit are as follows:

- Upper Chamber Diameter 6.0 metres
- Upper Chamber Depth 3.6 metres
- Lower Grit Storage Chamber Diameter 1.5 metres
- Lower Chamber Depth 2.3 metres

The captured grit will be pumped to the grit classifier by a top mounted turbo grit pump. The pump includes a vacuum priming system. The grit would be pumped to a disposal room where trucks can easily access disposal bins. Odour control would be required in this area. In the disposal room is a hydrocyclone (grit concentrator) that further separates the water and grit. The underflow from the hydrocyclone drops to a clarifier. The supernatant water gravity discharges back to the inlet channel. The clarifier includes a grit dewatering screw conveyors. The conveyor will dewater the grit that then discharges to a disposal hopper.

4.4 Conventional Primary Sedimentation

Primary treatment provides removal of suspended particle by creating a quiescent settling zone. In the same tank, floatable materials, plus fats oils and grease will be separated and removed.

Primary tanks have been sized for the PWWF of 356 ML/d using a surface overflow rate of 130 $m^3/m^2/d$.

The design basis assumes similar rectangular basins as currently employed at the LGWWTP. The primary clarification includes eight (8) concrete channels, 66.2 metre long by 6 metre wide by 4 metres deep. Each basin contains a longitudinal sludge collector with a 4 shaft arrangement. The longitudinal collectors will scrape the settled solids and transfer them to the feed end of the tank. The same collector will skim the surface and capture the scum and floatable materials.

Collected sludge will be concentrated in a sludge collection box at the inlet end of the channel by a chain and scraper type cross collector. One cross collector will concentrate sludge from 2 clarifiers for a total of 4 cross collectors. Two longitudinal collectors and one cross collector are driven by each drive unit. A total cross collector system of 4 drives is required, with each drive being located on the inlet end of the clarifiers.

The drive unit would drive two shafts by a high strength non-metallic chain. The cost estimate utilizes non-metallic chain and scraper type longitudinal sludge collectors and non metallic chain and sprockets per the current GVRD standard. This construction is easier to install and is cost effective versus wooden scrapers and metal chain.

Sludge pumps will extract the sludge from the clarifiers and convey the material to a gravity thickener. Each tank will include a manually operated worm gear scum skimmer extending the width of the tank. Pumps would be located in a pipe gallery on the inlet side of the clarifier.

The scum will be collected within a scum tank and pumped to the DAF. The scum system will have all scum troughs connected to 2 scum boxes. Each scum box will have 2 scum pumps. Prior to the DAF, the scum be screened with a rotary drum thickener.

Clarified water will flow over weirs into stainless steel effluent troughs. The clarified water will then flow to the secondary BAF process.

For odour control, the primary clarifiers will be covered with flat panel aluminum covers. The covers are similar to those used at AIWWTP on the grit tanks. Foul air will be drawn from under the covers and piped to the odour control system. The covers will be easily removable for inspection and service of the primary clarifier internals.

4.5 Low Footprint High Rate Primary Sedimentation (HRP) Options

Conventional primary sedimentation tanks and thickening facilities will require a significant footprint at the existing or future plants. A rough estimate would be about 25 % of the overall plant footprint for build out to secondary using a biological aerated filter system (BAF). This area is quite large because primary sedimentation will be provided for peak wet weather flows up to 356 ML/day. As discussed above the footprint for primaries is minimized using long narrow tanks built with common walls side by side. The peak wet weather flow design surface overflow rate of 130 $m^3/m^2/d$ equates to 5.4 m/hr rise rate which we can utilize for comparison to higher rate primary settling alternatives discussed in this section. One way to reduce the footprint of conventional primaries by roughly 50% is to use stacked primary tanks. This has been done at a number of locations in Japan. However this would require that the upper level tanks would have to be elevated by greater than 6 m above grade or the lower level tanks would need to be subsurface by a similar elevation.

There are a variety of higher rate options for primary sedimentation which could be utilized:

- Ultra fine screens in the 250 micron range of openings;
- Dissolved Air Flotation;
- Chemically assisted primary (CEP);
- Lamella plate with chemical addition;
- DensaDeg™ Sedimentation Process; and
- Ballasted Flocculation or Actiflo™ Sedimentation Process.

All of these options have a significant effect on the area requirements for primary treatment and could be advantageous for application for GVRD sites particularly for the sites where a covered plant facility is required. Many of the processes require the use of proprietary equipment and the last three can be classed as a variation of chemically assisted primary.

Ultra Fine Screening: In Europe, particularly Scandinavian countries, there is increasing use of very fine screens as an alternative to primary sedimentation. The Salsness™ screening system is a very fine screen in the range of 200 to 300 microns which has a very similar TSS removal capability to primary sedimentation (about 50 to 60%) with a slightly less BOD removal of about 20 to 25%. The screens are mounted as moving belts with an air assist to remove screenings to a hopper which feeds a screenings press. The screenings can be compressed and dewatered to a solids concentration of about 30%. The units come in a fairly small module size capable of handling about 12 ML/day so that multiple mechanical units would have to be employed for the range of flows experienced at Lion's Gate. Usually these systems are preceded by coarser screens down to about 6 mm. There is

only limited use in North America usually in the 5 ML/day range. Based upon demonstration scale testing of the process at Victoria, there would need to be about 28 modules to handle the peak day flows. The multiple units would require a significant amount of maintenance. The footprint for the multiple units would be about 60% of the conventional primary requirement.

Chemically Assisted Primary (CEP): This is a commonly used process in North America and can be as simple as adding coagulating and flocculating chemicals such as alum or ferric salts and polymers to the screened wastewater. At the Lion's site ferric would probably not be used if the new facilities are equipped with UV disinfection. The process has been considered for Lion's Gate and Iona in the past and demonstration and pilot scale trials have been carried out. Typical chemical dosage for the Lion's Gate flows might be in the range of 70 mg/L alum and 1.0 to 1.5 mg/l cationic polymer. Improvement in removal of TSS and BOD can be expected e.g. 85% for TSS and 60% for BOD at peak flow rates. The settling area required to achieve CEP is probably reduced by about 30 % because higher surface overflow rates can be used (for example the design peak day rise rates might be 6 to 7 m/hr). Chemicals can be dosed to influent channels but coagulation and flocculation capabilities are improved if 2 or three stage mixing, coagulation and flocculation facilities are provided with a retention time of about 5 minutes at average annual flow. Significantly more sludge can be expected for the CEP process (about 30% more) which contains a higher percentage of inerts and heavy metals than primary sludge without chemical addition. The addition of chemicals need not be continuous but can be utilized for periods when the TSS levels are high or during wet weather flows. Because there is improved solids and organics (BOD) removal the secondary biological treatment facilities can be made smaller. When space requirements for chemical conditioning and chemical storage are considered, the space requirement for implementing CEP alone is about 75% of the conventional settling area.

Chemically enhanced primary results in significant impact on sludge quantities and will require additional digestion capacity.

Lamella Plate Settling: In this process screened and chemically conditioned wastewater is introduced near the bottom of the sedimentation tanks which are equipped with inclined flat plates (between 45 and 60 degrees to the horizontal). The settling wastewater flows between a bank of plates set about 150 mm apart. Solids and associated organics settle vertically and then slide down the inclined plates to settle at the bottom of the 4.5m deep tanks. As for the CEP system, the coagulating chemicals are dosed to a rapid mix area for dispersion, a more gently mixed coagulation area with about 60 seconds retention and a flocculation area of very gentle mixing with about 180 seconds retention at max month flow rates. The impact of the lamella plates and the chemical conditioning is that rise rates increase to between 10 and 12 m/hr at peak flow conditions. The settling area therefore is reduced to 30 to 40 % of the plain sedimentation area. The requirement for chemical

conditioning and storage reduces the footprint savings to an estimated 60% of the conventional primary settling process. Treatment with lamella plate settling is about 10 to 15 % more efficient than the CEP process without lamella and therefore the sludge quantities increase proportionately.

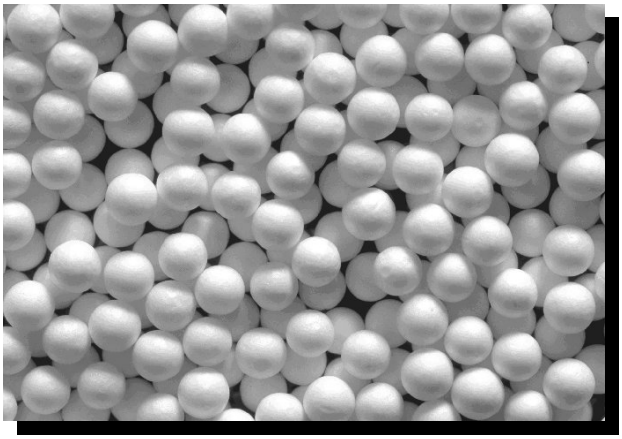
Ballasted Flocculation Process: In this process, inert micro-sand particles, are applied to the wastewater, as it is chemically conditioned, with polymer and coagulating chemicals. The inerts add weight and bulk to the flocculating solids in the wastewater mixture such that settling rates increase. The conditioned wastewater is then introduced to a settling tank equipped with lamella plates. Rise rates of 80-100 m/hr can be used to size the settling section of ballasted flocculation facilities which are usually about 5 m deep. The settled sand and flocculated material from the settling unit are sent to a hydro-cyclone which separate out the sand and recycles it to a maturation tank. Periodically sand must be added to replace the small percentage carrying over into the sludge. The footprint of the chemical conditioning, storage and proportioning equipment make up a significant proportion of the footprint. The resulting plant footprint for the ballasted flocculation plant would be approximately 25 to 30% of the size of conventional primary settling facilities. For the PWWF of 356 ML/d we have completed preliminary sizing and 4 trains each with dimensions of 8 m wide by 17 m long with 5 m side water depth would be required. This is a very significant footprint reduction and would be ideal for consideration to reduce the footprint of underground options being considered. However the cost of proprietary ballasted flocculation facilities such as “Actiflo” is significant. The other drawback is that the settled sludge is quite low in concentration, 0.25 – 0.50% solids. The efficiency of removal of BOD and TSS is very similar to other CEP processes so the process does impact the sizing of secondary treatment facilities such as BAF’s e.g. 20 % smaller. Sludge quantities are similar to other CEP processes and are about 30% greater than conventional primary yields and the amount of inerts in the sludge are higher.

DensaDeg™ Sludge Process: This is a very similar process to the ballasted flocculation process with the exception that no inerts are added to the wastewater as it is conditioned. The settled solids and organic material is recycled by pumping to the flocculation tank to form seed microfloc particles to assist in increasing settling rates. Coagulating chemicals are added to an aerated mixing zone. The chemically treated wastewater then flows to a two stage flocculation tank to which polymers are added in the first stage together with chemically conditioned sludge re-circulated form the settling tank. The wastewater sludge mixture then enters a settling tank equipped with lamella plates where sludge is settled to the bottom of the tank and either recycled or pumped for stabilization and dewatering. In the flocculation tank oil, and grease floats to the top and can be skimmed off. Rise rates in the settling section are generally about 20% lower than for the ballasted flocculation process (60 m/hr). The space savings for the dense sludge process over the conventional settling are only slightly less than for the ballasted flocculation. (say 30% of the conventional). The

sludge is much denser for the DensaDeg™ sludge process. However the process has a significant lag time from start up to efficient operation (say in the vicinity of 45 minutes). Similar to ballasted flocculation the dense sludge process is a proprietary system.

4.6 Biological Aerated Filters

Biological aerated filters, commonly referred to as BAF, are a fixed film biological process in which primary effluent is introduced at the bottom of a 2 to 4 metre bed of porous media. Microorganisms grow on the surface of the 2 to 4 mm diameter media particles. Packing materials for upflow beds can be expanded clay shale materials (Biofor), or polystyrene beads (Biostyr). As the wastewater travels a tortuous path through the media, the organics are utilized by the organisms as food. Compressed air is introduced through fine bubble diffusers into the media bed in sufficient quantity to satisfy the oxygen demand of aerobic microorganisms degrading the wastewater into carbon dioxide and water. Suspended solids are removed from the wastewater by a filtering action of the media and biological film. The filtering action of the BAF's is an advantage for application as a low footprint system because final settling facilities are not required to produce a secondary quality effluent.



Polystyrene Media

As the aerobic biological process proceeds additional microorganism cells are grown. The yield of excess sludge is similar to the conventional activated sludge process or approximately 0.8 – 0.95 kg cells / kg of BOD removed. Multiple BAF cells are utilized so that periodically – once every 24 hours – a filter cell can be taken offline and backwashed with effluent so that the daily accumulation of solids can be removed from the bed. During the backwash cycle the bed is also expanded by use of compressed air introduced as an air scour. Sufficient effluent is stored in a clearwell to provide backwash water. Effluent not required for backwash is then allowed to flow directly to the disinfection facilities and thence to the outfall. The backwash water is directed to an interim dirty backwash storage well and thence to a solids separation unit such as a dissolved air flotation system to produce a 3.5% solids concentration in the waste

Clay or Shale Media

biological sludge which is fed to the sludge dewatering or sludge stabilization facilities. Centrifuges can also be utilized to thicken the backwash stream but require polymer addition.

Typical loading rates for BAF's are 4.5 to 5.5 kg BOD / m^3 of media/day and 4.6 kg TSS/m^3/day. Because of the fixed film nature of the biological population the systems can handle a wide range of flows with typical design hydraulic loadings of 136 $m^3/m^2/d$ for maximum month loadings and up to 367 $m^3/m^2/d$ which would allow the peak flows to be treated in the BAF's. To accommodate the maximum month organic and solids loads expected at Lion's Gate in 2046, the BAF should consist of 8 filter cells 10.9 m x 12.9 m x 7.5 m deep or 140 m^2 each (1,120m^2 total). These would be built side by side in two rows of 4 cells with a central pipe gallery. With one filter offline for backwashing the filtration rate is 226 $m^3/m^2/d$ which is within recommended guidelines.

BAF Plenum Floor

The effluent quality will not be quite as good as an equivalent capacity activated sludge plant particularly for BOD. However an 80% removal of BOD_5 / TSS from the primary effluent could be expected. The typical effluent concentrations of around 28 or 29 mg/l for BOD and 16 to 17 mg/l for TSS could be expected during both max month average flow and peak flow conditions. If chemically enhanced primary (CEP) treatment preceded the BAF's the improved influent quality at similar loadings would improve the effluent quality down to 18 and 10 mg/l respectively for BOD and TSS.

The footprint for the BAF has to provide significant space for an effluent pump station, an effluent clear-well capable of storing approximately 5% of the average annual daily flow, backwash pump facilities, process air and air scour blowers, pipe galleries and mechanical and electrical equipment rooms.

The BAF was the selected process in the 2005 Facility Plan because it was cost effective, had a small footprint, and would easily satisfy the MSR treatment objectives.

4.7 Other Emerging Low Footprint Secondary Treatment Options

There are a number of existing and emerging biological treatment secondary process options in addition to the BAF system described above.

These include:

- Membrane Bioreactor (MBR)
- Moving Bed Bioreactor (MBBR)
- Integrated Fixed Film Activated Sludge (IFAS)
- High Purity Oxygen Activated Sludge (HPO)
- U Tube Bioreactor e.g. Deep Shaft

All of these technologies use concentrations of activated sludge or combinations of activated sludge and fixed film to minimize the size of the bioreactor. However reducing the size of the bioreactor by 50 to 75% as can be achieved by most of these technologies is not the major space saver. Processes that eliminate the use of secondary clarifiers for similar solids separation as achieved by the BAF process provide the major space savings. Only membrane technology (MBR) and the Deep Shaft process are the technologies, other than BAF which accomplish final clarifier elimination. A discussion on membrane technology is provided below as it has become a more common technology since completion of the 2005 Facility Plan. It is more commonly being used where water re-use is a consideration because it produces a high quality affluent with TSS and BOD < 5 mg/L.

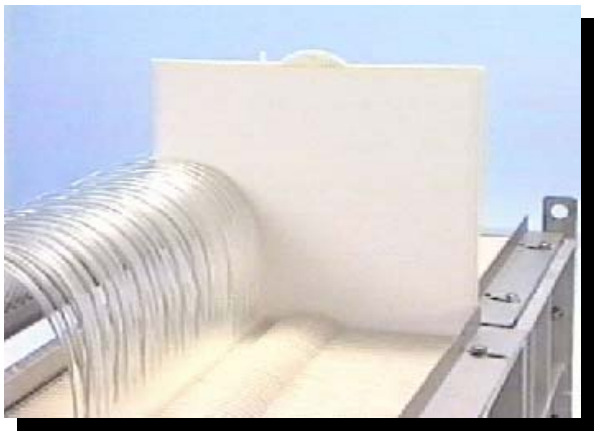
Hollow Fiber Membrane

Membrane Bioreactor Technology: Membrane bioreactor systems utilize semi permeable membranes for solids separation following biological treatment in a short retention time bioreactors. To accommodate maximum month flows and loads the typical retention time in a 5 m deep MBR bioreactor designed for BOD and TSS removal would be about 4 hours at average daily flows and loadings. Usually this main bioreactor is equipped with efficient fine bubble aeration diffusers. Hollow fiber membrane systems which draw the wastewater permeate through the membrane bundles by vacuum pump are a popular option. The membrane bundles are grouped together in 1.5m x 1m x 2.5 m cassettes set in a shallow (3.5 m deep membrane tank. This membrane tank is equipped with coarse bubble aeration

diffusers to create sufficient turbulence to minimize fouling by biological growths as a film on the membrane surface. Flat plate membranes are another option which are installed directly in one compartment of the main reaction tank along with coarse bubble aeration.

The activated sludge (MLSS) concentrations in MBR bioreactors are maintained at elevated levels of around 8000 to 10000 mg/l which is 3 to 5 times the concentration of conventional activated sludge bioreactors. The bioreactors therefore occupy a footprint which is about 25 to 30% of the footprint of conventional activated sludge. High recycle rates of 4 to 5 times the plant inflow are required from the solids separation tanks to the main bioreactors to achieve the high concentrations. The membrane solids separation equipment occupy significantly less space than equivalent capacity secondary clarifiers associated with conventional activated sludge. e.g. 25% of the secondary clarifier footprint. A significant amount of space is required for the vacuum permeate pumps, backwash pumps piping, valves and fittings which are usually housed inside a building.

Another feature of the MBR technology is that if primary clarifiers are replaced by fine screening of say down to 2 to 6 mm spacing the bioreactor for an equivalent level of treatment is only about 10% larger than if preceded by primary treatment. Elimination of the primary clarifier portion of a plant also significantly reduces plant footprint.



Flat Plate Membrane

Overall the space requirements for an MBR system compared to the footprint of an equivalent capacity BAF system are about 25% larger. However the effluent produced is much better in terms of BOD, TSS and coliform bacteria with levels of around 5 mg/l readily achievable for BOD and TSS and coliforms <100 MPN / 100 ml because of the physical barrier of the membrane. This enables the designer to use flow splitting and effluent blending of the MBR with say CEP to achieve target effluent quality such as 45:45 BOD/TSS. This concept would be required for Lions Gate if membranes were to be given serious consideration because membranes sized for the hydraulic PWWF of 356 ML/d would be cost prohibitive.

For the North Shore Lion's Gate flows and loads the MBR is an option for an underground low footprint plant provided the following strategies are used:

- Fine screening (2 to 6 mm) of all flows is provided- requiring an expanded headworks.

- MBR treatment is provided for flows and associated loads up to 160 ML/day e.g. 5 mg/l BOD and TSS effluent.
- High Rate CEP treatment is provided for flows in excess of 160 ML/day ( )<69 mg/l BOD and TSS.
- Effluent is blended prior to disinfection to achieve the 45/45 effluent goals equivalent to conventional secondary treatment of all flows up to 2 x ADWF.
- CEP primary sludge is thickened using mechanical thickeners such as drum thickeners.
- Waste Activated sludge WAS is thickened using centrifuges located in the dewatering building alongside the dewatering centrifuges for anaerobically digested sludge.

The MBR system does have drawbacks of significantly more mechanical maintenance, high capital investment for the initial membrane system and associated mechanical equipment, and recurring cost for membrane replacement every 6 – 8 years.

For a similar size (137 ML/d) facility which is under construction in Seattle (Brightwater WWTP), the costs are estimated at $550 million US dollars. Although the MBR does have technical merit, the high costs in comparison to BAF treatment do not make it an attractive option for Lions Gate.

5.0 Secondary Treatment Process – Solids Train

5.1 Design Criteria

To estimate site size requirements for the expected 2046 flows and loads, the solids treatment process facilities described in the 2005 Facility Plan Summary Report have been assumed as the base-case scenario. Because the decision with respect to the final disposal or re-use of those solids has not yet been made, a second process alternative has been added so that one alternative provides a final product (no digestion) with high VSS, for consideration if power generation becomes the ultimate use of the residuals. The other alternative minimizes the mass of sludge that must be transported for final disposal. In the first case, the process train involves thickening and dewatering only, while the second case involves extended thermophilic digestion to minimize the mass of solids for trucking. At the time of the pre-design exercise, an appropriate evaluation of various residuals management alternatives can be made but this thermophilic digestion option provides a good base case for costing purposes.

Footprint requirements for major components of the residuals management train have been calculated based on the following loadings and assumptions.

Loadings:

- Influent Flow = 133 ML/d (AAF from 2005 Facility Plan Summary Report)
- Influent BOD Load = 28 Tpd (MM from 2005 Facility Plan Summary Report)
- Influent TSS Load = 32 Tpd (MM from 2005 Facility Plan Summary Report)

Design Assumptions:

- PC Solids Removal Efficiency = 70% (without CEP)
- PC BOD Removal Efficiency = 40% (without CEP)
- BAF biomass yield from BOD removal = 0.94 kg TSS/kg BOD removed
- BAF effluent BOD = 25 mg/L
- VSS destruction in extended thermophilic digestion = 65%
- Solids capture in thickening and dewatering facilities
  - Gravity thickener = 90%
  - DAFT = 94%
  - Centrifuge = 95%

Figure 5.1 shows a mass balance process schematic for the facility without digestion facilities, while **Figure 5.2** shows a schematic with digestion added. Both schematics show a solids handling stream that consists of gravity thickening for primary sludge, DAF thickening for waste solids from the proposed BAF reactor, and centrifuge dewatering for the combined flows of sludge from the thickening facilities in the case of one process alternative, and from the secondary digester in the case of the other process alternative. Again, it should be noted that during any pre-design activity, the possibility of co-settling of BAF waste solids in the primary clarifiers should be investigated because of the potential savings if DAF thickening can be eliminated. For most of the time the primary sedimentation tanks will be underloaded as they are sized for PWWF. An option which could be considered would be to include lamella plates in one of the clarifiers and dedicate that clarifier to handle BAF and primary waste in a co-thickening operational regime.

The following sections show the development of the sizing of the thickeners, digesters, and centrifuges for the two alternative process trains.

5.2 Primary Sludge Gravity Thickeners

Design loadings for the gravity thickeners are determined by the expected solids loading in the raw sewage and the anticipated efficiency of the primary clarifiers for removing those solids. By using the design loadings and assumptions presented on the previous page, the solids loading to the thickener is calculated to be 23 Tpd at a design solids concentration of about 2%. At a fairly conservative thickener solids loading rate of 100 kg/m2.d, a thickener footprint of about 230 m2 (plus ancillaries) is indicated. This would result in a 3, 10 metre diameter thickeners being required for the LGWWTP. The thickened sludge output has been assumed to have a solids content of 7%, with a solids capture rate of 90%. These numbers are shown on **Figures 5.1 and 5.2** (solids mass balance schematics).

5.3 DAF Thickeners for Waste Biological Solids

The proposed Dissolved Air Flotation Thickener (DAFT) facility is intended to thicken the BAF backwash water solids before they are sent to either the digesters or the centrifuge. The source of the solids in that backwash water is twofold: biosolids that are formed by BOD utilization in the BAF; and solids that were not removed by the primary clarifier. Assuming that 25 mg/L of BOD will not be degraded in the BAF, and using the previously stated yield coefficient of 0.94 kg TSS/kg BOD converted, a solids yield of 11,200 kg/d is calculated for the BAF. When that is added to the 14,500 kg/d of solids that escape in the primary effluent, the total design load to the DAFT facility becomes about 22.7 Tpd (see **Figure 5.1 & 5.2**). Using the design solids loading rate (SLR) shown in the Facility Plan Summary Report of 48 kg/m^3/d, the design area for the DAFT tanks becomes 475 m^3. This would require 3 – 14.5 m diameter DAFT tanks for the 2046 design flow. To this area there must be added enough

space in the building to accommodate all the ancillary pumps, air delivery system, and controls.

Another option which could be considered for elimination of DAFT thickeners is the use of thickening centrifuges. For this option 4 additional centrifuges would be required. This option would reduce footprint requirements which may be particularly advantageous for underground options.

5.4 Extended Thermophilic Digesters

The purpose of extended thermophilic digestion is to minimize the mass of residuals that must be trucked to any final disposal or reuse site. Using extended thermophilic digestion does not significantly reduce the volume of digesters compared to that necessary for the more common mesophilic digestion, but it does convert a much higher percentage of VSS to methane and carbon dioxide. For purposes of this comparative exercise, it has been assumed that the use of a 15 d HRT along with a solids loading rate of 2.8 kg VSS/m^3/d will assure a VSS reduction of 65%. It has further been assumed that two-stage digestion will be used, with the first stage being where the solids degradation occurs, and the second stage being used for thickening plus some further gas storage.

Reference to **Figure 5.2** will show that the total design solids loading to the first stage digester is expected to be 42,000 kg/d in a flow of 700 m^3/d. Using these 2046 loading estimates together with the design loading rates quoted in the paragraph above, a required primary digestion volume of 13,600 m^3 is calculated. Four primary digestion tanks of 3400 m^3 each makes a reasonable arrangement for site layout.

Because of the expected 65% reduction in VSS that the extended thermophilic digesters provide, the mass of TSS leaving the primary digesters will be about 18,000 kg/d in an expected flow of 700 m^3/d. Such characteristics mean that the secondary digestion volume can be about half that of the primary volume. Hence the total expected digester layout will include 6 tanks, each of which will have a volume of about 3400 m^3.

5.5 Sludge Dewatering

All sludge produced in the plant will settle in the second stage digesters. The sludge will thicken in the digesters and be pumped to the dewatering process. The cost estimate assumes the use of decanter centrifuges as are currently used at the LGWWTP. This dewatering process provides the driest cake, takes the least space and is enclosed to limit the escape of odours.

The centrifuge facility sizing is very dependent upon whether or not there is a digester in the solids treatment train. Reference to **Figures 5.1 and 5.2** shows that the expected centrifuge loadings will be as follows:

- For the alternative that includes no digestion, the design centrifuge loading will be about 42 Tpd of solids in a flow of 700 m^3/d (about 6% solids). That flow includes both TWAS and gravity thickened primary sludge.
- For the alternative that includes extended thermophilic digestion of the combined primary and secondary sludges, the calculated centrifuge loading from the secondary digester is 16.2 Tpd of TSS in a flow of about 200 m^3/d.

Upstream of the centrifuge, polymer is required to aid in the separation of liquids from solids. The estimate assumes the use of a dry polymer preparation system using 1 ton totes of polymer. The volumes required for the LGWWTP favour the use of tote chemical storage. Dry polymer will be dropped by gravity into chemical feeder which then conveys chemical to a mixing system to prepare a solution for injection into the sludge line.

Typical performance for dewatered digested sludge:

- Inlet solids 2 to 4% - ds
- Outlet solids 25 – 27%
- Polymer required 7 – 10 kg / tonne
- Centrate quality >95%

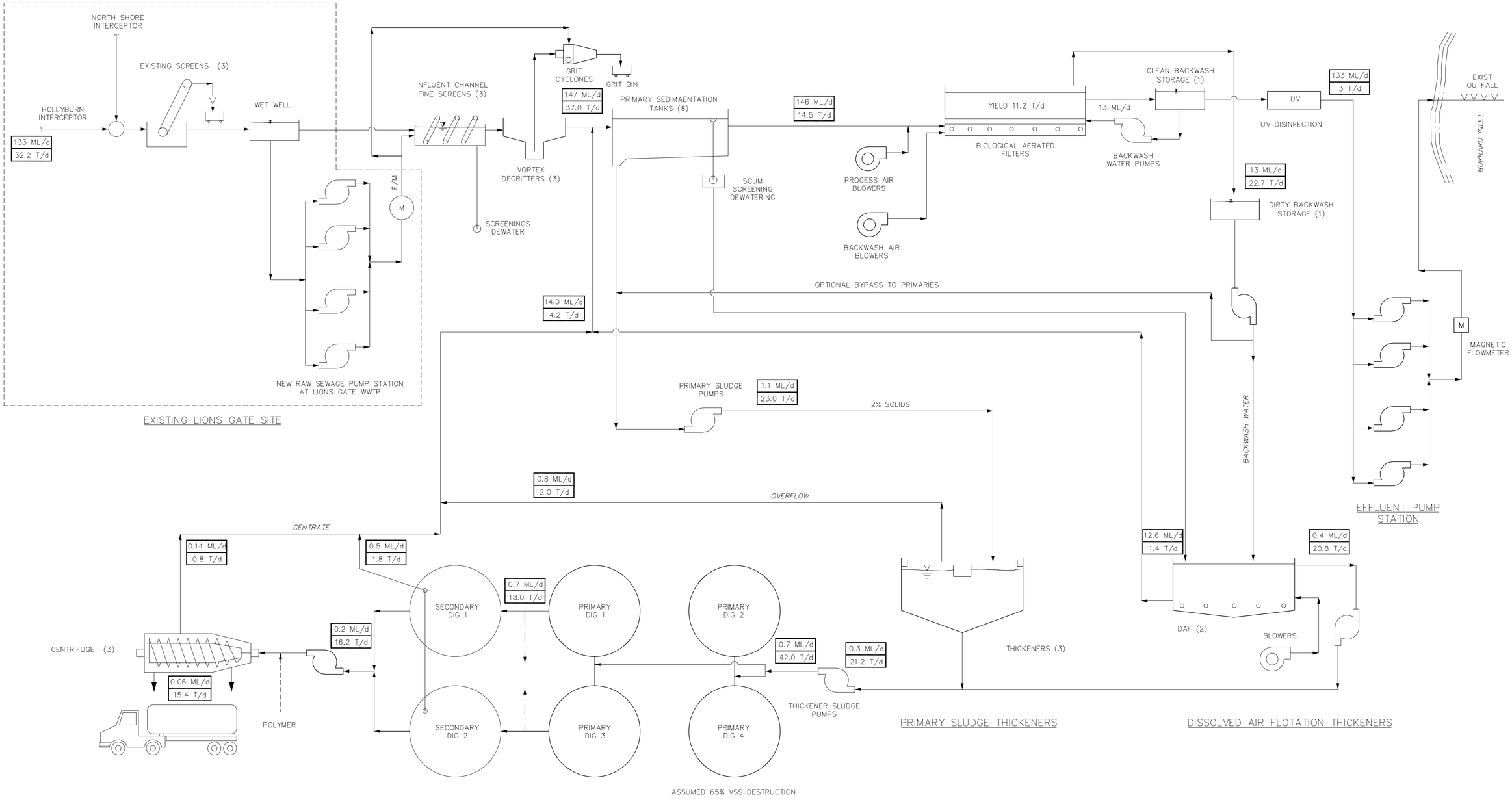
To meet the hydraulic and solids loading requirements, three units are proposed for the base case of thickened, digested sludge. This will provide two operating and one standby unit. Four larger units are required for the undigested sludge option. Performance of the centrifuge dewatering system is controlled by the speed of rotation and the speed of the internal conveyor. The centrifuge manufacturer includes specialized controls to control all operating elements and provide an interface for operation staff.

Centrate from the process will be pumped to the headworks. The recovered cake will gravity discharge to inclined conveyors. The conveyors will transfer the cake to a single cake conveyor. The inclined conveyors include a lower drain. During initial operation of the centrifuge plus during upset conditions, sludge can drop out of the cake chute. The inclined conveyor can not transfer fluid so it will drain to the lower end of the conveyor. This liquid will be piped to the centrate line for pumping back to the headworks.

The discharge from the inclined conveyors will connect to a single conveyor. This will move material to the disposal bin located in a separate room. The separate room will require additional ventilation for odour control particularly for the undigested sludge options.

The disposal room will be sized to provide room for two bins. The transfer conveyor will connect to one of two leveling conveyors. The leveling conveyor will convey cake to fill the entire length of the bin. The bins will be on weigh scales. Once the bin is full as detected by the weight, a diverter will automatically convey dewatered cake to the second bin.

The above grade option assumes the centrifuges will be installed at a high elevation and material will be transferred and stored in lower levels. For the below grade option, the transfer conveyor would be replaced with a cake pump. The cake pumps allow transference of cake in a vertical direction while taking a minimum of space. This will allow the disposal bins to be above the dewatering thus improve access for trucks. The proposed cake pumps are similar to those used at the Annacis and Lulu Island plants. The estimate assumes the use of three cake pumps with one installed for each centrifuge.



METRIC

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W IJ8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com
www.stantec.com

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Issue	Date	Desn	Dr'n	Chkd	Appd	Description
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Drawn: ESD
Checked:
Approved
Manager

LIONS GATE WASTEWATER TREATMENT PLANT

SOLIDS MASS BALANCE DIAGRAM WITH 2 STAGE THERMOPHILIC DIGESTION

SCALE: 1:250
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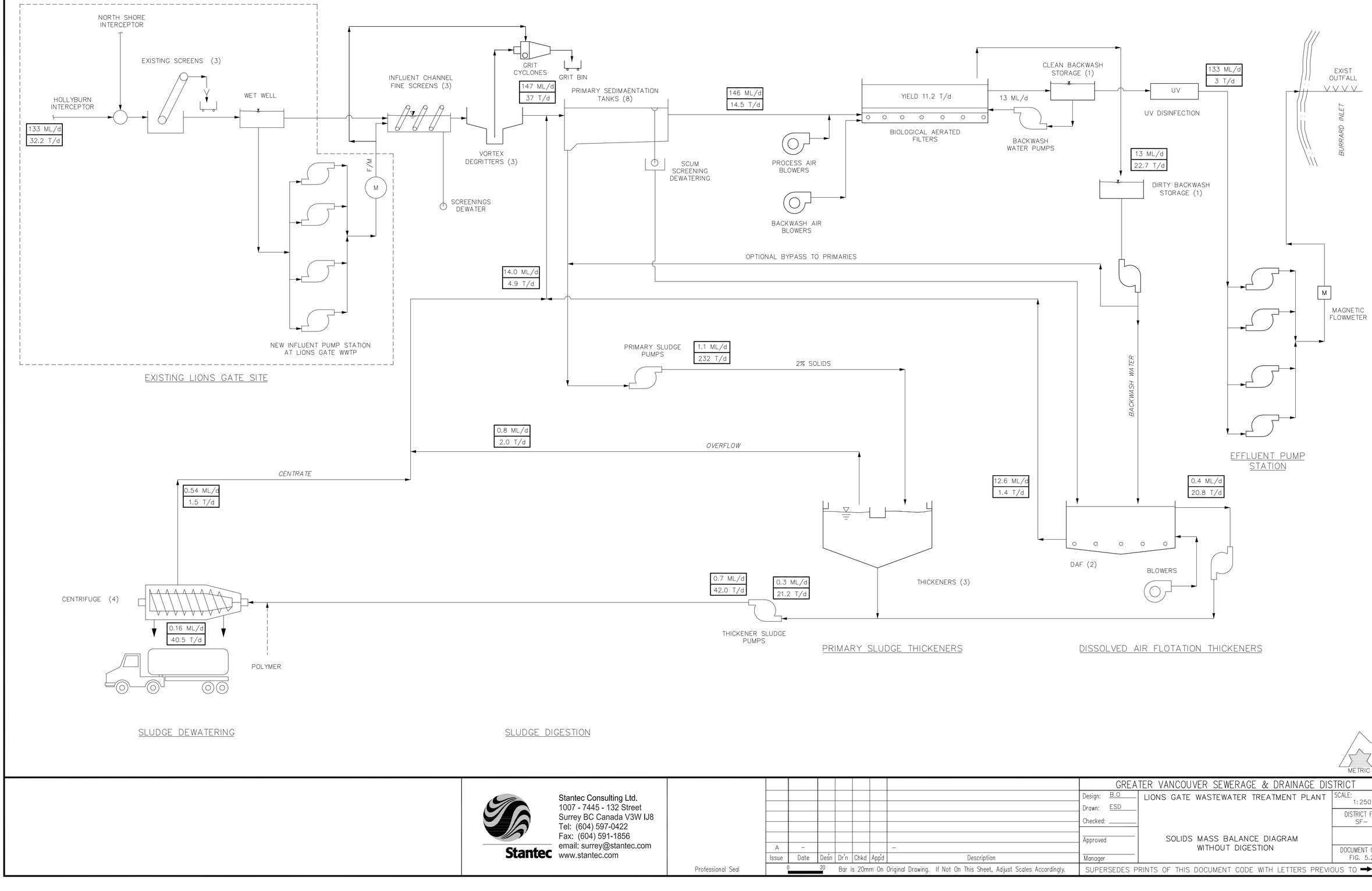

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W IJ8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com
www.stantec.com

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Manager

LIONS GATE WASTEWATER TREATMENT PLANT

SOLIDS MASS BALANCE DIAGRAM WITHOUT DIGESTION

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6.0 Odour Control

6.1 Odour Control Options

Control of odours requires considerable attention and thus conservative estimates for the upgrade of the LGWWTP. There is limited operating data for the design basis but good odour control design typically treats air streams to 3 odour units or less. This odour level criteria is based on other plants operating within close proximity to residences and businesses. The odour control system must therefore be designed to include significant investment for the collection and treatment of odours.

The areas of the plant that produce significant odours include:

- Headworks
- Primary Clarifiers
- Thickeners
- DAF tanks (minimal)
- Dewatering including the biosolids storage and load-out areas

As filtered aerated effluent is exposed to the atmosphere in a counter current configuration odour from the BAF process is not usually an issue but we have provided an allowance for odour control for the unit process as requested by GVS & DD.

Typical Biofilter

The odours in these areas are typically associated with Hydrogen Sulphide, other reduced sulphurs such as Methyl Mercaptan (MM), Di-Methyl Sulfide (DMS), Dimethyl Disulfide and VOC's. Wastewater treatment plants have utilized many methods for treating odours depending on the air stream being treated.

Carbon adsorbers include a bed of activated carbon that captures odours as the foul air passes through the bed. This option is typically the lowest capital cost option and the systems are typically effective on the majority of odourous compounds. The

carbon bed option however represents the highest operating cost as the carbon bed requires regular replacement once its adsorption capacity is spent. The use of carbon filters is typically limited to low levels of odours where long bed life is anticipated, intermittent use, or for smaller applications.

Chemical scrubbing technology includes either a packed tower or fine mist of chemical that contacts the foul air. The chemical will react with the contaminants to reduce odour. The chemicals are selected based on the incoming air stream and for difficult applications; two or three phases of treatment can be utilized. Chemical scrubbers are a well - established technology. They are a medium capital cost but have high operating cost due to the use of chemicals. They are ideally suited for high concentration H2S removal on steady contaminant loads.

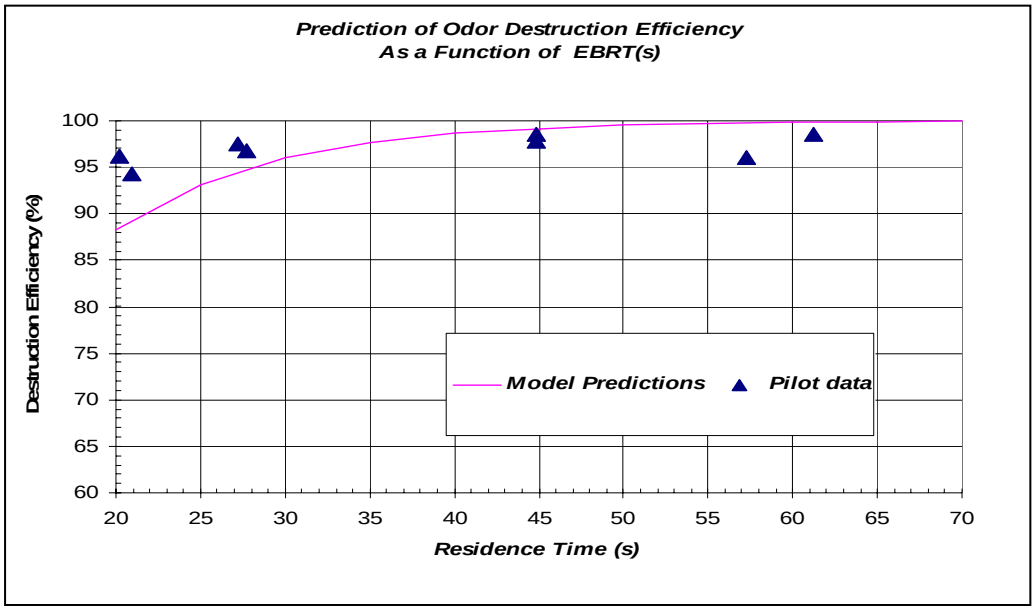
Biological processes for odour control have been the most widely used technology in the industry because of their low operating cost and generally good performance. These process are typically referred to as biofilters or biotrickling filters. The filters are a medium to high initial capital cost but take a larger footprint. The advantage is consistent treatment, low operating cost and ease of operation. The beds require irrigation to maintain moisture to keep the bioculture health. Some systems include a nutrient feed to maintain the bed that aids in the treatment where odours fluctuate. Biofilters provide good H2S removal – provided levels are not excessive and typically provide good overall odor control.

Recent advances in biofilters have seen the evolution of pre-engineered inorganic media. Typical biofilters utilize a mixture of woodchips and compost. The variability of this media resulted in wide variations of performance and low bed life. This appears to be the case at the AIWWTP and we understand that the biofilters at this plant have experience consistency problems with the woodchip media. Suppliers of this media are providing a long term performance warranty. The bed life for a biofilter is determined by the effective removal of odour as well as the bed pressure drop. Inorganic media biofilters tend to have less decomposition and degradation of the media. Suppliers of this media are providing a performance warranty of 10 years. This media has been piloted and will be used at the 800 ML/d Ashbridges Bay WWTP in Toronto. In addition, the mechanical properties of the media are such that it is stronger, thus preventing bed compaction. The other advantage is the beds can be deeper. This reduces the footprint while maintaining contact time of air (empty bed residence time – EBRT) in the biofilter.

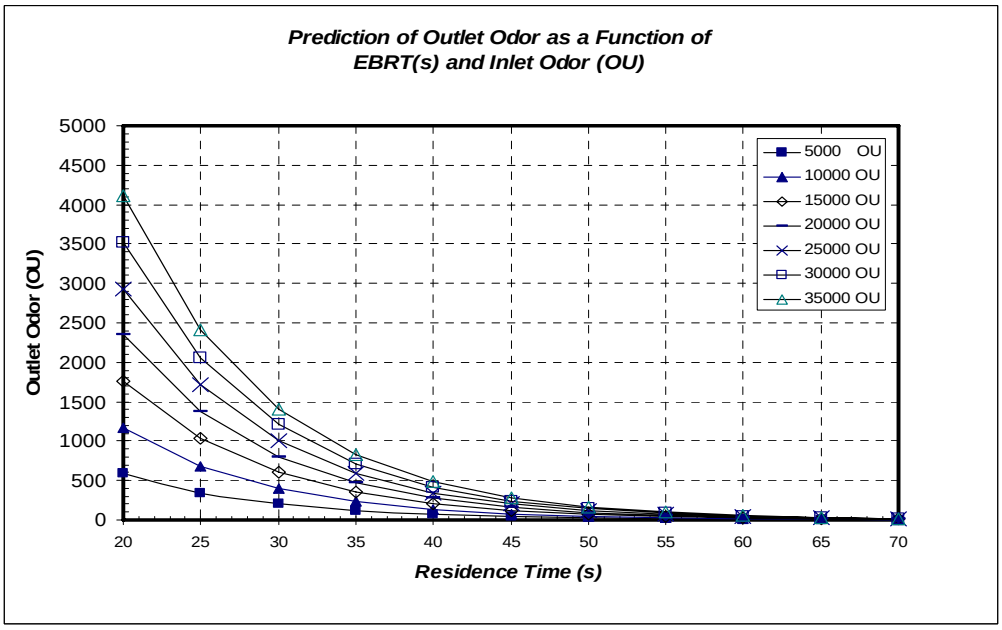
Inorganic beds have long lasting bed life, often exceeding ten years versus wood chip/compost beds that last between 2-5 years. The media also has a higher surface area to volume ratio. This allows a lower volume over typical biofilter beds. Inorganic beds also require loss maintenance than soil / wood chip beds.

6.2 Design Criteria for Odour Control

The biofilter design is a function of the level of odour in the air stream and odourous constituents within the stream. The design should provide for less than 3 odour units at the property line. These factors determine the required residence time (EBRT) within the bed. For this estimate, we obtained design data from Biorem - a manufacturer of inorganic media that provided the following curve for odour removal. The graphs are based on typical odour testing methods using dilutions and odour panel testing.



The next graph provided by Biorem compares the performance of the biofilter with various inlet odour levels.



High odour is typically associated with headworks in very warm climates with long collection system as well as digestion processes. For the level of this study we assume moderate inlet odours and assume a required bed time of 45 seconds. This provides good reduction of odour while limiting the footprint required for the treatment processes. We assume the use of the inorganic media with a bed depth of 1.8 metres.

The biofilter layout will consist of adjacent repetitive systems in parallel with the air inlet plenum at one end. As a conservative design, we assume the use of a chemical scrubber for both the headworks and the dewatering to handle anticipated high odour concentrations and maintain neutral pH in the biofilter bed.

Pre-Engineered Inorganic Biofilter

Odour control for the various plant areas is discussed below.

6.2.1 Headworks

The total building area is roughly 600 square metres with an assumed 6 metre headspace. This results in a total air volume of 3600 cu.m. The odour control system will be based on treating 6 air changes per hour. When operations staff enter the building, they can double the ventilation rate to 12 air changes per hour. The double volume can be treated within the biofilter for short term duration the staff is in the building to do regular maintenance, complete overhaul as well as typical operational checks.

The highest odours come from the inlet screens. The system will include foul air piping direct to the screen. The screen will include integral covers to limit odour escape. A separate blower has been sized for 100 cu.m/hr. The blower will pull air off the top of the screens. All inlet channels will be covered. Inlet air for the screen and channels will include dampers to proportion air draw and create down draft in high odour areas. The total air volume for the odour control will thus be 22,000 cu.m/hr. As a conservative design approach, the system will include a chemical scrubber in front of the biofilter to strip potential high H2S.

6.2.2 Primary Sedimentation Basins

For the above ground treatment plant options, our design basis assumes the primary clarifiers will be covered. The foul air system will be based on treating the air between the cover and top water elevation with 3 air changes per hour. Our design basis assumes a .5 metre headspace for a total size requirement of 4,800 cum/hr.

For the underground option, the clarifiers would be installed in a building. This would result in the system increasing the treated volume requirement to 115,000 cu.m/hr using 6 air changes per hour. The building ventilation system would include a two speed fan to increase air changes when operators were in the room. The fan capacity would therefore be 230,000 cu.m/hr.

6.2.3 Dewatering and Biosolids

The solids handling process will be roughly the same as the headworks with the same two stage chemical scrubber / biofilter system. Dewatering will be completed using centrifuges. This is an enclosed operation therefore the units emit limited odours. The system will include conveyors to transport the solids to the disposal bin. The conveyors will be covered and will include foul air piping to a dedicated fan to maintain negative pressure throughout the conveying operation. The recovered biosolids will be dropped to a disposal bin. This room will be enclosed and separated from the remainder of the plan. This room would have 12 air changes per hour. In addition, the ventilation system will include dusting to pull air from the top of the disposal bins. The bins must include covers for transport. Once a bin is full, operation staff will close covers before opening the door for removal of the bin.

6.2.4 Primary and DAF Thickeners

The primary and DAF thickeners would be equipped with covers to contain odours. The odours would be collected from the headspace of each tank and directed to a biofilter scrubber. Since the DAF process is an aerobic process, odours are not usually significant from this unit process but occasionally there can be nuisance odours.

6.2.5 Digestion

The digestion process is completely contained. For above ground digestion options, the primary digester will include a floating cover. The cover will rise and fall with the incoming and outgoing flow to limit any venting of the tank. The cover will also seal gas used for the mixing system. The secondary digester will include a floating gas cover that stores digestion gas thus limiting the need for odour control. The ventilation requirements for this area would be more concerned with the safety of the area and would require vented air to pass through a flare stack to burn any gas that may escape. We assume the area would include methane

gas monitoring. The room would be sealed from the rest of the plant and operation staff would enter only upon review of the monitoring equipment plus confirmation of air quality with hand held units. The servicing of this area is minimal and we anticipate weekly inspection.

For below ground options a concrete roof is necessary for the digesters. A gas collection dome would be constructed as part of the concrete cover and appropriate gas extraction piping from the dome would be provided. A similar design has been used successfully in Regina where the anaerobic digesters have been constructed underground.

7.0 Site Layout Options

7.1 Plant Siting Considerations

The siting of a wastewater treatment plant involves the consideration of technical, social, environmental, and economic factors. The social, environmental and economic factors are often referred to as a "triple bottom line" evaluation. The weighting that is placed by a community on various factors is highly dependent on the objectives of the community.

While beyond the scope of this assignment, some considerations which would be part of a future triple bottom line assessment for future site selection are outlined in **Table 7.1**.

Table 7.1
Factors for Consideration in WWTP Siting

Criteria	Considerations
Technical	
• Track Record	Proven technology track record at a similar scale.
• Space Requirements	Must fit on candidate sites.
• Future Expansion	Ideally sites should have adequate space to be useful beyond 2046 planning horizon.
• Meet effluent objectives of MSR	Must meet MSR requirement to treat up to 2 x ADWF. Can technology be upgraded to meet possible more stringent future regulations?
• Constructability	Can the plant be economically constructed at the site under consideration?
• Geotechnical	Are foundation conditions adequate for construction? What type of foundation preparation or dewatering will be necessary?
• Odour	What level of odour control is required for each site?
• Impact on existing operations	What will the impacts be on the existing plant operations during construction? Is there any potential for damage to existing facilities during construction?

Criteria	Considerations
Economic	
• Capital Costs	What is the capital cost for above ground and below ground options? What is the cost premium for underground construction options?
• Operating Costs	What are the operating costs for above and below ground options?
• Life Cycle Costs	What is the appropriate technology or site choice based on life cycle cost evaluation?
Environmental	
• Impact of Construction on Local Environment	What are the impacts arising from the construction process?
• Site Remediation	Can the sites be remediated and at what cost?
• Improved Level of Treatment	What is the net benefit of providing higher level of treatment?
• Greenhouse Gas Emissions	Will the treatment technology produce significant greenhouse gases?
Social	
• Visual / Aesthetics Impacts	How will the new plant look?
• Land Impacts	What impact will the plant construction and operation have on current land use?
• Noise	Are there any noise impacts from ongoing operation that will impact the community?
• Odour	Will odours be mitigated?
• Rate Impacts	What are the user rate impacts from new plant development?
• Disruption during construction	Can construction impacts be mitigated?

The above are just some of the considerations that will require careful assessment and public consultation as the GVS & DD moves forward on the evaluation of alternatives sites for the LGWWTP.

The subsequent sections provide a discussion on specific considerations for the options under evaluation in the report.

7.2 Lions Gate WWTP Above Ground BAF

The 2005 Facility Plan Report identified that expansion of the Lions Gate plant using BAF as a secondary treatment process is a viable option. The major advantage of this option was maximizing the use of the significant capital investment at the current site. Major influent pumping, headworks, primary sedimentation tanks, digesters and dewatering facilities are already in place and much of this infrastructure can be incorporated into the new BAF secondary process.

One of the major disadvantages of this site is the limited space availability for expansion beyond 2046. However, if digestion were moved to another location or if digestion was eliminated from the solids handling train, it is possible that the current site could meet the requirements of a 100 year design horizon.

The 2004 Trow geotechnical assessment of the site indicated that soils would be subject to liquefaction and that some ground densification would be necessary. In addition, deeper below grade structures would require soil anchors to counteract uplift forces. A 15m wide densification berm along the water front to reduce the potential of sloughing during a seismic spreading event was suggested. This berm, if necessary, would further limit the site development area for future works.

7.3 Lions Gate WWTP Below Ground BAF

A below grade option for development of a BAF plant at the existing Lions Gate Site has been considered. One of the significant disadvantages of the below grade construction will be the requirement for shoring and dewatering. The Trow geotechnical assessment indicated the groundwater table fluctuates with tide levels and is normally approximately 2m below grade. Much of the existing plant including the primary sedimentation tanks, and chlorine contact tanks, was constructed partially above grade to avoid dewatering and uplift considerations.

While it is technically feasible that a below ground facility could be constructed, there would be significant costs associated with sheet pile shoring, dewatering and soil anchorage systems. Our initial opinion is that an underground construction option at the existing Lions Gate site should not be considered. All of these systems would have to be constructed adjacent to an existing operational plant and it is possible that there could be impacts such as settlement during the construction period. The 2005 Facility Report has an intermediate pump station proposed in the above ground BAF option to avoid the requirement of deep excavations for the BAF tanks.

As shown on the site drawings, there is little room for development of an underground option as a series of pipe gallery tunnels would be required to access the underground facility. It

would be necessary to reconstruct the primary clarifiers using a high rate process such as a lamella clarifiers, DensaDeg™, or Actiflo™ to reduce the footprint of the facility.

7.4 PEC Site Option

The PEC site is located approximately 0.5 km east of the existing Lions Gate WWTP. It is our understanding the site has been partially remediated from contamination from air borne metals which were deposited from stockpiles along Burrard Inlet. The site is registered as a contaminated site in British Columbia.

The site is bounded by the CNR railway on the north and by Burrard Inlet on the south. Access to the site is via a narrow roadway which runs parallel to the railway. To facilitate permanent access to the site, an overpass would have to be constructed.

The PEC site is suitable for development of above ground and below ground treatment options. However for below ground options it is probable that there will be dewatering and uplift issues which will add significantly to the plant costs.

One of the main advantages of this site is that other than remediation, it would be a relatively greenfield construction project with minimal impact on existing infrastructure in comparison to the Lions Gate site. It also has the advantage of having sufficient site capacity to meet the 100 year design population for the North Shore. The location of the PEC site with respect to Burrard Inlet also make it ideally suited to use a marine loading facility for transport of sludge to offsite sludge digestion or to power generation facilities.

7.5 Vancouver Wharves Site

The inner oval area of the Vancouver Wharves site has sufficient area to accommodate underground and above ground treatment plant options.

There is sufficient space on the existing site to accommodate the 100 year design population.

One of the major considerations of the below ground option is that, with proper design, a large container storage area is preserved. This option results in significant additional cost for underground construction. The fact that this site is also a working storage and loading terminal will also require careful coordination during the construction period.

This site would also be suited to use as a marine loading facilities for sludge transport to another location for treatment. We understand that the existing site is contaminated and will require remediation. For the purposes of cost assessment we have assumed that all soils removed during excavation would require remediation.

7.6 BC Rail Passenger Lands Site

The BC Rail Passenger Lands site has sufficient area to meet the 2046 design horizon. The configuration of the site (long and narrow) is not optimal for a treatment plant site, but if higher rate or larger individual digesters are provided or sludge digestion were provided at another location, this site could provide the 100 year design capacity. Ideally this site would be suited to the use of high rate primary clarification to reduce the overall plant footprint. In its current preliminary conceptual design configuration, sludge digestion facilities occupy approximately 25% of the available site area, so it would be desirable to relocate these facilities to another location if the GVS & DD would like to consider this site for expansion beyond the 2046 design horizon.

The existing site is located within 0.5 km of the Vancouver Wharves site.

7.7 Klahanie Park Site

The Klahanie Park site is situated in North Vancouver adjacent to the Capilano River. The Park is currently set up for soccer and baseball. A site plan has been developed for an underground plant which would be situated in the available space. A service tunnel would be constructed around the perimeter of the plant to enable access to the various plant areas. Loading of dewatered sludge would be completed below ground. One of the major disadvantages of this site is its proximity to residential development and limited available space for long term development beyond 2046. The site also requires increased pumping because it is located approximately 10 metres higher than the existing LGWWTP.

Access to the site could be gained by existing roadways or a new roadway which could bypass existing residential areas.

The plant location will require a high degree of odour control but this is technically viable.

Geotechnical conditions at this site are unknown but the location adjacent to the Capilano River could require dewatering for deep excavations that will be associated with underground construction. It is also possible that rock could be encountered in this area. If rock is encountered, it would have to be removed by controlled blasting and excavation.

8.0 Opinion of Probable Cost

8.1 Review of Construction Cost Escalation Factors in the Vancouver Market

The Vancouver construction market has seen significant cost escalation since the preparation of the 2005 Facility Plan Report. Statistics Canada reported a May 2007 cost index of 150.8 for the Vancouver area up from 120.2 in 2004 (mid August) or a 25.5% increase. The BTY Group Quantity Surveyors reported an increase of 7 – 8% for 2006. The BTY Group predicted a 41% increase in construction costs over the same period from 2004 to 2007.

A number of factors are impacting construction costs in the Lower Mainland including:

- Shortage of skilled labour.
- Increase in construction material prices.
- Competition for contractors as a result of the 2010 Olympics and other major provincial infrastructure projects.
- Significant activity in the construction industry.
- Contractors being risk adverse.
- Increased business costs related to fuel price increases.
- Brisk activity in Alberta where construction industry is more lucrative.

The 2007 construction market has been very active with all contractors reporting brisk activity. On several projects we have found that there is limited contracting capacity available with fewer general contractors willing to undertake high risk projects such as would be the case for the underground plant construction options for Lions Gate WWTP.

Based on our experience in the Lower Mainland and industry related experience, we estimate costs for construction of infrastructure facilities such as wastewater treatment plants have risen by approximately 30 - 35% since 2004 when previous estimates were prepared for the Facility Planning Report.

8.2 Basis of Cost Estimate

The cost estimates prepared as part of this report have been based on conceptual design work completed by a senior team of specialists over a 5 week period to meet GVS & DD

scheduling requirements. Geotechnical information was available for only the existing Lions Gate site, and it is probable that significant geotechnical issues could be encountered at all sites.

To enable preparation of estimates, preliminary sizing was completed on major process and structural elements. Quotations for major equipment were solicited for most items and cost information from our files was used to supplement this information.

Given the preliminary nature of this work, a significant contingency has been applied to all costs. The accuracy of these estimates is considered to be ± 50%.

8.3 Update of 2005 Lions Gate Facility Plan Estimate

The estimate in 2003 November dollars for the Lions Gate WWTP was estimated at $107,959,000 for build out to the 2046 design flow and load. The operation and maintenance costs were estimated at $4,094,000. Applying appropriate escalation factors of 35%, this would translate to a cost of $145,745,000 in 2007 dollars.

However for the purpose of costing in this report for the Lions Gate above grade option we have assumed the following additional work:

- Installation of higher level of odour control. ($6,380,000 including E & C)
- Reconstruction of the primary clarifiers to high rate primary clarifiers because they do not meet current MCE seismic design criteria. ($15,608,525 including E & C)
- Additional digestion capacity following completion of solid mass balances. ($7,250,000 including E & C)
- Construction of a new headworks and influent pumping station. ($26,897,500 including E & C)
- Inclusion of 15% owner indirect costs ($27,761,400)

When the above additional items are included, the 2007 cost to construct an above grade BAF plant to meet the 2046 design case is **$240,598,600** excluding land costs. In comparison to the scope of work envisaged in the 2005 Facility Plan, the costs are similar with the exception of inflation. At pre-design it may be possible to lower costs by upgrading the influent pumping station and undertaking a seismic retrofit of the existing primary clarifiers.

8.4 Cost Estimates for Plant Options

Cost estimates for a total of 9 options have been prepared and are included in the attached spreadsheets **Table 8.2**. For the BC Rail Passenger Lands site we have also costed an option without on site sludge digestion facilities for comparison purposes. The costs include 30% contingency, 15% engineering and 15% owner indirect costs. G.S.T. of 6% is also included in the equipment costs. The costs for land are based on information provided by the GVS & DD. The costs are summarized as follows:

Table 8.1
Treatment Plant Costs

Plant Site / Option	Cost
Lions Gate Above Ground	$ 254,111,900
Lions Gate Below Ground	$ 443,283,600
PEC Site Above Ground	$ 318,458,520
PEC Site Below Ground	$ 483,882,520
Vancouver Wharves Above Ground	$ 321,560,520
Vancouver Wharves Below Ground	$ 533,186,620
BC Rail Passenger Lands Above Ground with Digestion	$ 335,185,000
BC Rail Passenger Lands Above Ground without Digestion	$ 277,972,200
Klahanie Park Below Ground	$ 464,180,420

The Lions Gate above ground option is the most cost effective because it make use of the existing infrastructure developed at the site. The below ground options are the most expensive because of the requirement for dewatering and shoring, soil uplift anchorage, and additional works for tunnels. The above ground options at PEC, Vancouver Wharves and BC Rail Passenger Lands have similar costs.

8.5 Impact of High Rate Primary on Costs

High rate primary clarifiers will occupy an area at least 60% smaller than conventional primary sedimentation tanks. The cost for the Actiflo system would be about $5 million which is significant. There would however be substantial savings in concrete cost and in particular

primary sedimentation basins. This would result in a cost saving of approximately $ 3.0 million for underground options.

8.6 Operating Costs

Annual operating costs have been prepared and included in **Table 8.3.**

8.7 Land Costs

Land costs are included in **Table 8.4**. Some options would only have a lease option available. These annual lease costs when considered over a project life cycle may make some options unviable.

TABLE 8.2
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Summary of Probable Costs

Date: September, 2007

Item No.	Description	Option 1 Lions Gate Above Ground with High Rate Primary Clarifiers (Base Case)	Option 2 Lions Gate Below Ground with High Rate Primary Clarifiers	Option 3 PEC Site Above Ground	Option 4 PEC Site Below Ground	Option 5 Vancouver Wharf Above Ground	Option 6 Vancouver Wharf Below Ground	Option 7 Costco Site Above Ground with High Rate Primary Clarifiers	Option 8 Costco Site Above Ground with High Rate Primary Clarifiers without Digestion	Option 9 Klahanie Park Site Below Ground
1.0	**General Requirements**	**$13,669,300**	**$23,845,300**	**$17,130,600**	**$26,029,200**	**$17,297,500**	**$28,681,400**	**$18,030,400**	**$14,952,800**	**$24,969,400**
2.0	**Siteworks:**									
2.1	Demolition/Site Cleaning	$1,500,000	$1,500,000	$100,000	$100,000	$200,000	$200,000	$200,000	$200,000	$100,000
2.2	Civil Works:									
	- Excavation	$244,000	$3,655,000	$782,000	$3,874,000	$627,000	$3,874,000	$500,000	$420,000	$4,178,000
	- Backfill	$11,900	$348,000	$535,000	$2,301,000	$380,000	$2,301,000	$254,000	$216,000	$2,695,000
	- Roads and Sidewalks	$750,000	$22,744,500	$1,000,000	$8,700,000	$1,000,000	$18,450,000	$750,000	$750,000	$22,575,000
	- Yard Piping Allowance	$4,000,000	$4,000,000	$3,500,000	$3,000,000	$3,500,000	$3,000,000	$3,500,000	$3,200,000	$3,000,000
	- 1800 mm dia. Forcemain to new site	$0	$0	$1,820,000	$1,820,000	$5,040,000	$5,040,000	$6,160,000	$6,160,000	$3,920,000
	- 1800 mm dia. Forcemain from new site to exist outfall	$0	$0	$1,820,000	$1,820,000	$5,040,000	$5,040,000	$6,160,000	$6,160,000	$3,920,000
	- Soil Anchors	$0	$23,425,500	$0	$24,150,000	$0	$31,050,000	$0	$0	$32,085,000
	- Soil Densification	$8,595,000	$7,770,000	$14,700,000	$14,700,000	$14,700,000	$14,700,000	$18,750,000	$15,975,000	$0
	- Fencing Allowance	$100,000	$15,000	$90,000	$15,000	$80,000	$15,000	$95,000	$90,000	$15,000
	- Contaminated Soil Removal	$0	$0	$7,663,600	$9,491,300	$6,144,600	$9,491,300	$500,000	$500,000	$0
	- Contaminated Groundwater Treatment	$0	$0	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$1,000,000	$1,000,000	$0
	- Underground Tunnels	$0	$11,032,500	$0	$19,500,000	$0	$24,180,000	$0	$0	$22,950,000
	- Shoring	$6,800,000	$14,800,000	$3,920,000	$8,760,000	$3,840,000	$8,760,000	$4,160,000	$3,840,000	$9,624,000
	- Slab for container storage on balance of site	$0	$0	$0	$6,604,500	$0	$6,604,500	$0	$0	$0
2.3	Railway Overpass	$0	$0	$4,774,000	$4,774,000	$1,714,000	$1,714,000	$0	$0	$0
2.4	Landscaping Allowance	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$1,000,000
2.5	Dewatering Allowance	$500,000	$5,000,000	$500,000	$5,000,000	$500,000	$5,000,000	$500,000	$500,000	$5,000,000
	Subtotal Siteworks	**$23,000,900**	**$94,790,500**	**$44,704,600**	**$118,109,800**	**$46,265,600**	**$142,919,800**	**$43,029,000**	**$39,511,000**	**$111,062,000**
3.0	**Headworks and Influent Pump Station:**									
3.1	Substructure Concrete	$240,000	$315,000	$240,000	$387,000	$240,000	$387,000	$240,000	$240,000	$315,000
3.2	Superstructure	$1,200,000	$1,548,000	$1,200,000	$1,548,000	$1,200,000	$1,548,000	$1,200,000	$1,200,000	$1,548,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	$6,675,000	$6,675,000	$6,675,000	$6,675,000	$6,675,000	$6,675,000	$6,675,000	$6,675,000	$6,675,000
3.4	Influent Pumping Equipment	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000
3.5	Coarse Screens	$792,000	$792,000	$792,000	$792,000	$792,000	$792,000	$792,000	$792,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	$1,404,000	$1,404,000	$1,404,000	$1,404,000	$1,404,000	$1,404,000	$1,404,000	$1,404,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	$1,377,000	$1,377,000	$1,377,000	$1,377,000	$1,377,000	$1,377,000	$1,377,000	$1,377,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	$144,000	$144,000	$144,000	$144,000	$144,000	$144,000	$144,000	$144,000	$144,000
3.10	Slide Gates	$360,000	$360,000	$360,000	$360,000	$360,000	$360,000	$360,000	$360,000	$360,000
3.11	Piping and Valving	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000
3.12	Cranes	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
3.13	Odour Control System Allowance	$1,500,000	$1,800,000	$1,500,000	$1,800,000	$1,500,000	$1,800,000	$1,500,000	$1,500,000	$1,800,000
	Subtotal Headworks and Influent Pump Station	**$18,550,000**	**$19,273,000**	**$18,550,000**	**$19,345,000**	**$18,550,000**	**$19,345,000**	**$18,550,000**	**$18,550,000**	**$19,273,000**
	.									
4.0	**Primary Clarifiers:**									
4.1	Substructure Concrete	$580,500	$616,500	$2,320,500	$2,554,500	$2,320,500	$2,554,500	$580,500	$580,500	$2,463,000
4.2	Superstructure	$349,500	$1,057,500	$1,398,000	$5,961,000	$1,398,000	$5,961,000	$349,500	$349,500	$4,228,500
4.3	High Rate or Regular Primary Clarifier Mechanisms	$6,900,000	$6,900,000	$1,684,800	$1,684,800	$1,684,800	$1,684,800	$6,900,000	$6,900,000	$1,684,800
4.4	Chemical Feed Systems, Eductor, Primary Sludge Pumps	$1,000,000	$1,000,000	$180,000	$180,000	$180,000	$180,000	$1,000,000	$1,000,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	$48,000	$48,000	$280,000	$280,000	$280,000	$280,000	$48,000	$48,000	$280,000
4.6	Primary Clarifier Covers for Odour Control	$279,000	$279,000	$1,696,320	$1,696,320	$1,696,320	$1,696,320	$279,000	$279,000	$1,696,320
4.7	Scum Pumps	$200,000	$200,000	$90,000	$90,000	$90,000	$90,000	$200,000	$200,000	$90,000
4.8	Piping and Valving	$300,000	$300,000	$400,000	$400,000	$400,000	$400,000	$300,000	$300,000	$400,000
4.9	Slide Gates	$108,000	$108,000	$216,000	$216,000	$216,000	$216,000	$108,000	$108,000	$216,000
4.10	Odour Control System Allowance	$1,000,000	$1,200,000	$1,500,000	$1,800,000	$1,500,000	$1,800,000	$1,000,000	$1,000,000	$1,800,000
	Subtotal Primary Clarifiers	**$10,765,000**	**$11,709,000**	**$9,765,620**	**$14,862,620**	**$9,765,620**	**$14,862,620**	**$10,765,000**	**$10,765,000**	**$13,038,620**

Item No.	Description	Option 1 Lions Gate Above Ground with High Rate Primary Clarifiers (Base Case)	Option 2 Lions Gate Below Ground with High Rate Primary Clarifiers	Option 3 PEC Site Above Ground	Option 4 PEC Site Below Ground	Option 5 Vancouver Wharf Above Ground	Option 6 Vancouver Wharf Below Ground	Option 7 Costco Site Above Ground with High Rate Primary Clarifiers	Option 8 Costco Site Above Ground with High Rate Primary Clarifiers without Digestion	Option 9 Klahanie Park Site Below Ground
5.0	**Biological Aerated Filters**									
5.1	Substructure Concrete	$2,001,000	$3,316,500	$2,001,000	$3,316,500	$2,001,000	$3,316,500	$2,001,000	$2,001,000	$3,316,500
5.2	Superstructure	$2,826,000	$7,737,000	$2,826,000	$7,737,000	$2,826,000	$7,737,000	$2,826,000	$2,826,000	$7,737,000
5.3	Backwash Storage Tank / Waste Storage Tank	$1,179,000	$2,356,500	$1,179,000	$2,356,500	$1,179,000	$2,356,500	$1,179,000	$1,179,000	$1,893,000
5.4	BAF Equipment Package	$8,560,000	$8,560,000	$8,560,000	$8,560,000	$8,560,000	$8,560,000	$8,560,000	$8,560,000	$8,560,000
5.5	BAF Covers for Odour Control	$1,041,600	$1,041,600	$1,041,600	$1,041,600	$1,041,600	$1,041,600	$1,041,600	$1,041,600	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000
5.7	Piping and Valving	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000
5.8	Slide Gates	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000
5.9	Miscellaneous Metals, Handrails	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
5.10	Odour Control System Allowance	$400,000	$600,000	$400,000	$600,000	$400,000	$600,000	$400,000	$400,000	$600,000
	Subtotal BAF	**$18,507,600**	**$26,111,600**	**$18,507,600**	**$26,111,600**	**$18,507,600**	**$26,111,600**	**$18,507,600**	**$18,507,600**	**$25,648,100**
6.0	**UV Disinfection and Effluent Pump Station:**									
6.1	Substructure Concrete	$904,500	$736,500	$904,500	$904,500	$904,500	$904,500	$904,500	$904,500	$736,500
6.2	Superstructure	$2,806,000	$3,619,700	$2,806,000	$3,619,700	$2,806,000	$3,619,700	$2,806,000	$2,806,000	$3,619,700
6.3	UV Equipment	$3,144,900	$3,144,900	$3,144,900	$3,144,900	$3,144,900	$3,144,900	$3,144,900	$3,144,900	$3,144,900
6.4	Effluent Pump Station Substructure	$0	$6,675,000	$892,500	$892,500	$892,500	$892,500	$892,500	$892,500	$595,500
6.5	Effluent Pumps	$0	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000	$2,178,000
6.6	Effluent Pump Process Piping	$0	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	$20,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
6.8	Slide Gates	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000
6.9	Cranes	$12,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
	Subtotal UV Disinfection and Effluent Pump Station	**$6,977,400**	**$18,094,100**	**$11,665,900**	**$12,479,600**	**$11,665,900**	**$12,479,600**	**$11,665,900**	**$11,665,900**	**$12,014,600**
7.0	**Solids Handling (Sludge Thickening/Dewatering, Digestion)**									
7.1	Substructure									
	- Primary Sludge Thickeners	$318,000	$750,000	$477,000	$220,500	$477,000	$220,500	$477,000	$477,000	$189,000
	- Digesters	$1,740,000	$2,493,000	$2,916,000	$2,916,000	$2,916,000	$2,916,000	$5,928,000	$0	$2,493,000
	- Dewatering	$280,500	$369,000	$280,500	$453,000	$280,500	$453,000	$280,500	$280,500	$369,000
	- Dissolved Air Flotation Thickeners	$1,485,000	$588,000	$1,485,000	$684,000	$1,485,000	$684,000	$1,485,000	$1,485,000	$588,000
7.2	Superstructure									
	- Primary Sludge Thickeners	$159,000	$600,000	$238,500	$220,500	$238,500	$220,500	$238,500	$238,500	$855,000
	- Digesters	$4,602,000	$2,493,000	$6,903,000	$2,916,000	$6,903,000	$2,916,000	$10,284,000	$0	$2,493,000
	- Dewatering	$1,125,000	$1,476,000	$1,125,000	$453,000	$1,125,000	$453,000	$1,125,000	$1,125,000	$1,476,000
	- Dissolved Air Flotation Thickeners	$750,000	$2,655,000	$750,000	$3,060,000	$750,000	$3,060,000	$750,000	$750,000	$2,655,000
7.3	Primary Sludge Thickener Mechanisms, Covers for Above-Ground	$342,000	$432,000	$513,000	$432,000	$513,000	$432,000	$513,000	$513,000	$432,000
7.4	Digester Mixing Systems, Covers for Above-Ground	$6,000,000	$7,200,000	$9,000,000	$7,200,000	$9,000,000	$7,200,000	$11,700,000	$0	$7,200,000
7.5	Thickened Sludge Transfer Pumps	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$300,000	$120,000
7.6	Centrifuge Feed Pumps	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$300,000	$120,000
7.7	Centrifuges	$3,240,000	$3,240,000	$3,240,000	$3,240,000	$3,240,000	$3,240,000	$3,240,000	$8,400,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms	$1,047,000	$900,000	$1,047,000	$900,000	$1,047,000	$900,000	$1,047,000	$1,047,000	$900,000
7.9	Dewatered Cake Conveyance System	$770,400	$770,400	$770,400	$770,400	$770,400	$770,400	$770,400	$1,540,800	$770,400
7.10	Cogeneration System	$3,900,000	$3,900,000	$3,900,000	$3,900,000	$3,900,000	$3,900,000	$3,900,000	$0	$3,900,000
7.11	Piping and Valving	$900,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
7.12	Polymer Storage and Feed Systems	$450,000	$450,000	$450,000	$450,000	$450,000	$450,000	$450,000	$600,000	$450,000
7.13	Cranes	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000
7.14	Odour Control System Allowance	$1,500,000	$1,800,000	$1,500,000	$1,800,000	$1,500,000	$1,800,000	$1,500,000	$1,600,000	$1,800,000
	Subtotal Solids Handling	**$28,928,900**	**$31,436,400**	**$35,915,400**	**$30,935,400**	**$35,915,400**	**$30,935,400**	**$45,008,400**	**$19,736,800**	**$31,130,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**									
8.1	62kV - 25kV Substation	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	$2,250,000	$2,250,000	$2,250,000	$2,250,000	$2,250,000	$2,250,000	$2,250,000	$2,250,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000
8.4	Power Distribution and Motor Control Centres	$3,420,000	$3,420,000	$3,420,000	$3,420,000	$3,420,000	$3,420,000	$3,420,000	$3,420,000	$3,420,000
8.5	Process Control Panels	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000
8.6	Process Control Instrumentation	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000
	Subtotal EIC	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**	**$17,770,000**

Item No.	Description	Option 1 Lions Gate Above Ground with High Rate Primary Clarifiers (Base Case)	Option 2 Lions Gate Below Ground with High Rate Primary Clarifiers	Option 3 PEC Site Above Ground	Option 4 PEC Site Below Ground	Option 5 Vancouver Wharf Above Ground	Option 6 Vancouver Wharf Below Ground	Option 7 Costco Site Above Ground with High Rate Primary Clarifiers	Option 8 Costco Site Above Ground with High Rate Primary Clarifiers without Digestion	Option 9 Klahanie Park Site Below Ground
9.0	**Operations Building**									
9.1	Substructure	$240,000	$387,000	$240,000	$387,000	$240,000	$387,000	$240,000	$240,000	$150,000
9.2	Superstructure	$2,880,000	$3,240,000	$2,880,000	$3,240,000	$2,880,000	$3,240,000	$2,880,000	$2,880,000	$3,240,000
9.3	Furniture and Lab Equipment	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000
	Subtotal Operations Building	**$3,370,000**	**$3,877,000**	**$3,370,000**	**$3,877,000**	**$3,370,000**	**$3,877,000**	**$3,370,000**	**$3,370,000**	**$3,640,000**
10.0	**Heating and Ventilation**									
10.1	Heating and Ventilation Above Ground Structures	$3,836,100	$6,691,800	$4,807,500	$7,304,700	$4,854,300	$8,049,000	$5,060,000	$4,196,300	$7,007,300
10.2	Heating and Ventilation Below Ground Structures	$4,986,900	$8,699,300	$6,249,800	$9,496,100	$6,310,600	$10,463,700	$6,578,000	$5,455,200	$9,109,500
	Subtotal HVAC	**$8,823,000**	**$15,391,100**	**$11,057,300**	**$16,800,800**	**$11,164,900**	**$18,512,700**	**$11,638,000**	**$9,651,500**	**$16,116,800**
	Subtotal Capital Costs	**$150,362,100**	**$262,298,000**	**$188,437,020**	**$286,321,020**	**$190,272,520**	**$315,495,120**	**$198,334,300**	**$164,480,600**	**$274,662,920**
	Contingencies (30 % of Capital Subtotal)	$45,108,600	$78,689,400	$56,531,100	$85,896,300	$57,081,800	$94,648,500	$59,500,300	$49,344,200	$82,398,900
	Engineering (15% of Subtotal & Contingencies)	$29,320,600	$51,148,100	$36,745,200	$55,832,600	$37,103,100	$61,521,500	$38,675,200	$32,073,700	$53,559,300
	Owner Direct and Indirect Costs (15% of Subtotal and Contg)	$29,320,600	$51,148,100	$36,745,200	$55,832,600	$37,103,100	$61,521,500	$38,675,200	$32,073,700	$53,559,300
	Total Capital Costs	**$254,111,900**	**$443,283,600**	**$318,458,520**	**$483,882,520**	**$321,560,520**	**$533,186,620**	**$335,185,000**	**$277,972,200**	**$464,180,420**

Notes:

1. Costs are in 2007 Canadian Dollars. GST is not included.
2. Construction costs will vary depending on market conditions at the time of tender. Stantec has no control over those conditions.
3. Primary service is assumed to be at 62kV from BC Hydro Substation
4. 62kV transformers are 2 x 16/20MVA for 100% redundancy at phase 1
5. BC Hydro charges are not included
6. 25kV Transformers are 4 x 4MVA for phase 1 construction
7. Standby Power Generators are 3 x 2000kW units for phase 1 construction

TABLE 8.2.1
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 1 - Lions Gate Above Ground Base Case **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$13,669,300**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
2.2	Civil Works:						
	- Excavation	m^3	24,400	$10	$244,000	Included	$244,000
	- Backfill	m^3	1,190	$10	$11,900	Included	$11,900
	- Roads and Sidewalks	LS	1	$750,000	$750,000	Included	$750,000
	- Yard Piping Allowance	LS	1	$4,000,000	$4,000,000	Included	$4,000,000
	- 1800 mm dia. Forcemain to new site	m	0	$0	$0	Included	$0
	- 1800 mm dia. Forcemain from new site to exist outfall	m	0	$0	$0	Included	$0
	- Soil Anchors	each	0	$0	$0	Included	$0
	- Soil Densification	m^2	11,460	$750	$8,595,000	Included	$8,595,000
	- Fencing Allowance	LS	1	$100,000	$100,000	Included	$100,000
	- Contaminated Soil Removal	m^3	0	$0	$0	Included	$0
	- Contaminated Groundwater Treatment	LS	1	$0	$0	Included	$0
	- Underground Tunnels	m^3	0	$0	$0	Included	$0
	- Shoring	m^2	6,800	$1,000	$6,800,000	Included	$6,800,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	0	$0	$0	Included	$0
	- Approaches	m^3	0	$0	$0	Included	$0
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$500,000	$500,000	Included	$500,000
	Subtotal Siteworks						**$23,000,900**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	160	$1,500	$240,000	Included	$240,000
3.2	Superstructure	m^2	600	$2,000	$1,200,000	Included	$1,200,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Headworks and Influent Pump Station						**$18,550,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	387	$1,500	$580,500	Included	$580,500
4.2	Superstructure	m^3	233	$1,500	$349,500	Included	$349,500
4.3	High Rate Primary Clarifier Mechanism	each	4	$1,150,000	$4,600,000	$2,300,000	$6,900,000
4.4	Chemical Feed Systems, Sludge Pumps, and Sand Eductor	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$48,000	$48,000	Included	$48,000
4.6	Primary Clarifier Covers for Odour Control	m^2	450	$620	$279,000	Included	$279,000
4.7	Scum Skimmers and Pumps	LS	1	$200,000	$200,000	Included	$200,000
4.8	Piping and Valving	LS	1	$300,000	$300,000	Included	$300,000
4.9	Slide Gates	each	6	$12,000	$72,000	$36,000	$108,000
4.10	Odour Control System Allowance	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	Subtotal Primary Clarifiers						**$10,765,000**
5.0	**Biological Aerated Filters:**						
5.1	Substructure Concrete	m^3	1,334	$1,500	$2,001,000	Included	$2,001,000
5.2	Superstructure	m^3	1,884	$1,500	$2,826,000	Included	$2,826,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	786	$1,500	$1,179,000	Included	$1,179,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$400,000	$400,000	Included	$400,000
	Subtotal BAF						**$18,507,600**
6.0	**UV Disinfection:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,000	$2,806,000	Included	$2,806,000
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	603	$0	$0	Included	$0
6.5	Effluent Pumps	each	0	$0	$0	$0	$0
6.6	Eflluent Pump Process Piping	LS	1	$0	$0	Included	$0
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$20,000	$20,000	Included	$20,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$12,000	$12,000	Included	$12,000
	Subtotal UV Disinfection						**$6,977,400**

TABLE 8.2.1
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 1 - Lions Gate Above Ground Base Case **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering):**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	212	$1,500	$318,000	Included	$318,000
	- Digesters	m^3	1,160	$1,500	$1,740,000	Included	$1,740,000
	- Dewatering	m^3	187	$1,500	$280,500	Included	$280,500
	- Dissolved Air Flotation Thickeners	m^3	990	$1,500	$1,485,000	Included	$1,485,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	106	$1,500	$159,000	Included	$159,000
	- Digesters	m^3	3,068	$1,500	$4,602,000	Included	$4,602,000
	- Dewatering	m^3	750	$1,500	$1,125,000	Included	$1,125,000
	- Dissolved Air Flotation Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
7.3	Primary Sludge Thickener Mechanisms and Covers	each	2	$114,000	$228,000	$114,000	$342,000
7.4	Digester Mixing System and Covers (22 m Dia.)	each	4	$1,000,000	$4,000,000	$2,000,000	$6,000,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms and Covers	each	2	$349,000	$698,000	$349,000	$1,047,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$900,000	$900,000	Included	$900,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Solids Handling						**$28,928,900**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centres	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	160	$1,500	$240,000	Included	$240,000
9.2	Superstructure	m^2	600	$4,800	$2,880,000	Included	$2,880,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,370,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$3,836,100	$3,836,100	Included	$3,836,100
10.2	Heating and Ventilation Below Ground Structures	LS	1	$4,986,900	$4,986,900	Included	$4,986,900
	Subtotal HVAC						**$8,823,000**
	Subtotal Capital Costs						**$150,362,100**
	Contingencies (30 % of Capital Subtotal)						**$45,108,600**
	Engineering (15% of Subtotal & Contingencies)						**$29,320,600**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$29,320,600**
	Total Capital Costs - Option 1						**$254,111,900**

Notes:
1. Re-use two existing digsters.
2. Re-use one existing sludge thickener.

TABLE 8.2.2
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 2 - Lions Gate Below Ground

Date: September, 2007

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$23,845,300**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
2.2	Civil Works:						
	- Excavation	m^3	365,500	$10	$3,655,000	Included	$3,655,000
	- Backfill	m^3	34,800	$10	$348,000	Included	$348,000
	- Roads and Sidewalks (Concrete)	m^3	15,163	$1,500	$22,744,500	Included	$22,744,500
	- Yard Piping Allowance	LS	1	$4,000,000	$4,000,000	Included	$4,000,000
	- 1800 mm dia. Forcemain to new site	m	0	$0	$0	Included	$0
	- 1800 mm dia. Forcemain from new site to exist outfall	m	0	$0	$0	Included	$0
	- Soil Anchors	each	3,395	$6,900	$23,425,500	Included	$23,425,500
	- Soil Densification	m^2	10,360	$750	$7,770,000	Included	$7,770,000
	- Fencing Allowance	LS	1	$15,000	$15,000	Included	$15,000
	- Contaminated Soil Removal	m^3	0	$0	$0	Included	$0
	- Contaminated Groundwater Treatment	LS	1	$0	$0	Included	$0
	- Underground Tunnels	m^3	7,355	$1,500	$11,032,500	Included	$11,032,500
	- Shoring	m^2	14,800	$1,000	$14,800,000	Included	$14,800,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	0	$0	$0	Included	$0
	- Approaches	m^3	0	$0	$0	Included	$0
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$5,000,000	$5,000,000	Included	$5,000,000
	Subtotal Siteworks						**$94,790,500**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	210	$1,500	$315,000	Included	$315,000
3.2	Superstructure	m^2	600	$2,580	$1,548,000	Included	$1,548,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Headworks and Influent Pump Station						**$19,273,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	411	$1,500	$616,500	Included	$616,500
4.2	Superstructure	m^3	705	$1,500	$1,057,500	Included	$1,057,500
4.3	High Rate Primary Clarifier Mechanism	each	4	$1,150,000	$4,600,000	$2,300,000	$6,900,000
4.4	Chemical Feed Systems, Sludge Pumps, and Sand Eductor	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$48,000	$48,000	Included	$48,000
4.6	Primary Clarifier Covers for Odour Control	m^2	450	$620	$279,000	Included	$279,000
4.7	Scum Skimmers and Pumps	LS	1	$200,000	$200,000	Included	$200,000
4.8	Piping and Valving	LS	1	$300,000	$300,000	Included	$300,000
4.9	Slide Gates	each	6	$12,000	$72,000	$36,000	$108,000
4.10	Odour Control System Allowance	LS	1	$1,200,000	$1,200,000	Included	$1,200,000
	Subtotal Primary Clarifiers						**$11,709,000**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	2,211	$1,500	$3,316,500	Included	$3,316,500
5.2	Superstructure	m^3	5,158	$1,500	$7,737,000	Included	$7,737,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	1,571	$1,500	$2,356,500	Included	$2,356,500
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$600,000	$600,000	Included	$600,000
	Subtotal BAF						**$26,111,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	491	$1,500	$736,500	Included	$736,500
6.2	Superstructure	m^2	1,403	$2,580	$3,619,700	Included	$3,619,700
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$18,094,100**

TABLE 8.2.2
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 2 - Lions Gate Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
	- Digesters	m^3	1,662	$1,500	$2,493,000	Included	$2,493,000
	- Dewatering	m^3	246	$1,500	$369,000	Included	$369,000
	- Dissolved Air Flotation Thickeners	m^3	392	$1,500	$588,000	Included	$588,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	400	$1,500	$600,000	Included	$600,000
	- Digesters	m^3	1,662	$1,500	$2,493,000	Included	$2,493,000
	- Dewatering	m^3	984	$1,500	$1,476,000	Included	$1,476,000
	- Dissolved Air Flotation Thickeners	m^3	1,770	$1,500	$2,655,000	Included	$2,655,000
7.3	Primary Sludge Thickener Mechanisms	each	3	$96,000	$288,000	$144,000	$432,000
7.4	Digester Mixing System	each	6	$800,000	$4,800,000	$2,400,000	$7,200,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms	each	2	$300,000	$600,000	$300,000	$900,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Solids Handling						**$31,436,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	258	$1,500	$387,000	Included	$387,000
9.2	Superstructure	m^2	600	$5,400	$3,240,000	Included	$3,240,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,877,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$6,691,800	$6,691,800	Included	$6,691,800
10.2	Heating and Ventilation Below Ground Structures	LS	1	$8,699,300	$8,699,300	Included	$8,699,300
	Subtotal HVAC						**$15,391,100**
	Subtotal Capital Costs						**$262,298,000**
	Contingencies (30 % of Capital Subtotal)						**$78,689,400**
	Engineering (15% of Subtotal & Contingencies)						**$51,148,100**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$51,148,100**
	Total Capital Costs - Option 2						**$443,283,600**

TABLE 8.2.3
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 3 - PEC Site Above Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$17,130,600**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$100,000	$100,000	Included	$100,000
2.2	Civil Works:						
	- Excavation	m^3	78,200	$10	$782,000	Included	$782,000
	- Backfill	m^3	53,500	$10	$535,000	Included	$535,000
	- Roads and Sidewalks	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	- Yard Piping Allowance	LS	1	$3,500,000	$3,500,000	Included	$3,500,000
	- 1800 mm dia. Forcemain to new site	m	650	$2,800	$1,820,000	Included	$1,820,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	650	$2,800	$1,820,000	Included	$1,820,000
	- Soil Anchors	each	0	$0	$0	Included	$0
	- Soil Densification	m^2	19,600	$750	$14,700,000	Included	$14,700,000
	- Fencing Allowance	LS	1	$90,000	$90,000	Included	$90,000
	- Contaminated Soil Removal	m^3	31,280	$245	$7,663,600	Included	$7,663,600
	- Contaminated Groundwater Treatment	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- Underground Tunnels	m^3	0	$0	$0	Included	$0
	- Shoring	m^2	4,900	$800	$3,920,000	Included	$3,920,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	2,220	$2,000	$4,440,000	Included	$4,440,000
	- Approaches	m^3	8,350	$40	$334,000	Included	$334,000
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$500,000	$500,000	Included	$500,000
	Subtotal Siteworks						**$44,704,600**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	160	$1,500	$240,000	Included	$240,000
3.2	Superstructure	m^2	600	$2,000	$1,200,000	Included	$1,200,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Headworks and Influent Pump Station						**$18,550,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	1,547	$1,500	$2,320,500	Included	$2,320,500
4.2	Superstructure Concrete	m^3	932	$1,500	$1,398,000	Included	$1,398,000
4.3	Primary Clarifier Drive Mechanisms c/w Skimmers	each	8	$140,400	$1,123,200	$561,600	$1,684,800
4.4	Primary Sludge Pumps	each	6	$20,000	$120,000	$60,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$280,000	$280,000	Included	$280,000
4.6	Primary Clarifier Covers for Odour Control	m^2	2,736	$620	$1,696,320	Included	$1,696,320
4.7	Scum Pumps	each	4	$15,000	$60,000	$30,000	$90,000
4.8	Piping and Valving	LS	1	$400,000	$400,000	Included	$400,000
4.9	Slide Gates	each	12	$12,000	$144,000	$72,000	$216,000
4.10	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Primary Clarifiers						**$9,765,620**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	1,334	$1,500	$2,001,000	Included	$2,001,000
5.2	Superstructure Concrete	m^3	1,884	$1,500	$2,826,000	Included	$2,826,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	786	$1,500	$1,179,000	Included	$1,179,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$400,000	$400,000	Included	$400,000
	Subtotal BAF						**$18,507,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,000	$2,806,000	Included	$2,806,000
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Concrete	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$11,665,900**

TABLE 8.2.3
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 3 - PEC Site Above Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	318	$1,500	$477,000	Included	$477,000
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	187	$1,500	$280,500	Included	$280,500
	- Dissolved Air Flotation Thickeners	m^3	990	$1,500	$1,485,000	Included	$1,485,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	159	$1,500	$238,500	Included	$238,500
	- Digesters	m^3	4,602	$1,500	$6,903,000	Included	$6,903,000
	- Dewatering	m^3	750	$1,500	$1,125,000	Included	$1,125,000
	- Dissolved Air Flotation Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
7.3	Primary Sludge Thickener Mechanisms and Covers	each	3	$114,000	$342,000	$171,000	$513,000
7.4	Digester Mixing System and Covers	each	6	$1,000,000	$6,000,000	$3,000,000	$9,000,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms and Covers	each	2	$349,000	$698,000	$349,000	$1,047,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Solids Handling						**$35,915,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	160	$1,500	$240,000	Included	$240,000
9.2	Superstructure	m^2	600	$4,800	$2,880,000	Included	$2,880,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,370,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$4,807,500	$4,807,500	Included	$4,807,500
10.2	Heating and Ventilation Below Ground Structures	LS	1	$6,249,800	$6,249,800	Included	$6,249,800
	Subtotal HVAC						**$11,057,300**
	Subtotal Capital Costs						**$188,437,020**
	Contingencies (30 % of Capital Subtotal)						**$56,531,100**
	Engineering (15% of Subtotal & Contingencies)						**$36,745,200**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$36,745,200**
	Total Capital Costs - Option 3						**$318,458,520**

TABLE 8.2.4
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 4 - PEC Site Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$26,029,200**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$100,000	$100,000	Included	$100,000
2.2	Civil Works:						
	- Excavation	m^3	387,400	$10	$3,874,000	Included	$3,874,000
	- Backfill	m^3	230,100	$10	$2,301,000	Included	$2,301,000
	- Roads and Sidewalks (Concrete)	m^3	5,800	$1,500	$8,700,000	Included	$8,700,000
	- Yard Piping Allowance	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- 1800 mm dia. Forcemain to new site	m	650	$2,800	$1,820,000	Included	$1,820,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	650	$2,800	$1,820,000	Included	$1,820,000
	- Soil Anchors	each	3,500	$6,900	$24,150,000	Included	$24,150,000
	- Soil Densification	m^2	19,600	$750	$14,700,000	Included	$14,700,000
	- Fencing Allowance	LS	1	$15,000	$15,000	Included	$15,000
	- Contaminated Soil Removal	m^3	38,740	$245	$9,491,300	Included	$9,491,300
	- Contaminated Groundwater Treatment	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- Underground Tunnels	m^3	13,000	$1,500	$19,500,000	Included	$19,500,000
	- Shoring	m^2	10,950	$800	$8,760,000	Included	$8,760,000
	- Slab for container storage on balance of site	m^2	6,290	$1,050	$6,604,500	Included	$6,604,500
2.3	Railway Overpass:						
	- Structure	m^2	2,220	$2,000	$4,440,000	Included	$4,440,000
	- Approaches	m^3	8,350	$40	$334,000	Included	$334,000
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$5,000,000	$5,000,000	Included	$5,000,000
	Subtotal Siteworks						**$118,109,800**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	258	$1,500	$387,000	Included	$387,000
3.2	Superstructure	m^2	600	$2,580	$1,548,000	Included	$1,548,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Headworks and Influent Pump Station						**$19,345,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	1,703	$1,500	$2,554,500	Included	$2,554,500
4.2	Superstructure Concrete	m^3	3,974	$1,500	$5,961,000	Included	$5,961,000
4.3	Primary Clarifier Drive Mechanisms c/w Skimmers	each	8	$140,400	$1,123,200	$561,600	$1,684,800
4.4	Primary Sludge Pumps	each	6	$20,000	$120,000	$60,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$280,000	$280,000	Included	$280,000
4.6	Primary Clarifier Covers for Odour Control	m^2	2,736	$620	$1,696,320	Included	$1,696,320
4.7	Scum Pumps	each	4	$15,000	$60,000	$30,000	$90,000
4.8	Piping and Valving	LS	1	$400,000	$400,000	Included	$400,000
4.9	Slide Gates	each	12	$12,000	$144,000	$72,000	$216,000
4.10	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Primary Clarifiers						**$14,862,620**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	2,211	$1,500	$3,316,500	Included	$3,316,500
5.2	Superstructure Concrete	m^3	5,158	$1,500	$7,737,000	Included	$7,737,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	1,571	$1,500	$2,356,500	Included	$2,356,500
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$600,000	$600,000	Included	$600,000
	Subtotal BAF						**$26,111,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,580	$3,619,700	Included	$3,619,700
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Concrete	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$12,479,600**

TABLE 8.2.4
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 4 - PEC Site Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	147	$1,500	$220,500	Included	$220,500
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	302	$1,500	$453,000	Included	$453,000
	- Dissolved Air Flotation Thickeners	m^3	456	$1,500	$684,000	Included	$684,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	147	$1,500	$220,500	Included	$220,500
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	302	$1,500	$453,000	Included	$453,000
	- Dissolved Air Flotation Thickeners	m^3	2,040	$1,500	$3,060,000	Included	$3,060,000
7.3	Primary Sludge Thickener Mechanisms	each	3	$96,000	$288,000	$144,000	$432,000
7.4	Digester Mixing System	each	6	$800,000	$4,800,000	$2,400,000	$7,200,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms	each	2	$300,000	$600,000	$300,000	$900,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Solids Handling						**$30,935,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	258	$1,500	$387,000	Included	$387,000
9.2	Superstructure	m^2	600	$5,400	$3,240,000	Included	$3,240,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,877,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$7,304,700	$7,304,700	Included	$7,304,700
10.2	Heating and Ventilation Below Ground Structures	LS	1	$9,496,100	$9,496,100	Included	$9,496,100
	Subtotal HVAC						**$16,800,800**
	Subtotal Capital Costs						**$286,321,020**
	Contingencies (30 % of Capital Subtotal)						**$85,896,300**
	Engineering (15% of Subtotal & Contingencies)						**$55,832,600**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$55,832,600**
	Total Capital Costs - Option 4						**$483,882,520**

TABLE 8.2.5
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 5 - Vancouver Wharf Above Ground

Date: September, 2007

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$17,297,500**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$200,000	$200,000	Included	$200,000
2.2	Civil Works:						
	- Excavation	m^3	62,700	$10	$627,000	Included	$627,000
	- Backfill	m^3	38,000	$10	$380,000	Included	$380,000
	- Roads and Sidewalks	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	- Yard Piping Allowance	LS	1	$3,500,000	$3,500,000	Included	$3,500,000
	- 1800 mm dia. Forcemain to new site	m	1,800	$2,800	$5,040,000	Included	$5,040,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	1,800	$2,800	$5,040,000	Included	$5,040,000
	- Soil Anchors	each	0	$0	$0	Included	$0
	- Soil Densification	m^2	19,600	$750	$14,700,000	Included	$14,700,000
	- Fencing Allowance	LS	1	$80,000	$80,000	Included	$80,000
	- Contaminated Soil Removal	m^3	25,080	$245	$6,144,600	Included	$6,144,600
	- Contaminated Groundwater Treatment	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- Underground Tunnels	m^3	0	$0	$0	Included	$0
	- Shoring	m^2	4,800	$800	$3,840,000	Included	$3,840,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	690	$2,000	$1,380,000	Included	$1,380,000
	- Approaches	m^3	8,350	$40	$334,000	Included	$334,000
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$500,000	$500,000	Included	$500,000
	Subtotal Siteworks						**$46,265,600**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	160	$1,500	$240,000	Included	$240,000
3.2	Superstructure	m^2	600	$2,000	$1,200,000	Included	$1,200,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Headworks and Influent Pump Station						**$18,550,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	1,547	$1,500	$2,320,500	Included	$2,320,500
4.2	Superstructure	m^3	932	$1,500	$1,398,000	Included	$1,398,000
4.3	Primary Clarifier Drive Mechanisms c/w Skimmers	each	8	$140,400	$1,123,200	$561,600	$1,684,800
4.4	Primary Sludge Pumps	each	6	$20,000	$120,000	$60,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$280,000	$280,000	Included	$280,000
4.6	Primary Clarifier Covers for Odour Control	m^2	2,736	$620	$1,696,320	Included	$1,696,320
4.7	Scum Pumps	each	4	$15,000	$60,000	$30,000	$90,000
4.8	Piping and Valving	LS	1	$400,000	$400,000	Included	$400,000
4.9	Slide Gates	each	12	$12,000	$144,000	$72,000	$216,000
4.10	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Primary Clarifiers						**$9,765,620**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	1,334	$1,500	$2,001,000	Included	$2,001,000
5.2	Superstructure Concrete	m^3	1,884	$1,500	$2,826,000	Included	$2,826,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	786	$1,500	$1,179,000	Included	$1,179,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$400,000	$400,000	Included	$400,000
	Subtotal BAF						**$18,507,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,000	$2,806,000	Included	$2,806,000
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Concrete	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$11,665,900**

TABLE 8.2.5
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 5 - Vancouver Wharf Above Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	318	$1,500	$477,000	Included	$477,000
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	187	$1,500	$280,500	Included	$280,500
	- Dissolved Air Flotation Thickeners	m^3	990	$1,500	$1,485,000	Included	$1,485,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	159	$1,500	$238,500	Included	$238,500
	- Digesters	m^3	4,602	$1,500	$6,903,000	Included	$6,903,000
	- Dewatering	m^3	750	$1,500	$1,125,000	Included	$1,125,000
	- Dissolved Air Flotation Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
7.3	Primary Sludge Thickener Mechanisms and Covers	each	3	$114,000	$342,000	$171,000	$513,000
7.4	Digester Mixing System and Covers	each	6	$1,000,000	$6,000,000	$3,000,000	$9,000,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms and Covers	each	2	$349,000	$698,000	$349,000	$1,047,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Solids Handling						**$35,915,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	160	$1,500	$240,000	Included	$240,000
9.2	Superstructure	m^2	600	$4,800	$2,880,000	Included	$2,880,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,370,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$4,854,300	$4,854,300	Included	$4,854,300
10.2	Heating and Ventilation Below Ground Structures	LS	1	$6,310,600	$6,310,600	Included	$6,310,600
	Subtotal HVAC						**$11,164,900**
	Subtotal Capital Costs						**$190,272,520**
	Contingencies (30 % of Capital Subtotal)						**$57,081,800**
	Engineering (15% of Subtotal & Contingencies)						**$37,103,100**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$37,103,100**
	Total Capital Costs - Option 5						**$321,560,520**

TABLE 8.2.6
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 6 - Vancouver Wharf Below Ground

Date: September, 2007

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$28,681,400**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$200,000	$200,000	Included	$200,000
2.2	Civil Works:						
	- Excavation	m^3	387,400	$10	$3,874,000	Included	$3,874,000
	- Backfill	m^3	230,100	$10	$2,301,000	Included	$2,301,000
	- Roads and Sidewalks (Concrete)	m^3	12,300	$1,500	$18,450,000	Included	$18,450,000
	- Yard Piping Allowance	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- 1800 mm dia. Forcemain to new site	m	1,800	$2,800	$5,040,000	Included	$5,040,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	1,800	$2,800	$5,040,000	Included	$5,040,000
	- Soil Anchors	each	4,500	$6,900	$31,050,000	Included	$31,050,000
	- Soil Densification	m^2	19,600	$750	$14,700,000	Included	$14,700,000
	- Fencing Allowance	LS	1	$15,000	$15,000	Included	$15,000
	- Contaminated Soil Removal	m^3	38,740	$245	$9,491,300	Included	$9,491,300
	- Contaminated Groundwater Treatment	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- Underground Tunnels	m^3	16,120	$1,500	$24,180,000	Included	$24,180,000
	- Shoring	m^2	10,950	$800	$8,760,000	Included	$8,760,000
	- Slab for container storage on balance of site	m^2	6,290	$1,050	$6,604,500	Included	$6,604,500
2.3	Railway Overpass:						
	- Structure	m^2	690	$2,000	$1,380,000	Included	$1,380,000
	- Approaches	m^3	8,350	$40	$334,000	Included	$334,000
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$5,000,000	$5,000,000	Included	$5,000,000
	Subtotal Siteworks						**$142,919,800**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	258	$1,500	$387,000	Included	$387,000
3.2	Superstructure	m^2	600	$2,580	$1,548,000	Included	$1,548,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Headworks and Influent Pump Station						**$19,345,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	1,703	$1,500	$2,554,500	Included	$2,554,500
4.2	Superstructure	m^3	3,974	$1,500	$5,961,000	Included	$5,961,000
4.3	Primary Clarifier Drive Mechanisms c/w Skimmers	each	8	$140,400	$1,123,200	$561,600	$1,684,800
4.4	Primary Sludge Pumps	each	6	$20,000	$120,000	$60,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$280,000	$280,000	Included	$280,000
4.6	Primary Clarifier Covers for Odour Control	m^2	2,736	$620	$1,696,320	Included	$1,696,320
4.7	Scum Pumps	each	4	$15,000	$60,000	$30,000	$90,000
4.8	Piping and Valving	LS	1	$400,000	$400,000	Included	$400,000
4.9	Slide Gates	each	12	$12,000	$144,000	$72,000	$216,000
4.10	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Primary Clarifiers						**$14,862,620**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	2,211	$1,500	$3,316,500	Included	$3,316,500
5.2	Superstructure	m^3	5,158	$1,500	$7,737,000	Included	$7,737,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	1,571	$1,500	$2,356,500	Included	$2,356,500
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$600,000	$600,000	Included	$600,000
	Subtotal BAF						**$26,111,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,580	$3,619,700	Included	$3,619,700
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$12,479,600**

TABLE 8.2.6
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 6 - Vancouver Wharf Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	147	$1,500	$220,500	Included	$220,500
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	302	$1,500	$453,000	Included	$453,000
	- Dissolved Air Flotation Thickeners	m^3	456	$1,500	$684,000	Included	$684,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	147	$1,500	$220,500	Included	$220,500
	- Digesters	m^3	1,944	$1,500	$2,916,000	Included	$2,916,000
	- Dewatering	m^3	302	$1,500	$453,000	Included	$453,000
	- Dissolved Air Flotation Thickeners	m^3	2,040	$1,500	$3,060,000	Included	$3,060,000
7.3	Primary Sludge Thickener Mechanisms	each	3	$96,000	$288,000	$144,000	$432,000
7.4	Digester Mixing System	each	6	$800,000	$4,800,000	$2,400,000	$7,200,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms	each	2	$300,000	$600,000	$300,000	$900,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Solids Handling						**$30,935,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	258	$1,500	$387,000	Included	$387,000
9.2	Superstructure	m^2	600	$5,400	$3,240,000	Included	$3,240,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,877,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$8,049,000	$8,049,000	Included	$8,049,000
10.2	Heating and Ventilation Below Ground Structures	LS	1	$10,463,700	$10,463,700	Included	$10,463,700
	Subtotal HVAC						**$18,512,700**
	Subtotal Capital Costs						**$315,495,120**
	Contingencies (30 % of Capital Subtotal)						**$94,648,500**
	Engineering (15% of Subtotal & Contingencies)						**$61,521,500**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$61,521,500**
	Total Capital Costs - Option 6						**$533,186,620**

TABLE 8.2.7
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 7 - BC Rail Passenger Lands Site Above Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$18,030,400**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$200,000	$200,000	Included	$200,000
2.2	Civil Works:						
	- Excavation	m^3	50,000	$10	$500,000	Included	$500,000
	- Backfill	m^3	25,400	$10	$254,000	Included	$254,000
	- Roads and Sidewalks	LS	1	$750,000	$750,000	Included	$750,000
	- Yard Piping Allowance	LS	1	$3,500,000	$3,500,000	Included	$3,500,000
	- 1800 mm dia. Forcemain to new site	m	2,200	$2,800	$6,160,000	Included	$6,160,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	2,200	$2,800	$6,160,000	Included	$6,160,000
	- Soil Anchors	each	0	$0	$0	Included	$0
	- Soil Densification	m^2	25,000	$750	$18,750,000	Included	$18,750,000
	- Fencing Allowance	LS	1	$95,000	$95,000	Included	$95,000
	- Contaminated Soil Removal (Note 1)	LS	1	$500,000	$500,000	Included	$500,000
	- Contaminated Groundwater Treatment (Note 1)	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	- Underground Tunnels	m^3	0	$0	$0	Included	$0
	- Shoring	m^2	5,200	$800	$4,160,000	Included	$4,160,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	0	$0	$0	Included	$0
	- Approaches	m^3	0	$0	$0	Included	$0
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$500,000	$500,000	Included	$500,000
	Subtotal Siteworks						**$43,029,000**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	160	$1,500	$240,000	Included	$240,000
3.2	Superstructure	m^2	600	$2,000	$1,200,000	Included	$1,200,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Headworks and Influent Pump Station						**$18,550,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	387	$1,500	$580,500	Included	$580,500
4.2	Superstructure	m^3	233	$1,500	$349,500	Included	$349,500
4.3	High Rate Primary Clarifier Mechanism	each	4	$1,150,000	$4,600,000	$2,300,000	$6,900,000
4.4	Chemical Feed Systems, Sludge Pumps, and Sand Eductor	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$48,000	$48,000	Included	$48,000
4.6	Primary Clarifier Covers for Odour Control	m^2	450	$620	$279,000	Included	$279,000
4.7	Scum Skimmers and Pumps	LS	1	$200,000	$200,000	Included	$200,000
4.8	Piping and Valving	LS	1	$300,000	$300,000	Included	$300,000
4.9	Slide Gates	each	6	$12,000	$72,000	$36,000	$108,000
4.10	Odour Control System Allowance	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	Subtotal Primary Clarifiers						**$10,765,000**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	1,334	$1,500	$2,001,000	Included	$2,001,000
5.2	Superstructure	m^3	1,884	$1,500	$2,826,000	Included	$2,826,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	786	$1,500	$1,179,000	Included	$1,179,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$400,000	$400,000	Included	$400,000
	Subtotal BAF						**$18,507,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,000	$2,806,000	Included	$2,806,000
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$11,665,900**

TABLE 8.2.7
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 7 - BC Rail Passenger Lands Site Above Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	318	$1,500	$477,000	Included	$477,000
	- Digesters (37.5 m dia.)	m^3	3,952	$1,500	$5,928,000	Included	$5,928,000
	- Dewatering	m^3	187	$1,500	$280,500	Included	$280,500
	- Dissolved Air Flotation Thickeners	m^3	990	$1,500	$1,485,000	Included	$1,485,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	159	$1,500	$238,500	Included	$238,500
	- Digesters (37.5 m dia.)	m^3	6,856	$1,500	$10,284,000	Included	$10,284,000
	- Dewatering	m^3	750	$1,500	$1,125,000	Included	$1,125,000
	- Dissolved Air Flotation Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
7.3	Primary Sludge Thickener Mechanisms and Covers	each	3	$114,000	$342,000	$171,000	$513,000
7.4	Digester Mixing System and Covers (37.5 m Dia.)	each	4	$1,950,000	$7,800,000	$3,900,000	$11,700,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms and Covers	each	2	$349,000	$698,000	$349,000	$1,047,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Solids Handling						**$45,008,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	160	$1,500	$240,000	Included	$240,000
9.2	Superstructure	m^2	600	$4,800	$2,880,000	Included	$2,880,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,370,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$5,060,000	$5,060,000	Included	$5,060,000
10.2	Heating and Ventilation Below Ground Structures	LS	1	$6,578,000	$6,578,000	Included	$6,578,000
	Subtotal HVAC						**$11,638,000**
	Subtotal Capital Costs						**$198,334,300**
	Contingencies (30 % of Capital Subtotal)						**$59,500,300**
	Engineering (15% of Subtotal & Contingencies)						**$38,675,200**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$38,675,200**
	Total Capital Costs - Option 7						**$335,185,000**

Note 1: Costs for contaminated soil removal and contaminated groundwater treatment may vary with the remedial option used.

TABLE 8.2.8
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 8 - BC Rail Passenger Lands Site Above Ground Without Digestion **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$14,952,800**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$200,000	$200,000	Included	$200,000
2.2	Civil Works:						
	- Excavation	m^3	42,000	$10	$420,000	Included	$420,000
	- Backfill	m^3	21,600	$10	$216,000	Included	$216,000
	- Roads and Sidewalks	LS	1	$750,000	$750,000	Included	$750,000
	- Yard Piping Allowance	LS	1	$3,200,000	$3,200,000	Included	$3,200,000
	- 1800 mm dia. Forcemain to new site	m	2,200	$2,800	$6,160,000	Included	$6,160,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	2,200	$2,800	$6,160,000	Included	$6,160,000
	- Soil Anchors	each	0	$0	$0	Included	$0
	- Soil Densification	m^2	21,300	$750	$15,975,000	Included	$15,975,000
	- Fencing Allowance	LS	1	$90,000	$90,000	Included	$90,000
	- Contaminated Soil Removal (Note 1)	LS	1	$500,000	$500,000	Included	$500,000
	- Contaminated Groundwater Treatment (Note 1)	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	- Underground Tunnels	m^3	0	$0	$0	Included	$0
	- Shoring	m^2	4,800	$800	$3,840,000	Included	$3,840,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	0	$0	$0	Included	$0
	- Approaches	m^3	0	$0	$0	Included	$0
2.4	Landscaping Allowance	LS	1	$500,000	$500,000	Included	$500,000
2.5	Dewatering Allowance	LS	1	$500,000	$500,000	Included	$500,000
	Subtotal Siteworks						**$39,511,000**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	160	$1,500	$240,000	Included	$240,000
3.2	Superstructure	m^2	600	$2,000	$1,200,000	Included	$1,200,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
	Subtotal Headworks and Influent Pump Station						**$18,550,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	387	$1,500	$580,500	Included	$580,500
4.2	Superstructure	m^3	233	$1,500	$349,500	Included	$349,500
4.3	High Rate Primary Clarifier Mechanism	each	4	$1,150,000	$4,600,000	$2,300,000	$6,900,000
4.4	Chemical Feed Systems, Sludge Pumps, and Sand Eductor	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$48,000	$48,000	Included	$48,000
4.6	Primary Clarifier Covers for Odour Control	m^2	450	$620	$279,000	Included	$279,000
4.7	Scum Skimmers and Pumps	LS	1	$200,000	$200,000	Included	$200,000
4.8	Piping and Valving	LS	1	$300,000	$300,000	Included	$300,000
4.9	Slide Gates	each	6	$12,000	$72,000	$36,000	$108,000
4.10	Odour Control System Allowance	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
	Subtotal Primary Clarifiers						**$10,765,000**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	1,334	$1,500	$2,001,000	Included	$2,001,000
5.2	Superstructure	m^3	1,884	$1,500	$2,826,000	Included	$2,826,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	786	$1,500	$1,179,000	Included	$1,179,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$400,000	$400,000	Included	$400,000
	Subtotal BAF						**$18,507,600**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	603	$1,500	$904,500	Included	$904,500
6.2	Superstructure	m^2	1,403	$2,000	$2,806,000	Included	$2,806,000
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	595	$1,500	$892,500	Included	$892,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$11,665,900**

TABLE 8.2.8
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 8 - BC Rail Passenger Lands Site Above Ground Without Digestion **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	318	$1,500	$477,000	Included	$477,000
	- Digesters	m^3	0	$0	$0	Included	$0
	- Dewatering	m^3	187	$1,500	$280,500	Included	$280,500
	- Dissolved Air Flotation Thickeners	m^3	990	$1,500	$1,485,000	Included	$1,485,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	159	$1,500	$238,500	Included	$238,500
	- Digesters	m^3	0	$0	$0	Included	$0
	- Dewatering	m^3	750	$1,500	$1,125,000	Included	$1,125,000
	- Dissolved Air Flotation Thickeners	m^3	500	$1,500	$750,000	Included	$750,000
7.3	Primary Sludge Thickener Mechanisms and Covers	each	3	$114,000	$342,000	$171,000	$513,000
7.4	Digester Mixing System and Covers	each	0	$0	$0	$0	$0
7.5	Thickened Sludge Transfer Pumps	each	4	$50,000	$200,000	$100,000	$300,000
7.6	Centrifuge Feed Pumps	each	4	$50,000	$200,000	$100,000	$300,000
7.7	Centrifuges	each	4	$1,400,000	$5,600,000	$2,800,000	$8,400,000
7.8	Dissolved Air Flotation Thickener Mechanisms and Covers	each	2	$349,000	$698,000	$349,000	$1,047,000
7.9	Dewatered Cake Conveyance System	each	4	$256,800	$1,027,200	$513,600	$1,540,800
7.10	Cogeneration System	each	0	$0	$0	$0	$0
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	8	$50,000	$400,000	$200,000	$600,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,600,000	$1,600,000	Included	$1,600,000
	Subtotal Solids Handling						**$19,736,800**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	160	$1,500	$240,000	Included	$240,000
9.2	Superstructure	m^2	600	$4,800	$2,880,000	Included	$2,880,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,370,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$4,196,300	$4,196,300	Included	$4,196,300
10.2	Heating and Ventilation Below Ground Structures	LS	1	$5,455,200	$5,455,200	Included	$5,455,200
	Subtotal HVAC						**$9,651,500**
	Subtotal Capital Costs						**$164,480,600**
	Contingencies (30 % of Capital Subtotal)						**$49,344,200**
	Engineering (15% of Subtotal & Contingencies)						**$32,073,700**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$32,073,700**
	Total Capital Costs - Option 9						**$277,972,200**

Note 1: Costs for contaminated soil removal and contaminated groundwater treatment may vary with the remedial option used.

TABLE 8.2.9
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 9 - Klahanie Park Site Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
1.0	**General Requirements**	LS	1				**$24,969,400**
2.0	**Siteworks:**						
2.1	Demolition/Site Cleaning	LS	1	$100,000	$100,000	Included	$100,000
2.2	Civil Works:						
	- Excavation	m^3	417,800	$10	$4,178,000	Included	$4,178,000
	- Backfill	m^3	269,500	$10	$2,695,000	Included	$2,695,000
	- Roads and Sidewalks (Concrete)	m^3	15,050	$1,500	$22,575,000	Included	$22,575,000
	- Yard Piping Allowance	LS	1	$3,000,000	$3,000,000	Included	$3,000,000
	- 1800 mm dia. Forcemain to new site	m	1,400	$2,800	$3,920,000	Included	$3,920,000
	- 1800 mm dia. Forcemain from new site to exist outfall	m	1,400	$2,800	$3,920,000	Included	$3,920,000
	- Soil Anchors	each	4,650	$6,900	$32,085,000	Included	$32,085,000
	- Soil Densification	m^2	0	$0	$0	Included	$0
	- Fencing Allowance	LS	1	$15,000	$15,000	Included	$15,000
	- Contaminated Soil Removal	m^3	0	$0	$0	Included	$0
	- Contaminated Groundwater Treatment	LS	1	$0	$0	Included	$0
	- Underground Tunnels	m^3	15,300	$1,500	$22,950,000	Included	$22,950,000
	- Shoring	m^2	12,030	$800	$9,624,000	Included	$9,624,000
	- Slab for container storage on balance of site	m^2	0	$0	$0	Included	$0
2.3	Railway Overpass:						
	- Structure	m^2	0	$0	$0	Included	$0
	- Approaches	m^3	0	$0	$0	Included	$0
2.4	Landscaping Allowance	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
2.5	Dewatering Allowance	LS	1	$5,000,000	$5,000,000	Included	$5,000,000
	Subtotal Siteworks						**$111,062,000**
3.0	**Headworks and Influent Pump Station:**						
3.1	Substructure Concrete	m^3	210	$1,500	$315,000	Included	$315,000
3.2	Superstructure	m^2	600	$2,580	$1,548,000	Included	$1,548,000
3.3	Influent Pump Station Substructure @ Lions Gate WWTP	m^3	4,450	$1,500	$6,675,000	Included	$6,675,000
3.4	Influent Pumping Equipment	each	4	$363,000	$1,452,000	$726,000	$2,178,000
3.5	Coarse Screens	each	2	$264,000	$528,000	$264,000	$792,000
3.6	Vortex Grit Removal c/w Dewatering Conveyor/Classifier	each	3	$312,000	$936,000	$468,000	$1,404,000
3.7	Fine Screens c/w Covers/Washers/ Compactors	each	3	$306,000	$918,000	$459,000	$1,377,000
3.8	Cleanshot System (Screenings Conveyor)	each	2	$360,000	$720,000	$360,000	$1,080,000
3.9	Sluice Trough with Diverter Gate	each	1	$96,000	$96,000	$48,000	$144,000
3.10	Slide Gates	each	16	$15,000	$240,000	$120,000	$360,000
3.11	Piping and Valving	LS	1	$1,500,000	$1,500,000	Included	$1,500,000
3.12	Cranes	LS	1	$100,000	$100,000	Included	$100,000
3.13	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Headworks and Influent Pump Station						**$19,273,000**
	.						
4.0	**Primary Clarifiers:**						
4.1	Substructure Concrete	m^3	1,642	$1,500	$2,463,000	Included	$2,463,000
4.2	Superstructure	m^3	2,819	$1,500	$4,228,500	Included	$4,228,500
4.3	Primary Clarifier Drive Mechanisms c/w Skimmers	each	8	$140,400	$1,123,200	$561,600	$1,684,800
4.4	Primary Sludge Pumps	each	6	$20,000	$120,000	$60,000	$180,000
4.5	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$280,000	$280,000	Included	$280,000
4.6	Primary Clarifier Covers for Odour Control	m^2	2,736	$620	$1,696,320	Included	$1,696,320
4.7	Scum Pumps	each	4	$15,000	$60,000	$30,000	$90,000
4.8	Piping and Valving	LS	1	$400,000	$400,000	Included	$400,000
4.9	Slide Gates	each	12	$12,000	$144,000	$72,000	$216,000
4.10	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Primary Clarifiers						**$13,038,620**
5.0	**Biological Aerated Filters**						
5.1	Substructure Concrete	m^3	2,211	$1,500	$3,316,500	Included	$3,316,500
5.2	Superstructure	m^3	5,158	$1,500	$7,737,000	Included	$7,737,000
5.3	Backwash Storage Tank / Waste Storage Tank	m^3	1,262	$1,500	$1,893,000	Included	$1,893,000
5.4	BAF Equipment Package including Blowers	each	8	$1,070,000	$8,560,000	Included	$8,560,000
5.5	BAF Covers for Odour Control	m^2	1,120	$620	$694,400	$347,200	$1,041,600
5.6	Backwash Supply Pumps and Backwash Waste Pumps	each	4	$120,000	$480,000	$240,000	$720,000
5.7	Piping and Valving	LS	1	$1,000,000	$1,000,000	$500,000	$1,500,000
5.8	Slide Gates	each	8	$15,000	$120,000	$60,000	$180,000
5.9	Miscellaneous Metals, Handrails	LS	1	$100,000	$100,000	Included	$100,000
5.10	Odour Control System Allowance	LS	1	$600,000	$600,000	Included	$600,000
	Subtotal BAF						**$25,648,100**
6.0	**UV Disinfection and Effluent Pump Station:**						
6.1	Substructure Concrete	m^3	491	$1,500	$736,500	Included	$736,500
6.2	Superstructure	m^2	1,403	$2,580	$3,619,700	Included	$3,619,700
6.3	UV Equipment	each	2	$1,048,300	$2,096,600	$1,048,300	$3,144,900
6.4	Effluent Pump Station Substructure	m^3	397	$1,500	$595,500	Included	$595,500
6.5	Effluent Pumps	each	4	$363,000	$1,452,000	$726,000	$2,178,000
6.6	Eflluent Pump Process Piping	each	1	$1,500,000	$1,500,000	Included	$1,500,000
6.7	Misc. Metals (Including checker plate, handrails and grating)	LS	1	$50,000	$50,000	Included	$50,000
6.8	Slide Gates	each	6	$10,000	$60,000	$30,000	$90,000
6.9	Cranes	LS	1	$100,000	$100,000	Included	$100,000
	Subtotal UV Disinfection and Effluent Pump Station						**$12,014,600**

TABLE 8.2.9
GVS&DD Lions Gate WWTP
Opinion of Probable Costs for Plant Expansion / Relocation
Option 9 - Klahanie Park Site Below Ground **Date: September, 2007**

Item No.	Description	Unit	Quantity	Material or Equipment Costs		Labour & Overhead	Total Costs
				Unit Price	Total Price		
7.0	**Solids Handling (Sludge Thickening, Digestion and Dewatering)**						
7.1	Substructure Concrete						
	- Primary Sludge Thickeners	m^3	126	$1,500	$189,000	Included	$189,000
	- Digesters	m^3	1,662	$1,500	$2,493,000	Included	$2,493,000
	- Dewatering	m^3	246	$1,500	$369,000	Included	$369,000
	- Dissolved Air Flotation Thickeners	m^3	392	$1,500	$588,000	Included	$588,000
7.2	Superstructure Concrete						
	- Primary Sludge Thickeners	m^3	570	$1,500	$855,000	Included	$855,000
	- Digesters	m^2	1,662	$1,500	$2,493,000	Included	$2,493,000
	- Dewatering	m^3	984	$1,500	$1,476,000	Included	$1,476,000
	- Dissolved Air Flotation Thickeners	m^3	1,770	$1,500	$2,655,000	Included	$2,655,000
7.3	Primary Sludge Thickener Mechanisms	each	3	$96,000	$288,000	$144,000	$432,000
7.4	Digester Mixing System	each	6	$800,000	$4,800,000	$2,400,000	$7,200,000
7.5	Thickened Sludge Transfer Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.6	Centrifuge Feed Pumps	each	4	$20,000	$80,000	$40,000	$120,000
7.7	Centrifuges	each	3	$720,000	$2,160,000	$1,080,000	$3,240,000
7.8	Dissolved Air Flotation Thickener Mechanisms	each	2	$300,000	$600,000	$300,000	$900,000
7.9	Dewatered Cake Conveyance System	each	2	$256,800	$513,600	$256,800	$770,400
7.10	Cogeneration System	each	2	$1,300,000	$2,600,000	$1,300,000	$3,900,000
7.11	Piping and Valving	LS	1	$1,000,000	$1,000,000	Included	$1,000,000
7.12	Polymer Storage and Feed Systems	each	6	$50,000	$300,000	$150,000	$450,000
7.13	Cranes	LS	1	$80,000	$80,000	Included	$80,000
7.14	Odour Control System Allowance	LS	1	$1,800,000	$1,800,000	Included	$1,800,000
	Subtotal Solids Handling						**$31,130,400**
8.0	**Electrical, Control, Instrumentation, and Standby Generator**						
8.1	62kV - 25kV Substation	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.2	High Voltage Switchgear and 25kV Transformers	LS	1	$1,500,000	$1,500,000	$750,000	$2,250,000
8.3	Diesel Generators and Transfer Switches	LS	1	$1,800,000	$1,800,000	$900,000	$2,700,000
8.4	Power Distribution and Motor Control Centre	LS	1	$2,320,000	$2,320,000	$1,100,000	$3,420,000
8.5	Process Control Panels	LS	1	$1,750,000	$1,750,000	$750,000	$2,500,000
8.6	Process Control Instrumentation	LS	1	$2,000,000	$2,000,000	$1,000,000	$3,000,000
8.7	Lighting for Plant Buildings and Site General Lighting	LS	1	$800,000	$800,000	$400,000	$1,200,000
	Subtotal EIC						**$17,770,000**
9.0	**Operations Building**						
9.1	Substructure	m^3	100	$1,500	$150,000	Included	$150,000
9.2	Superstructure	m^2	600	$5,400	$3,240,000	Included	$3,240,000
9.3	Furniture and Lab Equipment	LS	1	$250,000	$250,000	Included	$250,000
	Subtotal Operations Building						**$3,640,000**
10.0	**Heating and Ventilation**						
10.1	Heating and Ventilation Above Ground Structures	LS	1	$7,007,300	$7,007,300	Included	$7,007,300
10.2	Heating and Ventilation Below Ground Structures	LS	1	$9,109,500	$9,109,500	Included	$9,109,500
	Subtotal HVAC						**$16,116,800**
	Subtotal Capital Costs						**$274,662,920**
	Contingencies (30 % of Capital Subtotal)						**$82,398,900**
	Engineering (15% of Subtotal & Contingencies)						**$53,559,300**
	Owner Direct and Indirect Costs (15% of Subtotal and Contingen.)						**$53,559,300**
	Total Capital Costs - Option 8						**$464,180,420**

Table 8.3
Opinion of Probable Costs for Plant Operation and Maintenance

AAF= **133 ML/d**

Power Costs Without Cogeneration System

Item No.	Facility	Power Use per ML Flow Treated kWh/ML	Daily Power Consumption kWh/d	Annual Power Consumption kWh	Unit Power Costs $	Annual Power Costs $
1	Primary Treatment	353	46,949	17,136,385	$0.06	$1,028,200
2	BAF	241	32,053	11,699,345	$0.06	$702,000
3	UV Disinfection	21	2,793	1,019,445	$0.06	$61,200
4	Dewatering	9	1,197	436,905	$0.06	$26,200
	Total Power Costs					**$1,817,600**

Power Costs With Cogeneration System

Item No.	Facility	Power Use per ML Flow Treated kWh/ML	Daily Power Consumption kWh/d	Annual Power Consumption kWh	Unit Power Costs $	Annual Power Costs $
1	Primary Treatment	105	13,965	5,097,225	$0.06	$305,800
2	BAF	241	32,053	11,699,345	$0.06	$702,000
3	UV Disinfection	21	2,793	1,019,445	$0.06	$61,200
4	Dewatering	9	1,197	436,905	$0.06	$26,200
	Total Power Costs					**$1,095,200**

	Annual O & M Costs	
Description	**Without Cogeneration**	**With Cogeneration**
Power Costs	$1,817,600	$1,095,200
Operating Labour Costs	$1,500,000	$1,500,000
Operating Non-Labour Costs	$2,400,000	$2,400,000
Maintenance	$1,500,000	$1,500,000
Biosolids Managements	$224,000	$224,000
Total Annual O & M Costs	**$7,441,600**	**$6,719,200**

Table 8.4
Land Costs for WWTP Sites

Option	Description	Unit	Quantity	Unit Land Cost	Total Land Costs	Annual Leasing Costs	25-year Leasing Costs at Present Value
1	Lions Gate Above Ground	ha	3.5	$7,410,000	**$25,935,000**	$2,593,500	**$35,142,852**
2	Lions Gate Below Ground	ha	3.5	$7,410,000	**$25,935,000**	$2,593,500	**$35,142,852**
3	PEC Site Above Ground	ha	7.0	$4,940,000	**$34,580,000**	$8,000,000	**$108,402,860**
4	PEC Site Below Ground	ha	5.0	$4,940,000	**$24,700,000**	$8,000,000	**$108,402,860**
5	Vancouver Wharf Above Ground	ha	6.9	$7,410,000	**$51,129,000**	$5,112,900	**$69,281,623**
6	Vancouver Wharf Below Ground	ha	6.3	$7,410,000	**$46,683,000**	$4,668,300	**$63,257,134**
7	BC Rail Passenger Lands Site Above Ground	ha	2.9	$6,180,000	**$17,922,000**		
8	BC Rail Passenger Lands Site Above Ground without Digestion	ha	2.9	$6,180,000	**$17,922,000**		
9	Klahanie Park Site Below Ground	ha	3.5	$7,410,000	**$25,935,000**	$2,593,500	**$35,142,852**

Note: An annual discount rate of 6% is used for Present Value calculations. Only Option 7 & 8 are assumed as direct purchase. All other options assumed an annual lease rate of 10% of land value.