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Enhancing our communities

Thornbury West Drainage Master Plan

MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT – PHASES 1 & 2

Town of The Blue Mountains

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Executive Summary

Tatham Engineering Limited has been retained by the Town of the Blue Mountains to complete a Drainage Master Plan which addresses Phases 1 and 2 of the Municipal Class Environment Assessment (MCEA) process. The MCEA process applies to all municipal road, water and wastewater projects and is used to identify, compare and evaluate alternative solutions to an identified problem considering the physical, natural, social, cultural and economic environments.

This Drainage Master Plan is a broad level assessment to support the development of a Preferred Alternative Solution to address the drainage deficiencies in the Thornbury West study area. The Thornbury West study area encompasses approximately 250 ha and is generally north of Russell Street to Georgian Bay and east of Albert Street to the Beaver River. Drainage infrastructure in the study area generally consists of a combination of open channels, ditches, culverts, storm sewers, overland flow routes and stormwater management facilities that outlet to the Beaver River, the Little Beaver River or Georgian Bay.

In the study area, several deficiencies were identified including:

- Undersized and deteriorating infrastructure;
- Areas absent of drainage infrastructure;
- Areas where municipal drainage is conveyed across private property or through privately owned infrastructure; and
- The absence of stormwater quality controls.

Opportunities exist to improve the drainage systems to meet the Town's design criteria, improve water quality and water balance conditions, reduce flooding and erosion, improve maintenance opportunities and eliminate public safety hazards. Following the MCEA process, this Drainage Master Plan has been completed to identify and evaluate drainage improvements based on their impacts to the social, physical, natural, cultural and economic environments. The Alternative Improvement Options that were considered as part of this Drainage Master Plan are:

1. Alternative 1 – Do Nothing (provides a benchmark to gauge the physical, natural, social, cultural and economic implications of the other alternatives)
2. Alternative 2 – Flow Reduction/Water Quality Improvement Opportunities
    i. Alternative 2A – New Stormwater Management Facilities
    ii. Alternative 2B – Lot Level Low Impact Development Measures
    iii. Alternative 2C – Linear Low Impact Development Measures
    iv. Alternative 2D – Centralized Low Impact Development Measures
    v. Alternative 2E – Mechanical Devices
3. Alternative 3 – Minor Drainage System Conveyance Capacity Improvements

   i. Alternative 3A – Minor Drainage System Improvements
   ii. Alternative 3B – Elimination of Municipal Drainage Entering Private Property
   iii. Alternative 3C – Service Areas Absent of Minor Drainage Systems
4. Alternative 4 – Major Drainage System Conveyance Capacity Improvements

Public consultation is very important to allow affected or interested stakeholders to exchange information and provide input for decision-making. To meet the public consultation requirements of the MCEA process, two public information centres were held to solicit feedback regarding the existing deficiencies and the proposed improvement alternatives. Following a comprehensive review of the alternatives, receipt of all comments from the interested stakeholders and agencies and completion of the improvement alternatives evaluation, the preferred alternative solution has been selected as follows:

1. Alternative 2E – Mechanical Devices ($1,643,000)
2. Alternative 3 – Minor Drainage System Conveyance Capacity Improvements
   i. Alternative 3A – Minor Drainage System Improvements ($2,417,000)
   ii. Alternative 3B – Elimination of Municipal Drainage Entering Private Property ($478,000)
   iii. Alternative 3C – Service Areas Absent of Minor Drainage Systems ($1,117,000)
3. Alternative 4 – Major Drainage System Conveyance Capacity Improvements ($3,038,000)

Overall, the Preferred Alternative Solution has an estimated cost of $8,693,000. The costs have been estimated assuming many of the projects occur in conjunction with future road reconstruction works and are based on the difference between the replacement price of the existing infrastructure and the cost to construct the recommended upgrade. It is expected that funding will occur from Development Charges, direct Developer Contributions, and/or taxation dependent on the project location and circumstances. The ratification of this Master Plan document by Town Council will allow for publication of the Notice of Study Completion. If no Orders for the project to comply with Part II of the Environmental Assessment Act are requested within thirty (30) days of publication, Phases 1 and 2 of the Municipal Class EA process will be complete, fulfilling the requirements for Schedule B projects.

1 Introduction

Tatham Engineering Limited (Tatham) has been retained by the Town of The Blue Mountains (Town) to complete a Drainage Master Plan following Approach #2 of the Master Planning process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). This Drainage Master Plan is a broad level assessment detailing the drainage deficiencies identified in the study area. It considers improvement options to address these deficiencies and completes an evaluation of these alternatives developing a preferred alternative solution to be implemented moving forward. Approach #2 involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process fulfilling the requirements for Schedule B projects.

1.1 STUDY AREA

The study area is approximately 250 ha and is located within the community of Thornbury, Ontario in the Town of The Blue Mountains. The study area encompasses the downtown core and the primary land uses are residential and commercial. The study area is generally bound by Russel Street and 10th Line to the south, Georgian Bay to the north, the Little Beaver River to the west and the Beaver River to the east. The location of the study area is illustrated on Figure 1 – Site Location Plan provided overleaf. It is generally referred to as the Thornbury West study area.

1.2 BACKGROUND

In 2015, Tatham was retained by the Town of The Blue Mountains to complete a Stormwater Management (SWM) Needs Study for a subarea within the Thornbury West study area as part of the Thornbury Road Infrastructure Project (TRIP). The purpose of the study was to identify the existing minor and major drainage systems, identify the existing drainage deficiencies, identify and evaluate alternative design concepts to improve the drainage deficiencies and prioritize the recommended preferred alternatives with a risk-based approach to capital planning.

Based on this evaluation, it was recommended that the minor drainage systems be upgraded to service the Town climate adjusted storms under future land use conditions, sections of storm sewer or ditches be constructed in areas that do not have defined drainage systems and that municipal drainage is diverted from private lands. Furthermore, it was recommended that the Rankin's Landing private system be cleaned out and that the Little Beaver River tributary watercourse be realigned and improved. Also, Low Impact Development (LID) measures and mechanical devices (oil grit separators) were recommended for consideration during detailed design to improve stormwater quality.

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THORNBURY WEST
DRAINAGE MASTER PLAN
SITE LOCATION PLAN

DWG. No.
FIG. 1

SCALE: NTS | DATE: MAY/18 | JOB NO. 117092

1.3 PROJECT TEAM

The project team responsible for the preparation of this report and the supporting documentation is comprised of the following:

- The Town of The Blue Mountains (Town);
- Tatham Engineering Limited (Tatham) – Engineering;
- Azimuth Environmental Consulting Inc. (AEC) – Natural Heritage;
- Archeoworks Inc. (AW) – Archeological;
- Peto MacCallum Ltd. (Peto) – Geotechnical; and
- Zubek, Emo, Patten & Thomsen Ltd. – Legal Survey.

1.4 MASTER PLANNING PROCESS – APPROACH #2

Approach #2 of the Master Planning process involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The Master Plan document is to be made available to the public and interested stakeholders for review and comment prior to adoption by the Town. Following Approach #2, the Master Plan satisfies the Municipal Class EA requirements for Schedule B projects allowing these projects to proceed directly to Phase 5 of the EA process and detailed design by way of a Notice of Study completion.

The Master Plan is a broad level assessment. In order to fulfil the requirements of the Municipal Class EA, recommended Schedule C projects require more detailed investigations at the project specific level. As such, the Master Plan document becomes the basis for, and is used in support of, future detailed investigations for the specific Schedule C projects. After completion of the Master Plan, Schedule C projects are required to fulfil Phases 3 and 4 prior to completing the Environmental Study Report (ESR) for public review.

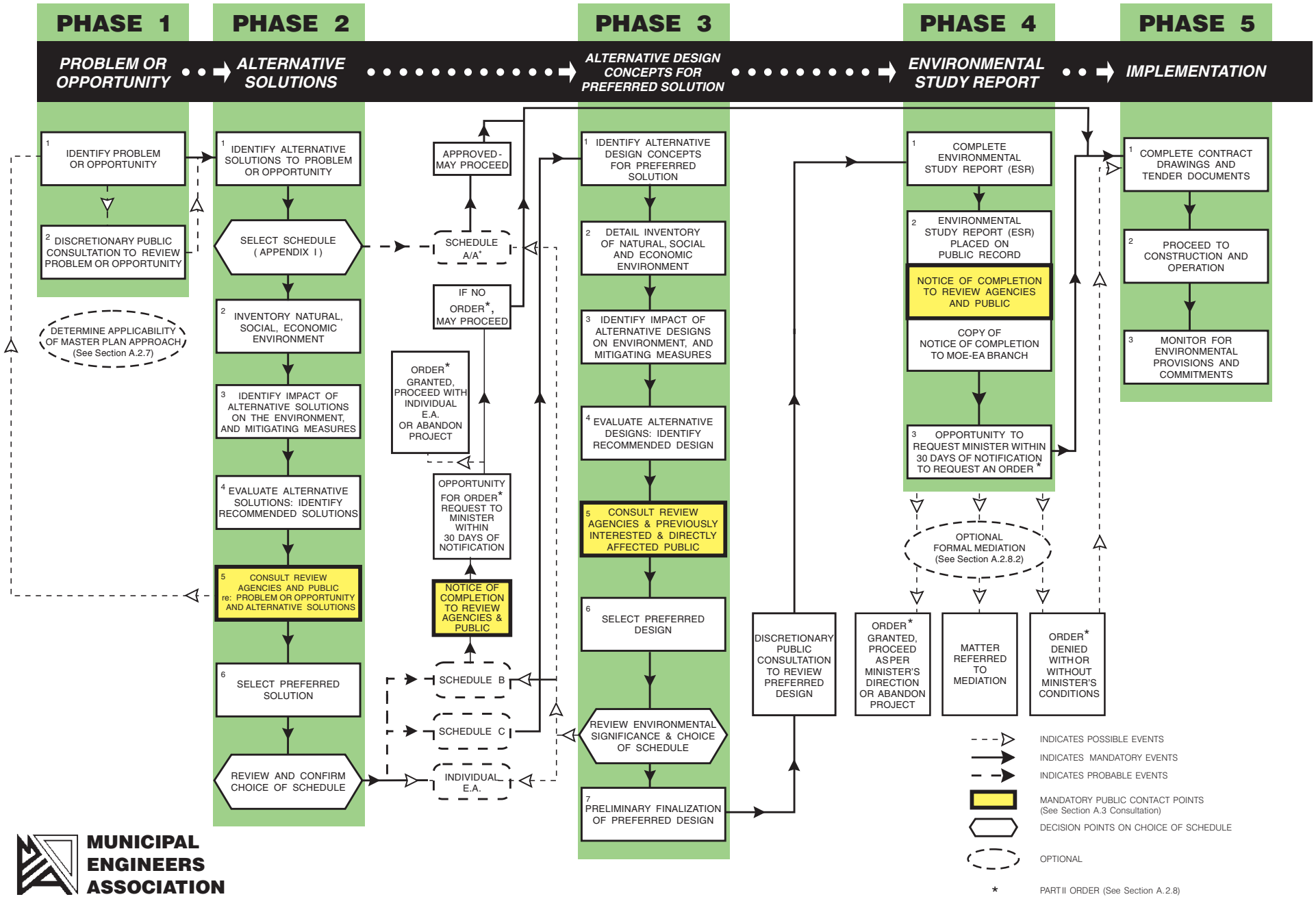
Master Plans are long-range plans that integrate infrastructure requirements for existing and future land uses with environmental assessment planning processes. Master Plans consider all aspects of the environment: physical, natural, social, cultural and economic, and involves consultation with the public, affected parties and review agencies throughout the process.

The Drainage Master Plan for the Town of The Blue Mountains is proceeding through Phases 1 and 2 of the Class EA process (provided overleaf) as follows:

Phase 1: Identify the Problem

EXHIBIT A.2 MUNICIPAL CLASS EA PLANNING AND DESIGN PROCESS

NOTE: *This flow chart is to be read in conjunction with Part A of the Municipal Class EA*



MUNICIPAL ENGINEERS ASSOCIATION

Phase 2: Identify and assess, at a strategic level, alternative solutions to the identified problem, then recommend the preferred master plan that can be implemented as separate subsequent projects.

The Drainage Master Plan will be finalized upon the conclusion of Phases 1 and 2 of the Class EA process and made available for public comment prior to being approved and adopted by the Town.

1.5 EXISTING POLICIES

There are several policies, regulations and guidelines which are to be adhered to as part of the proposed improvement alternatives. The most recent versions of these documents include the following:

1.5.1 The Blue Mountains' Stormwater Management System Design Criteria For Thornbury West Stormwater Drainage Master Plan EA (2017) and Engineering Standards (2009)

The Blue Mountains' Stormwater Management System Design Criteria For Thornbury West Stormwater Drainage Master Plan EA provides direction for the effective management of stormwater in the Town recognising the impact of snow melt and climate. This document has been provided to supplement and supersede the Town's *Engineering Standards* where applicable. These documents provide uniform minimum standards and policies for the planning process and stormwater infrastructure design. The documents include the Town's policies and guidelines regarding environmental protection (water quality, water quantity, etc.), natural hazards (flood and erosion hazards), stormwater management facility design, and urban design concepts. Generally, these guidelines include the mandates of other policies, regulations and guidelines discussed in this section. As such, these guidelines act as the basis for the development of the improvement alternatives in the study area. As per the Town's criteria, the minor drainage system (storm sewer) shall be designed to convey the 1:5 year (minimum) design storm peak flow. Open channels shall be capable of conveying the 1:100 year return frequency design storm with a free board equal to 0.20 times the depth and major storms must remain entirely within Town owned lands. Maximum flowing or ponding water must be a minimum of 300 mm below the lowest ground elevation adjacent to a building and street grading must provide a continuous gradient to direct surface flows to an adequate outlet at low points. Flooding of existing buildings and/or property shall be eliminated where feasible. Road culvert crossings and road elevations shall be designed to satisfy the following design criteria:

Table 1: Flow Design Guidelines for Road Crossings

ROAD CLASSIFICATION	DESIGN FLOOD FREQUENCY
Arterial	1:100 Year
Collector	1:50 Year
Local	1:25 Year

1.5.2 Stormwater Management Planning and Design Manual (2003)

The *Stormwater Management Planning and Design Manual* evolved from the Ministry of the Environment, Conservation and Parks (MECP) *Stormwater Quality Best Management Practices* manual (June 1991) in response to evolving stormwater management practices to provide an integrated approach to effective stormwater management planning and design focused on water quality, water quantity and erosion control. The Planning and Design Manual is a tool, not a rulebook, providing guidance for the effective design of lot level, conveyance, and end-of-pipe stormwater practices. The objectives of the Planning and Design Manual are to apply an integrated treatment train approach to manage stormwater to maintain the hydrologic cycle, protect water quality and prevent increased erosion and flooding.

In accordance with the Town's guidelines and *Ontario Regulation 219/09*, all new development and SWMF's shall provide as a minimum Enhanced Level water quality control as specified in the *Stormwater Management Planning and Design Manual* unless it can be demonstrated to the satisfaction of the Director (MECP) that it is impractical to achieve this level of protection.

1.5.3 GSCA Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation

The Grey Sauble Conservation Authority (GSCA) has a number of policy objectives including the protection of public health and safety, prevention of property damage and prevention of social disruption caused by natural hazards and conservation, protection and management of natural resources within the Grey Sauble watershed. The GSCA administers the *Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation* (Ontario Regulation 151/06) under Section 28 of the *Conservation Authorities Act*. Development within the GSCA Regulation Limits is subject to GSCA review and approvals allowing the GSCA to ensure development proposals have regard for the existing natural hazards. The Policies provide direction on land use and development considering natural hazards, natural heritage features, and the natural environment to protect public health and safety and to prevent property damage and social disruption.

1.5.4 The Town of The Blue Mountains Official Plan (2016)

The Official Plan (OP) outlines the goals, objectives and policies for land use and development within the Town of The Blue Mountains. The OP provides the Town direction for controlling growth, implementing by-laws and making public and private development decisions as a means of ensuring a healthy community. The OP provides guidance for land use changes, municipal initiatives and the provision of public works. As such, the OP provides policies for the effective management of stormwater.

The OP requires that all major commercial, industrial, institutional and residential development are supported by a SWM Report that shall:

- Provide recommendations on a stormwater quantity system which ensures that post-development run-off rates will not be greater than the pre-development run-off rates for storms up to and including the 1:100 year flood and the regional storm flood;
- Document the possible impacts of development on watershed flow regimes including their interconnection with groundwater resources;
- Provide recommendations on how to maintain pre-development water quality and improve run-off where appropriate;
- Document the means by which stormwater volume control will be provided;
- Provide a design that considers recreational amenity opportunities; and
- Determine and describe the necessary measures required to be undertaken during construction to mitigate potential negative impact of development.

Where applicable, the alternatives for this project will consider the OP's goals, objectives and policies.

1.5.5 Provincial Policy Statement (2005)

The 2005 *Provincial Policy Statement* was developed as a regulatory policy for land use planning and development. This statement supports the protection of public health and safety, the natural environment and the resources of provincial interest while providing for appropriate development. The policy identifies the natural and built features to be protected and the areas where development and site alteration are restricted. Key requirements of this policy are as follows:

- Development and site alterations are restricted on lands adjacent to natural heritage features unless it is demonstrated that the natural features and their ecological function are not negatively impacted;
- Development and site alteration are restricted on lands adjacent to sensitive surface water and groundwater features unless mitigative measures or alternative development approaches protect these natural features; and

- Significant built heritage features are to be conserved.

1.5.6 Low Impact Development Stormwater Management Planning and Design Guide (2010)

The Credit Valley Conservation Authority (CVC) and Toronto and Region Conservation Authority (TRCA) developed the *Low Impact Development Stormwater Management Planning and Design Guide* which speaks to the importance of at source SWM controls versus typical end-of-pipe facilities. The advantages of the LID approach include:

- Reduction in overall runoff volume;
- Reduction in phosphorus discharge; and
- Reduced long term operation and maintenance.

As such, implementing LID measures where feasible will help reduce flooding and improve the overall water quality of the watershed. On this basis, all future development should evaluate the use of LID development principles as part of the SWM design.

1.5.7 Natural Heritage Strategy

According to the *Official Plan*, the *Natural Heritage Strategy* for the Town has an overall goal to protect and enhance significant natural heritage features, areas and functions in the Town and to work towards the establishment of a Natural Heritage System. The specific strategic objectives are as follows:

- Protect significant natural heritage and hydrologic features and their associated habitats and ecological functions;
- Ensure that an understanding of the natural environment, including the values, opportunities, limits and constraints that it provides, guides land use decision-making in the Town;
- Make planning decisions that contribute to the protection, conservation and enhancement of water and related resources on a watershed and sub watershed basis;
- Maintain and enhance surface and groundwater resources in sufficient quality and quantity to meet existing and future needs on a sustainable basis;
- Discourage the loss or fragmentation of significant woodlands and habitats and ecological functions they provide;
- Recognize that an interconnected system of open spaces and natural heritage features contributes to the health and character of a community;
- Prohibit the loss or fragmentation of Provincially Significant Wetlands and significant habitat of endangered and threatened species;
- Maintain and enhance significant areas of natural and scientific interest, significant valley lands, escarpment slopes and related landforms, and significant wildlife habitat areas; and
- Promote and establish programs to increase the forest cover of the Town.

1.5.8 Natural Hazard Policies

The Natural Hazard Policies under the *Provincial Policy Statement* provide direction on land use and development in areas where there is a risk to public health and safety or a risk of property damage from flooding and/or erosion hazards. The Natural Hazard Policies aim to reduce the long-term risk to public health and safety or property damage through land management and by directing development outside hazardous lands. The natural hazards lands are defined in the Town's *Official Plan*.

1.5.9 Lakes and Rivers Improvements Act (LRIA)

The Lakes and Rivers Improvements Act is administered by the Ministry of Natural Resources and Forestry (MNRF) for the purpose of managing, protecting, and preserving the use of the water of the lakes and rivers of Ontario and the land under them. The purpose of the LRIA is to provide for:

- The protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario;
- The protection of the interests of riparian owners;
- The management, perpetuation and use of the fish, wildlife and other natural resources dependant on the lakes and rivers;
- The protection of the natural amenities of the lakes and rivers and their shores and banks; and
- The protection of persons and of property by ensuring that dams are suitably located, constructed, operated and maintained and are of an appropriate nature.

Approvals must be obtained from the MNRF under the LRIA for the following:

- Dams;
- Watercourse crossings (bridges, culverts and causeways) where the drainage area for the watershed upstream of the crossing is greater than 5 km2 unless construction is being undertaken by a Provincial Ministry or municipality, or contractors employed by a Provincial Ministry or municipality on lands owned by the Crown or the municipality undertaking the construction;
- River channels (channelization of rivers, including dredging, diverting or enclosing a channel except for the installation or maintenance of a drain subject to the Drainage Act) where channelization of a river or stream may harmfully alter fish habitat, or impede the movement of fish in a river, stream or lake. Where the potential impact of channelization work on fish habitat and/or fish movement is unknown, such impacts must be confirmed with the Department of Fisheries and Oceans (DFO) or their delegate in consultation with the MNRF. Where it is determined that proposed work will adversely affect fish habitat and/or impede the movement of fish an LRIA approval is required;

- Enclosures (river or stream enclosures) that enclose a length of watercourse greater than 20 m and may harmfully alter fish habitat or impede fish movement;
- Buried pipelines and cables where they hold back, forward or divert water; and
- Municipal and other drains.

1.5.10 Habitat Protection Provisions of the Fisheries Act

The habitat protection provisions are in place to address threats to fish from habitat loss/degradation and changes to natural flow regimes. The habitat protection provisions prohibit the carrying on of a work, undertaking or activity that results in serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery. Serious harm to fish is considered the death of fish or permanent alteration to, or destruction of, fish habitat including spawning grounds and any other area, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes. The habitat protection provisions are administered by the DFO under the Fisheries Act.

Proposals that cause serious harm to fish are subject to review and approval by the DFO under the Fisheries Act. The DFO requires the proponent of projects near water to undertake a self-assessment to determine if a DFO review is required. For those projects that cannot avoid serious harm to fish or is likely to contravene one of the Species at Risk Act prohibitions with respect to aquatic species, and does not satisfy the DFO exemption criteria, then a DFO review is required.

Waterbodies that do not require a DFO review are as follows:

- Approved marine disposal or dumping sites;
- Artificial waterbodies that are not connected to a waterbody that contain fish at any time during any given year, such as private ponds, commercial ponds, stormwater management facilities, irrigation ponds or channels, agricultural drains and drainage ditches, roadside drainage ditches, quarries and aggregate pits; and
- Any other waterbody that does not contain fish at any time during any given year and is not connected to a waterbody that contains fish at any time during any given year.

2 Problem/Opportunity Statement

The Problem and Opportunity Statements for this Drainage Master Plan are critical to demonstrate the need for the study and define an appropriate scope. These statements are provided in the following sections.

2.1 PROBLEM STATEMENT

Through previous stormwater studies, portions of the Thornbury West drainage area were identified with deficient infrastructure under minor and major storm events. Furthermore, several areas were identified where municipal drainage (minor and major flows) is currently conveyed across private property or through privately owned infrastructure with no easements or formal allowances, making it difficult to access and maintain. This private infrastructure is largely undocumented and its level of service is largely unknown.

In addition to capacity issues under existing conditions, the existing storm infrastructure is reaching its service life expectancy and deteriorating. Development, intensification, urbanization and growth in the watershed have also adversely impacted the stormwater quality and ecological health of the receiving water bodies. The culmination of the above noted factors results in a storm system that does not meet the Town's engineering and development standards.

2.2 WATERSHED AND SITE SPECIFIC PROBLEMS

Several existing problem areas have been identified through review of the available background information and previous stormwater studies and through consultation with Town staff and the general public. These problem areas include the following:

1. A makeshift drainage system consisting of a series of pipes and catchbasins north of Alfred Street and east of Lemon Street to Moore Crescent is located on private property with an indeterminate level of service. Field investigations indicate that the infrastructure is deteriorating and likely undersized.
2. A major drainage system behind Rankin's Landing receives municipal stormwater and conveys it across private property. The drainage system is limited by pipe obstructions and is undersized for major storm events such that there is a high probability of flooding under existing conditions.
3. The Little Beaver tributary watercourse has significant conveyance capacity deficiencies. Under major storm events, there is a spill north of King Street that will travel through the backyards of the properties fronting Huron Street. A second spill point exists at the low point on Huron Street, west of Lansdowne Street. This spill also has potential to impact a number of private properties as it travels north towards Georgian Bay.

Many of the problem areas identified through public consultation were related to undersized drainage infrastructure and lot grading issues. Lot grading issues are outside the scope of this study.

2.3 OPPORTUNITY STATEMENT

The Town is planning to mitigate the drainage deficiencies and replace the aging and deteriorating storm infrastructure throughout the study area as part of future works. Opportunities exist to improve the drainage systems beyond the level of service currently provided, improve water quality and water balance conditions, reduce flooding and erosion, improve maintenance opportunities and eliminate public safety hazards. As such, the Town has initiated this Drainage Master Plan to identify and evaluate drainage improvements based on their impacts to the social, physical, natural, cultural and economic environments. Through this study, a set of preferred improvement alternatives having the greatest positive impact and a recommended approach for implementing the alternatives will be developed.

3 Project Environment

This section provides a description of the existing physical, natural, social, cultural and economic environments within the study area. The detailed description of the project environment has been developed from a review of the available background information as well as recent field investigations.

3.1 PHYSICAL ENVIRONMENT

3.1.1 Private Property

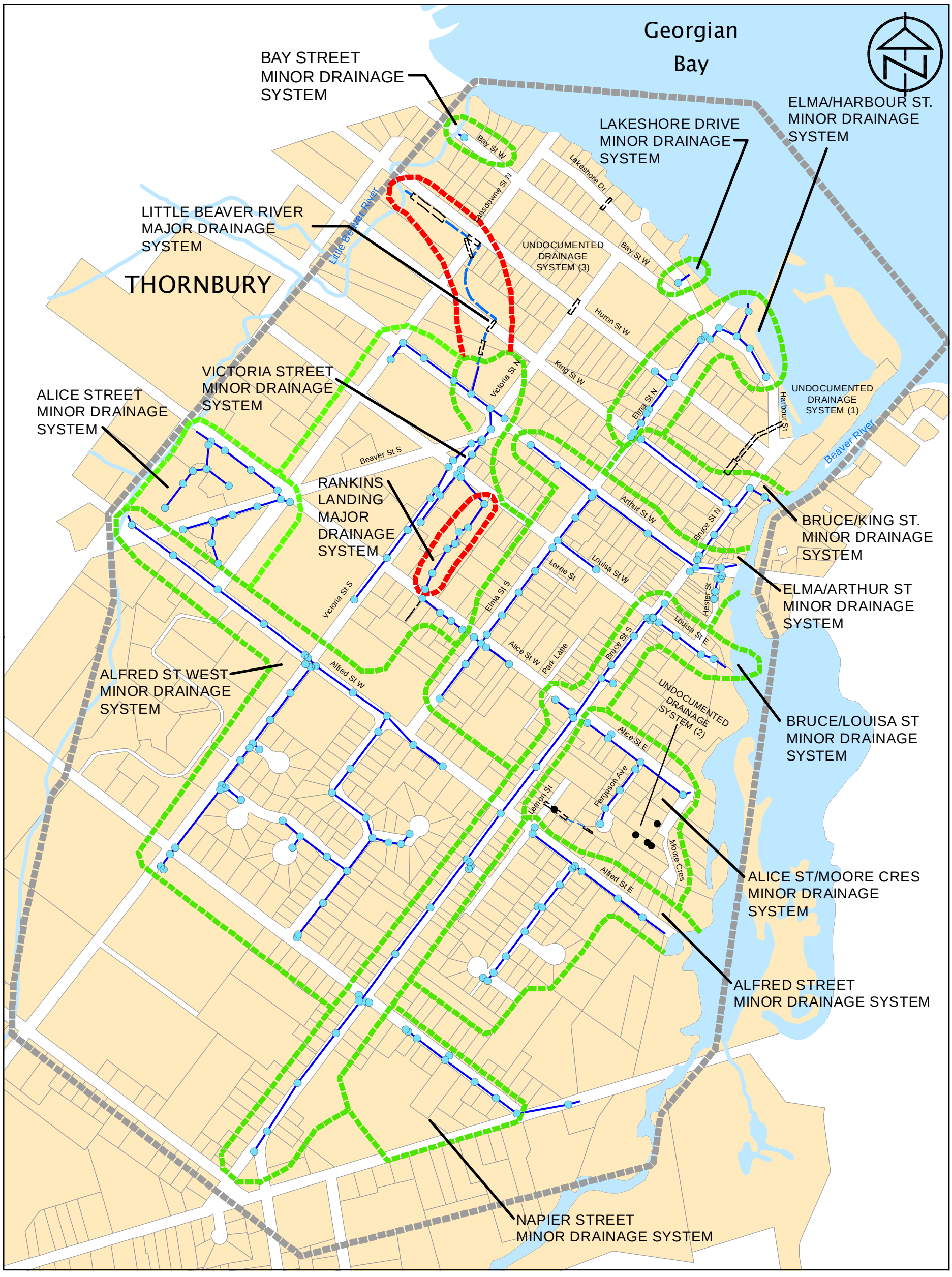
Within the study area there is a mix of residential, commercial, institutional, industrial, and open space land uses. As discussed, the existing drainage systems are located on both municipal and private property in the study area. Also, there is potential for flooding of private land during minor and major events due to undersized drainage infrastructure and the routing of municipal drainage through private property.

The improvement alternatives proposed aim to prevent/reduce flooding and conveyance of municipal drainage on private property.

3.1.2 Drainage Systems

Within the study area, the drainage systems consist of storm sewers, culverts, ditches, and open channels. The ultimate outlets for these systems are the Beaver River, Little Beaver River, and Georgian Bay. Local storm sewers convey flow during minor storm events to one of the ultimate outlets or to a major drainage system that continues to one of the ultimate outlets. The existing drainage areas and associated infrastructure are illustrated on Figure 2 – Minor/Major Drainage Systems Plan provided overleaf.

As per the Town's guidelines, the minor drainage system (storm sewer) shall be designed to convey the 1:5 year (minimum) design storm peak flow. Watercourses and channels shall be capable of conveying the Regulatory storm peak flow without flooding adjacent private property. Flooding of existing buildings and/or property shall be eliminated where feasible. Road culvert crossings and road elevations shall be designed to satisfy the design flood frequency criteria for the corresponding road classification. In the Study Area, the roads are classified as arterial and urban local roads. The design flood frequency criteria for each road classification is provided in Table 1 in Section 1.5.1.



Legend

- Storm Maintenance Hole
- Minor Drainage System
- Major Drainage System
- Culvert
- Undocumented Storm Structure

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THORNBURY WEST DRAINAGE MASTER PLAN
MINOR/MAJOR DRAINAGE SYSTEMS PLAN

DWG. No. **FIG-2**

SCALE: 1:5000 | DATE: MAY 2018 | JOB NO. 117092

As previously discussed, the existing storm infrastructure in the Thornbury West study area is reaching its service life expectancy and deteriorating. Many of the aging storm sewers are undersized considering historic rainfall data and the current climate models predict future increases in rainfall intensities and volumes. In some locations, municipal storm infrastructure is located on private property outside the municipal right-of-way making it difficult to access and maintain. For these reasons, the replacement of storm infrastructure in the study area is required.

The extent/locations of the existing minor and major drainage system deficiencies are described further in the *Existing Conditions Report* and illustrated on Drawings DDP-1 through DDP-7 enclosed in Appendix A.

It is recommended that the upsizing of local storm sewers to satisfy current design standards is considered as part of future road reconstruction projects. Similarly, relocating storm sewer to the municipal road allowance should be considered. Also, it is recommended that consideration be given to service the streets absent of a minor drainage system throughout the study area. The areas/streets absent of minor drainage systems are illustrated on Drawing DDP-1 in the *Existing Conditions Report* enclosed in Appendix A.

3.1.3 Existing Infrastructure (Sanitary, Water and Utilities)

Utilities including sanitary sewers, water main, gas, hydro and other overhead and buried utilities have been identified in the study area from the available record drawings. Conflicts with existing utilities will be reviewed for each improvement alternative proposed and potential conflicts and resolutions will be identified. Minor utility relocations and lowering of existing sanitary sewer and water main may be required to accommodate the improvement alternatives being evaluated.

3.1.4 Transportation System

In the study area, the roads are classified as Provincial Highway, arterial (County roads) and local roads. The road classifications are summarized in the following table and illustrated on the Town's OP *Schedule B-2 Transportation Thornbury and Clarksburg* provided overleaf.

Table 2: Road Classification

STREET	ROAD CLASSIFICATION	DESIGN FLOOD FREQUENCY
Highway 26/Arthur Street West	Provincial Highway	1:100
Alfred Street West	Arterial (County Road)	1:50
Bruce Street		
All other roads	Local	1:25

The Blue Mountains
Official Plan Schedule 'B-2'
Transportation
Thornbury and Clarksburg

Designations

- Highway 26
- County Roads
- Major Collector Roads
- Minor Collector Roads
- Local Roads
- Local Heritage Roads
- Private Roads
- Proposed Collector Roads
- Proposed Local Roads
- Bruce Trail - Existing Route
- Georgian Trail
- Trails
- Community Gateway

0 250 500 750 1,000 Metres

N W E S

Note: This Schedule forms part of the Official Plan and must be read and interpreted in conjunction with the text. The information depicted on this Schedule has been compiled from various sources. While every effort has been made to accurately depict the information, data/mapping errors may exist.

Download PDF: www.thebluemountains.ca June 2016

TOWN OF THE BLUE MOUNTAINS

Lake Dr
10th Line
Cameron St
Highway 26
High Bluff Lane
Peel St N
Peel St S
Baring St
Alice St W
Lansdowne St N
King St W
Huron St W
Lakeshore Dr
Harbour St
Cottage Ave
Arthur St W
Louisa St W
Beaver St S
33rd Sideroad
Albert St
Alfred St W
Elma St S
Bridge St E
Mill St
Duncan St W
Pyatt Ave
Alice St E
Huron St E
King St E
Bay St E
Victoria St S
Napier St W
Bruce St S
Riverside Cres
Elgin St S
Grey St N
Napier St E
Russell St E
Russell St W
Highway 26
Bayview Ave
Edward St
Mary St
Fulton St
Clark St
Lake Shore Rd
30th Sideroad
Brook St
John St
Hill St
Marsh St
Matilda St
Grey Road 2
Grey Road 13
Grey Road 40
Grey Road 113
Lot 35
Lot 34
Lot 33
Lot 32
Lot 31
Lot 30
Lot 29
Lot 28
X
IX
VIII

The proposed improvement alternatives include construction within the roadway to replace culverts and improve channel sections. These improvements will result in isolated temporary disturbances to the existing transportation system during construction. Storm sewer improvements are to be considered as part of future road reconstruction projects and as such, will not increase the disturbance to the existing transportation system beyond the planned disruption required for road reconstruction. The impact each improvement alternative has on the transportation systems is an important consideration for this study.

3.1.5 Floodplain

For the Thornbury West Study Area, the floodplains of the Beaver River and the Little Beaver River have been established on a piecemeal basis subject to nearby development. There are no private property concerns related to the floodplain.

3.1.6 Parkland

The existing parks are an important consideration within the study area. The parks provide a green space amenity within the Town for pedestrian connectivity and community use. The parks are features enjoyed by not only surrounding residents but residents throughout the Town. The maintenance of the parks is an important consideration. Parkland has been identified for its potential inclusion of LID measures and/or SWMF's. LID measures can be constructed in existing parklands to reduce minor drainage system peak flows, enhance water quality treatment, improve the water balance and reduce erosion while maintaining the existing function/use of the parkland. SWMF's may provide the added benefit of reducing major drainage system peak flows, however at a cost of disturbing the surface features, function and use of the parkland or a portion of it.

3.2 NATURAL ENVIRONMENT

Azimuth Environmental Consulting Inc. completed an Environmental Impact Study (EIS) in support of this Master Plan to identify potential constraints associated with Natural Heritage Features and Functions in the study area. Specifically, the EIS evaluates constraints based on possible considerations related to vegetation communities, Species at Risk (SAR), fish and fish habitat, and Significant Wildlife Habitat. To support this evaluation, Azimuth completed a review of background information and collected general site characterization data during 2017 field surveys in 21 representative areas. Preliminary results indicate that proposed improvements will not pose net negative impacts on Natural Heritage Features or Functions in the study area provided recommended mitigation measures are followed. Key aspects of the EIS are summarized in the following sections and the specific recommendations to mitigate natural heritage impacts are detailed in the EIS enclosed in Appendix B.

3.2.1 Vegetation

Residential and commercial land uses with manicured lawns and hardscape surfaces dominate the study areas in which drainage improvements are proposed. Beyond the urban areas, the study area is interspersed with agricultural fields and pockets of cultural wooded areas and open meadows. Common native vascular plant species observed included Sugar Maple, Canada Goldenrod, Red Osier Dogwood, Paper Birch, White Cedar, and White Pine. Non-native vascular plant species observed included Queen Anne's Lace, Purple Cow Vetch and European Buckthorn. Overall, the improvement alternatives will provide opportunities to enhance native plantings.

3.2.2 Fisheries

The drainage systems in the study area outlet to the Beaver River, Little Beaver River, and Georgian Bay. The Beaver River includes a fishway (i.e. fish ladder) that allows migratory fish such as Rainbow Trout, Chinook Salmon and Pacific Salmon to access upper reaches of the Beaver River during spawning season. The Beaver River also provides habitat for Brown Trout, Channel Catfish, Smallmouth Bass and White Sucker. The Little Beaver River does not have fish community data, but salmonids are anticipated to use this watershed. A historical list of fish species in Georgian Bay is included in the EIS. The Beaver River, Little Beaver River and Georgian Bay are coldwater systems containing migratory salmonids and as such, no in-water work is permitted between September 30 and July 15 of the following year.

As many of the drainage systems contribute flow directly to areas where fish occur, project planning should include considerations of fisheries and mitigation measures for avoiding direct or inadvertent impacts during improvements. Specifically, 20 areas have been identified where fisheries should be considered during the planning stages of potential projects to identify permitting requirements. A qualified fisheries ecologist should provide confirmation of the extent of impacts to fish habitat and permitting requirements during detailed design for projects in these areas. Submission to Fisheries and Oceans Canada (DFO) may be required.

3.2.3 Terrestrial Wildlife

No species-specific surveys were conducted as part of this study. However, general field surveys, inventories and background data/mapping reviews were completed to identify habitat for threatened and endangered species and significant wildlife habitat. Per the habitat surveys of the 21 areas where municipal road and drainage improvements are being considered, 13 were identified with potential natural heritage sensitivities, including the possibility of habitat for breeding amphibians, woodland area-sensitive breeding birds and SAR occurring within or adjacent to the potential work areas. The SAR that were identified to have potential to occur in or adjacent to the study area are:

- Barn Swallow (threatened);

- Blanding's Turtle (threatened);
- Butternut (endangered);
- Little Brown Myotis (endangered bat);
- Northern Myotis (endangered bat);
- Northern Map Turtle (special concern);
- Snapping Turtle (threatened); and
- Tri-colored Bat (endangered).

The turtle and the bat species have potential to occur adjacent to the proposed work footprints and therefore would not be anticipated to pose environmental constraints provided appropriate avoidance/mitigation measures are followed.

Significant Wild Habitat features and functions were found with potential to occur in the study area, however proposed work footprints were not found to extend into any of these identified areas and therefore these habitats do not pose potential constraints.

3.2.4 Water Quality

The Thornbury West study area is predominantly developed. Generally, the developed areas do not have water quality controls that meet current standards, but this is not considered as potential new sources of water quality degradation. Based on the substandard existing condition, opportunities to improve water quality should be considered where feasible, including the following:

1. Low Impact Development measures;
2. SWMF's; and
3. Mechanical Devices.

All new developments shall provide the minimum Enhanced Level water quality control as specified in the *Stormwater Management Planning and Design Manual* unless it can be demonstrated to the satisfaction of the Director (MECP) that it is impractical to achieve this level of protection.

3.3 SOCIAL ENVIRONMENT

3.3.1 Property Value

Existing flooding and the presence of municipal infrastructure on private property can negatively impact property values. As such, any improvement alternatives that will prevent/reduce flooding on private property and relocate municipal infrastructure/drainage into municipally owned lands will be a positive improvement.

3.3.2 Public Safety

The existing drainage systems throughout the study area operate at levels below current Town standards and as such result in nuisance flooding on municipal and private property. The flooding presents a potential for public safety concerns. The conveyance of both minor and major storm flows and compliance with the *Provincial Policy Statement* is an important consideration in the review of improvement alternatives.

In addition to flooding, the lack of safety grates on storm sewer and culvert inlets/outlets and the lack of pedestrian barricades at fall hazards pose a threat to public safety. Therefore, the installation of safety grates and pedestrian barricades is highly recommended.

3.4 CULTURAL/ARCHAEOLOGICAL ENVIRONMENT

Archeoworks Inc. completed a *Stage 1 Archaeological Assessment* in 2018 in support of this Drainage Master Plan. Based on background research, there is an elevated potential for the recovery of archaeologically significant materials within the study area. A desktop review identified parts of the study area that have had archaeological potential removed and parts of the study area that have no or low archaeological potential. The assessment concluded that lands that were previously deemed free of further archaeological concern through previous studies are recommended to be exempt from further assessment. For the remaining areas, the Stage 1 assessment provided specific direction for the requirements of a Stage 2 Archaeological Assessment in areas that are to be impacted by the improvement alternatives. No construction activities shall take place within the study area prior to the Ministry of Tourism, Culture and Sport (Archaeology Programs Unit) confirming in writing that all archaeological licensing and technical review requirements have been satisfied. The conclusions and recommendations of the assessment are detailed in the *Stage 1 Archaeological Assessment* enclosed in Appendix C for reference.

3.5 ECONOMIC ENVIRONMENT

3.5.1 Drainage System Maintenance Costs

Throughout the study area, the Town incurs costs to maintain their existing drainage systems on both municipal and private property. Clearing obstructions, repairing erosion and removing accumulated sediment are routine maintenance activities the Town must coordinate and complete. As existing storm infrastructure reaches its service life expectancy and deteriorates, the maintenance costs increase. Limited access to drainage infrastructure on both private and municipal lands also increases maintenance costs.

The improvement alternatives being considered aim to attenuate peak flows, improve water quality, increase conveyance capacities and prevent/reduce the flooding on private property. Through these improvements, maintenance costs associated with conveyance can be expected

to decrease. Proposed SWMF's or LID measures will require routine maintenance that must be considered.

3.5.2 Construction Costs

Each improvement alternative has a capital cost to construct. Preliminary cost estimates for each improvement alternative shall be considered to aid in the evaluation of the economic impacts to implement each alternative. In general, the alternative improvement options shall be considered as part of future renewal projects to reduce costs.

4 Existing Conditions System Analysis

As described in Section 1.2, Tatham completed a SWM Needs Study for a portion of the study area as part of the Thornbury Road Infrastructure Project (TRIP). The SWM Needs Study included the development of minor and major drainage system models to be used in the identification and analysis of the minor and major drainage system deficiencies. Tatham prepared a PCSWMM hydrologic/hydraulic model of the minor drainage systems in the study area and a Visual OTTHYMO hydrologic model and HEC-RAS hydraulic model of the major drainage systems. The models developed for the SWM Needs Study were used as a basis for the Master Plan.

The base models for the SWM Needs Study area were developed from information provided by the Town including a map of the minor drainage SWM infrastructure, record/design drawings of the existing SWM infrastructure, and inspection reports/videos for undocumented infrastructure within the study area. For the Master Plan, the Town supplemented the SWM Needs Study information with GIS data and record/design drawings for the SWM infrastructure in the larger study area.

The results of the Master Plan models represent existing conditions across the study area and are summarized in the following sections. The minor and major drainage systems, the hydraulic and hydrologic analysis and the minor and major system deficiencies are fully detailed in the *Existing Conditions Report* included in Appendix A.

4.1 EXISTING DRAINAGE SYSTEMS

The minor drainage systems are defined as networks of storm sewer, ditches and culverts collecting and conveying surface runoff from private and municipal lands to Georgian Bay, the Beaver River, the Little Beaver River and tributaries of the rivers during frequent (minor) storm events. The major drainage systems are defined as municipal roadways, overland flow routes, drainage channels and the river tributaries conveying surface runoff during infrequent (major) storm events. Twelve minor drainage systems have been identified within the study area. The municipal roadways are the basis of the major drainage systems in the study area and generally mirror the minor drainage systems. In addition to the municipal roadways, two significant open channel/culvert systems have been identified. The drainage systems are illustrated on the Minor/Major Drainage Systems Plan (Figure 2) and are summarized in Table 3:

Table 3: Minor/Major Drainage Systems Summary

MINOR DRAINAGE SYSTEM	OUTLET	OUTLET ID	CONTRIBUTING AREA (ha)
Napier Street	Little Beaver River	BR_2057	3.7
Alfred Street	Beaver River	BR_2481	8.6
Alice Street/Moore Crescent	Beaver River	BR_2587	6.3
Bruce/Louisa Street	Beaver River	BR_2639	14.8
Elma/Arthur Street	Beaver River	BR_03	16.1
Bruce/King Street	Beaver River	BR_401	2.4
Elma/Harbour Street	Georgian Bay	GB_402	7.0
Victoria Street	Tributary Watercourse (Little Beaver River)	HW_0016	20.7
Lakeshore Drive	Georgian Bay	GB_403	2.4
Bay Street	Little Beaver River	LBR_404	0.4
Alice Street	Little Beaver River	LBR_2048	6.0
Alfred Street West	Little Beaver River	LBR_3761	33.3
Little Beaver River Tributary Watercourse	Little Beaver River	1200 mm dia. conc. culvert	61.5
Rankin's Landing Drainage System	Little Beaver River	Ditch_0011	15.0

There are also several undocumented drainage systems within the study area which are on private lands. Three significant networks of undocumented stormwater conveyance infrastructure have been identified and are fully described in the *Existing Conditions Report*.

4.2 HYDROLOGIC ANALYSIS

Following identification of the minor and major drainage systems, a hydrologic analysis was completed to develop runoff hydrographs for each drainage system. Throughout the Master Plan study area, it was confirmed that the climate adjusted Owen Sound IDF curves for summer storms govern over the Spring Potential Rain on Snow events. The hydrologic model results were derived from the PCSWMM and Visual OTTHYMO models. The results of the hydrologic analyses under existing and future conditions are detailed in the *Existing Conditions Report* enclosed in Appendix A and are summarized in Table 4 overleaf.

Table 4: Drainage System Peak Flow Summary (m^3/s)

MINOR DRAINAGE SYSTEM	EXISTING CONDITIONS (5 YEAR PEAK FLOW)	FUTURE CONDITIONS (5 YEAR PEAK FLOW)
Napier Street	0.20	0.42
Alfred Street	0.55	0.69
Alice Street/Moore Crescent	0.51	0.59
Bruce/Louisa Street	0.80	0.85
Elma/Arthur Street	1.03	1.04
Bruce/King Street	0.43	0.51
Elma/Harbour Street	1.16	1.16
Victoria Street	1.50	1.96
Lakeshore Drive	0.33	0.42
Bay Street	0.07	0.09
Alice Street	0.53	0.56
Alfred Street West	1.36	1.56
Little Beaver River Tributary Watercourse	3.36	4.88
Rankin's Landing Drainage System	0.51	1.14

4.3 HYDRAULIC ANALYSIS

To evaluate the capacity of the minor and major drainage systems and identify the deficiencies in each, hydraulic analyses of the minor and major drainage systems were completed. The minor and major drainage system hydraulic models were generated in PCSWMM and HEC-RAS/HY-8, respectively. Upon completion of the hydraulic analysis, the deficiencies in the minor and major drainage systems within the study area were identified based on the Town's design criteria.

4.3.1 Minor Drainage System Deficiencies

The storm sewer sections that do not meet the Town's design criteria for minimum diameter, grade, or velocity are illustrated on Drainage System Deficiency Plan DDP-1 included in the *Existing Conditions Report* enclosed in Appendix A. The areas/streets absent of a minor drainage system are also illustrated on Drawing DDP-1. Per the Town design criteria, the minor drainage systems must convey the peak flow generated by the 5 year return frequency storm without

surcharge. The surcharging deficiencies were evaluated for the 5 year storm to determine the severity of the deficiency as follows:

1. Maximum flow versus storm sewer full flow capacity – the peak flow of the runoff hydrograph at each individual storm sewer has been compared to the full flow capacity of the pipe. Maximum flow to full flow capacity ratios greater than 1 (maximum flow exceeds full flow capacity) indicate a deficiency in the system.
2. Pipe surcharge duration – when the maximum flow exceeds the full flow capacity of the storm sewer, the storm sewer surcharges. The duration or length of time the surcharge occurs indicates the severity of the deficiency.
3. Maintenance hole surcharge depth – when the capacity of the storm sewer is exceeded, the storm maintenance holes have the potential to surcharge to grade causing overland flow. The depth of surcharge above grade at each maintenance hole is an indication of the severity of the deficiency.

The sections of storm sewer that do not satisfy the 5 year return frequency criteria under existing and future land use conditions have been identified on the Drainage System Deficiency Plans (Drawings DDP-2 through DDP-5) included in the *Existing Conditions Report* enclosed in Appendix A. Summaries of the deficiencies within each minor drainage system are provided in Table 5 overleaf.

Table 5: Minor Drainage System Deficiency Summary

MINOR DRAINAGE SYSTEM	NUMBER OF DEFICIENT STORM SEWER SECTIONS					
	MAXIMUM FLOW/FULL FLOW CAPACITY		PIPE SURCHARGE DURATION		MAINTENANCE HOLE SURCHARGE DEPTH	
	EXISTING	FUTURE	EXISTING	FUTURE	EXISTING	FUTURE
Napier Street	3	4	3	5	0	0
Alfred Street	5	10	11	13	0	8
Alice Street/Moore Crescent	1	1	1	2	0	0
Bruce/Louisa Street	17	22	29	30	12	16
Elma/Arthur Street	13	18	21	28	6	9
Bruce/King Street	0	0	1	1	0	0
Elma/Harbour Street	9	11	15	16	6	8
Victoria Street	3	6	9	13	0	3
Lakeshore Drive	1	1	1	1	1	1
Bay Street	0	0	0	0	1	0
Alice Street	3	3	12	12	0	0
Alfred Street West	9	16	15	27	1	5

As shown in Table 5, the existing minor drainage systems are deficient under existing land use conditions as pipe and maintenance hole surcharging is expected. Future development and intensification will increase the runoff to each drainage system and consequently increase the number of deficiencies in the minor drainage systems.

4.3.2 Major Drainage System Deficiencies

The dual drainage system in the PCSWMM model has been used to identify sections of roadway that do not satisfy the return frequency ponding criteria described in the Town's design criteria. The dual drainage system was based on standardized road cross-sections that do not necessarily mimic existing conditions but provide a reasonable estimate. The deficient areas have been identified on Drawings DDP-6 and DDP-7 included in the *Existing Conditions Report* enclosed in Appendix A. Summaries of the number of storm sewer sections with overlying municipal roadway (major) deficiencies within each minor drainage system are provided in Table 6:

Table 6: Number of Major Drainage System Deficiencies

MINOR DRAINAGE SYSTEM	25 YEAR STORM PONDING CRITERIA		100 YEAR STORM PONDING CRITERIA	
	EXISTING	FUTURE	EXISTING	FUTURE
Napier Street	0	0	0	0
Alfred Street	5	7	3	4
Alice Street/Moore Crescent	0	0	0	0
Bruce/Louisa Street	17	21	19	24
Elma/Arthur Street	9	13	6	11
Bruce/King Street	0	0	0	0
Elma/Harbour Street	3	7	3	3
Victoria Street	4	13	0	10
Lakeshore Drive	0	0	0	0
Bay Street	0	0	0	0
Alice Street	0	0	0	0
Alfred Street West	6	13	5	9

The major drainage system HEC-RAS hydraulic model was used to evaluate the function of the existing Little Beaver River tributary watercourse against the Town's design criteria for channel capacity and road culvert crossing capacity. The key capacity and deficiency data is summarized in Table 7:

Table 7: Little Beaver River Tributary Watercourse Deficiency Summary

REACH/CULVERT	EXISTING CAPACITY (m^3/s)	REQUIRED CAPACITY (m^3/s)	
		EXISTING	FUTURE
Channel - HW1 – Georgian Trail	**2.30**	**2.52**	**3.58**
Georgian Trail Crossing (1500 mm Ø CSP)	2.79	1.41	2.53
Channel - Georgian Trail – King Street	> 3.58	2.52	3.58
King Street Crossing (1120 mm Ø CSP)	**0.83**	**1.64**	**2.81**
Channel – King Street – Lansdowne Street	**1.64**	**2.84**	**3.95**
Channel – Parallel to Lansdowne Street	> 3.95	2.84	3.95
Lansdowne Street Crossing (750 mm Ø CSP and 700 mm × 1300 mm CSP Arch)	**< 0.74**	**1.90**	**2.99**
Channel - Lansdowne Street to Outlet Culvert	**1.90**	**3.16**	**4.51**
Outlet Culvert (1200 mm Ø Concrete)	**0.57**	**3.36**	**4.88**

Notes: **Bold text** indicates a deficient section of channel or a deficient culvert crossing.

Details and model results of the major drainage system deficiencies are provided in the *Existing Conditions Report* enclosed in Appendix A and are illustrated on Drawings DDP-6 and DDP-7.

The Rankin's Landing major drainage system consists of CSP culverts that are partially to fully obstructed by rip rap and debris. The existing obstructions create a deficient system. Conveyance of any flow through Rankin's Landing is dependant on a proper cleanout.

4.3.3 Undocumented Drainage Systems

The undocumented drainage systems are illustrated on Figure 2. Undocumented SWM infrastructure south of the Georgian Trail and north of Alfred Street (Undocumented Drainage Systems 1 and 2) are known to be deficient in that they take municipal drainage through private lands. Furthermore, flooding/undesirable ponding issues along Undocumented Drainage System 2 have been noted by residents.

Undocumented Drainage System 3 is similarly deficient. A hydraulic analysis of the Lakeshore Drive and Lansdowne Street culvert crossings confirm the crossings do not have sufficient capacity to convey the 25 year design storm peak flows downstream without overtopping the road. The hydraulic calculations for these culverts are included in the *Existing Conditions Report* in Appendix A.

5 Description of Improvement Alternatives

Integral to the planning process is the consideration and evaluation of alternatives to address the problem statement and where possible, correct the noted deficiencies. The improvement alternatives developed as part of this study are described in the following sections.

5.1 EXISTING CONDITIONS

5.1.1 Alternative 1 – "Do Nothing"

The "Do Nothing" alternative allows for the consideration of not implementing any changes to the existing minor and major drainage system infrastructure within the study area. This alternative is being considered to provide a benchmark to gauge the physical, natural, social, cultural, and economic implications of the other alternatives.

5.2 FLOW REDUCTION/WATER QUALITY IMPROVEMENT OPTIONS

Opportunities exist in the study area to implement SWM measures to attenuate flows, improve water quality and divert flows around areas susceptible to flooding. These opportunities include the creation of new SWMF's, implementation of lot level, linear, and centralized LID's, and the installation of mechanical devices such as oil grit separators. The flow reduction/water quality improvement options considered as part of this study are described in the following sections and are illustrated on Figure A enclosed.

5.2.1 Alternative 2A – New Stormwater Management Facilities

An opportunity exists to create new SWMF's within the study area to improve water quantity control, attenuate peak flows, reduce downstream flooding, improve watershed water quality, promote infiltration, and improve the water balance. There is limited municipal land available within the study area to construct SWMF's that will have an appreciable reduction in peak flow and acquisition of private property has been considered to facilitate construction of new SWMF's. Furthermore, the study area is composed of numerous small drainage systems where peak flow attenuation will have limited potential to provide appreciable cost savings for downstream infrastructure. Based on these limitations, three areas were identified to have the greatest potential to provide positive impacts on the project environments. These three areas have been carried forward for future analysis. Remaining areas were pre-screened out based on excessive property acquisition requirements or unsuitable topographic or environmental conditions. The three areas that have been considered for evaluation are described as follows:

1. Arthur Street SWMF – An opportunity exists to acquire the vacant commercial lot at the outlet of the Victoria Street minor drainage system for the creation of a new SWMF. A wet pond at this location has the potential to provide Enhanced water quality treatment and peak flow attenuation for the 5 year design frequency storm with a permanent pool volume of 3,450 m3 and an active storage volume of 2,695 m3. There is no potential to provide significant peak flow attenuation for storms greater than the 5 year design frequency storm. Due to the potential for adverse backwater effects, this pond has been designed for the 5 year design frequency storm. Flows produced by less frequent storm events will continue to drain to the channel with no attenuation. Beyond the quantifiable quality and quantity improvements, construction of this SWMF will have the added benefit of improving wildlife habitat.
2. Alfred Street SWMF 1 – An opportunity exists to acquire private property (backyards of residential lots) north of the Beaver Valley Community Centre for creation of a new SWMF. A dry pond at this location has the potential to provide peak flow attenuation for the spill from the Alfred Street West minor drainage system with an active storage volume of 1,000 m3. This SWMF would reduce the 100 year design frequency storm peak flow by 70%. This SWMF will have the added benefit of improving wildlife habitat.
3. Alfred Street SWMF 2 – An opportunity exists to provide underground storage in the parking lot of the Beaver Valley Community Centre. An underground storage system at this location has the potential to provide peak flow attenuation for the spill from the Alfred Street West minor drainage system with an active storage volume of 1,060 m3. This SWMF would reduce the 100 year design frequency storm peak flow by 95%. This SWMF will have limited impact on the existing land use.

Conceptual design drawings for the SWMF's are included in Appendix D.

5.2.2 Alternative 2B – Lot Level Low Impact Development Measures

An opportunity exists to promote the use of lot level LID's on private property to improve watershed water quality, promote infiltration, and improve the water balance. Specifically, the opportunity exists to promote the use of rain barrels and implementation of soakaway pits by residents and property owners in the study area and the Town at large.

5.2.3 Alternative 2C – Linear Low Impact Development Measures

An opportunity exists to implement linear LID's to attenuate peak flows, improve watershed water quality, promote infiltration, and improve the water balance. Specifically, the opportunity exists to implement perforated pipe infiltration systems as part of local road reconstruction projects within the study area. Consistent with the recommendations of the *Low Impact Development Stormwater Management Planning and Design Guide* (2010), perforated pipe infiltration systems are only recommended for local roads.

5.2.4 Alternative 2D – Centralized Low Impact Development Measures

An opportunity exists to implement centralized LID's to attenuate peak flows, improve watershed water quality, promote infiltration, and improve the water balance. Specifically, the opportunity exists to implement infiltration galleries within existing parkland and at locations absent of any water quantity or quality controls. There are limited parks within the study area that are feasible for centralized LID's. Therefore, acquisition of private property for potential centralized LID's has also been considered. Most areas were pre-screened out based on excessive property acquisition requirements, unsuitable topography, or unsuitable environmental conditions. The two areas that have been considered for evaluation are described as follows:

1. Arthur Street Centralized LID – An opportunity exists to acquire the vacant commercial lot at the outlet of the Victoria Street minor drainage system for the creation of a centralized LID. An underground infiltration system at this location has the potential to provide water quality and quantity control for the 25 mm storm with a storage volume of 1,405 m3.
2. Alfred Street West Centralized LID – An opportunity exists to use a portion of the park at the corner of Alfred Street West and Victoria Street for the creation of a centralized LID. An underground infiltration system at this location has the potential to provide water quality and quantity control for the 25 mm storm with a storage volume of 1,085 m3.

Neither of these areas will provide significant peak flow attenuation, however they will provide water quality treatment, promote infiltration, and improve the water balance. Conceptual design drawings for the centralized LID's are included in Appendix D.

5.2.5 Alternative 2E – Mechanical Devices (Oil Grit Separators)

An opportunity exists to implement mechanical devices to improve watershed water quality. Specifically, the opportunity exists to install oil grit separators within the minor drainage system storm sewer networks where SWMF's or centralized LIDs are not feasible to treat the stormwater.

5.3 CONVEYANCE CAPACITY IMPROVEMENT OPTIONS

Opportunities exist in the study area to implement conveyance capacity improvements to reduce flooding on both private and municipal property. These opportunities include minor drainage system improvements, elimination of municipal drainage entering private property, servicing areas absent of a minor drainage system, and major drainage system improvements including culvert improvements, channel/overland flow route improvements, and trunk storm sewer construction. Trunk storm sewer is generally used to describe sewer that has been designed with capacity beyond the 5 year storm flows to eliminate overland flow route deficiencies. The conveyance capacity improvement options considered as part of this study are described in the following sections and are illustrated on Figure B enclosed.

5.3.1 Alternative 3A – Minor Drainage System Improvements

An opportunity exists to implement minor drainage system improvements across the study area. The existing storm infrastructure is reaching its service life expectancy and deteriorating. Furthermore, a majority of the aging storm sewers are undersized considering the Town's design criteria. The opportunity to upsize existing storm pipes to satisfy current design standards should be considered as part of future road reconstruction projects. The minor drainage system deficiencies are illustrated on the Drainage System Deficiency Plans (Drawings DDP-1 through DDP-5) included in the *Existing Conditions Report* enclosed in Appendix A.

5.3.2 Alternative 3B – Elimination of Municipal Drainage Entering Private Property

An opportunity exists to eliminate municipal drainage from entering private property. In addition to the deficient minor drainage systems within the municipal right-of-way, specific areas have been identified where undocumented storm sewer systems take municipal drainage through private properties. For these cases, options exist to divert the municipal drainage such that it stays within the municipal right-of-way as follows:

1. Lemon Street Diversion – An opportunity exists to route the drainage from Lemon Street away from Undocumented Drainage System 2. Undocumented Drainage System 2 takes drainage through private property between Alfred Street East and Alice Street East. The Lemon Street diversion can be routed to the Alfred Street Minor Drainage System or the Alice Street/Moore Crescent Minor Drainage System. As part of this improvement opportunity, it is recommended that a storm sewer service is extended along Moore Crescent to provide a formal system to the Alice Street outlet. Furthermore, it is recommended that the Alfred Street and Alice Street/Moore Crescent improvements are sized to account for the future potential connection of the private drainage system that currently comprises Undocumented Drainage System 2.
2. Victoria Street Diversion – An opportunity exists to route the drainage from Alice Street West and the spill from the Alfred Street West minor drainage system spill away from Rankin's Landing and divert it to the Victoria Street minor drainage system. Currently, there is a private drainage system through Rankin's Landing that takes municipal drainage and is susceptible to flooding.

Conceptual design drawings for the flow diversions are included in Appendix D.

5.3.3 Alternative 3C – Service Areas Absent of Minor Drainage Systems

An opportunity exists to service areas that currently have no minor drainage systems. Through review of the drainage systems, a number of streets in the study area have been identified that are absent of minor drainage systems. As such, it is recommended that consideration be given to service the streets absent of minor drainage systems throughout the study area.

5.3.4 Alternative 4 – Major Drainage System Conveyance Capacity Improvements

An opportunity exists to implement major drainage system improvements across the study area. Opportunities exist to improve overland flow routes and road crossing culverts to meet the Town's design criteria for major system conveyance. Furthermore, the opportunity exists to construct trunk storm sewer or implement road grading improvements as part of road reconstruction projects to eliminate excessive ponding depths or flows within the municipal right-of-way. The major drainage system deficiencies are illustrated on the Drainage System Deficiency Plans (Drawings DDP-6 and DDP-7) included in the *Existing Conditions Report* enclosed in Appendix A.

The primary area where overland flow route, channel improvements and road crossing culvert improvements are required is the Little Beaver River tributary watercourse. Options have been developed to re-route or improve the channel to the Little Beaver River or Georgian Bay. The options that have been considered are illustrated on a conceptual drawing included in Appendix D.

There is a significant spill from Alfred Street West that drains through Rankin's Landing. As such, improvement options have been considered to eliminate the spill through Rankin's Landing. These options include the provision of a trunk storm sewer on Alfred Street West to eliminate the spill or the diversion of the spill to a trunk storm sewer on Victoria Street. Diversion to Victoria Street will impact the sizing of the downstream storm sewer and therefore, quantity control facilities for the spill have also been considered. The options for the spill diversion are illustrated on the conceptual drawings included in Appendix D.

6 Public Consultation – Discretionary Public Information Centre (PIC#1)

For the Thornbury West Drainage Master Plan, public consultation was completed in accordance with the Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). The public consultation undertaken leading up to and including the discretionary public information centre (PIC#1) for this study is outlined in the following sections.

6.1 PUBLIC INFORMATION CENTRE

A Public Information Centre (PIC) was held on March 10, 2018 at the Town Hall (32 Mill Street, Thornbury) to present drainage deficiencies identified throughout the study area, elicit input/feedback regarding any additional drainage deficiencies not identified through the study, and to present the preliminary alternative design solutions. The Notice of PIC#1 was posted at the Town Hall and L.E. Shore Memorial Library on February 22. Notification letters for PIC#1 were also mailed out or hand delivered on February 22. The mail-outs and deliveries went to properties with significant potential to be impacted by the identified deficiencies or the preliminary alternative design solutions.

At the PIC, local residents were presented with maps identifying the various drainage deficiencies across the study area and the preliminary alternative design solutions. The public was encouraged to provide input/feedback regarding the study. Comment sheets were provided and attendees were encouraged to identify their preferences regarding the alternative design solutions. The PIC notifications and presentation materials are enclosed in Appendix E for reference.

6.2 RESULTS OF PUBLIC CONSULTATION

The Discretionary Public Information Centre (PIC#1) was attended by 29 interested stakeholders and 10 written comments were received. Many of the comments were related to lot grading and maintenance issues outside the scope of this project. 9 of the comment sheets indicated a preliminary preferred alternative solution(s). Copies of the comments received are available in Appendix E for reference.

6.3 IDENTIFIED DRAINAGE ISSUES

During the PIC, a number of attendees identified drainage issues they have witnessed. Of note, the following drainage issues were identified:

- No road drainage infrastructure on Alice Street east of Victoria Street causes frequent nuisance ponding;
- The drainage through the Bay Street unopened allowance does not have a proper outlet;
- Frequent nuisance ponding occurs at the intersection of Alfred and Lemon Street due to a deficient drainage system; and
- Obstructed culverts reduce the efficacy of stormwater conveyance during routine storm events.

6.4 PUBLIC PREFERENCE

The majority of public responses preferred a combination of alternative drainage solutions to address the identified drainage issues. Implementing flow reduction/water quality improvement options in combination with conveyance system improvements was generally preferred. A summary of the public's preferred alternative drainage solution(s) following PIC#1 is included in the following table. The alternative drainage solutions that were present at PIC#1 are fully described in the supporting material in Appendix E.

Table 8: Public Consultation Preliminary Preferred Alternative Summary

RESPONDENT	PRELIMINARY PREFERRED ALTERNATIVE SOLUTION(S)
Respondent 1	Combination of Alternatives 2A, 2B, 3A, 3C, 3D
Respondent 2	Combination of Alternatives 2A, 2B, 3A, 3B, 3C, 3D
Respondent 3	Combination of Alternatives 2A, 3A, 3B, 3C, 3D
Respondent 5	Combination of Alternatives 2A, 2B, 3C
Respondent 6	Alternative 3D
Respondent 7	Combination of Alternatives 2B, 3B
Respondent 8	Combination of Alternatives 2A, 2B, 3B, 3C, 3D
Respondent 9	Combination of Alternatives 2A, 2B, 3A, 3C
Respondent 10	Combination of Alternatives 2B, 3D

6.5 PRIVATE PROPERTY DRAINAGE ISSUES

There were a number of comments from the public related to private property drainage issues. Ultimately surface or groundwater drainage issues on private property or between two or more private properties is the responsibility of the private property owners. Dealing with the issues raised by these comments is outside the scope of this study.

Of note, the Town plays a role in reducing private property drainage issues as part of the development review process and the best practice is to minimize issues during the planning/construction phases. Current practices are to review development applications for conformance to current standards and guidelines. Based on comments received and our experience with developments in the area, we recommend that the groundwater monitoring requirements associated with new developments are increased. Town guidelines currently note that basement floor slabs are to be set 0.3 meters above the seasonal high groundwater levels in new developments. However, the groundwater monitoring data used in design is often insufficient to establish the seasonal high groundwater level. The Town should consider prescribing the duration of groundwater monitoring required to determine the seasonal high groundwater level. Where that monitoring period cannot be met, the separation between basement grades and estimated seasonal high groundwater levels should be increased. The groundwater monitoring requirements should be reviewed as part of the next Town Standards update.

7 Overall Improvement Alternatives Assessment

To assess the effectiveness of the improvement alternatives considered, the existing conditions minor and major drainage system models of the study area have been revised to include the proposed improvement alternatives where applicable. The results of the analysis are discussed in the subsequent sections. The improvement options were reviewed and assessed based on their physical, natural, social, cultural, and economic impacts. A broad level assessment was completed to eliminate improvement alternatives that are not required to address the problem statement and produce negative impacts on the environments. Similarly, for improvement alternatives that provide the same function, the broad level assessment was completed to determine the alternative with the greatest positive impact on the project environments. The improvement alternatives that provide a required function with the greatest positive impact were carried forward and evaluated in detail on a project specific level.

7.1 EXISTING CONDITIONS

7.1.1 Alternative 1 – "Do Nothing"

Alternative 1 represents the "do nothing" alternative and generally does not meet the Town's design criteria. Undersized storm sewer results in frequent nuisance flooding throughout the study area and safety concerns. Similarly, private systems with limited maintenance are subject to frequent nuisance flooding, ponding water, and safety concerns which are exacerbated when they receive municipal drainage. Areas absent of minor drainage system are subject to similar issues. Undersized major drainage systems have significant flooding and safety concerns during major storm events. Existing systems without proper quality control will have continued growing negative impacts on the water quality of receiving water bodies. Due to the extent of water quantity and water quality deficiencies throughout the study area, the implementation of the "do nothing" alternative has been eliminated as it is not practical due to the impacts on the physical, natural, and social environments.

7.2 FLOW REDUCTION/WATER QUALITY IMPROVEMENTS

7.2.1 Alternative 2A – New Stormwater Management Facilities

The Visual OTTHYMO hydrologic model of the major drainage catchments in the study area has been revised to include the contemplated SWMF creation opportunities and has been digitally submitted with this Master Plan. The hydrologic model results and the stage-storage-discharge tables developed for the proposed SWMF's are included in Appendix F. The conceptual drawings

are included in Appendix D. The flow reductions for the SWMF creation opportunities are summarized in the following table:

Table 9: SWMF Creation Flow Reduction Hydrologic Model Results Summary (Alternative 2A)

SWMF ID	FLOW REDUCTION (m^3/s / %)									
	2 YEAR		5 YEAR		25 YEAR		100 YEAR		REGIONAL	
Arthur Street	0.80	*93.6%*	0.87	*66.3%*	0.00	*0.0%*	0.00	*0.0%*	0.00	*0.0%*
Alfred Street 1	0.04	*68.4%*	0.09	*77.9%*	0.47	*92.2%*	0.64	*70.1%*	0.07	*16.8%*
Alfred Street 2 (UGS)	0.13	*93.5%*	0.20	*93.8%*	0.51	*95.5%*	0.87	*95.8%*	0.23	*85.6%*

The analysis demonstrates that the proposed SWMF's considered under Alternative 2A result in a measurable reduction in peak flow downstream of each SWMF. The Arthur Street SWMF provides peak flow reduction for minor storm events, however it does not provide attenuation for major storm events due to the limited depth available for active storage. The Alfred Street SWMF options significantly reduce the peak flows from the Alfred Street spill for all storm events.

In addition to peak flow attenuation, the Arthur Street SWMF has been designed to provide water quality treatment. The Arthur Street SWMF provides 80% total suspended solids removal for the Victoria Street minor drainage system which qualifies as Enhanced water quality control. Under existing conditions there is negligible water quality control for the Victoria Street minor drainage system. The Alfred Street SWMF options are strictly designed for peak flow attenuation to deal with the spills from the Alfred Street West system during major storm events and no water quality benefits are provided.

Construction cost estimates have been prepared for improvement Alternative 2A. The construction cost estimates are included in Appendix G and are summarized in the following table:

Table 10: SWMF Creation Construction Cost Estimates (Alternative 2A)

SWMF ID	ESTIMATED CONTRUCTION COST
Arthur Street	$1,016,000
Alfred Street 1	$705,000
Alfred Street 2 (UGS)	$1,566,000

Note: Estimated construction costs include property acquisition costs.

7.2.2 Alternative 2B – Lot Level Low Impact Development Measures

The PCSWMM minor drainage system hydrologic/hydraulic model was updated to include rain barrels and soakaway pits throughout the study area to determine the impact of each lot level LID measure on runoff volumes and peak flows for each drainage system. The PCSWMM models created for the rain barrels and soakaway pits have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models and are summarized in the tables presented below.

For the PCSWMM model, rain barrels were assumed to have surface areas of approximately 0.34 m^2 and heights of 1.25 m. The application rate for rain barrels was assumed to be 1 unit per 4 roofs in areas zoned residential. The area that drained to the rain barrels was assumed to be 6.25% of the residential building areas (25% of the roof area of 1 in 4 buildings). For each subcatchment, the number of rain barrels and the corresponding drainage areas were calculated and applied to the PCSWMM model. Detailed descriptions of the design parameters, usage characteristics and methodology of application for the rain barrels are included in Appendix H. The results of the analysis for the 100 year design storm are summarized in the following table.

Table 11: Rain Barrel Rainfall Interception Summary (Alternative 2B)

DRAINAGE AREA	INTERCEPTION (mm)	PEAK FLOW REDUCTION (m^3/s/%) 100 YEAR STORM	
Napier	0.06	0.000	0.0%
Alfred	0.08	0.001	0.1%
Alice/Moore	0.10	0.001	0.1%
Bruce/Louisa	0.09	0.001	0.1%
Elma/Arthur	0.05	0.000	0.0%
Bruce/King	0.05	0.001	0.1%
Elma/Harbour	0.06	0.003	0.2%
Victoria	0.06	0.010	0.3%
Lakeshore	0.06	0.001	0.1%
Bay	0.08	0.000	0.1%
Alice	0.08	0.002	0.2%
Alfred West	0.05	0.000	0.0%

For the PCSWMM model, soakaway pits were assumed to have surface areas of 4.0 m^2 and the depths were calculated based on a design infiltration rate and a 48 hour drawdown time. The maximum soakaway pit depth was set to 900 mm and the minimum depth was set to 300 mm. The design infiltration rates are calculated based on the hydraulic conductivity and a safety factor associated with the subcatchment soil type. Details for the design infiltration rate calculation are included in Appendix H. The applicate rate and drainage area for soakaway pits was assumed to be the same as rain barrels. For each subcatchment, the number of soakaway pits and the corresponding drainage areas were calculated and applied to the PCSWMM model. Detailed descriptions of the design parameters, usage characteristics and methodology of application for the soakaway pits are included in Appendix H. A typical soakaway pit detail is also included in Appendix H. The results of the analysis for the 100 year design storm are summarized in the following table.

Table 12: Soakaway Pit Infiltration Summary (Alternative 2B)

DRAINAGE AREA	INTERCEPTION (mm)	PEAK FLOW REDUCTION (m^3/s/%) 100 YEAR STORM	
Napier	0.08	0.001	0.2%
Alfred	0.12	0.002	0.2%
Alice/Moore	0.13	0.002	0.2%
Bruce/Louisa	0.15	0.002	0.2%
Elma/Arthur	0.08	0.000	0.0%
Bruce/King	-0.01	0.001	0.1%
Elma/Harbour	0.00	0.003	0.2%
Victoria	0.10	0.005	0.2%
Lakeshore	-0.01	0.001	0.2%
Bay	0.00	0.000	0.1%
Alice	0.14	0.003	0.3%
Alfred West	0.08	0.000	0.0%

As shown in the above summary tables, the lot level LID's provide only a modest increase in interception/infiltration and have a negligible impact on peak flows for major storms. Due to the uncertainty of application, any reductions in peak flows cannot be relied on. However, the general water quality and water balance improvements provided by lot level LID's are sufficient

to promote their use. Full summaries of the evaluation completed for the 25 mm storm and for the 5 year and 100 year design storms are included in Appendix I.

7.2.3 Alternative 2C – Linear Low Impact Development Measures

The PCSWMM minor drainage system hydrologic/hydraulic model was updated to include linear LID's on all local roads throughout the study area to determine their impact on runoff volumes and peak flows for each drainage system. The PCSWMM model created for the linear LID's has been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital model and the results are summarized in the tables below.

For this Master Plan, a typical perforated pipe system was designed to model the potential impacts of widespread implementation. Conceptual design details are included in Appendix H for reference. Implementation of linear LID measures is assumed to occur within the municipal road allowance for local roads only. The LID footprint area for each subcatchment is assumed to be 16% of the road area which corresponds to 1.4 m of an 8.5 m paved roadway. The total driveway area and road area within each subcatchment is assumed to drain to the linear LID. The design depth is calculated based on a design infiltration rate and a drawdown time of 48 hours. As with soakaway pits, the maximum design depth is capped at 900 mm and the minimum design depth is 300 mm. A detailed description of the design parameters, usage characteristics and methodology of application for the PCSWMM modelling of linear LID's is included in Appendix H. The results of the analysis for the linear LID application are summarized in the following table:

Table 13: Linear LID Flow Reduction Results Summary (Alternative 2C)

WATERSHED/ DRAINAGE AREA	FLOW REDUCTION (m^3/s/%) 100 YEAR STORM					
	25 mm STORM		5 YEAR STORM		100 YEAR STORM	
Napier	0.017	*26.5%*	0.031	*15.6%*	0.025	*4.1%*
Alfred	0.030	*15.4%*	0.020	*3.8%*	0.013	*1.1%*
Alice/Moore	0.040	*20.9%*	0.066	*12.9%*	0.036	*3.5%*
Bruce/Louisa	0.012	*2.7%*	0.009	*1.1%*	0.009	*0.9%*
Elma/Arthur	0.024	*3.8%*	0.002	*0.2%*	0.000	*0.0%*
Bruce/King	0.031	*18.3%*	0.022	*5.4%*	0.005	*0.7%*
Elma/Harbour	0.026	*7.3%*	0.013	*1.6%*	0.004	*0.3%*
Victoria	0.024	*3.4%*	0.048	*3.4%*	0.032	*1.1%*
Lakeshore	0.000	*0.0%*	0.000	*0.0%*	0.000	*0.0%*
Bay	0.000	*0.0%*	0.000	*0.0%*	0.000	*0.0%*
Alice	0.029	*15.2%*	0.042	*7.9%*	0.052	*5.0%*
Alfred West	0.084	*14.8%*	0.094	*7.1%*	0.004	*0.2%*

As shown in the above table, the linear LID measures have a limited impact on the major storm event peak flows. However, linear LID measures have the potential to improve peak flow attenuation for minor storm events and reduce frequent nuisance flooding. Full summaries of the evaluation completed for the 25 mm storm and for the 5 year and 100 year design storms are included in Appendix I.

A construction cost estimate has been prepared for improvement Alternative 2C. The construction cost estimate assumes that the linear LID perforated pipe system is completed as part of road reconstruction and storm sewer replacement. Across the entire study area, the cost estimate for installation of a perforated pipe system on local roads is $1,883,000 as detailed in Appendix G.

To determine the potential impact of combining the lot level (both rain barrels and soakaway pits) and linear LID measures, a combined scenario PCSWMM model (Alternatives 2B and 2C applied in combination) was created and has been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models and are summarized in the following table:

Table 14: Combined Lot Level/Linear LID Flow Reduction Results Summary (Alternatives 2B & 2C)

WATERSHED/ DRAINAGE AREA	FLOW REDUCTION ($m^3/s/\%$)					
	25 mm STORM		5 YEAR STORM		100 YEAR STORM	
Napier	0.018	28.0%	0.033	16.6%	0.027	4.4%
Alfred	0.035	17.6%	0.023	4.2%	0.016	1.4%
Alice/Moore	0.046	24.0%	0.072	14.2%	0.038	3.6%
Bruce/Louisa	0.017	3.9%	0.012	1.5%	0.011	1.1%
Elma/Arthur	0.026	4.0%	0.004	0.4%	0.001	0.1%
Bruce/King	0.032	18.6%	0.023	5.8%	0.006	0.8%
Elma/Harbour	0.028	8.1%	0.014	1.7%	0.009	0.6%
Victoria	0.030	4.3%	0.057	4.0%	0.044	1.5%
Lakeshore	0.000	0.0%	0.001	0.4%	0.002	0.3%
Bay	0.000	0.4%	0.000	0.3%	0.000	0.2%
Alice	0.032	16.5%	0.049	9.4%	0.058	5.6%
Alfred West	0.098	17.2%	0.112	8.5%	0.002	0.1%

Similar to the linear LID measures scenario, the combined LID's have a limited impact on the major storm event peak flows. However, they have the potential to improve peak flow attenuation for minor storm events and reduce frequent nuisance flooding. Full summaries of the evaluation completed for the 25 mm storm and for the 5 year and 100 year design storms are included in Appendix I.

7.2.4 Alternative 2D – Centralized Low Impact Development Measures

The centralized LID creation opportunities were evaluated to determine the water quality benefits that could be achieved. As previously described, two areas were identified for centralized LID's and the conceptual drawings are included in Appendix D.

Centralized LID's were designed to treat the runoff produced from their contributing area during the 25 mm design storm. The centralized LID's were designed as Underground Infiltration Chamber Systems with perforated 750 mm diameter CSP pipes. The design infiltration rates were based on soils mapping for the area. The soils mapping was generally confirmed through the geotechnical investigation completed by Peto MacCallum Ltd. in December 2017. The geotechnical investigation report is included in Appendix J for reference. Details of the storage characteristics for the infiltration chambers are included in the design sheets for each Centralized

LID in Appendix K. A summary of the centralized LID characteristics is provided in the following table:

Table 15: Centralized LID Summary (Alternative 2D)

AREA	DRAINAGE AREA (ha)	STORAGE VOLUME (m^3)	RUNOFF VOLUME CAPTURED (mm)
Arthur Street	32.3	1,420	4.2
Alfred Street West	32.6	1,090	3.4

Neither of the areas considered provide significant peak flow attenuation. However, they will provide water quality treatment, promote infiltration, and improve the water balance.

Construction cost estimates have been prepared for improvement Alternative 2D. The construction cost estimates are included in Appendix G and are summarized in the following table:

Table 16: Centralized LID Construction Cost Estimates (Alternative 2D)

CENTRALIZED LID	ESTIMATED CONSTRUCTION COST
Arthur Street	$2,717,000
Alfred Street West	$1,820,000

7.2.5 Alternative 2E – Mechanical Devices

As previously described, an opportunity exists to install oil grit separators within the minor drainage system storm sewer networks where SWMF's or centralized LID's are not feasible. Oil grit separators (OGS) have been designed for each drainage area to treat the 25 mm storm. Associated cost estimates have been prepared for each OGS unit assuming only peak flows up to the 25 mm storm event will be diverted to the OGS units. This is to limit the potential for resuspension of sediment within each unit during larger storm events. A summary of the key design criteria and estimated construction costs for each OGS unit is provided in the following table. Detailed construction cost estimates are included in Appendix G.

Table 17: Mechanical Devices Construction Cost Estimates (Alternative 2E)

DRAINAGE AREA	TREATMENT AREA (ha)	PEAK FLOW (m^3/s)	UNIT TYPE	ESTIMATED CONSTRUCTION COST
Napier	3.74	0.13	Vortech 4000	$96,000
Alfred	8.60	0.28	Vortech 7000	$154,000
Alice/Moore	6.29	0.16	Vortech 1000 / 4000	$103,000
Bruce/Louisa	14.83	0.37	Vortech 9000	$153,000
Elma/Arthur	16.14	0.61	Vortech 16000	$223,000
Bruce/King	2.38	0.16	Vortech 4000	$77,000
Elma/Harbour	6.95	0.31	Vortech 3000 / 5000	$185,000
Little Beaver River Tributary	20.70	0.79	Vortech 7000 / 11000	$348,000
Alice	5.98	0.17	Vortech 4000	$103,000
Alfred West	33.25	0.42	Vortech 11000	$201,000

7.3 CONVEYANCE CAPACITY IMPROVEMENT OPTIONS

7.3.1 Alternative 3A – Minor Drainage System Improvements

As previously described, there is an opportunity to upsize existing storm pipes to satisfy current design standards as part of future road reconstruction projects. A PCSWMM minor drainage system hydrologic/hydraulic model has been created with storm sewer upsized to meet the Town's design criteria under future land use conditions and has been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models. The construction cost estimate for this alternative is based on the difference in price between straight replacement of the existing storm sewer and replacement with storm sewer that satisfy the Town's design criteria. The construction cost estimate for storm sewer upsizing across the entire study area is $2,417,000 as detailed in Appendix G.

7.3.2 Alternative 3B – Elimination of Municipal Drainage Entering Private Property

As previously described, opportunities exist to remove municipal drainage from private property by diverting flow to the municipal road allowance. PCSWMM minor drainage system hydrologic/hydraulic models have been created to evaluate and size the storm sewer required for the diversion options. The PCSWMM models have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models.

For Undocumented Drainage System 2, there are two options to route drainage from Lemon Street away from the private drainage system and keep municipal drainage within the municipal right-of-way. These options are fully described and evaluated in Section 9. Construction cost estimates for the options have been developed based on the difference in price between the existing and upsized storm sewer and the price for new storm sewer and maintenance holes. The evaluated options have estimated construction costs between $329,000 and $546,000. Detailed construction estimates for the diversion options are provided in Appendix G.

For the Victoria Street Diversion, there is an opportunity to route the drainage from Alice Street West and the spill from Alfred Street West to the Victoria Street minor drainage system. To divert the minor drainage system flows from Alice Street West and formalize the Victoria Street minor drainage system (storm sewer) from a series of ditches and culverts, the construction cost is estimated at $149,000. A detailed construction cost estimate is included in Appendix G. Additional diversion options for major flows from the Alfred Street West spill are evaluated under Alternative 4.

7.3.3 Alternative 3C – Service Areas Absent of Minor Drainage Systems

As previously described, there is an opportunity to service areas that currently have no minor drainage system. For the areas/streets identified on Drawing DDP-1 (Appendix A), a construction cost estimate for new storm sewer, maintenance holes and oil grit separators has been developed. The Lakeshore Drive area has been excluded from the estimate as a storm sewer system on this road is not practical or required based on the proximity to Georgian Bay. The construction cost for servicing areas absent of a minor drainage system across the study area is $826,000 as detailed in Appendix G.

The Elma/Harbour Street minor drainage system has also been identified as deficient and there is an opportunity to upgrade the existing ditch and culvert system to a formalized storm sewer system. This improvement has been modelled in PCSWMM and the construction cost estimate is $291,000 as detailed in Appendix G.

7.3.4 Alternative 4 – Major Drainage System Conveyance Capacity Improvements

Little Beaver River Tributary

As previously described, opportunities exist to improve overland flow routes and road crossing culverts to meet the Town's design criteria for major system conveyance. For the Little Beaver River tributary watercourse, options were evaluated to route drainage from the King Street crossing to the Lansdowne Street and Huron Street intersection. Beyond the Lansdowne Street and Huron Street intersection, the outlet to the Little Beaver River can be upsized to meet the required capacity or a diversion to Georgian Bay can be constructed. The Little Beaver River tributary improvement options are further described and evaluated in Section 9. The associated

HEC-RAS, HY-8 and PCSWMM models for each option have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models. The evaluated options have estimated construction costs between $760,000 and $965,000. Details for the construction cost estimates are included in Appendix G.

Overland Flow Route Deficiencies

To eliminate excessive ponding depths or flows within the municipal right-of-way, a PCSWMM hydrologic/hydraulic model has been created to evaluate the size of the storm sewer required to eliminate the overland flow route deficiencies according to the Town's design criteria. For this study, the major overland deficiencies were evaluated using the dual drainage system in PCSWMM and standardized road cross-sections between storm structures. The cross-sections do not necessarily mimic existing conditions; however, they do provide an estimate of the overland flow depths and velocities that will be experienced along the roadway during major storm events. To meet the overland flow route deficiencies, the PCSWMM model was updated to include the following:

- Storm sewer upsized to meet the Town's design criteria of a 5 year design storm capacity;
- Lemon Street diversion to Alfred Street;
- Alice Street West diverted from Rankin's Landing to Victoria and Victoria system formalized from ditch and culvert system to a storm sewer network; and
- Elma/Harbour system formalized from ditch and culvert system to a storm sewer network.

The PCSWMM model has been digitally submitted with this Master Plan and detailed model results may be accessed from the digital models. The construction cost estimate to upsize storm sewer beyond the 5 year design storm capacity to address the overland flow route deficiencies is $2,019,000. Details for the construction cost estimates are included in Appendix G.

Alfred Street West Spill

As previously described, there is a significant spill from the Alfred Street West drainage system that travels through the Rankin's Landing private drainage system during major storm events. Four (4) options were developed to address the spill and these options are fully described and evaluated in Section 9. The associated conceptual drawings are included in Figures 5 through 8 in Appendix D for reference. PCSWMM hydrologic/hydraulic models have been created to evaluate the four (4) options and have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models. The evaluated options have estimated construction costs between $259,000 and $1,625,000. Detailed cost estimates for each option are included in Appendix G.

8 Alternatives Evaluation

The improvement alternatives developed in Section 5 (further discretized and assessed in Section 7) have been evaluated with respect to their impact on the physical, natural, social, cultural and economic environments presented in Section 3.

The evaluation of the improvement alternatives is descriptive or qualitative in nature allowing for a comparative evaluation of the positive and negative impacts associated with each alternative. The evaluation is focused on the ability of the alternatives to adequately address the problem statement, and in doing so, provide a solution that is consistent with the requirements of the governing policies. The alternatives evaluation completed is provided next in Tables 18 to 22.

Table 18: Evaluation of Improvement Alternatives

	Evaluation Criteria	How Criteria is Being Assessed	Alternative 1A: Do Nothing		Flow Reduction / Water Quality Improvements 2A Stormwater Management Facilities	
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding		Continued flooding of private property during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems		Reduction of peak flows downstream of SWMF's during minor and major storm events resulting in a decrease in private property flooding, however, flooding will still occur
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area		Aging/deteriorating storm infrastructure deficient throughout the study area. Areas absent of any minor drainage system		Reduction in peak flow to local and trunk storm sewers throughout the study area
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer		No conflicts with the existing sanitary sewer system/services Continued inflow of stormwater to sanitary sewer system during minor and major storm events		No conflicts with the existing sanitary sewer system or services Reduction of stormwater inflow to sanitary sewer during minor and major storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services		No conflicts with the existing water mains/services		No impact on existing water mains or services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities		No impact on existing utilities		No impact on existing utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance Severity of the disturbance to the transit system during construction		Continued flooding of existing transportation system during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems No disturbance to existing transits system as no construction is involved in this alternative		Decrease in flooding of existing transportation system downstream of the proposed SMWF's; temporary disturbance to local roadway during construction
	Impact on Parklands	Loss/Gain of parkland and/or green space		No impact on parkland or green space		Loss of greenspace with proposed SWMF construction.
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern Enhancement/Diminishment of native species		No impact on existing vegetation		Loss of vegetation through SWMF construction Opportunity to enhance native plantings through SWMF landscaping
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Lack of stormwater treatment in the study area will result in the continued degradation of water quality which will negatively impact fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Reduced erosion and improved water quality will positively impact fish habitat and aquatic features in the Little Beaver River and Georgian Bay
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area		No impact to wildlife habitat in the study area		Opportunity to enhanced wildlife habitat in proposed SWMF's; however, there is a potential loss of habitat for SWMF construction
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality		Continued diminishment of the stormwater quality throughout the watershed		Improvement in water quality

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 1A: Do Nothing Minor Drainage Systems		Flow Reduction / Water Quality Improvements 2A Stormwater Management Facilities	
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property		Decrease in property value due to continued flooding during minor and major storms Municipal Infrastructure to remain on private property		Increase in property values due to reduced flooding; Alternative does not remove municipal infrastructure from private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion		Potential public safety concerns remain due to continued flooding during minor and major storm events		Decrease in potential public safety hazards due to reduced flows, flooding and erosion during minor and major storm
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources		No archaeological or heritage impacts		Potential contribution to the removal of archaeological resources for the construction of SWMF's
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure		Increase in drainage system maintenance costs due to aging/deteriorating storm infrastructure and continued flooding/erosion No improvement to access to the existing drainage infrastructure		Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements No impact on access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs		$0		$489,000
	Impact on Construction Costs	Estimated construction costs		$0		$1,232,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding		Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								

Table 18: Evaluation of Improvement Alternatives (continued)

Evaluation Criteria		How Criteria is Being Assessed	Flow Reduction / Water Quality Improvements 2B Lot Level Low Impact Development Measures		Flow Reduction / Water Quality Improvements 2C Linear Low Impact Development Measures	
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding		Essentially no reduction of minor/major storm peak flows		Minor reduction of minor storm peak flows resulting in the reduction of frequent nuisance flooding. Insignificant reduction in major system peak flows and flooding. Does not resolve minor and major drainage system deficiencies.
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area		Essentially no reduction of flows to local and trunk storm sewer during minor/major storm events		Minor reduction of flows to local and trunk storm sewer during minor storm events, however no significant reduction of flows during major storm events. Existing storm sewer deficiencies persist.
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer		No conflicts between lot level LID's and sanitary sewer system or services No reduction of stormwater inflow to sanitary sewer during minor storm events		Potential conflicts between linear LID's and sanitary sewer system or services Reduction of stormwater inflow to sanitary sewer during minor storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services		No conflicts between lot level LID's and water services		Potential conflicts between linear LID's and water main/services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities		No conflicts between lot level LID's and utilities		Potential conflicts between linear LID's and utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance Severity of the disturbance to the transit system during construction		Continued flooding of existing transportation system during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems No disturbance to existing transits system as construction is limited to private properties		Continued flooding of existing transportation system during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems Increased disturbance to existing transits system during construction and maintenance
	Impact on Parklands	Loss/Gain of parkland and/or green space		No loss/gain of parkland and/or greenspace		No loss/gain of parkland and/or greenspace
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern Enhancement/Diminishment of native species		No loss/gain of vegetation		No loss/gain of vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Lack of stormwater treatment in the study area will result in the continued degradation of water quality which will negatively impact fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay.		Improved water quality and reduced erosion will positively impact fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area		No impacts to wildlife in the study area		No impacts to wildlife in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality		Continued diminishment of the stormwater quality throughout the watershed		Improvement of water quality throughout the study area during minor storm events

	Evaluation Criteria	How Criteria is Being Assessed		Flow Reduction / Water Quality Improvements 2B Lot Level Low Impact Development Measures		Flow Reduction / Water Quality Improvements 2C Linear Low Impact Development Measures
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property		Decrease in property value due to continued flooding during minor and major storms Municipal Infrastructure to remain on private property		Increase in property values due to reduce frequent nuisance flooding during minor storm events, Alternative does not remove municipal infrastructure from private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion		Potential public safety concerns remain due to continued flooding during minor and major storm events		Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources		No archaeological or heritage impacts		No archaeological or heritage impacts
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure		Increase in drainage system maintenance costs due to aging/deteriorating storm infrastructure and continued flooding/erosion No improvement to access to the existing drainage infrastructure		Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements of storm sewer; increased maintenance requirements to maintain function of linear LID's No impact on access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs		$0		$0
	Impact on Construction Costs	Estimated construction costs		$0		$1,883,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								

Table 18: Evaluation of Improvement Alternatives (continued)

	Evaluation Criteria	How Criteria is Being Assessed	Flow Reduction / Water Quality Improvements 2D Centralized Low Impact Development Measures		Flow Reduction / Water Quality Improvements 2E Mechanical Devices	
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding		Minor reduction of minor storm peak flows resulting in the reduction of frequent nuisance flooding. Insignificant reduction in major system peak flows and flooding. Does not resolve minor and major drainage system deficiencies.		Continued flooding of private property during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area		Minor reduction of flows to local and trunk storm sewer during minor storm events, however no significant reduction of flows during major storm events. Existing storm sewer deficiencies persist.		Aging/deteriorating storm infrastructure deficient throughout the study area. Areas absent of any minor drainage system
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer		No conflicts between centralized LID's and sanitary sewer system or services Reduction of stormwater inflow to sanitary sewer during minor storm events.		No conflicts with the existing sanitary sewer system/services Continued inflow of stormwater to sanitary sewer system during minor and major storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services		No potential conflicts between centralized LID's and water main/services.		No conflicts with the existing water mains/services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities		No potential conflicts between centralized LID's and utilities.		No impact on existing utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance Severity of the disturbance to the transit system during construction		Minor decrease in frequent nuisance flooding in localized areas.		Continued flooding of existing transportation system during minor and major storms in areas absent of minor drainage systems and with deficient minor and major drainage systems Limited disturbance to existing transit system as part of reconstruction
	Impact on Parklands	Loss/Gain of parkland and/or green space		No loss/gain of parkland and/or greenspace; temporary disturbance during construction and maintenance activities.		No impact on parkland or green space
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern Enhancement/Diminishment of native species		Minor loss of vegetation through centralized LID construction		No impact on existing vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Improved water quality and reduced erosion will positively impact fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Improved water quality will positively impact fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area		No impacts to wildlife in the study area		No impacts to wildlife in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality		Improvement of water quality throughout portion of the study area during minor storm events		Improvement of water quality throughout the study area during minor storm events

Evaluation Criteria		How Criteria is Being Assessed		Flow Reduction / Water Quality Improvements 2D Centralized Low Impact Development Measures		Flow Reduction / Water Quality Improvements 2E Mechanical Devices
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property		Increase in property values due to reduce frequent nuisance flooding during minor storm events, Alternative does not remove municipal infrastructure from private property		Decrease in property value due to continued flooding during minor and major storms Municipal Infrastructure to remain on private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion		Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events		Potential public safety concerns remain due to continued flooding during minor and major storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources		Potential contribution to the removal of archaeological resources for the construction of centralized LID's.		No archaeological or heritage impacts
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure		Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements of storm sewer; increased maintenance requirements to maintain function of centralized LID's No impact on access to existing drainage infrastructure		Increase in drainage system maintenance costs due to aging/deteriorating storm infrastructure and continued flooding/erosion. Increased maintenance requirements for mechanical devices. No improvement to access to the existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs		$92,000		$0
	Impact on Construction Costs	Estimated construction costs		$4,445,000		$1,643,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								

Table 18: Evaluation of Improvement Alternatives (continued)

	Evaluation Criteria	How Criteria is Being Assessed		Minor Drainage System Conveyance Capacity Improvements 3A Minor Drainage System Improvements		Minor Drainage System Conveyance Capacity Improvements 3B Elimination of Municipal Drainage Entering Private Property
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding		Reduced frequent nuisance flooding during minor storm events. Alternative does not remove municipal infrastructure from private property		Reduced flooding during minor storm events following removal of municipal drainage infrastructure from private property
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area		Resolves deficiencies in existing storm sewer system		Resolves routing of municipal drainage to private property
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer		Minor potential for conflicts with existing sanitary sewer system Significantly reduces inflow of stormwater to sanitary sewer system		Minor potential for conflicts with existing sanitary sewer system for new infrastructure Some reduction in inflow of stormwater to sanitary sewer system due to proper routing of stormwater
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services		Minor potential for conflicts with existing water main		Minor potential for conflicts with existing water main for new infrastructure.
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities		Minor potential for conflicts with existing utilities		Minor potential for conflicts with existing utilities for new infrastructure
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance Severity of the disturbance to the transit system during construction		Significant decrease in the extent and frequency of flooding within the road allowance Moderate disturbance to transit system as part of road reconstruction projects		Some reduction in the extent and frequency of flooding within the road allowance due to proper routing of stormwater Potential for disturbance to transit system during construction
	Impact on Parklands	Loss/Gain of parkland and/or green space		No impact on parkland or green space		No impact on parkland or green space
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern Enhancement/Diminishment of native species		No impact on existing vegetation		No impact on existing vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		Provides opportunity to implement stormwater treatment in the study area as part of capacity improvements		No impact on fisheries
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area		No impact to wildlife habitat in the study area		No impact to wildlife habitat in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality		Provides additional opportunities to implement water quality treatment		No improvement in water quality

Evaluation Criteria		How Criteria is Being Assessed	Minor Drainage System Conveyance Capacity Improvements 3A Minor Drainage System Improvements		Minor Drainage System Conveyance Capacity Improvements 3B Elimination of Municipal Drainage Entering Private Property	
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property		Increase in property values due to reduce frequent nuisance flooding during minor storm events. Alternative does not remove municipal infrastructure from private property		Significant increase in property values by removing municipal drainage from entering private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion		Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events		Decrease in potential public safety hazards due to removal of municipal drainage from private property
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources		No archaeological or heritage impacts		Limited potential for archaeological or heritage impacts as new construction will take place within municipal road allowance.
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure		Reduction in maintenance costs due to replacement of aging/deteriorating infrastructure		Improvement in access to drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs		$0		$0
	Impact on Construction Costs	Estimated construction costs		$2,417,000		$478,000 - $695,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding		Elimination of private property maintenance costs due removal of municipal drainage from private property

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								

Table 18: Evaluation of Improvement Alternatives (continued)

	Evaluation Criteria	How Criteria is Being Assessed	Minor Drainage System Conveyance Capacity Improvements 3C Service Areas Absent of Minor Drainage Systems		Alternative 4 Major Drainage System Conveyance Capacity Improvements	
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding		Reduced frequent nuisance flooding during minor storm events. Alternative does not remove municipal infrastructure from private property		Increase in property values due to significantly reduced flooding during minor and major storm events
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area		Does not resolve existing storm sewer deficiencies but provides formal conveyance for areas lacking a proper storm sewer system.		Generally, improves conveyance of existing storm sewer system, but does not specifically resolve minor system deficiencies
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer		Minor potential for conflicts with existing sanitary sewer system for new infrastructure Some reduction in inflow of stormwater to sanitary sewer system due to improved routing of stormwater		Minor potential for conflicts with existing sanitary sewer system based on upsized infrastructure Reduction in inflow of stormwater to sanitary sewer system
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services		Minor potential for conflicts with existing water main for new infrastructure.		Minor potential for conflicts with existing water main
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities		Minor potential for conflicts with existing utilities for new infrastructure		Significant potential for conflicts with existing utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance Severity of the disturbance to the transit system during construction		Some reduction in the extent and frequency of flooding within the road allowance due to proper routing of stormwater Potential for disturbance to transit system during construction		Decrease in the extent and frequency of flooding within the road allowance to meet Town Standards Disturbance to transit system part of general reconstruction
	Impact on Parklands	Loss/Gain of parkland and/or green space		No impact on parkland or green space		No impact on parkland or green space
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern Enhancement/Diminishment of native species		No impact on existing vegetation		Minor impact on existing vegetation for tributary watercourse improvements. Potential for plantings to offset impact.
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the Beaver River, Little Beaver River and Georgian Bay		No impact on existing fisheries		No impact on existing fisheries
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area		No impact to wildlife habitat in the study area		Minor impact on existing wildlife habitat for tributary watercourse improvements. Potential for design improvements to offset impact.
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality		Provides additional opportunities to implement water quality treatment		No impact on existing water quality

Evaluation Criteria		How Criteria is Being Assessed	Minor Drainage System Conveyance Capacity Improvements 3C Service Areas Absent of Minor Drainage Systems		Major Drainage System Conveyance Capacity Improvements	
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property		Increase in property values due to reduced frequent nuisance flooding during minor storm events.		Significant increase in property values due to reduced flooding during minor and major storm events and elimination of spills on to private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion		Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events		Decrease in potential public safety hazards due to reduction of flooding during minor and major storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources		Limited potential for archaeological or heritage impacts as new construction will take place within municipal road allowance.		Potential for archaeological or heritage impacts during construction of tributary watercourse
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure		Reduction in maintenance due to proper routing of stormwater.		Reduction in maintenance due to improved conveyance of major system flows.
	Impact on Property Acquisition Costs	Property and easement acquisition costs		$0		$0
	Impact on Construction Costs	Estimated construction costs		$1,117,000		$2,778,000 - $4,609,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property		Increase in private property maintenance costs due to aging/deteriorating storm infrastructure located on private property and continued flooding		Decrease in private property maintenance costs due to reduction of major system spills on to private property

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								

9 Individual Drainage Solution (Project) Evaluation

As described in Section 2, three significant problem areas were identified in the study area as shown on Figure D. For each of these areas, a number of individual projects were considered within the Improvement Alternatives described in Section 7. The individual projects for these areas were evaluated with respect to their impact on the environments presented in Section 3. The evaluations were completed prior to PIC#2 and were then refined considering feedback/input received from the public and interested stakeholders.

The evaluation of the individual projects is quantitative allowing for a comparative evaluation of the positive and negative impacts associated with each alternative. The evaluation is focused on the ability of the solutions to adequately address the problem statement, and in doing so, provide a solution that is consistent with the requirements of the governing policies. The individual projects are described in the following sections and the evaluations are provided in Table 27.

9.1 UNDOCUMENTED DRAINAGE SYSTEM 2 IMPROVEMENT OPTIONS

The improvement options considered for Undocumented Drainage System 2 are to route drainage from Lemon Street within the municipal right-of-way away from the private drainage system. Option 1 is to route the Lemon Street to the Alice Street Beaver River outlet via Ferguson Avenue. This option will require a new easement across private property. Option 2 is to route the drainage from Lemon Street to the Alfred Street Beaver River outlet. Under both options, storm sewer is to be installed on Moore Crescent (roadway is currently absent of a minor drainage system). These options are shown on the conceptual design drawings in Appendix D. In both cases, the Alfred Street and Alice Street improvements have been sized to account for the potential connection of the private drainage system that currently comprises Undocumented Drainage System 2. Furthermore, the storm sewer from Lemon Street has been sized for the 100 year design storm since there is no appropriate overland flow route. Construction cost estimates for the options have been developed based on the difference in price between the existing and upsized storm sewer and the price for new storm sewer and maintenance holes. Detailed construction estimates for the diversion options are provided in Appendix G and are summarized in the following table:

Table 19: Flow Diversion Construction Cost Estimates (Alternative 3B)

OPTION	DESCRIPTION	ESTIMATED CONSTRUCTION COST
1	Lemon Street diversion (Ferguson Avenue and Alice Street). New storm sewer on Moore Crescent.	$546,000
2	Lemon Street diversion (Alfred Street). New storm sewer on Moore Crescent	$329,000

Note: Estimated construction costs include property acquisition costs.

9.2 LITTLE BEAVER RIVER TRIBUTARY IMPROVEMENT OPTIONS

For the Little Beaver River tributary watercourse, two options were evaluated to route drainage from the King Street crossing to the Lansdowne Street and Huron Street intersection as illustrated on the conceptual drawings (Figure 9, Appendix D). Option 1A is to enlarge and improve the existing channel, upsize the King Street crossing to a 1590 x 1120 mm CSP arch and upsize the Lansdowne Street crossing to an 1800 x 1200 mm concrete box culvert. Option 1B is to re-route the channel south of King Street to the King/Lansdowne Street intersection, install a culvert crossing under the intersection and improve the ditch west of Lansdowne Street to Huron Street. The HEC-RAS hydraulic model for the Little Beaver River tributary watercourse was updated with the future land use condition flows (Appendix A) to determine the culvert sizes and channel improvements required to satisfy the Town's design criteria for each option. Under both scenarios, the culvert sizes required to safely convey the required flows when 50% obstructed were unreasonably large. Therefore, the proposed culverts are modelled unblocked and protective measures (ex. maintenance protocol, trash racks, etc.) will need to be included as part of detailed design to ensure the culverts are not obstructed during significant storm events.

Beyond the Lansdowne Street and Huron Street intersection, the outlet to the Little Beaver River can be upsized to meet the required capacity (Option 2A) or a diversion to Georgian Bay can be constructed (Option 2B). For Option 2A, a HEC-RAS analysis confirmed that a 2400 x 1200 mm concrete box culvert is required for the Little Beaver River tributary outlet to have unobstructed capacity for the worst case 100 year storm peak flow. For Option 2B, a PCSWMM model was created to size the required storm sewer and channel outlet to Georgian Bay (Figure 9, Appendix D). The storm sewer and channel were sized to convey the peak flow beyond the unobstructed capacity of the existing 1200 mm diameter concrete culvert that outlets to the Little Beaver River (flow at which water levels start overtopping Huron Street). A 1200 mm diameter storm sewer is required on Lansdowne Street from Huron Street to Bay Street and a 1200 mm deep

trapezoidal ditch (~6 m top width) is required to convey the flows from Bay Street to Georgian Bay.

The associated HEC-RAS, HY-8 and PCSWMM models for each option have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models. As previously noted, the proposed conditions models have assumed all culverts function unobstructed to ensure reasonable sizing. As such, it is critical that measures are developed during detailed design to ensure the unobstructed condition is maintained during significant storm events. A summary of the required culvert sizes and channel improvements for each option are presented in the following table:

Table 20: Little Beaver River Tributary Improvement Options Summary (Alternative 4)

CHANNEL/CULVERT	SIZE	LEVEL OF SERVICE		CAPACITY (m^3/s)	
		REQUIRED	PROVIDED	REQUIRED	PROVIDED
Option 1A – Existing Channel Improvements					
King Street Crossing	1590 x 1120 mm CSPA	1:25 Year	1:100 Year	2.81	3.26
Channel: King Street to Lansdowne Street	N/A	1:100 Year	1:100 Year	3.95	> 3.95
Channel: Parallel to Lansdowne Street	N/A	1:100 Year	1:100 Year	3.95	> 3.95
Lansdowne Street Crossing (at Huron Street)	1800 x 1200 mm Conc. Box	1:25 Year	1:100 Year	2.81	4.82
Option 1B – Channel Re-routing (King Street to Huron Street)					
Channel: King Street	N/A	1:100 Year	1:100 Year	3.95	> 3.95
King/Lansdowne Street Crossing	1840 x 1260 mm CSPA	1:25 Year	1:100 Year	2.81	4.20
Channel: Lansdowne Street	N/A	1:100 Year	1:100 Year	3.95	> 3.95
Option 2A – Little Beaver River Tributary Outlet Improvements					
Channel: Huron Street	N/A	1:100 Year	1:100 Year	4.88	> 4.88
Outlet Culvert	2400 x 1200 mm Conc. Box	1:25 Year	1:100 Year	3.26	5.27
Option 2B – Georgian Bay Diversion					
Culvert: Parallel to Lansdowne Street	1200 mm dia.	1:25 Year	1:100 Year	2.66	2.81
Channel: Parallel to Lansdowne Street	N/A	1:100 Year	1:100 Year	2.66	> 2.66

A summary of the construction cost estimates for each option is presented in the following table:

Table 21: Little Beaver River Tributary Improvements Construction Cost Estimates (Alternative 4)

DIVERSION OPTION	NAME	ESTIMATED CONSTRUCTION COST
Option 1A	Existing Channel Improvements	$378,000
Option 1B	Channel Re-routing (King Street to Huron Street)	$202,000
Option 2A	Little Beaver River Tributary Outlet Improvements	$558,000
Option 2B	Georgian Bay Diversion	$587,000

Note: Estimated construction costs include property acquisition costs.

As shown in the above table, Options 1B and 2A provide the most economically efficient solution to the drainage deficiencies. The total cost for Options 1B and 2A is $760,000. Details for the construction cost estimates are included in Appendix G.

9.3 ALFRED STREET WEST SPILL IMPROVEMENT OPTIONS

As previously described, there is a significant spill from the Alfred Street West drainage system that drains through the Rankin's Landing private drainage system during major storm events. Four (4) options were developed to address the spill as follows:

- Option 1 – Capture entire spill on Beaver Valley Community Centre property and divert to proposed Victoria Street trunk storm sewer;
- Option 2 – Capture entire spill at proposed Alfred Street stormwater management facility and divert to proposed Victoria Street trunk storm sewer;
- Option 3 – Capture entire spill at proposed Alfred Street underground storage system and divert to proposed Victoria Street trunk storm sewer; or
- Option 4 – Provide trunk storm sewer on Alfred Street West to eliminate spill.

The associated conceptual drawings are included in Figures 5 through 8 in Appendix D for reference. PCSWMM hydrologic/hydraulic models have been created to evaluate the four (4) options and have been digitally submitted with this Master Plan. Detailed model results may be accessed from the digital models. A summary of the associated construction cost estimates for each option is presented in the following table and detailed cost estimates are included in Appendix G. The construction cost estimates are based on the difference in price from the base trunk storm sewer price of $2,019,000.

Table 22: Alfred Street West Spill Construction Cost Estimates (Alternative 4)

OPTION	DESCRIPTION	ESTIMATED TRUNK SEWER COST INCREASE	ESTIMATED QUANTITY CONTROL COST
Option 1	Divert full spill to Victoria	$259,000	$0
Option 2	Divert full spill to Victoria with Alfred Street SWMF to reduce peak flow	$58,000	$705,000
Option 3	Divert full spill to Victoria with Alfred Street Underground Storage System to reduce peak flow	$59,000	$1,566,000
Option 4	Provide Alfred Street West trunk to eliminate spill	Immediate requirement for trunk sewer upgrades to ultimate condition	

Note: Estimated construction costs include property acquisition costs.

Of note, the trunk storm sewer system required to eliminate all dual drainage system deficiencies will eliminate the spill. Therefore, Option 4 has no cost associated with it relative to the base trunk storm sewer price of $2,019,000. However, the cost to immediately upgrade the Alfred Street West system to the ultimate trunk storm sewer design is significant. The cost to upgrade the Alfred Street West drainage system from existing conditions is $1,478,000 as detailed in Appendix G.

Table 23: Evaluation of Individual Projects

Project	Location	Option	Description	Total Score
Little Beaver River Tributary Improvement Options	Georgian Trail to Huron/Lansdowne Street	1A	Improved channel from King Street to Lansdowne/Huron Street intersection. Improved 1590 x 1120 mm CSPA culvert crossing King Street, improved 1800 x 1200 mm concrete box culvert crossing Lansdowne Street (at Huron Street).	-11
		1B	Re-routed channel from King Street to Lansdowne/Huron Street intersection. New 1840 x 1260 mm CSPA culvert crossing King/Lansdowne Street (diagonal).	4
	Huron/Lansdowne Street to Georgian Bay/Little Beaver River	2A	Improved channel along Huron Street to outlet culvert. Improved 2400 x 1200 mm box culvert outletting to the Little Beaver River.	2
		2B	New 1200 mm diameter culvert/storm sewer along Lansdowne Street from Huron Street to Bay Street to take excess flow. Improved channel along Lansdowne Street from Bay Street to Georgian Bay.	-1
	Upstream of tributary between Arthur Street and the Georgian	3A	Quality control stormwater management facility between Arthur Street and the Georgian Trail.	-26
		3B	Quality control centralized LID between Arthur Street and the Georgian Trail.	-35
		3C	Quality control OGS between Arthur Street and the Georgian Trail.	1
Rankin's Landing Drainage System Improvement Options	Beaver Valley Community Centre, Alice Street ROW, Victoria Street ROW, Alfred Street West ROW	1	Improved Victoria Street trunk storm sewer to capture entire spill on Beaver Valley Community Centre property.	4
		2	New Alfred Street stormwater management facility (northeast of BVCC) to capture entire spill and improved Victoria Street trunk storm sewer for conveyance.	-6
		3	New Alfred Street underground storage system (BVCC parking lot) to capture entire spill and improved Victoria Street trunk storm sewer for conveyance.	0
		4	Trunk storm sewer improvements for Alfred Street West drainage system to eliminate spill to Rankin's Landing.	-9
Undocumented Drainage System 2 Improvement Options	Area between Alice Street and Alfred Street, Lemon Street and Moore Crescent	1	Lemon Street diversion to Ferguson Avenue and Alice Street. New storm sewer on Moore Crescent.	-17
		2	Lemon Street diversion to Alfred Street. New storm sewer on Moore Crescent.	3

10 Public Consultation – Mandatory Public Information Center (PIC#2)

A second PIC was held in accordance with the requirements of the Municipal Class Environmental Assessment process. PIC#2 marked the first mandatory contact with the public and provided information on the identification and evaluation of the alternative solutions with respect to the natural, social, physical, cultural and economic environments.

10.1 PUBLIC INFORMATION CENTRE

PIC#2 was held on September 13 and 15, 2018 at the Town Hall (32 Mill Street, Thornbury) to present the various drainage improvement alternatives that were evaluated and to present the preliminary preferred alternative solutions. The Notice of PIC#2 was posted at the Town Hall and L.E. Shore Memorial Library on August 27, 2018. Notification letters for PIC#2 were also mailed out or hand delivered on August 27. The mail-outs and deliveries went to property owners who had requested notifications through previous communication and to properties with significant potential to be impacted by the identified deficiencies or the alternative design solutions.

At the PIC, local residents were presented with maps identifying the alternative drainage solutions that were considered and the preliminary preferred alternative solutions to address the various drainage deficiencies across the study area. The public was encouraged to review the presentation material and to provide input/feedback regarding the drainage improvement alternatives evaluated and the preliminary preferred alternative solutions. Comment sheets were provided for the attendees to provide feedback and identify their preferred alternative design solutions. The PIC notifications and presentation materials are enclosed in Appendix E for reference.

10.2 RESULTS OF PUBLIC CONSULTATION

The Mandatory Public Information Centre (PIC#2) was attended by 13 interested stakeholders and five (5) written comments were received. Many of the comments were related to issues outside the scope of this project. Four (4) of the comment sheets indicated a preferred alternative solution(s). A copy of the comments received at the PIC are available in Appendix E for reference.

10.3 PUBLIC PREFERENCE

The majority of public responses preferred a combination of alternative drainage solutions to address the identified drainage issues. A summary of the public's preferred alternative drainage solution(s) following PIC#2 is included in the following table.

Table 24: Public Consultation Preferred Alternative Summary

RESPONDENT	PREFERRED ALTERNATIVE SOLUTION(S)
Respondent 1	Alternative 3B
Respondent 2	Combination of Alternatives 3A, 3C, 4
Respondent 3	Combination of Alternatives 2B, 2C, 2E, 3A, 3B, 3C, 4
Respondent 4	Combination of Alternatives 2A, 2B, 2C, 2E, 3A, 3B, 3C

Generally, the public's responses did not indicate any opposition to the presented alternatives. The responses highlighted specific concerns and the specific alternatives considered to be most beneficial. These comments have been considered in the selection of the preferred alternative solution.

11 Selection of the Preferred Alternative Solution

Following a comprehensive review of the alternatives, receipt of all comments from the interested stakeholders and agencies and completion of the improvement alternatives evaluation, the preferred alternative solution has been selected. The preferred alternative solution is comprised of Alternative 2E – Mechanical Devices, Alternative 3A – Minor Drainage System Improvements, Alternative 3B – Elimination of Municipal Drainage Entering Private Property, Alternative 3C – Improving Service Areas Absent of Minor Drainage Systems and Alternative 4 – Major Drainage System Conveyance Capacity Improvements. The preferred alternative solutions are described in more detail in the following sections and are illustrated on Figures C and D enclosed.

11.1 FLOW REDUCTION/WATER QUALITY IMPROVEMENTS

It is recommended that the Town implements mechanical devices such as oil grit separators (2E) to address stormwater quality in the study area. Under existing conditions there is very limited quality control and this negatively impacts the ecological health of the receiving water bodies. Based on the qualitative analysis of flow reduction/water quality improvement alternatives, Alternative 2E has the greatest positive impact on the project environments. Land constraints limit the efficacy of large-scale water quality improvement options such as stormwater management facilities (2A) or centralized LIDs (2C). The locations of the proposed oil grit separators to address water quality concerns are illustrated on Figure C provided overleaf.

Due to the existing level of development, there are limited opportunities for LID strategies to be effectively implemented in the study area. Linear LIDs (2C) have significant negative impacts on the physical and economic environments as detailed in Section 8 and are not recommended. The implementation of lot level LIDs (2B) on private properties will increase infiltration, improve the water balance and water quality and will provide an overall benefit to the preferred alternatives. Therefore, the Town is encouraged to promote the use of rain barrels and soakaway pits by residents and property owners. However, these measures will not have a quantifiable impact on the identified deficiencies. For future developments, LID strategies should be promoted to increase infiltration and address water quality and water balance.

11.2 MINOR SYSTEM CONVEYANCE CAPACITY IMPROVEMENT OPTIONS

It is recommended that the Town implements minor drainage system improvements (3A), eliminates municipal drainage from entering private property (3B) and services areas absent of

minor drainage systems (3C) to reduce flooding, improve maintenance opportunities and address safety concerns across the study area. For all capital projects, it is recommended that upsizing local storm sewers to satisfy current design standards be considered as part of future road reconstruction projects (3A). To eliminate municipal drainage from entering private property, new storm sewer is recommended on Victoria and Alice Street to re-route the municipal drainage from the Rankin's Landing system and new storm sewer is recommended on Lemon Street and Moore Crescent to divert the municipal drainage from Undocumented Drainage System 2 (3B). It is also recommended that streets with no minor drainage systems include storm sewers as part of future road reconstruction projects and that the deficient Elma/Harbour Street ditch and culvert system is formalized as a storm sewer system (3C). The specific areas for storm sewer improvements are illustrated on Figure C.

Two options were considered for the diversion of municipal drainage from Undocumented Drainage System 2 and they were evaluated on a quantitative basis against the project environments as detailed in Section 9. The Alfred Street diversion option was less expensive and less disruptive than the Ferguson Avenue diversion option and it produced the greatest positive impact on the project environments. Therefore, the diversion of flow to Alfred Street has been identified as the preferred Undocumented Drainage System 2 improvement project as illustrated on Figure D.

11.3 MAJOR SYSTEM CONVEYANCE CAPACITY IMPROVEMENT OPTIONS

It is recommended that the Town implements major drainage system improvements (Alternative 4) to eliminate municipal drainage from spilling to private property, reduce flooding, improve maintenance opportunities and address safety concerns across the study area. To address the overland flow route deficiencies, specifically excessive flow depths and velocities, upsizing storm sewer to increase the conveyance capacity of the minor drainage system and reduce major drainage system flows should be considered as part of road reconstruction projects. The locations of storm sewer that should be considered for upsizing beyond the 5 year storm capacity are illustrated on Figure C as trunk storm sewer.

Multiple projects were identified to address the deficiencies with the tributary watercourse to the Little Beaver River and the options were evaluated on a quantitative basis against the project environments as detailed in Section 9. Re-routing the channel from King Street to the Lansdowne/Huron Street intersection has less impact on private properties and is less expensive than improving the channel and culverts along the current alignment. Therefore, the re-routing option is recommended from King Street to the Lansdowne/Huron Street intersection. From the Lansdowne/Huron Street intersection, the options to improve the current outlet to the Little Beaver River or construct a new outlet to Georgian Bay have similar impacts on the project environments. However, improving the existing outlet is slightly less expensive and slightly less disruptive such that it is the recommended alternative. The preferred conveyance improvement projects for the Little Beaver River tributary are illustrated on Figure D.

The final major system deficiency for which various projects were considered is the spill from the Alfred Street West drainage system that drains through the Rankin's Landing private drainage system during major storm events. Four options were developed to deal with the spill and these options were quantitatively evaluated against the project environments as detailed in Section 9. The evaluation confirmed similar impacts on the project environments with the improved Victoria Street trunk storm sewer scoring highest. Though the Alfred Street West trunk storm sewer improvements will ultimately eliminate the spill, the associated cost is significant such that deferring the cost by designing the Victoria Street drainage system to convey the spill has been identified as the preferred alternative. The preferred Victoria Street trunk system improvement project is illustrated on Figure D.

11.4 CONSTRUCTION COSTS

Construction cost estimates have been prepared for the Preferred Alternative Solution presented in the previous sections. Of note, the storm sewer improvements are to be implemented as part of road reconstruction projects and the estimates reflect the cost to upsize the storm sewer being replaced as part of the renewal works. The estimates reflect the cost above the replacement cost to upsize the sewer. Similarly, the trunk storm sewer cost estimate reflects the cost above

the improved storm sewer recommended under Alternative 3. The construction cost estimates for the Preferred Alternative Solution are included in Appendix G for reference. A summary of the projected construction costs is included in the following table:

Table 25: Construction Costs - Preferred Alternative Solution

IMPROVEMENT ALTERNATIVE	CONSTRUCTION COST
Alternative 2E – Mechanical Devices	$1,643,000
Alternative 3A – Minor Drainage System Improvements	$2,417,000
Alternative 3B – Elimination of Municipal Drainage Entering Private Property	
a) Lemon Street diversion to Alfred Street	$329,000
b) Alice Street West diversion to Victoria Street and formalization of Victoria Street minor system	$149,000
Alternative 3C – Service Areas Absent of Minor Drainage System	
a) Improvement to areas absent of minor drainage systems	$826,000
b) Formalize Elma/Harbour Street drainage system	$291,000
Alternative 4 – Major Drainage System Conveyance Capacity Improvements	
a) Trunk storm sewer to eliminate major drainage system deficiencies	$2,019,000
b) Little Beaver River tributary improvements	$760,000
c) Elimination of Alfred Street West major system spill	$259,000
Total – Construction Costs	**$8,693,000**

12 Project Prioritization

For all future road reconstruction projects within the study area, this Drainage Master Plan document should be referenced to determine where oil grit separators are recommended and confirm the ultimate storm sewer size recommendations. In general, the storm sewer improvements should proceed from the most downstream section. However, it is understood that additional factors may influence the timing of projects such that it might not be feasible to implement improvements in this order.

Elimination of municipal drainage from private property is critical and projects that address this concern should be prioritized. As such, individual projects are recommended to occur in the following order based on the severity of the private property impacts:

1. Lemon Street diversion to Alfred Street
2. Alice Street West diversion to Victoria Street and formalization of Victoria Street minor system
3. Little Beaver River tributary improvements
4. Elimination of Alfred Street West major system spill

13 Detailed Design and Construction

Following ratification by Town Council and successful completion of the Class EA process, the individual projects will proceed to detailed design and construction subject to available capital funding. Prior to construction, all required approvals will be identified and obtained as part of detailed design.

During the detailed design of the Preferred Alternative Solution, the owners of the existing utilities should be notified of the proposed works, of any impacts the proposed works will have on the existing utilities and of any conflicts or relocates required to complete the infrastructure improvements. Coordination with existing utilities will be required through detailed design and construction.

Implementation of the conveyance capacity improvements recommended under the preferred alternative solution should start at the downstream end of each conveyance system and progress upstream. It is envisioned that the implementation of the conveyance capacity improvements will be completed in conjunction with road reconstruction projects. As such, it is understood that additional factors may influence the timing of projects and that it might not be feasible to implement improvements in the order recommended.

14 Conclusions

The recommendations contained herein will be presented to Town Council for ratification. Those individuals and parties that requested to be kept informed of the Municipal Class EA process will be notified of the selection of a Preferred Alternative Solution and the steps of the process moving forward after ratification.

If concerns are raised during this process which cannot be resolved in discussion with the Town of The Blue Mountains, the Minister of the Environment, Conservation and Parks may be requested to make an Order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order), which addresses individual Environmental Assessments. Requests must be received by the Minister at the address below within thirty (30) days of the publication of the Notice of Completion for the project. A copy of the request must also be sent to the Town of The Blue Mountains Infrastructure and Public Works Department.

The Honourable Rod Phillips
Minister of the Environment, Conservation and Parks
77 Wellesley Street West
Ferguson Block, 11th Floor
Toronto, ON M7A 2T5

Reg Russwurm, MBA, P.Eng.
Director of Infrastructure and Public Works
The Corporation of The Town of The Blue Mountains
32 Mill Street, P.O. Box 310
Thornbury, ON N0H 2P0

Following the successful completion of the Municipal Class EA process (no Part II Orders received) it would be the Town's intention to implement the Preferred Alternative Solution, subject to available capital funding and Council approval.

LEGEND

- New Centralized LID
- New SWMF
- New Oil/Grit Separator
- Linear LIDs
- Existing Maintenance Holes
- Existing Storm Sewer/Ditch/Culvert
- Study Area Boundary

Georgian Bay

THORNBURY

Cameron St
High Bluff Lane
Peel St North
Little Beaver River
Bay St W
Lakeshore Dr
450Ø CSP
450Ø CSP
600Ø CSP
1200Ø CONCRETE
700 x 1300 CSPA
750Ø CSP
Georgian Trail
WATERCOURSE 1
4500 CSP
1120Ø CSP
1500Ø CSP
King St W
Huron St W
Victoria St N
Lansdowne St N
Beaver St S
Junction 0014
DCBMH 12024
Elma St N
Harbour St
Beaver River
3750 CSP
900Ø CP
ABANDONED
Arthur St W
Bruce St N
MH 050
MH 055
MH 053
Bridge St E
Hester St
Louisa St E
Louisa St W
Lorne St
Elma St S
Victoria St S
Alice St W
Park Lane
Bruce St S
Alfred St W
Orchard Dr
Pyatt Ave.
Napier Street West
Alice St E
Lemon St
500Ø CSP
CB
450 x 750 CSPA
375Ø CSP
Ferguson Ave
600Ø CSP
CB
CB
CB
CB
UNDOCUMENTED DRAINAGE SYSTEM
Moore Cres
Abbotts Lane
Leming St
Cobblestone Lane
Riverbank Court
Limestone Lane
Alfred St E
Napier Street East
Duncan Street West
Bruce St S
Russell Street East
ABANDONED

NOTES

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NO.	REVISIONS	DATE	INITIAL

APPROVED

THORNBURY WEST DRAINAGE MASTER PLAN

TOWN OF THE BLUE MOUNTAINS

POTENTIAL FLOW REDUCTION WATER QUALITY IMPROVEMENT PROJECTS

TATHAM ENGINEERING

SCALE: 1:3,000		JOB NO.	117092
DESIGN: ASB	CHECKED: DRT	DWG.	FIG-A
DRAWN: WHG	DRAWN: JUNE 2018		

LEGEND

- No Drainage System
- Existing Ditch/Culvert System (to remain)
- Existing Storm Sewer/Ditch/Culvert (to be removed and replaced)
- Existing Storm Sewer/Ditch/Culvert (to remain)
- Existing Storm Sewer (to be upsized to satisfy Town's design standards)
- New Storm Sewer
- Trunk Storm Sewer (sewer to be considered for upsizing to address major overland flow deficiencies)
- Existing Maintenace Holes (to be removed)
- Existing Maintenance Holes (to remain)
- New Maintenance Holes
- Study Area Boundary

Georgian Bay

THORNBURY

Cameron St
Peel St North
High Bluff Lane
Georgian Trail
Little Beaver River
NEW WATERCOURSE
NEW WATERCOURSE
Bay St W
Lakeshore Dr
Bay St W
Huron St W
King St W
Victoria St N
Lansdowne St N
Beaver St S
Elma St N
Harbour St
ABANDONED
Beaver River
Arthur St W
Bruce St N
Bridge St E
Victoria St S
Elma St S
Lorne St
Louisa St W
Hester St
Louisa St E
Alice St W
Park Lane
Bruce St S
Alfred St W
Alice St E
Little Beaver River
Orchard Dr
Ferguson Ave
Lemon St
Pyatt Ave.
CB
CB
CB
CB
UNDOCUMENTED DRAINAGE SYSTEM
Moore Cres
Victoria St S
Napier Street West
Abbotts Lane
Leming St
Cobblestone Lane
Alfred St E
Riverbank Court
Limestone Lane
Beaver River
Napier Street East
Duncan Street West
Bruce St S
Russell Street East

NOTES

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NO.	REVISIONS	DATE	INITIAL

APPROVED

THORNBURY WEST DRAINAGE MASTER PLAN

TOWN OF THE BLUE MOUNTAINS

POTENTIAL MINOR/MAJOR DRAINAGE SYSTEM CONVEYANCE CAPACITY IMPROVEMENTS

TATHAM ENGINEERING

SCALE:	1:3,000	JOB NO.	117092
DESIGN:	ASB	CHECKED:	DRT
DRAWN:	WHG	DRAWN:	JUNE 2018
DWG.	**FIG-B**		

LEGEND

- No Drainage System
- Existing Ditch/Culvert System (to remain)
- Existing Storm Sewer/Ditch/Culvert (to be removed and replaced)
- Existing Storm Sewer/Ditch/Culvert (to remain)
- Existing Storm Sewer (to be upsized to satisfy Town's design standards)
- New Storm Sewer
- Trunk Storm Sewer (sewer to be considered for upsizing to address major overland flow deficiencies)
- Existing Maintenace Holes (to be removed)
- Existing Maintenance Holes (to remain)
- New Maintenance Holes
- New Oil/Grit Separator
- Study Area Boundary

NOTES

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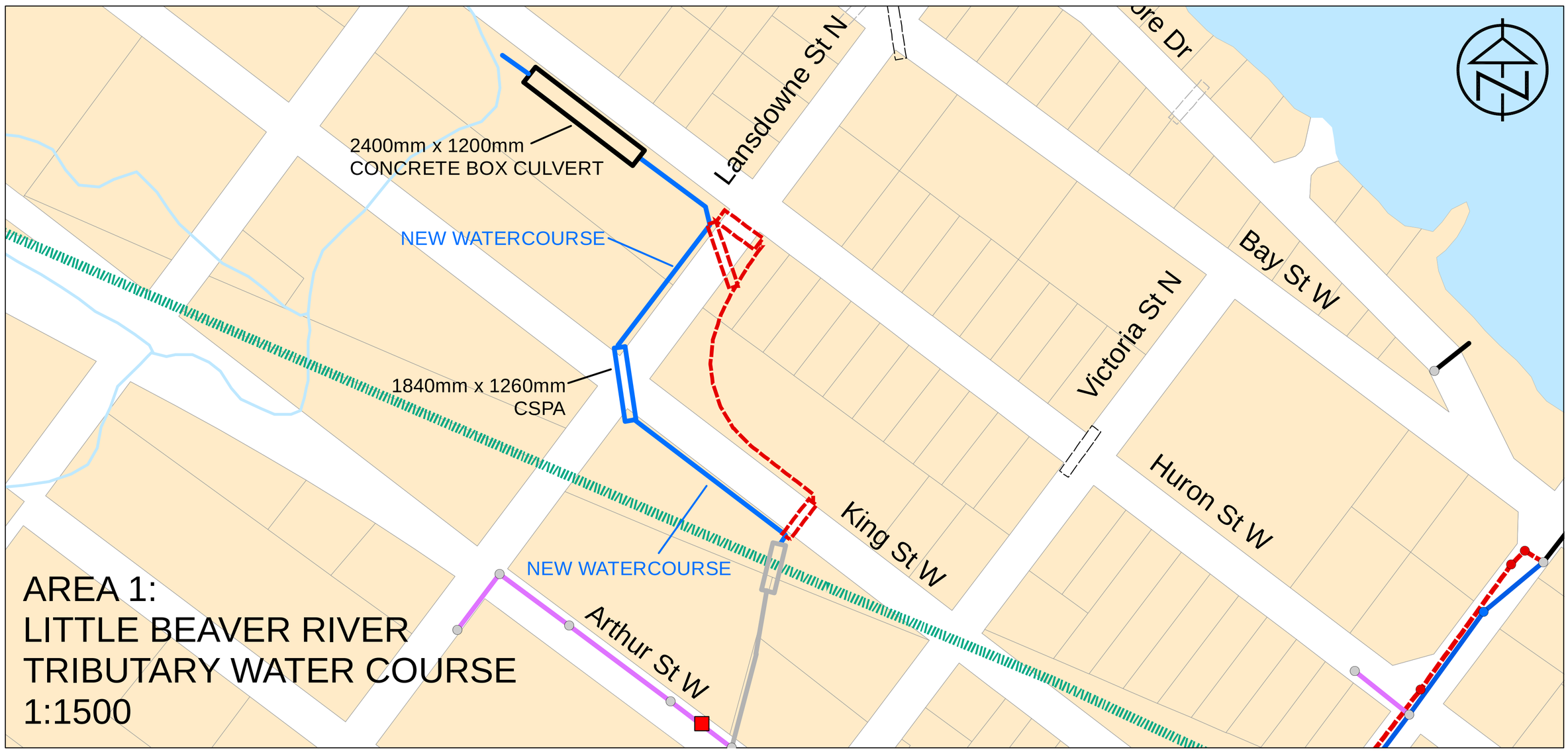
THORNBURY WEST DRAINAGE MASTER PLAN

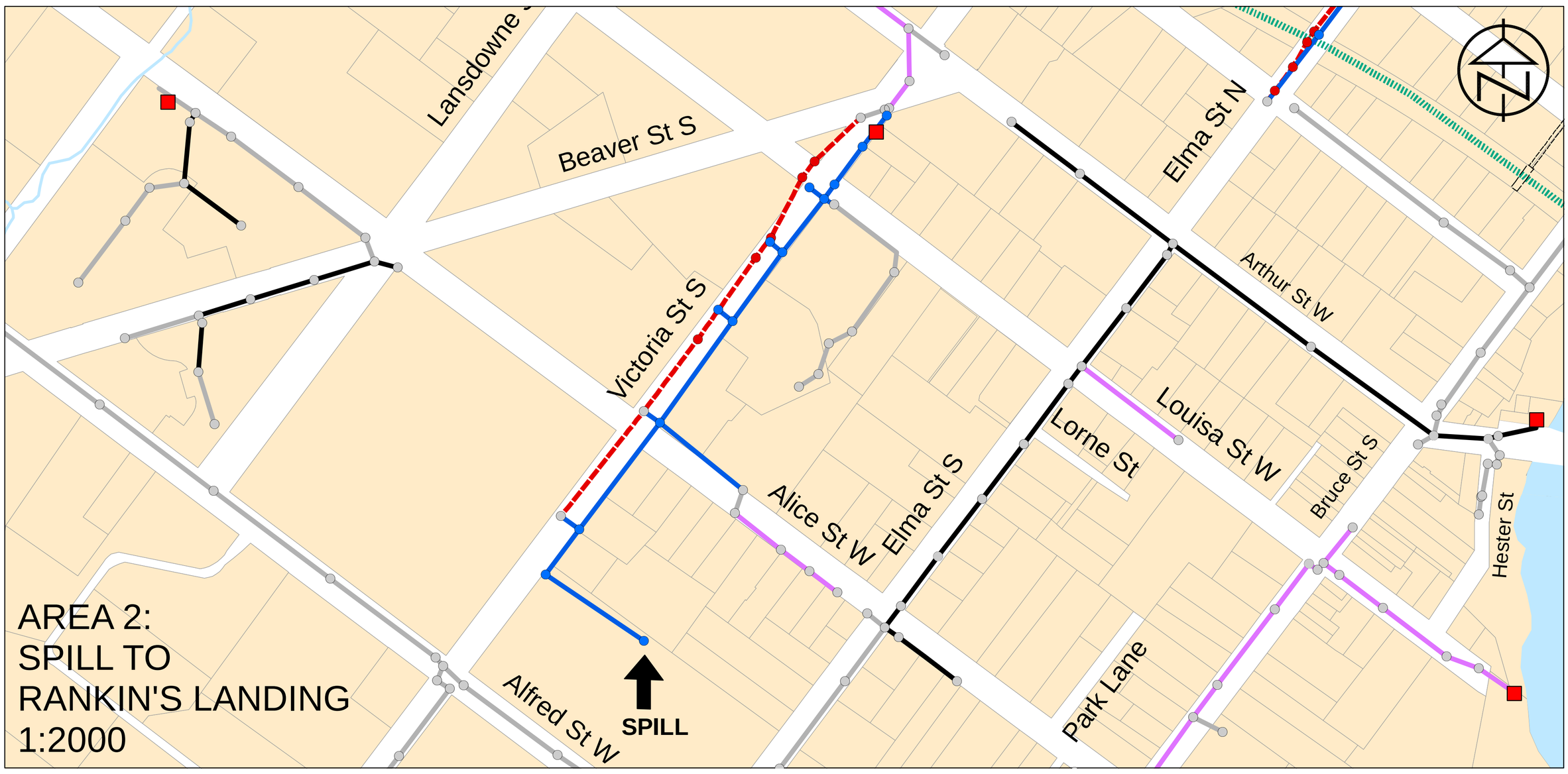
TOWN OF THE BLUE MOUNTAINS

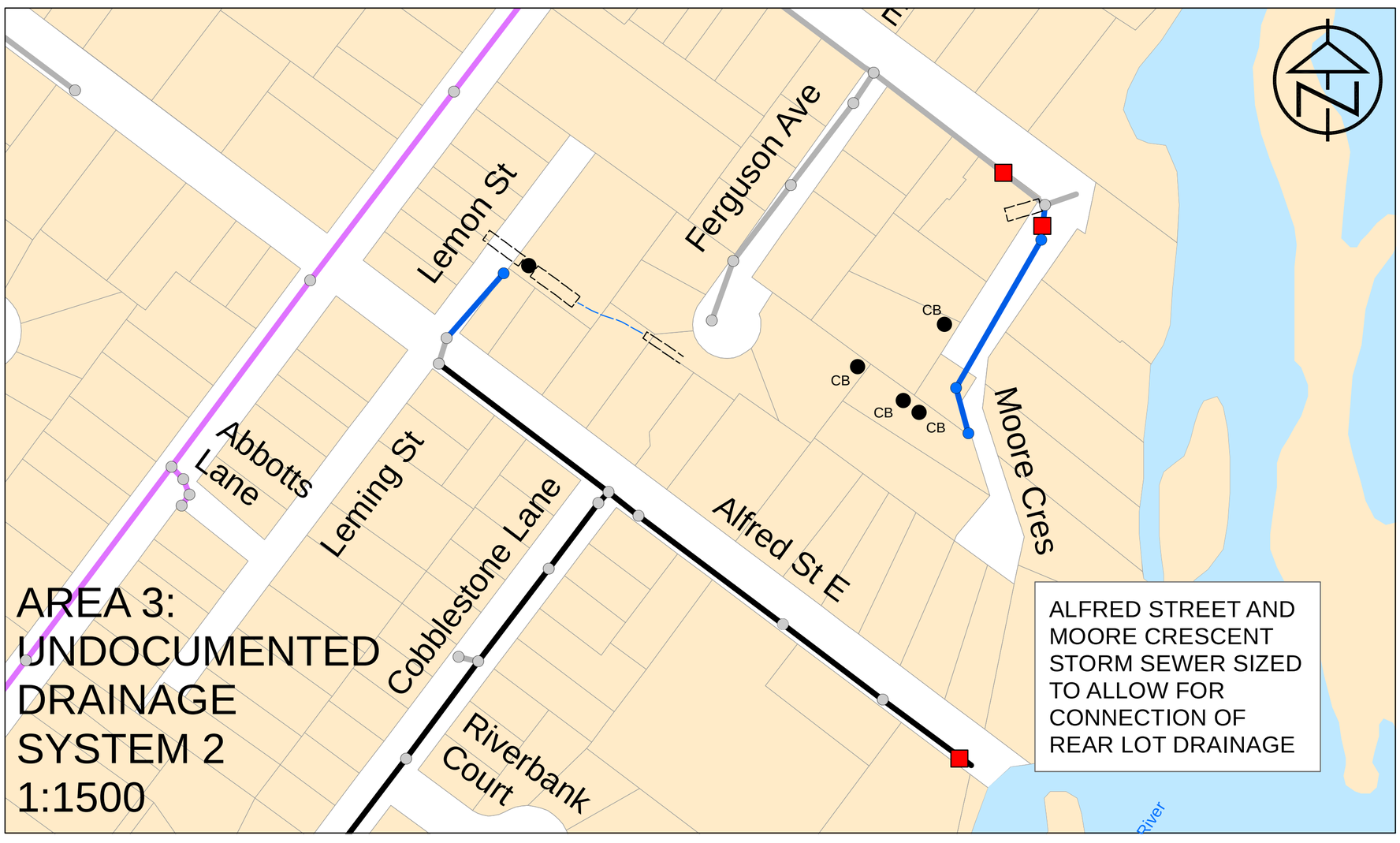
PREFERRED ALTERNATIVE SOLUTION

TATHAM ENGINEERING

SCALE: 1:3,000		JOB NO.	117092
DESIGN: ASB	CHECKED: DRT	DWG.	**FIG-C**
DRAWN: WHG	DRAWN: DEC 2018		







LEGEND

Capacity Improvements

- Existing Storm Sewer/Ditch/Culvert (to be removed and replaced)
- Existing Storm Sewer/Ditch/Culvert (to remain)
- Existing Storm Sewer (to be upsized to satisy Town's design standards)
- New Storm Sewer
- Trunk Storm Sewer (sewer to be considered for upsizing to address major overland flow deficiencies)
- Existing Maintenace Holes (to be removed)
- Existing Maintenance Holes (to remain)
- New Maintenance Holes
- Oil-Grit Separator

NOTES

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NO.	REVISIONS	DATE	INITIAL

APPROVED

THORNBURY WEST DRAINAGE MASTER PLAN

TOWN OF THE BLUE MOUNTAINS

INDIVIDUAL
PROJECT PREFERRED
ALTERNATIVE SOLUTIONS

TATHAM ENGINEERING

SCALE: AS NOTED		JOB NO.	117092
DESIGN: ASB	CHECKED: DRT	DWG.	**FIG-D**
DRAWN: WHG	DRAWN: DEC 2018		