January 2014

TSAWWASSEN FIRST NATION
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Bulk Water and Sanitary Trunk Master Plan

Tsawwassen First Nation

January 24, 2014 File: 2177.0043.01

Tsawwassen First Nation
1926 Tsawwassen Drive
Tsawwassen BC V4M 4G2

Attention: Ed Chanter, Director of Lands

RE: Bulk Water and Sanitary Trunk Master Plan

Please find enclosed the updated and final Bulk Water and Sanitary Trunk Master Plan Report. This revision fully incorporates the construction of a standalone waste water treatment plant on TFN lands. It also incorporates the current development phasing and revised sanitary force main routing to the waste water treatment plant.

We recommend that TFN adopt the Bulk Water and Sanitary Trunk Master Plan as a policy document to guide future development within TFN lands.

Please do not hesitate to contact the undersigned if you have any further questions regarding this matter.

Sincerely,

URBAN SYSTEMS LTD.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA #37807

Dan Todd, P.Eng.
Project Engineer

Steve Brubacher, P.Eng.
Senior Review

/dt

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Executive Summary

The Tsawwassen First Nation (TFN) is undergoing significant development as it realizes the opportunities afforded by the Treaty Lands. In order to effectively plan and service the expanded community TFN has embarked on the creation of two key water policy documents. The first is the Integrated Rainwater Management Plan that illustrates how rainwater will be managed within the context of the TFN lands. The second is this Bulk Water and Sanitary Trunk Master Plan which outlines the provision of potable water and sanitary sewer services. Together these two policy documents illustrate how the interactions between the land and water will be managed.

This Master Plan presents a servicing strategy that will allow the Tsawwassen First Nation to provide consistent levels of water and sanitary sewer service through to the build out of its lands. This strategy provides a cost effective approach that allows for phasing and will also allow TFN to respond to evolving design and construction practices. It represents best practices in water and sanitary sewer systems life cycle design and is well suited to the unique geographic conditions of the TFN lands.

The following table illustrates the maximum daily water demand and sewage generation rates at the completion of each of the development timeframes:

Development Horizon	2013	2015	2021	2031	2041 / Build out	Increased Density 2041/Build out
Status Quo Water Demand (l/s)	26	69	108	140	153	160
Increased Water Conservation Water Demand (l/s)	18	41	62	82	92	96
Status Quo Sanitary Flow (l/s)	28	75	107	135	150	155
Increased Water Conservation Sanitary Flow (l/s)	22	53	79	104	116	120

It is recommended that TFN:

- Adopt the proposed service delivery policies
- Proceed with infrastructure sizing to meet the increased density status quo demand scenario
- In order to position TFN as a leader in water conservation practices and principles that TFN:
    - Adopt the preferred sanitary servicing option
    - Implement universal fixed base radio read water metering
    - Adopt water conservation based meter rates
    - Develop a lot based irrigation allotment strategy
    - Review and update the Building Regulation
    - Develop a water use and conservation education plan

1.0 Introduction

The Tsawwassen First Nation is undergoing significant development as it realizes the opportunities afforded by the Treaty Lands. In order to effectively plan and service the expanded community TFN has embarked on the creation of two key water policy documents. The first is the Integrated Rainwater Management Plan that illustrates how rainwater will be managed within the context of the TFN lands. The second is this Bulk Water and Trunk Sanitary Master Plan which outlines the provision of potable water and sanitary sewer services. Together these two policy documents illustrate how the interactions between the land and water will be managed.

2.0 Land Use

2.1 Existing

The existing TFN community can generally be characterized into four distinct areas: the main community, Tsatsu Shores, Stahaken and the Tsawwassen Beach Lots.

The main community is located north of Highway 17 along Tsawwassen Drive. The main community includes the core residential lands and community facilities. TFN has estimated that the community consists of approximately 66 single family housing units which include social housing units and 12 trailer units in 2011. In addition, there are approximately 7 rural homes that are part the existing TFN community. These are generally located along 27B Avenue are not currently serviced by TFN.

The community facilities include the Community Administration Office, Community Hall, Long House, Youth Center, Church, Preschool/Daycare, Elders Trailer, Counsellor's Office, existing wastewater treatment plant, and cemetery.

The existing businesses within the main community include Splashdown Park, Park Canada, Tsatsu Gas, and the Tsawwassen Ferry Park N' Go. In addition to the main community, TFN has developed market housing, which are based on 99 year leases. These developments are located south of Highway 17 and include Tsatsu Shores - a four storey condominium, Stahaken - a single family residential area, and Tsawwassen Beach Lots - a single family residential area that fronts the Georgia Straight (Salish Sea).

The lands outside the TFN main community to the north (where the industrial lands are planned) and to the east (where the Enterprise Zone Neighbourhood Plan residential area, Tsawwassen Mills Mall and Power Centre are planned) are generally undeveloped and under active soil filling or agricultural crops. There are a half-dozen rural homes located on or adjacent to these pasture lands, some of which will be removed as development of the industrial area proceeds. These homes receive their water supply from the Corporation of Delta directly and rely on individual septic fields for sanitary servicing. Splashdown Park and Park Canada RV Park are located just on the north side of Highway 17 to the east of the existing community while Tsatsu Gas and a few residential homes exist immediately to the south of Highway 17.

2.2 Future

The TFN land use approach is based on the comprehensive TFN Land Use Plan (June, 2009). The entire land will be developed into distinct portions involving different land uses and projected densities. The northeast area of the TFN lands will remain agricultural and forested with very little or no development proposed. The other areas will be developed in general in accordance with the Land Use Plan.

It is proposed that two ultimate land use scenarios be evaluated for the Master Plan. It is our understanding that there is flexibility within the Land Use Plan that may see some variability in the actual densities to be realized. We have developed the base case build out scenario which is summarized in Table 2-1 and discussed in the sections following.

Through discussions with TFN we have confirmed that the higher population scenario should include an allowance for a total population increase of approximately 15% in the neighbourhood enterprise area, or 658 persons. This increases the total TFN population at build-out to 8343, an increase of approximately 8.5% over the base scenario. Note that this population increase will only be applied in year 2041 and will not affect interim servicing demands.

Table 2-1 Build out Phasing by Land Use Type (Base Case)

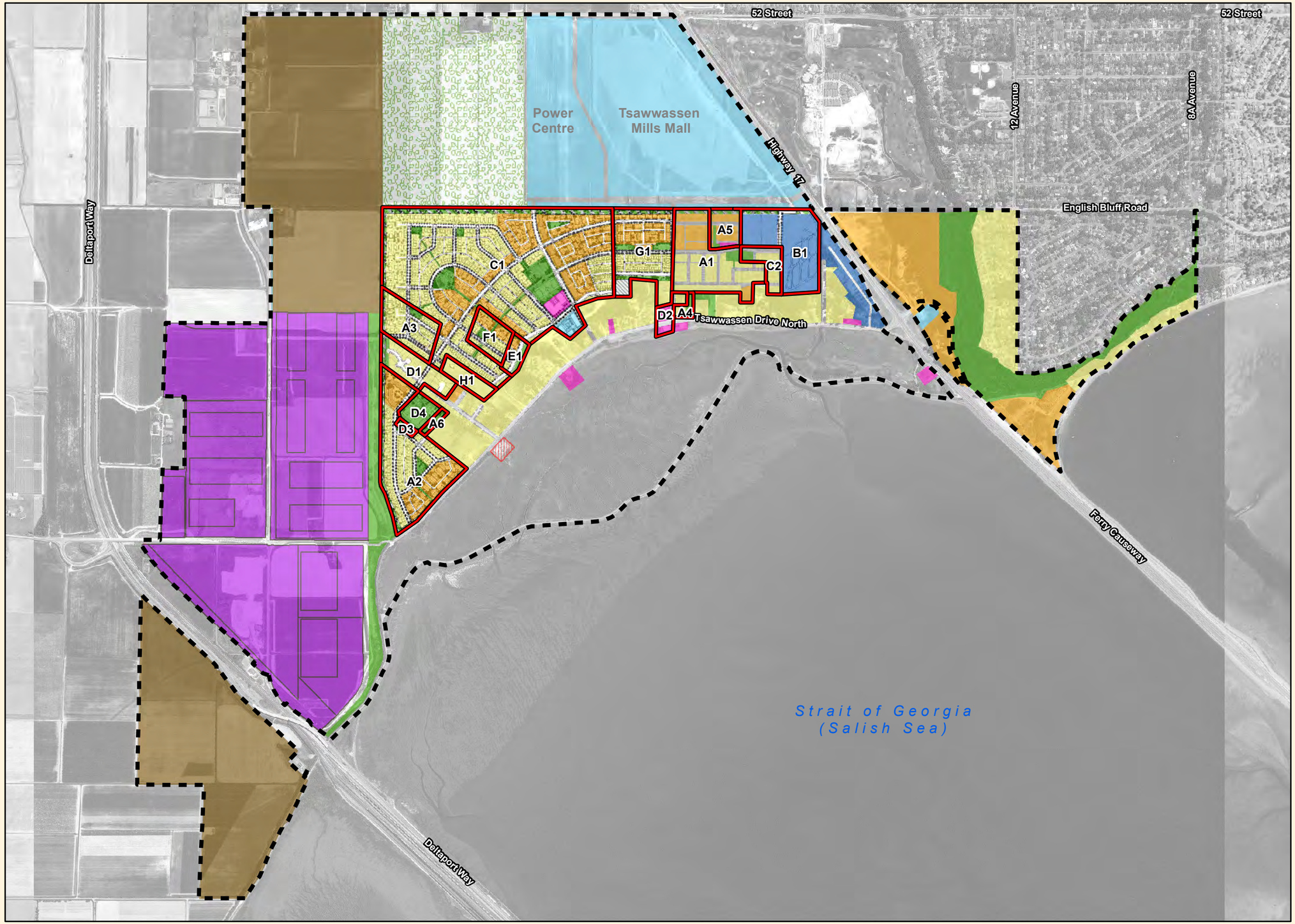
Land Use Type	2013	2015	2021	2031	2041
Residential Single Family Large Lot (Units)	25	150	600	800	932
Residential Single Family Small Lot (Units)					
Residential Multi-Family Townhouse (Units)	18	105	420	560	653
Residential Multi-Family Apartment (Units)	8	45	180	240	280
Residential TFN community Housing (Units)	88	108	158	258	270
Residential South of Hwy 17 (Units)	197	287	557	1,007	1,320
Commercial Retail (Square Metres Floor Area)	39,939	160,818	160,818	160,818	160,818
Commercial Other (Hectares)	0	0	3	6	8
Industrial (Hectares)	13	46	78	117	130
Institutional (Hectares)	0	0	3	3	3
Parks (Hectares)	1	4	17	23	27

2.2.1 Enterprise Zone Neighbourhood Plan Area

The TFN adopted the Enterprise Zone Neighbourhood Plan in March, 2011. This plan builds upon the concepts developed in the Land Use Plan and accounts for about 110 hectares of the TFN lands. A preferred land use concept was developed for the Neighbourhood Plan.

The Neighbourhood Plan development area has been divided into several Development Precincts. These Precincts are labelled on Figure 2-1 Proposed Land Use in accordance with the Neighbourhood Plan. Tsawwassen Fee Simple Interest (TFSI) holders own the majority of the Neighbourhood Plan area. TFN owns approximately 3% of the Neighbourhood Plan area.

As part of the neighbourhood plan area, the village centre and school facilities are proposed within Precinct C1. The probable timing for construction of these facilities is 2021. In order to support population growth in the study area TFN may consider advancing the construction schedule of these facilities.



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Legend

- TFN Boundary
- Development Precincts

Proposed Land Use

- Agricultural
- Commercial
- Tourist Commercial
- ESA
- Industrial
- Institutional
- Managed Forest
- Multi-Family Residential
- Single Family Residential
- Park
- Utility
- Proposed Land Use Unknown

Note: Orthophoto taken July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Land Use

Figure 2-1

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 2-1 - Proposed Land Use.mxd Last revised by: bpauls on 15/01/2014 at 4:33:04 PM

2.2.2 Industrial Area

Tsawwassen First Nation is proceeding with the development of approximately 125 hectares of its settlement lands for industrial use. The industrial lands were designated through the TFN Land Use Plan that was adopted in January of 2009. Further land use study of the industrial area was undertaken through the second half of 2009 by the preparation of the Industrial Lands Master Plan that identified a preferred land use concept. The Master Plan was finalized in October 2009. The preferred land use is described below and is shown in Figure 2-2.

The proposed development is zoned for industrial uses. The preferred plan provides for approximately 75% of the development site to be used for warehousing and distribution type facilities, a portion of which may be utilized for energy park purposes. The remaining 25% is being considered for container storage and other port related activities.

Figure 2-2 Preferred Industrial Land Use Plan

Urban Systems prepared a Preliminary Design Report for the entire industrial lands in December of 2009. The design report for Phase 1 servicing was finalized in March 2010 following review sessions with TFN and Delta and the issuance of permitting by DFO and ALC for construction of the Phase 1 servicing works. Construction of Phase 1 servicing works is currently nearing completion.

The TFN Sewage Treatment Plant (STP) will also be located in the industrial lands. The sewage treatment plant is discussed in further detail in subsequent sections of this report.

2.2.3 TFN Community

The TFN community lands are approximately 48 hectares. Currently, the lands are made up of sparsely set single family residential homes and TFN community facilities. The future plan of this area as highlighted in Figure 2-1 Proposed Land Use is a mixed use of single family residential, parks and administration centers, TFN recreational and cultural facilities.

For the purpose of our study, we have assumed that the TFN community facilities will remain. However, we have assumed that the administration building will be expanded to accommodate the population growth on the TFN lands. The ultimate build out of the TFN community area is projected to be 270 residential units.

2.2.4 Commercial Lands North of Highway 17

The area north of Highway 17 and south of Eagle Way has been designated as tourist commercial and single family residential in the Land Use Plan. For the ultimate build out scenario, this area is modelled as commercial development since this results in higher water and sewer needs.

The area just north of Eagle Way that currently consists of Splashdown Park and Park Canada RV Park (Precinct B1) is modelled as full density commercial development in the built out scenario. In addition, the F440 Kart Racing Track is located in this area and lies within Precincts B1 and A5. As such, the area will be redeveloped as part of the respective development plans.

2.2.5 Multi-Family Market and Single Family South of Highway 17

The existing Tsatsu Shores Development, Tsawwassen Beach Lots and Stahaken will remain with the following densities as outlined in the TFN Land Use Plan: Tsatsu Shores: 87 units/200 residents, Stahaken: 92 lots/200 residents, Tsawwassen Beach Lots 19 lots/60 residents. Note that there are 3 vacant lots on the Tsawwassen Beach Lots which if included would bring the total number of lots to 22.

The remaining undeveloped area to the south of Highway 17 is modelled as multi-family/ residential use and is assumed to take on higher density characteristics than the lands in the Neighbourhood Plan. The predicted ultimate number of new units is 1,320 which will be added to the existing units to reflect the ultimate build out scenario.

2.2.6 Tsawwassen Mills Mall and Power Centre

The Tsawwassen Mills Mall is located on an approximately 48 hectare site on the northwest corner of the Highway 17 and 52nd Street intersection between 48th Street and 52nd Street. The enclosed mall area is approximately 108,000 m^2. The remaining area is parking for the mall.

A collector road is proposed to the north of the mall and will be used as an access road for Tsawwassen Mills Mall and for the Power Centre. The Power Centre is a commercial area with a strip mall type arrangement. The majority of the Power Centre is located across the collector street from Tsawwassen Mills Mall. The total site area for the Power Centre is 23 hectares. The summation of the building areas in the Power Centre is estimated at 53,000 m^2. The remaining site area will be used for parking for the Power Centre. There will be a combined total of 8,560 parking spaces in the Tsawwassen Mills Mall parking lot and the Power Centre parking lot.

2.3 Phasing

TFN is embarking on multiple development initiatives that will see the community grow appreciably over the coming years. To estimate the infrastructure phasing requirements, the following development horizons have been incorporated into this study:

- 2 year (2013)
- 4 year (2015)
- 10 year (2021)
- 20 year (2031)
- 30 year / Build out (2041)

Projected development levels at each of these horizons are based on the land use inputs to the TFN Area Wide Traffic Study and input from Jorden Cook Associates and TFN in consultation with several of the developers. During the preparation of this report, Urban Systems received the phasing strategy for Tsawwassen Mills Mall and the Power Centre. Essentially, both retail/commercial developments were projected to be complete by 2015. Given their significant contribution towards overall servicing demand in the study area, 2 year (2013) and 4 year (2015) horizon have been added to the interim development scenarios reviewed. The calculated development rates at each horizon are presented in the following table:

Table 2-2 Development Phasing

Development Area	Development Phasing (% of Build out)				
	2013	2015	2021	2031	2041 (Build out)
Residential Single Family Large Lot	3%	16%	64%	86%	100%
Residential Single Family Small Lot	3%	16%	64%	86%	100%
Residential Multi-Family Townhouse	3%	16%	64%	86%	100%
Residential Multi-Family Apartment	3%	16%	64%	86%	100%
Residential TFN community Housing	33%	40%	59%	96%	100%
Residential South of Hwy 17	15%	22%	42%	76%	100%
Commercial Retail (Combined growth for Tsawwassen Mills and Power Centre)	25%	100%	100%	100%	100%
Commercial Other	0%	0%	40%	80%	100%
Industrial	10%	35%	60%	90%	100%
Institutional	0%	0%	100%	100%	100%
Parks	3%	16%	64%	86%	100%

From a physical planning perspective we have also considered in which geographic sequence the development may proceed. This sequence is an important consideration when evaluating the sizing and requirement for infrastructure in advance of the build out condition. Through discussion with TFN the following phasing sequence has been established (as illustrated in Figure 2-3 Development Phasing).

Table 2-3 Physical Phasing

Precinct	Phase 1	Phase 2	Phase 3 (Build out)
A1	x	x	x
A2			x
A3			x
A4	x	x	x
A5	x	x	x
A6			x
B1			x
C1		x	x
C2		x	x
D1			x
D2		x	x
D3			x
D4			x
E1			x
F1			x
G1		x	x
H1			x
Tsawwassen Mills Mall	x	x	x
Retail & Power Center	x	x	x
Industrial Lands	30%	30%	x
Lands South of Hwy 17			x
Future TFN Developments			x

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Legend

- TFN Boundary
- Development Precincts

Development Phasing

- Phase 1
- Phase 2
- Phase 3

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Development Phasing

Figure 2-3

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 2-3 - Development Phasing.mxd Last revised by: bpauls on 15/01/2014 at 4:36:34 PM

3.0 Servicing Policies

In order to guide the development of this master plan a set of proposed servicing policies have been developed through consultation with TFN. These policies are outlined in Appendix A. It is envisioned that in conjunction with the adoption of this master plan that TFN will embody these policies into the appropriate legislation and policy.

The sizing of the bulk water and sanitary sewer trunk system is based on the ability to provide the required capacity under the stated conditions. For the water system the assessment of this is generally done under two demand conditions. The first condition is during peak hourly demands. The second condition is during a fire flow event that is occurring concurrent with the maximum day demands. For the sanitary sewer network the assessment is generally completed under a peak wet weather flow event. This peak wet weather event considers a peak hourly flow rate occurring within a maximum daily flow condition.

4.0 Water and Sewer Generation Rates

In order to ensure the infrastructure is appropriately sized one objective of this study is to establish future potable water demands and sanitary discharge rates based on realistic development requirements.

Information from TFN, the existing businesses and future developers was collected to produce data to input to the model of the systems. This information was compiled and used to determine the future water demands and sanitary flow rates.

It should be noted that this study is only focussed on evaluating the sanitary and water servicing that is to be provided by the Tsawwassen First Nation. At the present, Stahaken receives both water and sanitary servicing directly from Delta and the Tsawwassen Beach Lots receive water servicing directly from Delta. It is assumed that this will continue and as such no capacity will be provided within the TFN systems for these flows. Sewer flows from the Beach Lots are collected by a TFN beachfront gravity sewer and pump station and pumped into the pump station that services Tsatsu Shores.

4.1 Information from Tsawwassen First Nation

4.1.1 Existing Condition

The models for both sanitary and water, require detailed information on the existing system to accurately calculate the existing demands and peak flows which will help in determining future requirements. Existing water consumption information is based on information provided by TFN, and includes the following:

- Existing building description with associated occupancies including Commercial, Institutional and residential usage types;
- Quarterly water meter records for the two bulk water meters (2007, 2009, 2010); and
- Water truck counts for the soil fill operations provided by TFN.

4.1.2 Future Condition

The information provided for the Tsawwassen Community was only for existing conditions. As mentioned in previous sections, the future development of this land is somewhat unknown. For

the purpose of this study, we have assumed that the existing recreational, community and cultural buildings will remain, and that the ultimate build out includes a total of 270 residential units within the area defined as the Tsawwassen Community. Assumptions of the future land use for the existing commercial tenants have been made in Section 4.2 of this report.

4.2 Information from Existing Commercial Tenants

4.2.1 Existing Condition

There are existing businesses located on the TFN lands which will remain in place for initial building scenarios. These areas include Splashdown Park and the Park Canada RV Park. Flow meter data was obtained from the Corporation of Delta for both the Splashdown Park and the Park Canada RV Park.

4.2.2 Future Condition

The area containing Splashdown Park and Park Canada RV Park has been designated as commercial in the Land Use Plan. Future water and sewer flows will be calculated consistent with the commercial assumptions for the Neighbourhood Plan.

4.3 Information from Developers

A request for information was sent to the known developers. The request was for the following information for consideration in the water and sanitary models:

1) Preliminary site layout showing land use designations and road right-of-ways.

2) Preliminary build out density calculations broken down as follows:
   a. Single Family Residential Units (without secondary suites)
   b. Single Family Residential Units (with secondary suites)
   c. Multi Family Residential Units
   d. Commercial (floor area)
   e. Industrial (floor area)
   f. Institutional (floor area)

3) Phasing plan and timing for each phase: 2013, 2015, 2021, 2031, 2041

For areas where there was no response to the information request, general assumptions derived from the land use plan, Neighbourhood Plan, similar nearby developments, and other sources have been used to estimate demands for the models.

It is understood that the information provided by developers was the most current information available as of January 2014.

4.4 Methodology

The water and sanitary models have been developed to reflect demand characteristics over a maximum day 24 hour period. As such, each load is assigned two components:

1) Unit Flow – this value is used to represent the maximum day average flow rate which varies throughout the day
2) Load Pattern – this is the diurnal pattern that is applied to the unit flow in order to produce the variation that is seen to occur throughout the day

As components of water consumption and sanitary loading are directly correlated, unit flow rates and load patterns for both water and sanitary were developed concurrently. The details of this methodology are outlined in the following sections.

4.4.1 Unit Flow Rates

As described in the previous section, unit flow rates represent the maximum day average demand rate within the existing and proposed TFN community. In general, demand rates vary for different land use types. As such, unit flow rates were developed for the each of the proposed land use types. Unit load rates were developed for the following land use types:

1. Residential Single Family Large Lot
2. Residential Single Family Small Lot
3. Residential Multi-Family Townhouse
4. Residential Multi-Family Apartment
5. Residential TFN Community Housing
6. Residential South of Hwy 17
7. Commercial Retail

8. Commercial Other
9. Industrial
10. Institutional
11. Irrigated Parks
12. Non Revenue
13. Inflow and Infiltration

The Non Revenue unit load rate was developed and applied to account for leakage and unmetered demands within the water system. The leakage/unaccounted for rate for the water system was established at 5% of the maximum daily demands, consistent with best practices for fully metered water systems.

For the sanitary sewer system an allowance was established for inflow and infiltration from both rain and groundwater sources. This rate was established at a maximum 24 hour rate of 0.1 l/s/ha which is consistent with best practices for new sewer systems within high ground water conditions. This is below the Greater Vancouver Sewer and Drainage District Liquid Waste Management Plan target of 0.13 l/s/ha. We believe this should be easily achievable given the lack of dependence on trunk gravity sewers. It should be noted however, that in order to keep inflow and infiltration within this range requires an ongoing commitment to ensuring that construction practices (particularly on private lots) do not inadvertently admit rain or groundwater flows into the sewer through poor construction practices.

4.4.2 Load Patterns

The load patterns account for the fluctuations in water and sewage demands that occur throughout the maximum day. Together with the unit load rates, these patterns allow us to simulate the water and sanitary demands on each of the respective systems over a 24 hour period.

Seven load patterns were developed for this project (contained in Appendix B):

1. Residential
2. Commercial
3. Industrial
4. Institutional
5. Irrigation

6. Non Revenue (Leakage and Unaccounted for Water Use)
7. Inflow and Infiltration (Sanitary Sewer)

TFN is generally undeveloped in its current state. In addition, very limited water meter record information is available for the existing development at TFN. As such, load patterns could not be derived from existing information. Instead, we utilized our experience with flow monitoring in other communities to arrive at load patterns for this study. This included information from the City of Victoria, the University of British Columbia, the City of Richmond that was collected for studies similar in nature to the TFN Bulk Water and Sanitary Trunk Master Plan. In addition we have also reviewed and considered flow meter records for the Cross Iron Mills Mall in Calgary.

Table 4-1 summarizes the various land use/unit load types that were used for this study and the associated load pattern.

Table 4-1 Land Use/Unit Load Type and Associated Load Patterns

Land Use/Unit Load Type	Load Pattern
Residential Single Family Large Lot	Residential
Residential Single Family Small Lot	Residential
Residential Multi-Family Townhouse	Residential
Residential Multi-Family Apartment	Residential
Residential TFN community Housing	Residential
Residential South of Hwy 17	Residential
Commercial Retail	Commercial
Commercial Other	Commercial
Industrial	Industrial
Institutional	Institutional
Irrigated Parks (water only)	Irrigation
Non Revenue (water only)	Non Revenue
Inflow and Infiltration (sanitary only)	Inflow and Infiltration

4.4.3 Future Loading Scenarios

As previously explained, this plan considers two different density scenarios for future water and sanitary demands. Each of these scenarios is then modeled under two additional conditions. These conditions assume the following:

1. Status Quo
2. Increased Water Conservation

Status Quo – Under this scenario, existing water consumption behaviors are extended into the future in order to service the future growth. This is the base case scenario to which the other scenarios are compared.

Increased Water Conservation – This scenario represents an increase in sustainability and the associated water conservation. It is chosen to represent what these increased commitments might mean to the infrastructure requirements to service the 30 year growth projections at TFN. This includes a 19 to 39% reduction in the residential water consumption from the current usage rates. For commercial retail there is a large variability of projected flow rates depending on the type and mix of retail businesses, the amount of irrigation, and the impact of water conservation strategies. The status quo represents the upper range of what the estimated flow projections might be while the increased water conservation represents the lower range.

Table 4-2 Percentage Reduction in Water Consumption Rate from Status Quo to Increased Water Conservation

Land Use Type	Status Quo Maximum Day Consumption Rate (l/person/day)	Increased Water Conservation Maximum Day Consumption Rate (l/person/day)	% Reduction in Consumption Rate
Residential Single Detached Large Lot	980	600	39%
Residential Single Detached Small Lot	980	600	39%
Residential Townhouse	620	500	19%
Residential Apartment	620	500	19%
Residential TFN community Housing	980	600	39%
Residential South of Hwy 17	620	500	19%
Commercial Retail	468	225	52%

4.4.4 Water and Sewer Demand Correlation

As the majority of water consumed within a community is discharged into the sanitary sewer system, water and sewage rates are directly correlated. Sanitary dry weather flow rates typically represent a specific percentage of the water consumption rates within a community, and the percentage varies with different land use types. The correlation rates are well documented within many local communities. As such, we have used this knowledge to estimate the correlation rates for the existing and future TFN developments. Table 4-3 provides the percentage of domestic water demands that are expected enter the sanitary sewer system at TFN for each considered land use type.

The table below suggests different correlation ratios for the two demand scenarios.

Table 4-3 Percentage of Sanitary Dry Weather Demand to Water Demand

Land Use/Unit Load Type	Water Demand	Sanitary Demand (Status Quo)	Sanitary Demand (Increased Water Conservation)
Residential Single Family Large Lot	100%	75%	80%
Residential Single Family Small Lot	100%	80%	85%
Residential Multi-Family Townhouse	100%	85%	85%
Residential Multi-Family Apartment	100%	85%	85%
Residential TFN Community	100%	75%	80%
Residential South of Hwy 17	100%	85%	85%
Commercial Retail	100%	95%	95%
Commercial Other	100%	90%	90%
Industrial	100%	95%	95%
Institutional	100%	90%	90%

4.5 Water Demands

The Status Quo and Increased Water Conservation water unit flow rates for each land usage type are presented in Table 4-4 below.

Table 4-4 - Increased Water Conservation and Status Quo Max Day Water Unit Flow Rates

Land Usage Type	Status Quo Scenario Water Unit Flow Rates (l/s/ha)	Increased Water Conservation Scenario Water Unit Flow Rates (l/s/ha)
Residential Single Family Large Lot	0.92	0.56
Residential Single Family Small Lot	0.82	0.50
Residential Multi-Family Townhouse	0.67	0.54
Residential Multi-Family Apartment	0.81	0.65
Residential TFN community Housing	0.36	0.22
Residential South of Hwy 17	0.90	0.72
Commercial Retail	0.54	0.26
Commercial Other	0.26	0.26
Industrial	0.11	0.11
Institutional	0.24	0.24
Irrigated Parks	0.96	0.00
Non Revenue	10% of Average Day Demand	10% of Average Day Demand

The irrigation rate for the parks has been established based on irrigating 25mm per week over 3 days (33% of this flow occurs during the maximum day), consistent with Metro Vancouver best practices. With the Status Quo scenario these flows are provided from the potable water system while for the Increased Water Conservation scenario this water is assumed to be provided from non potable sources.

Based on the above unit rates and calculated developable areas, total maximum daily demand loads are predicted for each land use type and two scenarios as shown on Table 4-5.

Table 4-5 - Existing Water Demand

Land Use Type	Existing Maximum Day Demand (l/s)	Existing Maximum Day Demand to Remain Post Development Phase 1 and Phase 2 (l/s)	Existing Maximum Day Demand to Remain Post Development Phase 3 (l/s)
Residential Single Family Large Lot	0.00	0.00	0.00
Residential Single Family Small Lot	0.00	0.00	0.00
Residential Multi-Family Townhouse	0.00	0.00	0.00
Residential Multi-Family Apartment	1.44	1.44	1.44
Residential TFN community Housing	2.52	2.52	2.25
Residential South of Hwy 17	0.00	0.00	0.00
Commercial Retail	0.00	0.00	0.00
Commercial Other	1.87	1.87	0.03
Industrial	1.05	0.00	0.00
Institutional	0.20	0.65*	0.65*
Irrigated Parks	0.00	0.00	0.00
Non Revenue	0.26	0.23	0.22
Total	**7.33**	**6.71**	**4.59**

*The increase in institutional loads is to account for the growing administration staff. The projected build out growth in administration staff has been applied to all future development phases for simplicity.

Table 4-6 Increased Water Conservation and Status Quo Total Water Demand (Build out)

Land Use Type	Base Case Density		Increased Density	
	Build out Status Quo Maximum Day Demand (l/s)	Build out Increased Water Conservation Maximum Day Demand (l/s)	Build out Status Quo Maximum Day Demand (l/s)	Build out Increased Water Conservation Maximum Day Demand (l/s)
Residential Single Family Large Lot	8.82	5.40	10.14	6.21
Residential Single Family Small Lot	17.61	10.78	20.25	12.40
Residential Multi-Family Townhouse	11.71	9.45	13.47	10.86
Residential Multi-Family Apartment	4.45	3.87	4.90	4.23
Residential TFN community Housing	12.96	8.81	12.96	8.81
Residential South of Hwy 17	18.94	15.28	18.94	15.28
Commercial Retail	36.51	17.55	36.51	17.55
Commercial Other	2.84	2.84	2.84	2.84
Industrial	12.53	12.53	12.53	12.53
Institutional	1.03	1.03	1.03	1.03
Irrigated Parks	18.41	0.00	18.41	0.00
Non Revenue	7.29	4.38	7.64	4.58
Total	**153.11**	**91.90**	**159.62**	**96.32**

From a phasing perspective the following table illustrates the total demand that is projected to be required under each development horizon.

Table 4-7 Phased Maximum Day Water Demand Rates (Base Case Density)

Development Horizon	2013	2015	2021	2031	2041/Build out
Status Quo Water Demand (l/s)	25.95	68.62	107.60	137.09	153.11
Increased Water Conservation Water Demand (l/s)	18.12	40.81	62.23	81.70	91.90

Table 4-8 - Phased Maximum Day Water Demand Rates (Increased Density)

Development Horizon	2013	2015	2021	2031	2041/Build out
Status Quo Water Demand (l/s)	26.12	69.77	111.82	142.71	159.62
Increased Water Conservation Water Demand (l/s)	18.27	41.58	65.08	85.50	96.32

4.6 Sanitary Demands

As indicated in Section 4.4.3, the sanitary demand rates are directly correlated to the water demand rates. The sanitary dry weather demands represent a percentage of the corresponding water demand, this percentage varies with land use type. The Status Quo and Increased Water Conservation sanitary unit flow rates for each land usage type are presented in Table 4-9.

Table 4-9 Increased Water Conservation and Status Quo Sanitary Maximum Daily Flow Rates

Land Usage Type	Status Quo Scenario Sanitary Unit Flow Rates (l/s/ha)	Increased Water Conservation Scenario Sanitary Unit Flow Rates (l/s/ha)
Residential Single Family Large Lot	0.69	0.45
Residential Single Family Small Lot	0.66	0.43
Residential Multi-Family Townhouse	0.57	0.46
Residential Multi-Family Apartment	0.69	0.55
Residential TFN community Housing	0.27	0.18
Residential South of Hwy 17	0.76	0.62
Commercial Retail	0.51	0.25
Commercial Other	0.23	0.23
Industrial	0.10	0.10
Institutional	0.22	0.22
Inflow and Infiltration	0.1 l/s/ha	0.1 l/s/ha

Similar to water demands, total sanitary maximum daily loads are predicted for each land use type and two scenarios as shown on Table 4-10.

Table 4-10 Increased Water Conservation and Status Quo Total Sanitary Flow (Build out)

Land Use Type	Existing Maximum Day Flow Rates (l/s)	Existing Maximum Day Flow Rates to Remain Post Development Phase 1 and Phase 2 (l/s)	Maximum Day Flow Rates to Remain Post Development Phase 3 (l/s)	Build out Status Quo Maximum Day Flow Rates (l/s)	Future Increased Water Conservation Maximum Day Flow Rates (l/s)
Residential Single Family Large Lot	0.47	0.47	0.47	7.08	4.79
Residential Single Family Small Lot	0.00	0.00	0.00	14.09	9.16
Residential Multi-Family Townhouse	0.00	0.00	0.00	9.96	8.03
Residential Multi-Family Apartment	1.08	1.08	1.08	3.64	3.14
Residential TFN community Housing	1.89	1.89	1.68	9.72	6.93
Residential South of Hwy 17	0.00	0.00	0.00	16.10	12.99
Commercial Retail	0.00	0.00	0.00	34.91	16.78
Commercial Other	0.02	0.02	0.02	2.56	2.56
Industrial	0.00	0.00	0.00	11.90	11.90
Institutional	0.18	0.59*	0.59*	0.92	0.92
Inflow and Infiltration	2.30	2.30	0.00**	39.19	39.19
Total	**5.93**	**6.35**	**3.84**	**150.08**	**116.40**

*The increase in institutional loads is to account for the growing administration staff. The projected build out growth in administration staff has been applied to all future development phases for simplicity.
**Accounted for in future loading

From a phasing perspective the following table illustrates the total flow that is projected to be generated under each development horizon.

Table 4-11 - Phased Sanitary Maximum Daily Flow Rates (Base Case Density)

Development Horizon	2013	2015	2021	2031	2041/Build out
Status Quo Sanitary Flow (l/s)	27.70	74.83	106.61	135.82	150.08
Increased Water Conservation Sanitary Flow (l/s)	21.57	53.36	79.33	104.38	116.40

Table 4-12 - Phased Sanitary Maximum Daily Flow Rates (Increased Density)

Development Horizon	2013	2015	2021	2031	2041/Build out
Status Quo Sanitary Flow (l/s)	27.84	75.63	109.81	140.10	155.06
Increased Water Conservation Sanitary Flow (l/s)	21.66	53.93	81.61	107.42	119.94

4.7 Fire Flows

Fire flows for TFN are categorized according to fire zones. Fire flow zones were developed to encompass each of the land use types proposed for TFN. The fire flow and residual pressure requirement for each of the land use types are provided in Appendix A. Since there is no reservoir storage currently within TFN lands these fire flows must be supplied from the GVWD supply system.

5.0 Off-Site Capacity

The proposed development within TFN lands will impose significant demands on the servicing system. Therefore, the interim and ultimate servicing systems must be developed in such a way that they are capable of delivering the required level of service at each time horizon considered in the study. Equally important is the off-site capacity, or the ability of the regional servicing system to deliver required water demands in the future.

As sewage will be treated onsite and treated effluent will be discharged to an onsite wetland, the availability of offsite sanitary systems is not a factor in TFN sanitary servicing strategy.

5.1 Water

There are two supply points for the TFN water system to tie-in to the Greater Vancouver Water District (GVWD) system. These supply points are (illustrated in Figure 6-3 Proposed Water System Increased Density Status Quo) located at:

1. 28th Ave. @ 52nd St. (north supply point)
2. 52nd St. north of Hwy 17 (south supply point)

The north supply point was recently completed by TFN.

The supply of water from the GVWD is governed by the entry agreement of the TFN into the GVWD. The agreement commits to supply TFN with up to 266 l/s under peak-day demand conditions up to the year 2031. This is well above the projected water needs for the build out conditions modeled. It should be noted that similar to most other municipalities in the GVWD there is no guarantee of flows or pressures to meet peak hour, emergency, or fire flow requirements. Since TFN does not have any storage within its lands there is a dependence on the GVWD for these additional flow volumes. This is not unlike most other communities within the GVWD.

The Greater Vancouver Water District (GVWD) has indicated an available pressure of 35.75 metres (350 kPa) at the north and south supply points along 52nd St. These locations will be the principal supply points for the entire TFN community in the future. Each of these locations will have a flow metering station to record overall community consumption. As soon as the south

connection is activated, the existing supply connection on Hwy 17 off Delta water system will be disconnected.

As part of the agreement with the GVWD there is an identified upgrade required of the South Delta Main #1. An upgrade to this main between 28th Avenue and 12th Avenue has been included in the agreement. The timing for this upgrade is at the discretion of the GVWD at full cost to TFN.

5.2 Sanitary

Concurrently with this analysis, the TFN is currently completing the detailed design and construction of a stand-alone sewage treatment plant located on TFN lands that will meet the servicing requirements for the build out of the lands. .

The sanitary configuration has been modelled using the WaterCAD hydraulic modelling software as explained earlier. The system has been configured so that the sewage is directed to the north end of the site, to a new wastewater treatment plant that will be located in the industrial lands. The proposed sewage treatment plant location is shown on Figure 6-8 Proposed Sanitary Increased Density Status Quo.

The pump stations throughout the development precincts have been sized to overcome a hydraulic grade line of 8.6 metres at the proposed sewage treatment plant.

6.0 Servicing Concept

The following information was utilized in developing an optimized servicing concept for the water and sanitary systems:

- compiled existing information on the water and sewer systems;
- preliminary layouts provided by the developers; and
- fixed connection points and conceptual road layout shown in the Neighbourhood Plan area.

Refer to Figure 6-1 Existing Water Layout and Figure 6-2 Existing Sanitary Layout for schematics of the existing infrastructure. The following section goes into further detail on the strategy used to optimize the location of both the existing and proposed water and sanitary systems.

6.1 Water

The proposed water servicing concept generally follows the recommendations provided in previous Urban Systems reports. The concept has been further refined to reflect the information obtained from developers.

6.1.1 Methodology

The objectives that were considered for the water system layout are as follows:

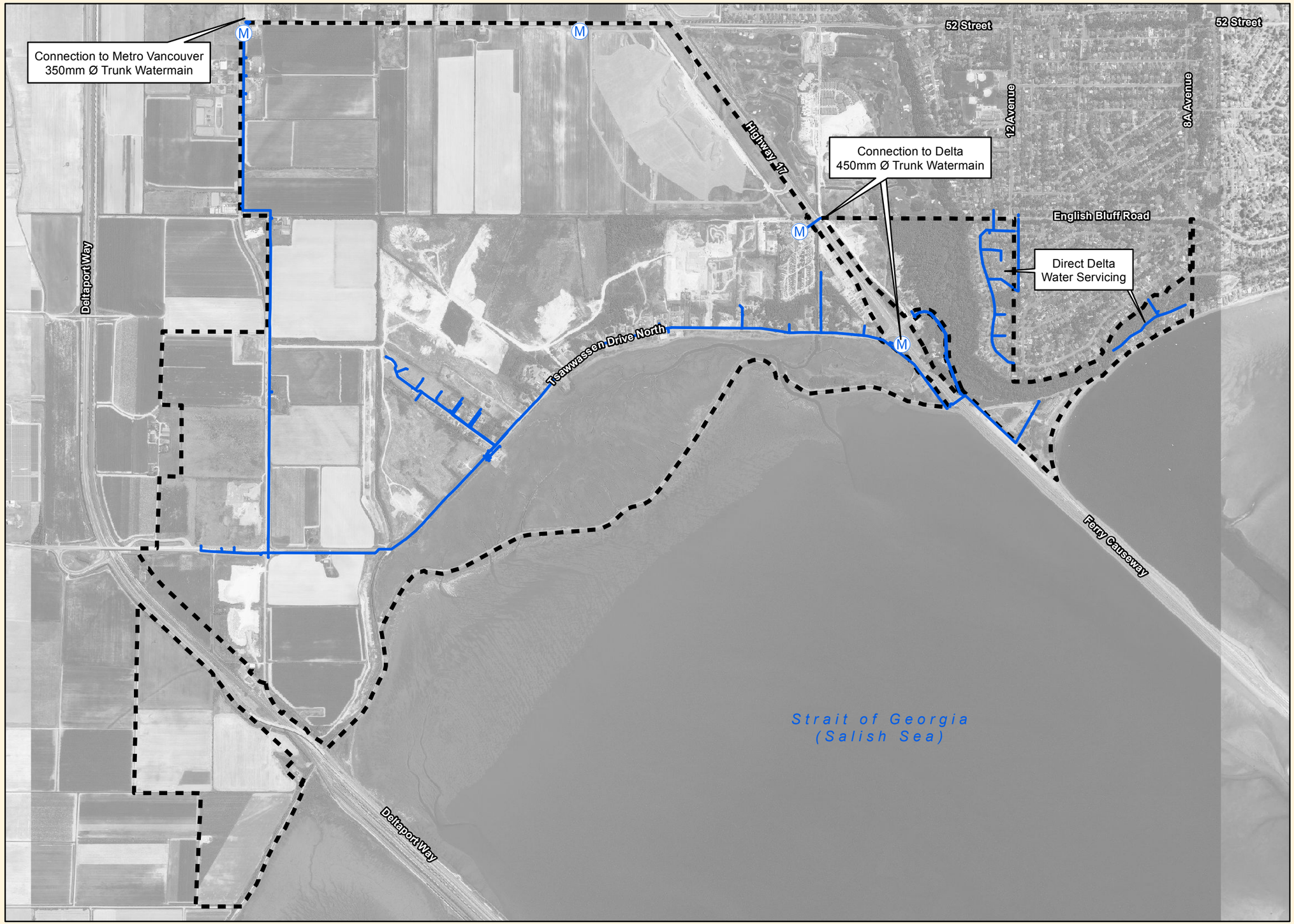
- Utilize the existing system without reconfiguration as much as possible;
- Avoid work along Tsawwassen Drive which would pose a risk to the integrity of the dyke;
- Strategically loop water mains for water quality considerations and to allow sections of individual pipes to be shut down for repair or maintenance; and
- Minimize crossing the drainage canal on 48th Street.

6.1.2 Overall Servicing Concept

The trunk pipe network is placed to follow the road networks as shown in the Neighbourhood Plan and Land Use Plan and to follow the road networks shown in the individual precinct schematics provided by the developers. The proposed system will connect to the existing watermain along Tsawwassen Drive which currently connects to Metro's watermain at 28th Avenue and 52nd Street. A second metered connection to Metro will be located at the

intersection of 52nd Street and the collector road located between Tsawwassen Mills Mall and the Power Centre.

There are three connections across the drainage canal on 48th Street which will provide redundancy in the system for fire safety in the event of a breakage or for maintenance.



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Meter
- Existing Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

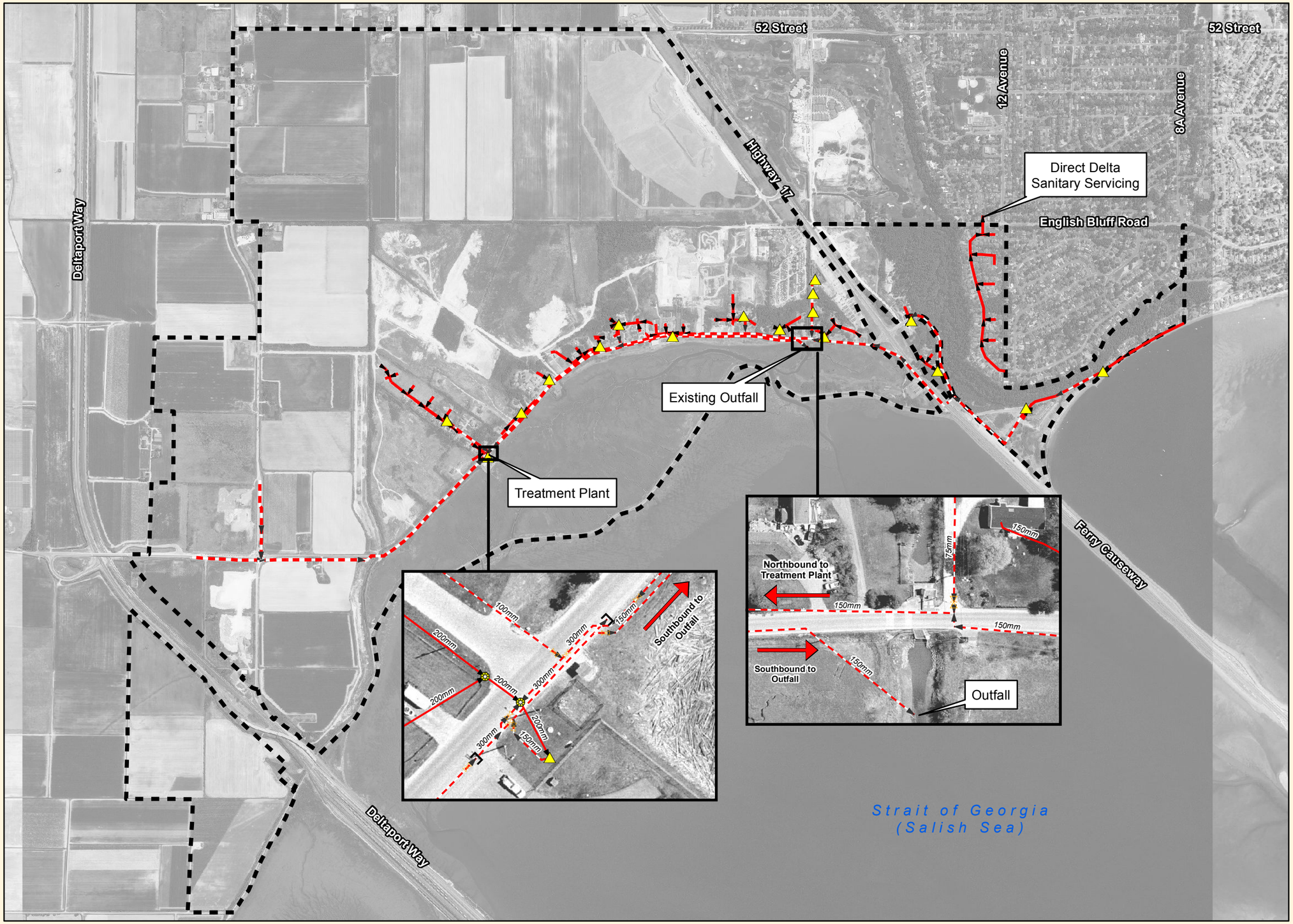
TFN Bulk Water & Sanitary Trunk Master Plan

Existing Water Layout

Figure 6-1

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-1 - Existing Water Layout.mxd Last revised by: bpauls on 15/01/2014 at 4:39:04 PM



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Legend

- Sanitary Lift Station
- Sanitary Force Main
- Sanitary Gravity Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

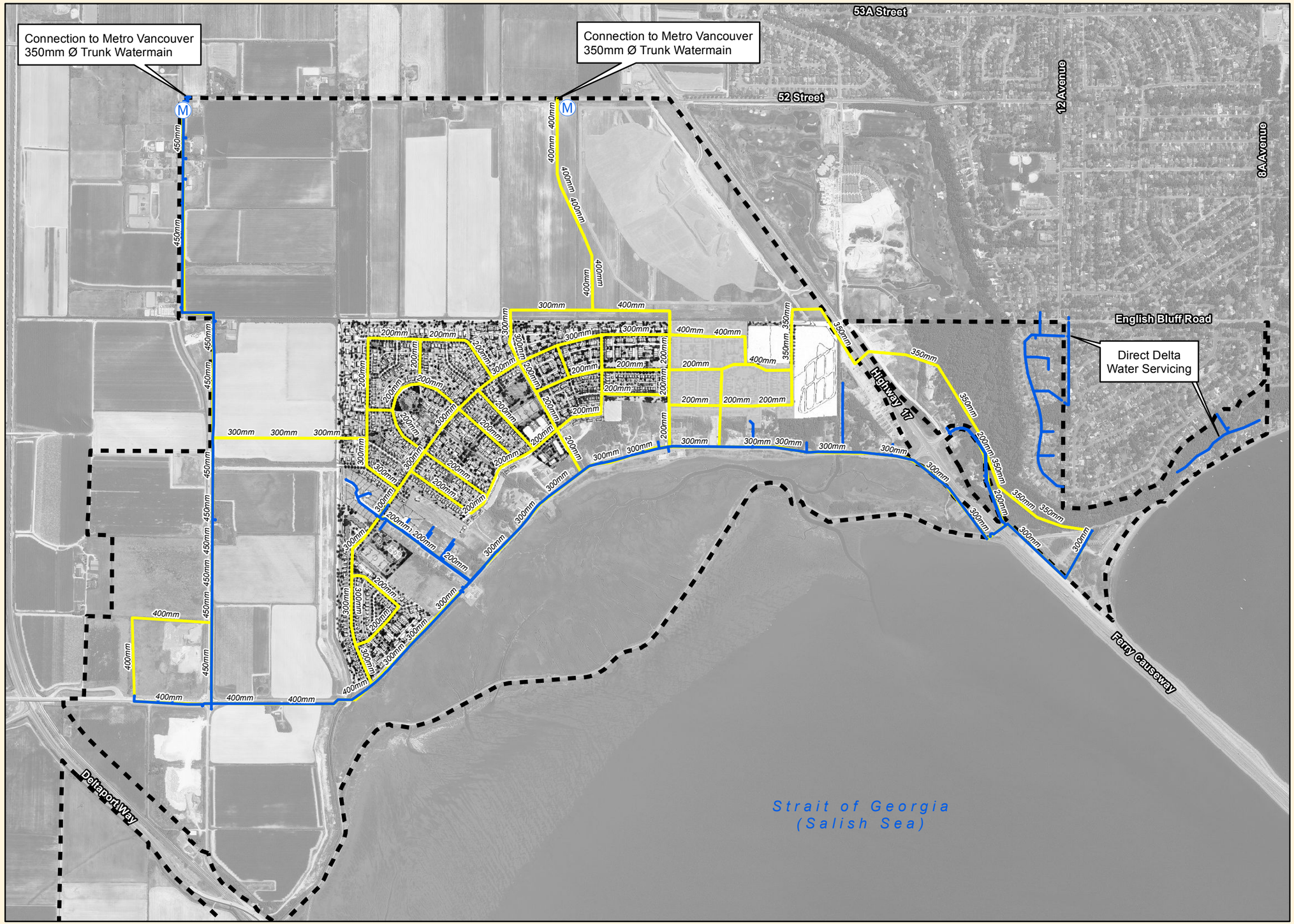
TFN Bulk Water & Sanitary Trunk Master Plan

Existing Sanitary Layout

Figure 6-2

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-2 - Existing Sanitary Layout.mxd Last revised by: bpauls on 15/01/2014 at 4:41:28 PM



TSAWWASSEN FIRST NATION
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Legend

- Meter
- Existing Water Main
- Proposed Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

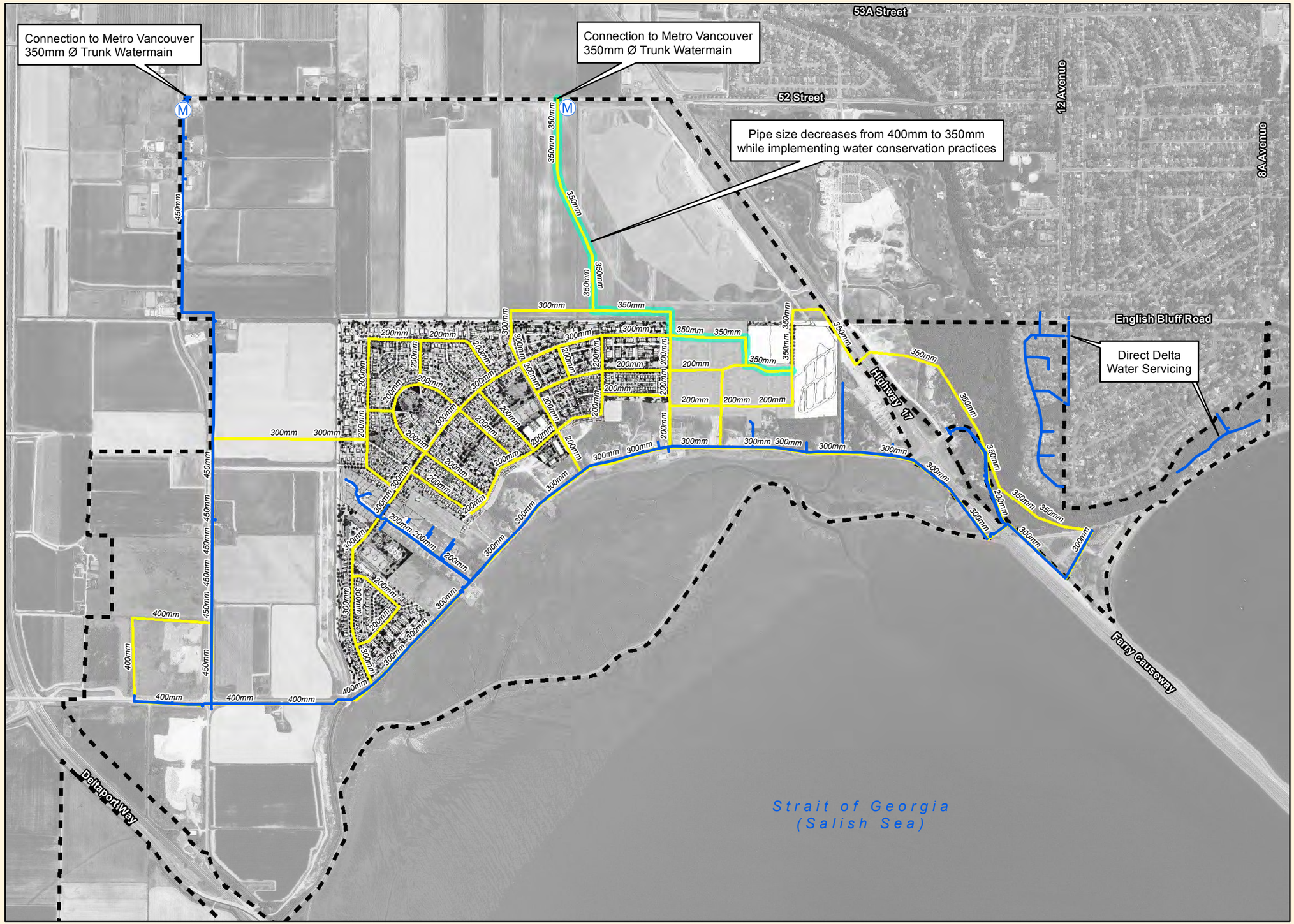
TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water System Increased Density Status Quo

Figure 6-3

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-3 - Proposed Water System - Increased Density Status Quo.mxd Last revised by: bpauls on 15/01/2014 at 4:51:57 PM



TSAWWASSEN FIRST NATION
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Legend

- Meter
- Proposed Water Main
- Existing Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water System
Increased Density
Increased Water Conservation

Figure 6-4

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-4 - Proposed Water System - Increased Density Increased Water Conservation.mxd Last revised by: bpauls on 16/01/2014 at 7:58:18 AM

The system has also been looped internally throughout the network to ensure that water will be available for fire protection in the occurrence of breakages or shut down of pipe segments for maintenance and to avoid stagnant water at the end of a pipe.

For the purpose of estimating residual pressures under different demand scenarios the following maximum ground elevations were assumed:

Table 6-1 Maximum Assumed Ground Elevations of Development Areas

Development Area	Maximum Ground Elevation (metres geodetic)
Neighbourhood Plan Area	6.0
TFN Community Area	3.5
South of Hwy 17	6.0
Power Centre/Tsawwassen Mills	6.0
Industrial Lands	3.5

A water model was created of the system using Bentley WaterCAD V8i. The system was analyzed for the two development densities (Base Case and Increased Density) and two water use scenarios (Status Quo and Increased Water Conservation) under two conditions:

- peak hour demands; and
- maximum day plus fire flow demands.

While the figures within this report provide nominal water main diameters, the inside diameter of the pipe (assumed to be PVC C-900 DR 18 for all future pipe) was used in infrastructure sizing.

It should be noted that the two water use scenarios did make a difference to the size of the south connecting main to the GVWD and the main servicing south of Highway 17. The two development cases did not alter any main sizes. Figure 6-3 Proposed Water System Increased Density Status Quo and Figure 6-4 Proposed Water System Increased Density Increased Water Conservation illustrate the infrastructure sizing under the two water use scenarios (assuming all pipes are in service).

From a supply capacity perspective the following table illustrates the maximum day and peak hourly demands for each scenario. Appendix C contains a tabular summary of the performance of the system.

Table 6-2 Projected Maximum Day and Peak Hour Demands

Water Use Scenario	Base Density Max Day Demand (L/s)	Base Density Peak Hour Demand (L/s)	Increased Density Max Day Demand (L/s)	Increased Density Peak Hour Demand (L/s)
Status Quo	153	224	160	234
Increased Water Conservation	92	119	96	125

Given the limited difference in infrastructure sizing between the various scenarios it is recommended that TFN proceed with the sizing based on the Status Quo Increased Density Scenario.

6.1.3 Phasing

In order to confirm the sizing of the proposed infrastructure a phasing review was completed using the Increased Density Status Quo Scenario. Each phase was added in sequence to the system and the required infrastructure was identified. Since the timing of each phase is uncertain it was assumed that each phase would reach build out before the next phase began.

The following table illustrates the maximum day, peak hour, and maximum day + fire flow demands supplied from each GVWD connection point at the completion of each phase. For the maximum day + fire flow condition there are two separate conditions listed, one with a fire in the north area and one with a fire in the south area since given the location of these fires the flows from each connection vary. Since a portion of the industrial and commercial areas come on line in Phase 1 the fire flow requirements for these sites govern in all phases.

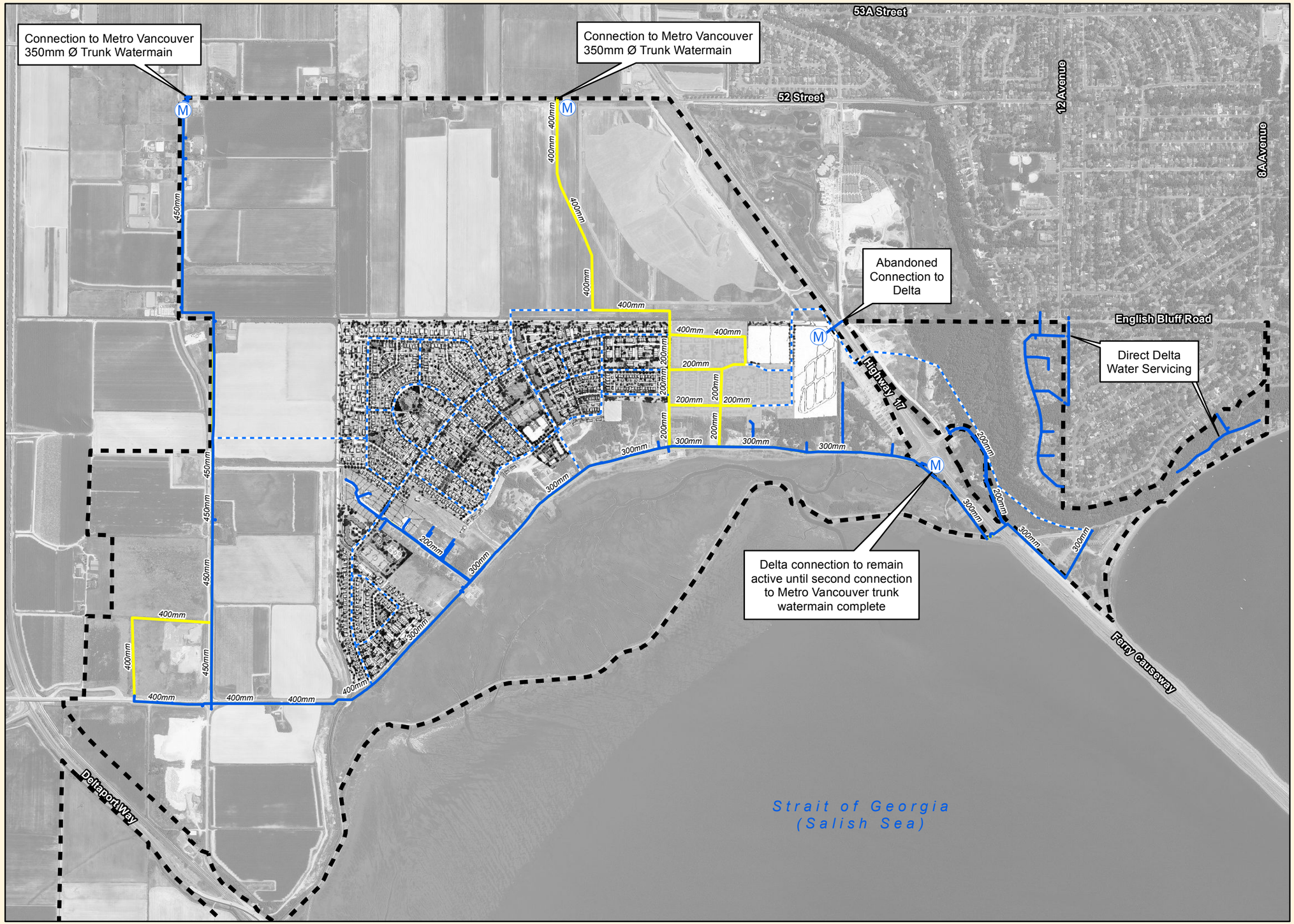
Table 6-3 Water Supplied by Phase

	Maximum Day (L/s)	Peak Hour (L/s)	Max Day + North Fire (L/s)	Max Day + South Fire (L/s)
Phase 1			*270L/s FF*	*250L/s FF*
North Connection	43.5	59.0	197.8	70.1
South Connection	14.5	17.0	129.3	237.0
Total	**58.0**	**76.0**	**327.1**	**307.1**
Phase 2			*270 L/s FF*	*250 L/s FF*
North Connection	64.5	82.5	174.0	113.4
South Connection	31.0	44.0	191.4	232.0
Total	**95.5**	**126.5**	**365.4**	**345.4**
Phase 3			*270 L/s FF*	*250 L/s FF*
North Connection	98.5	140.0	189.9	148.9
South Connection	61.0	94.0	239.2	260.2
Total	**159.5**	**234.0**	**429.1**	**409.1**

Upsizing of infrastructure was completed as required in order to meet the level of service during each phase. The results of this analysis are illustrated in Figure 6-5 Proposed Water Phase 1 to Figure 6-7 Proposed Water Phase 3. Specific commentary on each Phase is discussed below:

Phase 1

Phase 1 construction includes development of precincts A1, A4, A5, approximately 30% of the industrial lands and the Tsawwassen Mills Mall and Power Centre. To satisfy the multi family fire flow requirements in precincts A1, A4 and A5, the south supply point located at 52nd St. north of Hwy 17 is required. However, it should be noted that the fire flow requirements for single family residential development could be satisfied within these precincts prior to construction of the south supply point.



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Meter
- Proposed Water Main (Constructed)
- Proposed Water Main (Not Constructed)
- Existing Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

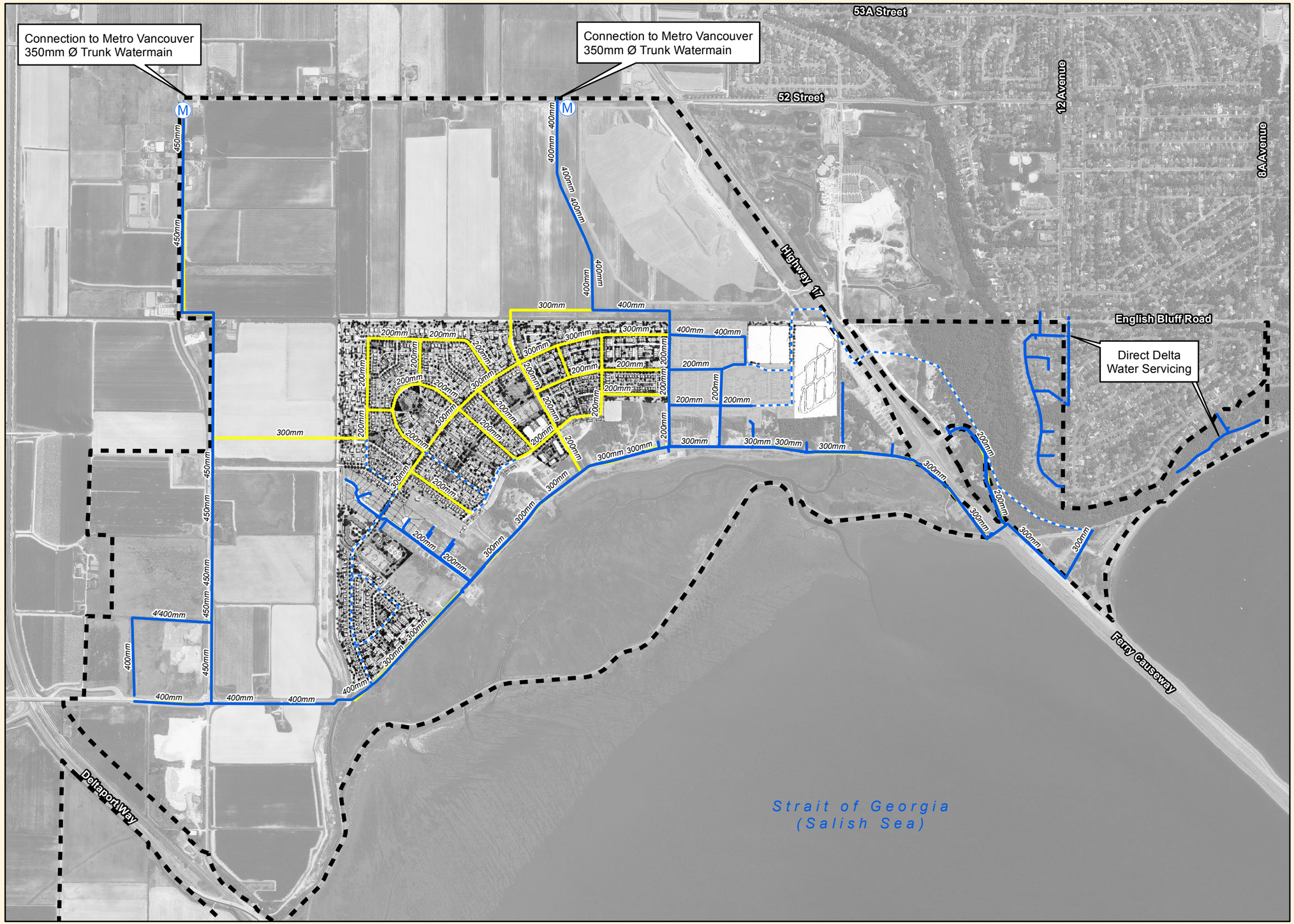
TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water Phase 1

Figure 6-5

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-5 - Proposed Water Phase 1.mxd Last revised by: bpauls on 16/01/2014 at 3:45:25 PM



TSAWWASSEN FIRST NATION
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Legend

- Meter
- Proposed Water Main (Constructed)
- Proposed Water Main (Not Constructed)
- Existing Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water Phase 2

Figure 6-6

0 125 250 500
Meters

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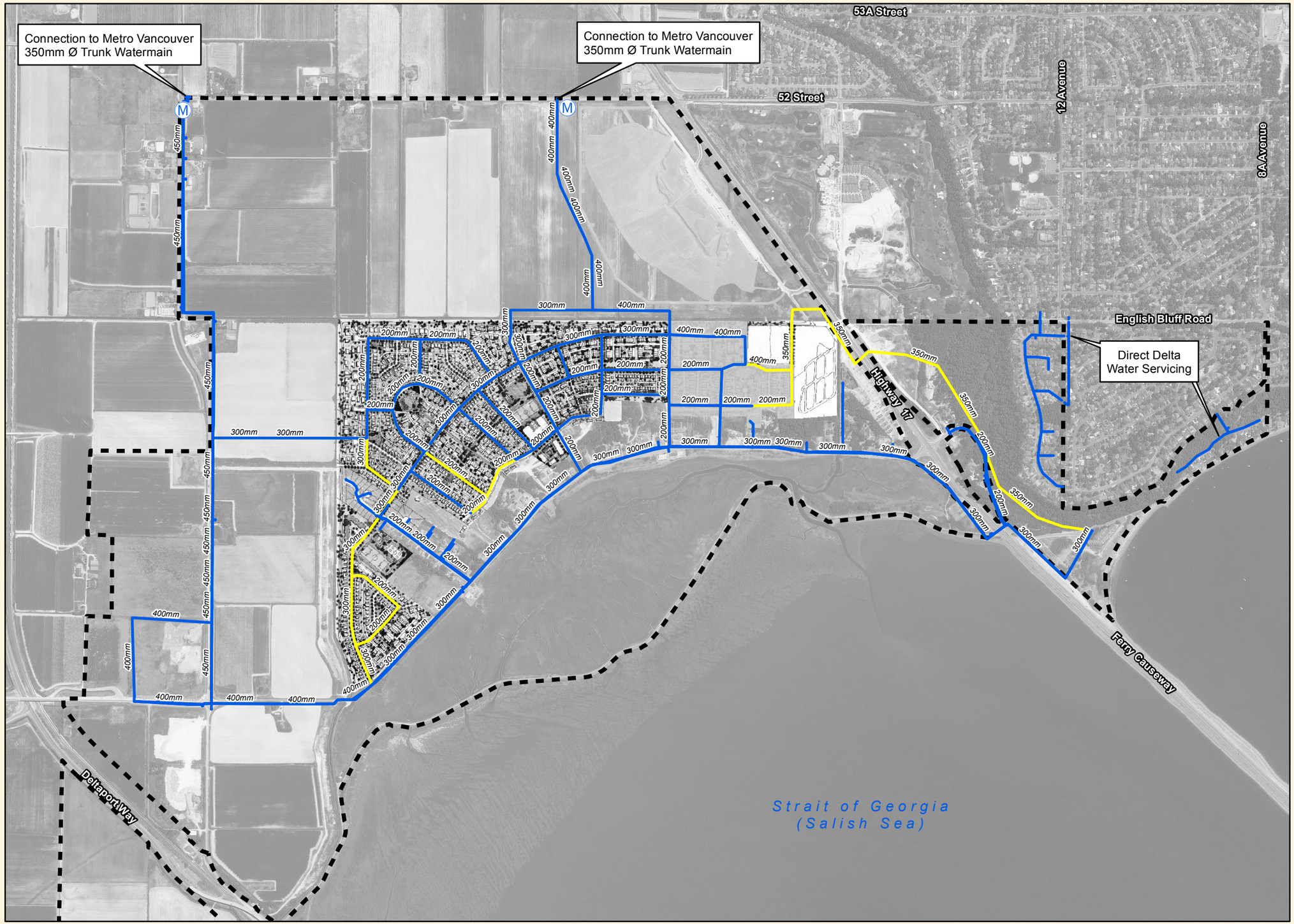

TSAWWASSEN FIRST NATION
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Legend

- Meter
- Proposed Water Main (Constructed)
- Proposed Water Main (Not Constructed)
- Existing Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water Phase 3

Figure 6-7

0 125 250 500
Meters

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The single family residential fire flow requirements can be achieved with two connections to the existing 300mm diameter main on Tsawwassen Drive North.

From a sizing perspective the south supply connection is only required to be 300mm in diameter for this phase. Oversizing is required to meet the requirements of future phases.

Phase 2

Phase 2 construction includes development of precincts C1, C2, G1 and D2. It is anticipated that the south supply point at 52nd St. north of Hwy 17 is required would already be constructed under the Phase 1 works.

Phase 3

Phase 3 construction includes precincts A2, A3, A6, B1, D1, D3, D4, E1, H1, F1TFN community lands, industrial lands and the area south of Highway 17. All Trunk mains are complete under this phase.

6.2 Sanitary

In December, 2009 a preliminary conceptual sanitary layout was developed to test the feasibility of connecting to the Corporation of Delta. This conceptual layout was developed using the Land Use Plan. However, since that time, TFN has chosen to construct an onsite Waste Water Treatment Plant located within the industrial lands. This concept is explained in the following sections.

6.2.1 Methodology

Section 5.0 of the report provides initial information for the sanitary servicing option. Refer to Figure 6-8 Proposed Sanitary Increased Density Status Quo for a schematic of the sanitary sewer system layout. In general, the objectives that were considered for the sanitary sewer system layout are as follows:

- Utilize the existing system without reconfiguration as much as possible.
- Avoid work along Tsawwassen Drive which may compromise the existing dyke.
- Provide centralized pump stations within each precinct where possible which will service the most units possible.

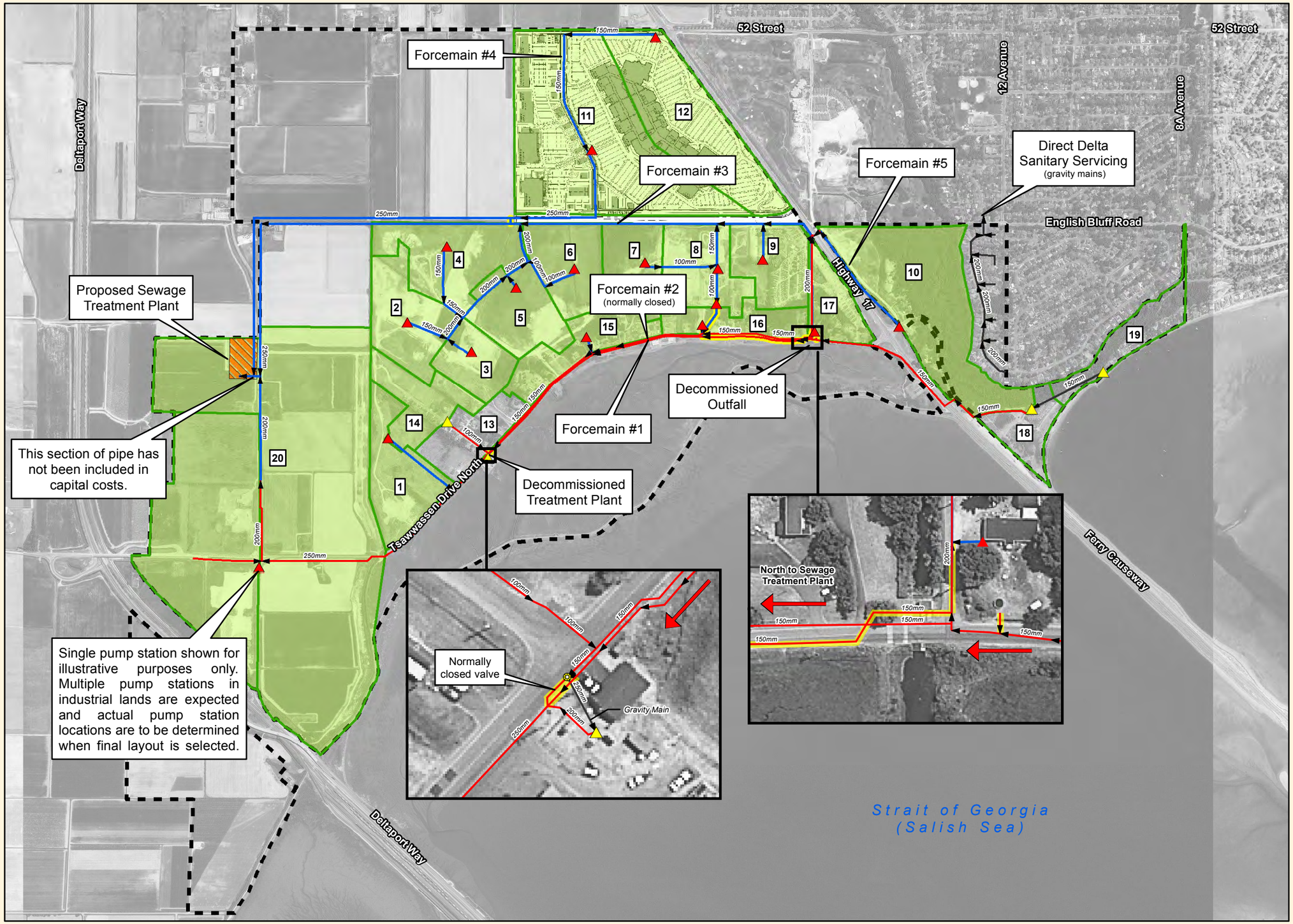
- Try to locate pump stations adjacent to parks where possible to allow for better visual integration into the surrounding neighbourhood.
- Strategically loop force mains to allow sections of individual pipes to be shut down for repair or maintenance.
- Avoid double pumping of sewage where possible.
- Provide a centrally located force main trunk to minimize the length of force main required to receive the feed from the individual pump stations.
- Avoid crossing the drainage canal on 48th Street.
- Maximize use of gravity sewers.

6.2.2 Overall Servicing Concept

The proposed sewage system incorporates: the existing gravity main and force main; new gravity sewers for sewage collection and conveyance to lift stations; modification of 4 existing lift stations; 23 new lift stations complete with storage capacity; and new force mains. The following sections describe the servicing concept in greater detail.

It should be noted that the minimum building elevation and minimum road elevations are identified in the TFN Development Permit Areas Regulation. It is also worth noting that for the water system maximum elevations were used, while minimum elevations were used for the sanitary system. For the sanitary system minimum elevations are critical since we are maximizing the conveyance of flows by gravity.

As mentioned previously, the gravity collection system, sanitary catchment layout and pump station locations are fixed and will not change in the future unless there is a need for slight adjustment to fit the final site layout. However, the sewage flow direction in the pressurized conveyance system and location of sewage treatment will be affected by the adopted strategy.



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Proposed Sanitary Lift Station
- Existing Sanitary Lift Station
- Manhole
- Meter
- Existing Forcemain
- Sanitary Gravity Main
- Proposed Sanitary Force Main
- Normally Closed Pipe
- TFN Boundary
- Catchment Boundaries
- Pump Station Constructed - Phase 1,2 and 3
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Sanitary Increased Density Status Quo

0 125 250 500
Meters

Figure 6-8

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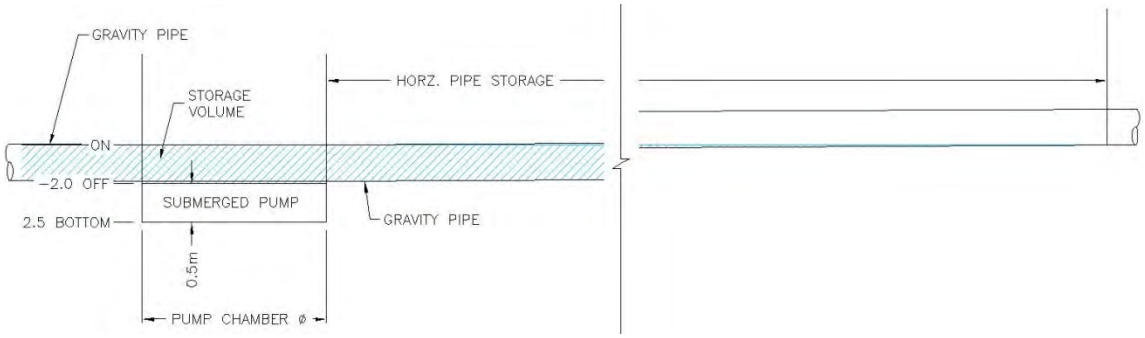
Based on our experience in installing sanitary sewer pump stations at TFN we have limited the minimum pump station elevation to -3.0m geodetic (to the bottom of the tank). The ground water table is high in this area and a deeper pump station would be much more difficult to install or repair. In order to maximize the length of gravity sewers we have submerged the incoming sewers to each pump station, thereby allowing the pump station level to rise above the invert of these sewers. This is illustrated graphically below.

Figure 6-9 - Storage in Submerged Gravity Mains



The depth of sewer at the inlet to each new pump station has been established at -2.5m geodetic. In order to ensure solids deposition and pump cycling does not become an issue in the submerged portion of the sewer has been oversized to 500 mm in order to satisfy two criteria:

- Ensure cleansing velocity is achieved at 20% pipe depth; and
- Ensure that adequate pipe capacity exists at 50% depth to meet or exceed pump capacity.

These two criteria are based on extensive experience with the City of Richmond in operating pump stations under these conditions. These oversized sewers provide an additional benefit by buffering volume for peak flows. Based on an incoming grade (post settlement) of 0.50% all sewers within 95m of the lift station must be oversized. For the purpose of calculating storage volumes we have assumed that there are 190m of oversized sewers per sewage pump station for a minimum pump station operating volume of 30 cubic metres (including pump station wet well and submerged pipe).

Sanitary Layout for Neighbourhood Plan, South of Highway 17 and TFN Community

The assumptions used to determine the layout of sanitary catchment areas and pump station locations are listed below:

- It was assumed that the minimum building elevation is 3.5 m geodetic and the minimum road elevation is 2.5 m geodetic for the entire TFN lands.
- The maximum slope of the gravity pipe within the roadway was assumed to be 1% for the purpose of gravity systems extent calculations. Actual gravity sewer capacities use an assumed minimum grade of 0.5% to account for settlement.

Based on all the above assumptions: using the maximum depth of 1.5 m, minimum pipe depth of -2.5 m geodetic and a slope of 1%, it was determined that the maximum reach of the gravity sewers to each pump station to meet these criteria is 400 m.

Sanitary Layout for Tsawwassen Mills Mall and Power Centre

Similar assumptions were made as described in the previous section to determine the servicing scheme for Tsawwassen Mills Mall and the Power Centre. Additional or different assumptions made are listed below:

- It was assumed that the parking lot elevation minimum was 2.5 m geodetic. Therefore, the maximum invert elevation of the pipe in the parking lot was assumed to be 1.3 m geodetic.
- The maximum slope of the gravity pipe within the private lands (parking lots) was assumed to be 0.75% instead to minimize the number of pump stations required on site (this assumption will likely trigger a need for preload placement along anticipated gravity sanitary sewers on private properties to reduce differential settlement)

Based on all the above assumptions: using the maximum elevation of 1.5 m, minimum pipe elevation of -2.5 m geodetic and a slope of 0.75%, it was determined that the maximum reach of the gravity sewers to each pump station to meet these criteria is 510 m.

Sanitary Layout of Industrial Lands

As the exact configuration of buildings is unknown on the industrial lands at this time, it is difficult to deduce the location of gravity main and pump stations. For the model, we have utilized a single pump station to conservatively represent the flows from the industrial lands. For the cost estimate it has been assumed that 7 pumps stations will be constructed. It is expected that servicing assumptions for these lands would be consistent with the Tsawwassen Mills and Power Centre sites.

The following sections further explain the key force main system components.

The pressurized conveyance system is comprised of five primary force mains as identified in Figure 6-8 Proposed Sanitary Increased Density Status Quo

Force Main #1: Existing high pressure force main along Tsawwassen Drive. This force main collects flow from pump stations along Tsawwassen Drive and from Tsatsu Shore and directs flow into Force Main #3.

Force Main #2: Existing low pressure force main that collects flows from the existing Tsawwassen Community pump stations and discharges into pump station 13 where it is double pumped into Force Main #1. Under the future condition flows from the replacement pump stations will discharge into Force Main #1 thereby allowing Force Main #2 to serve as a backup in the event the Force Main #1 is needed to be repaired.

Force Main #3: Proposed high pressure force main that discharges to the proposed sewage treatment plant and services ultimate flows from the Neighbourhood Plan Area. An interconnection (cross connect valve) between Force Main #3 and Force Mains #4 is provided in order to provide redundancy in the event Force Main #3 is required to be taken out of service.

Force Main #4: Proposed high pressure force main that discharges to the proposed sewage treatment plant and services the proposed Power Centre and Tsawwassen Mills Mall.

Force Main #5: Proposed high pressure force main that discharges to Force Main #3 and services the proposed development on the south side of Highway 17.

A hydraulic model was created of the pump stations and force main system using Bentley WaterCAD v8i. The incoming gravity sewer system and pump station wetwells were modelled as tanks in order to replicate the storage characteristics and to allow the model to dictate how many pump stations are activated at any one point in time.

The system was analyzed for the two development densities (Base Case and Increased Density) and two sewage generation scenarios (Status Quo and Increased Water Conservation) under peak wet weather flow and average dry weather flow conditions.

From a capacity perspective the following table illustrates the maximum wet weather day and peak hourly discharge rates for each scenario. Pump and force main sizing has been completed in order to ensure a minimum velocity of 0.9 m/s is achieved under average dry weather flow conditions and that the designated operating volume within the gravity sewer and pump station are not exceeded. While the figures within this report provide nominal force main diameters, the inside diameter of the pipe (assumed to be HDPE DR 17 for all future pipe) was used in force main and pump sizing. Appendix D contains a summary of the design flow and total dynamic head for each pump station under each scenario.

Table 6-4 Maximum Wet Weather Day and Peak Hourly Discharge Rates

Scenario	Maximum Wet Weather Day (l/s)	Peak Hourly Discharge Rate (l/s)
Increased Density - Status Quo	155	219
Increased Density - Increased Water Conservation	119	210
Base Density - Status Quo	150	191
Base Density- Water Conservation	116	183

Based on our review, we have sized the force mains and pumps to operate effectively over the full range of operating conditions. Therefore, there are no force main size differences associated with any of the scenarios. There are a limited number of pump stations which are affected by the change in flow associated with the scenarios. The primary difference between scenarios is energy costs associated with how often each pump station will run. We have selected 7 standard pump models that will service the needs of all pump stations for both options and

allow the TFN to minimize the need for spare parts and pumps. Through the use of flow meters at all pump stations and variable motor speed controllers at select stations, TFN will be able to optimize the efficiency of the system and match the pump capacities to actual flow conditions. The pump station details are provided in Appendix D.

Therefore, given the limited impact on infrastructure sizing, it is our recommendation that TFN proceed with planning based on the Increased Density Status Quo Scenario.

6.2.3 Phasing

In order to confirm the sizing of the proposed infrastructure a phasing review was completed using the Status Quo Increased Density Scenario. Each phase was added in sequence to the system and the required infrastructure was identified. Since the timing of each phase is uncertain it was assumed that each phase would reach build out before the next phase began.

The following table illustrates the maximum day and peak hourly flows conveyed from TFN to the TFN sewage treatment plant at the completion of each phase:

Table 6-5 Maximum Wet Weather Day and Peak Hourly Discharge Rates:

Phase (Increased Density Status Quo Scenario)	Maximum Wet Weather Day (l/s)	Peak Hourly Discharge Rate (l/s)
Phase 1	71	132
Phase 2	106	207
Phase 3	155	219

Specific commentary on each Phase is discussed below:

Phase 1

Figure 6-10 Proposed Sanitary Phase 1. Phase 1 construction includes development of precincts A1, A4, A5, the Tsawwassen Mills Mall and Power Center and a portion of the Industrial Lands. Areas A1, A4 and A5 will be serviced by two sewage pump stations (SPS 8a and SPS 8b). Due to the location of these pump station in relation to the Sewage Treatment Plan, a proposed 100mm force main should be constructed to connect to the existing Force Main #1 on Tsawwassen Drive. This is an interim connection until Force Main #3 is constructed. During Phase 2, these pump stations will be redirected to Force Main #3. The portion of force main

connecting to Force Main # 3, as well as the section of force mains connecting precinct G1 (SPS 7) to Force Main #3 should be installed dry until Phase 2 proceeds.

Phase 2

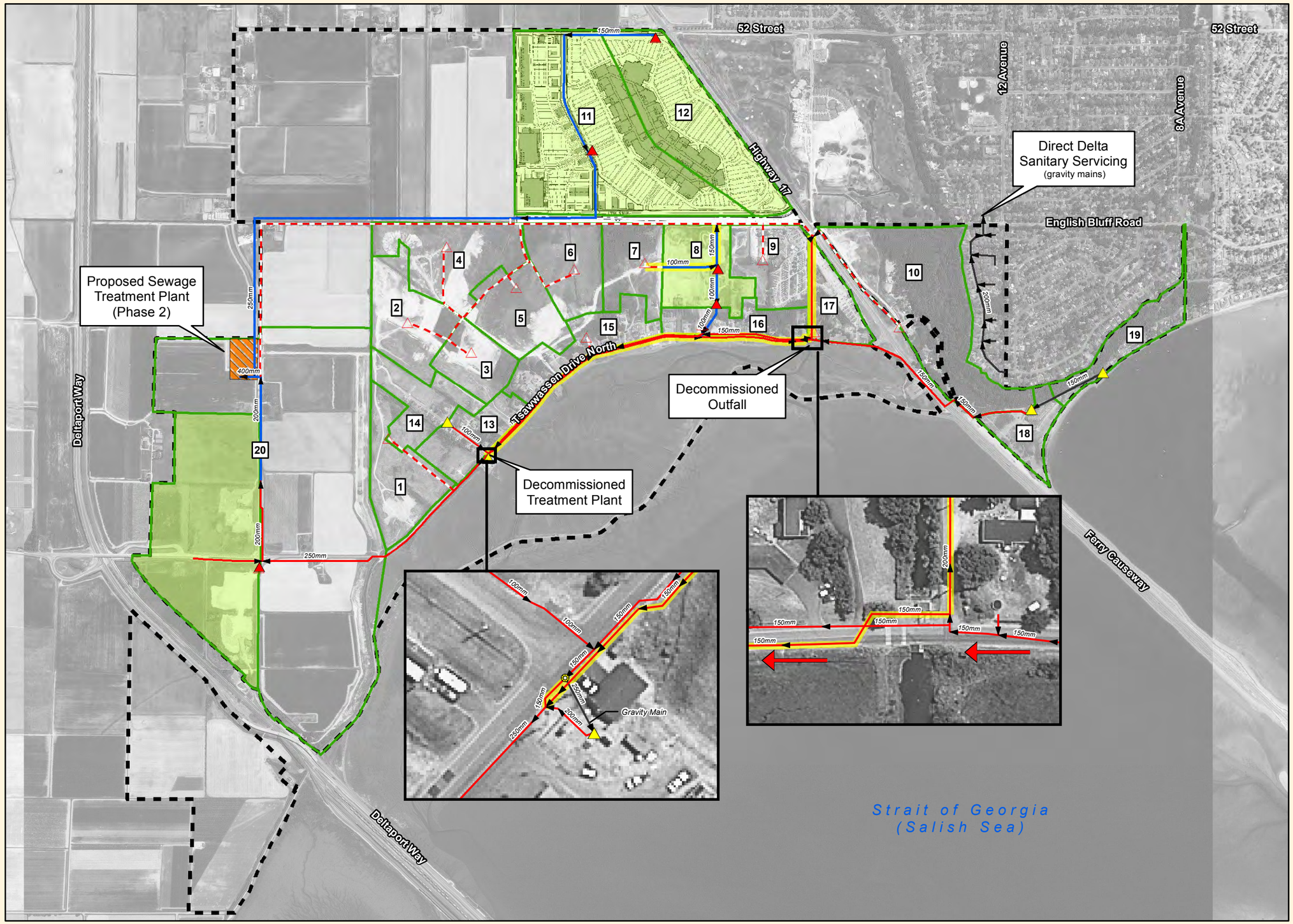
Refer to Figure 6-11 Proposed Sanitary Phase 2. Phase 2 construction includes development of precincts C1, C2, G1 and D2. To service these areas requires the construction of five sanitary pump stations and associated force mains.

Precinct G1 involves construction of one pump stations and the construction and activation of a portion of the force main within precincts A1 and A5, as well as a portion of Force Main #3. Once activated the 100mm force main from SPS 8 to Force Main #1 can be closed and kept as a backup interconnecting main (albeit with limited capacity).

Phase 3

Refer to Figure 6-12 Proposed Sanitary Phase 3. The Phase 3 construction includes the completion of the industrial lands, the lands south of Highway 17, the TFN community lands and the majority of the remaining neighbourhood plan area. To service this phase all of the remaining sanitary pump stations and trunk force mains will be constructed. For the TFN community lands, once all of the pump stations have been replaced and discharge force mains moved over to the high pressure force main, the low pressure Force Main #2 can be closed and maintained as a backup. While only one of the force mains is required we have also confirmed that alternatively both force mains can be left in service and still achieve cleansing velocity. Keeping both force mains in service helps ensure that both force mains are fully operational in the event that one needs to be taken out of service. It is recommended that the pump stations in the TFN community maintain a connection to both force mains.

For the industrial area, as already mentioned, it is not certain how may pump stations will ultimately be required or the sequencing of how they will be constructed.



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Proposed Sanitary Lift Station (Constructed)
- Proposed Sanitary Lift Station (Not Constructed)
- Existing Sanitary Lift Station
- Manhole
- Meter
- Existing Forcemain
- Sanitary Gravity Main
- Proposed Sanitary Force Main (Constructed)
- Proposed Sanitary Force Main (Not Constructed)
- Normally Closed Pipe
- TFN Boundary
- Catchment Boundaries
- Pump Station Constructed - Phase 1
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

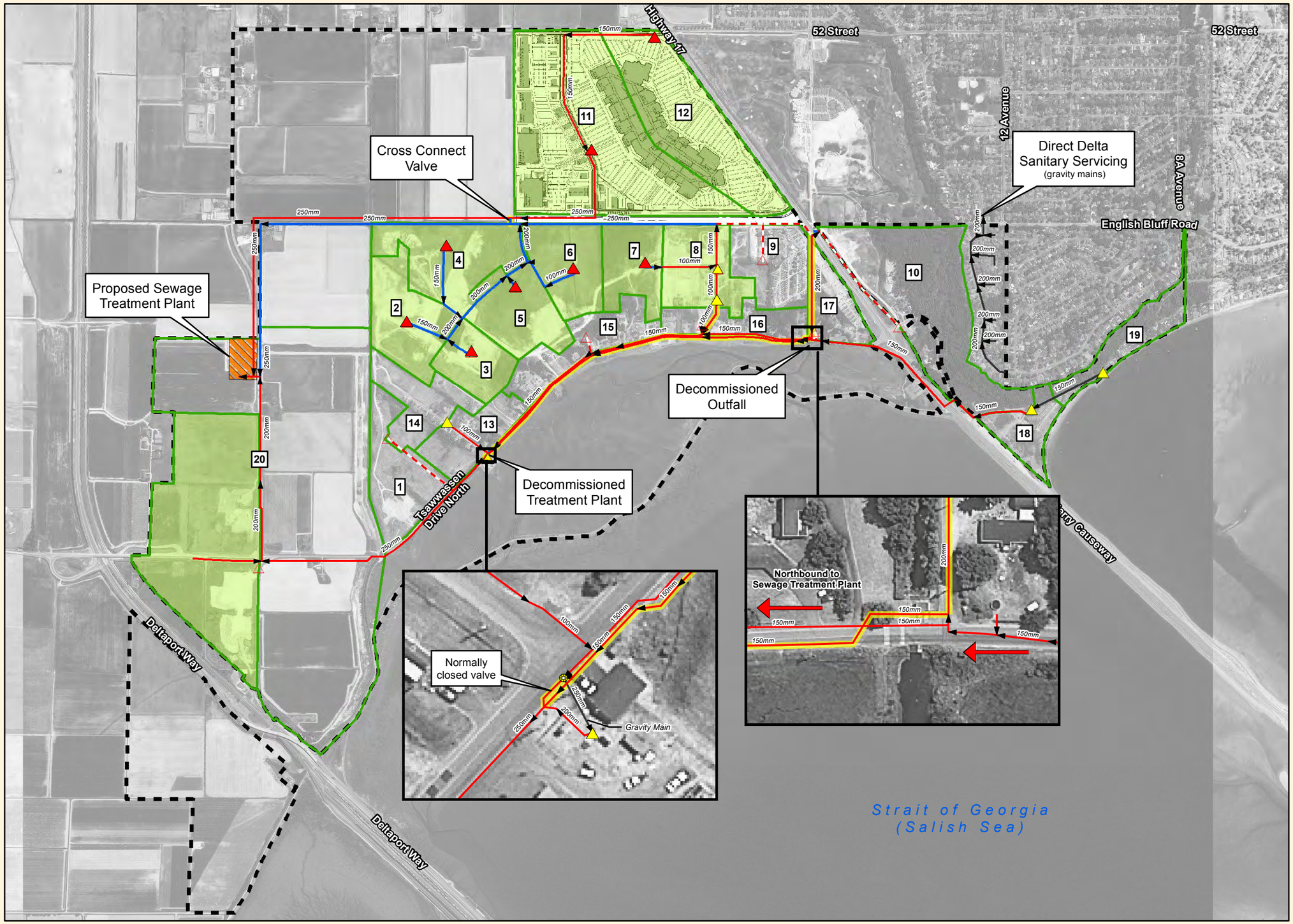
TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Sanitary Phase 1

0 125 250 500
Meters

Figure 6-10

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-10 - Proposed Sanitary Phase 1.mxd Last revised by: bpauls on 04/02/2014 at 2:36:26 PM



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Proposed Sanitary Lift Station (Constructed)
- Proposed Sanitary Lift Station (Not Constructed)
- Existing Sanitary Lift Station
- Manhole
- Meter
- Existing Forcemain
- Sanitary Gravity Main
- Proposed Sanitary Force Main (Constructed)
- Proposed Sanitary Force Main (Not Constructed)
- Normally Closed Pipe
- TFN Boundary
- Catchment Boundaries
- Pump Station Constructed - Phase 2
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Sanitary Phase 2

0 125 250 500
Meters

Figure 6-11

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 6-11 - Proposed Sanitary Phase 2.mxd Last revised by: bpauls on 04/02/2014 at 2:39:12 PM

TSAWWASSEN FIRST NATION
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Cross Connect Valve

Direct Delta Sanitary Servicing
(gravity mains)

Proposed Sewage Treatment Plant

Decommissioned Outfall

Decommissioned Treatment Plant

Normally closed valve

Gravity Main

Highway 17
52 Street
52 Street
12 Avenue
8A Avenue
English Bluff Road
Tsawwassen Drive North
Deltaport Way
Deltaport Way
Deltaport Causeway
Strait of Georgia
(Salish Sea)

Legend

- Proposed Sanitary Lift Station (Constructed)
- Proposed Sanitary Lift Station (Not Constructed)
- Existing Sanitary Lift Station
- Manhole
- Meter
- Existing Forcemain
- Sanitary Gravity Main
- Proposed Sanitary Force Main (Constructed)
- Proposed Sanitary Force Main (Not Constructed)
- Normally Closed Pipe
- TFN Boundary
- Catchment Boundaries
- Pump Station Constructed - Phase 3
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Sanitary Phase 3

0 125 250 500
Meters

Figure 6-12

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7.0 Cost Estimates

7.1 Capital Costs

Capital costs have been established for the proposed bulk water and trunk sanitary sewer system illustrated. The following assumptions have been incorporated into these cost estimates:

- restoration of any existing surfaces to existing conditions is included;
- for works in new development areas costs for any fill and road construction have not been included;
- it is assumed that there will be no cost associated with acquiring the necessary right-of-ways;
- a 35% allowance has been included for engineering and contingency; and
- no borrowing or administration costs have been included.

A detailed breakdown of the cost estimates is provided in Appendix E. Below is a summary of the cost of the works that are required by phase. We have broken the works into two categories for each utility. Category 1 works are the works that will likely be funded in whole or in part through community wide financial tools and include:

- all water mains 300mm and larger;
- all sanitary force mains that service multiple pump stations;
- set-up costs for a fixed radio base water meter reading system; and
- upgrade costs for a new supervisory control and data acquisition (SCADA) system.

Not included in the costs are any upgrading works by GVWD. The cost of the sewage treatment plant has also not been included in this estimate but has been separately provided. Finally, we have not included the costs associated with construction of the gravity sanitary sewers and local water distribution mains due to the unknown configuration of the system. Gravity sewers and distribution mains will be treated as Category 2 works as explained below.

There are a number of technologies available for water meter reading. However, given that TFN doesn't currently have the staff in place for meter reading and given the flat terrain of the site it is recommended that TFN pursue a fixed base radio system and reads the meters from a central tower location and transmits the information to the accounting office. It is assumed that only a single base station is required, however, this will need to be confirmed by a path study.

The SCADA system monitors the performance of the sanitary sewer pump stations. The central core of this system is currently in the process of being upgraded and commissioned however the

existing radios utilize obsolete technology. The upgrade costs will bring this system up to date and allow for the expansion to service all of the new pump stations.

Category 2 works are works that are expected to funded by the individual developer and include:

- all identified trunk water mains 250mm and smaller;
- all sanitary sewer pump stations; and
- all force mains that only service a single pump station.

Refer to
Figure 7-1 and Figure 7-2 which show the cost allocation for the bulk water system and sanitary system. Below are two tables that summarize the costs of the bulk water system and the sanitary system costs.

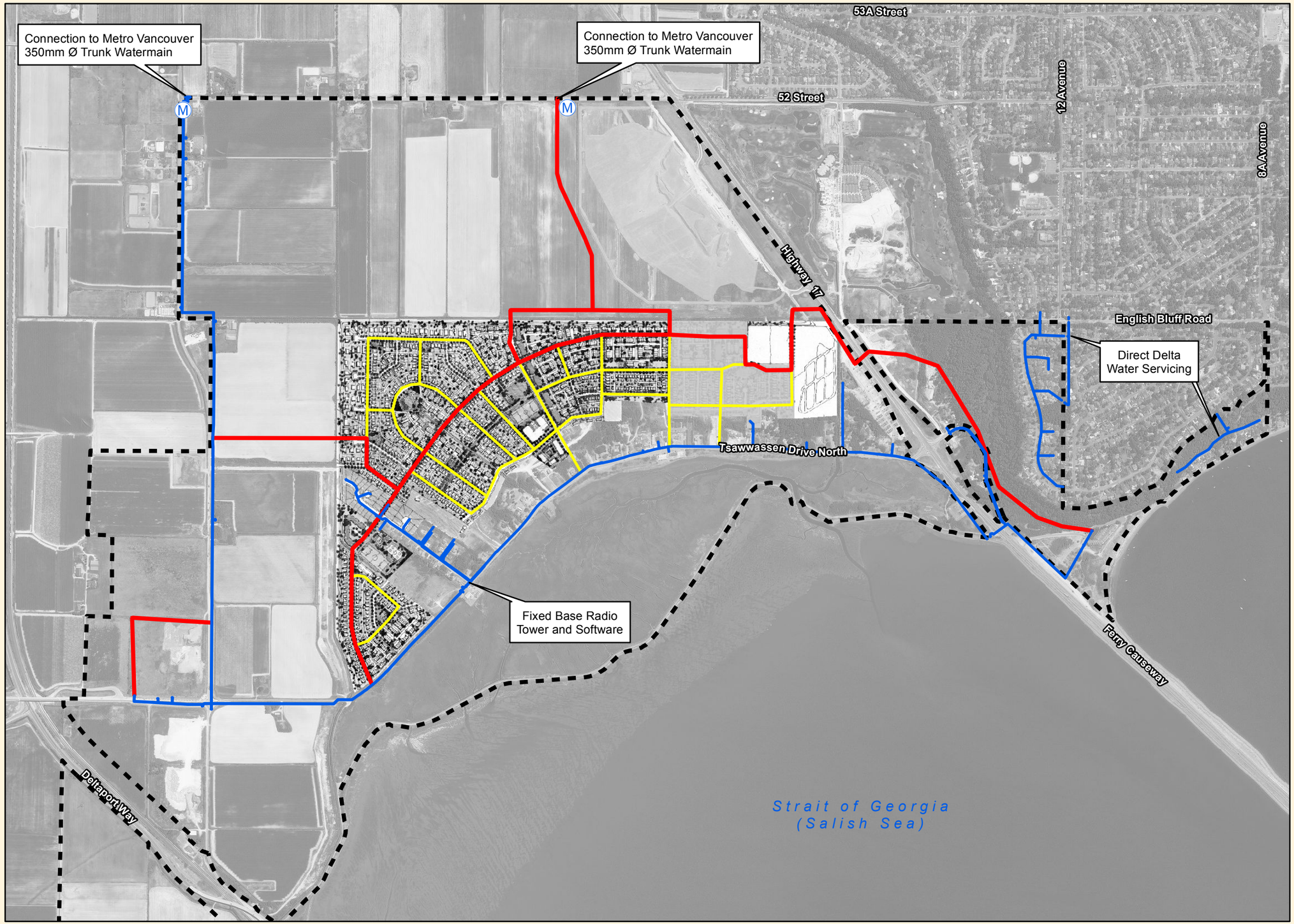
Table 7-1 Capital Cost Summary - Water System

	Bulk Water	
	Category 1	Category 2
Phase 1	$2,688,000	$767,000
Phase 2	$1,522,000	$2,703,000
Phase 3	$2,312,000	$749,000
Total	$6,522,000	$4,219,000

Table 7-2 Capital Cost Summary - Sanitary System

	Sanitary	
	Category 1	Category 2
Phase 1	$977,000	$3,062,000
Phase 2	$1,209,000	$3,189,000
Phase 3	$157,000	$6,050,000
Total	$2,343,000	$12,301,000

The above capital cost estimates identify the infrastructure costs that is required to service build out of each phase, however, it should be noted that some components may be constructed out of sequence if cost savings are recognized (e.g. twinned sanitary forcemains may be constructed together in a common trench, even if they are not required from a servicing perspective within the same phase).



TSAWWASSEN FIRST NATION
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Legend

- Meter
- Existing Water Main

Proposed Water Main

- Category 1
- Category 2
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

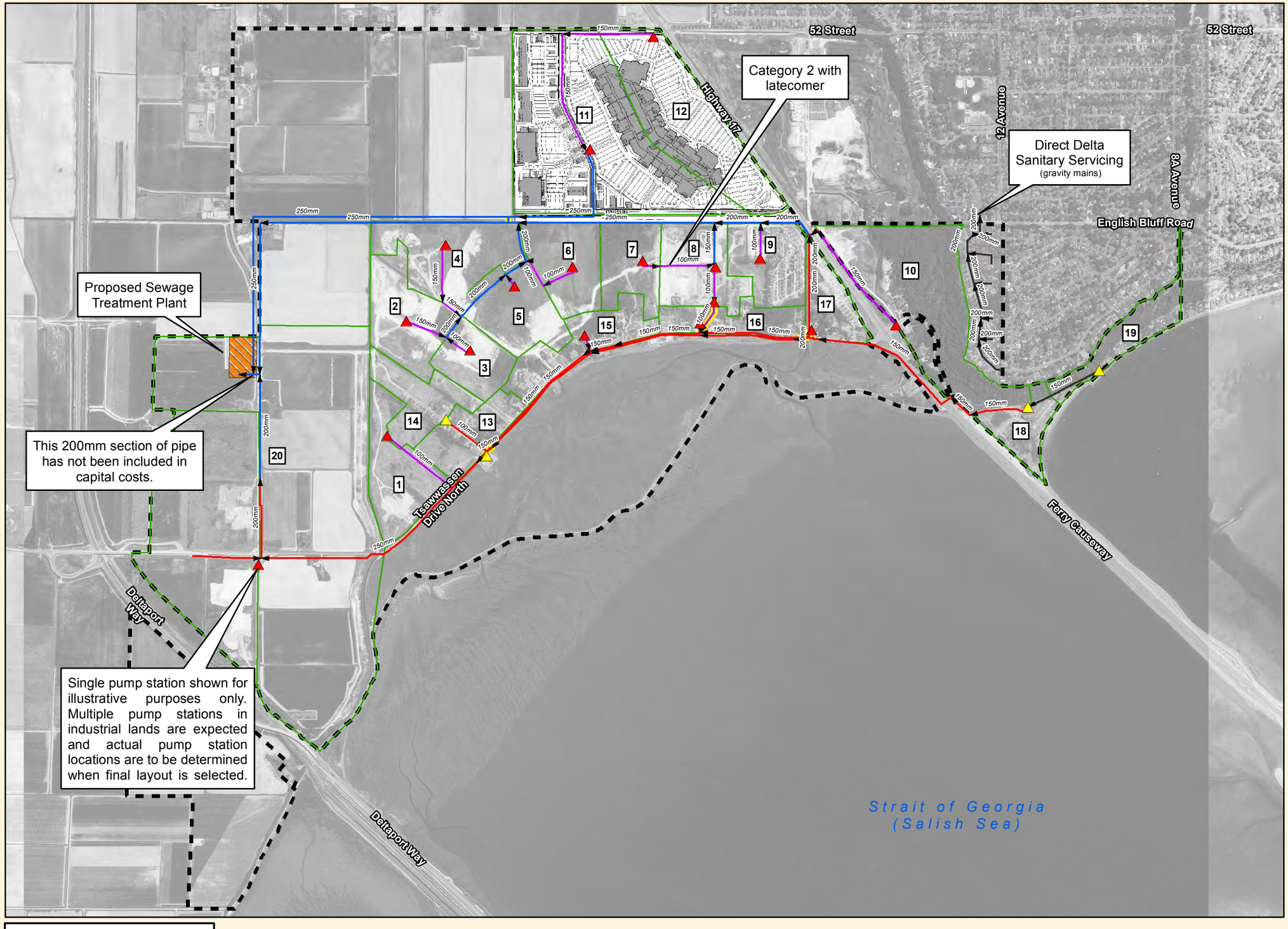
TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Water System Cost Allocation

0 125 250 500
Meters

Figure 7-1

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 7-1 - Proposed Water System Cost Allocation.mxd Last revised by: bpauls on 16/01/2014 at 5:00:29 PM



TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Proposed Sanitary Lift Station
- Existing Sanitary Lift Station
- Manhole
- Meter
- Existing Forcemain
- Sanitary Gravity Main

Proposed Sanitary Force Mains

- Category 1
- Category 2
- Normally Closed Pipe
- TFN Boundary
- Catchment Boundaries
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Proposed Sanitary System Cost Allocation

Figure 7-2

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure 7-2 - Proposed Sanitary System Cost Allocation.mxd Last revised by: bpauls on 04/02/2014 at 2:38:45 PM

7.2 Operations and Maintenance Costs

Operations and maintenance costs include labour and material costs associated with the regular running of the bulk water and trunk sanitary systems. Examples of these costs include:

- Regular monitoring of system performance (via SCADA)
- Scheduled inspection of system components (visual inspection and video inspection of sewers)
- Regular maintenance of system components (ie. pump station cleaning and pump maintenance, hydrant maintenance, water main and sewer main flushing/cleaning, valve exercising, meter maintenance and testing)
- Repair activities due to system failures

Based on our review of the TFN Maintenance Management Plan that TFN actively follows, we have established the following average fixed and variable operations and maintenance costs for the sanitary pump stations. For the sanitary force mains and water distribution mains the values listed below are based on the water main Capital Asset Inventory System (CAIS) funding formula from Aboriginal Affairs and Northern Development Canada. All costs include a 30% allowance for administration and contingency.

Table 7-3 Operations and Maintenance Unit Cost Summary

Description	Units	Unit Cost
Sanitary Pump Station		
- Fixed costs	$/PS/year	$17,000
- Electricity costs	$/kWh	$0.10
Sanitary Force Main	$/m/year	$4.20
Water Distribution Main	$/m/year	$4.20

The above costs do not include the cost to purchase water from the GVWD since this cost is not known at this point in time. Similarly, we have not included the operations and maintenance for the Sewage Treatment Plant which was included in a separate study. These costs also do not include the costs associated with local distribution mains (or associated hydrants) or individual lot water meters.

For a detailed breakdown of the operations and maintenance costs included in this evaluation, refer to Appendix F.

Based on the above unit prices and detailed breakdowns in Appendix F, the following is a summary of the annual operations and maintenance costs at the build out of each phase associated with the proposed bulk water and trunk sanitary sewer elements. These costs do not include existing infrastructure with the exception of Phase 3 where a credit has been applied associated with the removal of 14 existing pump stations.

Table 7-4 Operations and Maintenance Total Cost Summary

	Water	Sanitary
Phase 1	$15,000	$133,000
Phase 2	$28,000	$277,000
Phase 3	$59,000	$459,000

7.3 Infrastructure Renewal/Replacement Costs

In addition to the initial capital costs and the operations and maintenance costs it is important that TFN has given consideration to how it will fund the eventual replacement of the infrastructure once it reaches the end of its useful life. Since the majority of the system will be brand new, this issue is not something that will require significant expenditure for some time. It is recommended that TFN consider this in the context of establishing utility rates so that the systems can be operated in perpetuity.

8.0 Complementary Considerations

There are a number of complementary activities that the TFN is recommended to implement in order to help ensure that the conservation principles outlined in this Master Plan are achieved to their fullest extent. Below is a list of recommended activities.

Implement Universal Fixed Base Radio Read Water Metering

The first recommended action is to implement a universal water metering program for all service connections as part of the first phase of development. A number of technologies exist that vary from manual read meters through to meters that are read continually by radio technology. The continually read meters are referred to as fixed base radio meter (since the station that reads the meters is fixed in place). These meters have a significant advantage over the manual meters because they provide hourly data of water use that allows for the accurate assessment of water demands. They also do not require sending meter readers to each site. The capital cost for this fixed base system is already included in the capital cost estimate. In order to get a complete understanding of water use it is recommended that all service connections be metered (and not just the new connections).

Adopt Water Conservation Based Meter Rates

The second recommendation is that TFN adopt a water and sanitary sewer rate structure that is based on an inclining block. The more water that is used the higher the cost per m^3. It is recommended that a monthly billing cycle be adopted since it provides the greatest opportunity for customers to adjust their habits and for TFN to address any system issues.

Develop Lot Based Irrigation Allotment Strategy

As recommended in the Service Delivery Policies TFN should adopt a lot based irrigation allotment strategy. This strategy would require that actual water use for irrigation be established at the time of development. In order to ensure that the land occupier doesn't significantly modify what has been approved TFN may consider adopting one or more enforcement tools such as:

- Retaining a security deposit that can be cashed to restore the landscaping to its originally approved condition – this practice is commonly employed for street trees and other community landscaping amenities that are located on private property; and

- Formally establishing an irrigation allotment registry so that all future lease holders can see what has been allotted to their land are clear what they are purchasing – this practice is employed by communities that service agricultural lands.

Review and Update the Building Regulation

It is recommended that TFN review and update the Building Regulation in order to require that water efficient appliances be installed. The USEPA has established the WaterSense labelling system for appliances sold in the USA. Canada is reviewing bringing a similar program to Canada. TFN could adopt a standard in line with the WaterSense program.

It is also recommended that TFN ensure that appropriate legislation is in place allowing TFN to enforce that the requirements of the Building Regulation are followed in perpetuity. This needs to be supported by appropriate resources for building permit inspections and post construction compliance inspections. In addition to the water efficiency of fixtures and appliances it is also critical that the integrity of the sanitary sewer connection be maintained and that no groundwater or rainwater is permitted to enter into the service lateral on private property.

Develop Water Use and Conservation Education Plan

The final recommendation is that TFN develop a Water Use and Conservation Education Plan. This plan would be primarily focussed at educating the TFN community on its water use and ways that it can be as efficient as possible. TFN may consider use of web based technology to provide customers with access to their water meter records and educational tools.

9.0 Conclusions and Recommendations

In conclusion this Master Plan presents a servicing strategy that will allow the Tsawwassen First Nation to provide consistent levels of water and sanitary sewer service through to the build out of its lands. This strategy provides a cost effective approach that allows for phasing and will allow TFN to respond to evolving design and construction practices. It represents best practices in water and sanitary sewer systems life cycle design and is well suited to the unique geographic conditions of the TFN lands.

It is recommended that TFN:

- Adopt the preferred sanitary servicing option
- Adopt the proposed service delivery policies
- Proceed with infrastructure sizing to meet the increased density status quo demand scenario
- In order to position TFN as a leader in water conservation practices and principles it is also recommended that TFN:
    - Implement universal fixed base radio read water metering
    - Adopt water conservation based meter rates
    - Develop a lot based irrigation allotment strategy
    - Review and update the Building Regulation
    - Develop a water use and conservation education plan

Appendix

Service Delivery Policies

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JANUARY, 2014

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TSAWWASSEN FIRST NATION
PROPOSED SERVICE DELIVERY POLICIES

1.0 Introduction

The purpose for this memorandum is to outline proposed service delivery policies that will form the basis for the Bulk Water and Trunk Sanitary Sewer Master Plan.

2.0 Planning Process

Policies:

a. The Tsawwassen First Nation will provide potable water and sanitary sewer servicing capacity for each customer up to a defined, consistent level of service.

b. Any development that will increase the potable water or sanitary sewer requirements from present conditions must be reviewed and approved by the TFN. The TFN may require that the customer complete or provide funding to complete upgrading to off-site infrastructure before the development is authorized to proceed.

c. Each customer is responsible for ensuring the potable water demand and sewage generation rates within their site remain at or below the established levels of service. For existing customers serviced at the time of the initial adoption of this policy compliance will be required at the time of redevelopment or sooner as directed by the TFN.

2.1 Levels of Service

The following define design criteria and maximum levels of service that will be provided to TFN customers.

a. These levels of service are not guarantees and are subject to the availability of supply and conveyance capacity. For example interruptions may occur as the result of routine operations and maintenance activities, emergency conditions, or capacity limitations beyond the control of the TFN from Metro Vancouver or Delta.
b. For industrial and commercial uses where flows are anticipated to exceed the values in the tables below the developer must submit substantiation for the increased flows based on actual flow meter records from similar uses for approval by TFN. Upon approval these increased flows will form the basis of the maximum level of service to these customers subject to the developer funding all necessary off-site infrastructure upgrade requirements, both within TFN Lands and external to TFN Lands.
c. All developers will be required to submit required fire flow calculations in accordance with the latest Fire Underwriter's Survey Guidelines to demonstrate that the proposed buildings are designed in conformance with the maximum fire flow requirements listed below. If these flows are not able to be achieved due to the nature of the materials being stored then increased service levels may be approved by TFN subject to the developer funding all necessary off-site water supply upgrade requirements.

Table 1a. Potable Water System – Status Quo

	Maximum Day		Peak Hour		Fire Flow*	
	Flow	Pressure	Flow	Pressure	Flow	Pressure
Residential Single Family Detached – Large Lot	980 l/cap/day	275 kPa	1588 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Single Family Detached – Small Lot	980 l/cap/day	275 kPa	1588 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Multi-Family Townhouse	620 l/cap/day	275 kPa	1004 l/cap/day	255 kPa	170 l/s	140 kPa
Residential Multi-Family Apartment	620 l/cap/day	275 kPa	1004 l/cap/day	255 kPa	170 l/s	140 kPa
Residential TFN Community	980 l/cap/day	275 kPa	1588 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Multi-Family – South of Highway 17	620 l/cap/day	275 kPa	1004 l/cap/day	255 kPa	170 l/s	140 kPa
Commercial Retail	46,800 l/ha/day	275 kPa	71,604 l/ha/day	255 kPa	250 l/s	140 kPa
Commercial Other	22,500 l/ha/day	275 kPa	34,425 l/ha/day	255 kPa	170 l/s	140 kPa
Industrial	9,153 l/ha/day	275 kPa	12,631 l/ha/day	255 kPa	270 l/s	140 kPa
Institutional	21,000 l/ha/day	275 kPa	55,440 l/ha/day	255 kPa	120 l/s	140 kPa
Irrigated Parks	83,333 l/ha/day	275 kPa	240,832 l/ha/day	255 kPa	n/a	n/a
Non Revenue Water	10% of ADD	n/a	10% of ADD	n/a	n/a	n/a

*Simultaneous with Maximum Day

Table 1b. Potable Water System – Increased Water Conservation

	Maximum Day		Peak Hour		Fire Flow*	
	Flow	Pressure	Flow	Pressure	Flow	Pressure
Residential Single Family Detached – Large Lot	600 l/cap/day	275 kPa	972 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Single Family Detached – Small Lot	600 l/cap/day	275 kPa	972 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Multi-Family Townhouse	500 l/cap/day	275 kPa	810 l/cap/day	255 kPa	170 l/s	140 kPa
Residential Multi-Family Apartment	500 l/cap/day	275 kPa	810 l/cap/day	255 kPa	170 l/s	140 kPa
Residential TFN Community	600 l/cap/day	275 kPa	972 l/cap/day	255 kPa	70 l/s	140 kPa
Residential Multi-Family – South of Highway 17	500 l/cap/day	275 kPa	810 l/cap/day	255 kPa	170 l/s	140 kPa
Commercial Retail	22,500 l/ha/day	275 kPa	34,425 l/ha/day	255 kPa	250 l/s	140 kPa
Commercial Other	22,500 l/ha/day	275 kPa	34,425 l/ha/day	255 kPa	170 l/s	140 kPa
Industrial	9,153 l/ha/day	275 kPa	12,631 l/ha/day	255 kPa	270 l/s	140 kPa
Institutional	21,000 l/ha/day	275 kPa	55,440 l/ha/day	255 kPa	120 l/s	140 kPa
Irrigated Parks*	0 l/ha/day	275 kPa	0 l/ha/day	255 kPa	70 l/s	140 kPa
Non Revenue Water	10% of ADD	n/a	10% of ADD	n/a	n/a	n/a

* Irrigation water from other sources.

Table 2. Sanitary Sewer System

	Status Quo		Increased Water Conservation	
	Peak Day Flow	Peak Hour Flow	Peak Day Flow	Peak Hour Flow
Residential Single Family Detached – Large Lot	735 l/cap/day	1191 l/cap/day	480 l/cap/day	778 l/cap/day
Residential Single Family Detached – Small Lot	784 l/cap/day	1270 l/cap/day	480 l/cap/day	778 l/cap/day
Residential Multi-Family Townhouse	527 l/cap/day	854 l/cap/day	425 l/cap/day	689 l/cap/day
Residential Multi-Family Apartment	527 l/cap/day	854 l/cap/day	425 l/cap/day	689 l/cap/day
Residential TFN Community	735 l/cap/day	1191 l/cap/day	480 l/cap/day	778 l/cap/day
Residential Multi-Family – South of Highway 17	527 l/cap/day	854 l/cap/day	425 l/cap/day	689 l/cap/day
Commercial Retail	44,460 l/ha/day	68,024 l/ha/day	20,250 l/ha/day	30,983 l/ha/day
Commercial Other	20,250 l/ha/day	30,983 l/ha/day	20,250 l/ha/day	30,983 l/ha/day
Industrial	8,695 l/ha/day	11,999 l/ha/day	8,695 l/ha/day	11,999 l/ha/day
Institutional	18,900 l/ha/day	49,896 l/ha/day	18,900 l/ha/day	49,896 l/ha/day
Inflow and Infiltration	8,640 l/ha/day	8,640 l/ha/day	8,640 l/ha/day	8,640 l/ha/day

2.2 Metering

All water connections require the installation of meters in accordance with the following policies:

a. While a single service is permitted to each property, service lines are to be separated at property line are required for all fire sprinklers or onsite fire systems and must be equipped with approved backflow prevention devices equipped with detector meters at property line.
b. Service connections for other than fire flow uses require approved meters located at property line.
c. The developer must pay for the cost for the installation of the backflow preventer, meter and chamber, however the water meter remains the property of the TFN.
d. For leasehold strata developments all water mains and hydrants within the strata are to be owned and maintained by the TFN within a registered right-of-way. For townhouse units individual water meters are required for each unit.
e. For any private water mains that loop back to the TFN water system a check valve must be installed at each connection point in order to prevent backflow into the TFN water system.

2.3 Sanitary Sewer Pump Stations

a. All sanitary pump stations are to be owned and maintained by the TFN.

b. All development must convey sanitary sewer flows by gravity to the designated sanitary sewer pump station.
c. Where possible pump stations should located adjacent to park facilities. Public bathrooms are to be incorporated at the direction of TFN where sufficient community benefit exists.
d. All pump stations must include standby power.

2.4 Irrigation

a. All development must be planned to minimize or eliminate the need for irrigation water from potable water sources (other than to establish plantings).
b. Developers must prepare a lot based irrigation allocation plan in accordance with TFN requirements. All customers will be responsible for ensuring that all landscaping is planned, installed and maintained in accordance with the approved water allocation plan.

2.5 Reuse

a. All developments shall explore opportunity for water reuse including rainwater capture and greywater sources.

2.6 Phasing

a. All development phasing must be consistent with the overall servicing concept in the Master Plan. Temporary infrastructure will not be permitted in order to avoid the construction of offsite infrastructure.

b. At the completion of each phase levels of service must match those outlined in Table 1 and 2. No reduced interim service levels will be permitted.

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Appendix

Diurnal Patterns

B

JANUARY, 2014

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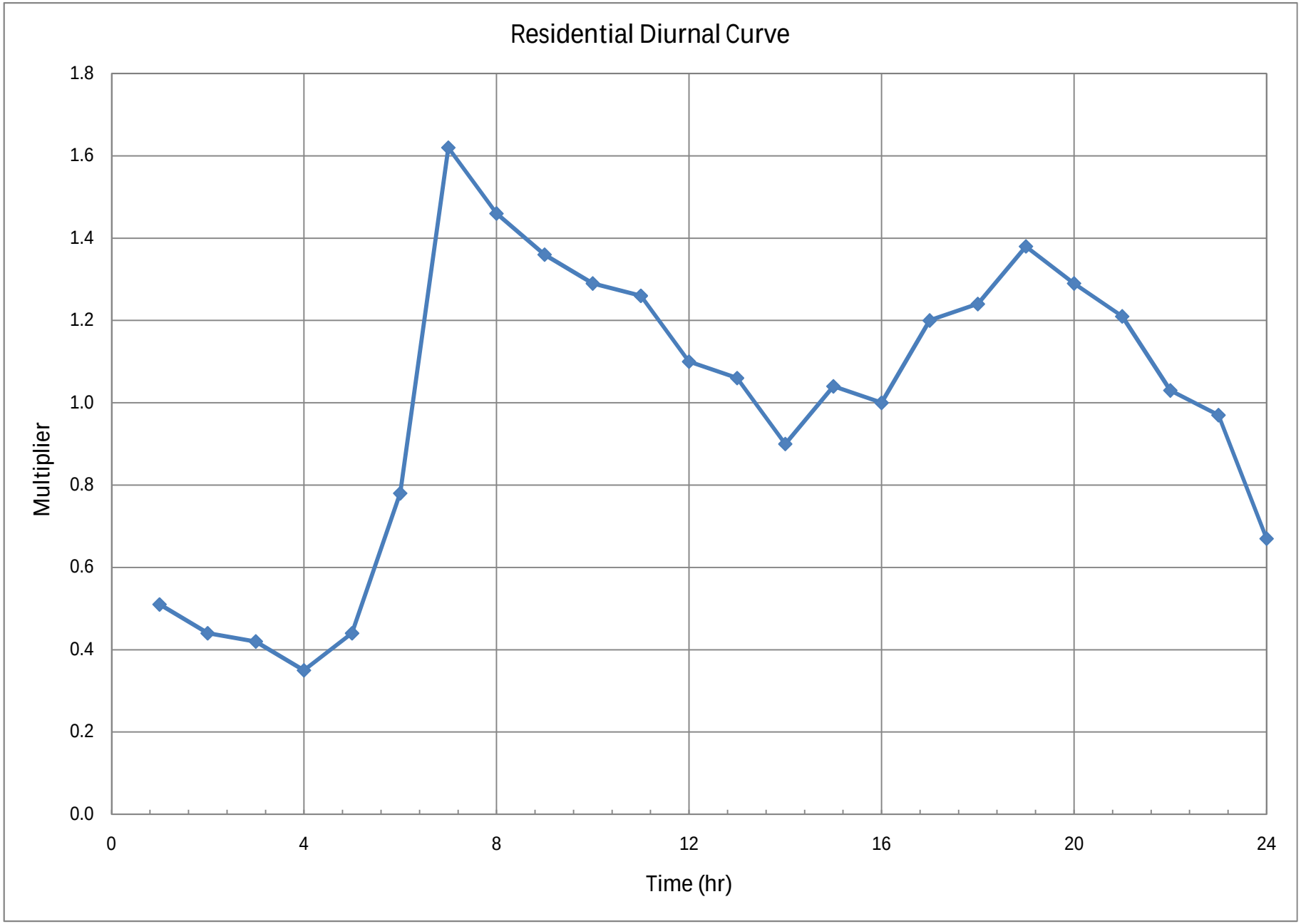
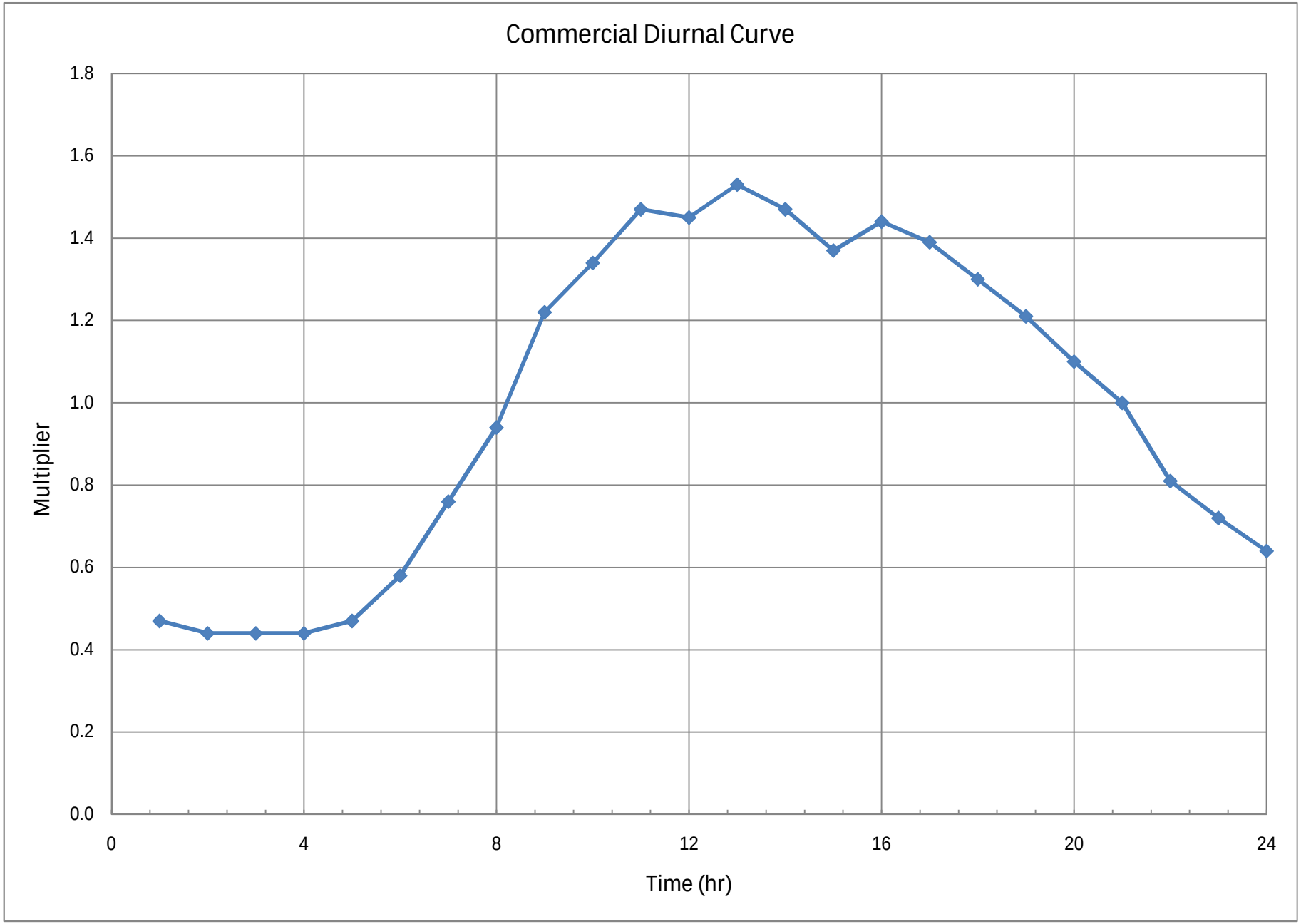
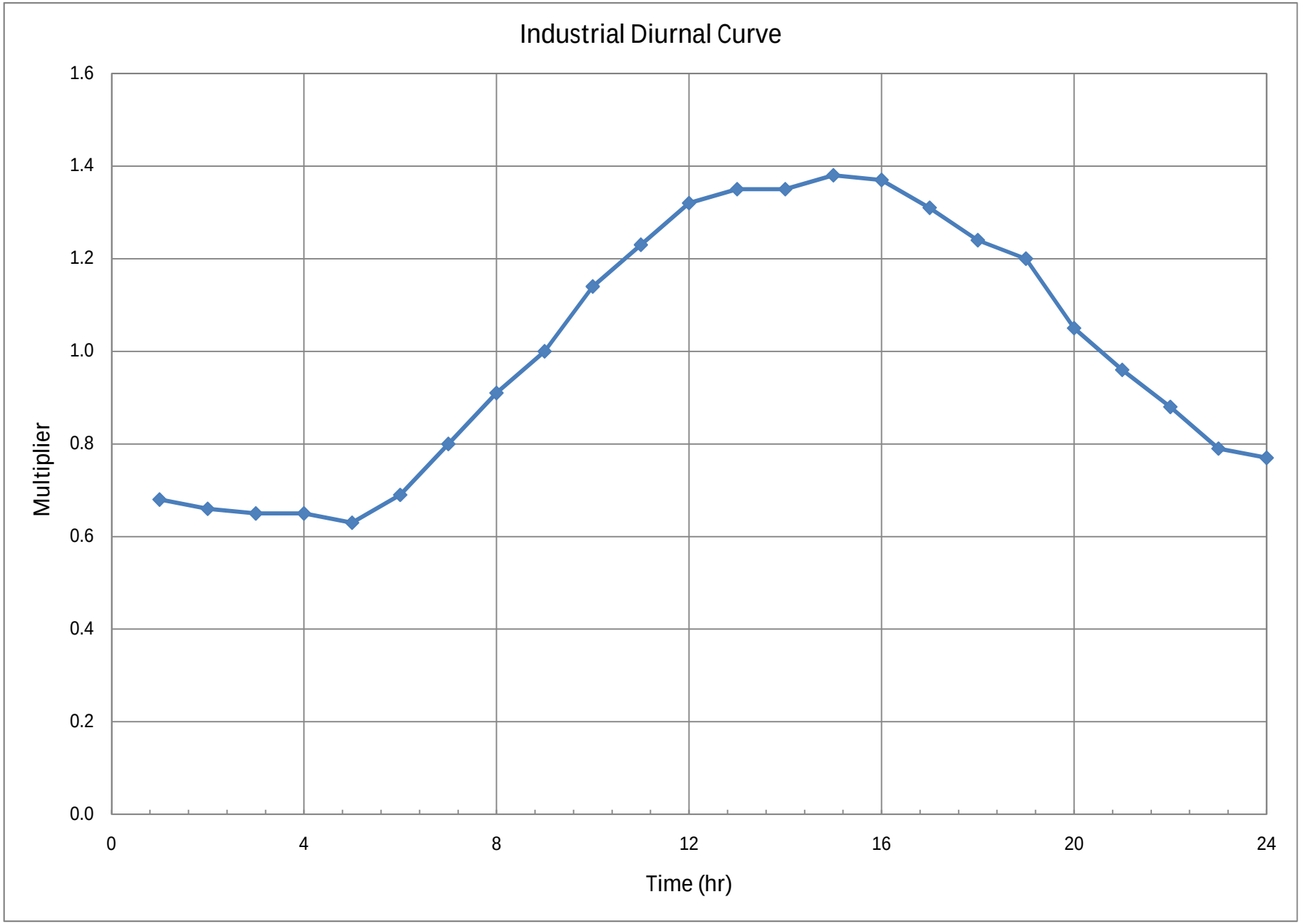
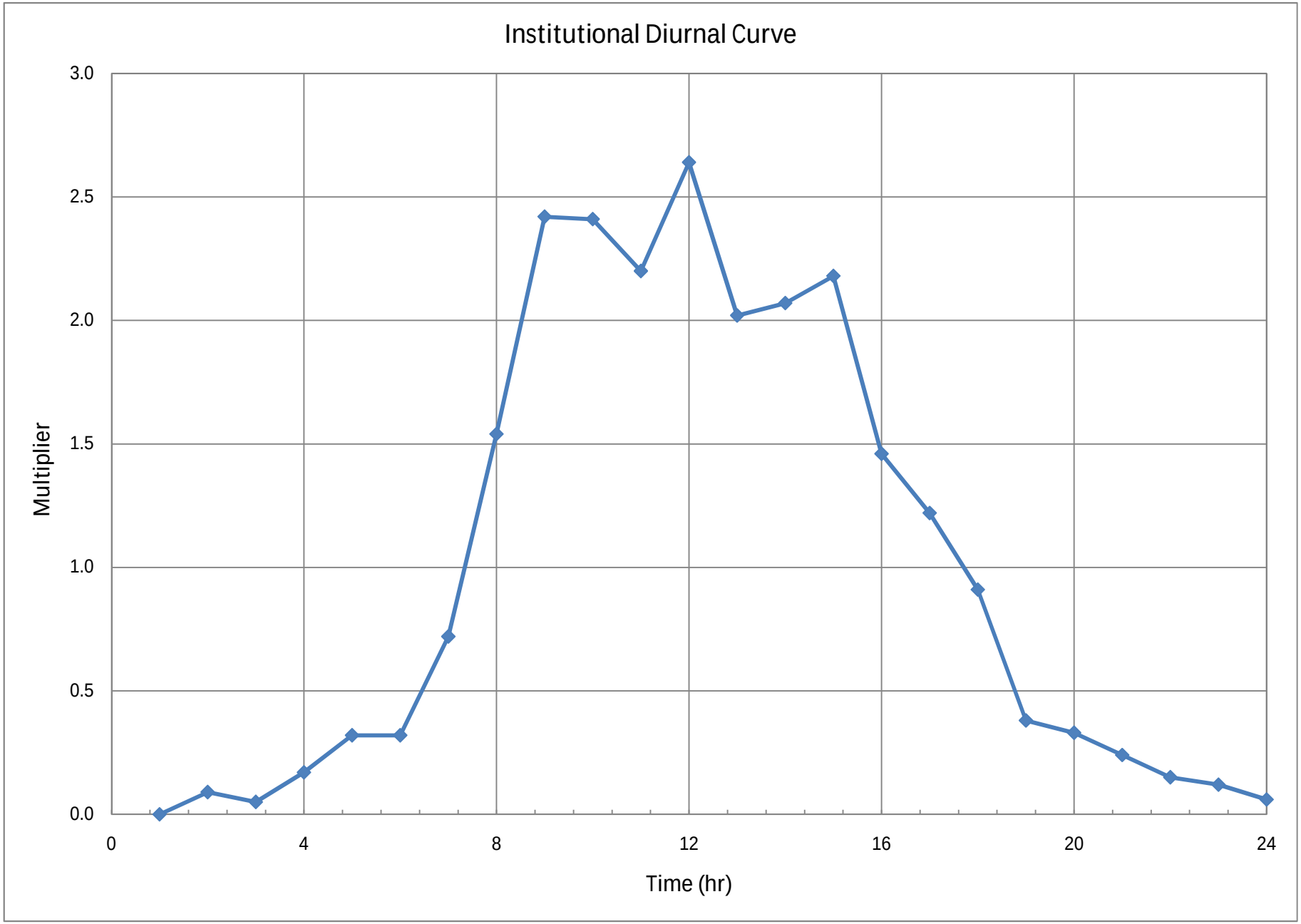
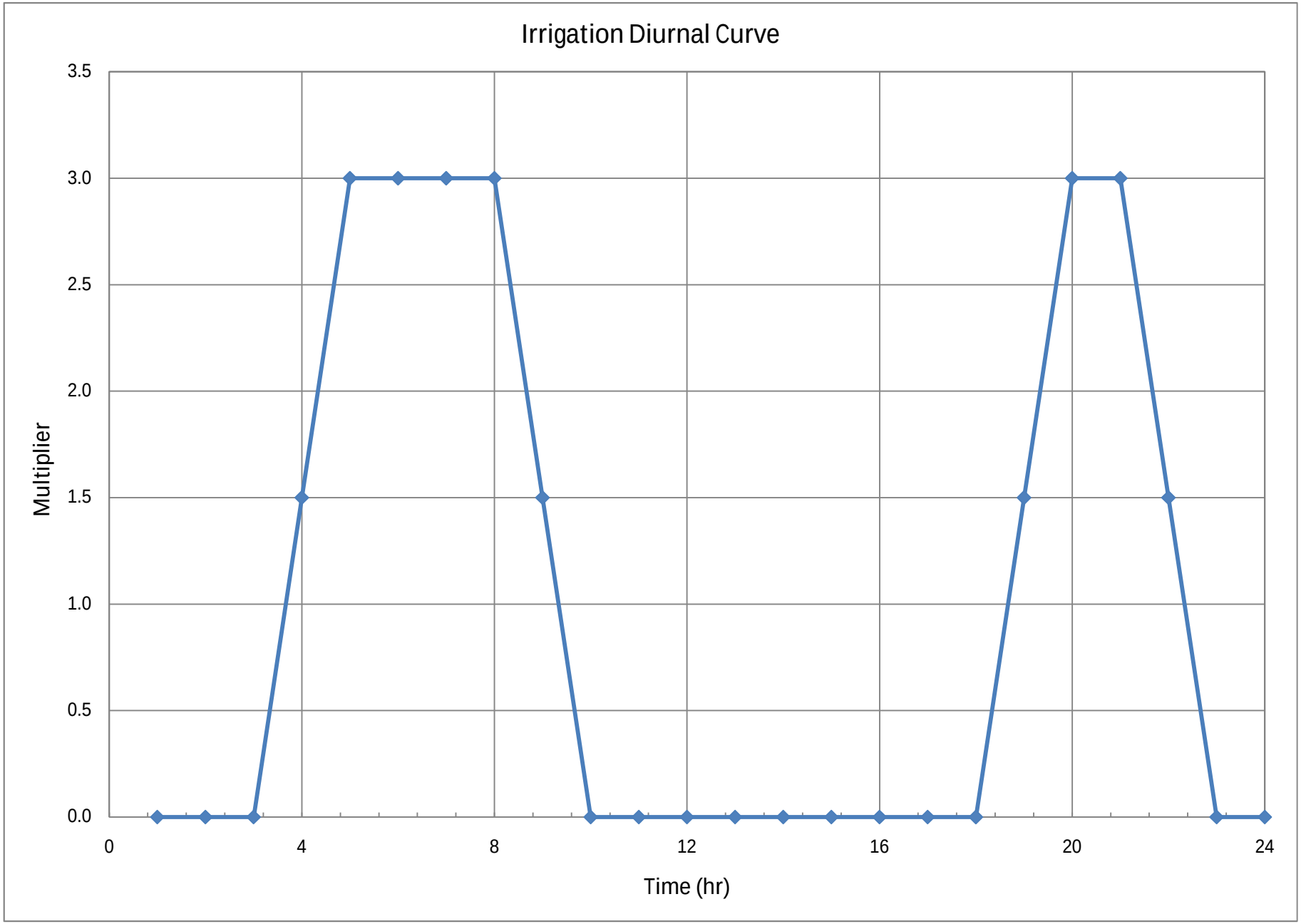

Residential Diurnal Curve
Multiplier
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
4
8
12
16
20
24
Time (hr)

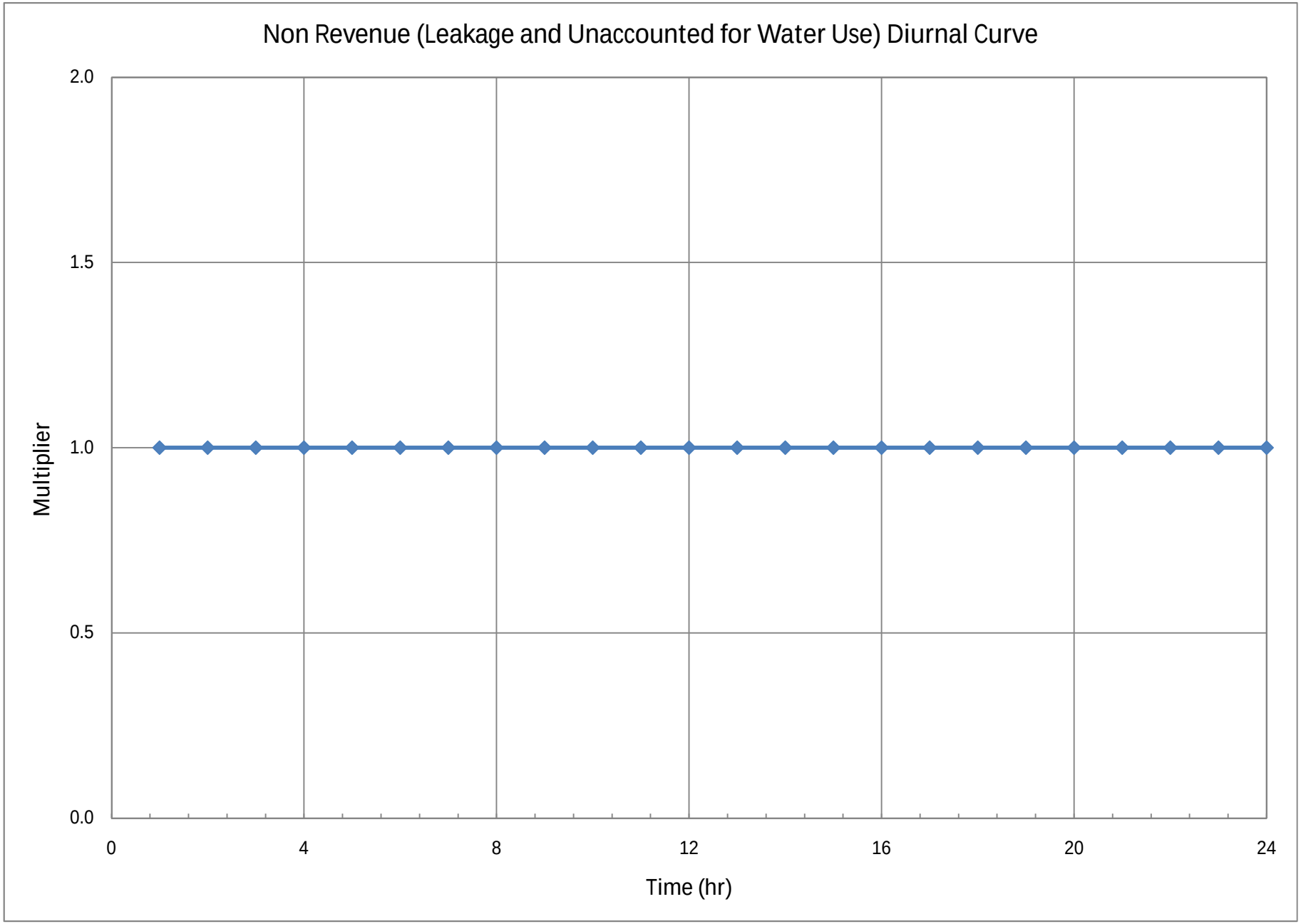

Commercial Diurnal Curve
Multiplier
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
4
8
12
16
20
24
Time (hr)

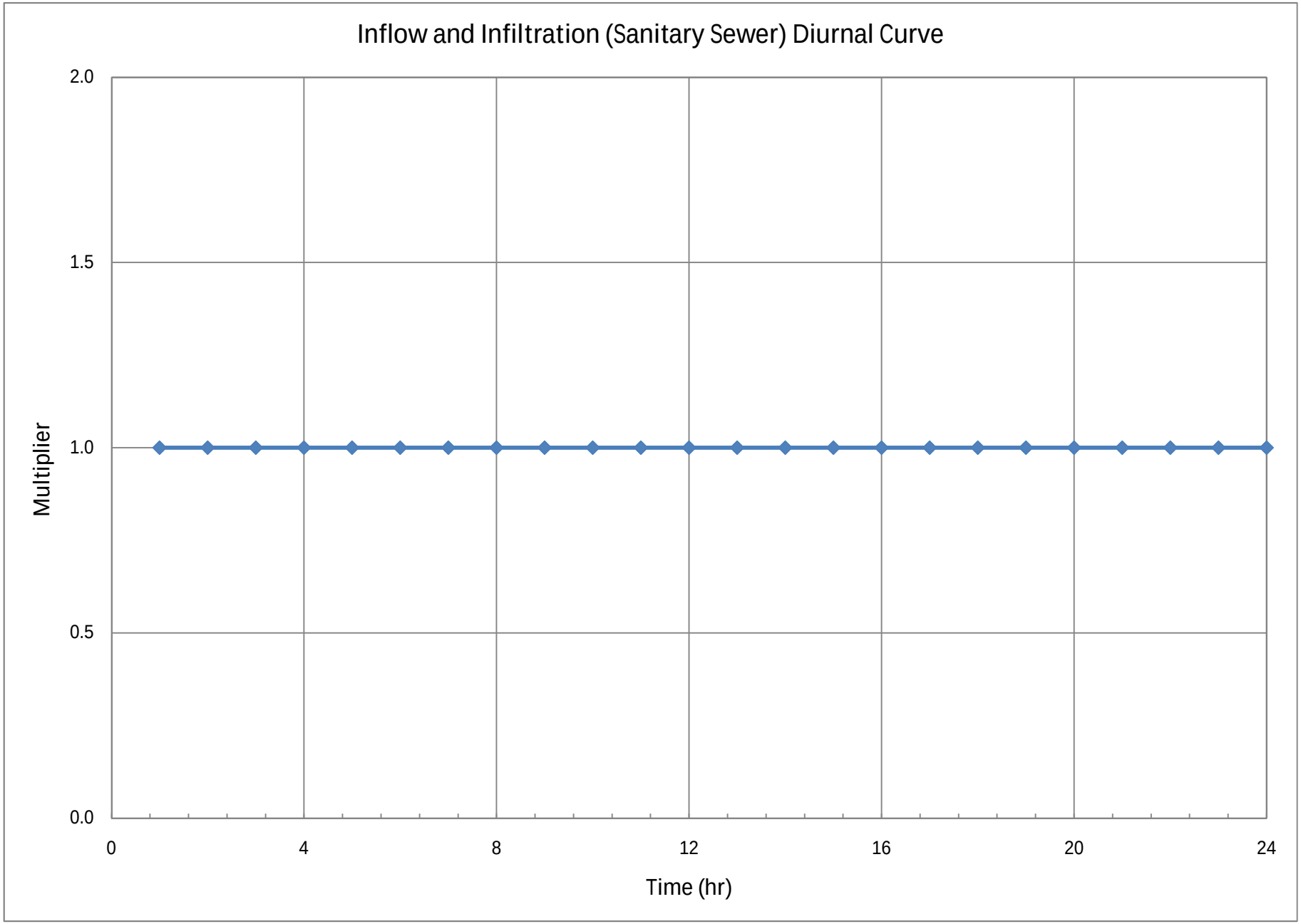
TSAWWASSEN FIRST NATION BULK WATER AND SANITARY TRUNK MASTER PLAN




Institutional Diurnal Curve
Multiplier
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
4
8
12
16
20
24
Time (hr)


Irrigation Diurnal Curve
Multiplier
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
4
8
12
16
20
24
Time (hr)


Non Revenue (Leakage and Unaccounted for Water Use) Diurnal Curve
Multiplier
2.0
1.5
1.0
0.5
0.0
0
4
8
12
16
20
24
Time (hr)


Inflow and Infiltration (Sanitary Sewer) Diurnal Curve
2.0
1.5
1.0
0.5
0.0
Multiplier
0
4
8
12
16
20
24
Time (hr)

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Appendix

Water Model Results

C

JANUARY, 2014

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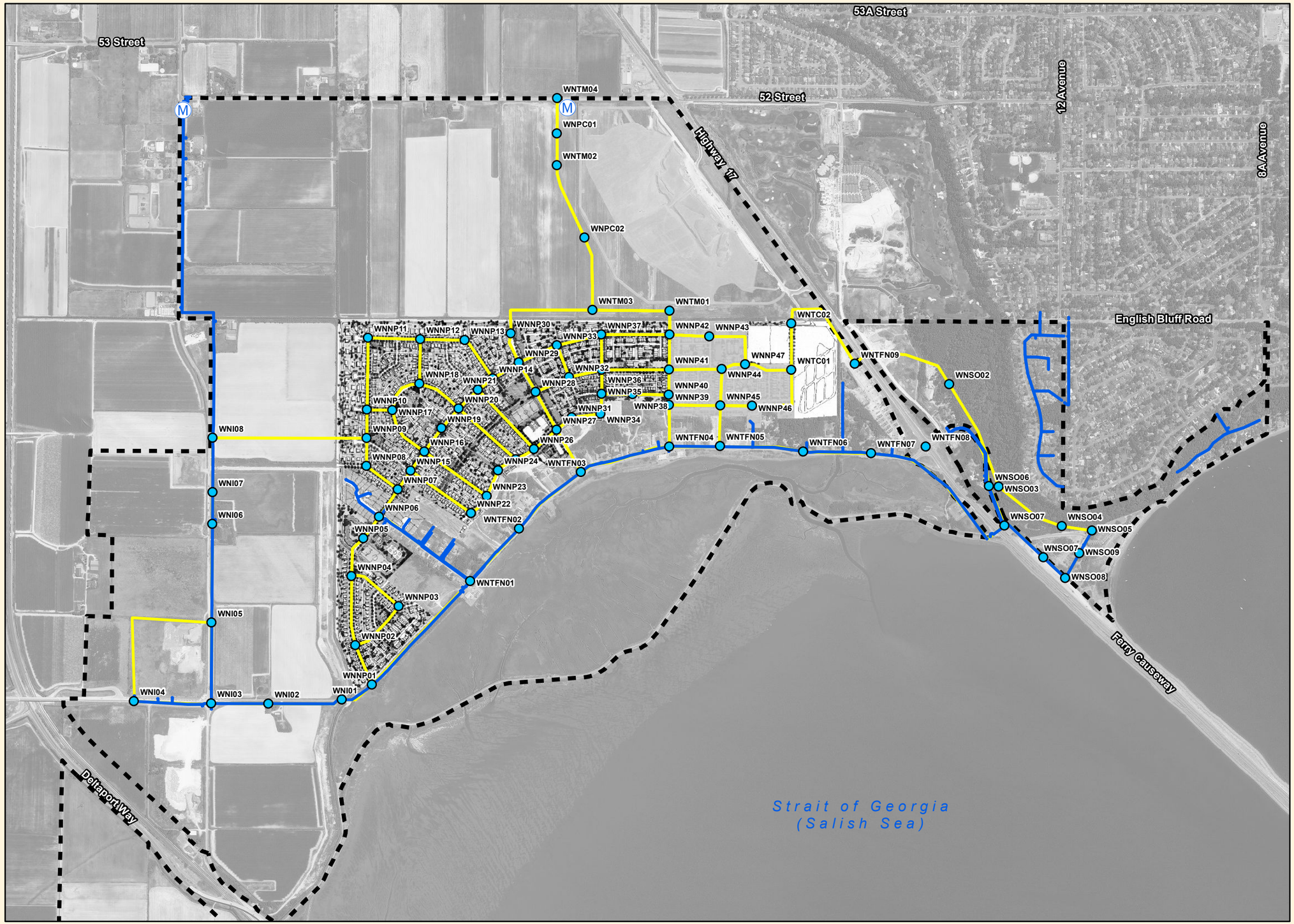

TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Legend

- Meter
- Water Nodes
- Existing Water Main
- Proposed Water Main
- TFN Boundary

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Water Nodes

Figure C1

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure C1 - Water System Nodes.mxd Last revised by: bpauls on 16/01/2014 at 11:28:48 AM

Node ID	Status Quo			Increased Density Status Quo			Increased Water Conservation			Increased Density Increased Water Conservation		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNI01	302	270	275	300	270	271	308	270	274	307	270	271
WNI02	302	270	292	301	270	288	308	270	289	307	270	287
WNI03	302	270	299	301	270	295	308	270	296	308	270	293
WNI04	302	270	280	301	270	277	308	270	281	308	270	279
WNI05	302	270	302	301	270	298	308	270	302	308	270	299
WNI06	303	270	332	302	270	328	309	270	327	308	270	324
WNI07	304	270	342	303	270	338	309	270	338	308	270	334
WNI08	304	270	366	303	270	359	309	270	356	309	270	351
WNNP01	277	170	266	276	170	262	283	170	266	283	170	263
WNNP02	277	70	256	276	70	252	283	70	255	283	70	253
WNNP03	277	70	171	276	70	169	283	70	174	283	70	172
WNNP04	277	70	255	276	70	252	283	70	254	283	70	251
WNNP05	277	170	268	276	170	264	283	170	264	282	170	261
WNNP06	277	70	282	276	70	278	283	70	277	282	70	273
WNNP07	277	70	300	276	70	294	283	70	291	282	70	287
WNNP08	277	70	288	276	70	284	283	70	281	283	70	278
WNNP09	277	70	290	276	70	285	284	70	284	283	70	281
WNNP10	277	70	234	276	70	231	283	70	233	282	70	231
WNNP11	277	70	165	276	70	163	283	70	167	282	70	166
WNNP12	277	70	201	276	70	198	283	70	202	282	70	200
WNNP13	277	70	185	276	70	182	283	70	186	282	70	184
WNNP14	277	70	304	276	70	299	283	70	289	282	70	285
WNNP15	277	70	294	276	70	289	283	70	286	282	70	282
WNNP16	277	170	293	276	170	288	283	170	284	282	170	281
WNNP17	277	170	232	276	170	229	283	170	231	282	170	228

Node ID	Status Quo			Increased Density Status Quo			Increased Water Conservation			Increased Density Increased Water Conservation		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNNP18	277	170	226	276	170	222	283	170	224	282	170	222
WNNP19	277	170	287	276	170	283	283	170	278	282	170	275
WNNP20	277	170	297	276	170	292	283	170	285	282	170	282
WNNP21	277	170	301	276	170	296	283	170	287	282	170	283
WNNP22	277	70	186	276	70	183	283	70	187	282	70	185
WNNP23	277	70	212	276	70	209	283	70	211	282	70	209
WNNP24	277	170	204	276	170	202	283	170	204	282	170	202
WNNP25	277	70	234	276	70	230	283	70	231	282	70	228
WNNP26	277	170	243	276	170	240	283	170	239	282	170	236
WNNP27	277	170	267	276	170	263	283	170	257	282	170	254
WNNP28	277	170	253	276	170	250	283	170	244	282	170	241
WNNP29	277	170	319	276	170	314	283	170	298	282	170	294
WNNP30	277	170	303	276	170	298	283	170	284	283	170	280
WNNP31	277	170	214	276	170	212	283	170	211	282	170	209
WNNP32	277	170	255	276	170	252	283	170	246	282	170	243
WNNP33	277	170	304	276	170	299	283	170	284	282	170	281
WNNP34	277	70	208	276	70	205	283	70	205	282	70	203
WNNP35	277	70	239	276	70	236	283	70	231	282	70	229
WNNP36	277	170	273	276	170	269	283	170	259	282	170	256
WNNP37	277	170	300	276	170	296	283	170	279	282	170	276
WNNP38	277	70	203	275	70	200	283	70	199	282	70	198
WNNP39	277	70	247	275	70	244	283	70	237	282	70	234
WNNP40	277	70	253	275	70	249	283	70	241	282	70	239
WNNP41	277	170	269	276	170	265	283	170	254	282	170	251
WNNP42	277	170	328	276	170	323	283	170	293	282	170	289

Node ID	Status Quo			Increased Density Status Quo			Increased Water Conservation			Increased Density Increased Water Conservation		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNNP43	277	170	310	276	170	305	283	170	274	282	170	271
WNNP44	277	170	247	275	170	244	283	170	233	282	170	231
WNNP45	277	70	249	275	70	246	283	70	236	282	70	234
WNNP46	277	70	187	275	70	185	283	70	183	282	70	181
WNNP47	277	170	292	275	170	287	283	170	260	282	170	257
WNPC01	286	250	504	285	250	504	288	250	489	288	250	486
WNPC02	281	250	427	280	250	421	285	250	360	285	250	356
WNSO02	276	170	210	274	170	208	282	170	201	281	170	199
WNSO03	276	170	187	274	170	185	282	170	183	281	170	181
WNSO04	276	170	180	274	170	177	282	170	177	281	170	175
WNSO05	276	170	181	274	170	179	282	170	178	281	170	176
WNSO06	276	170	185	274	170	183	282	170	182	281	170	180
WNSO07	276	170	183	274	170	181	282	170	180	281	170	178
WNSO07	276	170	176	274	170	173	282	170	173	281	170	172
WNSO08	276	170	174	274	170	172	282	170	172	281	170	170
WNSO09	276	170	174	274	170	172	282	170	172	281	170	170
WNTC01	301	0	222	300	0	222	307	0	222	306	0	222
WNTC02	301	170	252	300	170	248	307	170	231	306	170	229
WNTFN01	301	120	268	300	120	265	308	120	263	307	120	260
WNTFN02	301	120	265	300	120	262	307	120	259	307	120	256
WNTFN03	301	120	289	300	120	285	307	120	277	307	120	274
WNTFN04	301	120	287	300	120	284	307	120	270	306	120	267
WNTFN05	301	70	273	300	70	269	307	70	255	306	70	252
WNTFN06	301	170	230	299	170	227	307	170	223	306	170	221
WNTFN07	300	170	215	299	170	212	307	170	209	306	170	207

Node ID	Status Quo			Increased Density Status Quo			Increased Water Conservation			Increased Density Increased Water Conservation		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNTFN08	300	0	221	299	0	221	307	0	221	306	0	221
WNTFN09	300	70	217	299	70	214	307	70	207	306	70	205
WNTM01	277	250	345	276	250	340	283	250	300	282	250	296
WNTM02	284	250	513	284	250	513	287	250	436	287	250	433
WNTM03	279	250	367	278	250	361	284	250	322	283	250	318
WNTM04	288	250	500	288	250	500	289	250	500	289	250	500

Notes:

4) Available fire flow results are theoretical and do not take into account the flow limitation of fire hydrants. Hydrant spacing for each development should be reviewed to confirm that coverage complies with the latest edition of the Fire Underwriters Survey.

Node ID	Phase 1 Increased Density Status Quo			Phase 2 Increased Density Status Quo			Phase 3 Increased Density Status Quo		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
[1]WNI01	314	270	229	311	270	231	300	270	271
[1]WNI02	314	270	250	311	270	255	301	270	288
[2]WNI03	314	270	268	312	270	279	301	270	295
[2]WNI04	314	270	265	312	270	279	301	270	277
WNI05	314	270	275	312	270	289	301	270	298
WNI06	315	270	302	312	270	327	302	270	328
WNI07	315	270	311	312	270	342	303	270	338
WNI08	315	270	328	312	270	379	303	270	359
WNNP01	290	170	222	287	170	223	276	170	262
WNNP02	(N/A)	70	(N/A)	(N/A)	70	(N/A)	276	70	252
WNNP03	(N/A)	70	(N/A)	(N/A)	70	(N/A)	276	70	169
WNNP04	(N/A)	70	(N/A)	(N/A)	70	(N/A)	276	70	252
WNNP05	(N/A)	170	(N/A)	(N/A)	170	(N/A)	276	170	264
WNNP06	289	70	82	286	70	80	276	70	278
WNNP07	(N/A)	70	(N/A)	285	70	197	276	70	294
WNNP08	(N/A)	70	(N/A)	(N/A)	70	(N/A)	276	70	284
WNNP09	(N/A)	70	(N/A)	287	70	251	276	70	285
WNNP10	(N/A)	70	(N/A)	285	70	243	276	70	231
WNNP11	(N/A)	70	(N/A)	285	70	173	276	70	163
WNNP12	(N/A)	70	(N/A)	285	70	209	276	70	198
WNNP13	(N/A)	70	(N/A)	285	70	192	276	70	182
WNNP14	(N/A)	70	(N/A)	285	70	304	276	70	299
WNNP15	(N/A)	70	(N/A)	285	70	216	276	70	289
WNNP16	(N/A)	170	(N/A)	285	170	240	276	170	288
WNNP17	(N/A)	170	(N/A)	285	170	238	276	170	229
WNNP18	(N/A)	170	(N/A)	285	170	231	276	170	222

Node ID	Phase 1 Increased Density Status Quo			Phase 2 Increased Density Status Quo			Phase 3 Increased Density Status Quo		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNNP19	(N/A)	170	(N/A)	285	170	257	276	170	283
WNNP20	(N/A)	170	(N/A)	285	170	282	276	170	292
WNNP21	(N/A)	170	(N/A)	285	170	295	276	170	296
WNNP22	(N/A)	70	(N/A)	285	70	97	276	70	183
WNNP23	(N/A)	70	(N/A)	(N/A)	70	(N/A)	276	70	209
WNNP24	(N/A)	170	(N/A)	(N/A)	170	(N/A)	276	170	202
WNNP25	(N/A)	70	(N/A)	285	70	199	276	70	230
WNNP26	(N/A)	170	(N/A)	285	170	228	276	170	240
WNNP27	(N/A)	170	(N/A)	285	170	241	276	170	263
WNNP28	(N/A)	170	(N/A)	285	170	260	276	170	250
WNNP29	(N/A)	170	(N/A)	285	170	328	276	170	314
WNNP30	(N/A)	170	(N/A)	285	170	316	276	170	298
WNNP31	(N/A)	170	(N/A)	285	170	214	276	170	212
WNNP32	(N/A)	170	(N/A)	285	170	267	276	170	252
WNNP33	(N/A)	170	(N/A)	285	170	318	276	170	299
WNNP34	(N/A)	70	(N/A)	285	70	216	276	70	205
WNNP35	(N/A)	70	(N/A)	285	70	253	276	70	236
WNNP36	(N/A)	170	(N/A)	285	170	290	276	170	269
WNNP37	(N/A)	170	(N/A)	285	170	319	276	170	296
WNNP38	(N/A)	70	(N/A)	285	70	216	275	70	200
WNNP39	289	70	220	285	70	253	275	70	244
WNNP40	289	70	217	285	70	266	275	70	249
WNNP41	289	170	242	285	170	290	276	170	265
WNNP42	289	170	314	285	170	353	276	170	323
WNNP43	289	170	301	285	170	331	276	170	305
WNNP44	289	170	247	285	170	266	275	170	244

Node ID	Phase 1 Increased Density Status Quo			Phase 2 Increased Density Status Quo			Phase 3 Increased Density Status Quo		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNNP45	289	70	220	285	70	237	275	70	246
WNNP46	289	70	135	285	70	137	275	70	185
WNNP47	289	170	282	285	170	307	275	170	287
WNPC01	290	250	504	289	250	504	285	250	504
WNPC02	289	250	419	287	250	449	280	250	421
WNSO02	(N/A)	170	(N/A)	(N/A)	170	(N/A)	274	170	208
WNSO03	(N/A)	170	(N/A)	(N/A)	170	(N/A)	274	170	185
WNSO04	(N/A)	170	(N/A)	(N/A)	170	(N/A)	274	170	177
[3]WNSO05	288	170	98	285	170	97	274	170	179
[3]WNSO06	288	170	87	285	170	87	274	170	183
[3]WNSO07	288	170	110	285	170	110	274	170	181
[3]WNSO07	288	170	104	285	170	104	274	170	173
[3]WNSO08	288	170	101	285	170	101	274	170	172
[3]WNSO09	288	170	98	285	170	98	274	170	172
WNTC01	(N/A)	0	(N/A)	(N/A)	0	(N/A)	300	0	222
WNTC02	(N/A)	170	(N/A)	(N/A)	170	(N/A)	300	170	248
WNTFN01	314	120	200	310	120	199	300	120	265
WNTFN02	313	120	214	310	120	214	300	120	262
WNTFN03	313	120	225	310	120	230	300	120	285
WNTFN04	313	120	222	310	120	237	300	120	284
WNTFN05	313	70	207	310	70	218	300	70	269
[3]WNTFN06	313	170	162	309	170	166	299	170	227
[3]WNTFN07	313	170	143	309	170	144	299	170	212
WNTFN08	313	0	196	309	0	200	299	0	221
WNTFN09	(N/A)	70	(N/A)	(N/A)	70	(N/A)	299	70	214

Node ID	Phase 1 Increased Density Status Quo			Phase 2 Increased Density Status Quo			Phase 3 Increased Density Status Quo		
	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)	Peak Hour Pressure (kPa)	Required Fire Flow (L/s)	Available Fire Flow (L/s)
WNTM01	289	250	336	285	250	369	276	250	340
WNTM02	290	250	513	288	250	513	284	250	513
WNTM03	289	250	359	286	250	390	278	250	361
WNTM04	290	250	500	290	250	500	288	250	500

Notes:

1) These areas of the industrial lands are projected for construction in Phase 3. The required fire flow should be available when Phase 3 is constructed

2) These areas of the industrial lands are projected for construction in Phase 1. The available fire flow is generally achieved in these areas

3) The areas are projected to be constructed in Phase 3. The required fire flows in these area will not be achieved until Phase 3 is constructed.

4) Available fire flow results are theoretical and do not take into account the flow limitation of fire hydrants. Hydrant spacing for each development should be reviewed to confirm that coverage complies with the latest edition of the Fire Underwriters Survey.

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Appendix

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Sanitary Model Results

JANUARY, 2014

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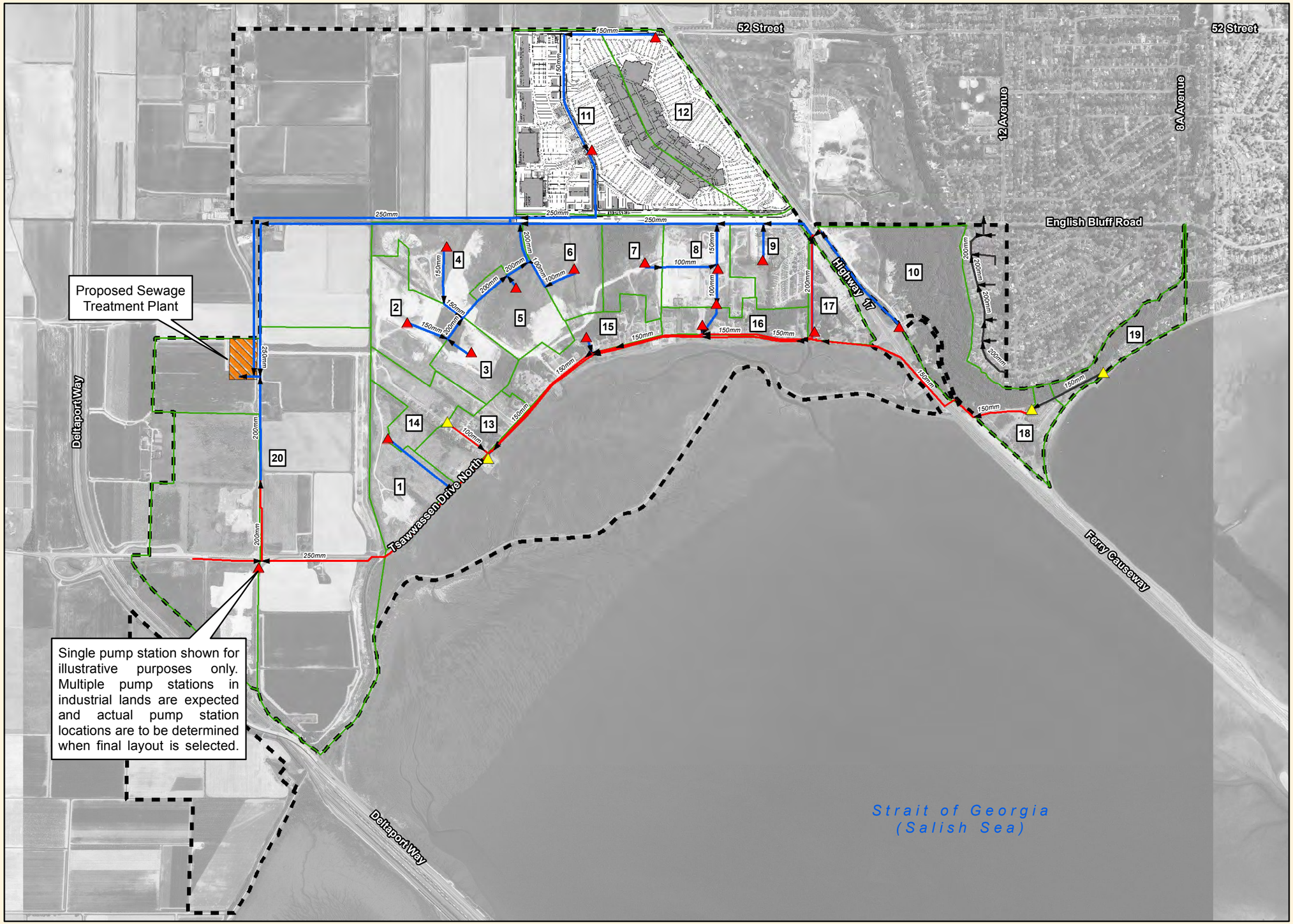

TSAWWASSEN FIRST NATION
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Legend

- Proposed Sanitary Lift Station
- Existing Sanitary Lift Station
- Meter
- Existing Forcemain
- Sanitary Gravity Main
- Proposed Sanitary Force Main
- TFN Boundary
- Catchment Boundaries
- 1 Sanitary Catchment ID

Note: Orthophoto taken on July 31, 2013

TFN Bulk Water & Sanitary Trunk Master Plan

Sanitary Lift Stations

Figure D-1

0 125 250 500
Meters

U:\Projects_VAN\2177\0043\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\FINAL TFN Water and Sanitary Master Plan Figures\Figure D-1 - Sanitary Lift Stations.mxd Last revised by: bpauls on 04/02/2014 at 2:37:24 PM

PUMP STATION RESULTS SUMMARY - PHASE 1

Pump Station ID	Area Serviced	High Density Status Quo Design Flow (L/s)	High Density Status Quo		Pump Model	VFD
			Min TDH (m)	Max TDH (m)		
1	NP	-	-	-	-	-
2	NP	-	-	-	-	-
3	NP	-	-	-	-	-
4	NP	-	-	-	-	-
5	NP	-	-	-	-	-
6	NP	-	-	-	-	-
7	NP	-	-	-	-	-
8	NP	9.59	25.0	30.9	NP 3127 SH 248	Y
9	NP	-	-	-	-	-
10	S. Of Hwy 17	-	-	-	-	-
11	Commercial	38.25	25.6	29.1	NP 3171 HT 270	Y
12	Commercial	20.69	30.0	37.7	NP 3153 SH 275	Y
13 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
14 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
15	TFN Community	-	-	-	-	-
16	TFN Community	-	-	-	-	-
17	TFN Community	-	-	-	-	-
18	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
19 Existing	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
20***	Industrial Lands	30.07	19.5	34.9	NP 3171 SH 278	Y

*Based on the minimum cleansing velocity of 0.9m/s

**Based on the minimum cleansing velocity of 0.9m/s in the existing 200mm dia. forcemain

***As the layout of the industrial lands is unknown at this time, we have modeled this area using a single pump station. The pump model for the industrial lands shown in the table above has been estimated using the assumption that 7 pump stations will be installed in the industrial lands. The actual pump station model will have to be confirmed once the industrial lands layout is confirmed.

PUMP STATION RESULTS SUMMARY - PHASE 2

Pump Station ID	Area Serviced	High Density Status Quo Design Flow (L/s)	High Density Status Quo		Pump Model	VFD
			Min TDH (m)	Max TDH (m)		
1	NP	-	-	-	-	-
2	NP	11.03	22.6	38.9	NP 3153 SH 276	Y
3	NP	7.3*	23.9	39.3	NP 3127 SH 248	Y
4	NP	13.24	25.6	40.0	NP 3153 SH 275	Y
5	NP	7.3*	19.1	36.0	NP 3127 SH 248	Y
6	NP	8.67	27.4	37.6	NP 3127 SH 248	Y
7	NP	7.3*	30.3	38.2	NP 3127 SH 248	Y
8	NP	9.59	19.0	34.0	NP 3127 SH 248	Y
9	NP	-	-	-	NP 3127 SH 249	Y
10	S. Of Hwy 17	-	-	-	NP 3171 SH 278	Y
11	Commercial	38.25	19.4	26.2	NP 3171 HT 270	Y
12	Commercial	20.69	30.0	36.2	NP 3153 SH 275	Y
13 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
14 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
15	TFN Community	-	-	-	-	-
16	TFN Community	-	-	-	-	-
17	TFN Community	-	-	-	-	-
18	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
19 Existing	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
20***	Industrial Lands	30.07	19.5	34.8	NP 3171 SH 278	Y

*Based on the minimum cleansing velocity of 0.9m/s

**Based on the minimum cleansing velocity of 0.9m/s in the existing 200mm dia. forcemain

***As the layout of the industrial lands is unknown at this time, we have modeled this area using a single pump station. The pump model for the industrial lands shown in the table above has been estimated using the assumption that 7 pump stations will be installed in the industrial lands. The actual pump station model will have to be confirmed once the industrial lands layout is confirmed.

PUMP STATION RESULTS SUMMARY - PHASE 3

Pump Station ID	Area Serviced	High Density Status Quo Design Flow (L/s)	High Density Status Quo		Pump Model	VFD
			Min TDH (m)	Max TDH (m)		
1	NP	9.8	32.8	44.1	NP 3153 SH 276	Y
2	NP	11.03	24.8	41.1	NP 3153 SH 276	Y
3	NP	7.3*	23.9	41.4	NP 3127 SH 248	Y
4	NP	13.24	25.6	42.2	NP 3153 SH 275	Y
5	NP	7.3*	19.1	39.0	NP 3127 SH 248	Y
6	NP	8.67	27.6	40.0	NP 3127 SH 248	Y
7	NP	7.3*	30.5	41.7	NP 3127 SH 248	Y
8	NP	9.59	19.2	39.8	NP 3127 SH 248	Y
9	NP	7.3*	23.8	38.5	NP 3127 SH 249	Y
10	S. Of Hwy 17	20.13	30.3	44.7	NP 3171 SH 278	Y
11	Commercial	38.25	25.6	29.2	NP 3171 HT 270	Y
12	Commercial	20.69	30.0	37.8	NP 3153 SH 275	Y
13 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
14 Existing	TFN Community	-	-	-	Existing Pump Station Remains	-
15	TFN Community	7.3*	24.1	42.9	NP 3127 SH 249	Y
16	TFN Community	7.3*	30.5	43.2	NP 3127 SH 249	Y
17	TFN Community	29.4**	25.6	42.1	NP 3153 SH 275	Y
18	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
19 Existing	S. Of Hwy 17	-	-	-	Existing Pump Station Remains	-
20***	Industrial Lands	30.07	19.1	36.7	NP 3171 SH 278	Y

*Based on the minimum cleansing velocity of 0.9m/s

**Based on the minimum cleansing velocity of 0.9m/s in the existing 200mm dia. forcemain

***As the layout of the industrial lands is unknown at this time, we have modeled this area using a single pump station. The pump model for the industrial lands shown in the table above has been estimated using the assumption that 7 pump stations will be installed in the industrial lands. The actual pump station model will have to be confirmed once the industrial lands layout is confirmed.

Appendix

Capital Cost Estimates

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JANUARY, 2014

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TSAWWASSEN FIRST NATION
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TFN Bulk Water
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Master Plan

CONSTRUCTION COST ESTIMATE

Phase 1 - Water System High Density Status Quo

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Watermain (Category 2)**							
1.1	200mm dia. PVC and Smaller	l.m	1,290	$440	$567,600			
							$567,600	
2.0	**Watermain (Category 1)**							
2.1	300mm dia. PVC	l.m	0	$490	$0			
2.2	350mm dia. PVC	l.m	0	$560	$0			
2.3	400mm dia. PVC	l.m	2,140	$650	$1,391,000			
2.4	Connection to Metro Vancouver	ea.	1	$500,000	$500,000			
						$1,891,000		
3.0	**Communication (Category 1)**							
3.1	Fixed Base Radio Tower and Software	ea.	1	$100,000	$100,000			
						$100,000		
Subtotal Construction						$1,991,000	$567,600	
Engineering and Contingency (35% of Construction)						$696,850	$198,660	
TOTAL COST (ROUNDED)						$2,688,000	$767,000	$3,455,000

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.
3. Water meter chamber, setter and meter costs are assumed to be the responsibility of the developer and are not included in the above costs.

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CONSTRUCTION COST ESTIMATE
Phase 2 - Water System High Density Status Quo

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Watermain (Category 2)**							
1.1	200mm dia. PVC	l.m	4,550	$440	$2,002,000			
							$2,002,000	
2.0	**Watermain (Category 1)**							
2.1	250mm dia. PVC	l.m	0	$460	$0			
2.2	300mm dia. PVC	l.m	2,300	$490	$1,127,000			
2.3	350mm dia. PVC	l.m	0	$560	$0			
2.4	400mm dia. PVC	l.m	0	$650	$0			
						$1,127,000		
Subtotal Construction						$1,127,000	$2,002,000	
Engineering and Contingency (35% of Construction)						$394,450	$700,700	
TOTAL COST (ROUNDED)						$1,522,000	$2,703,000	$4,225,000

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.
3. Water meter chamber, setter and meter costs are assumed to be the responsibility of the developer and are not included in the above costs.

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CONSTRUCTION COST ESTIMATE

Phase 3 - Water System High Density Status Quo

USL File:	**2177.0043.01**
Date:	**2014-01-14**
This Estimate is Class:	**D**

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Watermain (Category 2)**							
1.1	200mm dia. PVC	l.m	1,260	$440	$554,400			
							$554,400	
2.0	**Watermain (Category 1)**							
2.1	300mm dia. PVC	l.m	1,040	$490	$509,600			
2.2	350mm dia. PVC	l.m		$560	$0			
2.3	400mm dia. PVC	l.m	1,850	$650	$1,202,500			
						$1,712,100		
Subtotal Construction						$1,712,100	$554,400	
Engineering and Contingency (35% of Construction)						$599,235	$194,040	
TOTAL COST (ROUNDED)						$2,312,000	$749,000	$3,061,000

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.
3. Water meter chamber, setter and meter costs are assumed to be the responsibility of the developer and are not included in the above costs.

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CONSTRUCTION COST ESTIMATE

Phase 1 - Sanitary System High Density Status Quo

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Proposed Sanitary Forcemain (Category 2)**							
1.1	100mm dia. PVC	l.m	590	$200.00	$118,000.00			
1.2	150mm dia. PVC	l.m	935	$230.00	$215,050.00			
1.3	150mm dia. PVC (to service industrial lands pump stations)	l.m	300	$230.00	$69,000.00			
							$402,050.00	
2.0	**Proposed Sanitary Forcemain (Category 1)**							
2.1	150mm dia. PVC	l.m	200	$230.00	$46,000.00			
2.2	250mm dia. PVC	l.m	2,300	$290.00	$667,000.00			
						$713,000.00		
3.0	**Proposed Sanitary Pump Stations (Category 1)**							
3.1	SCADA Upgrade	LS	1	$10,000.00	$10,000.00			
						$10,000.00		
4.0	**Proposed Sanitary Pump Stations (Category 2)**							
4.1	SPS 8	ea.	1	$355,000.00	$355,000.00			
4.2	SPS 11	ea.	1	$402,000.00	$402,000.00			
4.3	SPS 12	ea.	1	$363,000.00	$363,000.00			
4.4	SPS INDUSTRIAL LAND	ea.	2	$373,000.00	$746,000.00			
							$1,866,000.00	
Subtotal Construction						$723,000.00	$2,268,050.00	
Engineering and Contingency (35% of Construction)						$253,050.00	$793,817.50	
TOTAL COST (ROUNDED)						$977,000.00	$3,062,000.00	$4,039,000.00

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.

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CONSTRUCTION COST ESTIMATE

Phase 2 - Sanitary System High Density Status Quo

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Proposed Sanitary Forcemain (Category 2)**							
1.1	100mm dia. PVC	l.m	550	$200.00	$110,000.00			
1.2	150mm dia. PVC	l.m	596	$230.00	$137,080.00			
1.3	250mm dia. PVC	l.m	0	$290.00	$0.00			
							$247,080.00	
2.0	**Proposed Sanitary Forcemain (Category 1)**							
2.1	150mm dia. PVC	l.m	0	$230.00	$0.00			
2.2	200mm dia. PVC	l.m	1,500	$270.00	$405,000.00			
2.3	250mm dia. PVC	l.m	1,690	$290.00	$490,100.00			
						$895,100.00		
3.0	**Proposed Sanitary Pump Stations (Category 2)**							
3.1	SPS 2	ea.	1	$363,000.00	$363,000.00			
3.2	SPS 3	ea.	1	$363,000.00	$363,000.00			
3.3	SPS 4	ea.	1	$324,000.00	$324,000.00			
3.4	SPS 5	ea.	1	$355,000.00	$355,000.00			
3.5	SPS 6	ea.	1	$355,000.00	$355,000.00			
3.6	SPS 7	ea.	1	$355,000.00	$355,000.00			
							$2,115,000.00	
Subtotal Construction						$895,100.00	$2,362,080.00	
Engineering and Contingency (35% of Construction)						$313,285.00	$826,728.00	
TOTAL COST (ROUNDED)						$1,209,000.00	$3,189,000.00	$4,398,000.00

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.

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CONSTRUCTION COST ESTIMATE

Phase 3 - Sanitary System High Density Status Quo

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	CATEGORY 1 TOTAL	CATEGORY 2 TOTAL	TOTAL
1.0	**Proposed Sanitary Forcemain (Category 2)**							
1.1	100mm dia. PVC	l.m	735	$200.00	$147,000.00			
1.2	150mm dia. PVC	l.m	560	$230.00	$128,800.00			
1.3	200mm dia. PVC	l.m	0	$270.00	$0.00			
1.4	150mm dia. PVC (to service industrial lands pump stations)	l.m	700	$230.00	$161,000.00			
							$436,800.00	
2.0	**Proposed Sanitary Forcemain (Category 1)**							
2.1	200mm dia. PVC	l.m	430	$270.00	$116,100.00			
						$116,100.00		
3.0	**Proposed Sanitary Pump Stations (Category 2)**							
3.1	SPS 1	ea.	1	$363,000.00	$363,000.00			
3.2	SPS 9	ea.	1	$355,000.00	$355,000.00			
3.3	SPS 10	ea.	1	$386,000.00	$386,000.00			
3.4	SPS 15	ea.	1	$357,000.00	$357,000.00			
3.5	SPS 16	ea.	1	$355,000.00	$355,000.00			
3.6	SPS 17	ea.	1	$363,000.00	$363,000.00			
3.7	SPS INDUSTRIAL LAND	ea.	5	$373,000.00	$1,865,000.00			
							$4,044,000.00	
Subtotal Construction						$116,100.00	$4,480,800.00	
Engineering and Contingency (35% of Construction)						$40,635.00	$1,568,280.00	
TOTAL COST (ROUNDED)						$157,000.00	$6,050,000.00	$6,207,000.00

NOTES

1. Cost of pipework does not include any pavement restoration since works are expected to be constructed outside of currently paved roads.
2. Costs do not include any permit, RoW or land acquisition costs.

Appendix

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Operations and Maintenance Cost Estimates

JANUARY, 2014

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TFN Bulk Water
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ANNUAL OPERATIONS AND MAINTENANCE COST ESTIMATE
Phase 1

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	WATER	SANITARY
1.0	**Phase 1**						
1.1	Sanitary Pump Stations Fixed Costs (w/ genset) (excluding existing)	ea	5	$12,820.00	$64,100		$64,100
1.2	Sanitary Pump Stations Electrical (excluding existing)	kWh	240,000	$0.10	$24,000		$24,000
1.3	Sanitary Force Main (excluding existing)	m	4,325	$3.20	$13,840		$13,840
1.4	Water Distribution Main (excluding existing)	m	3,430	$3.20	$10,976	$10,976	
Subtotal Construction						$10,976	$101,940
Administration + Contingency (30%)						$3,293	$30,582
TOTAL COST (ROUNDED)						$15,000	$133,000

NOTES

Estimate does not include local distribution system, gravity collection system, hydrants or water meter maintenance.

TSAWWASSEN FIRST NATION
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ANNUAL OPERATIONS AND MAINTENANCE COST ESTIMATE
Phase 2

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	WATER	SANITARY
1.0	**Phase 2**						
1.1	Sanitary Pump Stations Fixed Costs (w/ genset) (excluding existing)	ea	11	$12,820.00	$141,020		$141,020
1.2	Sanitary Pump Stations Electrical (excluding existing)	kWh	437,000	$0.10	$43,700		$43,700
1.3	Sanitary Force Main (excluding existing)	m	8,661	$3.20	$27,715		$27,715
1.4	Water Distribution Main (excluding existing)	m	10,280	$3.20	$32,896	$32,896	
Subtotal Construction						$32,896	$212,435
Administration + Contingency (30%)						$9,869	$63,731
TOTAL COST (ROUNDED)						$43,000	$277,000

NOTES

Estimate does not include local distribution system, gravity collection system, hydrants or water meter maintenance.

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TFN Bulk Water
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Master Plan

ANNUAL OPERATIONS AND MAINTENANCE COST ESTIMATE
Phase 3

USL File: 2177.0043.01
Date: 2014-01-14
This Estimate is Class: D

COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	WATER	SANITARY
1.0	**Phase 3**						
1.1	Sanitary Pump Stations Fixed Costs (w/ genset) (excluding existing)	ea	22	$12,820.00	$282,040		$282,040
1.2	Sanitary Pump Stations Electrical (excluding existing)	kWh	850,000	$0.10	$85,000		$85,000
1.3	Sanitary Force Main (excluding existing)	m	11,086	$3.20	$35,475		$35,475
1.4	Water Distribution Main (excluding existing)	m	14,430	$3.20	$46,176	$46,176	
1.5	O&M Credit for Removal of Existing 14 Pump Stations	LS	1	-$50,000.00	-$50,000		-$50,000
Subtotal Construction						$46,176	$352,515
Administration + Contingency (30%)						$13,853	$105,755
TOTAL COST (ROUNDED)						$61,000	$459,000

NOTES

Estimate does not include local distribution system, gravity collection system, hydrants or water meter maintenance.