

GREATER VERNON SERVICES MASTER WATER PLAN

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Background

The Duteau Creek Water Treatment Plant is the largest and most important step in the Master Water Plan capital program. Treatment of the Duteau Creek source will:

- Address water quality issues affecting existing Greater Vernon residents;
- Provide operational flexibility in conjunction with the Kalamalka Lake source;
- Allow maximum use of existing water licenses.

The conceptual design of the Duteau Creek Water Treatment Plant was completed by Earth Tech Canada Inc. (Earth Tech) in late October 2005. The work took approximately 12 months to complete, and included a pilot study of clarification technology, which was presented in a separate report.

The primary goals of the work included:

- Identification of a site for the plant;
- Definition of plant capacity, within the context of the system separation program;
- Identification of treatment processes, within the context of the water quality parameters set out in the Master Water Plan and recent and anticipated regulatory changes from the Interior Health Authority (IHA);
- Completion of capital cost estimates for a number of options (plant sizes, locations), with a more detailed estimate of the recommended option.

Earth Tech has recommended a 151MLD plant, incorporating clarification, filtration (which can be deferred) and chlorination. The plant would be located near the Headgates intake. This is in line with previous work done under the Master Water Plan. Earth Tech has also identified additional work that is required for the plant to meet the water quality objectives, including:

- Construction of a domestic water main from the plant site to PRV #1 (approx. 13 km);
- System separation in the Lavington area;
- Formation of a dedicated irrigation zone using the King Edward Lake source.

The latter two projects had been previously identified, with work on the dedicated irrigation zone scheduled for 2006. The study essentially defines the balance between separation and treatment, and provides direction for completion of the Master Water Plan upgrades.

While the overall cost estimate for the Master Water Plan capital projects closely matches previous estimates, the cost estimate for first phase of the Duteau Creek Water Treatment Plant exceeds funds available under the current borrowing authority. Additional infrastructure, namely the domestic trunk main had also not been considered as part of the Phase 1 estimates in Working Paper 15.

The report was presented to the Technical Steering Committee on October 28, 2006. The Committee requested staff address a number of questions prior to bringing the report forward. These questions are addressed in detail later in this memorandum.

The table below illustrates that overall project costs are projected to be within 6% of those predicted in Working Paper 15, and are within the estimates for the range of options discussed in the Master Water Plan in 2002 (Working Paper 12).

**Master Water Plan
 Comparison of Current Scenario to Previous Estimates**

Scenario	Capital Cost Estimate (excluding filtration)	Capital Cost Estimate (including filtration)	Comment
Current	\$73,160,000	\$102,070,000	Gradual separation, two treatment plants
Working Paper 15 - 2004	\$66,600,000	\$97,600,000	Gradual separation, two treatment plants
MWP 2002 – Option 1A	\$74,800,000	\$92,800,000	Immediate full separation, one treatment plant
MWP 2002 – Option 1B	\$83,400,000	\$100,400,000	Immediate full separation, two treatment plants
MWP 2002 – Option 2A	\$84,800,000	\$104,800,000	Gradual separation, one treatment plant
MWP 2002 – Option 2B	\$86,400,000	\$103,400,000	Gradual separation, two treatment plants
MWP 2002 – Option 2C	\$83,900,000	\$113,400,000	Gradual separation, two treatment plants, develop Okanagan Lake

Escalation has not been applied to previous cost estimates.

The following tables depict the cost projection for current and future projects and form the basis for the “Current” scenario above.

Current Projects Excluding Duteau Creek WTP

Project	Projected Final Cost	Timing
Project Management		
GVW Project Manager	\$380,000	
Program Mgmt – Sandwell	\$1,600,000	
System Planning	\$300,000	On-going 2006/2007
Subtotal Project Mgmt	\$2,280,000	
Separation Program		
Bella Vista	\$3,800,000	Completion Target April 2006
West Swan Lake	\$6,900,000	Pre-design nearing completion. Construction target 2006/2007
King Edward Irrigation Zone	\$1,450,000	Per Earth Tech - Design/Construction in 2006
Subtotal Separation Projects	\$12,150,000	
McMechan Reservoir	\$4,500,000	Complete
Mission Hill WTP	\$5,900,000	Completion Target June 2006
Kal Lake Pump Station	\$700,000	Completion Target March 2006
Mains, Misc. Improvements	\$1,800,000	Work commencing in 2006
Duteau Creek WTP	-	Under discussion
Total (not including Duteau Creek WTP)	\$26,930,000	

Projected Future Total under Current Scenario

Project	Projected Final Cost	Timing
Project Management		
GVW Project Manager	\$380,000	
Program Mgmt – Sandwell	\$1,600,000	
System Planning	\$300,000	
Subtotal Project Mgmt	\$2,280,000	
Separation Program		
Bella Vista	\$3,800,000	
West Swan Lake	\$6,900,000	
King Edward Irrigation Zone	\$1,450,000	
<i>Lavington Separation</i>	<i>\$7,900,000</i>	<i>Dependent on Duteau WTP</i>
Subtotal Separation Projects	\$20,050,000	
McMechan Reservoir	\$4,500,000	
Mission Hill WTP		
Phase 1	\$5,900,000	
<i>Phase 2 - Filtration</i>	<i>\$18,100,000</i>	<i>2015 per WP#15</i>
Subtotal Mission Hill WTP	\$24,000,000	
Kal Lake Pump Station	\$700,000	
Mains, Misc. Improvements		
Phase 1	\$1,800,000	
<i>Conveyance Mains</i>	<i>\$9,500,000</i>	<i>Concurrent w/Duteau WTP</i>
Subtotal Mains, Misc. Improvements	\$11,300,000	
Duteau Creek WTP		
<i>Plant General</i>	<i>\$23,960,000*</i>	<i>Under discussion</i>
<i>Add Filtration</i>	<i>\$9,810,000</i>	<i>2015 per WP#15</i>
<i>Engineering</i>	<i>\$5,470,000</i>	<i>Under discussion</i>
Subtotal Duteau Creek WTP	\$39,240,000	
Total	\$102,070,000	
Total Excluding Filtration	\$74,160,000	

Note: Project management costs are rolled into items in *italics*. *Site purchase not included.

Summary of Conceptual Design

Water Quality

The design has been based on the water quality goals set out in the Master Water Plan, though Earth Tech identified two areas in which the regulations have changed, or have a high probability of changing in the near future.

- Cryptosporidium inactivation – The Interior Health Authority (IHA) has recently revised its guidelines for cryptosporidium removal in new treatment plants from 2-log (~99%) to 3-log (99.9%);
- Disinfection Bi-products (DBPs) – The current guidelines address trihalomethanes (THMs), which are produced when chlorine reacts with organic matter. The guidelines must currently be met by a quarterly running average, which means that high levels in certain areas of the system may be masked by lower readings closer to the source. The US EPA has addressed this shortcoming and will be specifying a locational running average, meaning that utilities will have to report the highest levels from individual sampling points. In addition, Canada is likely to follow the lead of the United States with respect to haloacetic acids (HAAs). These DBPs are not currently regulated in Canada, but have been regulated in the United States for some time. It is Earth Tech's opinion that the Canadian Guidelines will be aligned with those of United States with respect to DBPs within the life cycle of the treatment plant.

Earth Tech has recommended that the new plant be designed to accommodate these current and anticipated revisions and the conceptual design reflects this.

The IHA has recently focused attention on turbidity as a factor influencing public health. A new program, to be launched in mid-March, will require water purveyors with surface water sources to notify its customers when source water turbidity exceeds 1 NTU. While IHA has been careful to state that this program does not constitute a rejection of the phased approach to water treatment, in practical terms it means that some purveyors will be issuing substantially more water quality advisories despite improvements in treatment (e.g. UV disinfection without filtration).

Treatment Technology

Three clarification technologies were piloted during the 2005 spring freshet, using raw Duteau Creek water. The three technologies included:

- Dissolved Air Flotation (DAF);
- High-rate DAF (AquaDAF™);
- Ballasted Sedimentation (Actiflo®).

The study concluded that all three technologies were viable for the treatment of the Duteau Creek Source, and that the long-term goals could be met when clarification was combined with filtration. With respect to turbidity, all technologies demonstrated the ability to maintain turbidity less than 2 NTU, and were able to achieve results at or less than 1 NTU most of the time.

The conceptual design was based around conventional DAF with Granular Media Filtration and chlorination. The building requirements are conservative, as conventional DAF requires the largest footprint. Conventional DAF has a slight advantage in that it has demonstrated 2-log removal of giardia cysts. Documentation of similar effectiveness has not yet been documented for the other technologies. This distinction may prove critical if filtration is deferred to a later date.

Conventional DAF also provides the opportunity for installation of granular filters within the DAF structure, which could reduce the overall cost of the plant.

It will be noted that UV treatment has not been included. Earth Tech has determined that UV would not significantly improve treated water quality in the presence of clarification and filtration.

Treatment Plant Siting and Sizing

Earth Tech has analyzed five options, based on two locations and various combinations of plant size and system separation. In all cases, a dedicated irrigation zone centred around King Edward Intake is required, as is the separation of Goose Lake (Bella Vista/Old Kamloops Road). All options require significant on-site clearwell storage (10 ML). Briefly, the options are summarized as follows:

- Option 1 – 221 MLD plant located near Headgates, minimal separation. This option essentially treats all water regardless of use and does not require significant upgrades to the pipe network, but does require a booster pump station in order to meet peak flows;
- Option 2 – 151 MLD plant located near Headgates, some separation. Separation of the Lavington area allows a significant reduction in the volume of treated water. The requires approximately 13 km of 750 mm diameter treated water main in place of the booster pump station;
- Option 3 – 31 MLD plant located near Headgates, full system separation. System separation is required throughout the Coldstream Valley and BX area, as is a 500 mm diameter treated water main (~20 km) in place of the booster pump station;
- Option 4 – 151 MLD plant located near PRV #1, some separation. The booster pump station is required to meet peak flows. The Lavington area would be separated, requiring a smaller pump station to supply the area east of the site;
- Option 5 – 31 MLD plant located near PRV #1, full separation. The booster pump station is required, as is the smaller station servicing Lavington. The areas west and north of PRV #1 would be separated.

Earth Tech evaluated the sites based on factors including: cost, ease of land acquisition, water quality impacts, hydraulic constraints, flexibility for future expansion, access, aesthetic impacts and others. Although the PRV#1 site scored relatively well from a life-cycle and capital cost standpoint, it proved to be quite unfavourable for a number of reasons:

- Water Quality Impacts – Options 4 and 5 would require continued chlorination at Headgates, resulting in inherently higher concentrations of DBPs in the water reporting to the plant;
- Flexibility – The ability to accommodate future growth in the Lavington area could be hindered;
- Access – Options 4 and 5 would require access up a steep slope;
- Hydraulic Constraints – The PRV site would require additional pumping and transmission system upgrades;
- Aesthetic Impacts – The PRV site would be highly visible and in close proximity to relatively dense residential areas;

Cost Estimates

The costs estimates for the five options, for the purpose of comparison, are tabulated below. The estimates include costs for system separation and appurtenances, which are in addition to the cost to construct and operate the treatment plant.

Estimated Capital Costs

	Option 1	Option 2	Option 3	Option 4	Option 5
Plant Capacity (ML/D)	221	151	31	151	31
Treatment Plant General	\$37.77	\$28.44	\$13.94	\$31.56	\$13.94
Add Filtration	\$12.53	\$9.81	\$5.0	\$9.81	\$5.0
Land Acquisition	<i>In camera</i>	<i>In camera</i>	<i>In camera</i>	<i>In camera</i>	<i>In camera</i>
3-Phase Power	\$1.54	\$1.54	\$1.54	\$0.54	\$0.54
Subtotal – Treatment	\$51.84*	\$39.79*	\$20.48*	\$41.91*	\$19.48*
New conveyance pipeline from Headgates	N/A	\$9.1	\$7.5	N/A	N/A
Peak Flow Booster Station	\$1.75	N/A	N/A	\$1.75	\$1.75
Raw Water Supply Main	\$0.35	\$0.35	\$0.2	\$0.5	\$0.25
New Treated Water Pipelines	N/A	N/A	N/A	N/A	N/A
Subtotal – Conveyance	\$2.10	\$9.45	\$7.70	\$2.25	\$2.25
Lavington Domestic Supply	N/A	\$7.90	\$7.90	\$8.40	\$8.40
King Edward Irrigation Zone	\$1.05	\$1.05	\$1.05	\$1.05	\$1.05
Inter-urban System Separation	N/A	N/A	\$26.58	N/A	\$26.58
Subtotal – Separation	\$1.05	\$8.95	\$35.53	\$9.45	\$36.03
Grand Total	\$54.99*	\$58.19*	\$63.71*	\$53.61*	\$57.76*

* Totals do not include land purchase

Net Present Value of Operating Cost

	Option 1	Option 2	Option 3	Option 4	Option 5
NPV of WTP Operations	\$34.14	\$25.37	\$10.46	\$25.37	\$10.46
NPV of Booster Station Ops	\$0.1	N/A	N/A	\$0.1	\$0.1
NPV of New Wtr Main Maint.	N/A	\$1.51	\$5.97	\$1.51	\$5.97
Grand Total	\$34.24	\$26.88	\$16.43	\$26.98	\$16.53

The PRV #1 sites offered the lowest life cycle cost but were generally unacceptable for the reasons listed above. Of the remaining options, Option 3 (31 MLD plant, full separation) has the lowest life cycle cost, but total system separation must be complete before the treatment plant can be constructed. Option 3 had the highest initial capital cost.

Earth Tech recommended Option 2 (151 MLD plant, some separation) as the preferred alternative and proceeded with the conceptual design on that basis.

The capital cost for the 151 MLD plant exceeds existing borrowing authority, even in the absence of some necessary appurtenances. As previously stated, the discussion of cost must be within the context of the entire Master Water Plan. Total project costs are consistent with previous estimates, although the problem with short term funding and phasing of the work remains.

Alternative Scenarios

This section addresses a number of questions raised by the Technical Steering Committee.

- Q. *Could the entire service area be supplied through the Duteau source? i.e. Could a larger plant be built such that the eventual expansion of the Mission Hill plant can be avoided?*
- A. Before the potential cost impacts are explored it must first be determined whether the Aberdeen Plateau is capable of supplying Greater Vernon as a sole source.

Total demands (all uses) are projected to reach approximately 35,000 ML per year in 2041. The current license on Duteau Creek is 24,992 ML/Y. A license of 3,699 ML/Y is held on Deer Creek, which will be used for the King Edward Irrigation Zone. Assuming that the Deer Creek license is used with 100% efficiency, approximately 6,300 ML of additional license is required.

It is reasonable to assume that the license on Duteau Creek can be increased by raising the reservoir dams. A study is planned for 2006 to determine the feasibility of raising the dams. The total storage currently available for use is approximately 16,300 ML, or 65% of the total license.

In order to reliably supply the entire service area, storage capacity in the reservoir lakes would have to increase by approximately 15,000 ML. A high-level review of

the depth/capacity characteristics of the lakes indicates a corresponding dam raise of approximately 2.4 m.

A more detailed hydrologic study would be required to determine if the watershed itself can supply over 31,000 ML per year. Experience has shown that in most years there is more water available than can currently be stored. There have been years, however, when the reservoir lakes have not filled.

Intuitively, Duteau Creek does not appear to be suitable as a sole source of water for the service area. This conclusion is consistent with the Master Water Plan, which concluded that both Kalamalka Lake and Duteau Creek are required for future supply.

Staff will pursue additional storage (and license) on the Duteau Creek source, but a more reasonable goal would be maximizing the capture of available water to better weather consecutive dry years.

The other side to the original question is "To what extent can Kalamalka Lake service Greater Vernon". The Kalamalka Lake source is currently limited by available license. Existing demand utilizes approximately 75% of the license, and the remainder will be taken up by planned conversions and growth. It is estimated that the source will be fully utilized within 10 – 15 years, meaning that treatment of the Duteau source will have to be addressed in any case. Although no additional license is available on Kalamalka Lake at this time, staff is investigating the possibility of works to improve lake level management, which could in turn result in "new" license coming available.

- Q. *Can current customers be provided with a filtration unit in the home (i.e. point of entry device) and will this adequately address water quality issues?*
- A. Staff commissioned Urban Systems in 2004 to assess the viability of point of entry devices. The report indicated that the devices, utilizing a combination of treatments, could adequately address water quality concerns for isolated properties. Capital cost for four configurations ranged from \$11,000 to \$14,000 and annual operating costs ranged from \$2,200 to \$3,000 per unit.

The high cost for point of entry treatment stems from the Interior Health Authority's position on the devices. The IHA has stated that the operator of the water system is responsible for the operation, maintenance and testing of the devices. This leads to the requirement for outdoor kiosks, which are inaccessible to the property owner. To date the IHA has allowed point of entry devices in small numbers (less than 10), where centralized treatment has not been feasible. It is questionable whether the IHA would endorse point of entry as an alternative to centralized treatment for a large number of customers, as would be the case here.

Urban Systems determined that 1.5 full time operators and 1 full time vehicle would be required to adequately maintain 200 point of entry systems. If point of entry devices were adopted as an interim or even long term measure by the utility, the present value per unit would be approximately \$45,000. Conversion would likely reduce the number of households requiring point of entry devices to approximately 3,000. This would require a capital outlay of approximately \$36,000,000 for point of

entry devices and operating costs of approximately \$7.5 million per year and approximately 22 additional operators.

Point of entry devices are available to individuals for significantly less than \$11,000. Home membrane filtration units that can be purchased and installed for approximately \$4,000. These units will address health risk posed by giardia and cryptosporidium, and will reduce colour somewhat, but will not reduce disinfection byproducts. This is consistent with Urban Systems' findings that a combination of treatment processes (e.g. granular activated carbon with membrane filtration) is required to treat the water to the standards required by IHA. DBP targets may not be achieved regardless of the type of device.

For the reasons described above it would not be feasible for the utility to provide and be responsible for point of entry treatment to a large number of customers on the Duteau Creek source.

Q. *Can Black Mountain-style basin clarification be implemented?*

A. Earth Tech has indicated that crude sedimentation could be implemented at potentially lower cost, although the level of treatment would not meet the water quality goals set out in the Master Water Plan.

A study has been commissioned to assess the feasibility of improving water quality through improvements to Harvey Lake. Sediment deposited in Harvey Lake is stirred up in periods of high runoff, increasing turbidity at the intake. Silt barriers, partitioning of the lake and construction of a bypass channel were examined. It was determined that minimal benefit would be realized from these improvements. Turbidity could be reduced, but issues with colour and DBPs would remain.

Conclusion

The recommended option allows long-term water quality goals to be met within the original time frame and at a comparable overall price, but the short-term financial impact exceeds the borrowing authority granted in the 2004 referendum.

The GVSC has approved the following course of action:

- **Proceed with preliminary design on the basis of Earth Tech's conceptual design report;**
- **Confirm and purchase the site;**
- **Continue to pursue funding for the project, including appurtenances;**
- **Review funding options;**

Completion of preliminary design will support future grant applications and would allow flexibility to determine future project delivery methods (e.g. design-bid-build, design-build, EPCM or other variants).

References

1. Earth Tech 2005 "Duteau Creek Water Treatment Plant – Conceptual Design Report" – *in-camera pending site acquisition*
2. Earth Tech 2005 "Duteau Creek Water Treatment Plant – Pilot Testing Report"