70 Hampton Road
Rothesay, NB
E2E 5L5 Canada

Rothesay Council
March 12, 2017

TO: Mayor Grant and Members of Rothesay Council

SUBMITTED BY: John Jarvie, Town Manager

DATE: March 7, 2018

SUBJECT: Maiden/Goldie/Brock Drainage Study

RECOMMENDATION

It is recommended that the drainage study for the Maiden/Goldie/Brock neighborhood submitted by Dillon Consulting Ltd. be received for information and that the recommendation for a storm sewer project on Maiden Lane be considered during the 2019 budget deliberations.

ORIGIN

The 2018 General Fund Operating Budget includes funding for the completion of a drainage study in Maiden/Goldie/Brock neighborhood.

BACKGROUND

A number of residents in the Brock Court area have experienced backyard/sideyard flooding and in some cases water-in-basement events over the past few years. Residents on Goldie Court have also experienced overland flooding which, in at least one reported case, resulted in a water-in-basement event. Residents on Maiden Lane have expressed concerns about property flooding though staff is not aware of any specific events or occurrences of actual flooding.

Neighborhood residents attended two separate meetings of the Public Works and Infrastructure Committee to express their flood related concerns. The Committee, at their November meeting, unanimously passed a recommendation that Council approve a sum of $20,000 to survey the area, assess the current conditions, qualify and quantify flooding concerns and make recommendations for future direction in the neighborhood. Council adopted the recommendation at their meeting of December 11, 2017 and Dillon Consulting was subsequently engaged to complete the study work and submit a final report.

Two separate landowners have submitted plans to the Town's Planning Advisory Committee (PAC) to alter the property boundaries of civic 3188 Rothesay Road and civic 20 Goldie Court. The neighborhood concern was that this construction would negatively alter the existing drainage and overwhelm the neighborhood storm sewer infrastructure causing flooding. Part of Dillon's mandate was to determine the current level of storm sewer service and assess the impact of adding two more homes on landscaped lots in the neighborhood.

DISCUSSION

The basic tenet of a public storm sewer system is that it collects, conveys and responsibly discharges runoff from public facilities ie. roads, roofs of public buildings and public parking lots. The municipality is not responsible to collect and manage water which arrives on private property via rainfall, snow melt, runoff from other private properties or surcharging watercourses.

In the case of Brock Court the study found that storm water which collects in the rear and side yards of properties could not accumulate to a level where it could spill into a public storm sewer prior to finding other relief methods such as flooding adjacent basements. The study suggested that the low lying areas could be infilled and storm sewer inlets could be lowered to force the water into the public system and alleviate the property owner concerns, however the water in question does not originate from a public road, roof of public building or a public parking lot. The acceptance of this water into the public system will have effects on the downstream system.

In the case of Goldie Court the study found that a storm sewer system exists on the upper and lower portions of the street, however it is not continuous. Water from the Brock Court storm sewer is directed to the upper portion of Goldie Court and discharges to an open ditch, which also collects runoff from adjacent private properties, and eventually reaches natural storage at the rear of 3188 Rothesay Road. The system on the upper portion of Goldie Court is currently overwhelmed in any precipitation event exceeding the 10 year return period storm. More water from the rear and side yards on Brock Court would further degrade the level of service this system provides and would ultimately discharge more water onto the rear of 3188 Rothesay Road. The lower portion of Goldie Court has a storm sewer that connects to the storm sewer on Maiden Lane.

In the case of Maiden Lane the study found that the existing 200 mm storm sewer is inadequate to handle runoff from the lower section of Goldie Court and Maiden Lane during relatively frequent high intensity/ short duration precipitation events.

The basic findings and recommendations of the study were as follows:

1) There is no capacity to accept additional "private" storm water from Brock Court as it will overwhelm upper Goldie Court and discharge to private property at 3188 Rothesay Road. This can be resolved by connecting the upper and lower sections of storm sewer on Goldie Court. This connection would also serve to remove ambiguity about ownership of runoff discharging to the rear of 3188 Rothesay Road ie. all Town runoff would stay on Town property.

2) The Maiden Lane storm sewer has no capacity to receive additional water from Goldie Court. The existing 200 mm storm sewer should remain in place and be twinned with a 450 mm storm sewer between Knoll Lane and Rothesay Road.

3) The subdivisions of 3188 Rothesay Road and 20 Goldie Court will have no effect on area drainage now or in any future scheme so long as the net zero policy developed by EXP is followed on 20 Goldie Court and the loss of existing storage on 3188 Rothesay Road is compensated for by providing on site retention or conveying displaced water through a piped system to Rothesay Road. The study included specific language regarding the development of 3188 Rothesay Road related to water issues unique to any dwelling being constructed there ie. it is a wet area and without proper design and mitigation measures the new home could itself experience flooding.

It is staffs opinion, based on the in-depth work completed by Dillon Consulting that the subdivision of 20 Goldie Court and 3188 Rothesay Road will not increase flooding potential to area homes and deliberation on the issue should not be further delayed by PAC and Council with regard to stormwater.

Report Prepared by: Brett McLean, Director of Operations

Report Reviewed by: Doug MacDonald, Treasurer

A copy of this report can be obtained by contacting the Rothesay Town Clerk, 70 Hampton Road, Rothesay, NB E2E 5L5 (506-848-6664).

DILLON CONSULTING

TOWN OF ROTHESAY

Flood Risk Assessment – Maiden Lane and Surrounding Area

March 2018 – 18-6889

March 2, 2018

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Town of Rothesay
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Attention: Mr. Brett McLean

Flood Risk Assessment – Maiden Lane and Surrounding Area

Dear Mr. McLean,

Dillon Consulting Limited (Dillon) is pleased to present the following report outlining our flood risk assessment of Maiden Lane and surrounding areas. This report is being provided for review by the Town of Rothesay.

The attached report outlines the methodology and hydrologic/hydraulic simulation results for the drainage network around Maiden Lane. The purpose of this assessment is to: 1) investigate the current level of flood risk within the study area, and 2) evaluate the incremental impact of a proposed development at 3188 Rothesay Road.

Please feel free to contact the undersigned should you have any questions or comments regarding this report.

Sincerely,

DILLON CONSULTING LIMITED

Jeff Melanson, M.Sc.E, P.Eng.
Water Resources Engineer

JAM:mhc

Our file: 18-6889

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Executive Summary

The Town of Rothesay (Town) has retained Dillon Consulting Limited (Dillon) to undertake a flood risk vulnerability assessment along Maiden Lane and surrounding streets in Rothesay, New Brunswick. The assessment included review of topographical data sets (LiDAR), site survey and video inspections. These data were used to support hydrologic and hydraulic simulation of existing drainage conditions to identify flood vulnerable areas within the study area. Numerical simulation was also used to investigate the impact of a proposed development at 3188 Rothesay Road.

The following key findings have been identified as a result of this study:

- A section of the existing 450 mm sewer along Rothesay Road downstream of Maiden Lane was found to be approximately 50% blocked with sediment. This blockage is expected to increase HGL elevations along the Maiden Lane storm sewer during extreme rainfall conditions.
- Surface ponding along Brock Court near civic addresses 4 and 6 was observed. This ponding is expected to be due to the accumulation of runoff in a localized depression between 4 and 6 Brock Court.
- Significant surface runoff volumes converge at Goldie Court, particularly at the intersection with Maiden Lane. The hydraulic simulation indicates that the infrastructure along Goldie Court and Maiden Lane is inadequately sized to convey this runoff. The storm sewer along Goldie Court adjacent to civic number 5, 3 and 1 is estimated to have less than a 5-year level of service. The existing sewer system along Maiden Lane is also expected to surcharge during the 5-year simulated rainfall event.
- The existing flood vulnerabilities along Goldie Court and Maiden Lane suggest that future development within the upper watershed could have significant impacts if a net-zero approach to runoff is not followed. It is recommended that future development in the watershed contributing to Goldie Court have strict stormwater controls to limit runoff to pre-development levels, at a minimum. This includes the proposed residential developments at both 3188 Rothesay Road and 20 Goldie Court.
- The proposed subdivision of 3188 Rothesay Road was evaluated to estimate the incremental impact on flood risk for neighbouring properties along Maiden Lane and Goldie Court. This analysis suggests that the proposed sub-divided property will have a minimal impact on flood risk, and is limited to a minor (+0.01 m) increase in HGL in the storage area north of Maiden Lane for the 100-year, 24-hour rainfall simulation only (see section 5.2.1).

Based on these findings, a set of recommended flood mitigation measures were also identified. These measures include the following:

- It is recommended that the Blockage identified along the Rothesay Road storm sewer be flushed and cleared to restore capacity along the sewer.
- The localized ponding at Brock Court near civic addresses 4 and 6 is due to a lack of outlet capacity to drain the low-lying area between the two properties. Possible mitigation measures may include: 1) re-grading the area to promote runoff to the existing catch basin, 2) installing an inlet to the storm system, or 3) lowering the catch basin rim elevation if possible.
- Upgrades to the Maiden Lane storm system were investigated. A parallel storm sewer ranging in diameter from 300 to 450 mm diameter along the south road perimeter is expected to limit surcharging of the storm system during the 5-year historical rainfall event.

  Simulation of the projected future rainfall event indicated that some surcharging of flows into the roadway would be expected at the intersection of Rothesay Road and Maiden Lane for the upgraded scenario. It is anticipated that upgrades to the Rothesay Road sewer would be required to further improve capacity.
- The proposed twinned system along Maiden Lane is expected to significantly reduce tail water conditions for the Goldie Court storm sewer. As a result, no surcharging is expected along the existing Goldie Court system for the historical 5-year rainfall event.

  The projected future 5-year rainfall event simulation suggests that some surcharging of the Goldie Court storm system may be expected. Upgrading two sections (~40 m) of sewer along Goldie Court is recommended to limit surcharging during the projected future 5-year rainfall event.
- The study has identified a small increase in hydraulic grade line (HGL) elevation (+0.01 m) for the 100-year rainfall event. It is recommended that a stormwater management plan for 3188 Rothesay Road include measures to compensate for the storage capacity expected to be in filled and mitigate increases in the HGL during extreme flood conditions. Maintaining or improving the existing conveyance (i.e. ditching) flowing through 3188 Rothesay Road is also critical to mitigate potential impacts to upstream areas.
- The proposed development described in the EXP Services Incorporated (2017) study was also reviewed at a high level. A net-zero approach to stormwater management is recommended as part of detailed design. Uncontrolled surface flows onto neighbouring private property should also be addressed as part of a detailed stormwater management plan.

1.0 Introduction

Dillon Consulting Limited (Dillon) has been retained by the Town of Rothesay (Town) to complete a flood risk vulnerability assessment along Maiden Lane and surrounding streets in Rothesay, New Brunswick. The general study area with street names, civic addresses and property boundaries is presented in Figure 2-1. The objective of this assessment is firstly to investigate the current level of flood risk within the study area, and secondly to evaluate the incremental impact of a proposed development at 3188 Rothesay Road. Commentary on a second residential development at 20 Goldie Court will also be provided at a high-level.

2.0 Background

The Town of Rothesay is located in southern New Brunswick approximately 15 kilometers northeast of Saint John, NB. The study area is located off of the Rothesay Road, behind the Shadow Lawn Inn, and consists of residential properties along Maiden Lane, Goldie Court and Brock Court. These residential areas receive surface runoff generated from steep, up-gradient watersheds consisting of a mix of low-density residential and undeveloped (wooded) land cover.

It is understood that residents along sections of Maiden Lane, Goldie Court, and Brock Court have reported instances of flooding in recent years. These flood reports have included flooding of basements and surface water ponding on private property. Discussions with residents were undertaken as part of this study to better define the nature of existing flood risk within the study area.

The property owner at 3188 Rothesay Road is proposing to subdivide the existing residential lot (see Figure 2-1). Near-by residents within the study area have expressed concern regarding the potential increase in impervious area and that this could lead to increased flood risk in the area. The property in question also lies within a low-lying area, leading to concern that the proposed development may reduce the currently available storage capacity within the existing storage area. The estimated limits of the natural storage area are shown in Figure 2-1.

To investigate the existing and potential future level of flood risk, a series of site visits and surveys has been undertaken. The information and data collected in the field has been used to develop a hydrologic/hydraulic model of the area to examine potential flood risk impacts. The following sections describe the methodology and findings of this assignment.

Town of Rothesay
Mainden Lane Flood Vulnerability Assessment

General Site Location
Figure 2-1

Property Lines with Civic ID Number
Storage Area
3188 Rothesay Road
Proposed Sub-Division Boundary

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MAP DRAWING INFORMATION:
DATA PROVIDED BY TOWN OF ROTHESAY

MAP CREATED BY: JEB
MAP CHECKED BY: JAM
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

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0 20 40 80 120 160 Meters

PROJECT: 18-6889 STATUS: DRAFT DATE: FEB 2018

3.0 Field Reconnaissance and Survey

A series of site visits and surveys were undertaken to characterize existing drainage routes and storm sewers within the study area. A summary of these site visits and findings is presented below.

3.1 December 18, 2017 – Site Survey

The first site visit included a targeted survey of local topography and storm sewer infrastructure. The survey was completed using a high accuracy portable GPS (Trimble R8 Model 3 GPS, estimated vertical accuracy ± 20 mm). Storm sewer data such as inverts, diameters, location of catch basins and rim elevations were collected within the study area.

The survey data collected as part of this site visit was used to generate a schematic of the existing storm sewer network. The survey identified that the existing storm sewers along Maiden Lane and Goldie Court consist predominately of 200 mm diameter PVC pipe. This is a notable deviation from the Town GIS database which indicated a pipe diameter of 300 mm. The existing pipe network based on the survey is presented in Figure 3-1.

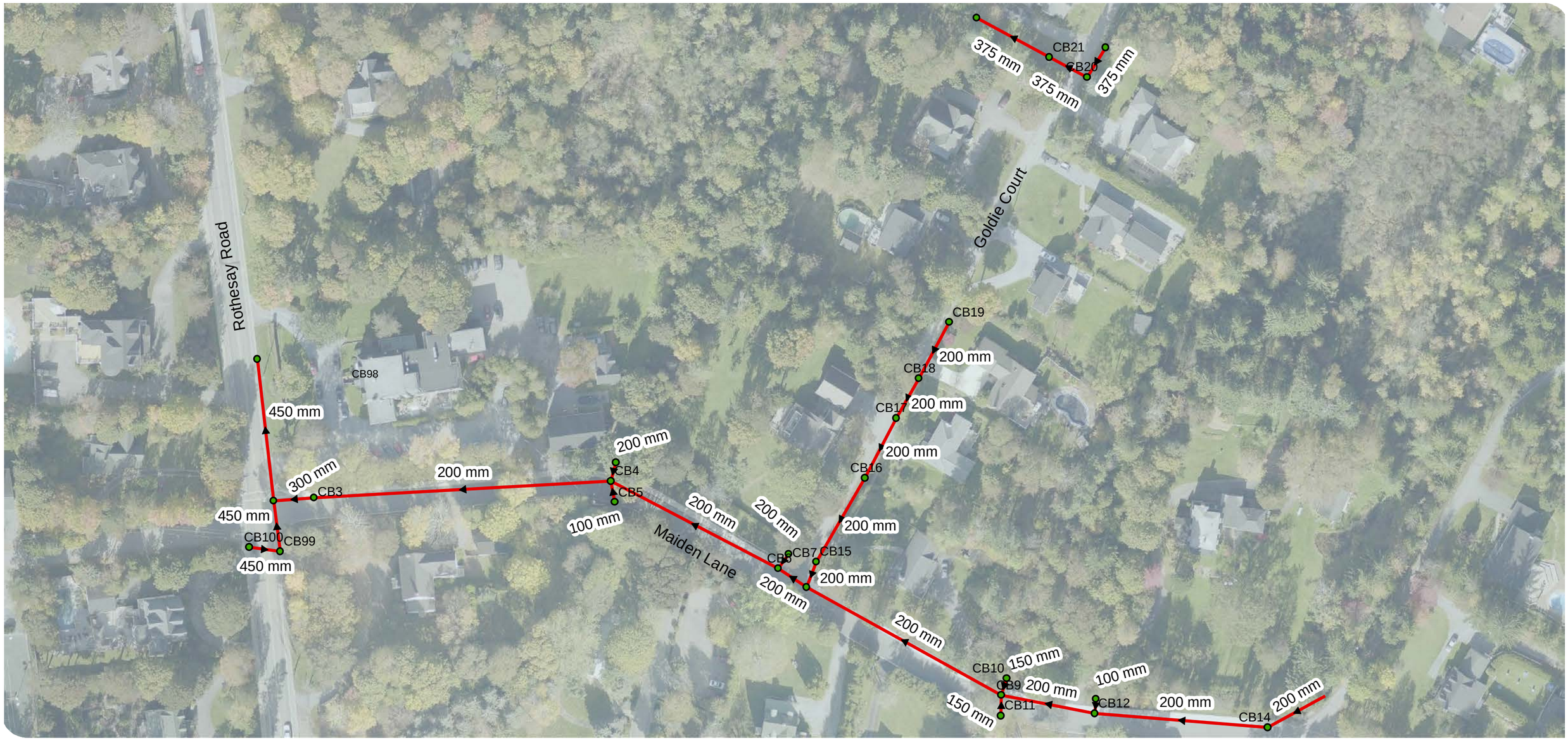
3.2 January 16, 2018 – Video Inspection

Video inspection of the existing storm sewer along Maiden Land and Goldie Court (approximately 550 m) was completed to verify existing drainage conditions and to identify additional inflows that are not visible from the surface. The existing 450 mm diameter sewer along Rothesay Road from Maiden Lane to the intersection with Hampton Road was also included in the video inspection (approximately 200 m). However, a significant blockage (~50% of flow area) was encountered 16.2 m downstream of CB98 – see section 63 in Appendix A. Survey downstream of this blockage was not possible due to inadequate clearance for the video recorder.

Summary sheets from the video survey are provided in Appendix A, including a photograph of the blockage along the Rothesay Road sewer. Digital video files of the video inspection survey were provided to the Town.

3.3 January 26 & 29, 2018 – Site Survey and Resident Interviews

After reviewing the data collected from the previous site visits, visual inspection of overland drainage routes and natural attenuation features was undertaken. The timing of the site visit offered a unique opportunity since a significant rainfall event had occurred several days prior (56 mm on January 23rd). Much of the surface runoff from this event had subsequently frozen, allowing for easy confirmation of surface ponding. The following sections describe findings associated with these site visits.



Town of Rothesay
Maiden Lane Flood Vulnerability Assessment

Existing Storm Sewer Network
Figure 3-1

- Catchbasins
- Conduits (with Direction of Flow and Pipe Diameter)
- 1 Meter Contours

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MAP DRAWING INFORMATION:
DATA PROVIDED BY TOWN OF ROTHESAY

MAP CREATED BY: JEB
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MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

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3.4 Maiden Lane

A visual inspection of Maiden Lane and discussions with nearby residents suggests that surface ponding at the corner of Maiden Lane and Goldie Court frequently occurs in the vicinity of 10 Maiden Lane, behind the Shadow Lawn Inn.

An existing ditch was observed to flow north behind the Shadow Lawn Inn property which appears to collect storm sewer surcharged flows along Maiden Lane. This leads to significant ponding of surface flows at this location during extreme rainfall events. The downstream limit of this ditch was also observed to be blocked (i.e. filled in) at the time of inspection, and is therefore not expected to have sufficient outlet capacity to the natural storage area north of Maiden Lane. The upstream limit of this ditch is presented in Figure 3-2.

Figure 3-2: Existing Ditch between Shadow Lawn Inn and 10 Maiden.

3.5 Goldie Court

Discussions with several residents along Goldie Court were undertaken, including residents at civic addresses 16, 11, 5, 12 and 8 Goldie Court. These discussions indicated several existing flood challenges, including past instances of surface and basement flooding.

The homeowner at 5 Goldie Court indicated that they have experienced basement flooding twice within the last five years. Basement flooding has also occurred at 3 Goldie Court at roughly the same frequency.

The homeowner at 11 Goldie Court has indicated that a sump pump has been installed in their basement and runs frequently during heavy rainfall events. The homeowner believes that this flooding is related to inadequate capacity in the ditch north of their property leading to the 375 mm diameter cross culvert.

Some surface flooding was reported at 16 Goldie, which the homeowner believes is associated with local runoff from an adjacent property (20 Goldie). The homeowner suggested that the ditch flowing from Brock Court down to the 375 mm cross culvert will frequently reach bank full conditions, though has not

to their knowledge spilled over Goldie and entered their property. However, photographs of this ditch overtopping the road in the 1970s were provided by the homeowner at 8 Goldie Court.

3.6 Brock Court

Discussions with the homeowner at 6 Brock Court indicated that this property experiences frequent surface ponding north of their property near an electrical transformer. The homeowner has been pumping this water themselves to protect their property from basement flooding. Photographs of the ponded area is presented in Figure 3-3, both photos have been provided by the current resident at 6 Brock Court.

Due to the frozen condition of the pond during the site visit, it was not possible to confirm an inlet within the ponded area. However, there is a catch basin located between the ponded area and the road way. This catch basin appears to be set too high to effectively collect the ponded water (see Figure 3-3). The existing catch basin had a surveyed rim elevation of 23.51 m.

Figure 3-3: Surface Ponding Extent (right) Immediately North of 6 Brock Court and Existing Catch Basin (left)

Generally, the flood challenges observed in the upper watershed (i.e. 6 Brock Court) appear to be localized, lot level drainage issues. In the lower reaches of the watershed (Maiden Lane and Goldie Court) significant quantities of surface runoff are expected to converge in these lower lying areas during extreme rainfall and/or snow melt events. Based on discussions with residents, this has resulted in historical basement flooding and ponding on private property, particularly along Goldie Court and near the intersection of Maiden and Goldie.

4.0 Hydrologic & Hydraulic Assessment

Review of available topographic, meteorological and geological data has been undertaken to develop an improved understanding of runoff potential and conveyance within the study area. These data and

parameters were then used to complete hydrologic and hydraulic numerical simulation of the watershed and conveyance network. The following sections describe our review of these data and model development.

4.1 Topographic Data Review

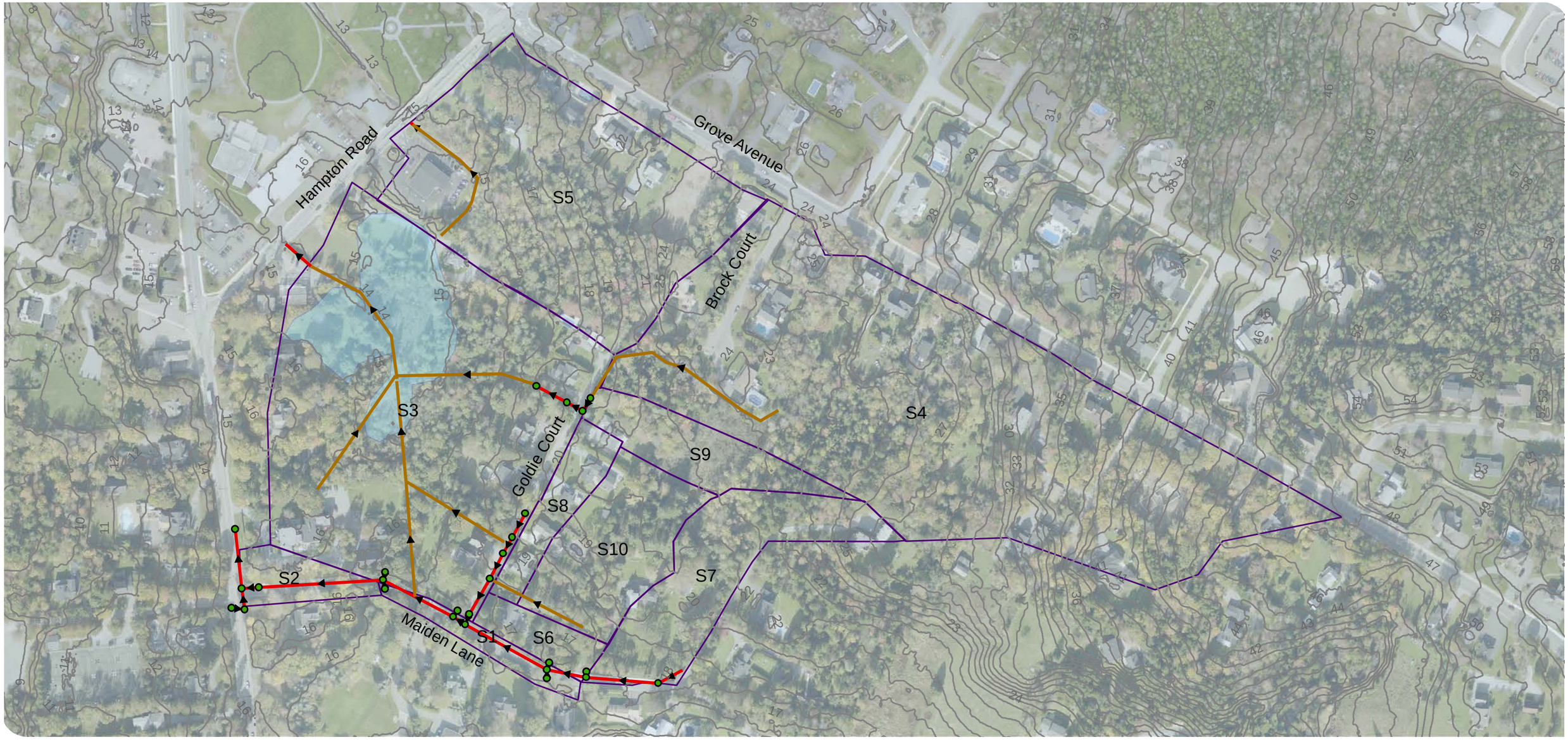
LiDAR data provided by the province for the study area was processed and used to support this assessment. The LiDAR data is estimated to have a vertical accuracy of approximately 0.13 m, and was collected between July and October 2013. The processed LiDAR was primarily used to delineate the drainage area, identify conveyance features, and calculate storage curves for low-lying areas where it is expected water pools. The survey data collected as part of this study has also been used to supplement the LiDAR data.

Review of topography near the project site under investigation suggests that the area north of Maiden Lane is relatively flat and receives significant volumes of runoff from the surrounding water. This area has also been identified in a recent study completed by Boreal Environmental (Boreal 2017). The approximate extents of this area, based on detailed topographical review, are presented in Figure 4-1.

4.2 Characterization of Existing Drainage Features

Based on review of the site topography and observations in the field, a drainage schematic was generated. A map of drainage features and sub-catchment boundaries is presented in Figure 4-1. Some notable drainage features include the following:

- The existing stormwater system along Maiden Lane and Goldie Court consist of primarily 200 mm diameter storm sewer with numerous catch basin inlets within the roadway. The northern portion of Maiden Lane consists of curb and gutter.
- A ditch collects surface runoff from Brock Court and flows southwest towards the 375 mm cross culvert near 11 Goldie Court.
- The following three ditches converge in the natural storage feature shown in Figure 4-1: 1) ditch flowing north between Shadow Lawn Inn and 10 Goldie Court, 2) the ditch conveying runoff from Goldie Court (via the 375 mm cross culvert), and 3) ditch conveying rear lot drainage from 3188 Rothesay Road.
- The aforementioned inflows enter the natural storage feature and discharge via an existing 600 mm inlet (invert elevation 13.30 m) to the Rothesay Road storm system, or north to a 900 mm concrete pipe (invert elevation 13.51 m) discharging to a watercourse flowing through the Rothesay Common.



Town of Rothesay
Maiden Lane Flood Vulnerability Assessment

Study Area Drainage Schematic
Figure 4-1

- Catchbasins
- Conduits (with Direction of Flow)
- Ditches (with Direction of Flow)
- Subcatchments
- 1 Meter Contours
- Storage Area

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MAP DRAWING INFORMATION:
DATA PROVIDED BY TOWN OF ROTHESAY

MAP CREATED BY: JEB
MAP CHECKED BY: JAM
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

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0 20 40 80 120 160 Meters

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4.3 Meteorological Data

A review of climate stations in close proximity to the study area was undertaken. Based on the period of record and the proximity to the study area, the Environmental Canada "Saint John A" climate station (#8104900) was chosen for the purpose of this project. The gauge is located approximately 10 kilometers south-east of the study area. The gauge contains temperature and precipitation from 1953 to present.

Current and future conditions were evaluated for the 5, 25 and 100-year 24-hour rainfall events. Total historical precipitation amounts were derived from the Environment Canada intensity-duration-frequency statistics. A potential future rainfall climate change scenario has also been considered in this assessment. The Canadian Water Networks IDF Climate Change Computerized Tool (https://www.idf-cc-uwo.ca) has been used to estimate future rainfall intensity. A comparison of historical and future rainfall for the Saint John A station is also presented in Table 4-1.

Table 4-1: 24-hour Design Storm Total Rainfall Amounts

Return Period (Years)	Historical 24-hour Total Rainfall (mm)	Projected Future Climate 24-hour Total Rainfall (mm)[1]	Deviation
5	96.0	123.9	+29%
10	112.8	153.6	+36%
25	136.4	174.2	+28%
100	176.5	231.5	+31%

[1]Assumes Moderate Emissions Scenario – RCP 4.5

It can be seen that for the range of return periods, and for a storm duration of 24-hours, an increase of roughly 28 – 36% is possible under estimated future conditions. The projected future rainfall depths will be used to support sizing of recommended infrastructure upgrades.

Using the SCS Type III rainfall distribution method storm events were created for each return period using the design storm creator within the PCSWMM package.

4.4 Watershed Parameters

The SCS runoff curve number (CN) method was used in combination with percent imperviousness to describe the rainfall-runoff relationship of each sub-catchment.

The SCS runoff CN value selected for this study was 60. SCS Soil Group B has been estimated based on review of surficial geology maps for study area (NB DNR, 2002). Percent imperviousness was then applied to each sub-catchment to account for runoff from hard surfaces (asphalt, concrete, etc.).

A summary of the sub-catchment parameters are presented in Table 4-2. It is noted that the overall site runoff characteristics remain largely unchanged given that the existing site consists primarily of wooded area with only one home being proposed. The locations of the sub-catchment boundaries are presented in Figure 4-1.

Table 4-2: Watershed Parameters

Sub-catchment	Drainage Area (ha)	Impervious (%)
S1	0.22	36
S2	0.28	34.4
S3	4.69	23.3 (Existing) 24.1 (Proposed)[1]
S4	6.11	22.1
S5	3.12	26.4
S6	0.25	28.4
S7	1.08	27.2
S8	0.36	38
S9	0.57	7
S10	0.93	11
TOTAL	17.67	-

[1] Imperviousness change based on one (1) home being developed in subdivision of 3188 Rothesay Road.

4.5 Model Development

The most recent version of Computational Hydraulic International (CHI) PCSWMM modelling software has been used to complete hydraulic simulation of existing and proposed future conditions. The software uses the U.S. Environmental Protection Agency (EPA) SWMM computational methods, and includes a GIS interface to assist in model development and the interpretation of output.

A PCSWMM model for the study was generated including conveyance, sub-watershed and storage nodes. The model framework is presented in Figure 4-2.

Figure 4-2: Detailed Study Area Map

An important component of the model is the storage feature receiving inflow from much of the study area. A storage node was used to simulate the volume of the natural storage feature north of Maiden Lane. A depth-area storage relationship was generated using LiDAR data; this relationship is presented in Figure 4-3.

Two modifications were made to the existing conditions model to simulate proposed future conditions:

1. The percent impervious in sub-watershed S3 was increased to account for the proposed subdivision of 3188 Rothesay Road. This update was based on proposed design drawings prepared by Hughes Surveys & Consultants (December 2017);
2. The available storage capacity in the natural storage feature is expected to reduce under proposed future conditions. A proposed future stage-storage curve was created excluding volume from the eastern portion of 3188 Rothesay Road. Both the existing and future stage-storage curves are presented in Figure 4-3.

The stage-storage curves presented in Figure 4-3 show that the existing and post-development storage curves are approximately equal up to a depth of approximately 0.4 m, where the two curves begin to diverge slightly. This can be attributed to the higher elevation of the storage area where the subdivision of 3188 Rothesay Road is proposed.

At the maximum elevation considered (depth of 0.8 m), the infilled storage under post-development conditions is estimated to be in the order of 130 m^3. This represents a reduction of approximately 4% of the total available storage volume. This assessment has assumed that the entire subdivided lot will be infilled.

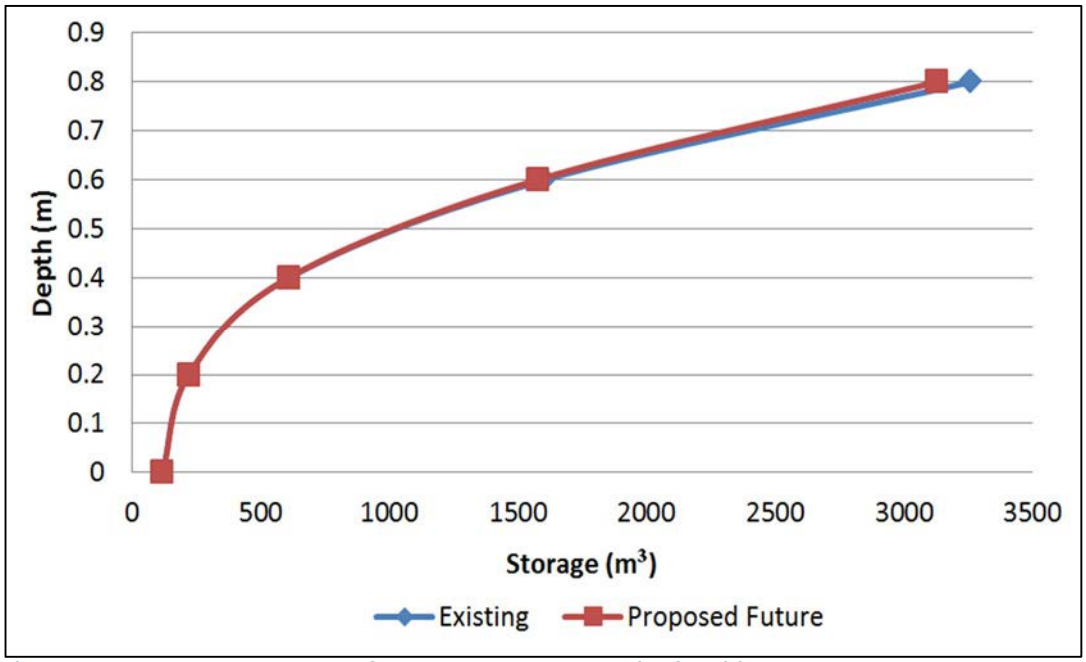


Figure 4-3: Stage-Storage Curves for Storage Feature North of Maiden Lane

5.0 Assessment of Flood Risk Vulnerability

The PCSWMM model was used to simulate a series of short-duration, high-intensity rainfall events to evaluate existing flood risk within the study area. The proposed development conditions model was then used to estimate the incremental impact on flood risk as a result of the proposed development at 3188 Rothesay Road.

5.1 Summary of Baseline Results

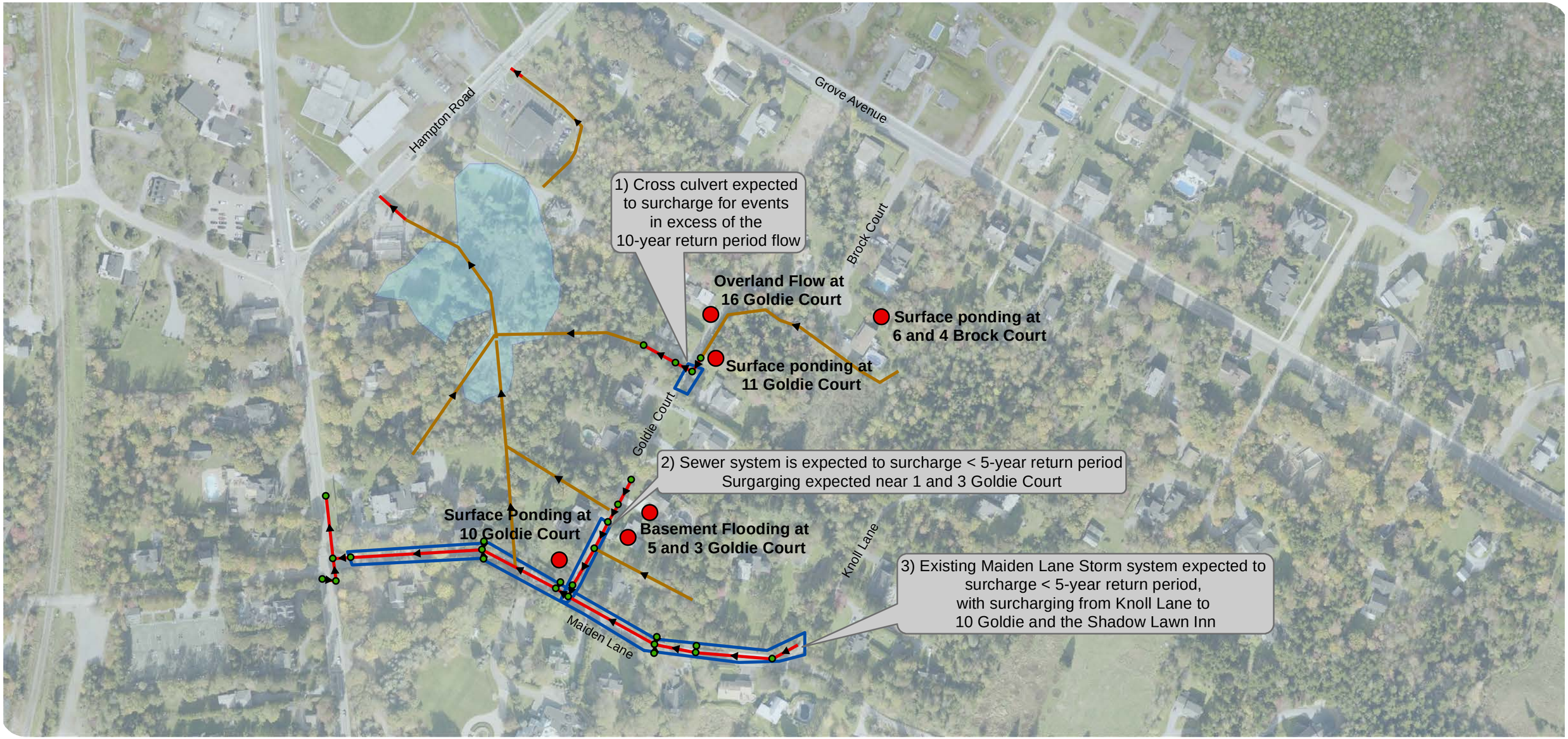
Simulation of existing conditions was undertaken for the 5, 10, 25 and 100-year rainfall events having a storm duration of 24-hours. Generally, the simulation results were consistent with reports of historical flooding from residents. The following areas were estimated to experience flooding for the simulated historical design storm events:

1. Surcharging of the 375 mm diameter cross culvert near 11 Goldie is expected for rainfall events with a return period in excess of 10-years.
2. Flooding near the intersection of Goldie and Maiden Lane is expected for all return periods considered. There is a sag in the roadway near 1 and 3 Goldie Court where water is expected to accumulate; this is consistent with reports of basement flooding in the area. The foundation/basement drain for 5 Goldie Court is suspected of discharging directly into one of the surcharged catch basins along Goldie Court.

3. Surcharging of the Maiden Lane storm system is expected throughout the system, notably at the upstream limit near Knoll Lane and behind Shadow Lawn Inn near the ditch inlet (see Figure 3-2). This surcharging was found to be the case both with and without the blockage in the Rothesay Road sewer.

   The blockage along Rothesay Road identified during the video survey is expected to increase hydraulic grade line elevations in the lower reaches of the Maiden Lane storm sewer. This increase was in the order of 0.15 m for the 5-year event, but had a diminished impact for higher intensity storms since the sewer was completely surcharged (i.e. roadway and overland conveyance dominated).

A graphical summary of flood vulnerable areas is presented in Figure 5-1 along with the estimated level of service in years for the drainage infrastructure. Generally the existing level of service described above is in line with historical flooding described by residents in the area. Particularly near the intersection of Goldie and Maiden where the most severe historical flooding is understood to have occurred; the model validated this area as having a low level of service.



Town of Rothesay
Maiden Lane Flood Vulnerability Assessment

Summary of Flood Vulnerability Areas
Figure 5-1

Catchbasins
Conduits (with Direction of Flow)
Flood Reports
Ditches (with Direction of Flow)
Simulated Flood Vulnerability Areas
1 Meter Contours
Storage Area

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED BY TOWN OF ROTHESAY

MAP CREATED BY: JEB
MAP CHECKED BY: JAM
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

N W E S

0 20 40 80 120 160 Meters

PROJECT: 18-6889 STATUS: DRAFT DATE: FEB 2018

5.2 Proposed Development Results

5.2.1 3188 Rothesay Road

Proposed future conditions were simulated to evaluate the incremental impact on flood risk within the study area as a result of the proposed subdivision of 3188 Rothesay Road. Flooding in the upper conveyance network through Brock, Goldie Court and Maiden Lane were found to be un-impacted by the proposed subdivided property. This is expected given that the flood prone areas of Goldie Court are approximately 1 m higher in elevation than 3188 Rothesay Road.

The simulation results indicate that a reduction of available storage capacity and the increase in impervious area at 3188 Rothesay Road marginally increases hydraulic grade line (HGL) elevations in the storage area north of Maiden Lane. A summary of simulated hydraulic grade line elevations for the storage area is presented in Table 5-1.

Table 5-1: Summary of Simulated Hydraulic Grade Line (HGL) Elevations for Storage Area

Return Period Rainfall Event (Years)	Simulated Existing HGL Elevation (m)	Simulated Proposed Future HGL Elevation (m)	Incremental Impact (m)
5	14.90	14.90	0.00
10	14.94	14.94	0.00
25	14.98	14.98	0.00
100	15.06	15.07	+0.01

The simulation results presented in Table 5-1 suggest that the impact to HGL elevations in the storage area is minimal. The impact is limited to the 100-year simulated rainfall event and is in the order of a 0.01 m increase. The HGL elevations presented in Table 5-1 result in maximum ponding depths (average over the storage area) of between 0.3 and 0.4 m. The slight increase in HGL during the 100-year event is consistent with the divergent stage-storage curves at higher elevations (see Figure 4-3).

Properties surrounding the storage area include the Scotia Bank (10 Hampton Road) and a Health Clinic (2 Hampton Road), as well as private residences at 8 Hampton Road and 3218, 3188 Rothesay Road. These sites generally have lot elevations between 15 and 16 m. The simulated HGL elevations presented in Table 5-1 suggest a risk of flooding during the more extreme events (i.e. 100-year); particularly basement flooding due to backing up of foundation drains that may discharge into the storage area. At least one small drain was identified discharging to the ditch; however the upstream connection to this drain could not be identified.

5.2.2 20 Goldie Court

Another residential development is proposed at 20 Goldie Court, whereby the existing lot would be subdivide into two lots. EXP Services Incorporated has been engaged by the developer to complete a drainage study to estimate pre and post-development peak flows and on-site storage requirements to maintain pre-development peak flows.

The EXP (2017) report does not include a grading plan or drainage routes for the proposed sub-divided lot. The analysis presented in the report was completed at a preliminary level and assumes that all runoff from the lots will be routed through the storage reservoir. In practice this can be impractical and proper implementation and function of the storage facilities should be refined as part of a detailed design exercise.

It is noteworthy that the current resident at 16 Goldie Court has suggested that surface runoff from 20 Goldie Court currently flows overland onto his property. Uncontrolled flows onto neighbouring property should be addressed as part of the stormwater management plan for the proposed sub-division of 20 Goldie Court.

6.0 Recommended Flood Mitigation Measures

Based on the estimated flood risk identified as part of this study, the following preliminary flood mitigation measures have been identified. This analysis focuses primarily on the minor drainage system and is expected to provide a 5-year level of service.

6.1 Rothesay Road

The blockage along the Rothesay Road storm sewer is expected to increase HGL elevations along the lower sections of the Maiden Lane sewer. It is recommended that this blockage be cleared to restore capacity in the Rothesay Road sewer. It is possible that other areas outside of the study area may also be impacted by the reduced capacity associated with the blockage.

6.2 Brock Court

A localized depression next to 6 Brock Court was observed to hold a considerable amount of surface water (see Figure 3-3), and is believed to back up into the rear yard of 6 Brock Court. An existing catch basin located between the ponded area and the roadway is set too high to capture this water. Possible mitigation measures may include: 1) re-grading the area to promote runoff to the existing catch basin, 2) installing an inlet to the storm system or 3) lowering the catch basin rim elevation if possible.

6.3 Maiden Lane

It is noteworthy that the existing 200 mm storm sewer along Maiden Lane is expected to surcharge during the 5-year, 24-hour rainfall event.

The hydraulic model was used to evaluate a range of storm sewer alignment and sizing options. The preferred system is presented in Figure 6-1, consisting of a new sewer ranging from 300 mm to 450 mm in diameter. The new system is proposed to start at the most up-gradient catch basin and run parallel to the existing sewer along the south roadside, and re-connect back into the existing system at CB3.

Figure 6-1: Proposed Maiden Lane Sewer Upgrade Concept (proposed sewers in red)

The proposed twinned system is expected to result in a peak flow of approximately 170 L/s entering the Rothesay Road storm sewer during the historical 5-year event. The pre-upgrade simulation indicated that roughly 70 L/s was expected to enter the Rothesay Road system for the same rainfall event.

The capacity of the existing Rothesay Road storm sewer has been evaluated to estimate the impact of the proposed Maiden Lane upgrades. The watershed contributing to the two upstream catch basins along Rothesay Road was delineated using LiDAR data for the area. The runoff contributions from these watersheds were simulated for the 5-year rainfall event. The simulation indicates that the additional flow from Maiden Lane (170 L/s) will not result in flooding along Rothesay Road. However, the HGL in the Rothesay Road sewer is expected to increase from 15.17 m to 15.45 m (+ 0.28 m), and could potentially impact residential sewer connections (i.e. foundation drains). These potential impacts should be considered prior to completing upgrades along Maiden Lane.

The downstream boundary HGL condition for the Rothesay Road storm sewer was set at the top of the pipe for the 5-year event simulation. The 450 mm sewer flows to the intersection of Rothesay and Hampton Road and enters an existing 900 mm storm sewer flowing toward Station Road. The current level of service for the 900 mm sewer is not known and is considered outside the scope of this study. It is recommended that the capacity of this system be reviewed prior to completing upgrades to understand the impacts of additional flows from Maiden Lane.

Installation of the proposed twin system along the southern roadway shoulder has been evaluated for the 5-year, 24-hour historical and projected future rainfall events. The following results were noted:

- The proposed system was found to result in no flooding of the storm sewer during the 5-year, 24-hour historical event.
- Some surcharging of the storm sewer was observed at the intersection of Maiden Lane and Rothesay Road during the projected future 5-year rainfall event.

It is anticipated that upgrades to the Rothesay Road storm system would be required to further improve capacity. New curb and gutter along the south shoulder of Maiden Lane is recommended to keep

surcharged flows within the roadway. Surcharged flows within the roadway would be expected to flow overland toward Hampton Road, eventually entering the 900 mm storm sewer flowing west toward Station Road.

6.4 Goldie Court

The recommended upgrades along Maiden Lane are expected to significantly improve drainage conditions along Goldie Court. Performance of the existing Goldie Court system was evaluated for both the historical and projected future 5-year, 24-hour rainfall events, the following results were noted:

- Simulation of the twinned Maiden Lane system indicates that the existing storm infrastructure along Goldie Court is sufficient to limit surcharging during the 5-year historical rainfall event.
- When simulating the projected future 5-year rainfall event, two sections of storm sewer between CB 16 and Maiden Lane need to be upgraded to 300 mm diameter. These upgrades are required to limit surcharging of the sewer system during the projected future 5-year rainfall event.

The 375 mm cross connection near 12 Goldie Court is estimated to have approximately a 10-year level of service (historical rainfall). Extending the existing storm system on Goldie Court upstream to meet the inlet of the 375 mm cross connection has been considered. The intent of this upgrade is to provide overflow capacity and improve the level of service of the cross connection, and reduce overland flow along Goldie Court when the cross connection is surcharged.

Hydraulic simulation indicates that the available overflow capacity from the 375mm cross connection to the Goldie sewer is not significant. Approximately 40 L/s could be diverted from the cross connection to the Goldie sewer without surcharging the downstream system, this represents a reduction in HGL at the inlet to the 375 mm cross connection of approximately 0.01 m.

It is expected that significant upgrades to the entire length of the Goldie Court sewer would be required to further improve the level of service at the 375 mm cross connection, and could compromise the proposed upgrades along Maiden Lane which is limited by the Rothesay Road sewer capacity. For these reasons, the storm sewer extension along Goldie Court was not considered further during this study.

6.5 Proposed Future Residential Development

It is recommended that a comprehensive stormwater management plan for the subdivided portion of 3188 Rothesay Road include measures to compensate for in-filled storage capacity and mitigate increases in HGL elevations during extreme flood conditions, estimated to be in the order of 0.01 m during the 100-year event.

A stormwater management plan is also critical for this property as the proposed development will be constructed immediately adjacent to a storage area expected to accumulate significant runoff volumes during extreme rainfall/snow melt events. Maintaining or improving the existing conveyance (i.e.

ditching) flowing through 3188 Rothesay Road is also critical to mitigate potential impacts to upstream areas.

Another proposed residential development at 20 Goldie Court was also reviewed at a conceptual level. The stormwater management plan for this property was prepared at a conceptual level and proposes that the sub-divided lot equate pre and post-development runoff conditions (EXP 2017). This net-zero approach to runoff management should be maintained and incorporated into detailed design and the final stormwater management plan.

It is noteworthy that the current resident at 16 Goldie Court has suggested that surface runoff from 20 Goldie Court currently flows overland onto his property. Uncontrolled flows onto neighbouring property should also be addressed as part of the stormwater management plan for the proposed sub-division of 20 Goldie Court.

7.0 Conclusion

This study has reviewed existing drainage conditions and flood risk within the study area, including sections of Maiden Lane, Goldie and Brock Court. Hydrologic and hydraulic simulation was completed to investigate performance of existing drainage systems, and evaluate potential impact of the proposed development at 3188 Rothesay Road. Based on these results, a set of recommended flood mitigations measures were prepared. Recommendations for infrastructure upgrades considered the projected impacts of climate change on rainfall intensity.

It is important to note that while inspecting the site and in speaking with residents, groundwater and sub-surface flows are expected to be an important factor in the area. Significant low-lying “wet” areas were identified east of Goldie Court, and most prominently in the storage area north of Maiden Lane. These areas will generally have a delayed runoff response during intense rainfall, and can rise significantly during the spring melt period. The analysis presented in this report has considered surface water flows generated by intense rainfall; flood risk vulnerability, particularly to basement flooding, may differ based on groundwater conditions in the area.

Appendix A

Video Inspection Summary Sheets

Tel:
Fax:
E-mail:

Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**60**
Certificate No.	**Survey Customer**	**System Owner**	**Date Cleaned**	**Pre-Cleaning**	**Sewer Category**
U-413-17418				**No Pre-Cleaning**	

Street123	**Goldie Court.**	Use of Sewer	**Stormwater**	Upstream MH	**CB15**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB8**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**8.81 m**	Section Length	**8.81 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**200 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:75	Position	Observation
CB15	0.00	Upstream Manhole, Survey Begins / CB15
	0.00	Water Level, 5 %of cross sectional area
CB8	8.81	Downstream Manhole, Survey Ends / CB8

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**59**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Goldie Court.**	Use of Sewer	**Stormwater**	Upstream MH	**CB16**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB15**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**29.60 m**	Section Length	**29.60 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**200 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:240	Position	Observation
CB16	0.00	Upstream Manhole, Survey Begins / CB16
	0.00	Water Level, 5 %of cross sectional area
CB15	29.60	Downstream Manhole, Survey Ends / CB15

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**56**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Goldie Court.**	Use of Sewer	**Stormwater**	Upstream MH	**CB19**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB18**
Loc. details		Flow Control		Dir. of Survey	**Upstream**
Location Code	**Light highway**	Length surveyed	**19.55 m**	Section Length	**19.55 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**200 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:165	Position	Observation
CB18	0.00	Downstream Manhole, Survey Begins / CB18
	0.00	Water Level, 5 %of cross sectional area
CB19	19.55	Upstream Manhole, Survey Ends / CB19

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**54**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Maiden Lane**	Use of Sewer	**Stormwater**	Upstream MH	**Buried MH**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB3**
Loc. details		Flow Control		Dir. of Survey	**Upstream**
Location Code	**Light highway**	Length surveyed	**87.71 m**	Section Length	**87.71 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**200 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:705	Position	Observation
CB3	0.00	Downstream Manhole, Survey Begins / CB3
	0.00	Water Level, 5 %of cross sectional area
Buried MH	87.71	Upstream Manhole, Survey Ends / Buried MH

87.71 m

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Rothesay	**Maiden Lane**			**54**

Photo: 61_61_319_A.JPG, VCR No.: 2
87.71m, Upstream Manhole, Survey Ends / Buried MH

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**55**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Maiden Lane**	Use of Sewer	**Stormwater**	Upstream MH	**CB3**
City	**Rothesay**	Drainage Area		Dowstream MH	**Rothesay Rd.**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**12.76 m**	Section Length	**12.76 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**300 mm**
Year Rehabilitated		Material	**Concrete Pipe**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:105	Position	Observation
CB3	0.00	Upstream Manhole, Survey Begins / CB3
	0.00	Water Level, 5 %of cross sectional area
Rothesay Rd.	12.76	Downstream Manhole, Survey Ends / Rothesay Rd.

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**52**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Maiden Lane**	Use of Sewer	**Stormwater**	Upstream MH	**CB4**
City	**Rothesay**	Drainage Area		Dowstream MH	**Buried MH**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**2.00 m**	Section Length	**2.00 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**100 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:50	Position	Observation
CB4	0.00	Upstream Manhole, Survey Begins / CB4
	0.00	Water Level, 5 %of cross sectional area
Buried MH	2.00	Downstream Manhole, Survey Ends / Buried MH

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**50**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Maiden Lane**	Use of Sewer	**Stormwater**	Upstream MH	**CB6**
City	**Rothesay**	Drainage Area		Dowstream MH	**Buried MH**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**57.85 m**	Section Length	**57.85 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**200 mm**
Year Rehabilitated		Material	**Polyvinyl Chloride**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:465	Position	Observation
CB6	0.00	Upstream Manhole, Survey Begins / CB6
	0.00	Water Level, 5 %of cross sectional area
Buried MH	57.85	Downstream Manhole, Survey Ends / Buried MH

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

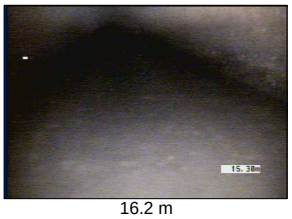
Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**63**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Rothesay Rd.**	Use of Sewer	**Stormwater**	Upstream MH	**CB98**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB97**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**16.20 m**	Section Length	**16.20 m**

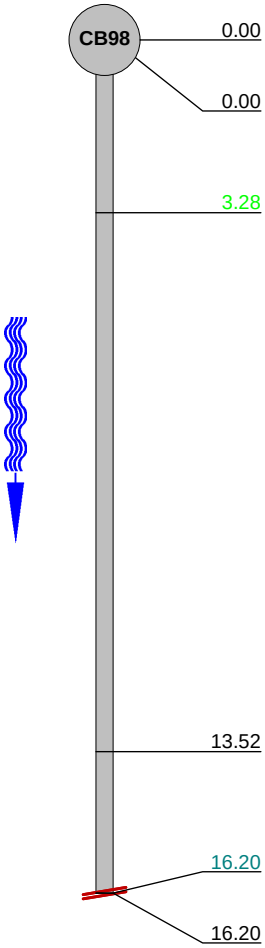
Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**450 mm**
Year Rehabilitated		Material	**Concrete Pipe**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:135 **Position** **Observation**



16.2 m



0.00 Upstream Manhole, Survey Begins / CB98

0.00 Water Level, 5 %of cross sectional area

3.28 Joint Separated Medium

13.52 Water Level, 25 %of cross sectional area

16.20 Deposits Settled Gravel, 50 %of cross sectional area, from 03 to 09 o'clock, , within 200mm of joint: YES

16.20 Survey Abandoned / Due to debris.

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
1100	**5100**	**1**	**5**	**6**	**1**	**5**	**3**

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Rothesay	**Rothesay Rd.**			**63**

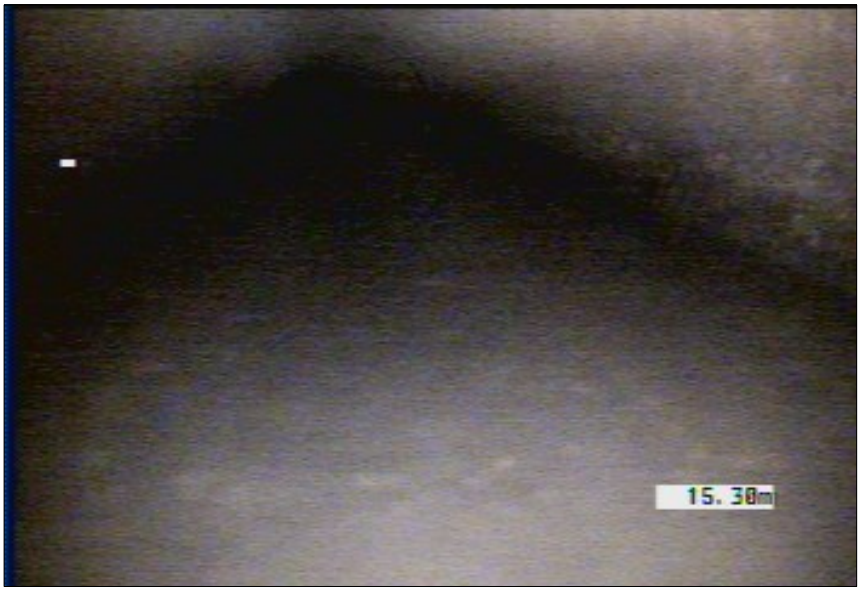

Photo: 70_70_354_A.JPG, VCR No.: 2
16.2m, Deposits Settled Gravel, 50 %of cross sectional area, from 03 to 09 o'clock, ,
within 200mm of joint: YES

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Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**61**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Rothesay Rd.**	Use of Sewer	**Stormwater**	Upstream MH	**CB100**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB99**
Loc. details		Flow Control		Dir. of Survey	**Upstream**
Location Code	**Light highway**	Length surveyed	**9.05 m**	Section Length	**9.05 m**

Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**450 mm**
Year Rehabilitated		Material	**Concrete Pipe**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:75	Position	Observation
CB99	0.00	Downstream Manhole, Survey Begins / CB99
	0.00	Water Level, 5 %of cross sectional area
CB100	9.05	Upstream Manhole, Survey Ends / CB100

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

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Inspection Report

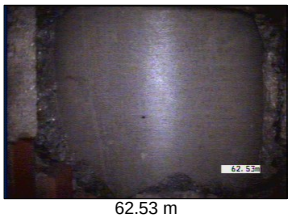
Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
1/16/2018		**Cold**	**Donny Barry**		**62**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-413-17418				**No Pre-Cleaning**	

Street123	**Rothesay Rd.**	Use of Sewer	**Stormwater**	Upstream MH	**CB99**
City	**Rothesay**	Drainage Area		Dowstream MH	**CB98**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**62.53 m**	Section Length	**62.53 m**

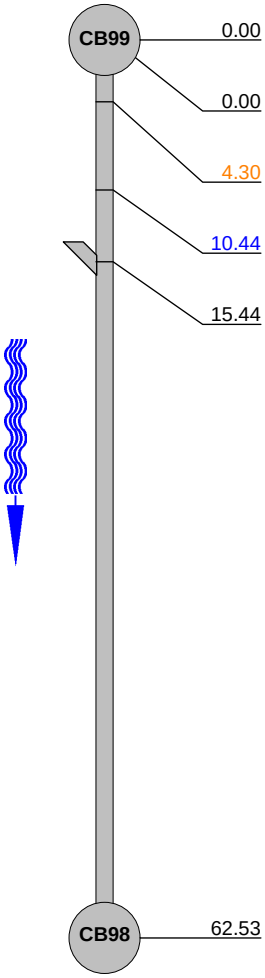
Purpose of Survey	**Capital Improvement Program Assessment**	Joint Length	
Year Laid		Dia./Height	**450 mm**
Year Rehabilitated		Material	**Concrete Pipe**
Tape / Media No.	**2**	Lining Method	

Add. Information :

1:495 **Position** **Observation**



62.53 m



0.00 Upstream Manhole, Survey Begins / CB99

0.00 Water Level, 5 %of cross sectional area

4.30 Deposits Settled Gravel, 15 %of cross sectional area, from 04 to 08 o'clock, , within 200mm of joint: YES

10.44 Joint Offset Large

15.44 Tap Break-In Intruding, at 02 o'clock, -, -, within 200mm of joint: YES, 300mm, 100mm

62.53 Downstream Manhole, Survey Ends / CB98 Buried

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
2100	**3100**	**2**	**3**	**5**	**2**	**3**	**2.5**

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E-mail:

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Rothesay	**Rothesay Rd.**			**62**

Photo: 69_69_349_A.JPG, VCR No.: 2
62.53m, Downstream Manhole, Survey Ends / CB98 Buried