TOWN OF FORT FRANCES

East End Sanitary Sewer Study

Final Report

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October 2, 2017 H-354684

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October 2, 2017 H-354684

Town of Fort Frances
320 Portage Ave
Fort Frances ON P9A 3P9

Attention: Travis Rob

Subject: East End Sanitary Sewer Study

The following is our report on the review of the sanitary sewer system in the south easterly portion of the Town (Church Street, Nelson Street, Minnie Avenue, Williams Avenue area) with respect to flooding which occurred during the major rainstorm event in June of 2014.

During the field review we did not identify any significant sources of direct inflow into the sanitary sewer system but did note some field conditions that contributed to a back-up in the Church Street Pumping Station drainage shed. The flow data and flooding that occurred suggests that the White Pine and Church Street Pumping Stations were simply overwhelmed by the flow and the most probable source was through the weeping tile in the residences and businesses.

Minor remedial work in manholes on Minnie Avenue will isolate the Church Street Pumping Station drainage shed from the rest of the system to help protect the area. However issues still exist with the Scott Street sewer and White Pine Pumping Station that require further review. Until these are resolved it will still be necessary to implement by-pass pumping during heavy rainfall events.

We thank you for the opportunity to be involved in this Study and will be pleased to discuss the report further with you at your convenience.

Yours truly,

Rob Marasco
Principal Project Manager

Gerald Buckrell, P. Eng.
Senior Project Engineer

GB:ks

Cc

Encl.

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1. Introduction

Between June 12 and June 15, 2014, the Fort Frances area experienced a significant rainfall event which resulted in flooding in the sanitary sewer system and some basements in the Church Street, William Avenue, Nelson Street and Minnie Avenue area as well as other areas of Town. To alleviate the flooding in the Church Street area the town staff setup temporary pumps at Church Street and Minnie Avenue and First Street East and Minnie Avenue to pump from the sanitary sewer into the adjacent storm sewers. This temporary pumping was effective in lowering the water level in the sanitary sewer to eliminate the flooding. By-pass pumping was also done adjacent to the overpass on Colonization Road East.

The homes that experienced flooding were predominantly in the area served by the Church Street pumping station. Additional development is being contemplated in this area and the Town initiated this Study to look at the area, try to determine the causes of the flooding and suggest remedial work to eliminate the causes or deal with the additional flow.

Drawing A1-354684-D1 illustrates the locations of the Church Street and White Pine Pumping Stations and their respective drainage areas.

2. Scope of Work

The scope of work proposed for the study was to:

- Review recent CCTV reports for the sewers in the area.
- Review pumping station and rainfall records.
- Conduct a visual survey of the Church Street area including sewer manholes to look for obvious signs of inflow (i.e. manholes in drainage paths, possible downspout connections, sinkholes).
- Carry out home inspections and discuss flood related issues with the homeowners (sump pump discharges, check valves, flood experience).
- Analyse flow data from the pumping stations to try to characterize the excess flow as inflow or infiltration.
- Identify deficiencies and problem areas.
- Make recommendations on remedial work to help alleviate sanitary sewer flooding in the study area.

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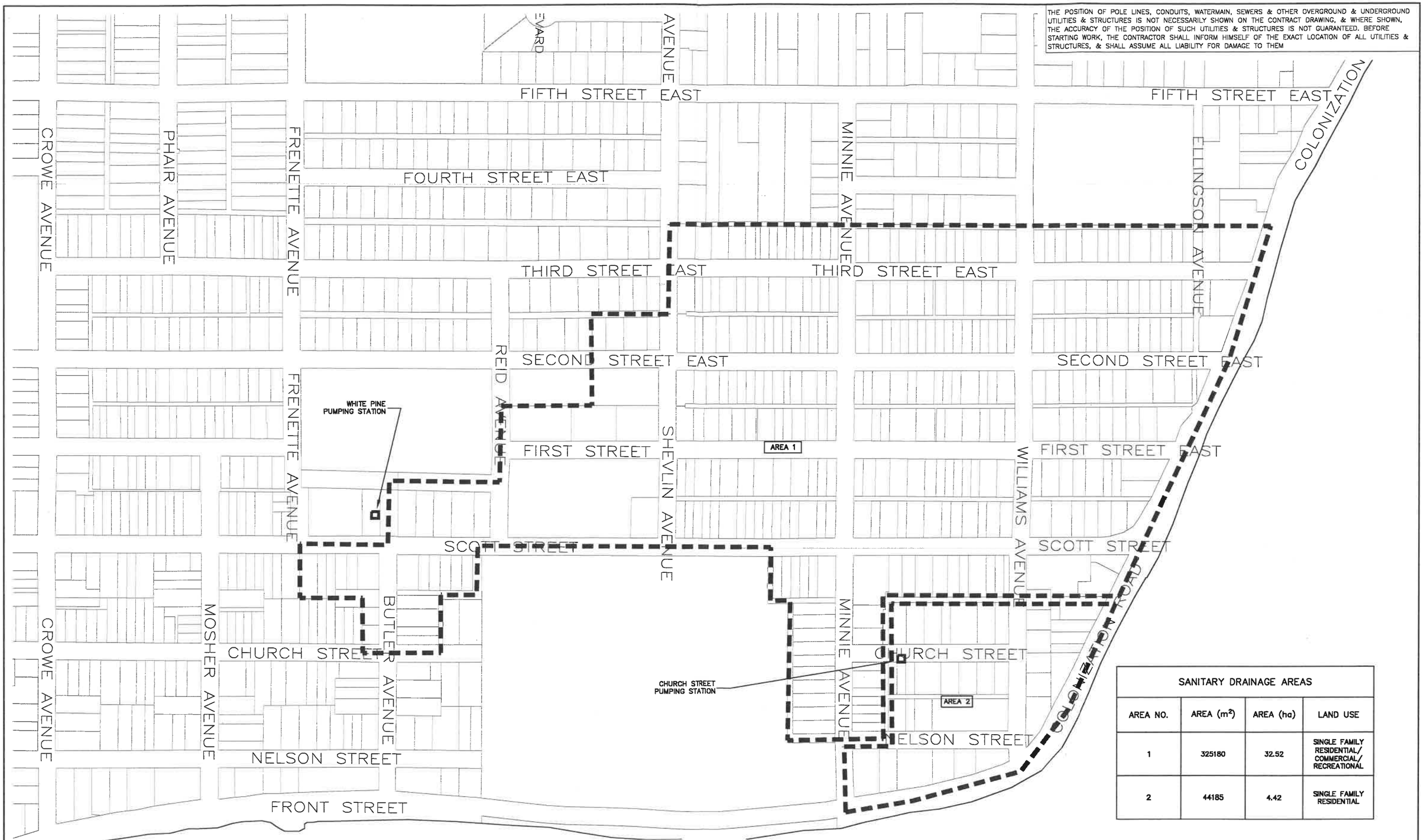
THE POSITION OF POLE LINES, CONDUITS, WATERMAIN, SEWERS & OTHER OVERGROUND & UNDERGROUND UTILITIES & STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWING, & WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES & STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL UTILITIES & STRUCTURES, & SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM



SANITARY DRAINAGE AREAS			
AREA NO.	AREA (m^2)	AREA (ha)	LAND USE
1	325180	32.52	SINGLE FAMILY RESIDENTIAL/ COMMERCIAL/ RECREATIONAL
2	44185	4.42	SINGLE FAMILY RESIDENTIAL

—PROPOSED STORM SEWER
—PROPOSED STORM MANHOLE
—PROPOSED STORM CB
—DRAINAGE AREAS
—EXISTING STORM SEWER
—EXISTING STORM MANHOLE
—EXISTING STORM CB

No.	Revision	Date	Initial
B	ISSUED FOR FINAL REPORT	09/29/17	CM/GB
A	ISSUED FOR 1ST CLIENT REVIEW	.	.

Approved

DRAINAGE PLAN

WHITE PINE LIFT STATION AND CHURCH STREET LIFT STATION

TOWN OF FORT FRANCES

EAST END SANITARY SEWER STUDY

HATCH

Scale NTS

Drawn By CM
Ckd. By GB

Date SEPTEMBER 2017

Dwg. No. A1-354684-D1

Rev. B

Created: Mar 07' 2017 - 5:22pm
Last Saved: Sep 29' 2017 - 10:53am
Plotted: Sep 29' 2017 - 11:13am
Drawing file: C:\pwworking\hi\mcca861915\d0209534\A1-354684-D1.dwg

3. Analysis

3.1 Chronology

The first storm event started around 8:30 pm on June 11, 2014 and continued intermittently until 1:00 pm on June 12, 2014. A total of 5.6" (142 mm) of rain fell during this period.

Reports of basement flooding in the Church Street, Minnie Avenue, Nelson Street area began to come in and the Public Works Department setup one pump at the intersection of Minnie Avenue and Nelson Street to pump from the sanitary sewer into the storm sewer. This was not having much effect so a second pump was setup at 2:36 pm. This was still not having a significant effect so a third pump was setup at First Street East and Minnie Avenue at 5:58 pm. This was having a very positive effect so one pump at Minnie Avenue and Nelson Street was shut down at 6:30 pm and the second pump at 10:00 pm. The pump at Minnie Avenue and First Street East operated over night and was shut down at 8:40 am on the morning of June 13, 2014. An estimated volume of 2276 cubic metres was pumped from the sanitary sewer into the storm sewer during this period. **Figure 1** shows the by-pass pumping locations.

Rain started again around midnight on June 13, 2014 and continued until 4:00 pm on June 15, 2014. A total of 4.7 inches (119 mm) of rain fell during this period. Temporary by-pass pumps were again setup at Church Street and Minnie Avenue at 1:47 pm and First Street East and Minnie Avenue at 2:17 pm on June 15, 2014. The Church Street pump was shut down at 5:53 pm on June 15, 2014 and the pump at First Street East and Minnie Avenue continued to operate until 4:05 pm on June 16, 2014. The volume of sewage pumped during the period was estimated to be 2051 m^3.

The chronology on the following page provides a more detailed breakdown of the rainfall and the pumping installations and a bar chart illustrates the rainfall pattern for the 5-day period. There were essentially two rainfall events separated by 35 hours with no rainfall. At the time, it was not clear why the pumping was so much more effective at the Minnie Avenue and First Street East location and a review of this is part of this Study. By-pass pumping was also implemented near the Mill Road overpass on the sewer from Couchiching First Nation during this period to relieve flooding in other parts of the sanitary sewer system.

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Storm Chronology

Date	Time	Detail
June 11, 2014	2038-2055 2243-2355	0.76” rain 1.1” rain
June 12, 2014	0155-0555 0613-0755 0955-1255 1255-2400 1255 1436 1758 1830 2200	2.01” rain 1.07” rain 0.62” rain No rain One bypass pump in service at Minnie & Nelson Second pump in service at Minnie & Nelson One pump in service at Minnie & First Shut off one pump at Minnie & Nelson Shut off second pump at Minnie & Nelson
June 13, 2014	0000-2400 0840	No rain Shut off pump at Minnie & First (volume pumped 2226 m^3)
June 14, 2014	0000-1916 1916-1955 2000-2100 2100-2400	0.65” rain 0.49” rain 0.29” rain 0.48” rain
June 15, 2014	0000-0900 0900-1055 1055-1200 1200-1255 1255-1355 1347 1417 1355-1731 1733 1731-2400	0.11” rain 0.82” rain 1.32” rain 0.28” rain 0.07” rain Set up one pump at Church & Minnie Set up one pump at First & Minnie 0.22” rain Shut down pump at Church & Minnie 0.02” rain
June 16, 2014	000-1555 1605 1555-2400	No rain Shut down pump at First & Minnie (volume pumped 2015 m^3) No rain

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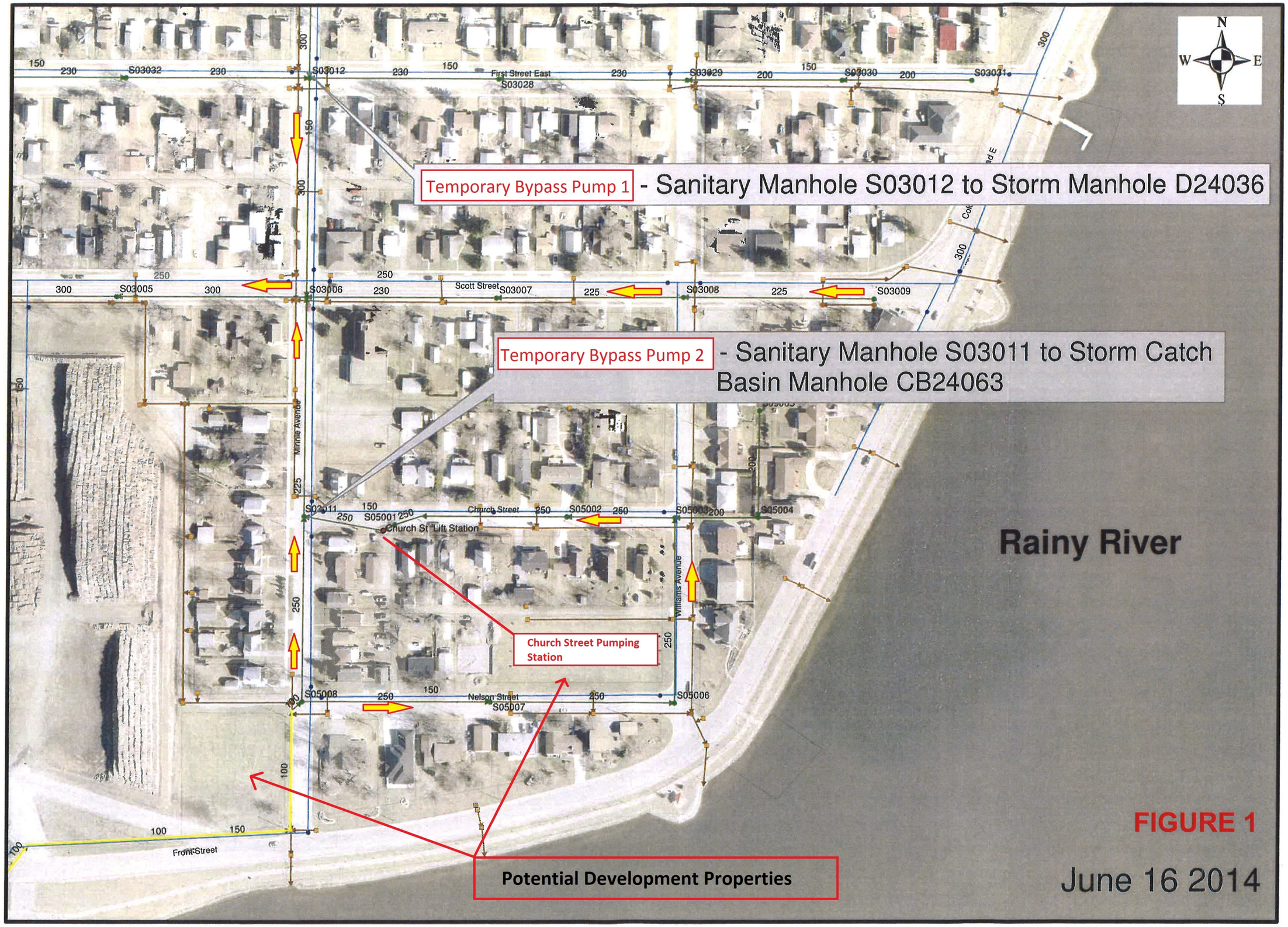

FIGURE 1

June 16 2014

3.2 Review of CCTV Inspection Video

The Town of Fort Frances had completed CCTV inspections of some of the sanitary sewers in the area and these were reviewed to determine whether there are any conditions that might contribute to high flows.

- Scott Street from Minnie Avenue to Butler Avenue June 2015
- Nelson Street from Minnie Avenue to Williams Avenue June 2013
- Church Street from Minnie Avenue to Williams Avenue June 2013
- Minnie Avenue from Scott Street to Nelson Street June 2013
- Williams Avenue from Church Street to Nelson Street June 2013
- Easement east of Williams Avenue at Church Street June 2013

There were no conditions in these videos that indicated a significant potential for infiltration. There were several locations with calcified joints and minor drips and trickles but overall the system appeared quite tight.

3.3 Visual Survey

A visual survey of the area was done to look for possible sources of inflow into the sewer system. These would include manhole covers sitting in areas that might flood during a storm, potential downspout connections and sink holes. This survey also included a check of the manholes to look for leaks or other deficiencies.

Most manholes are located in the roadway where potential for inflow is minimal. The following issues were noted.

MH S05001 (adjacent to the Church Street to Pumping Station) is located in the gutter line and water was observed flowing into the lift holes during the inspection. The inflow is not significant in volume but consideration should be given to changing the cover to a waterproof style.

MH S05004 (east of Williams Avenue along the extension of Church Street) appears to be under a garden shed so could not be evaluated.

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MH S05003 (Church Street and Williams Avenue) a significant flow was observed in this manhole coming from the east (from direction of MH S05004). There was a no video of this run of sewer. The video that was identified for this in the information package was for another unknown location. The proper video should be located and reviewed or re-televised to try to determine the source of the flow.

MH S03011 (Church Street and Minnie Avenue) is the discharge point for the overflow pipe and forcemain from the Church Street pumping station. The slope of the sewer on Minnie Avenue is quite flat here and, during the inspection, we noted that the discharge from the pump was flowing south as well as north. The overflow pipe is located very close to the bottom of the manhole.

Under normal conditions these conditions are not an issue. However, during high flows if there is any backup or surcharge in the pipe on Minnie Avenue between Church Street and Scott Street, there could be back flow into the Church Street pumping station. This would result in pumped flow from the station essentially going around in a circle and potentially cause flooding in the Church Street Pumping Station drainage shed. Consideration should be given to installing a check valve or manual gate valve on the overflow pipe.

MH S03006 (Scott Street and Minnie Avenue). This manhole has pipes coming into it from the north, south and east and one pipe flowing west along Scott Street. It is a small manhole (1200 mm diameter) for this many pipes and it is not benched very well so there is a lot of turbulence.

During our inspection, there was a substantial flow from the north and it was obvious that this flow was overwhelming the flow from the south and causing a backup in the sewer along Minnie Avenue toward Church Street. To help alleviate this condition the manhole should be replaced with a much larger one (2100 mm diameter) or three smaller ones so that the hydraulics can be improved to facilitate better flow from the south.

MH S05008 (Minnie Avenue and Nelson Street). This manhole is the high point on both the Minnie Avenue and Nelson Street sewers. The pipe running east along Nelson Street flows to the Church Street Pumping Station while the pipe running north along Minnie Avenue flows to Scott Street and the White Pine Pumping Station.

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At one time, there was a plug in the pipe running east along Nelson Street but this has been removed to facilitate maintenance. In the event of a significant back-up or surcharge in the Minnie Avenue sewer it is therefore possible that the sewage could flow into the Nelson Street sewer and into the Church Street Pumping Station. This could result in back-up in the Church Street drainage shed as the discharge flow is essentially going around in a circle. The plug should be reinstated or a new manhole installed on Nelson Street east of Minnie Avenue to separate the two drainage sheds.

4. Household Visits

Introductory letters were hand-delivered to 52 homes in the study area. Of these we were able to connect with 21 homeowners to ask questions about their experience during the event and obtain information on how the sump pump and eave trough flow is dealt with on the property. A summary of the observations and comments is presented in the following table

Of the 21 homes visited, 18 had sump pumps with 2 discharging to the sanitary sewer and 16 discharging to the yard. For the two that discharged to the sewer there was a valve on the discharge pipe so the flow could be directed to the yard in the summer and the sewer in the winter. A visual review noted only one house (406 Williams Avenue) where the eave trough downspouts connect to the weeping tile.

Twelve homes have check valves on the sewer connections. At one location (1113 Church Street) the check valve failed during the 2014 event.

5. Rainfall and Pumping Station Flow Analysis

Rainfall data from the International Falls Meteorological Station was reviewed to compare the rainfall pattern to the flow at the pumping stations. The following graphs represent the hourly rainfall from 8 pm on June 11 to noon on June 15 and daily rainfall superimposed on the daily pumped flow from the Church Street and White Pine Pumping Stations. Unfortunately, the SCADA system was not operating properly during this period so more detailed flow data (i.e. hourly) is not available to make a more refined analysis.

From the two pumping stations graphs it is apparent that the increase in the flow at the stations occurs fairly quickly (within 24 hours) after the rain events and decreases quickly as well.

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Town of Fort Frances
East End Sanitary Sewer Studay
House Questionaire Summary

4-Oct-17

Street	Number	Surveyed	Sump Pit	Discharge Location	Eavestrough discharge	Flooding History	Sewer Check Valve	Weeping Tile Connection	Discharge Location	Notes
		(Y/N)	(Y/N)				(Y/N)	(Y/N)		
Front Street	401	Y	Y	Yard	Yard	None	N	N		
	403	N								Not Home
	405	N								Not Home
	409	Y	Y	Yard	Yard	Twice - 2014 3 Basement Floods	Y	Y	Sump Pit	
Williams Avenue	302	N								Not Home
	306	Y	N	No Basement	Yard	None	N	Unsure		
	308	N								Not Home
	402	Y	Y	Possibly SAN	Yard	Unknown	Unknown	No		Note - Owner didn't allow us into the house, they were unsure where the Sump Pit discharged to
	406	Y	Y	Possibly SAN	Weeping Tile	Minor flooding due to sewage backup, no flooding during major floods	Y	Y		Note - Four rain leaders go into the ground - into weeping tile system
	408	Y	Y	Yard/SAN Sewer	Yard	No Issues, only been there a couple years	Y	Y	Sump Pit	Note - Owner has a two way switch for sump pit, summer goes to the yard, winter to the SAN Sewer
Church Street	1104	Y	Y - Not Used	Yard	Yard					Note - Sump pump not currently hooked up
	1109	Y	Unsure		No eavestrough	None - no Basement	unknown	N		Note - Dugout basement
	1111	N								Not Home
	1113	Y	Y	Yard	Yard	Yes - 2001,2014	Y	N		Note - Owner says he has the deepest basement in the neighbourhood - Blew through his check valve
	1116	Y	Y	Yard	Ground - Street through a weeper	Yes - Lots	unknown	Y		
	1117	N								Not Home
	1118	N								Not Home
	1120	N								Not Home
	1121	Y	Y	Yard/SAN Sewer	Yard	Yes - 2014	Y	Y	Sump Pit	Note - Owner has a two way switch for sump pit, summer goes to the yard, winter to the SAN Sewer
	1126	N								Not Home
	1127	N								Not Home
	1129	N								Not Home
	1130	Y	Y	Yard	Yard	No Issues	Y	Y	Sump Pit	
	1131	N								Not Home
	1132	N								Not Home
Nelson Street	1105	N								Not Home
	1109	N								Not Home
	1110	Y	Y	Yard	Yard	2014	Y	Unknown		Note - Gurgling toilet last summer
	1112	N								Not Home
	1114	Y	Y	Yard	Yard	No Issues	Y	Y	Sump Pit	
	1115	Y	Y	Yard	Yard	Once - 2014	Y	Y	Sump Pit	
	1121	N								Not Home
	1125	N								Not Home
	1129	Y	Y - Two	Yard	Yard	2014	Yes - Didn't work	Y	Sump Pit	
Minne Avenue	302	N								Not Home
	307	N								Not Home
	310	N								Not Home
	311	Y	Y	Yard	Yard	Yes - 2014, others	Y	Y	Sump Pit	
	312	N								Not Home
	305	N								Not Home
	316	N								Not Home
	319	Y	Y	Yard	Yard	Yes - 2014	N	Y	Likely inoperable	
	320	Y	Y	Yard	Yard	2001 - Sewer Backup	Y	Y	Sump Pit	
	323	N								Not Home
	324	Y	Y	Yard	Yard	2014 - Sewage	Y	Unknown		
	327	N								Not Home
	331	N								Not Home
	400	N								Not Home
	404	N								Not Home
	405	Y	Y	Yard	None	None - Half Basement	N	Yes	unknown	
	409	N								Not Home
	411	Y	N		Yard	None	unsure	Yes	Unknown - possibly SAN	

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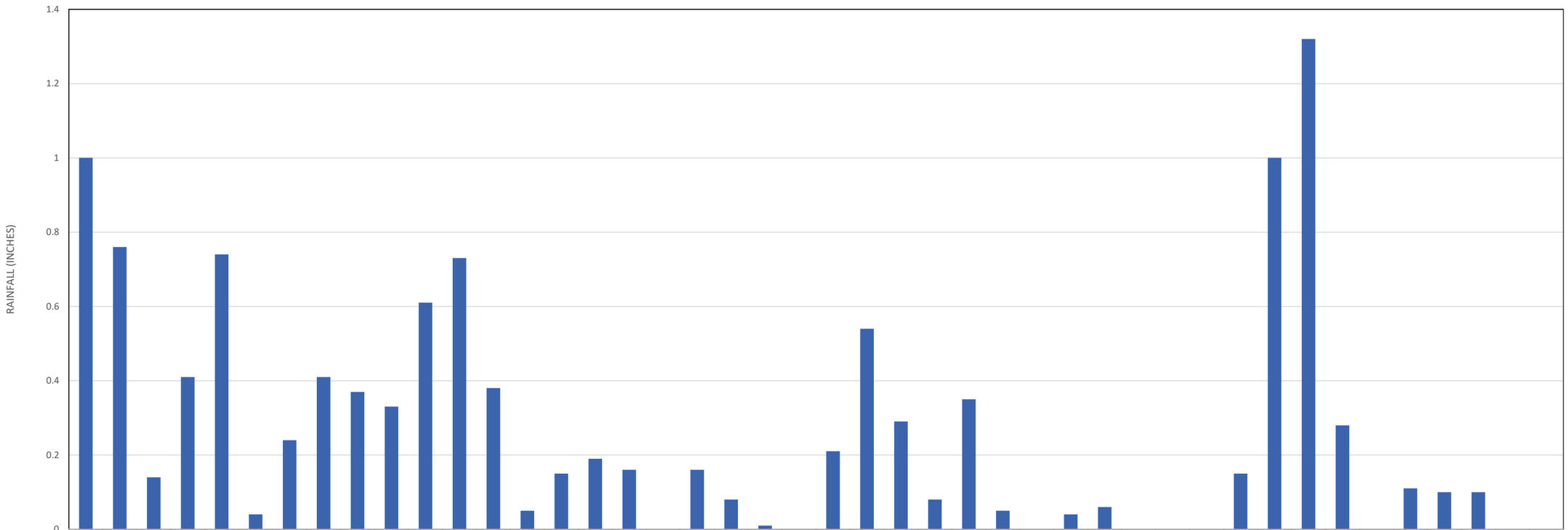
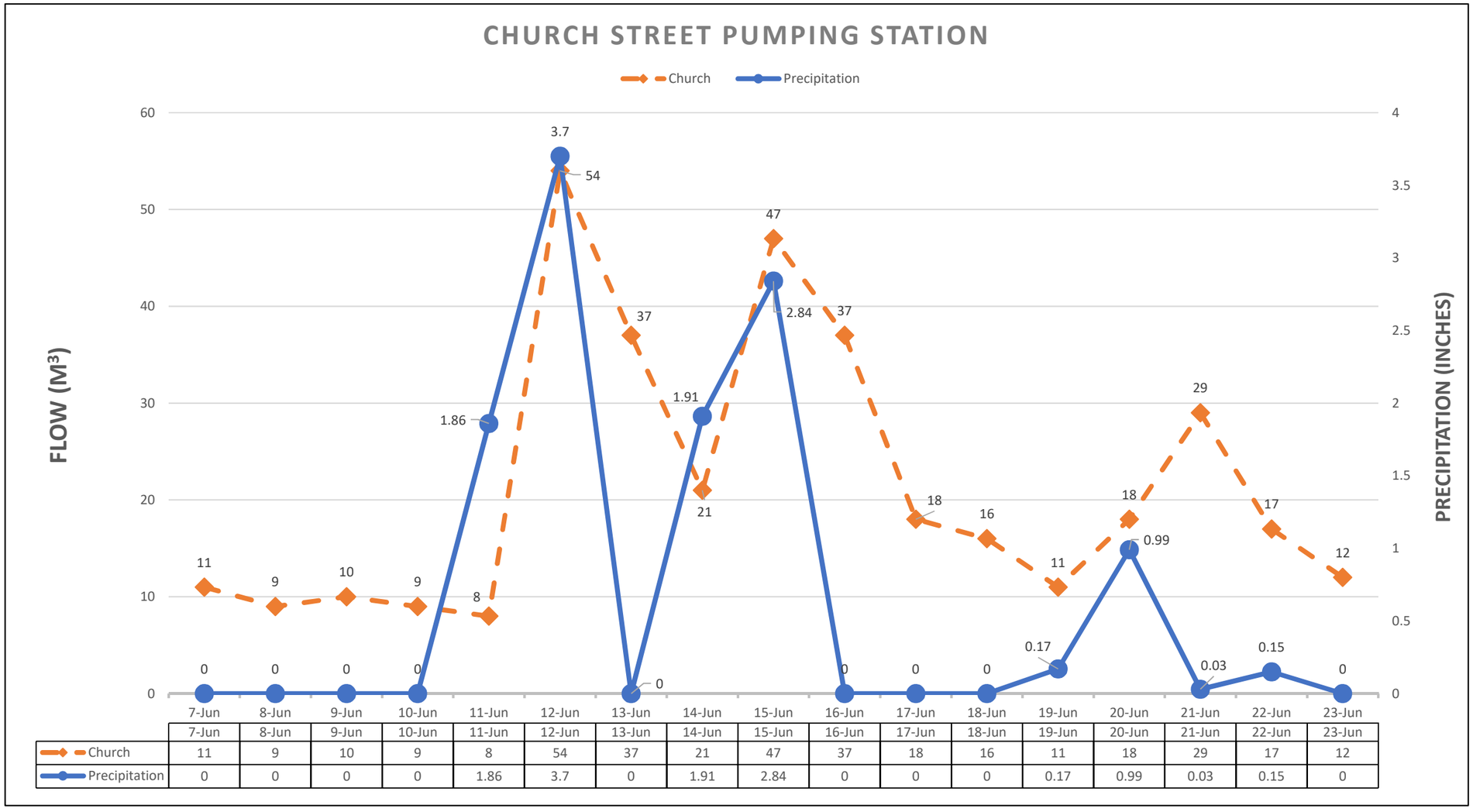
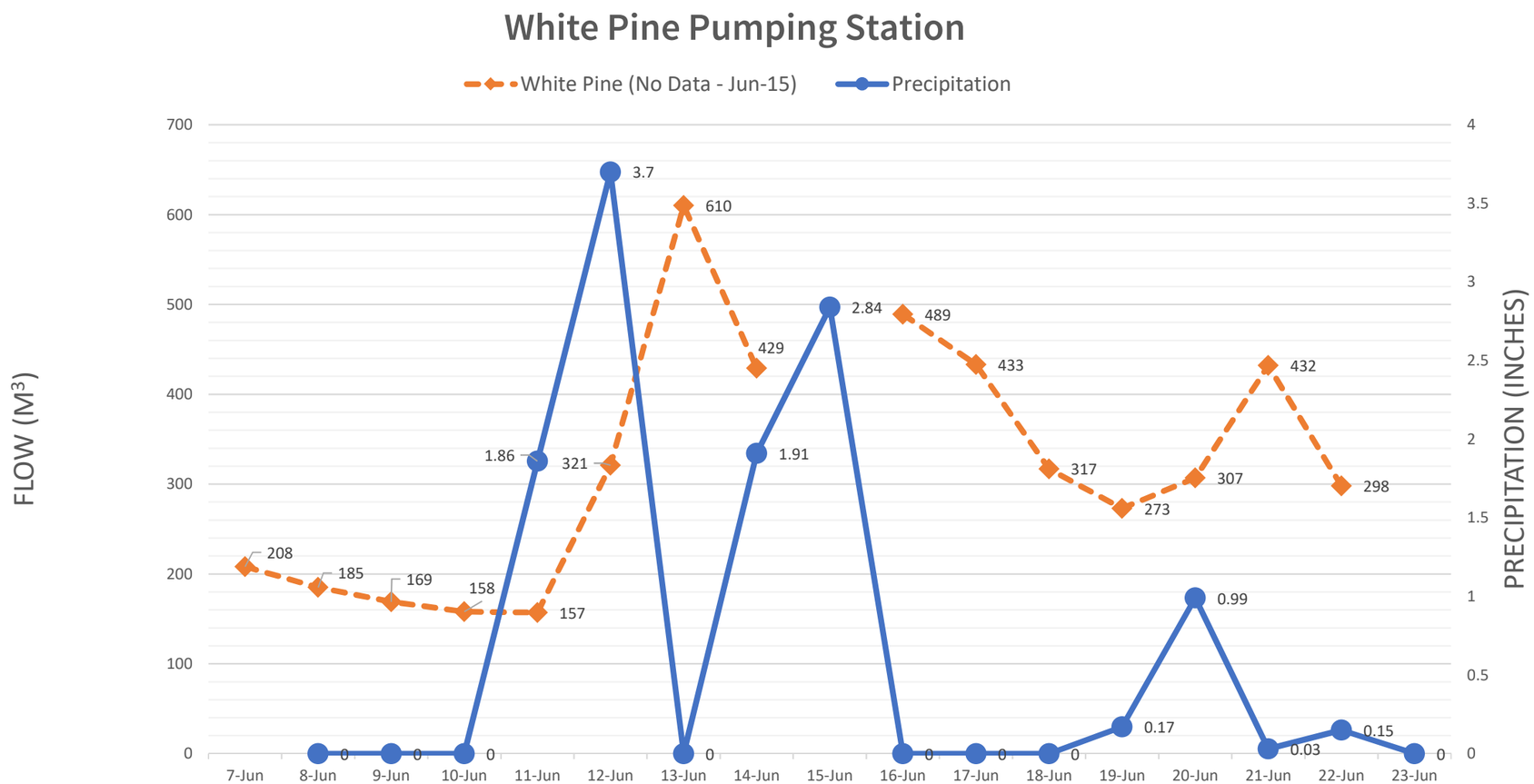
Town of Fort Frances
East End Sanitary Sewer Study
Rainfall Record
(from International Falls Met Station)
No Rainfall from 1:00pm June 12 to 12:00am June 13



	8:00 PM	9:00 PM	10:00 PM	11:00 PM	12:00 PM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM 12-Jun to 12:00 AM 13-Jun NO RAIN	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	12:00 AM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM
	11-Jun					12-Jun													14-Jun											15-Jun									16-Jun					
Rainfall	1	0.76	0.14	0.41	0.74	0.04	0.24	0.41	0.37	0.33	0.61	0.73	0.38	0.05	0.15	0.19	0.16	0	0.16	0.08	0.01	0	0.21	0.54	0.29	0.08	0.35	0.05	0	0.04	0.06	0	0	0	0.15	1	1.32	0.28	0	0.11	0.1	0.1	0	0



	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun
Church	11	9	10	9	8	54	37	21	47	37	18	16	11	18	29	17	12
Precipitation	0	0	0	0	1.86	3.7	0	1.91	2.84	0	0	0	0.17	0.99	0.03	0.15	0



	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun
White Pine (No Data - Jun-15)	208	185	169	158	157	321	610	429		489	433	317	273	307	432	298	
Precipitation		0	0	0	1.86	3.7	0	1.91	2.84	0	0	0	0.17	0.99	0.03	0.15	0

A reaction of this nature is normally considered to be the result of inflow from direct connections to the sewer (though manholes, sump pumps and downspouts) and through weeping tile systems that have a good connection to the surface. The pump flow data is also affected by the by-pass pumping and probable short-circuiting in the Church Street pumping station.

However, when one compares the pump station flows for the period before the storm (June 7-11) with the flow after the storm there is a noticeable and sustained increase in flow which is considered to be due to ongoing infiltration. Both stations also show a flow spike following a rainfall event on June 20 which indicates a fairly direct connection between the ground surface and the sewer system.

Direct connections (downspouts) do not appear to be significant in number in the Church Street SPS drainage shed and, we understand that the general opinion is that there are not many in the White Pine SPS drainage shed either as the Town has aggressively pursued a disconnect policy in the recent past. However, it would be worthwhile to consider another review of this area.

From the somewhat qualitative analysis it appears that the majority of the flow increase is due to the weeping tile connections. Achieving a significant reduction in this flow will be very difficult because of what it will entail. However, an inspection of the homes may identify some opportunities for sump pump installations which could be beneficial.

6. Pumping Station Review

6.1 Church Street

This station was re-built in 1992 and contains 2 Flygt 3085 MT submersible pumps with Model 438 impellers rated for 12 l/s. The 2005 report by Wardrop noted the flow rate to be in the order of 7 l/s. The impellers were subsequently replaced with a 463 'N' style which according the operating staff are presently performing at 9 l/s.

Theoretical calculations in the Wardrop report estimate the peak dry weather flow be in the order of 2.4 l/s and the peak wet weather flow to be in the order of 9 l/s.

Recent records (August 20-25, 2017) indicate a daily flow volume of approximately 25 cu.m. which represents a daily average flow rate of 0.3 l/s which is approximately half the rate estimated by Wardrop. The station

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therefore has ample capacity for the dry weather flow. Past records and comments from the operator indicate that this station has performed well under wet weather conditions with the exception of the June 11, 2014 event.

As discussed earlier the observations during the June 11, 2014 event present a strong indication that the entire system was flooded and the pump station performance was not a factor.

As noted earlier, isolating this station from the rest of the system will be the best way to minimize the impact of wet weather conditions. This will involve the following:

- Plugging or putting a control valve on the overflow pipe
- Installing an additional manhole at Nelson Street and Minnie Avenue to separate the Church Street drainage shed from Minnie Avenue System.

However, this will not help the situation on Minnie Avenue which appears to be affected by the hydraulic conditions at the manhole at Scott Street and Minnie Avenue.

6.2 White Pine

Reports from the 2014 event indicated this station did not appear to be overwhelmed by the high flows that occurred and the trunk sewer on Scott Street was flowing at about 90% full. However, during the peak of the storm, the flow in the sanitary sewer was being relieved by the by-pass pumping at Minnie Avenue and First Street.

The White Pine pumping station, located on Butler Avenue has two 7.5 hp pumps in a dry well/wet well configuration with a published capacity of 47 l/s. The station discharges to the 300-mm diameter gravity sewer at the intersection of Butler Avenue and Gillon Street, approximately 35 m from the station.

The 2005 report by Wardrop estimated the flows to the station to be as follows:

Average dry weather flow	5.36 l/s
Peak dry weather flow	17.11 l/s
Peak wet weather flow	64.69 l/s

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The pump capacity based on pump records at the time were estimated to be in the order of 35 l/s. Recent data (August 2017) indicates that the pumps are producing approximately 33 l/s.

During the 2014 event the maximum flow through the station was 610 cu.m. per day (June 13) which represents an average flow rate of approximately 70 l/s. From this it is presumed that both pumps were operating continuously and probably at or near their maximum capability. During this time, the Town was also taking flow out of the sanitary sewer system at a rate of approximately 22 l/s (350 US g.p.m.).

Detailed records on flow rates and water levels in the wet well during the June 2014 events were not available for a better analysis of the performance of the station but the information above suggests that the station would not have been able to keep up with the flow without the by-pass pumping.

The sanitary sewer on Scott Street is clay pipe installed in 1924. The CCTV video inspection done in 2015 indicates that it is in reasonably good condition. The construction drawings of the day show that it is laid at a slope of 0.26% which would give it a theoretical capacity of approximately 50 l/s under non-surcharge conditions.

The conclusion of this basic analysis is that the Scott Street sewer and White Pine Pumping Station did not have the capacity to deal with the June 2014 storm event. This of course is borne out by the fact that by-pass pumping was needed to prevent more intense flooding than did occur.

7. Conclusions

Based upon the available records and observations available from the 2014 flood event, observations from earlier reports, CCTV reports and videos and observations from inspections in August 2017 we offer the following conclusions:

- There is no evidence of a major source of surface inflow into the sanitary sewer system in the Church Street Pumping Station are.
- A back-up or surcharge in the Minnie Avenue sewer could result in back flow into the Church Street Pumping Station through the overflow pipe of MH S03011 (Church Street and Minnie Avenue) as there is no isolation valve or check valve on this pipe.

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- The size and configuration of the manhole at Scott Street and Minnie Avenue (MH S03006) can cause back-up in the sewer on Minnie Avenue south of Scott Street during moderate and heavy flows.

- The configuration of the manhole at the intersection of Minnie Avenue and Nelson Street could result in backflow into the Church Street Pumping Station drainage shed in the event of a back-up or surcharge in the Minnie Avenue sewer.

- Calculations indicate that the Church Street Pumping Station should have adequate capacity for the flow from this area even with a generous infiltration allowance.

- The sewer on Scott Street from Minnie Avenue to Butler Avenue does not appear to have adequate capacity to accommodate the flow that was experienced during the 2014 event when one considers that 350 US gpm of flow was taken out of the system through by-pass pumping.

- The White Pine Pumping Station does not appear to have adequate capacity to accommodate the flow that was experienced during the 2014 event when one considers that 350 US gpm of flow was taken out of the system by by-pass pumping.

8. Recommendations

- Install an isolation valve or check valve on the overflow pipe from the Church Street Pumping Station to prevent backflow during high flow periods in the Minnie Avenue sewer. Estimated cost $10,000.

- Install an additional manhole at the intersection of Minnie Avenue and Nelson Street to separate the Church Street Pumping Station drainage shed from the Minnie Avenue sewer. Estimated cost $10,000.

  The above two items would allow development of the vacant lands at Minnie Avenue and Nelson Street and Nelson Street and Williams Avenue to proceed with minimal impact from high rainfall events and high flows in the sewer system. However, development on those properties should be slab-on-grade construction (i.e. no basements).

- Reconfigure the manhole at Scott Street and Minnie Avenue to provide better hydraulics and reduce the potential for back-up in the Minnie Avenue sewer south of Scott Street. Estimated cost $50,000.

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- Carry out a review of the White Pine Pumping Station drainage shed to look for controllable sources of surface inflow into the sanitary sewer system. Estimated cost $50,000.

- Investigate increasing the capacity of the sewer on Scott Street the White Pine between Minnie Avenue and Butler Avenue to accommodate the additional flow during high flow events (nominal increase in capacity of 350 US gpm (22 l/s). Estimated cost $5,000.

- Investigate increasing the capacity of the White Pine Pumping Station (larger pumps) or permanent emergency pump. This exercise will also need to consider the impact on the sewer downstream of the discharge point and review of the capacity of the Scott Street sewer. Estimate cost $25,000.

- Review the White Pine SPS drainage shed for possible downspout connections.

- Maintain the by-pass pumping procedure for implementation as warranted during heavy rainfall events until such time as sewer and pumping station capacity is increased.

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