City of Edmonton
Total Loadings Plan
(TLP)

June 1, 2009

Executive Summary

The City of Edmonton, Drainage Services developed this Total Loadings Plan (TLP) to fulfill a requirement of its Approval to Operate (No. 639-02-07). This TLP establishes a framework for limiting annual loadings of contaminants from municipal operations to the North Saskatchewan River. For this Plan, Total Suspended Solids (TSS) are analyzed and modeled into the future, and infrastructure works are proposed to limit TSS discharges to baseline levels. Due to the high variance of annual loadings, the baseline is defined as the long-term average TSS loading from years 2000 to 2008. This baseline level has been applied to year 2009 and projected forward to future years assuming "normal" weather, annual increases in TSS loadings from new urban development, and anticipated reductions in TSS loadings from TLP mitigative works. Long-term averaging of TSS loadings for comparison is appropriate because of year to year variations in weather and precipitation that influence TSS loadings. This TLP is not intended to be used for year to year regulatory purposes but rather for showing trend improvements. Future updates of the TLP may include a similar analysis of other contaminants such as total phosphorous depending on the direction of Alberta Environment, and their endorsement of this approach.

Some key findings from the work done to prepare the TLP are:

- urban drainage is the major source of TSS to the river;
- the Enhanced Primary Treatment (EPT) process at EPCOR's Gold Bar WWTP has the potential to reduce TSS loadings by about 2,200 kg/d;
- all the Stormwater Quality Strategy (SWQS) components - 2 wetlands, 2 low flow diversions, and staged Low Impact Development (LID) implementation - have a combined potential TSS reduction credit of 2,440 kg/d; and
- the core concept of limiting TSS loads to the baseline level (average of years 2000 to 2008) is attainable long term, accommodating urban growth and expansion, so long as LID practices are implemented to curb future loadings from new land development.

Proposed works to limit TSS discharges include:

- Enhanced Primary Treatment (EPT) – This newly completed $55M facility at EPCOR's Gold Bar WWTP provides basic treatment for high flows that currently discharge to the river;
- New WESS W12 River Crossing Sewer – This $44M facility (to be completed in 2010) diverts combined sewer discharges away from the river for treatment at the EPT facility at Gold Bar WWTP;
- Kennedale Wetland – a $7M facility providing end-of-pipe treatment to a 7,250 ha storm drainage basin which is now nearing completion;
- Groat Road end-of-pipe Facility – In the concept stages, this facility will provide treatment to a 1,844 ha highly urbanized storm drainage basin,

currently budgeted at $11 million *(contingent on land sharing/acquisition and facility design reviews)*

- Low Flow diversions – diverting storm sewer flows to the Gold Bar plant for treatment, currently budgeted at $3.5 million
- Continuous Monitoring - monitoring programs (currently exceeding $450,000 per year), are key to proving that the plan and facilities work
- Further Study – e.g. investigation of creek discharges, identified through the development of this plan as significant sources of TSS

Estimates of the benefits of these facilities and the increasing loads due to growth are analyzed in a model to forecast the TSS loads from the City of Edmonton into the future. The model shows that the facilities and expenditures noted above should be able to limit City of Edmonton TSS discharges to baseline levels (2000-2008) for future years. The TLP aligns and supports City of Edmonton's 10 year corporate strategic goal of preserving and sustaining Edmonton's environment and the 3 year goal of increasing and broadening advancement towards zero waste.

Annual reports to Alberta Environment will outline the progress of the proposed works and study, and the results of monitoring programs.

1.0 Introduction

This Total Loadings Plan (TLP) is submitted to Alberta Environment (AENV) as required under the City's Approval-to-Operate by June 1, 2009. The fundamental principle of the TLP is to establish a framework to limit annual loadings of Total Suspended Solids (TSS) and other key parameters like Total Phosphorus (TP) in the future to baseline levels – defined as an average TSS loading from years 2000 to 2008. TSS was identified in the 2005 total loading report entitled "*NSR Impact Study: Development of Total Loading Management Objectives for the City of Edmonton*" (Golder Associates Ltd.) as a key parameter for river water quality. It also serves as a surrogate for other pollutants such as metals and is generally accepted as a key indicator for aquatic health in urban receiving watercourses. Recent multi-stakeholder work by AENV, North Saskatchewan Watershed Alliance (NSWA), and the City also indicated that TSS is a key water quality parameter (*Draft Summary Report on Setting Reach-Specific Objectives for the North Saskatchewan River*, March 2009, Golder Associates Ltd.).

A major step towards building this framework was the City developing its Stormwater Quality Strategy (SWQS). The SWQS directly supports the goal of TSS control to protect NSR water quality and aquatic health. In response to the SWQS (June 2008), AENV has directed the City to establish key performance indicators for water quality in the NSR and to establish clear and achievable reduction targets of key performance indicators. The draft TLP addresses the letter request from AENV dated July 23, 2008.

This framework is based on a numerical model that accounts for various major source loads of TSS to the river, namely: storm outfalls, combined sewer overflows (CSOs), and EPCOR's Gold Bar WWTP. The CSO Control Strategy is also fundamental to the TLP as it involves the Enhanced Primary Treatment (EPT) process being implemented at Gold Bar WWTP. This framework is a process that can evolve to include TP and other core parameters of interest, and shows that watershed monitoring and load reduction monitoring of particular treatment processes are critical aspects of the TLP. As the operator of the Gold Bar WWTP, a major source of TP, EPCOR will be more involved in future work related to the development of a TP framework.

2.0 Background

The TLP Framework provides a mechanism to benchmark clear and achievable targets for TSS control, and other core parameters such as TP. The framework is based on establishing a base level of TSS loading based on years 2000 through 2008. This average TSS load was then applied to 2009 to set the baseline level for future years as the compliance target. Although the units used are kg per day, it is in fact an annual load which is divided by the number of days in a year, i.e. 365. Annual variations in precipitation are not accounted for in the framework.

The baseline TSS loading applied to year 2009 was estimated (based on years 2000-2008) to be about 29,000 kg/d. This represents the regulatory compliance target to be met by 2015 (date of renewal for the Approval to Operate) and in future years. Each year new urban land development is assumed to be about 400 ha, contributing an estimated additional loading of 264 kg/d (assuming all traditional land development). The EPT process and a collective set of TSS control measures under the SWQS can provide as much as a 4,600 kg/d total reduction. This however assumes that EPT and end-of-pipe constructed wetlands function at a high level of treatment efficiency – a fact that needs to be confirmed through monitoring. Provided the EPT and SWQS systems perform as is assumed, projected TSS total loading to the NSR in 2020 is about 27,000 kg/d as shown in the table below.

	TSS Loads (kg/d)	
	2009	**2020**
Cumulative New Lands Developed	264	2,837
Kennedale Storm Outfall	2,550	1,382
Groat Road Storm Outfall	3,162	2,444
Quesnell Storm Outfall	5,441	4,917
30th Ave Storm Outfall	3,776	3,719
Mill Creek	4,890	4,890
Other Storm Outfalls	3,369	3,369
Total Storm	**23,452**	**23,558**
Rat Creek CSO	1,870	475
Other CSOs	224	224
Total CSOs	**2,094**	**699**
Gold Bar Final Effluent	1,779	1,953
Gold Bar Combined Bypasses	1,543	483
Gold Bar EPT	0	262
GBWWTP	**3,322**	**2,698**
Total TSS Loading to NSR	**28,868**	**26,955**

The goal of the TLP is achievable – TSS loads can be effectively capped to baseline levels (years 2000-2008) for the City of Edmonton and it is anticipated this can be done in a fiscally responsible, cost-effective manner. A caveat however is that in any given year, above average precipitation can result in TSS loadings higher than the baseline level of about 29,000 kg/d. For this reason, multi-year moving averages will be used to assess long-term performance.

Figure 1 shows the TSS load balance for major sources comparing the baseline level year as shown for year 2009 to the projected TSS load in 2020 assuming the EPT and SWQS are fully implemented. Figures 2 and 3 illustrate the breakdown of the TSS loads for years 2009 and 2020, respectively. The increase in TSS loadings that comes from new urban land development is evident in comparing these figures. Another interesting finding is the considerable loading from Mill Creek. Other creeks such as Whitemud Creek are not included in the TLP Framework because of a lack of monitoring data.

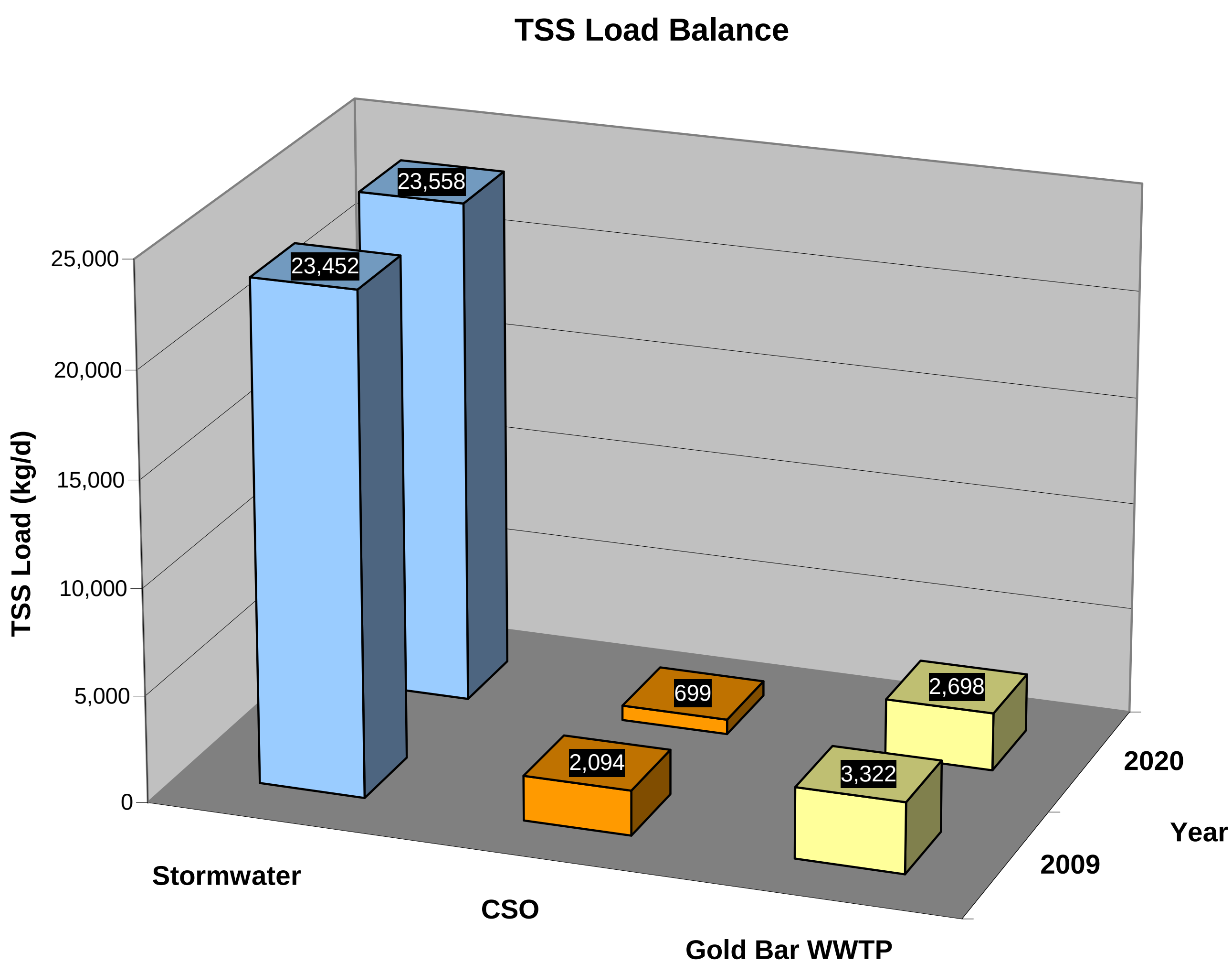

FIGURE 1. 2009 versus 2020 TSS Load Balance for Major Sources – Assuming Full EPT & SWQS Implementation.

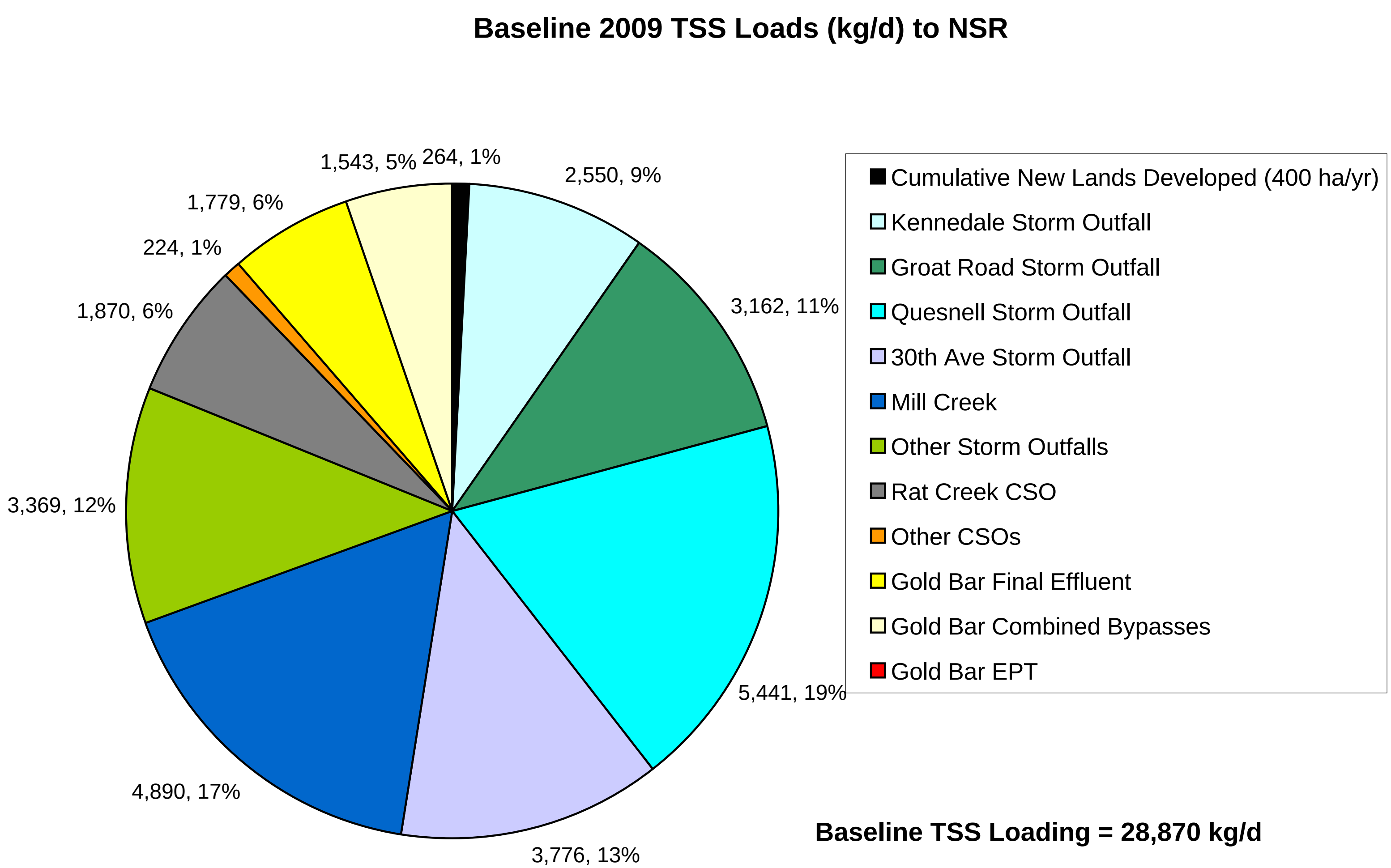

FIGURE 2. 2009 Baseline TSS Loadings (kg/d) and Relative Percentages

Projected 2020 TSS Loads (kg/d) to NSR

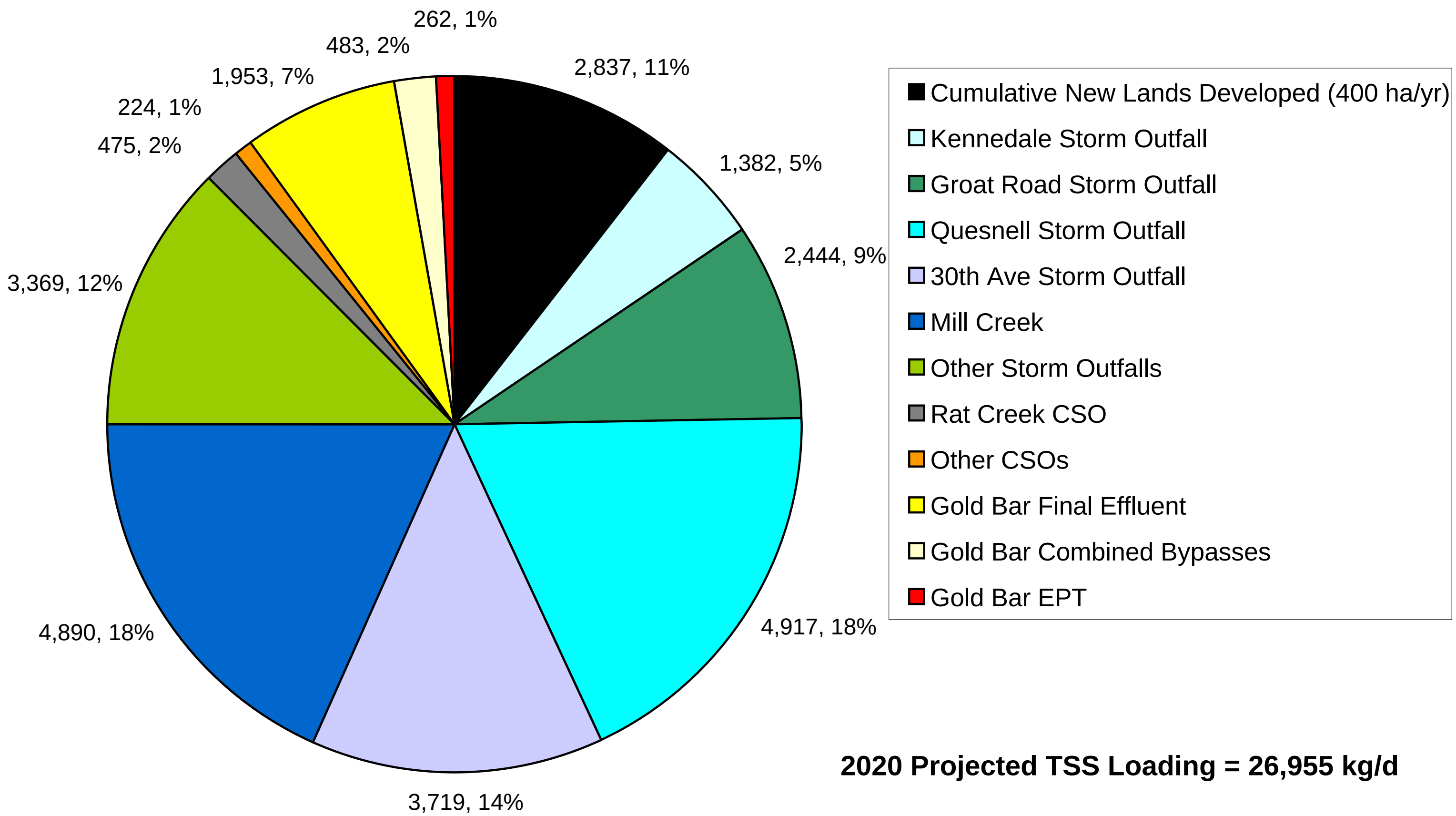

FIGURE 3. Projected 2020 TSS Loadings (kg/d) and Relative Percentages

3.0 Loadings Framework

The City's Approval-to-Operate requires that a Total Loadings Plan for implementation be developed to limit the loadings of select pollutants, in particular suspended solids, from all sources of City discharges to the NSR. Edmonton's Approval to Operate is based in principle on a total loadings framework. This management model serves to encourage Best Management Practices (BMPs) and Low Impact Development (LID) technology adoption. It is anticipated that the Province's regulatory framework stemming from the Water for Life Strategy will place more focus on urban stormwater issues in the years to come.

3.1 Benchmarking TSS Baseline Levels

The TLP Framework assumes that capping City of Edmonton TSS discharges to baseline levels is appropriate to ensure a healthy and safe river aquatic ecosystem. Due to the high variance of annual loadings, a long-term average is appropriate for baseline conditions (2000 through 2008 years were used). The 2005 total loading report "*NSR Impact Study: Development of Total Loading Management Objectives for the City of Edmonton*" (Golder Associates Ltd.) concluded that the average TSS loadings from years 1994 through 2004 were not causing observable biological effects. Recent TSS annual loadings were therefore deemed acceptable. Hence, limiting TSS loads to baseline levels should be appropriate.

Recent multi-stakeholder work on setting in-stream water quality objectives for the river reach of Devon to Pakan, (*Draft Summary Report on Setting Reach-Specific Objectives for the North Saskatchewan River*, Golder Associates Ltd.), indicated that TSS loadings exceed Canadian Council of Ministers of the Environment (CCME) draft guidelines. CCME (1999) recommends that during clear flow, the maximum average increase should be no more than 5 mg/L above background levels for long term durations. Based on median concentrations sampled from the long-term monitoring network, the TSS concentration (open water, flows < 350 m3/s) at Devon and Pakan is 12 and 20 mg/L, respectively. If Edmonton was the only source of TSS in the river reach of Devon to Pakan, the CCME approach would give a target TSS limit of 17 mg/L at Pakan. In other words, current TSS loadings appear to be already exceeding the draft guideline in-stream TSS water quality objective.

3.2 Load Framework Principles

The TLP will address load reductions from all major sources: storm, combined sewer, and sanitary. Near term reductions in CSO loadings can be measured, and long term gains from storm reductions will require on-going implementation of the SWQS. Some guiding principles of the TLP include:

- Operate the Gold Bar BWWTP and EPT process to maximize overall load reduction (in addition to meeting end-of-pipe effluent limits);
- Implement the SWQS and related programs such as LID;
- Commitment to TSS reduction, but also continue to monitor other parameters such as nutrients and bacteria;
- Monitor and report load reductions from EPT and Kennedale wetland to confirm performance assumptions;
- Pursue pilot demonstration projects for testing new stormwater design technologies; and
- On-going watershed monitoring programs.

3.3 GBWWTP/EPCOR Implications

With ownership and operation of the Gold Bar WWTP having been transferred to EPCOR Water on April 1, 2009, the operation of the EPT process is now the responsibility of EPCOR. The following assumptions have been made with respect to the role that EPT has and its effect on the TLP's goal of TSS control.

1. EPT and WESS W12 are fully operational by 2011.

2. On wet weather days, EPT takes on average 1,190 ML per year of Rat Creek CSO flow diverted to Gold Bar WWTP via WESS W12.

3. On wet weather days, EPT also takes on average 2,000 ML of flow from the headworks that would otherwise be combined bypass flow (nearly 100% secondary bypass flow).

4. Gold Bar WWTP final effluent (FE) TSS concentration = 7 mg/L

5. GB's EPT effluent TSS concentration = 30 mg/L

6. In 2016, Quesnell low-flow diversion averages 10 ML/d of storm flow to Gold Bar WWTP for treatment in main plant (FE concentration of 7 mg/L). On wet days when Rat Creek CSO overflows exceed 10 ML/d, it is assumed that the real time control shuts down the Quesnell low-flow diversion (this occurs an estimated 34 days per year).

7. In 2017, 30th Avenue low-flow diversion averages 1.4 ML/d of storm flow to Gold Bar WWTP for treatment in the main plant. No flow is diverted to Gold Bar WWTP on wet days (when any volume is discharged at Rat Creek CSO) – occurs an estimated 55 days per year.

4.0 TLP Components

The TLP builds on the City's CSO Control and SWQ Strategies already underway. The City has a long history of watershed protection efforts with major facilities such as Fulton Creek Marshland, Roper Pond, Pylypow Constructed wetland, Mill Creek Oil Removal Facility, and more than 13 wetlands and 70 wet ponds for managing urban runoff. As part of this work, specific outcomes for controlling TSS include:

- EPT at Gold Bar WWTP, along with the W12 trunk connecting north side CSO flows to the plant;
- end-of-pipe constructed wetlands on the Kennedale and Groat Road storm systems in Hermitage and Government House Park, respectively;
- low-flow diversions to convey stormwater in the Quesnell and 30th Avenue storm trunk sewer to Gold Bar WWTP for treatment in the main plant; and
- staged implementation of Low Impact Development (LID) urban drainage design practices.

4.1 TLP-Related Studies

The TLP has been in the works for many years and builds on a solid foundation of various monitoring, conceptual, and feasibility review studies. Some of these works completed and proposed are listed below.

- *Environmental Monitoring Program (EMP) and NSR Intake Sampling (an annual program dating back to 1994)*
- *NSR Impact Study - Development of Total Loading Management Objectives for the City of Edmonton (2005)*
- *Major Storm Outfall Mitigation and BMP Implementation Study (2006)*
- *Stormwater Quality Enhancement Study (early 2009).*
- *City of Edmonton Load Prioritorization Study (2009)*
- *Sediment Capture Study (2009)*
- *LID Design Standards and Planning (2009)*
- *LID cost study (2009)*
- *Government House Park End-of-Pipe Constructed Wetland Design Study (2009)*
- *Low-flow Diversion Detailed Design (2009)*
- *Concept Review Study for 30th Avenue (2010).*
- *Green Roof Monitoring Study (2009).*

4.2 Setting Clear and Achievable Targets

The TLP builds on the earlier work of the June 1, 2008 SWQS and addresses AENV's request for clear and achievable targets – for TSS at first:

- key performance indicators for NSR water quality;
- reduction targets for key performance indicators; and
- reporting protocols.

4.3 Stormwater Quality Strategy

The Stormwater Quality Strategy is a multi-million dollar program with a 2006-2018 timeline.

4.3.1 End-of Pipe Load Reductions

- Kennedale basin and its end-of-pipe constructed wetland project. This project is at the final construction stages at a projected cost of $10 million. This is a major cornerstone project in the overall Stormwater Quality Strategy as this facility will provide treatment of baseflow and runoff from small rainstorms for Edmonton's largest storm basin. This single facility can provide a measurable reduction in annual loadings.
- Assess site potential for end-of-pipe facilities in Groat Road basin at Government House Park, currently starting conceptual design.
- Monitor to assess end-of-pipe facility performance for pollutant load capture.

4.3.2 Low-Flow Diversion Load Reductions

- 2 low-flow diversions, Quesnell and 30th Avenue storm sewer trunks.

4.3.3 Retrofit Projects

- Oil/grit separators.
- bioswales (e.g. Altalink-Cumberland project).

4.3.4 Integrated Stormwater Management Design

- Low Impact Development (LID) design principles.
- Constructed wetland design guidelines.
- Policies that promote sustainable water resource use: preservation of natural areas and mitigation of impacts on natural wetlands and riparian protection.
- Big Lake Neighbourhood One bioswale design.

- Griesbach LID pilot by Canada Lands Corporation.
- The Quarters project for east downtown (subject to funding).
- North-East Area Structure Plan includes concept of Eco industrial development.

4.3.5 Partnering

- City Operations Water Use Management Committee.
- Examining re-use opportunities for grey water, stormwater and membrane filtered wastewater.
- Alberta Low Impact Development Partnership (ALIDP).
- Water Balance Model available in 2009 for urban hydrology design.
- North Saskatchewan Watershed Alliance (NSWA) for watershed management.

4.3.6 Education & Outreach

- Erosion & Sediment Control Guidelines and Field Handbook
- Treat It Right! Outreach Program for Grade 5 students, coordinated with Inside Education – piloting school visits to constructed wetlands in June 2008.

4.4 CSO Control Strategy

The CSO Control Strategy is a long-term program to improve capture and treatment of combined sewer overflows otherwise discharged to the river. The Strategy includes major infrastructure improvements such as construction of an Enhanced Primary Treatment (EPT) facility ($55 million) at the Gold Bar WWTP and the WESS W12 tunnel conveyance ($44 million) to the wastewater treatment plant.

4.5 Interconnection (I/C) Strategy

The I/C Strategy is an on-going program to monitor and eliminate dry weather sanitary overflows into the storm sewer system. From an original 390 I/C sites, the City has closed off some 248 sites and has only 142 I/C sites remaining. Of these remaining sites, overflow data and system hydraulics are reviewed. Whenever feasible, the interconnection is sealed-off to prevent further discharges to the receiving watercourse via storm sewers. The focus of the I/C Strategy is to better control bacterial discharges to the NSR. An updated I/C Strategy has been developed for 2010-2015, with a capital budget allocation of $5 million. Interconnections will be rectified on a neighbourhood approach focusing on McKernan, King Edward Park and Oliver in the early years and later on Rossdale, Bellevue and Crestwood.

5.0 Other Supporting Programs

The following programs support the goals of the TLP but are not included in the TSS load reduction model.

5.1 Catchbasin Cleaning

As part of the routine maintenance of the stormwater collection system, catch basin cleaning diverts a significant amount of sand, silt and other debris from the North Saskatchewan River. The source of the material is mainly the sand and grit that is spread on the roadways during the winter months. Every spring and summer, catchbasin cleaning is conducted on the major roadways, including all bus routes and the heavily sanded hills in the downtown area. During the past five years approximately 60,000 catchbasins were cleaned and 11,500 tonnes of sand and debris was removed. The catchbasin sumps are design to capture most of the sand and silt that enters the storm and combined sewer systems and the removal of the material reduces the negative environmental impact of the storms outfalls on the river. This work is in addition to the street sweeping efforts of the City's Transportation Department.

5.2 Pylypow Wetland

The Pylypow Regional Constructed Wetland is planned as a regional off-stream naturalized stormwater management facility, to be located adjacent to Fulton Creek in southeast Edmonton. The facility will mitigate the risk of local flooding at the entrance to the Argyll stormwater tunnel by better controlling runoff from existing and future developments in the Fulton Creek basin. By reducing peak flows and providing stormwater retention time, the wetland will also improve stormwater runoff quality. A monitoring program will be implemented to estimate the site's TSS annual load capture.

5.3 Morris Pond

The City of Edmonton has acquired a 10 ha wetland located in southeast in Edmonton near Goldbar Creek. It lies within the existing Goldbar Creek floodplain and presently provides flood attenuation for the creek. Goldbar Creek between the tablelands and the North Saskatchewan River is sensitive to water erosion. Further upstream developed areas along the Creek are subject to flooding. This wetland facility will provide flood control, erosion control, and water quality improvement benefits for the Goldbar Creek watershed.

5.4 Double Barrel Replacement Program

Drainage Services is presently designing the Mill Woods Double Barrel Replacement Project, and it will begin construction in 2009 with completion in

2012. The project will construct approximately 3.4 km of large diameter storm sewer and convert approximately 3 km of existing double barrel trunk sewer pipe into sanitary sewer at a cost of about $32 million. This work will prevent the recurring leakage of sanitary sewage into the storm sewer in the existing double barrel pipe.

5.5 Flood Prevention Program

Severe rainstorms in July 2004 caused flooding on streets, roadways and in more than 4,000 homes throughout Edmonton. As the result of the flooding, Drainage Services developed and implemented the Flood Prevention Program at an estimated cost of roughly $150 million. A public education program informs homeowners on how to make lot-level drainage improvements, and includes the following: Home Flood Prevention Check-up; Public Information Campaign; and Neighbourhood Education Initiative.

5.6 Erosion & Sediment Control (E&SC) Related Programs

Drainage Services has developed the City's E&SC Guidelines and a Field Manual to guide subdivision inspection staff on implementing E&SC best management practices for the land development industry and City in-house projects. The Branch also has an Overland Drainage Program, with a capital budget of about $0.8 million, to address localized flooding and related erosion problems caused by overland flow. Erosion studies for Whitemud Creek and Blackmud Creek have also been undertaken to establish allowable peak runoff rates from developed basins.

6.0 TLP Framework Metrics

Table 1 provides a high level summary of the findings of the TLP framework calculations. For further details, refer to Tables A1-A4 in the Appendix A. Footnotes detail the assumptions such as annual increase in Gold Bar WWTP final effluent volumes of +0.5% per annum. Assumptions are given in the table footnotes on details such as annual increase in Gold Bar WWTP final effluent volumes of +0.5% per annum. For the purposes of tables and illustrative charts to assist in explaining the findings, "Full TLP Implementation" assumes that all the mitigative measures to control TSS are being implemented, these are: EPT, Kennedale and Groat treatment facilities, Quesnell and 30th Avenue low flow diversions, and the proposed staged implementation of LID for new land development. The LID assumption is that starting in year 2010, 10 ha (from a total of 400 ha) is developed using LID principles and each successive year an additional 10 ha is LID development resulting in 110 ha being LID in 2020 (the remaining 290 ha being traditional development).

Figures 4-10 illustrate the findings from the TLP framework calculations. Figure 4 provides a benchmark of potential TSS control that each of the SWQS and EPT technologies can provide. Again, this is theoretical and based on assumptions that can only be proven out with monitoring of the full scale system in day-to-day operation. It does however suggest that the EPT tank at Gold Bar WWTP has a significant role in controlling TSS in the City in the short to medium term. Beyond 2020, LID has the potential to defer future requirements to build end-of-pipe treatment facilities. Figure 10 shows the major benefits that would accrue with respect to TSS control if LID was implemented fully – assuming that all new lands developed had only 25% of the annual runoff volume of traditional urban land development.

TABLE 1. Summary of Measured and Projected TSS Loads (kg/d) and EPT & SWQS Reductions

Year	System Improvements	Total Stormwater (kg/d)	CSO Total (kg/d)	GBWWTP Total (kg/d)	**Total Load (kg/d)**	GBWWTP EPT Net Reduction (kg/d)	Kennedale Facility Net Reduction (kg/d)	Groat Facility Net Reduction (kg/d)	Quesnell 10 ML/d Low-flow Diversion Net Reduction (kg/d)	30th Ave 1.5 ML/d Low-flow Diversion Net Reduction (kg/d)	Staged LID Implementation Net Reduction (kg/d)	**Total Load Reduction (kg/d)**
2000		20,930	2,306	3,391	**26,627**							
2001		18,413	2,371	3,856	**24,640**							
2002		13,954	1,118	2,272	**17,344**							
2003		23,388	2,474	3,749	**29,611**							
2004		27,981	3,465	2,953	**34,399**							
2005		20,144	2,045	3,775	**25,964**							
2006		21,240	2,560	2,898	**26,698**							
2007		27,690	1,390	4,231	**33,311**							
2008		27,086	1,112	2,667	**30,865**							
2009		23,452	2,094	3,323	**28,868**							
2010	Kennedale and LID	22,543	2,094	3,331	**27,968**		1,168				5	**1,173**
2011	EPT starts	22,797	699	2,542	**26,037**	2,193	1,168				10	**3,371**
2012	Groat wetland	22,328	699	2,551	**25,577**	2,193	1,168	717			15	**4,093**
2013		22,572	699	2,560	**25,830**	2,193	1,168	717			20	**4,098**
2014		22,811	699	2,569	**26,078**	2,193	1,168	717			25	**4,103**
2015		23,045	699	2,578	**26,321**	2,193	1,168	717			30	**4,108**
2016	Quesnell low-flow div.	22,750	699	2,651	**26,100**	2,193	1,168	717	460		35	**4,573**
2017	30th Ave low-flow div.	22,917	699	2,669	**26,285**	2,193	1,168	717	460	48	40	**4,626**
2018		23,136	699	2,679	**26,513**	2,193	1,168	717	460	48	45	**4,631**
2019		23,350	699	2,688	**26,737**	2,193	1,168	717	460	48	50	**4,636**
2020		23,559	699	2,697	**26,955**	2,193	1,168	717	460	48	55	**4,641**

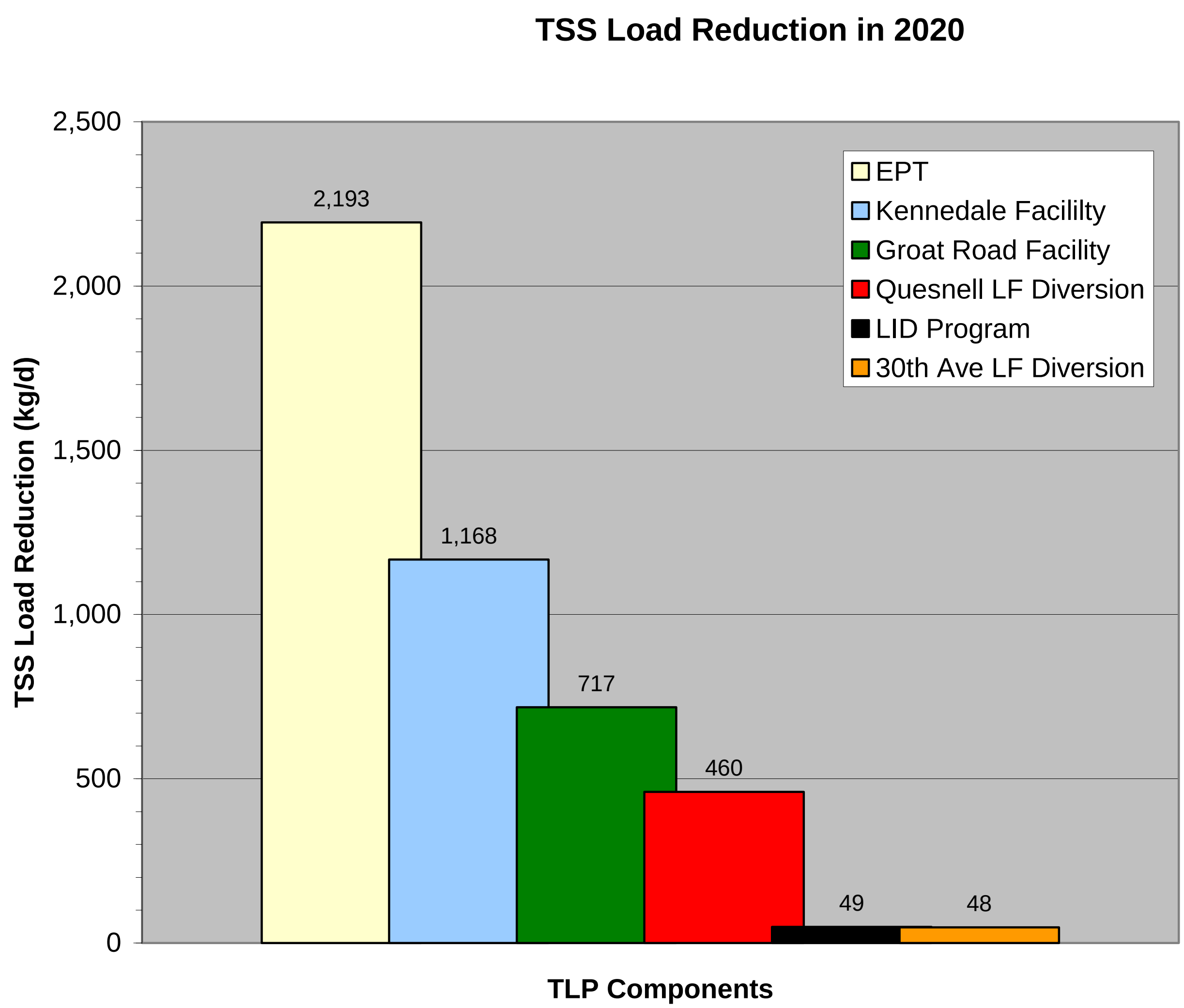

FIGURE 4. Net TSS Load Reductions (kg/d) for EPT and SWQS in 2020.

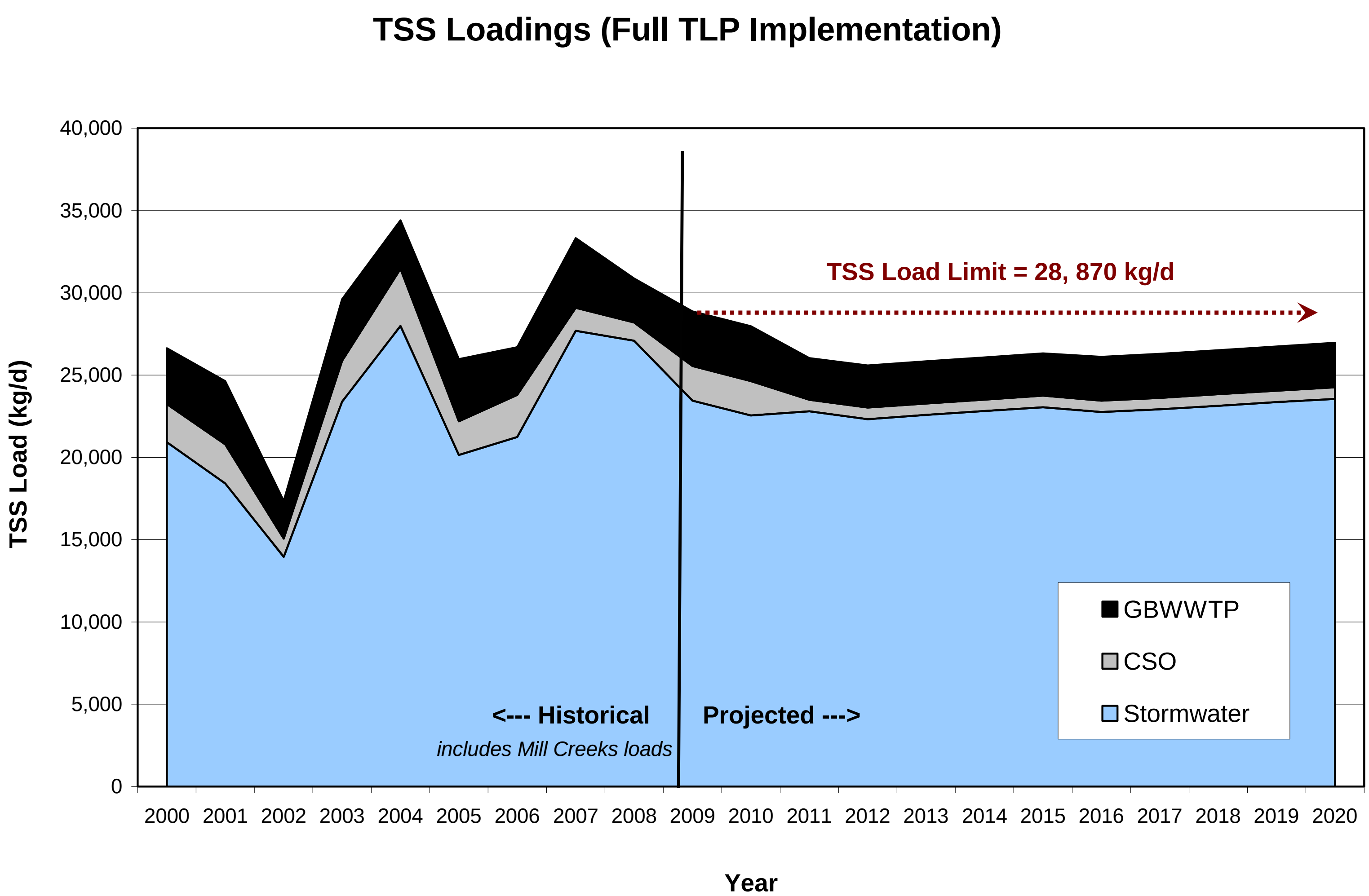

FIGURE 5. Measured and Projected TSS Loads (kg/d) Discharged to NSR from Major Sources – Assuming TLP & SWQS Implementation to 2020.

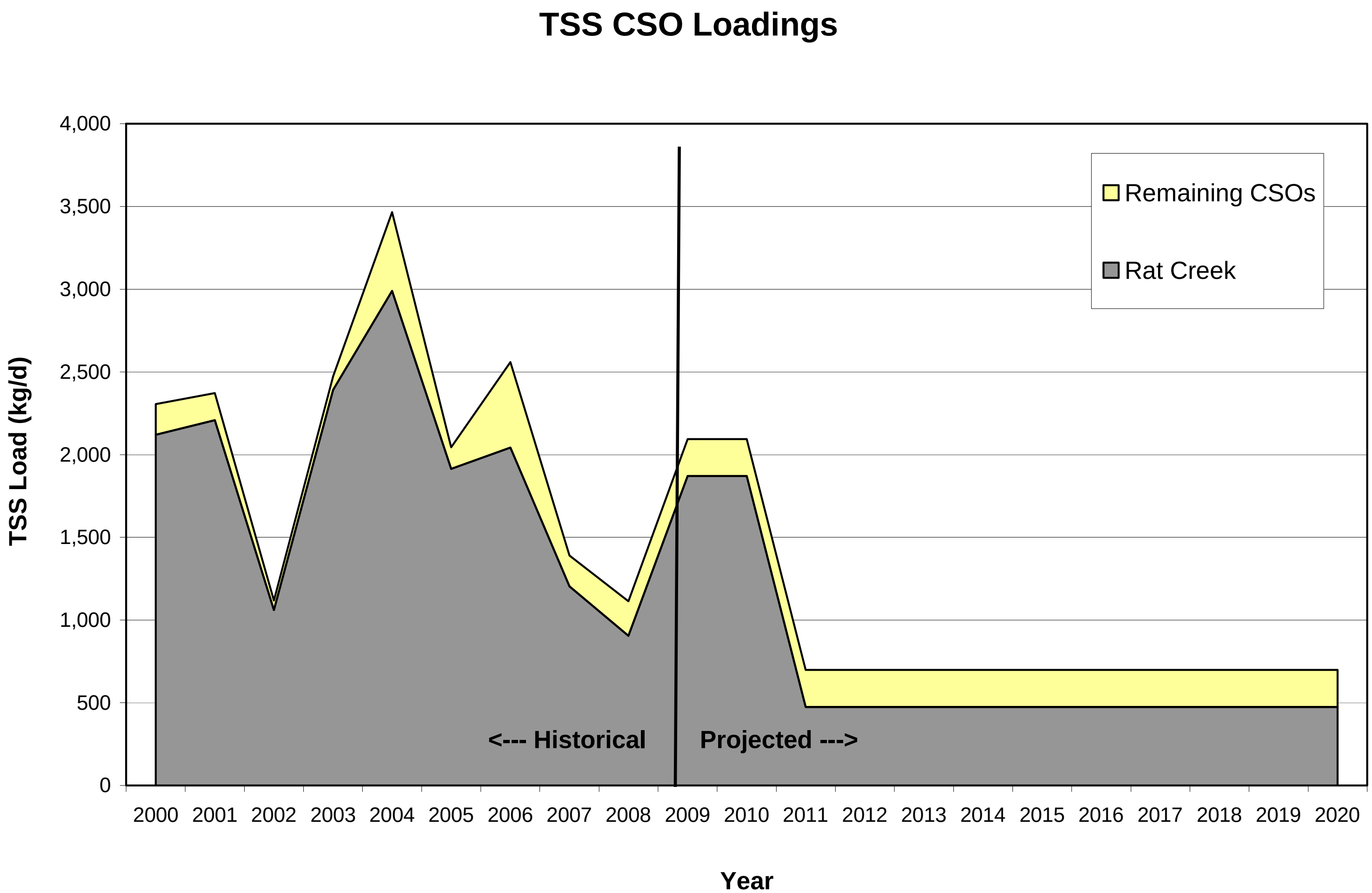

FIGURE 6. Measured and Projected TSS Loads (kg/d) from Combined Sewer Overflows (CSOs) to NSR – Assuming WESS W12 Conveyance of Rat Creek Flows of 1,190 ML per year to EPT at GBWWTP.

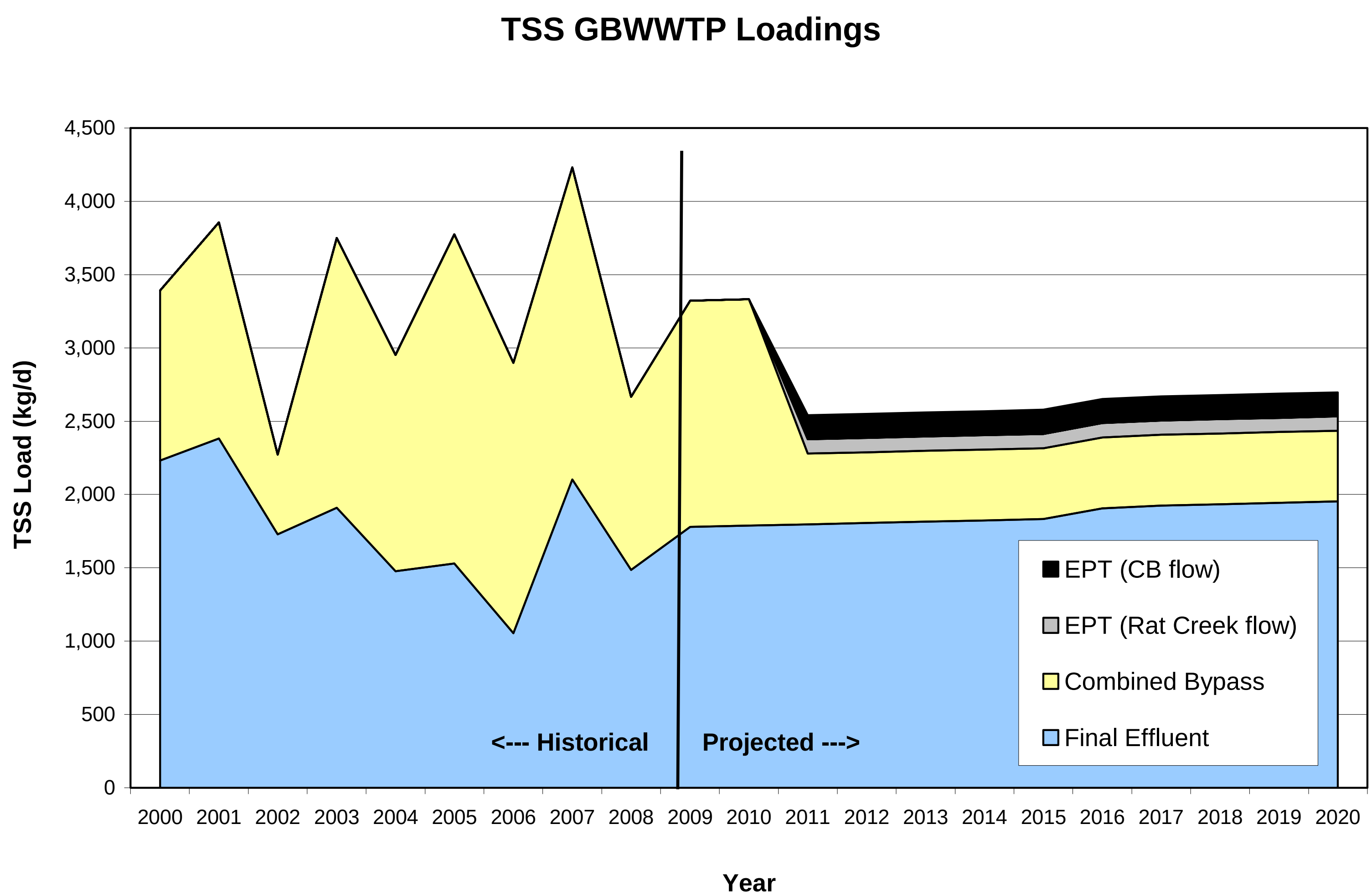

FIGURE 7. Measured and Projected TSS Loads (kg/d) from GBWWTP to NSR. Final Effluent Increases With Time Based on an WW Effluent Annual Flow Rate Increase of +0.5% and Quesnell & 30th Ave Trunk Sewer Low Flow Diversions in 2016 and 2017, respectively; Peak Wet Weather Flows Diverted to EPT Resulting in a Decrease of 2,000 ML per year of Secondary Bypass and Treatment of 1,190 ML of Rat Creek CSO from WESS W12; and EPT Loading Based on an Effluent TSS Concentration of 30 mg/L.

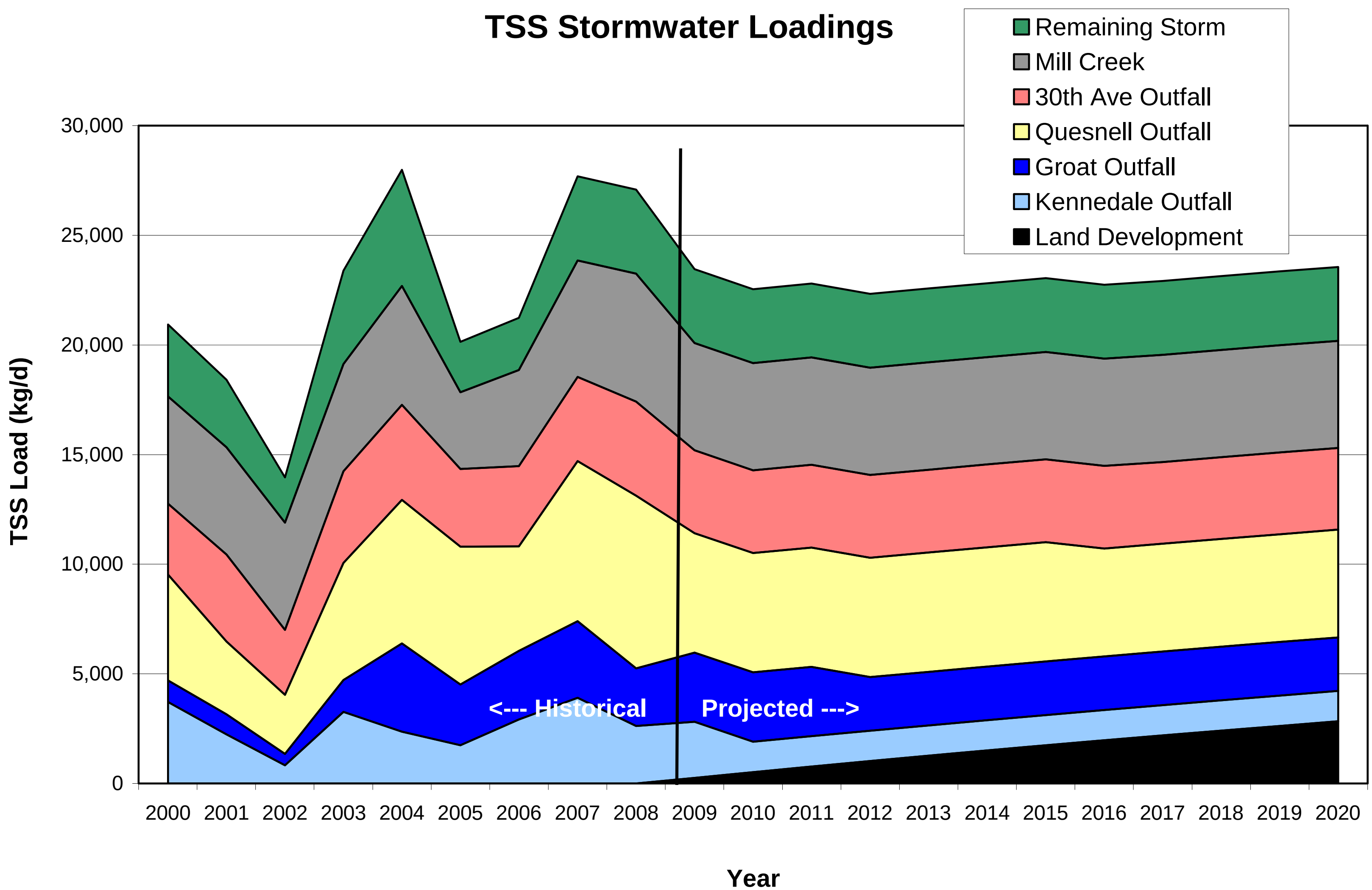

FIGURE 8. Measured and Projected Stormwater TSS Loadings (kg/d) from All Storm Outfalls and New Land Development (400 ha of land developed per year, with each year having an additional 10 ha of land developed based on LID Criteria) – Assuming TLP & SWQS Implementation to 2020.

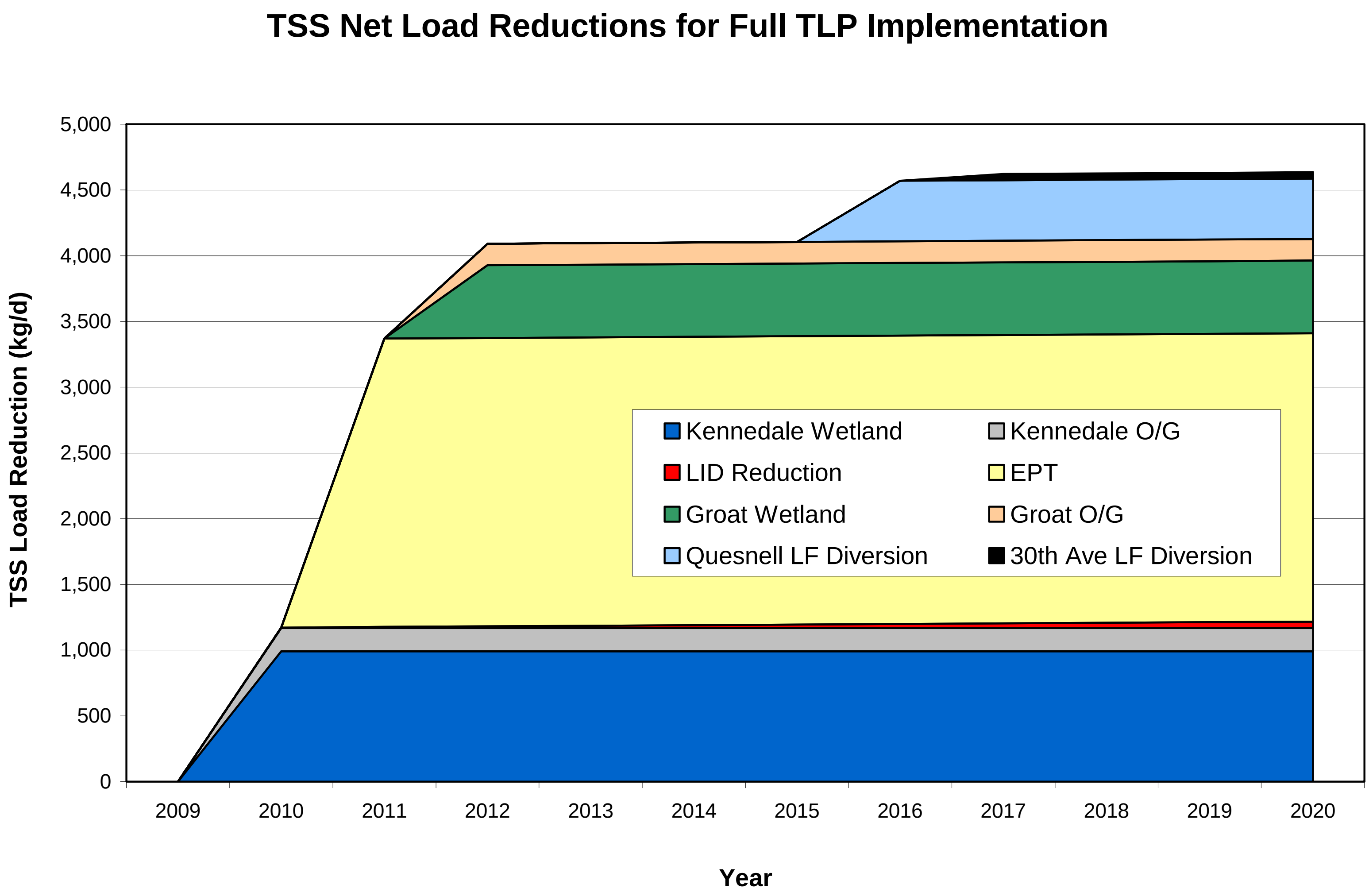

FIGURE 9. Estimated Net TSS Load Reductions (kg/d) from EPT Treatment of Rat Creek CSO & GBWWTP Combined Bypasses, End-of-Pipe Constructed Wetlands for Kennedale & Groat Road Storm Trunks, Low-flow Diversions for Quesnell & 30th Ave Storm Trunks, and Incremental LID Implementation (400 ha of land developed per year, each year having an additional 10 ha of land LID developed).

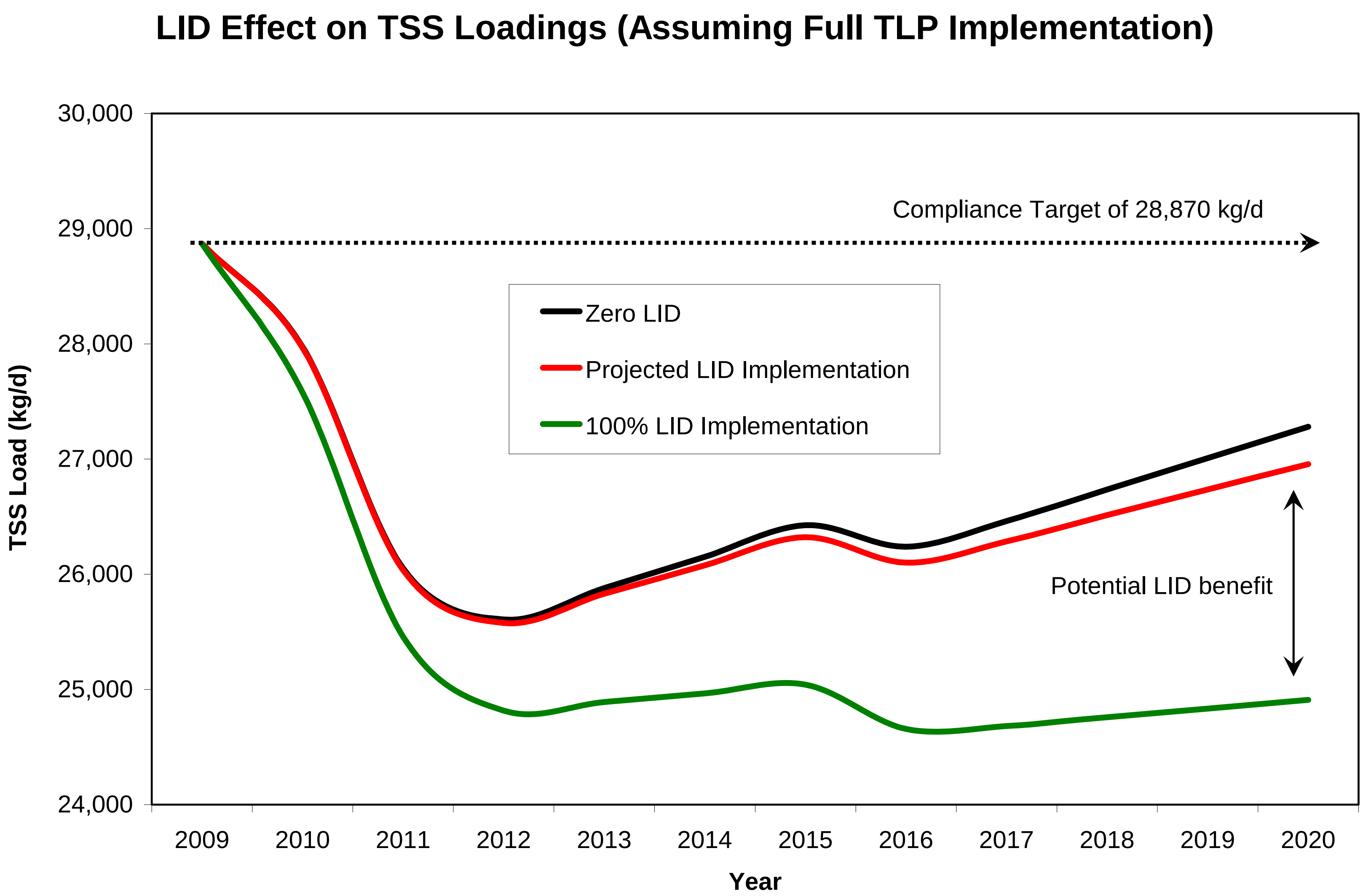

FIGURE 10. Potential for LID to Reduce TSS Loadings – Assuming Full EPT & SWQS Implementation, Developing All New Lands 100% Using LID Criteria (green line) versus Staged LID Implementation (red line).

7.0 Watershed Monitoring

The following is a listing of various watershed monitoring programs:

- Annual EMP and NSR river sampling;
- Quasi real-time river water intake sampling;
- Biological diversity assessment of constructed wetlands;
- Future site monitoring of the Kennedale constructed wetland;
- Site monitoring of Altalink-Cumberland bioswale;
- Monitoring of Clover Bar Creek and Mill Creek Roper Pond for site risk management;
- Monitoring for stormwater retention on any porous pavement surfaces installed on future demonstration sites in the Griesbach development or City-owned parking lots; and
- Annual system-wide total loadings assessment and reporting.

The TLP for TSS is based on the best available watershed data from piped outfalls, in-stream river monitoring, and daily computations archived in the Loads Calculator spreadsheets. A baseline TSS loading has been developed for year 2009 to serve as the TSS load limit. It is necessary that assumptions be made, and hence it is essential that a robust monitoring program continue to validate and refine these assumptions. Particulars that need to be validated with real-world monitoring is the net removal efficiencies in the EPT process at Gold Bar WWTP, the proposed oil/grit separators and end-of-pipe constructed wetlands at the Kennedale and Groat Road sites. The Framework provides an envelope of likely outcomes for TSS control performance but real-world data is needed to confirm on a multi-year basis.

The TLP suggests that with full implementation of the TSS control measures, and the assumed level of site treatment performance, that TSS can be capped at baseline levels up to about 2028. This accounts for continued urban growth and expansion until then. This is likely a best-case scenario given that site performance or process upsets in the EPT can easily reduce TSS control efficiency. The Framework does strongly suggest however that the goal of limiting TSS to 2005-era loadings is achievable by 2015. Mitigative measures such as EPT and end-of-pipe treatments provide effective stop-gap measures to achieve short and medium term expectations. Past 2020, the benefits of LID become more apparent with the “build it right the first time” design philosophy. Future urban development that contributes only marginal incremental TSS loading is more sustainable. Figure 10 illustrates the large potential benefits from having new lands being developed in accordance with LID principles of reduced stormwater runoff and hence reduced loadings. This concept aligns with the Drainage Branch’s new vision in the Zero Discharge Strategy.

Further work and discussion is needed to develop an accepted method for normalizing wet and dry years. TSS loadings vary considerably depending on the amount of precipitation in a given season and year. It is expected that some rules of thumb will be established in partnership with AENV to equalize loadings for some rainfall equivalent-depth. The specifics need to be worked out but this provides a means to relate years with differing precipitation amounts.

8.0 TLP Reporting

The TLP is intended to be an evolving framework that is regularly reviewed and updated to include the latest information from on-going watershed monitoring programs. An annual update report on the TLP would be submitted to AENV June 1st for information purposes. Again, this is a collaborative process and it is expected that assumptions on future loading rates would be revised as more information becomes available. Longer-term averages for loadings will be used to assess performance.

This framework for TSS is not parameter-specific, but rather serves as a template for other key parameters. The next parameter to be assessed using this framework will be TP. It is expected that a supplemental TLP report for TP will be submitted to AENV following the acceptance of this report.

9.0 Regional TSS Framework

The TLP Framework was specifically developed to address the City's Approval-to-Operate regulatory commitments. This approach provides a numerical platform easily adapted to include other loading sources such as EPCOR's Water Treatment Plant discharges and also the Capital Region's WWTP. It is expected that data EPCOR Water Services' Residual Management Program report will be included into a metro-region TLP in future years. The annual Environmental Monitoring Program (EMP) led by the City involves collaboration with EPCOR and the Capital Region for in-stream river monitoring. Further expansion of this Framework could include downstream discharges to the NSR from the Industrial Heartland.

10. TLP Implementation

Implementation of the TLP will be managed by Drainage Services. An annual summary report for information purposes will be produced highlighting progress on action plan items updating forecasts and estimates.

The TLP identifies the following major tasks to accomplish the TSS loading reduction target:

<u>Timeline:</u>

2009 Undertake related studies such as Stormwater Quality Enhancement Study, City of Edmonton Load Prioritization Study, Groat Road Wetland Concept Design, LID Design Guidelines, and others.

2010 Operation of Kennedale Wetland and Oil/Grit Separator.
Implement LID at an assumed rate of 10 ha of new development per year.
Begin design and construction of Groat Wetland and Oil/Grit Separator.

2011 EPT operation at Gold Bar WWTP and completion of the WESS W12 Tunnel sewer. Direct flows from Rat Creek CSO to EPT.

2012 Operation of Groat Wetland and Oil/Grit Separator.
Design and construct Quesnell and 30th Ave Low Flow Diversions.

2016 Operation of Quesnell Low Flow Diversion.

2017 Operation of 30th Avenue Low Flow Diversion.

The action plan items listed above will be monitored to document loading reductions and to verify assumptions.

Appendix A:
TSS Numerical Framework Tables

TABLE A1. Measured and Projected Stormwater Volumes Discharged to NSR

Year	System Improvements	Stormwater Measured & Projected Volumes Discharged to NSR													
		New Land Development			Kennedale		Groat Road		Quesnell		30th Ave		Mill Creek	Other	**Total Stormwater**
		Traditional (ha)	LID (ha)	New Runoff (ML)	Direct (ML)	Wetland + O/G (ML)	Direct (ML)	Wetland + O/G (ML)	Direct (ML)	LF Diversion (ML)	Direct (ML)	LF Diversion (ML)	(ML)	(ML)	**(ML)**
2000		374	0	550	11,676	0	2,602	0	11,478	0	13,414	0	12,267	10,298	**49,468**
2001		266	0	391	5,639	0	1,623	0	8,880	0	12,636	0	12,267	7,731	**36,509**
2002		548	0	806	2,107	0	934	0	7,174	0	11,153	0	12,267	5,175	**26,543**
2003		507	0	746	6,665	0	1,477	0	13,429	0	13,292	0	12,267	8,702	**43,565**
2004		543	0	799	6,196	0	3,164	0	14,880	0	14,863	0	11,950	10,837	**61,890**
2005		461	0	678	4,144	0	3,144	0	12,346	0	13,617	0	9,608	5,443	**48,302**
2006		634	0	933	10,221	0	4,632	0	11,411	0	14,380	0	12,427	6,610	**59,680**
2007		520	0	765	10,755	0	3,938	0	15,077	0	12,905	0	16,823	10,613	**70,111**
2008		256	0	377	6,522	0	3,098	0	13,468	0	11,570	0	10,525	6,978	**52,161**
2009		400	0	588	7,103	0	3,595	0	12,016	0	13,092	0	12,267	8,043	**56,704**
2010	Kennedale and LID	390	10	577	1,920	5,183	3,595	0	12,016	0	13,092	0	12,267	8,043	**57,281**
2011	EPT starts	380	20	566	1,920	5,183	3,595	0	12,016	0	13,092	0	12,267	8,043	**57,848**
2012	Groat wetland	370	30	555	1,920	5,183	2,340	1,255	12,016	0	13,092	0	12,267	8,043	**58,403**
2013		360	40	544	1,920	5,183	2,340	1,255	12,016	0	13,092	0	12,267	8,043	**58,947**
2014		350	50	533	1,920	5,183	2,340	1,255	12,016	0	13,092	0	12,267	8,043	**59,480**
2015		340	60	522	1,920	5,183	2,340	1,255	12,016	0	13,092	0	12,267	8,043	**60,003**
2016	Quesnell low-flow div.	330	70	511	1,920	5,183	2,340	1,255	8,716	3,300	13,092	0	12,267	8,043	**60,514**
2017	30th Ave low-flow div.	320	80	500	1,920	5,183	2,340	1,255	8,716	3,300	12,627	465	12,267	8,043	**61,014**
2018		310	90	489	1,920	5,183	2,340	1,255	8,716	3,300	12,627	465	12,267	8,043	**61,503**
2019		300	100	478	1,920	5,183	2,340	1,255	8,716	3,300	12,627	465	12,267	8,043	**61,981**
2020		290	110	467	1,920	5,183	2,340	1,255	8,716	3,300	12,627	465	12,267	8,043	**62,448**
	TSS load/vol mass conc (mg/L) =			164	135		334		165		105		146	153	164
	Storm wet weather FWC (mg/				182		315		321		144				
	Baseflow average conc. (mg/L) =				32		25		27		25				
	Annual Baseflow volume (ML) =				2,414		151								
						73% diverted		35% diverted		27% diverted		3.6% diverted			

Notes:

1. Assumed population increase of 0.9% per year, starting with 735,999 in 2009.
2. Assumed annual rainfall of 365.6 mm based on average of years 2000-2008.
3. Assumed total stormwater volume in 2009 is based on average of years 2000-2008 + unit rate of runoff volume for new typical lands developed = **4.03** m3/ha/d
4. Assume a 75% volume reduction in off site runoff for LID land development, gives a unit rate of LID runoff = **1.01** m3/ha/d
5. Assumed TSS unit loading rate for traditional lands developed = **0.66** kg/d/ha
6. Assumed TSS unit loading rate for LID lands developed = **0.16** kg/d/ha
7. Net LID load reduction factor = **0.49** kg/d/ha
8. Starting in 2004, Mill Creek flows are included in the Other category, and the Mill Creek load is included in the stormwater Total TSS load.
9. Kennedale end-of-pipe facility is a wetland and oil/grit separator in parallel treating 5,183 ML per year.
10. Groat Road basin end-of-pipe facility is a wetland and oil/grit separator in parallel. Based on equivalency to the Kennedale facility design, the Groat wetland is assumed to treat 895 ML, and the O/G system 360 ML (10% of the annual f
11. Groat Facility operates with wetland annual flow capacity of 895 ML, with all baseflow diverted to wetland. Remaining capacity used for wet weather flow. O/G separator takes only wet weather flow.
12. Groat Road Facility: for TSS loads inputted to wetland, assumed 80% treatment capture
13. Groat Road Facility: for TSS loads inputted to O/G separator, assumed 50% treatment capture
14. Quesnell low-flow diversion to convey baseflow of about 3,660 ML (or 10 ML/d) to GBWWTP for treatment. This reduces to about 3,300 ML because of expected RTC controls to avoid CSO overflows for an assumed 34 days.
15. 30th Avenue low-flow diversion to convey baseflow of about 539 ML (or 1.5 ML/d) to GBWWTP for treatment. This reduces to about 465 ML because of required RTC controls to avoid CSO overflows for an estimated 55 days.
16. For a typical year, the daily index calculation estimates an RTC-controlled Quesnell Low-Flow Diversion to convey to GBWWTP = **524** kg/d
17. For a typical year, the daily index calculation estimates an RTC-controlled 30th Ave Low-Flow Diversion to convey to GBWWTP = **57** kg/d
18. 30th Ave low-flow diversion to convey dry weather flow of 539 ML with a baseflow concentration of 15 mg/L to GBWWTP for treatment. (Stormwater Quality Strategy: Concept Feasibility Review, Final Report, Stantec, March 2009)
19. Rat Creek CSO volume in 2009 based on average for years 2000-2008.
20. With Rat Creek WESS12 diversion, assumed that only 405 ML will be discharging to the NSR starting 2011. Based on the average Rat Creek volume of 1,595 ML, this means 1,190 ML conveyed to EPT per year.
21. Starting in 2009, Other CSOs discharge 187 ML per year (historically 10.5% of Total CSO volume for years 2000-2008).
22. GBWWTP FE volume assumed to increase by 0.5% starting in 2009.
23. At GBWWTP, the Combined Bypass (= Primary + Secondary Treatment Bypass) has historically averaged 2,910 ML for year. The historic average Primary Treatment Bypass is only 7 ML per year.
24. 10-year FWC is 0.57 mg/L for TP.
25. 8-year average Rat Creek (and other CSOs) is 3.71 mg/L for TP.

TABLE A2. Measured and Projected Stormwater TSS Loads (kg/d) Discharged to NSR

Year	System Improvements	Stormwater Loads Discharged to NSR (i.e. annual loads divided by 365 days)														
		New Lands		Kennedale				Groat Road				Quesnell to NSR	30th Ave to NSR	Mill Creek	Other	**Total Stormwater**
		Trad + LID (kg/d)	Cumulative (kg/d)	Direct (kg/d)	Wetland (kg/d)	O/G (kg/d)	Total (kg/d)	Direct (kg/d)	Wetland (kg/d)	O/G (kg/d)	Total (kg/d)	(kg/d)	(kg/d)	(kg/d)	(kg/d)	**(kg/d)**
2000		NA	NA	3,716	0	0	3,716	978	0	0	978	4,838	3,230	4,890	3,278	**20,930**
2001		NA	NA	2,243	0	0	2,243	914	0	0	914	3,326	3,964	4,890	3,075	**18,413**
2002		NA	NA	839	0	0	839	518	0	0	518	2,682	2,963	4,890	2,062	**13,954**
2003		NA	NA	3,265	0	0	3,265	1,456	0	0	1,456	5,337	4,177	4,890	4,263	**23,388**
2004		NA	NA	2,369	0	0	2,369	4,018	0	0	4,018	6,549	4,332	5,424	5,290	**27,981**
2005		NA	NA	1,747	0	0	1,747	2,767	0	0	2,767	6,295	3,528	3,510	2,297	**20,144**
2006		NA	NA	2,923	0	0	2,923	3,132	0	0	3,132	4,759	3,668	4,375	2,384	**21,240**
2007		NA	NA	3,905	0	0	3,905	3,497	0	0	3,497	7,304	3,838	5,311	3,835	**27,690**
2008		NA	NA	2,620	0	0	2,620	2,630	0	0	2,630	7,880	4,288	5,831	3,838	**27,086**
2009		264	264	2,550	0	0	2,550	3,162	0	0	3,162	5,441	3,776	4,890	3,369	**23,452**
2010	Kennedale and LID	259	522	957	248	177	1,382	3,162	0	0	3,162	5,441	3,776	4,890	3,369	**22,543**
2011	EPT starts	254	776	957	248	177	1,382	3,162	0	0	3,162	5,441	3,776	4,890	3,369	**22,797**
2012	Groat wetland	249	1,025	957	248	177	1,382	2,141	138	165	2,444	5,441	3,776	4,890	3,369	**22,328**
2013		244	1,269	957	248	177	1,382	2,141	138	165	2,444	5,441	3,776	4,890	3,369	**22,572**
2014		239	1,508	957	248	177	1,382	2,141	138	165	2,444	5,441	3,776	4,890	3,369	**22,811**
2015		234	1,742	957	248	177	1,382	2,141	138	165	2,444	5,441	3,776	4,890	3,369	**23,045**
2016	Quesnell low-flow div.	229	1,971	957	248	177	1,382	2,141	138	165	2,444	4,917	3,776	4,890	3,369	**22,750**
2017	30th Ave low-flow div.	224	2,195	957	248	177	1,382	2,141	138	165	2,444	4,917	3,719	4,890	3,369	**22,917**
2018		219	2,414	957	248	177	1,382	2,141	138	165	2,444	4,917	3,719	4,890	3,369	**23,136**
2019		214	2,628	957	248	177	1,382	2,141	138	165	2,444	4,917	3,719	4,890	3,369	**23,350**
2020		209	2,837	957	248	177	1,382	2,141	138	165	2,444	4,917	3,719	4,890	3,369	**23,559**

TABLE A3. Measured and Projected Volumes and TSS Loads (kg/d) Discharged to NSR from CSOs, and GBWWTP - Including FE (Final Effluent), Combined Bypasses (CB) and Enhanced Primary Treatment (EPT)

		Stormwater		CSO & GB Measured & Projected Volumes Discharged to NSR						CSO & GB Loads (i.e. annual loads divided by 365 days)							
Year	System	Total	Total	CSO		GBWWTP				CSO			GBWWTP				
	Improvements	Volume	Load	Rat Creek	Others	FE	CB	EPT (2 inputs)		Rat Creek	Others	Total	FE	CB	EPT (2 outputs)		Total
		(ML)	(kg/d)	(ML)	(ML)	(ML)	(ML)	R.C. (ML)	CB (ML)	(kg/d)	(kg/d)	(kg/d)	(kg/d)	(kg/d)	R.C. (kg/d)	CB (kg/d)	(kg/d)
2000		**49,468**	**20,930**	1,865	143	90,520	3,030	0	0	2,119	187	**2,306**	2,232	1,159	0	0	**3,391**
2001		**36,509**	**18,413**	2,267	171	91,615	2,826	0	0	2,208	164	**2,371**	2,382	1,474	0	0	**3,856**
2002		**26,543**	**13,954**	730	39	89,425	2,760	0	0	1,061	57	**1,118**	1,728	544	0	0	**2,272**
2003		**43,565**	**23,388**	1,928	66	91,250	2,964	0	0	2,391	83	**2,474**	1,909	1,840	0	0	**3,749**
2004		**61,890**	**27,981**	2,639	433	92,345	2,788	0	0	2,989	477	**3,465**	1,477	1,475	0	0	**2,953**
2005		**48,302**	**20,144**	1,158	112	90,619	2,760	0	0	1,914	131	**2,045**	1,529	2,246	0	0	**3,775**
2006		**59,680**	**21,240**	1,691	318	90,482	2,965	0	0	2,042	518	**2,560**	1,055	1,843	0	0	**2,898**
2007		**70,111**	**27,690**	1,242	222	90,980	3,743	0	0	1,203	187	**1,390**	2,103	2,129	0	0	**4,231**
2008		**52,161**	**27,086**	839	179	91,113	2,352	0	0	905	207	**1,112**	1,485	1,182	0	0	**2,667**
2009		**56,704**	**23,452**	1,595	187	91,569	2,910	0	0	1,870	224	**2,094**	1,779	1,543	0	0	**3,323**
2010	Kennedale and LID	**57,281**	**22,543**	1,595	187	92,026	2,910	0	0	1,870	224	**2,094**	1,788	1,543	0	0	**3,331**
2011	EPT starts	**57,848**	**22,797**	405	187	92,487	910	1,190	2,000	475	224	**699**	1,797	483	98	164	**2,542**
2012	Groat wetland	**58,403**	**22,328**	405	187	92,949	910	1,190	2,000	475	224	**699**	1,806	483	98	164	**2,551**
2013		**58,947**	**22,572**	405	187	93,414	910	1,190	2,000	475	224	**699**	1,815	483	98	164	**2,560**
2014		**59,480**	**22,811**	405	187	93,881	910	1,190	2,000	475	224	**699**	1,824	483	98	164	**2,569**
2015		**60,003**	**23,045**	405	187	94,350	910	1,190	2,000	475	224	**699**	1,833	483	98	164	**2,578**
2016	Quesnell low-flow div.	**60,514**	**22,750**	405	187	98,122	910	1,190	2,000	475	224	**699**	1,906	483	98	164	**2,651**
2017	30th Ave low-flow div.	**61,014**	**22,917**	405	187	99,061	910	1,190	2,000	475	224	**699**	1,925	483	98	164	**2,669**
2018		**61,503**	**23,136**	405	187	99,538	910	1,190	2,000	475	224	**699**	1,934	483	98	164	**2,679**
2019		**61,981**	**23,350**	405	187	100,016	910	1,190	2,000	475	224	**699**	1,943	483	98	164	**2,688**
2020		**62,448**	**23,559**	405	187	100,498	910	1,190	2,000	475	224	**699**	1,953	483	98	164	**2,697**
	TSS load/vol ma			428	436	7.1	194	30	30								
		GBWWTP raw wastewater conc (mg/L) =				428											

Notes:

1. Assumed population increase of 0.9% per year, starting with 735,999 in 2009.
2. Assumed annual rainfall of 365.6 mm based on average of years 2000-2008.
3. Assumed total stormwater volume in 2009 is based on average of years 2000-2008 + unit rate of runoff volume for new typical lands developed = **4.03** m3/ha/d
4. Assume a 75% volume reduction in off site runoff for LID land development, gives a unit rate of LID runoff = **1.01** m3/ha/d
5. Assumed TSS unit loading rate for traditional lands developed = **0.66** kg/d/ha
6. Assumed TSS unit loading rate for LID lands developed = **0.16** kg/d/ha
7. Net LID load reduction factor = **0.49** kg/d/ha
8. Starting in 2004, Mill Creek flows are included in the Other category, and the Mill Creek load is included in the stormwater Total TSS load.
9. Kennedale end-of-pipe facility is a wetland and oil/grit separator in parallel treating 5,183 ML per year.
10. Groat Road basin end-of-pipe facility is a wetland and oil/grit separator in parallel. Based on equivalency to the Kennedale facility design, the Groat wetland is assumed to treat 895 ML, and the O/G system 360 ML (10% of the annual flow).
11. Groat Facility operates with wetland annual flow capacity of 895 ML, with all baseflow diverted to wetland. Remaining capacity used for wet weather flow. O/G separator takes only wet weather flow.
12. Groat Road Facility: for TSS loads inputted to wetland, assumed 80% treatment capture
13. Groat Road Facility: for TSS loads inputted to O/G separator, assumed 50% treatment capture
14. Quesnell low-flow diversion to convey baseflow of about 3,660 ML (or 10 ML/d) to GBWWTP for treatment. This reduces to about 3,300 ML because of expected RTC controls to avoid CSO overflows for an assumed 34 days.
15. 30th Avenue low-flow diversion to convey baseflow of about 539 ML (or 1.5 ML/d) to GBWWTP for treatment. This reduces to about 465 ML because of required RTC controls to avoid CSO overflows for an estimated 55 days.
16. For a typical year, the daily index calculation estimates an RTC-controlled Quesnell Low-Flow Diversion to convey to GBWWTP = **524** kg/d
17. For a typical year, the daily index calculation estimates an RTC-controlled 30th Ave Low-Flow Diversion to convey to GBWWTP = **57** kg/d
18. 30th Ave low-flow diversion to convey dry weather flow of 539 ML with a baseflow concentration of 15 mg/L to GBWWTP for treatment. (Stormwater Quality Strategy: Concept Feasibility Review, Final Report, Stantec, March 2009)
19. Rat Creek CSO volume in 2009 based on average for years 2000-2008.
20. With Rat Creek WESS12 diversion, assumed that only 405 ML will be discharging to the NSR starting 2011. Based on the average Rat Creek volume of 1,595 ML, this means 1,190 ML conveyed to EPT per year.
21. Starting in 2009, Other CSOs discharge 187 ML per year (historically 10.5% of Total CSO volume for years 2000-2008).
22. GBWWTP FE volume assumed to increase by 0.5% starting in 2009.
23. At GBWWTP, the Combined Bypass (= Primary + Secondary Treatment Bypass) has historically averaged 2,910 ML for year. The historic average Primary Treatment Bypass is only 7 ML per year.
24. 10-year FWC is 0.57 mg/L for TP.
25. 8-year average Rat Creek (and other CSOs) is 3.71 mg/L for TP.

TABLE A4. Projected TSS Load (kg/d) Reductions from EPT and SWQS – End-of-Pipe Treatment Facilties at Hermitage Park (Kennedale), Government House Park (Groat Road), Low-Flow Diversions on Quesnell and 30th Ave Storm Trunks, and Incremental Implementation of Low Impact Development (LID) for New Land Development.

	EPT				Kennedale 14 ML/d Wetland + O/G			Groat Road 3.4 ML/d Wetland + O/G			Quesnell 10 ML/d Low-flow Diversion			30th Ave 1.5 ML/d Low-flow Diversion			LID
Year	R.C. Reduction (kg/d)	CB Reduction (kg/d)	EPT Discharges (kg/d)	Net Reduction (kg/d)	Wetland Capture (kg/d)	O/G Separator Capture (kg/d)	Net Reduction (kg/d)	Wetland Capture (kg/d)	O/G Separator Capture (kg/d)	Net Reduction (kg/d)	Quesnell Reduction (kg/d)	GBWWTP FE Discharge (kg/d)	Net Reduction (kg/d)	30th Ave Reduction (kg/d)	GBWWTP FE Discharge (kg/d)	Net Reduction (kg/d)	**Net Reduction (kg/d)**
2000																	
2001																	
2002																	
2003																	
2004																	
2005																	
2006																	
2007																	
2008																	
2009																	
2010					991	177	**1,168**										**4.9**
2011	1,395	1,061	262	**2,193**	991	177	**1,168**										**9.9**
2012	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**							**14.8**
2013	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**							**19.8**
2014	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**							**24.7**
2015	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**							**29.7**
2016	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**	524	64	**460**				**34.6**
2017	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**	524	64	**460**	57	9	**48**	**39.5**
2018	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**	524	64	**460**	57	9	**48**	**44.5**
2019	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**	524	64	**460**	57	9	**48**	**49.4**
2020	1,395	1,061	262	**2,193**	991	177	**1,168**	553	165	**717**	524	64	**460**	57	9	**48**	**54.4**

Appendix B:
Alternate TSS Load Scenario

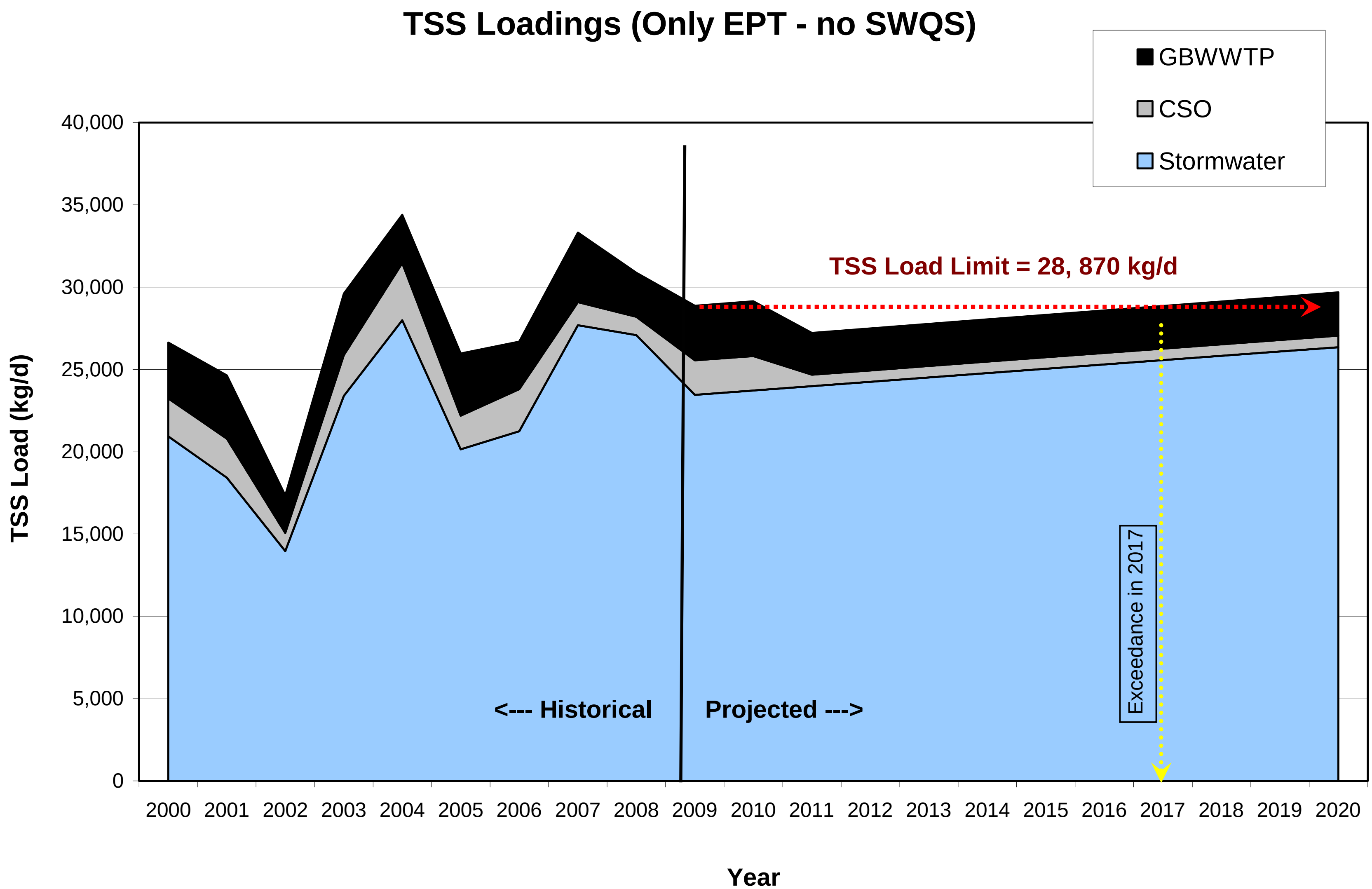

FIGURE B1. Measured and Projected TSS Loads (kg/d) Discharged to NSR from Major Sources – Assuming No Implementation of the SWQS (no wetlands, no low-flow diversions, no LID) and Only Implementation of EPT to Treat 2,000 ML per year of Secondary Bypass and 1,190 ML of Rat Creek CSO. Final Effluent Increases with Time Based on a WW Effluent Annual Flow Rate Increase of +0.5%.

Appendix C:
TSS Load Reduction Calculations

Appendix C1. Quesnell Storm Trunk 10 ML/d Low-Flow Diversion

A low flow diversion is proposed for the Quesnell storm trunk that will convey up to 3,660 ML per year, or about 10 ML/d to EPCOR's Gold Bar WWTP for treatment. Most days of a typical year, the flow rate in the Quesnell trunk sewer is greater than 10 ML/d. Given that the concentration of TSS in the storm trunk and volume conveyed to the outfall changes on a daily basis – the only practical means of estimating the average TSS load reduction for the Quesnell 10 ML/d flow diversion is to simulate a typical year with daily indexing. A typical year for the Quesnell basin was simulated based on 2000-2008 historical data. A snapshot of this calculation is shown below for the month of July.

					10 ML/d Low-flow Diversion, No RTC				RTC Controlled, 10 ML/d Low-flow Diversion				
Month	Day	TSS Conc. (mg/L)	Quesnell Volume (m3)	Quesnell Daily Load (kg)	Max. Flow Diverted to GBWWTP (m3)	Volume Discharged at Quesnell (m3)	Max. Load Diverted to GBWWTP (kg)	Quesnell Outfall Load (kg)	RTC controlled LF Diversion to GBWWTP (m3)	Volume Discharged at Quesnell (m3)	RTC Load Diverted to GBWWTP (kg)	Quesnell Outfall Load (kg)	Rat Creek CSO (m3)
July	1	382	36,617	13,988	10,000	26,617	3,820	10,168	0	36,617	0	13,988	10,189
	2	31	31,665	982	10,000	21,665	310	672	10,000	21,665	310	672	0
	3	302	48,365	14,606	10,000	38,365	3,020	11,586	10,000	38,365	3,020	11,586	0
	4	31	29,160	904	10,000	19,160	310	594	10,000	19,160	310	594	0
	5	167	208,921	34,890	10,000	198,921	1,670	33,220	0	208,921	0	34,890	89,680
	6	90	82,064	7,386	10,000	72,064	900	6,486	10,000	72,064	900	6,486	618
	7	31	47,699	1,479	10,000	37,699	310	1,169	10,000	37,699	310	1,169	0
	8	480	57,403	27,553	10,000	47,403	4,800	22,753	0	57,403	0	27,553	6,297
	9	480	42,376	20,340	10,000	32,376	4,800	15,540	10,000	32,376	4,800	15,540	0
	10	31	33,811	1,048	10,000	23,811	310	738	10,000	23,811	310	738	0
	11	31	32,734	1,015	10,000	22,734	310	705	10,000	22,734	310	705	0
	12	150	36,742	5,511	10,000	26,742	1,500	4,011	10,000	26,742	1,500	4,011	0
	13	336	41,493	13,942	10,000	31,493	3,360	10,582	10,000	31,493	3,360	10,582	0
	14	12	35,677	428	10,000	25,677	120	308	10,000	25,677	120	308	0
	15	12	31,377	377	10,000	21,377	120	257	10,000	21,377	120	257	0
	16	416	39,968	16,627	10,000	29,968	4,160	12,467	10,000	29,968	4,160	12,467	3
	17	12	37,511	450	10,000	27,511	120	330	10,000	27,511	120	330	0
	18	12	31,098	373	10,000	21,098	120	253	10,000	21,098	120	253	0
	19	12	30,674	368	10,000	20,674	120	248	10,000	20,674	120	248	0
	20	263	35,006	9,207	10,000	25,006	2,630	6,577	10,000	25,006	2,630	6,577	1
	21	12	31,937	383	10,000	21,937	120	263	10,000	21,937	120	263	0
	22	12	33,373	400	10,000	23,373	120	280	10,000	23,373	120	280	0
	23	12	33,882	407	10,000	23,882	120	287	10,000	23,882	120	287	0
	24	308	231,370	71,328	10,000	221,370	3,083	68,245	0	231,370	0	71,328	137,644
	25	98	136,461	13,344	10,000	126,461	978	12,366	0	136,461	0	13,344	97,919
	26	263	57,898	15,228	10,000	47,898	2,630	12,598	10,000	47,898	2,630	12,598	0
	27	12	44,285	531	10,000	34,285	120	411	10,000	34,285	120	411	0
	28	12	38,801	466	10,000	28,801	120	346	10,000	28,801	120	346	0
	29	12	35,017	420	10,000	25,017	120	300	10,000	25,017	120	300	0
	30	12	33,986	408	10,000	23,986	120	288	10,000	23,986	120	288	0
	31	12	34,192	410	10,000	24,192	120	290	10,000	24,192	120	290	0

Based on this numerical approach, with up to 10 ML/d diverted from the Quesnell storm trunk into the combined sewer system (some days have less than this amount of baseflow), the maximum TSS load intercepted and conveyed to the GBWWTP for treatment is estimated to be 869 kg/d.

The Quesnell low-flow diversion is expected to require a real-time control (RTC) system to avoid diverting 10 ML/d into the combined sewer system on days of wet weather. As stated in the *SWQS: Concept Feasibility Report* (Stantec, March 2009):

> *"Quesnell basin low flow diversions are only feasible during dry weather flow conditions when CSOs are zero. Once commissioned, the WESS W12 project will reduce CSO volumes at the Rat Creek site. This may allow low flow diversions to continue during small wet weather events without increasing CSO volumes."*

It was assumed that future WESS W12 pipe capacity will allow for Quesnell low-flow diversions for those wet weather days that currently produce a CSO overflow at Rat Creek of less than 10,000 m3 per day. As shown above for the month of July, this means that those simulated days with a CSO overflow greater than 10,000 m3 activate the RTC system to shut off the Quesnell diversion. Using this conservative assumption for WESS W12 conveyance capacity, it's estimated that a typical year will have 34 days of wet weather flow in which RTC does not permit any flow diversion from the Quesnell storm trunk to GBWWTP.

With the RTC assumption, the typical annual flow volume diverted to GBWWTP is estimated to be about 3,300 ML (or about 24% of the annual volume). With RTC active 34 days a year, the TSS load intercepted and conveyed to the GBWWTP for treatment is estimated to be 524 kg/d. With GBWWTP producing a final effluent with an average TSS concentration of 7 mg/L, this low flow contributes a FE mass loading of 64 kg/d. This means that an RTC-controlled Quesnell low-flow diversion of 10 ML/d is expected to provide a net TSS load reduction of 460 kg/d.

Shown below is an example of year 2000 flow, volume, concentration, and TSS loading characteristics for the Quesnell storm basin.

Events

Month	30TH AVE STORM		GROAT RD. STORM		QUESNELL STORM		KENNEDALE STORM		REMAINING STORM		TOTAL STORM	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
January	31	0	31	0	31	0	31	0	31	0	155	0
February	24	5	25	4	28	1	25	4	25	4	127	18
March	13	18	18	13	19	12	18	13	18	13	86	69
April	24	6	26	4	26	4	26	4	26	4	128	22
May	16	15	23	8	22	9	21	10	21	10	103	52
June	17	13	21	9	18	12	18	12	18	12	92	58
July	14	17	20	11	15	16	16	15	16	15	81	74
August	20	11	21	10	20	11	21	10	21	10	103	52
September	21	9	25	5	25	5	25	5	25	5	121	29
October	28	3	31	0	30	1	30	1	30	1	149	6
November	29	1	29	1	29	1	29	1	29	1	145	5
December	30	1	30	1	30	1	30	1	30	1	150	5
Total	267	99	300	66	293	73	290	76	290	76	1440	390
	73%	27%	82%	18%	80%	20%	79%	21%	79%	21%	79%	21%

VOLUME (m3)

Month	30TH AVE STORM		GROAT RD. STORM		QUESNELL STORM		KENNEDALE STORM		REMAINING STORM		TOTAL STORM	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
January	674,634	0	425,092	0	277,336	0	682,168	0	486,172	0	2,545,402	0
February	525,736	133,522	285,487	69,722	353,956	26,176	561,964	128,892	400,504	91,859	2,127,647	450,171
March	310,594	721,824	65,197	129,784	374,075	505,166	437,820	605,765	312,028	431,721	1,499,715	2,394,260
April	567,932	362,430	25,489	62,820	514,986	264,229	584,792	305,843	416,773	217,970	2,109,972	1,213,292
May	427,626	1,015,046	46,885	81,494	555,859	787,267	593,712	900,737	566,995	860,204	2,191,076	3,644,749
June	479,845	1,069,054	30,454	230,406	535,624	1,128,072	266,693	882,064	342,477	827,781	1,655,092	4,137,377
July	421,478	1,710,045	47,106	111,555	574,698	1,459,819	448,748	1,032,101	435,862	1,033,995	1,927,893	5,347,514
August	582,273	593,377	46,823	113,474	584,473	649,385	473,826	453,232	452,504	432,836	2,139,900	2,242,304
September	581,831	856,088	45,465	170,546	742,353	642,256	764,369	793,855	729,973	758,132	2,863,991	3,220,877
October	747,586	141,562	49,164	0	680,392	31,776	785,818	31,794	560,042	22,659	2,823,003	227,791
November	720,320	42,595	59,469	6,869	447,306	37,187	193,858	7,725	335,478	22,282	1,756,431	116,658
December	680,412	41,220	53,134	7,501	270,085	35,948	497,177	41,943	354,332	29,892	1,855,140	156,505
Total	6,720,267	6,686,763	1,179,765	984,171	5,911,143	5,567,281	6,290,946	5,183,951	5,393,141	4,729,332	25,495,261	23,151,497

TSS (mg/L)

Month	30TH AVE STORM		GROAT RD. STORM		QUESNELL STORM		REMAINING STORM		TOTAL STORM	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
January	33	-	18	-	57	-	33	-	33	-
February	33	445	18	502	57	1524	48	469	42	528
March	33	223	18	418	57	258	58	267	51	260
April	33	274	18	609	57	242	58	294	50	293
May	23	201	32	475	7	184	47	198	32	202
June	15	81	19	224	14	284	26	171	19	181
July	108	135	45	336	341	324	210	230	223	227
August	9	127	10	329	9	250	24	202	15	202
September	9	57	8	103	7	79	17	66	12	68
October	10	81	9	-	4	121	11	125	9	97
November	6	269	15	810	4	595	6	452	6	452
December	7	776	13	1480	14	1120	9	984	9	984
Total	23	152	18	332	53	261	44	204	40	208

LOADINGS

		30A DRY	30A WET	GRD DRY	GRD WET	QUE DRY	QUE WET	REMAIN DRY	REMAIN WET
TSS (kg)	JAN	22,128	0	7,751	0	15,838	0	38,788	0
	FEB	17,244	59,424	5,205	34,985	20,214	39,892	46,572	103,570
	MAR	10,187	160,766	1,189	54,241	21,363	130,504	43,444	277,474
	APR	18,628	99,361	465	38,254	29,410	63,930	58,047	154,102
	MAY	9,732	204,180	1,482	38,679	3,913	144,941	54,511	349,450
	JUN	7,117	86,805	578	51,589	7,446	320,445	16,111	292,052
	JULY	45,523	230,273	2,098	37,490	195,938	472,529	186,170	476,029
	AUG	5,008	75,291	474	37,367	4,991	162,371	22,635	178,720
	SEP	4,989	48,547	352	17,517	5,161	50,974	24,708	103,158
	OCT	7,213	11,513	425	0	2,986	3,845	15,214	6,829
	NOV	4,581	11,458	900	5,564	1,690	22,126	3,129	13,557
	DEC	4,559	31,987	691	11,101	3,781	40,262	7,662	70,717
	TOTAL	**156,911**	**1,019,606**	**21,609**	**326,788**	**312,730**	**1,451,819**	**516,992**	**2,025,658**

Appendix C2. 30th Ave Storm Trunk 1.5 ML/d Low-Flow Diversion

A low flow diversion is also proposed for the 30th Avenue storm trunk that will convey up to 539 ML per year, or about 1.5 ML/d to EPCOR's Gold Bar WWTP for treatment (SWQS: Concept Feasibility Report, Stantec, March 2009). Baseflow in the 30th Avenue trunk sewer is about 25 ML/d which means the diversion is very limited in load capture potential. The same approach of using a daily indexing of concentrations and volumes was used to estimate the average TSS load reduction for the 30th Avenue low flow diversion. The EMP data for year 2005 was used as it provides a total TSS load close to historic average. A snapshot of this calculation is shown below for the month of July.

					Low-flow Diversion, No RTC				RTC Controlled, Low-flow Diversion				
Month	Day	TSS Conc. (mg/L)	30th Ave Volume (m3)	30th Ave Daily Load (kg)	Max. Flow Diverted to GBWWTP (m3)	Volume Discharged at 30th Ave (m3)	Max. Load Diverted to GBWWTF (kg)	30th Ave Outfall Load (kg)	RTC controllec LF Diversion to GBWWTP (m3)	Volume Discharged at 30th Ave (m3)	RTC Load Diverted to GBWWTP (kg)	30th Ave Outfall Load (kg)	Rat Creek CSO (m3)
July	1	228	40,580	9,252	1,476	39,104	337	8,916	1,476	39,104	337	8,916	0
	2	228	29,758	6,785	1,476	28,282	337	6,448	1,476	28,282	337	6,448	0
	3	14	27,656	376	1,476	26,180	20	356	1,476	26,180	20	356	0
	4	14	27,420	378	1,476	25,944	20	358	1,476	25,944	20	358	0
	5	14	27,503	385	1,476	26,027	21	364	1,476	26,027	21	364	0
	6	14	27,635	378	1,476	26,159	20	358	0	27,635	0	378	7,082
	7	13	27,205	364	1,476	25,729	20	344	1,476	25,729	20	344	0
	8	13	27,548	360	1,476	26,072	19	341	1,476	26,072	19	341	0
	9	95	33,044	3,139	1,476	31,568	140	2,999	0	33,044	0	3,139	1,379
	10	95	29,845	2,835	1,476	28,369	140	2,695	1,476	28,369	140	2,695	0
	11	132	28,171	3,711	1,476	26,695	194	3,517	1,476	26,695	194	3,517	0
	12	258	63,039	16,264	1,476	61,563	381	15,883	0	63,039	0	16,264	440
	13	184	39,741	7,319	1,476	38,265	272	7,047	0	39,741	0	7,319	1,367
	14	39	30,587	1,193	1,476	29,111	58	1,135	1,476	29,111	58	1,135	0
	15	11	27,298	298	1,476	25,822	16	282	1,476	25,822	16	282	0
	16	119	205,543	24,460	1,476	204,067	176	24,284	0	205,543	0	24,460	83,364
	17	10	28,853	297	1,476	27,377	15	282	1,476	27,377	15	282	0
	18	96	44,741	4,295	1,476	43,265	142	4,153	0	44,741	0	4,295	28
	19	10	28,877	279	1,476	27,401	14	265	1,476	27,401	14	265	0
	20	9	27,720	259	1,476	26,244	14	246	0	27,720	0	259	7,346
	21	366	52,793	19,322	1,476	51,317	540	18,782	0	52,793	0	19,322	12,709
	22	9	28,580	250	1,476	27,104	13	237	1,476	27,104	13	237	0
	23	82	206,104	16,901	1,476	204,628	121	16,779	0	206,104	0	16,901	154,699
	24	8	30,506	248	1,476	29,030	12	236	1,476	29,030	12	236	0
	25	132	64,458	8,492	1,476	62,982	194	8,297	0	64,458	0	8,492	17,490
	26	40	40,695	1,628	1,476	39,219	59	1,569	0	40,695	0	1,628	14,527
	27	132	32,519	4,284	1,476	31,043	194	4,089	1,476	31,043	194	4,089	0
	28	422	102,785	43,375	1,476	101,309	623	42,752	0	102,785	0	43,375	36,783
	29	132	72,740	9,602	1,476	71,264	195	9,407	1,476	71,264	195	9,407	0
	30	94	35,383	3,328	1,476	33,907	139	3,189	1,476	33,907	139	3,189	0
	31	6	28,560	170	1,476	27,084	9	161	1,476	27,084	9	161	0

Using this robust estimation approach, a 1.5 ML/d diversion means that 539 ML is conveyed to GBWWTP (or 4% of the annual flow) with an associated TSS load of 94 kg/d (or 2.7% of the 30th Ave annual load).

The 30th Avenue low-flow diversion is expected to require a real-time control (RTC) system to avoid diverting flows into the combined sewer system on days of wet weather. As stated in the *SWQS: Concept Feasibility Report* (Stantec, March 2009):

> *"Contributions from the 30th Avenue basin low flow diversion also affect the CSO volumes at the Mill Creek CSO sites. … the 30th Avenue basin low flow diversion should only operate during the dry weather flow conditions to prevent increased CSO volume at the Mill Creek sites."*

For those days with any CSO discharge at the Rat Creek CSO, it is assumed that an RTC system shut off the 30th Avenue diversion. Based on this measure, there are a total of 55 days of wet weather in which the RTC does not permit any flow diversion from the 30th Avenue storm trunk to GBWWTP.

With the RTC assumption, the typical annual flow volume diverted to GBWWTP is estimated to be 465 ML (or 3.4% of the annual volume). With RTC active 55 days a year, the TSS load intercepted and conveyed to the GBWWTP for treatment is estimated to be 57 kg/d. With GBWWTP producing a final effluent with an average TSS concentration of 7 mg/L, this low flow contributes a FE mass loading of 9 kg/d. This means that an RTC-controlled 30th Avenue low-flow diversion of 1.5 ML/d is estimated to give a net TSS load reduction of 48 kg/d.

Appendix C3. EPT/Gold Bar WWTP

The Quesnell and 30th Avenue Low-Flow Diversions are routed through the main process train of the Gold Bar WWTP on dry weather days (slightly wet days also for the Quesnell diversion).

This section pertains to the flows routed through the newly commissioned EPT tanks at the Gold Bar WWTP. This tankage provides additional treatment capacity to handle flows captured from the Rat Creek CSO overflow and conveyed to the WWTP via WESS W12. As well, flows can be routed to the EPT that would otherwise trigger a secondary plant bypass. The key assumptions are provided below, EPT - :

- operational by 2011
- treats 1,190 ML per year of Rat Creek CSO flow
- treats 2,000 ML of flow that would otherwise be a secondary bypass
- final effluent TSS concentration is 7 mg/L
- discharges to NSR a TSS concentration of 30 mg/L.

No EPT treatment:

Rat Creek CSO: 1,595 ML x 428 mg/L / 365 days = 1,870.3 kg/d

GBWWTP C.B.: 2,910 ML x 194 mg/L / 365 days = 1,546.7 kg/d

Total TSS load = 3,417 kg/d

With EPT Treatment:

Rat Creek CSO: 405 ML x 428 mg/L / 365 days = 474.9 kg/d

EPT1 discharge (1,595 - 405) ML x 30 mg/L / 365 days = 97.8 kg/d

GBWWTP C.B. (2,910 – 2,000) ML x 194 mg/L / 365 days = 483.7 kg/d

EPT2 discharge: (2,910 – 910) ML x 30 mg/L / 365 days = 164.4 kg/d

Total TSS load = 1,220.8 kg/d

TSS Net Reduction for EPT = 2,196 kg/d

Appendix C4. Kennedale End-of-Pipe Treatment Facility

The Kennedale design is for about 0.9 m3/s through the wetland and another 0.7 m3/s through the oil/grit separators. These numbers were determined through an iterative process, based on the time of retention, time for the water level to go up from the NWL to HWL, and no surcharging in the off line. The way the Kennedale system is configured with all the upstream lakes, and the trunk basically at capacity in a 1:2 year design rainfall event, the long post event drawdown times result in extended periods of higher than base flow in the trunk. Based on the numbers in Table 2.6 (page 2.21), the Kennedale wetland can take about 2X base flow which results in an annual treated volume of about 4,300 ML.

Baseflow FWC = 32 mg/L
Wet weather FWC = 182 mg/L

For a typical year, annual flow = 7,100 ML
34% of annual volume is baseflow = 2,414 ML
66% of annual volume is wet weather flow = 4,686 ML

Based on the Stantec modeling, 63% of annual volume will be treated in the wetland and 10% of annual volume treated in the CDS in-parallel oil/grit separators. Because the flow is first conveyed through the wetland, this means that the CDS units only receive wet weather flows.

<u>Constructed Wetland:</u>

Load IN = 2,414 ML x 32 mg/L (baseflow)
+ (0.63 x 7,100 ML – 2,414) ML x 182 mg/L = 451, 986 kg = 1,238.2 kg/d

➔ 80% wetland TSS treatment efficiency assumed

Load OUT = 0.2 x 1,238.2 kg/d = 247.7 kg/d

Load Capture = 0.8 x 1,238.2 kg/d = 990.7 kg/d

<u>CDS Oil/Grit Separator:</u>

➔ only takes wet weather flow.

Annual treatment capacity = 710 ML

Load IN = 710 ML x 182 mg/L = 129,220 kg = 354.0 kg/d

➔ 50% O/G TSS treatment efficiency assumed.

Load OUT = 0.5 x 354.0 kg/d = 177.0 kg/d

Load Capture = 0.5 x 354.0 kg/d = 177.0 kg/d

<u>Trunk Sewer:</u>

- ➔ 27% of annual volume not diverted to off-line wetland & O/G facility (all baseflow routed to wetland therefore only wet weather)

Load Direct to NSR = 0.27 x 7,100 ML x 182 mg/L = 348,894 kg = 956 kg/d

<u>Segregated Discharges to NSR = 956 kg/d + 177 kg/d + 247.7 kg/d = 1,380.7 kg/d</u>

<u>Segregated Load Capture = 991 kg/d (wetland) + 177 kg/d (O/G) = 1,168 kg/d</u>

Appendix C5. Groat Road End-of-Pipe Treatment Facility

For the concept level, we are suggesting 1X base flow for either the oil/grit or a constructed surface wetland, so if a parallel system was implemented, it would be reasonable to expect that we could get 2X base flow.

The following approach for Groat Road is conceptually similar to that used for Kennedale storm basin. The annual hydrographs between basins is different and a computer simulation is needed for Groat Road as was done for Kennedale in the detailed process design.

Assumptions:

- ➔ Based on the 5 ha Kennedale wetland treating 4,473 ML, this gives a unit treatment rate of 895 ML/ha of wetland
- ➔ Groat constructed wetland assumed to be 1 ha in size.
- ➔ Groat typical annual volume = 3,595 ML (95.8%)
- ➔ Groat typical baseflow volume = 151 ML (4.2%)
- ➔ Groat wetland capacity is 895 ML with baseflow conveyed to the wetland first.
- ➔ Parallel O/G separators assumed with a 10% volume capacity = 360 ML
- ➔ 35% of annual Groat trunk sewer volume diverted off-line for treatment
- ➔ Baseflow FWC TSS conc. = 24 mg/L
- ➔ Wet weather FWC TSS conc. = 334 mg/L

Constructed Wetland:

Load IN = 151 ML x 24 mg/L (baseflow)
+ (895 – 151) ML x 334 mg/L = 252,120 kg = 690.7 kg/d

➔ 80% wetland TSS treatment efficiency assumed

Load OUT = 0.2 x 690.7 kg/d = 138.1 kg/d

Load Capture = 0.8 x 690.7 kg/d = 552.6 kg/d

CDS Oil/Grit Separator:

➔ only takes wet weather flow.

Annual treatment capacity = 360 ML

Load IN = 360 ML x 334 mg/L = 120,240 kg = 329.4 kg/d

➔ 50% O/G TSS treatment efficiency assumed.

Load OUT = 0.5 x 329.4 kg/d = 164.7 kg/d

Load Capture = 0.5 x 329.4 kg/d = 164.7 kg/d

<u>Trunk Sewer:</u>

➔ 65% of annual volume not diverted to off-line wetland & O/G facility (all baseflow routed to wetland therefore only wet weather)

Load Direct to NSR = 0.65 x 3,595 ML x 334 mg/L = 781,560 kg = 2,141 kg/d

<u>Segregated Discharges to NSR = 2,141 kg/d + 164.7 kg/d + 138.1 kg/d = 2,444 kg/d</u>

<u>Segregated Load Capture = 552.6 kg/d (wetland) + 164.7 kg/d (O/G) = 717 kg/d</u>

Appendix C6. Low Impact Development for new lands

For years 2000 to 2008, the number of hectares of newly developed land ranged from 256 ha to as much as 634 ha (Planning & Development, City of Edmonton). It is assumed that 400 ha of land will be developed per year in future years. Lands developed using traditional approaches will increase the post-development volume of runoff. A staged LID implementation schedule was considered most likely given the challenges involved in changing urban drainage practices. Of the 400 ha developed each year, it is assumed that 10 ha will be LID starting in 2010, with each successive an additional 10 ha being LID. By 2020, 110 ha of the 400 ha total would therefore developed using LID principles.

Assumptions:

- ➔ Unit rate of runoff for traditional land development = 4.03 m3/ha/d
- ➔ LID developed lands assumed to provide a 75% volume reduction in runoff
- ➔ Unit rate of runoff for LID land development = 1.01 m3/ha/d
- ➔ Assuming that the TSS concentration = 164 mg/L (for all lands)
- ➔ TSS unit loading rate for traditional lands = 0.66 kg/d/ha
- ➔ TSS unit loading rate for LID lands = 0.16 kg/d/ha
- ➔ Net TSS load reduction for LID = 0.49 kg/d/ha