ASSESSMENT REPORT

DANSON/BCR SEWAGE LAGOONS

Submitted to

City of Prince George

1100 Patricia Boulevard
Prince George BC
V2L 3V9

Submitted by

McElhanney Consulting Services Ltd.

1633 First Avenue
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June 2002
2341-00868-0

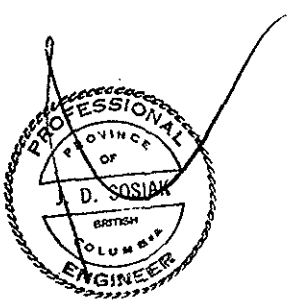

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Table of Contents

1.0 INTRODUCTION

1.1 Background

On October 23, 2001, the City of Prince George authorized McElhanney Consulting Services Ltd. (MCSL) to conduct an assessment of the existing lagoon systems at the Danson and BCR industrial subdivisions.

The City of Prince George operates two lagoon systems currently servicing a predominantly industrial area located on a bench of land between Highway 97 South and the Fraser River. The Danson lagoon operates as a facultative lagoon but has provision for the future installation of aeration equipment while the BCR system is a fully aerated lagoon. Both lagoon systems have submerged outlets in the Fraser River and are operating under British Columbia Ministry of Environment (MOE) permits.

The City has been considering consolidating the sewage treatment operations of the two lagoons to reduce the overall amount of maintenance required for the two systems. The consolidation is possible by means of installing a forcemain from the Danson system to the BCR lagoons and carrying out all treatment at the BCR lagoons. The purpose of MCSL's assignment is to determine the feasibility of the proposed forcemain along its most logical route and whether there are any other alternatives for improving the operation of the lagoon systems.

1.2 Scope of Work

The scope of the assignment was outlined at a meeting between the City of Prince George and MCSL on October 10, 2001. Initially, two alternative forcemain routes were to be assessed but it was subsequently decided to focus on one route only. The assignment was confirmed by a fax dated October 23, 2001. The assignment includes the following:

- Identify catchment areas for existing and future sanitary sewers affecting the lagoons.
- Review current and projected sewage flow rates.
- Assess capacities of existing lagoons and lift stations.
- Review and comment on current operation and condition of lagoons and collection systems where appropriate.
- Preliminary assessment of upgrading requirements for lagoons and lift stations.
- Identify requirements for diverting sewage flows from Danson Lagoon to BCR Lagoon.
- Prepare Class 'D' cost estimates (2001 dollars).

1.3 Methodology

The overall goals of the assessment were outlined at the October 10 meeting at which time the City provided MCSL with a site plan showing the locations of the existing lagoons, pump stations and collection systems as well as the two potential forcemain routes being considered by the City. Subsequent to the meeting, the City provided MCSL with flow records at the two lagoons, a copy of the MOE permit for the Danson Lagoon, record drawings for the BCR and Danson lagoons and a report, prepared by the City, assessing future water demands in the Danson/BCR area.

MCSL undertook site visits to view the lagoons, pump stations and potential forcemain route. MCSL analysed the flow rate data provided by the City to identify trends and significant extremes in sewage flow to the lagoons and compared these flows with design criteria noted on the record drawings and flow rates allowed under the MOE permit. This information was then used to assess the existing lagoons, pump stations and collection systems and potential improvements.

MCSL contacted equipment suppliers to confirm availability and suitability of potential installations and to update pricing. This information was used to prepare the Class 'D' cost estimates included in this report. A 'draft' report was submitted to the City on December 24, 2001 and reviewed at a meeting between the City and MCSL on January 10, 2002. The report has been updated to address the comments and issues raised at the January 10 meeting.

It should be noted that MCSL conducted a separate study of the overall City of Prince George sanitary system, including the preparation of a computer model, concurrently with the preparation of this report. The Sanitary Sewer Study contained some recommendations for improvements in the Danson/BCR area that should be referred to in conjunction with this report.

2.0 EXISTING SYSTEMS

2.1 General

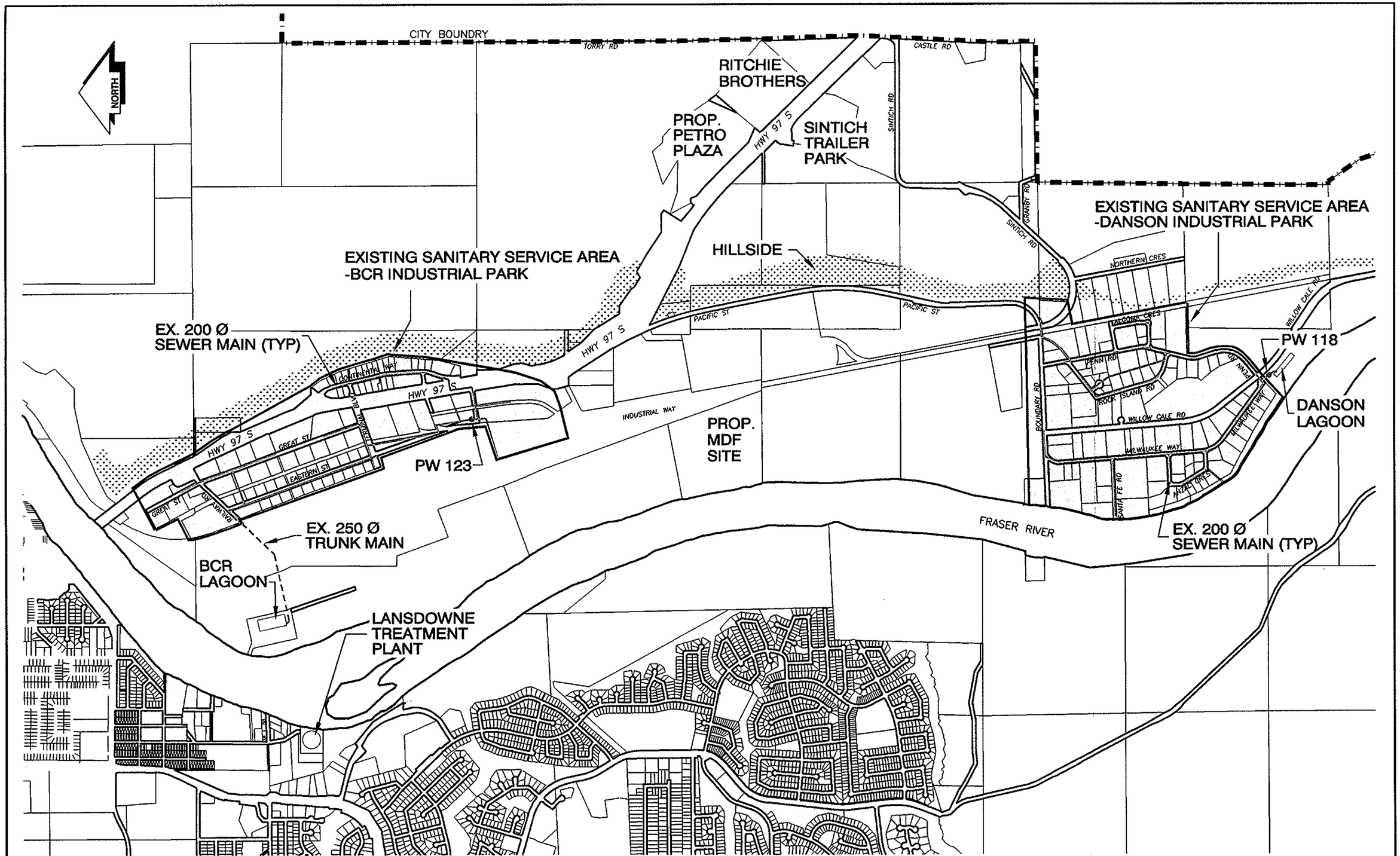
The BCR and Danson Industrial Parks occupy a bench of land on the east side of the Fraser River at the south end of the City of Prince George as shown on Figure 1. The central portion of the bench consists of vacant land or storage/working areas for logs and finished lumber for a number of mill sites. This central portion has no community sanitary sewer service but does have a watermain passing through it to connect the BCR and Danson subdivisions.

The BCR Industrial Park is at the north end of the bench and has both water and sanitary sewer services. The Fraser River separates the bench area from the rest of the City and isolates it from the main water and sewer systems. The Danson Industrial Park lies at the south end of the bench and has water servicing and a sewer system. There is approximately 2.5 km distance between the the BCR and Danson Industrial Parks and the two industrial areas have been provided with separate independent sewer systems within the limits identified by the shaded areas on Figure 1.

A community water system is fed by a well identified as PW627 that serves both the Danson and BCR industrial parks as well as the 'central' area and the Sintich Trailer Park.

A hillside defines the east limit of the industrial area. Highway 97 South and Sintich Road traverse the hillside and provide access to lands to the east. These lands are predominantly undeveloped except for the Sintich Trailer Park and the Ritchie Brothers Auction Site. The Sintich Trailer Park obtains water from the City and has its own sewage collection and treatment system. Treated effluent from the Sintich Trailer Park discharges to the Danson Sewer System through a private discharge line.

The City of Prince George prepared a report titled "BCR/Danson Water System, Petro Plaza Development – Water Supply Availability" in December 1997. The focus of this report was the availability of water for the proposed Petro Plaza Development near the Ritchie Brothers site but the report contained information on service areas and projected development that is relevant to the assessment of the Danson and BCR Lagoons.



No.	Date	Revision	Dr.	Ch.

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McElhanney

DANSON/BCR INDUSTRIAL PARKS

SITE LOCATION

DESIGN:		DATE:	DECEMBER 2001
DRAWN:	BLB	FILE:	2341-00668
CHECKED:	JS	TASK:	2001
SCALE:	1:20000	DRAWING No.	FIG.1
		REV.	

2.2 BCR Industrial Park

The BCR Lagoon is the larger of the two lagoon systems and consists of two cells, both of which are aerated. Record drawings provided by the City of Prince George indicate that the lagoon is designed to accommodate an average daily sewage flow of 936 m^3/day and a maximum daily flow of 1405 m^3/day (1.5 times higher than average day flow). The first cell has a detention time of 6.5 days at a 3.65 m depth under design flow conditions and the second cell has a detention time of 18.9 days. Treated effluent from the lagoon discharges to the Fraser River under an MOE permit.

The original design of the BCR Lagoon included provisions for the future construction of two additional cells to operate in parallel with the existing lagoon, effectively doubling its capacity. Land is set aside adjacent to the existing lagoon to permit this future expansion.

The BCR Lagoon system was constructed in the late 1970's with the first phase being intended to service an area of approximately 50 ha and the second phase to service an area of approximately 107 ha. The existing sewage collection system in the BCR Industrial Park services an area comparable in size to the full 'second phase' area but, according to flow records provided by the City, sewage flows entering the system are still within the design capability of the first phase (existing) of the lagoon. There is vacant land with potential for infill development in the BCR Industrial Park that could account for the relatively low usage of the system but it is also possible that conservative assumptions about sewage flows were used during the initial design.

Gravity sewers are 200 mm diameter except along Railway Road where a 250 mm diameter trunk main discharges directly to the lagoon system. The area north of Terminal Boulevard and west of Highway 97 feeds directly into the trunk main. Gravity collection mains serving Continental Way, Industrial Way and portions of Pacific Street terminate at a sewage lift station (PW123) that pumps the sewage to the sewer main at Terminal Boulevard. PW123 also collects effluent from a treatment plant operated by BC Rail. The PW123 lift station has a dual pump system consisting of two 5 hp Flygt CP3102 pumps capable of operating at 19 L/s against a head of 5.5 m.

According to the City's record drawings, the existing 200 mm diameter gravity mains between PW123 and Railway Road have grades of as little as 0.23%. Under current City standards, 200 mm gravity mains should have minimum grades of 0.40%. The shallow grades do not permit adequate scouring velocities in the main and these sewers could require more frequent cleaning as a result.

The BCR Lagoon system is on the river bank almost directly across from the City's main Lansdowne Sewage Treatment Plant. This location could permit a relatively short future river crossing connection from the BCR system to the Lansdowne Plant as an alternative to upgrading the BCR Lagoons. This connection requires crossing the Fraser River.

City Public Works staff reported that the lagoons, the PW123 lift station and the collection system were working well.

2.3 Danson Industrial Park

The Danson Industrial Park has an independent sewer system servicing approximately 133 ha of land. Gravity sewer mains (200 mm diameter) discharge to the existing lagoon. Gravity flow directly into the lagoon is not possible and there is a sewage lift station (PW118) that pumps the raw sewage into the Danson Lagoon System. PW118 has two 20 hp Flygt CP3152 pumps capable of operating at 76 L/s against a head of 5.5 m. Record drawings indicate that the pump station has an overflow pipe discharging to the lagoon but, in the event that this overflow pipe was actually operating, portions of the sewer mains and associated manholes upstream of the lift station would be surcharged.

The existing Danson Lagoon contains two basins and operates as a facultative lagoon discharging treated effluent to the Fraser River. Record drawings provided by the City indicate that the lagoon was designed to incorporate two stages with the second stage (not yet constructed) being the installation of equipment to convert the system to an aerated lagoon. Stage 1 was initially designed to accommodate an average day sewage flow rate of 34 m^3/day and a maximum day flow of 54 m^3/day under facultative conditions. The future Stage 2 upgrading increases design capacity with aeration to 681 m^3/day for average day sewage flow and 999 m^3/day for maximum day flow conditions. A factor of 1.5 appears to have been used to calculate maximum day flows versus average day flows.

The record drawings indicate that the liquid depth in the lagoon under Stage 1 design conditions is 1.5 m (5') with the operating depth being increased to 3.6 m (12') when the Stage 2 upgrades are installed. In practice, the existing lagoon is being operated at the higher depth of 3.6 m depth providing additional retention time for treatment. Under the conditions of Permit No. PE-4905 issued on July 13, 1978 and amended on February 14, 1991, the Danson Lagoon can be operated as a facultative lagoon as long as daily flows are less than 178 m^3/day. Applying the maximum day factor of 1.5 to this figure yields an allowable average day discharge of 118 m^3/day. With the future installation of aeration equipment, the permit will allow a maximum discharge of 1000 m^3/day which is consistent with the parameters for Stage 2 shown on the record drawings.

City Public Works staff did not report any problems with the operation of the lagoon, the PW118 lift station or the mains in the Danson Industrial Park.

2.4 Historical Performance

2.4.1 Recorded Sewage Flows

The City provided daily records of sewage flows entering the BCR and Danson Lagoons to MCSL in electronic spreadsheet format for the period from January 1, 1996 to October 31, 2001. Readings prior to June, 1998 were taken once a day from a weir chamber and therefore tend to reflect 'instantaneous' conditions. In 1998, the City installed totalizer meters at both lagoons to obtain more reliable flow measurements. MCSL analysed the data provided and calculated average day flow rates for both lagoon systems as well as theoretical average day and peak day flows resulting if the two systems were combined.

Table 1 following summarizes the data and includes calculated average daily flows for each lagoon system as well as projected results if the flows from the two systems were collected at a single point. It should be noted that peak daily flows at the Danson and BCR lagoons did not necessarily take place simultaneously and the calculated peak for the combined flows is not necessarily equivalent to the sum of the peaks at the individual lagoons.

Year	Recorded Effluent Flow (m^3/d)					
	BCR Lagoons		Danson Lagoons		Combined Flows	
	Average	Peak	Average	Peak	Average Day	Peak
1996*	304	527	78	508	381	923
1997*	368	1,084	103	2,869	472	3,415
1998*	333	711	72	313	404	987
1999	315	628	98	323	413	834
2000	298	539	107	369	404	865
2001	265	682	95	257	360	893
Avg.	315		92		407	

* Instantaneous readings from weir

Table 1 – Recorded Effluent Flows

Data for the period prior to 1999 in Table 1 is based on instantaneous once-daily readings and therefore may not accurately represent actual flow for that day, particularly in the case of peak flows. The overall averages included at the bottom of Table 1 are therefore based on the totalizer data only. Examination of Table 1 shows the following:

1. Average day flows to the BCR Lagoon are approximately one third of its existing design capacity of 936 m^3/day.
2. The ratio of recorded maximum (peak) day flow to recorded average day flow at the BCR Lagoon is approximately 2.0, exceeding the design maximum day factor of 1.5.

3. The ratio of recorded maximum day flow to recorded average day flow at the Danson Lagoon is approximately 3.0.
4. Excessively high flows were recorded at both lagoon systems in 1997.

Analysis of the flow data indicates that the BCR Lagoon is operating well below its design capacity. Surplus capacity is available and could be used to treat sewage flows diverted from the Danson system.

As shown in Table 1, recorded average day flows entering the Danson Lagoon are approximately 80% of the calculated average day rate of 118 m^3/day allowed under Permit No. PE-4905 but recorded peak flows exceed the allowable daily rate threshold of 178 m^3/day. It is possible that insufficient treatment could be taking place within the lagoon system under high flow conditions and aeration equipment may need to be provided to allow the lagoon to remain in compliance with the permit.

The serviced area in the Danson system is approximately 133 ha versus 107 ha serviced by the existing collection system in the BCR system. Though the serviced area in Danson is larger than BCR and the Danson Lagoon is accepting effluent from the Sintich Trailer Park, recorded average day sewage flows are considerably less than those in the BCR system. The lower flow rates are probably the result of larger industrial lots in the Danson area, differing usage and less infill.

2.4.2 Danson Lagoon

The City also provided record data specific to the Danson Lagoon for the period from 1988 to 2001. In addition to daily flow rates in m^3/day, the data included monthly averages for Biochemical Oxygen Demand (BOD) in mg/L, Total Suspended Solids (TSS) in mg/L, pH and coliform bacteria. Figure 2 is a graph summarizing the annual averages for daily flow rates, BOD, and TSS over the 14 year period.

The data indicates that the lagoon has been performing within the requirements of the MOE permit. The permit allows a maximum concentration of 100 mg/L for 5-day BOD and 100 mg/L for TSS. As shown on Figure 2, annual averages for these two parameters have tended to be less than 50 mg/L indicating good performance from the lagoon system. The data shows that there are variations in levels of BOD and TSS from month to month but, with the exception of a TSS reading in July, 1993, these levels are less than the maximum value allowed under the permit.

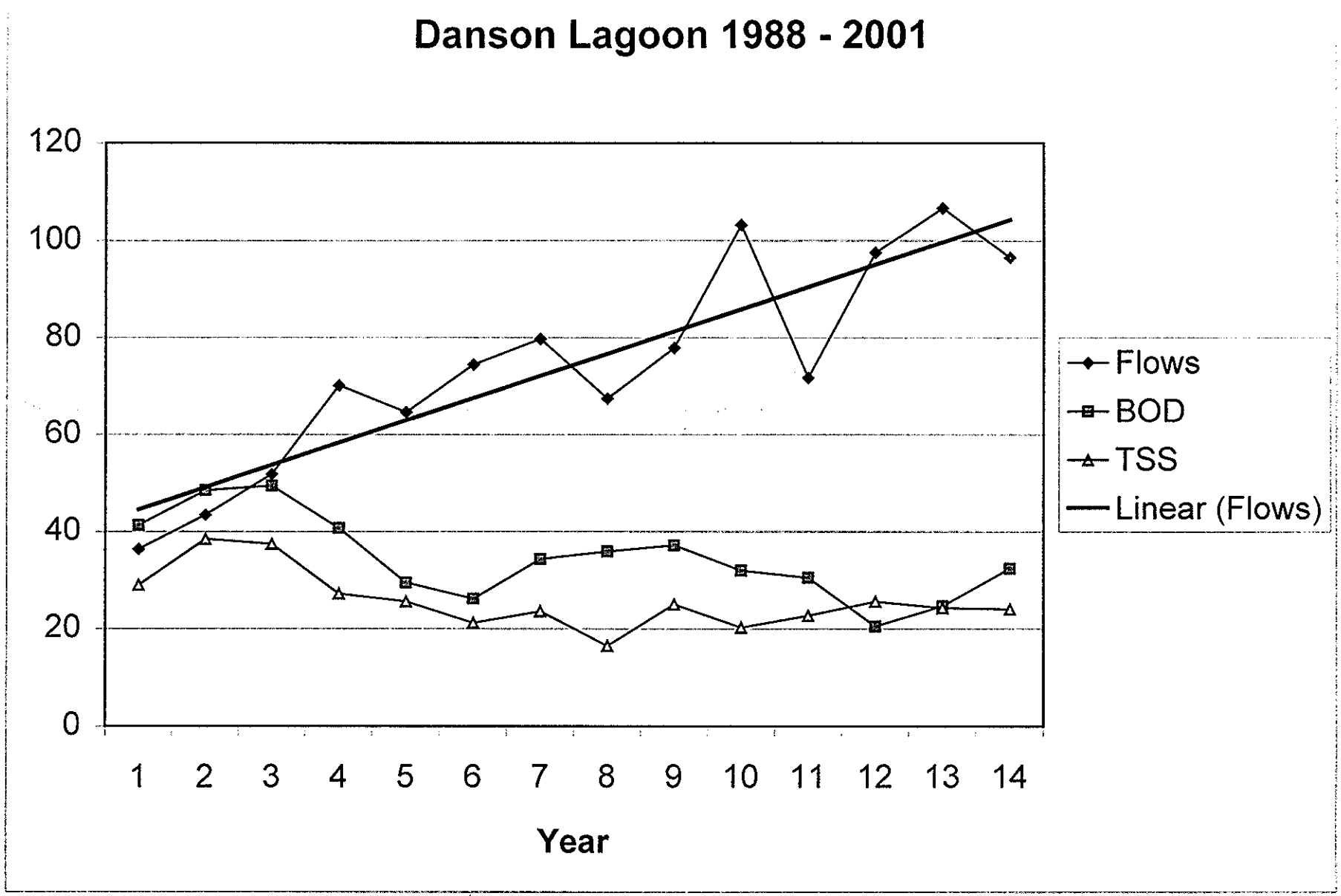

Danson Lagoon 1988 - 2001
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Year
Flows
BOD
TSS
Linear (Flows)

FIG. 2

Figure 2 indicates that average daily sewage flows fluctuate, sometimes by as much as 30%, from year to year. A linear trend line superimposed on the graph shows a historical increase in sewage flows over this period. Assuming that the trend line is applicable to the future, in approximately the year 2004 average daily sewage flow could be 118 m^3/day and peak daily flows (excluding infiltration and inflow effects) would be at the maximum limit allowed under the permit. Installation of aeration equipment would then be necessary to provide the capacity to comply with the conditions of the permit.

2.5 Infiltration and Inflow

The flow data provided by the City indicates that the ratio of maximum day flows to average day flows exceeds the factor of 1.5 that appears to have been used in the original designs for both the Danson and BCR systems. With the exception of 1997, peak flows in the BCR system took place in the summer or late fall. Peak flows at the Danson lagoon tended to occur early in the year, probably during 'spring' thaw runoff periods. In 1997, peak flows were recorded during the month of February at both lagoons. The high peak flows recorded in 1997 and the wide variance between average day and maximum day flows, particularly at the Danson Lagoon, indicate that excess water is entering the sewer systems through infiltration and inflow (I & I).

Though the accuracy of the 1997 figures is questionable, the records indicate that unusually high peak flows occurred at both the Danson and BCR Lagoons during this time period. The peak flow recorded in 1997, if representative of maximum day flow, exceeded even the future design Stage 2 capacity of the Danson Lagoon. Peak flows recorded at the Danson Lagoon between 1996 and 2001 exceed the daily rate allowed under the MOE Permit and could trigger the requirement for installation of aeration equipment if allowed to continue.

The I & I flows could be the result of a number of factors including breaks or faulty joints in the sewer mains, illegal connections to the sewer system such as roof leaders, surface catch basins or surface water entering low manhole covers. Poor surface drainage conditions can also be contributing factors to water inflow in the sanitary sewers. Ponding in the vicinity of mains and manholes can allow water to enter the system or a manhole could be used illegally as a discharge point for water pumped from flooded surface areas.

I & I is undesirable because:

- Pump operating costs increase due to longer run times needed to deal with the excess flows in the sewer system.
- Pumps installed in the system may wind up being oversized to deal with the high I & I flows making them less efficient and more costly to operate under 'normal' flow conditions.

- Pipes with marginal flow capacity could be overloaded and surcharge under high I & I conditions.
- Excess flow could hinder the treatment process efficiency of the lagoons, particularly at the Danson Lagoon.
- I & I from surface sources could introduce contaminants such as hydrocarbons or industrial chemicals that are not readily treatable by the lagoon systems.

I & I appears to be taking place in both the BCR and Danson sewer systems but is a more serious problem in the Danson Industrial Park because of its effect on the pumping system in PW118 and the treatment efficiency of the Danson Lagoon. In the BCR system I & I appears to be taking place at significantly lower levels and, with the exception of the high flows recorded in 1997, is possibly less of a concern.

The sources of I & I in both the BCR and the Danson sewer systems need to be identified and addressed. Corrective measures could include remedial works to the system such as raising manholes, replacing defective piping, etc. or education and enforcement procedures to prevent unauthorized use of the sewer system for disposal of surface runoff.

3.0 FUTURE GROWTH

3.1 Expansion Areas

Discussions with the City's Planning Department and a review of the Official Community Plan (OCP) indicate that there will be no expansions to the boundaries of the Danson and BCR Industrial Parks in the foreseeable future. Growth affecting sewage flows therefore will take the form of infill in or between existing developed areas or by a specific development such as the proposed Petro Plaza.

The "BCR/Danson Water System, Petro Plaza Development – Water Supply Availability" report prepared by the City in 1997 identified three potential areas for future growth as follows:

- Infill within BCR/Danson Industrial Parks.
- Proposed Canfor MDF Plant.
- Proposed Petro Plaza Development.

The report had to make a number of assumptions in the analysis of water usage and the status of the two proposed developments listed above is uncertain. However, it is not unreasonable to assume that some form of development will eventually take place and the report is therefore useful as a tool for predicting future water demands and resulting sewage flows.

The City's "Water Supply Availability" report noted that the existing PW627 groundwater well had a capacity of 3,455 L/min. and could not by itself satisfy the water demands resulting from infill, the MDF Plant and Petro Plaza. Additional water sources would have to be developed to supplement PW627.

3.2 Water Demands and Sewage Flows

The City's "Water Supply Availability" report included historical flow data for water production for the system servicing the BCR/Danson Industrial Parks and the Sintich Trailer Park covering the period from 1992 to 1996. Unfortunately, the available information is not sufficiently detailed to permit a precise determination of water usage within the Danson and BCR Industrial Parks versus usage by other users such as the Sintich Trailer Park.

A "rule of thumb" for estimating sewage flows is that sewage volume is approximately 80% of water usage volume. It is assumed that water not making its way into the sewer system is used for exterior purposes such as irrigation or washing or is lost due to wastage or leaking distribution mains.

As part of the assessment process, City staff reviewed water meter readings for the individual users serviced by the PW627 well. The volume of data did not make it practical to break down water usage within specific areas but the City was able to determine that the volume of water metered in 2001 was approximately 88% of the volume recorded at the production well. This proportion is reasonably consistent with the assumptions used in the "rule of thumb" procedure.

The "Water Supply Availability" report noted that the average volume pumped from the well at PW627 over this five year period was 690.5 ML/year which translates into an average daily water demand of 1,892 m^3/d. Recorded usage for the year 1996 was 657.8 ML yielding a daily rate of 1,797 m^3/d. From Table 1, the combined sewage effluent flow at the Danson and BCR lagoons was calculated to be 381 m^3/d for an average day in 1996 which is approximately 21% of the recorded total water production volume.

It should be noted that the existing water system services a number of industrial users that are not connected to either the existing Danson or BCR sewer systems. The proportion of recorded sewage flows to recorded water production for Danson/BCR therefore is low compared to the "rule of thumb" factor because of usage outside the areas serviced by the sanitary sewers.

The "Water Supply Availability" report included projections for water demands for possible expansions including Petro Plaza and the proposed MDF Plant. The proportions noted above were applied to the projected water demands for the BCR/Danson area to develop a range of projected sewage flows suitable for assessing the capacity of the existing lagoons.

3.3 Projected Sewage Flows

The "Water Supply Availability" report included estimates of maximum day water demands for potential infill development, Petro Plaza and two stages of the proposed MDF plant. Table 2 summarizes the City's estimates and includes calculations for possible average day sewage flows resulting from these developments. A factor of 1.5 was used to relate maximum day water demands to average day use for infill development.

The factor of 21% obtained by relating the recorded water production and sewage flow data was applied to the projected water demand to obtain an optimistic low range estimate of future sewage flows. The "rule of thumb" factor of 80% was used to develop a more conservative high range estimate of projected sewage flows in Table 2. The table also indicates a probable destination for the future sewage flows assuming that both the Danson and BCR lagoons are kept in service.

Future Expansion Area	Projected Water Demands from City Report		Projected Sewage Flows (m^3/day)		Discharge Location
	MDD (L/min)	ADD (m^3/day)	21% of water demand	80% of water demand	
Infill Development	728	700	147	560	50% each lagoon
MDF Phase 1	600	864	181	691	BCR Lagoon
MDF Phase 2	600	864	181	691	BCR Lagoon
Petro Plaza	378	272	57	218	Either
Total Additional Sewage Flow			566	2160	

Table 2 – Projected Additional Sewage Flows

Table 3 summarizes the possible impact of the future expansions/developments on the Danson Lagoon if it were to be kept in service.

Component	Average Daily Sewage Flow (m^3/day)	
	Low Range	High Range
Existing recorded sewage flow	92	92
Flows from Infill Development	74	280
Subtotal	**166**	**372**
Flows from Petro Plaza	57	218
Total Sewage Flow with Petro Plaza Included	**223**	**590**

Table 3 – Sewage Flows to Danson Lagoon

The proposed Petro Plaza Development is in a location approximately equidistant from both the Danson and BCR sewer systems. Barring unforeseen site conditions, tie-ins to either the BCR sewer system or the Danson system are probably equally feasible. For the purposes of this assessment it is assumed that sewage from Petro Plaza is directed to the Danson Lagoon as 'worst case' scenario.

As noted previously, infill development following historical trends could trigger the future Stage 2 upgrading of the Danson Lagoon as early as the year 2004. Upgrading the Danson Lagoon would increase the design capacity of the lagoon to 681 m^3/day at design average day rates giving it the capability to handle the 'high range' estimate of 590 m^3/day shown in Table 3. The upgraded Danson Lagoon would therefore have the capacity to accommodate sewage flows from Petro Plaza and would have some limited surplus capacity. The Danson Lagoon, even with the Stage 2 upgrading in place, does not have sufficient capacity to service large scale major developments such as an MDF plant.

The existing BCR Lagoon has a design capacity of 936 m^3/day. Impacts of potential developments on sewage flows to the BCR Lagoon are summarized in Table 4 following. Comparison of the design capacity of the lagoon with the estimated sewage flows in Table 4 indicates that any major development such as an MDF Plant or the Petro Plaza will tax the capacity of the existing lagoon even if the 'low range' of sewage flows is assumed.

Component	Average Daily Sewage Flow (m^3/day)	
	Low Range	High Range
Existing recorded sewage flows	315	315
Flows from Infill Development	74	280
Flows from MDF Plant (both phases)	362	1382
Subtotal #1	**751**	**1977**
Diversion from Danson Lagoon	166	372
Subtotal with Danson diversion	**917**	**2349**
Subtotal #1	751	1977
Flows from Petro Plaza	57	218
Subtotal with Petro Plaza	**808**	**2195**
Total Sewage Flow Including Danson diversion	**974**	**2567**

Table 4 – Sewage Flows to BCR Lagoon

If 'high range' conditions apply, flows diverted from the Danson Lagoon (excluding Petro Plaza) and potential infill development within the BCR area yield an average day inflow rate of 967 m^3/day which is approximately 3% higher than the existing design capacity of the BCR Lagoon.

The existing BCR Lagoon therefore is marginally capable of handling the additional flows from infill development and diversion of sewage from the Danson Lagoon. It does not have the capacity to accommodate any major development such as an MDF Plant or the proposed Petro Plaza.

3.4 BCR Lagoon Upgrade

The available water flow records for PW627 included in the City's "Water Supply Availability" report and the sewage effluent flow records for the Danson and BCR lagoons cover the period from 1992 to 2001. The combined data show fluctuations in water demands and sewage generation from year to year but do not appear to show any significant discernable growth trends affecting the BDR lagoon.

Some development has taken place over the period covered by the flow records, notably along Continental Way, but this growth either has had minimal impact on water demands and sewage flows or else has been offset by reductions elsewhere in the system. Infill development therefore is expected to be gradual and will not be a significant determinant of when expansions or improvements to the existing BCR lagoon system are necessary.

Even with the introduction of sewage flows from the Danson area, the BCR lagoon has sufficient design capacity for the foreseeable future and does not require immediate upgrading. Construction of a major development such as an MDF Plant or, to a lesser extent, Petro Plaza will be the governing factor affecting the operation of the BCR Lagoon. When additional treatment capacity is required, the lagoon can be expanded or sewage can be diverted across the Fraser River for treatment at the Lansdowne Plant.

The status of these developments is unknown at present. The "Water Supply Availability" report noted in 1997 that the MDF Plant was proposed to be constructed in two phases with the second phase taking place after 2005. The scale of these developments and the necessity for concurrent upgrades to the water supply system should provide sufficient lead time to allow the lagoon to be upgraded or permit alternatives such as a diversion to the Lansdowne Plant to be implemented.

4.0 PROPOSED UPGRADING

4.1 Improvement Alternatives

The existing Danson Lagoon appears to be operating well but if sewage flow rates continue to follow the trend shown in Figure 2, installation of aeration equipment may be necessary in the near future to remain in compliance with the MOE permit. The possible alternatives for treating sewage in the Danson Industrial Park are:

- Reduce I & I flows and retain Danson Lagoon as-is.
- Upgrade Danson Lagoon with the installation of aeration equipment.
- Decommission Danson Lagoon immediately and divert all sewage to the BCR Lagoon.
- Divert sewage to the BCR Lagoon as part of a long-range plan.

Reduction of I & I flows can have an impact on all the potential alternatives but, until a study is conducted to determine the source of I & I, it is not known whether the remedial works needed are either practical or cost effective. Reducing I & I or upgrading the Danson Lagoon allows works to be confined to the area of the Danson subdivision.

Alternatives involving diversion of flows to the BCR lagoon are costly and have impacts on large tracts of land. Works can be affected by I & I and the additional flows in the BCR system can trigger upgrading requirements for existing mains in the BCR area.

4.2 Alternative 1 – Reduce Infiltration and Inflow (I & I)

The flow data provided by the City indicates that maximum day sewage flows in both the Danson and BCR systems are excessively high in relation to average day flows and also exceed the maximum flow rate allowed for facultative operation of the Danson Lagoon under the MOE permit. Reducing infiltration and inflow (I & I) to acceptable levels lowers peak flows, allows for more efficient operation of pumping stations and allows the Danson lagoon to remain in compliance with the MOE permit.

An I & I study is necessary to determine the sources of I & I flows in the systems and what corrective measures are necessary to deal with them. An I & I study is also a desirable prerequisite to other improvement alternatives outlined in this report.

There is insufficient information available at this time to determine cost estimates for any remedial work that may be necessary.

4.3 Alternative 2 – Upgrade Danson Lagoon

4.3.1 General

Under Alternative 2, the sewer systems in the Danson and BCR Industrial Parks remain as separate independent systems. All works under this alternative take place in the Danson area.

The design and construction of the Danson Lagoon included provision for the future installation of aeration equipment. Design drawings were completed for this next stage concurrently with the drawings for the first phase of construction. The design will need to be checked for compliance with current regulations and for compatibility with available equipment.

All works required for upgrading the Danson lagoon will take place in the immediate vicinity of the lagoon and will have little or no effect on offsite areas.

4.3.2 PW118 Lift Station

The existing Flygt CP3152 pumps in PW118 are capable of operating at 76 L/s against a head of 5.5 m. From Table 3, the projected average day sewage flows passing through this lift station to the lagoon are estimated to be 590 m^3/day (high range, Petro Plaza included) which is equivalent to a flow rate of 6.82 L/s. The existing pumps therefore have a capacity approximately 11 times greater than the projected average day flow. Pump systems are normally designed to handle peak hour flow, the value of which is obtained by applying a factor of 4 or 5 to the average day flow rate.

The existing pumps in PW118 appear to be oversized but their surplus capacity has allowed them to deal with the high I & I flows entering the system in the past. No upgrading is necessary at PW118 if the Danson Lagoon remains in service.

If the sources of I & I in the Danson system are identified and corrected (Alternative 1), peak flows may be reduced to the point that smaller pumps could be installed in PW118.

4.3.3 Future Extensions

Upgrading the Danson Lagoon permits design capacity to accommodate existing sewage flows and flows resulting from future infill development in the Danson Industrial Park. As indicated in Table 3, there would also be additional reserve capacity that would allow service to a proposed Petro Plaza development.

Flow records indicate that water usage and sewage generation in the Danson and BCR areas has been relatively static, with the exception of I & I, for several years. Other than Petro Plaza, whose status in uncertain, there do not appear to be any major extensions or developments being contemplated in the foreseeable future.

4.3.4 Estimated Cost

Estimated costs in 2001 dollars for Alternative 2, upgrading the Danson Lagoon, are:

Siteworks and Miscellaneous	$ 31,000
Operations Building	$ 260,600
Aeration System	$ 353,000
Subtotal	$ 644,600
Engineering incl. Survey/Inspection (12%)	$ 77,300
Contingency (15%)	$ 108,300
Estimated Construction Cost	$ 830,200
GST (3%)	$ 24,906
Total	$ 855,106
Interim Financing (8%)	$ 68,408
Grand Total	**$ 923,514**

The existing pumps in PW118 have sufficient capacity to handle projected flows and the cost estimate assumes that these pumps are retained.

4.3.5 Advantages and Disadvantages

The advantages of Alternative 2, upgrading the existing Danson Lagoon, are:

- Minimal disruption to existing sewer systems and lagoon operation.
- No disruption to existing roads.
- Allows flexibility in scheduling of improvements to BCR Lagoon.
- The upgraded Danson lagoon can accommodate additional development similar in scope to proposed Petro Plaza.
- Lowest capital cost.

The Danson Lagoon, even with the Stage 2 upgrades in place, does not have the capacity to service developments of the scale of an MDF Plant. Sewage from these sites would have to be directed elsewhere.

Disadvantages of upgrading the Danson Lagoon are:

- Duplication of lagoon facilities.
- Installation of aeration equipment increases maintenance requirements at Danson Lagoon
- Limited potential for expansion of Danson system.

4.4 Alternative 3 – Decommission Danson Lagoon

4.4.1 General

Under this alternative, all sewage flows in the Danson Industrial Park are pumped to the BCR sewer system for treatment at the BCR Lagoon. The diversion requires that a new forcemain be installed along the approximate alignment shown on Figure 3 starting with a connection to the existing PW118 lift station. The new forcemain would follow existing road rights-of-way as much as possible and connect to an existing manhole in the BCR system located downstream of the PW123 lift station.

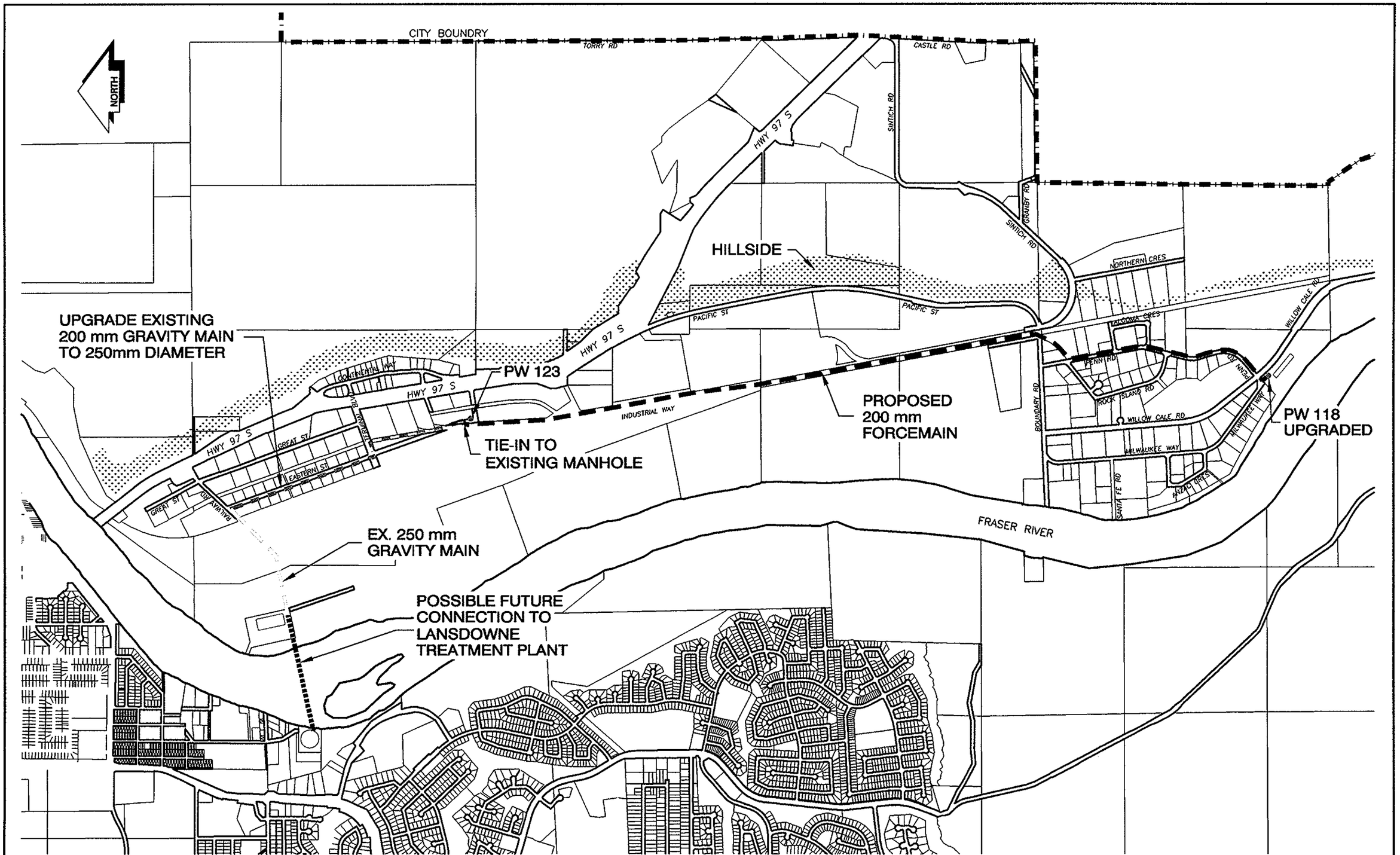
The City had also considered an alternative route for the forcemain along Milwaukee Way and several private properties with a direct connection to the BCR lagoon. Negotiations with multiple property owners would have been necessary and it was therefore decided not to include this route in the assessment.

Existing 200 mm gravity mains in the BCR system have deficient grades and do not have sufficient capacity to carry the pumped flows without surcharging. It will be necessary to upgrade portions of the system to 250 mm diameter.

The BCR Lagoon has sufficient capacity to accommodate the additional flows from the Danson system and will not require any upgrading until a major development such as the MDF Plant or Petro Plaza is constructed.

4.4.2 PW118 Lift Station

The proposed forcemain is approximately 4800 m long and the discharge location is approximately 17 m higher than the existing PW118 pump station. Under these conditions the existing Flygt CP3152 pumps in PW118 can still operate but their capacity is reduced from 76 L/s to approximately 14 L/s. As previously noted, the design average day flow rate for sewage flows passing through PW118 to the Danson Lagoon is 6.82 L/s. Design peak hour sewage flows which would be 27.3 L/s assuming a peaking factor of 4. Even if excessive I & I flows are ignored, the existing pumps would be undersized under peak flow conditions



No.	Date	Revision	Dr.	Ch.

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McElhanney

DANSON/BCR INDUSTRIAL PARKS

PROPOSED FORCEMAIN

DESIGN:		DATE:	DECEMBER 2001
DRAWN:	BLB	FILE:	2341-00868
CHECKED:	JS	TASK:	2001
SCALE:	1:20000	DRAWING No.	FIG.3
		REV.	

Possible replacements for the existing pumps are Flygt CP3300 pumps that would operate at approximately 34.2 L/s against a total head of 50 m. Information from ITT Flygt indicates that the proposed pumps are compatible with the discharge connections of the existing pumps. However, the new pumps are 88 hp versus the existing pumps which are 20 hp and existing electrical panels will need to be replaced.

The peak flow recorded at the Danson lagoon in 1997 is approximately equivalent to the pumping rate of the proposed pumps. It should be noted that, since the data in 1997 covered instantaneous flows only, the recorded rate would not necessarily be representative of the average flow over that particular day but might be applicable to a much shorter period of time. The excessively high peak flows recorded in 1997 are probably the result of I & I. Were similar conditions to occur again, the new pump(s) could be running continuously until inflow rates subsided to the point that the pumps could catch up.

If the recorded 1997 flow rate were representative of a 'peak hour' rather than a 'peak day' the proposed pump would likely be adequate. Otherwise, there is a possibility of the pumps being overwhelmed with the attendant risk of the pump station being flooded. Attempting to select a pump size to compensate for excessive I & I flows in the system will result in pumps that are oversized for "normal" usage and probably less efficient under lower inflows.

An I & I study (Alternative 1) is necessary so that sources of water infiltration and inflow to the sanitary sewer collection system in the Danson Industrial Park can be identified and corrected before any new pump system is installed.

4.4.3 Proposed Forcemain/Sewer Upgrading

To maintain a minimum 'scouring' velocity of 1 m/s in the forcemain, a 200 mm diameter pipe is necessary. The forcemain can be connected to an existing stub at PW118 and installed along the route shown on Figure 2. Grades are relatively 'flat' along the proposed route and air release valves will be necessary to maintain efficient operation of the forcemain. The forcemain should be installed at sufficient depth to provide protection from freezing.

The necessity for sufficient depth for frost protection and for avoiding conflicts with existing buried utilities will result in damage to existing concrete curbs and pavement in existing developed areas such as Penn Road. The construction process will incur high restoration costs along this portion of the route.

The remainder of the forcemain route follows gravel roads and will cross some BC Rail spur lines before it ties into an existing manhole located between PW123 and Terminal Boulevard. The forcemain bypasses pump station PW123 to avoid having to upgrade this lift station and double-pump the sewage from the Danson area. It is possible to substitute gravity piping for forcemain along Industrial Way but elevations at tie-in locations and the practicality of constructing deep sewer mains are constraints on the amount of gravity main that can be constructed. An intermediate pumping station would be necessary, adding both to initial capital cost and ongoing operation and maintenance costs.

It should be noted that the route along Industrial Way provides an opportunity for tying in properties between the two industrial parks into a common sewer system and also provides a possible connection point for a future MDF Plant or similar development. In the final construction, it is possible that the forcemain will not be a continuous pipe as shown on Figure 3 but may incorporate intermediate connections, pumping stations or gravity sewers.

The proposed forcemain ties into the gravity sewer in the BCR Industrial Park and sewage would then flow by gravity to the BCR Lagoons. The existing 200 mm gravity mains along Eastern St. and to the proposed forcemain tie-in point are not sufficiently graded according to the City's record drawings. These existing mains are undersized for the flow rate delivered by the forcemain and should be upgraded to 250 mm diameter.

The 2001 Sanitary Sewer Study also identifies deficiencies in gravity mains in the BCR Subdivision and recommends upgrading.

4.4.4 Future Development

The route of the proposed forcemain shares some locations with possible future servicing to developments such as an MDF Plant. It is probable that these developments would by themselves also make it necessary to upgrade existing gravity mains in the BCR system. It is therefore likely that over time portions of the proposed forcemain route along Industrial Way, including the tie-in to the existing BCR system, would be developed with sanitary sewers or forcemains even if the proposed diversion from the Danson lagoon does not take place immediately.

Diversion of sewage from the Danson Industrial Park to the BCR Industrial Park can be a long term objective. Servicing for intermediate developments such as a possible MDF Plant or upgrades to existing mains within the BCR area could include provision for the eventual collection of sewage from the Danson area.

Figure 3 shows a potential future crossing of the Fraser River to link the BCR Lagoon to the City's main Lansdowne Sewage Treatment Plant. This link could be used as an alternative to a future expansion of the BCR Lagoon.

4.4.5 Estimated Cost – Alternative 3

The cost estimate following assumes that the proposed forcemain is continuous from PW118 to the tie-in location in the BCR Industrial Park and that work takes place prior to any other developments along Industrial Way. The estimate also assumes that the I & I is addressed such that the upgraded pumps in the PW118 Lift Station are not required to deal with excessive peaks resulting from I & I.

Estimated costs in 2001 dollars for Alternative 3 , diverting sewage from the Danson Industrial Park to the BCR Lagoon, are:

Siteworks and Miscellaneous	$ 202,600
Upgrade PW118 Lift Station	$ 78,000
Install 200 mm diameter forcemain (approx. length 4800 m)	$ 832,000
Restoration works along Penn Road	$ 297,000
Upgrade 200 mm mains to 250 mm (approx. length 1400 m)	$ 443,000
Decommission Danson Lagoon	$ 8,000
Subtotal	$ 1,860,600
Engineering incl. Survey/Inspection (12%)	$ 223,300
Contingency (15%)	$ 312,600
Estimated Construction Cost	$ 2,396,500
GST (3%)	$ 71,895
Total	$ 2,468,395
Interim Financing (8%)	$ 197,472
Grand Total	**$ 2,665,867**

Costs for an I & I study and remedial works to the sewer system to address infiltration and inflow deficiencies are not included in the estimate above. The estimate makes no provision for possible cost sharing with existing or future developments along Industrial Way.

4.4.6 Advantages and Disadvantages

The advantages of Alternative 3, decommissioning the Danson Lagoon and diverting sewage to the BCR Lagoons are:

- Centralized treatment of sewage possible.
- One MOE discharge permit eliminated.
- Opportunity for servicing properties between Danson and BCR Industrial Parks.
- Work can be staged or costs shared in conjunction with other developments.
- Opportunity for future diversion of all sewage flows to the Lansdowne Treatment Plant by a pipe crossing the Fraser River.

Disadvantages of diversion to the BCR Lagoon are:

- 'Over-sized' pumps necessary if I & I not addressed.
- Existing sewer system disrupted in BCR area.
- Disruption to Penn Road and Industrial Way during construction.
- May trigger earlier expansion requirement at BCR Lagoon.
- Status of intermediate developments and tie-in requirements not known.
- High capital cost.

4.5 Alternative 4 – Temporary Diversion from Danson Lagoon

This alternative is essentially a variation of Alternative 3. Under this alternative, sewage flows are diverted to the BCR system until such time that expansion of the BCR lagoons is required. At that time, the Danson lagoon is reactivated with the appropriate upgrades necessary for it to accommodate flows entering the lagoon.

Initial costs are comparable to those of Alternative 2 but a future activation of the Danson Lagoon has significant hidden costs resulting from abandonment of the proposed forcemain along Penn Road and portions of Industrial Way.

The sole advantage of this alternative is that the Danson lagoon could be reactivated when sewage flows increase to the point that the full capacity of the BCR lagoons is being utilized. Upgrading the BCR Lagoon could therefore be deferred as a result.

4.6 Discussion of Alternatives

Alternative 1, the I & I Study and associated remedial works, has the potential benefit of reducing peak flows such that the operation of the Danson Lagoon remains in compliance with the MOE permit and of allowing sewage pumps to be sized more efficiently. Pumping requirements can have a significant impact on capital and operation costs for Alternative 3. Reducing I & I can allow the Danson Lagoon to remain in service without significant upgrading for several years. The extent of remedial work necessary is unknown and its associated cost can not be determined until an I & I Study is completed.

Upgrading the Danson Lagoon as discussed under Alternative 2 has as its advantages a relatively low capital cost and little or no impact on areas outside the limits of the lagoon. There are few 'unknowns' involved in the implementation of Alternative 2 and an I & I study, while desirable, is not a prerequisite. The disadvantages of retaining the Danson Lagoon are the continued duplication of lagoon facilities and the additional maintenance requirements of an aeration system at the Danson Lagoon.

Alternative 3, diverting sewage flows from the Danson Industrial Park to the BCR Lagoon, is costly and is dependent on a number of unknown factors such as the extent of I & I in the Danson system (affects pump selection at PW118) and future developments that would be serviced along the proposed forcemain route (possible effects on cost sharing). Alternative 3 is probably best suited as a long range objective and any facilities constructed along Industrial Way should include provision for the eventual diversion of sewage flows from the Danson Industrial Park.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following summarizes the conclusions in this report;

- Sewage flows to the Danson Lagoon are normally within the limits allowed under the MOE permit but peak flows occasionally exceed permit requirements.
- Peak flows at the Danson Lagoon appear to be the result of Infiltration and Inflow (I & I).
- I & I is taking place in both the Danson and BCR systems but is worse in the Danson system.
- Poor surface drainage might be a contributing factor to I & I and may also be introducing contaminants into the sanitary sewer system.
- Stage 2 upgrading of the Danson Lagoon gives it sufficient capacity for infill in the Danson Industrial Park as well as the possible inclusion of future development at Petro Plaza.
- The existing BCR Lagoon has sufficient capacity to accept flows from the Danson Lagoon as well as infill development in both industrial parks.
- Some existing 200 mm sewers in the BCR Industrial Park have insufficient grades.
- Addition of a major development such as an MDF Plant will result in sewage flows that exceed the capacity of the existing BCR Lagoon.
- Major developments such as an MDF Plant are the governing factor in determining when an expansion of the BCR Lagoon or a link to the Lansdowne Sewage Treatment Plant are necessary.

5.2 Recommendations

Recommendations for improving sanitary sewage collection and treatment in the Danson and BCR Industrial Parks are:

1. Conduct an I & I study (Alternative 1) on the existing sewage collection systems immediately. Perform the necessary remedial work on the sanitary sewer system or surface drainage facilities needed to eliminate the excess inflow and infiltration.

2. Provided that remedial works under Alternative 1 reduce peak flows sufficiently, keep the Danson Lagoon in service.

3. Monitor flows to ensure that they remain in permit requirements. Perform the Stage 2 Upgrading for the Danson Lagoon when warranted by natural population growth in the Danson area.

4. Sewer system extensions for future developments along Industrial Way should make provision for future growth and the eventual future diversion of sewage flows from the Danson Industrial Park to the BCR Lagoon.

5. Upgrading of existing sewers in the BCR Industrial Park should make provision for eventual diversion of sewage flows from the Danson Lagoon.

6. Sewage flows from future major developments such as an MDF Plant should be directed to the BCR Lagoons.

6.0 CLOSURE

This Report includes an assessment of the capacities of the existing lagoon systems and cost estimates for the proposed diversion from the Danson Lagoon to the BCR Lagoon. The cost estimates are intended to assist the City in determining whether the diversion is feasible or desirable.

This Assessment Report has been prepared by McElhanney Consulting Services Ltd. (MCSL) for the benefit of the City of Prince George. The information and data contained herein represent MCSL's best professional judgement in light of the knowledge and information available to MCSL at the time of preparation. Except as required by law, this Assessment Report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the client, its officers and employees.

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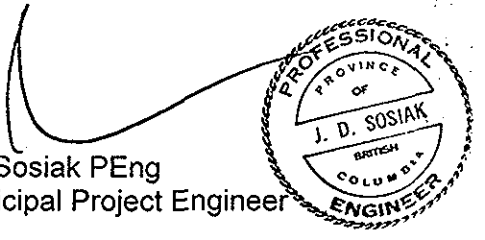

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JUN 06 2002