

**BROOKE AREA STORMWATER
MANAGEMENT STUDY
CITY OF OWEN SOUND
TOWNSHIP OF GEORGIAN BLUFFS
FINAL REPORT**

**GAMSBY AND MANNEROW LIMITED
CONSULTING PROFESSIONAL ENGINEERS
GUELPH – KITCHENER – LISTOWEL – OWEN SOUND**

July, 2008
Our File: M-1586

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1.0 BACKGROUND

1.1 INTRODUCTION

Gamsby & Mannerow Limited (G&M) was retained by the Township of Georgian Bluffs and the City of Owen Sound to undertake a Stormwater Management Study for the Townplot of Brooke. The scope of this study encompasses Stormwater Management analysis and planning within the Brooke area of the Township of Georgian Bluffs and the City of Owen Sound, as outlined in Figure 1, and on Drawing No. M-1586-1.

This submission describes the planning and review process, documents the engineering analyses and presents recommendations for implementation of the study findings. These recommendations are presented throughout this report and are recapitulated in Section 4.0.

1.2 STUDY PURPOSE

The purpose of the Study is to protect life and property from the effects of stormwater flooding by developing an appropriate drainage solution for each drainage basin within the study area, which is acceptable to both municipalities.

1.3 STUDY OBJECTIVE

The objective of the Brooke Area Stormwater Management Study is to present alternative drainage solutions and related costs to each municipality and, ultimately, to establish a recommended solution for each drainage area, with an implementation schedule, to the mutual satisfaction of the two participating municipalities.

1.4 STUDY AREA AND BACKGROUND

The study area and existing conditions are illustrated on Drawing No. M-1586-2.

In 1990, the former Township of Sarawak commissioned G&M to prepare a Stormwater Management Study (SWM), as supporting documentation for the Township Official Plan review, and is included in Appendix "E". As part of that Study, a Development Feasibility Study was

also prepared, which focussed on the Townplot of Brooke area within the Township of Sarawak, including drainage patterns.

The Stormwater Management Study delineated thirty-four (34) drainage areas within the Township of Sarawak, seven (7) of which relate to the Townplot of Brooke area and the subject Study Area, and are identified as catchment areas (basins) A1 to A7 on the attached Figure 2. Sub-basin areas are also delineated within each municipality, numbers representing sub-basins within the Townplot of Brooke (i.e. A3-1, A3-2, etc.), and lower-case letters representing sub-basins within the City of Owen Sound (i.e. A4a, A4b, etc.). Townplot of Brooke sub-basins often drain across the Owen Sound City limits at multiple locations which may confluence within one Owen Sound sub-basin.

1.4.1 Georgian Bluffs, Townplot of Brooke Drainage System

The following summarizes our understanding of the Georgian Bluffs, Townplot of Brooke drainage system.

Basin A1 outlets to the Pottawatomi River within the Townplot of Brooke and does not impact on City of Owen Sound storm sewer infrastructure.

Basin A2 has two (2) sub-basin areas. Sub-basin A2-1 drains across the municipal boundary and outlets to the Pottawatomi River through sub-basin A2a. Contribution from sub-basin A2a is considered to be negligible due to the close proximity of its outlet to the municipal boundary. A smaller sub-basin (Basin A2-2) outlets to a City storm sewer on 7th Ave W (A2b), between 15th St W and 16th St W (Hunters Run subdivision).

Basin A3 has six (6) ravine outlets from Georgian Bluffs into the City, at 19th St W, a location between 19th St W and 20th St W, 20th St W, 21st St W, 22nd St W, and 23rd St W. A study by G&M in 1992 of Basin A3 investigated design flows and three alternative stormwater management pond locations along the major drainage route, which outlets into the City at 21st St W.

Basin A4 has a main outlet (A4-2) to the City's 24th St W storm sewer, with a secondary, high flow spill outlet south-easterly from the SWM pond, combining with sub-basin A4-1, to a ravine between 23rd St W and 24th St W. A review of G&M archive files relating to this area indicates that the Township "purchased" 30 ft³/s (0.85 m³/s) capacity within the City's 24th St W storm sewer, with greater flows to be diverted into the "Fromager" stormwater management pond, south of Keppel Sarawak school. A design report, prepared by Ainley and Associates Limited in August, 1994, indicates how ultimate development flows to the Fromager pond are controlled to existing (1990) flow rates. The 1994 Final Design Report and Schedule "B" EA Report are included for reference in Appendix "E".

Basin A5 discharges from Georgian Bluffs at six (6) locations. Sub-basins A5-1 to A5-6 discharge from Georgian Bluffs via a 750 mm Ø CSP at 26th St W, 450 mm Ø CP between 26th St W and 27th St W, 450 mm Ø CSP at 27th St W, 300 mm Ø CSP at 27th St W, open channel flow at 28th St W, and open channel flow at 29th St W, respectively.

Basin A6 discharges to a ravine along the 30th St W right-of-way. Basin A7 also discharges via a ravine north of the City limit across Grey Road 1 to Owen Sound Bay. Within Basins A5, A6 and A7 were noted a variety of drainage complaints and potential for spills between the Basins. A review by G&M in 1992 included eight alternative drainage schemes for managing drainage within these three Basins.

1.4.2 City of Owen Sound Drainage System

The following summarizes our understanding of the City of Owen Sound drainage system.

The drainage areas, which outlet from Georgian Bluffs into the City of Owen Sound, discharge to Owen Sound Bay at four (4) major storm sewer outlets, at 19th St W (Kelso Beach – Basin A3), 24th St W (Yacht Club Basin – sub-basin A4a), 27th St W (sub-basin A5a), and 30th St W (Basin A6). Additional outlets exist at 8th Ave W (to the Pottawatomi River – sub-basin A2a), 7th Ave W (to the Pottawatomi River – sub-basin A2b), 24th St W (sub-basin A4b), 26th St W (drains local runoff), 28th St W (sub-basin A5b) and 29th St W (sub-basin A5c). These additional outlets, with the exception of sub-basins A2a and A2b, drain predominantly local area runoff within the City.

Drainage designs were prepared by G&M for the City of Owen Sound for outlets at 19th St W (Kelso Beach – Basin A3), 24th St W (Yacht Club – Basin A4), 27th St W (Basin A5) and 29th St W. The 30th St W outlet remains as an open channel to a culvert across Grey Road 1.

In 2003, following a joint meeting between Township and City officials regarding a drainage complaint in the 6th Ave W area, G&M prepared MIDUSS flow models on behalf of the City for the 24th St W storm sewer system within the City, with a view to re-routing discharge from the 7th Ave W storm sewer to the 22nd St W storm sewer, which connects to the 24th St W outlet. This project was not implemented due to the apparent need to investigate broader drainage issues in the area. More recent investigations were conducted by G&M, on behalf of the City, for the 19th St W – Kelso Beach storm sewer, including the recently constructed 8th Ave W / 19th St W storm sewer, 6th Ave W drainage course review and Kelso Beach outfall review.

1.5 PHYSIOGRAPHY

The Sydenham River descends Inglis Falls just south of the City limits, and flows northward through the central business district to the inner harbour of Owen Sound Bay. A series of crescent-shaped bluff and plateau features rise from the bay water level. The lower plateau represents the former glacial Lake Nipissing wave-cut terrace. The upper plateau represents the former glacial Lake Algonquin wave-cut terrace. The upper-most rise in the series was confined by the Niagara Escarpment.

The steep gradients of the rises and the relatively flat plateaus create unique challenges for establishing traditional gravity draining sewer systems. For example, despite the significant relief, large stormwater management ponds are often required to moderate peak runoff from development to maintain manageable storm sewer sizes downstream across the flatter plateau areas.

The Niagara Escarpment forms the westerly limit of the Study Area. The Brooke area of Sarawak is located predominantly on the upper plateau, or Algonquin terrace. The Nippissing Rise runs approximately along the boarder between the two municipalities, while the Nippissing terrace is located primarily within the City of Owen Sound.

1.6 OFFICIAL PLANS

The Grey County Official Plan includes the Township of Georgian Bluffs. The westerly half (approximately) portion of the Study Area is included in the Niagara Escarpment Planning area. The easterly half is designated as Hamlet. The Official Plan prepared for the Township of Sarawak in 1992 remains as the controlling document for development planning within the Study Area. The Township of Georgian Bluffs Comprehensive Zoning By-Law No. 6-2003, as amended January, 2007, designates the easterly half as R1 – General Residential zoning, with some EP – Environmental Protection zoning along the watercourses. Minor areas of I - Institutional and M1 – General Industrial zoning are also included within the area.

The Owen Sound Official Plan indicates that lands within the study area are predominantly residential, with small areas of hazard land, open space, and waterfront mixed use (small commercial).

1.7 DEVELOPMENT POTENTIAL

1.7.1 Georgian Bluffs

The background reports, which led to the development of the Township of Sarawak Official Plan, 1992, included the following:

- Development Feasibility Study, Townplot of Brooke, Township of Sarawak, May, 1990.
- Stormwater Management Study, Township of Sarawak, September, 1990.
- Background Report to the Official Plan for the Township of Sarawak, June, 1991.

These reports considered a variety of development scenarios, including one which would rely on the provision of municipal water and sewer servicing. The provision of municipal water and sewer servicing would allow development density to approach 5 units per acre, which is significantly greater than the development density achievable based on individual, private wells and sewage systems. The Official Plan (1992) restricts the density of development until such time as municipal water and sewer servicing is available. The development scenario advanced since that time does not include municipal water or sewer servicing and, for the purposes of this report, no extension of municipal servicing throughout the Brooke area of Georgian Bluffs is contemplated.

Generally, the lands within the Niagara Escarpment Planning area may be developed on 5 acre (2.0 ha) lots. Lands within the Hamlet designation may be developed on 0.5 acre (0.2 ha – R1c), 1.5 acre (0.6 ha – R1b), or 2.47 acre (1.0 ha – R1a) lots, with no municipal water or sewer services (depending on the ability of local soil conditions to support an on-site sewage system), or 0.4 acre (0.15 ha) lots where municipal water service, extended from the City of Owen Sound, currently exists. These areas are delineated in the Municipal Zoning By-law No. 6-2003, as

amended January, 2007, and is provided as Figure No. 4 for reference. Developable lot areas are delineated on Drawing No. M-1586-3.

The Stormwater Management Study utilizes the following criteria and assumptions in establishing existing and ultimate development runoff scenarios:

1. The density of development throughout the Township will be no greater than that illustrated on G&M Drawing No. M-1586-3, which reflects the Municipal Zoning By-law.
2. There will not be extensive industrial or commercial development.
3. Impervious areas consist of road surfaces, roof-tops and driveways.
4. Lawns and agricultural lands are considered as pasture land.
5. Runoff within Georgian Bluffs will continue to be controlled through open ditch drainage. No underground storm sewer network is contemplated.
6. The population growth rate within the Townplot of Brooke will continue at 2% per year, which will achieve an ultimate development condition within the 20-year planning horizon.

The Brooke area is an original Townplot. As such, the road and lot fabric is already surveyed and created. Therefore, development of these lots occurs on an individual basis and not through a plan of subdivision process. The result, with respect to stormwater management, is that there is little opportunity for Georgian Bluffs to have a developer construct a single facility to manage stormwater runoff on an area-wide basis.

1.7.2 Owen Sound

Aside from some small commercial and residential land uses, the lands within the Owen Sound portion of the Study Area are developed, predominantly with residential land use. For the purposes of this report, it is assumed that the City portion of the Study Area is already fully developed.

1.8 DRAINAGE CONSIDERATIONS

A watercourse is defined generally as a stream of water, which flows along a defined channel, with bed and banks, for a sufficient time to give it substantial existence. This may include streams that dry up periodically. Watercourses within the Study Area may be subject to Riparian Rights. These rights include the right to drain lands that abut the watercourse into the natural stream, with ditches and drains, even though it results in an increase in the volume or rate of flow. Riparian property owners are entitled to receive water flowing in its natural state (both quantity and quality) and, thereto, are required to accept the natural state of flowing water, even if flooding conditions occur.

Surface water not flowing in a natural watercourse has no right of drainage. An owner of lower land may, at his or her own choice, either allow the water from higher land to flow over it, or by dams or banks keep such water off his or her property. No owner has the right to collect such surface water by ditches or drains and discharge it on lands of another. He or she has the responsibility to take this water to a sufficient outlet, i.e., a natural watercourse or a drain constructed under The Drainage Act. For a municipality this means that, once water is collected in ditches or storm sewers, they cannot discharge it onto another property and should take responsibility to ensure the water is taken to a sufficient outlet.

The drainage basins delineated on G&M Drawing No M-1586-1 are based on historical documentation and current field reviews. In many instances, roadside ditches in the table lands area within Georgian Bluffs do not provide a clear drainage divide and high flows may spill from one drainage basin to the next. We recommend that clear separation of drainage be established by installing berms within the ditches at the locations where drainage divides between basins exist. In this manner, stormwater flows may be managed on a more consistent basis.

Allowable flows from Georgian Bluffs into the City of Owen Sound can be based on the greater of the pre-development design flow, or the capacity of existing storm sewer infrastructure within the City. Where the capacity of the existing City storm sewer system is inadequate, and no suitable overland flow route is available, the available options include providing SWM ponding areas to regulate flows, or increasing storm sewer capacity.

Georgian Bluffs has recently introduced the practice of requiring on-site stormwater management controls for developing lots within the Brooke area. Theoretically, this practice could control ultimate development peak flows downstream at existing condition flow rates. However, considering that the modelled ultimate development flows are not significantly greater than existing flow rates, and that private systems may not be sufficiently reliable, we have not included the effects of these private systems in our ultimate development flow calculations, or in our considerations for drainage infrastructure planning.

Design flows are considered as the calculated peak of runoff due to a statistical rainfall event, based on recorded rainfall events. In an un-controlled drainage system, the peak of runoff occurs only for a relatively short duration. In a controlled drainage system (i.e. a stormwater management pond) a volume of the runoff water is temporarily held back and released at a “lower than peak rate” for an extended period of time.

Generally, road crossing culverts and storm sewer systems are designed to convey the 1:5 year design flow with no surcharging. These systems may convey more than the 1:5 year design flow under surcharged conditions. Overland flow routes convey flows in excess of the drainage system capacity.

The Grey Sauble Conservation Authority (GSCA) has mapped regulated areas along watercourses and sloped areas within the Study Area. The municipality should take ownership of these hazard lands as development proposals are advanced.

There is a claim by Native Peoples on the lands of un-opened road allowances within the Georgian Bluffs portion of the Brooke area. Recent rulings by the Province dictate that Natives are to be consulted regarding any proposals to utilize lands under these claims.

1.9 THE CLASS ENVIRONMENTAL ASSESSMENT PROCESS

The key principles of successful environmental planning under the EA Act include the following:

- Consultation with affected parties early in and throughout the process, such that the planning process is a cooperative venture.

- Consideration of a reasonable range of alternatives.
- Identification and consideration of the effects of each alternative on all aspects of the environment.
- Systematic evaluation of alternatives in terms of their advantages and disadvantages.
- Provision of clear and complete documentation of the planning process.

The “environment” to be considered generally includes the natural, social, cultural, built and economic environments. The Municipal Engineers Association has prepared a “parent” Class EA for municipal projects, which outlines a generic process for municipal projects to fulfill the requirements of the EA Act. This document was amended in 2007 to include Schedule A+ projects (pre-approved with the public to be advised) and Municipal Transit Projects. A flowchart, illustrating the process, is provided as Figure No. 3. It is presumed that the projects discussed herein would be either Schedule “A”, “A+”, or “B” activities under the Municipal Class EA.

This report is intended to provide sufficient documentation to fulfill the requirements of the first two Phases of the Municipal Class Environmental Assessment process, although specific projects may require a further degree of public and review agency consultation prior to implementation.

2.0 RAINFALL AND SNOWMELT

Surface water management is often referred to as stormwater management, although the design practices also are reflective of runoff from snowmelt. Since snowmelt flows are difficult to predict, surface water management plans are based on calculated runoff from statistical rainfall events. The Atmospheric Environment Service records rainfall data at the City’s Water Pollution Control Plant (WPCP).

2.1 RAINFALL

Rainfall data are collected at the City of Owen Sound WPCP, with statistical analyses prepared by the Atmospheric Environment Service, for the years 1965 to 1990. A copy of the statistical rainfall data is included in Appendix “A”. The statistical data were entered into the MIDUSS computer modelling software to generate coefficients for the Chicago – type rainfall distribution patterns. Computer model output is located in Appendix “A”, and is summarized in the following Table 2-1.

Table 2-1 – Chicago Rainfall Distribution Coefficients

MIDUSS Coefficients	1:2-Year	1:5-Year	1:10-Year	1:25-Year	1:50-Year	1:100-Year
A	786.171	1129.529	1340.877	1648.994	1912.945	2117.123
B	6.530	7.382	7.570	8.074	8.567	8.610
C	0.822	0.840	0.846	0.855	0.863	0.864
R	0.375	0.375	0.375	0.375	0.375	0.375
Imax (mm/hr)	77.251	101.133	116.940	136.784	151.473	166.328
PTOT (mm)	36.810	47.462	54.358	63.313	69.976	76.527

The Regional storm for the study area is the Timmins Regional storm. This rainfall event has characteristics as outlined in Appendix “A”.

2.2 SNOWMELT

Runoff events due to snowmelt are difficult to quantify due to a high degree of variability in a number of natural conditions such as temperature, rainfall, amount of snow, density of snow, permeability of soils (frozen or saturated), etc. Therefore, statistical rainfall events are used to approximate the runoff due to snowmelt. This approximation is achieved by comparing streamflow records for spring runoff conditions, with dry weather conditions for a monitored watershed.

Historical streamflow records are compiled by Environment Canada, Inland Waters Directorate, Water Resources Branch, Water Survey of Canada, in the Historical Streamflow Summary, Ontario, 1990. The data is compiled for the Sydenham River near Owen Sound (Station No. 02FB007), with an upstream catchment area of 181 km². A table of Annual Extremes of Discharge for the Sydenham River, copied from the Historical Streamflow Summary, is included in Appendix “B”.

The data correlated between the years 1915 and 1990 indicate a maximum instantaneous discharge rate of 59.5 m³/s on April 19th, 1975 (no record is available prior to 1959), and a maximum daily discharge of 67.7 m³/s on April 12th, 1947. The minimum daily discharge on record is 0.028 m³/s, measured on July 17th, 1952.

The MIDUSS computer model was used to model runoff due to rainfall from the same 181 km² catchment area. Results are included in Appendix “B”, and are summarized in the following Table 2-2.

Table 2-2 – Peak Runoff Rates due to Rainfall in Sydenham River

	1:2-Year	1:5-Year	1:10-Year	1:25-Year	1:50-Year	1:100-Year	Regional
Peak Flow (m ³ /s)	12.140	27.856	41.526	63.613	83.336	104.555	382.557

Therefore, as a comparison, runoff due to snowmelt is approximately equivalent to the runoff due to a 1:25 year return rainfall event. Surface water management planning for this Brooke Area Stormwater Management Study includes runoff events due to a 1:100 year rainfall event, and a regional storm event (Timmins Regional storm), which is considered to also provide a sufficient degree of consideration for snow melt events.

3.0 DRAINAGE AREAS

The following sections include a description of existing conditions within each drainage area. Modelled design flows for pre-development, existing and ultimate development conditions are presented on Drawing Nos. M-1586-4 to 6, with capacity restrictions noted in bold type. Drawing No. M-1586-3 illustrates the remaining lots on which development may occur within

the Township, which was used in determining ultimate development conditions. Existing and potential drainage problems are identified and discussions regarding various alternative solutions to the drainage problems are presented. For the purposes of a Municipal Class Environmental Assessment, the “Do Nothing” option is also considered. Cost estimates are provided for various recommended solutions. The cost estimates include construction costs plus 15% for contingencies and 15% for engineering design and construction inspection. Land costs, legal costs, permit fees and additional investigative study costs (i.e. environmental impact study, geotechnical investigation, environmental assessment etc.) are not included. Recommended solutions are illustrated on Drawing Nos. M-1586-7 to 9, along with the resultant design flows on Drawing Nos. M-1586-10 to 12.

Recommendations are accompanied by a High, Medium or Low priority. A High priority correlates to a proposed implementation schedule of between 0 and 5 years, Medium between 5 and 10 years, and Low for 10 years and beyond.

Culvert capacities, denoted within this report and on G&M Drawings Nos. M-1586-4 to 6 and M-1586-10 to 12, were calculated based on a headwater/diameter ratio of 1.0, unless otherwise stated. In some instances, surcharge conditions may result in temporary ponding upstream where the ‘top of bank’ elevations permit. Culvert capacity design charts are provided in Appendix “C”.

MIDUSS computer model output is provided in Appendix “D”.

3.1 BASIN A1

3.1.1 Preamble

Drainage Basin A1 covers 13.8 ha, which discharges easterly on 14th St W to the Pottawatomi River, outside of the City of Owen Sound limits. Currently, a 450 mm Ø CSP conveys flows down the bluff to the river. The outlet is located where 14th Street West crosses the Pottawatomi River. Inlets to the sewer often become plugged with leaves and flows can spill overland along the roadway to the river. Roadside ditches are not well defined and nuisance flooding can occur. Increases in runoff due to anticipated development within Basin A1 is expected to be negligible, due to the large area of hazard land within the Basin, and only four potentially developable lots.

3.1.2 Design Flows

Due to the small catchment area, the 450 mm Ø CSP outlet pipe is considered to be the only key infrastructure within the Basin.

- 450 mm Ø CSP (14th St W) – Capacity of about 0.46 m³/s (most critical location), capable of conveying the 1:10 year flow.

3.1.3 Recommendations

We recommend that drainage improvements be incorporated into any road improvements planned for 14th St W. These improvements are summarized in the following:

Table 3-1 – Basin A1 Recommended Improvements

Description	Cost	Priority
Replace existing catchbasin grates on 14 th St W with bird cage style inlet grates, or other appropriate inlet to reduce plugging potential, to allow leaves to inlet to the sewer, rather than collecting and plugging at the inlet.	\$5,000	High
Reconstruct 14 th St W (350 m), including replacing the existing 450 mm Ø CSP with a larger diameter storm sewer (600 mm Ø), with a sufficient number of inlets, to improve flow hydraulics, increase capacity and facilitate maintenance, and improving roadside ditches to drain road granulars, direct surface flows to appropriate inlets, and reduce nuisance flooding.	\$385,000	Low

These works are Schedule A activities under the Municipal Class EA and, therefore, no further review of alternatives is warranted.

3.2 BASIN A2

3.2.1 Preamble

Drainage Basin A2 drains 123.8 ha and primarily discharges via a ravine system and outlets to the Pottawatomi River within the City of Owen Sound, approximately 25 m east of the City limits. There are reports of some nuisance flooding problems within the developed portions of this Basin, which may be attributed to poor lot grading and/or poorly defined private drainage routes.

The increase in runoff due to future development is relatively minor, due to the large area of hazards lands within the Basin. The twenty-two potentially developable lots would have some impact on downstream flow velocities and, therefore, channel protection measures are proposed.

3.2.2 Design Flows

The following components are considered to be key infrastructure within the Basin and are presented from upstream to downstream.

- (2) 450 mm Ø CSP (Park St) – Capacity of about 0.3 m³/s, capable of conveying the 1:2 year flow. Possible roadway overtopping conditions exist for the 1:5 year flow and greater.
- 900 mm Ø CSP (14th St W) – Capacity of about 0.9 m³/s, capable of conveying the 1:10 year flow.
- 1500 x 900 CSPA (Somers St) – Capacity of about 1.65 m³/s, capable of conveying the 1:10 year flow.
- 450 mm Ø CSP (16th St W, between Carney St and Somers St) – Capacity of about 0.15 m³/s, insufficient to convey the 1:2 year flow.
- 450 mm Ø Inlet and Outlet (Basin A2b) – Sufficient capacity exists for all modelled storm events and development conditions.

3.2.3 Recommendations

A smaller sub-basin (Basin A2-2) drains via a ravine system to a City storm sewer in the Hunters Run subdivision (7th Ave W). The storm sewer has sufficient capacity to convey the 1:100 year and Regional storm flows. Previous flooding, due to leaves blocking the inlet, has been corrected by City forces, however, a well defined overland flow route should be constructed to the street in the event that future plugging at the inlet occurs.

We recommend that the main outlet channel be walked with staff of the GSCA to target specific areas in need of erosion protection and to determine appropriate protection measures. In the following cost estimate, stone rip rap erosion protection is assumed to be provided at critical locations within the ravine and at the outlet to the river. Based on the foregoing, the recommendations for improvements within Basin A2 are presented in Table 3-2.

Table 3-2 – Basin A2 Recommended Improvements

Description	Cost	Priority
Remove and replace existing (2) 450 mm Ø CSP (Park St, between 13 th St W and 14 th St W) with (2) 600 mm Ø CSP	\$15,000	Medium
Create an overland flow route from the existing ditch inlet catchbasin to 7 th Ave W in the Hunters Run subdivision.	\$6,500	Low
Place stone rip rap protection at critical locations within the ravine system and at the outlet to the Pottawatomoni River.	\$6,500	Low
Remove and replace existing 450 mm Ø CSP (16 th St W, between Somers St and Carney St) with (2) 600 mm Ø CSP	\$15,000	Medium

These works are Schedule A activities under the Municipal Class EA and, therefore, no further review of alternatives is warranted.

3.3 BASIN A3

3.3.1 Preamble

Drainage Basin A3 covers 103.5 ha of land within Georgian Bluffs, and 44.1 ha within the City of Owen Sound. The Georgian Bluffs portion includes six smaller sub-catchment areas, which outlet across 8th Ave W (Albert Street) and eventually confluence within the City, and outlet via a 1500 mm Ø CSP on 19th St W, through Kelso Beach Park to Owen Sound Bay.

Following receipt of a drainage complaint in the Basin A3 area of 6th Ave W, in July, 2003, the City of Owen Sound retained G&M to review the potential implications of diverting flows from the 7th Ave W storm sewer, which currently discharge down the bluff within A3, to the 22nd St W storm sewer system in Basin A4, which connects with the 24th St W outlet. That review identified that capacity may be available within the Basin A4 storm sewer system, but the effect of diverting this flow on flows within Basin A3 would be minimal. The project was not implemented due to the apparent need to investigate broader drainage issues within the area, which precipitated this study.

3.3.2 Boundary Conditions

The capacities of the outlets, at the boundary between Georgian Bluffs and Owen Sound, from the six sub-basin areas within Drainage Basin A3 are summarized in the following Table 3-3.

Table 3-3 – A3 Boundary Condition Outlet Capacities

	A3-1	A3-2	A3-3	A3-4	A3-5	A3-6
Outlet Size	600Ø	300Ø	600Ø	Open Channel	800Ø	300Ø
Outlet Capacity (m ³ /s)	0.971	0.06	0.32	-	0.65	0.06

3.3.3 Outlet Conditions

Sub-basins A3-1 and A3-2 combine east of 8th Ave W (Albert Street) and flow via an open channel to 6th Ave W. A 600 Ø CSP culvert directs flow across 6th Ave W to an open channel along the south side of 20th St W. The capacity of this culvert is about 0.32 m³/s. The channel combines with flows from the other four upstream sub-basin areas at 5th Ave W.

Sub-basins A3-3 to A3-6 all combine just east of 7th Ave W, and drain along an open channel between two private residences to the inlet to a 2700 x 1500 box inlet to a twin 1500 mm Ø CSP storm sewer on 6th Ave W. Nuisance flooding has been reported in the area of the two private residences. The box section has an inlet capacity of about 6.8 m³/s. The storm sewer system has a capacity of about 6.2 m³/s. The storm sewer directs flow to an open channel south of 21st St W. The dwelling at the south east corner of 6th Ave W and 21st St W has a walk-out basement door facing the open channel. A significant portion of the drainage course between 20th St W and 21st St W is on private property and siltation has caused ponding, reduced capacity and nuisance flooding. A 3200 x 1000 box culvert conveys flows across 20th St W to the confluence with flows from A3-1 and A3-2, at 5th Ave W. An open channel then conveys the combined flows south-easterly to a 2740 x 1220 box inlet at 19th St W, where additional flows from within the City combine and flow easterly on 19th St W to the outlet at Kelso Beach.

The outlet portion of this storm sewer system, from the Eddie Sargent Parkway through Kelso Beach Park to the Bay, is a 1500 Ø CSP at 0.2% grade, with a capacity of about 1.712 m³/s. This is not adequate to convey a 1:2 year flow under existing conditions. It is assumed that, as the water level rises, storage is achieved within the ditches and low-lying areas along each side of the Parkway, and overland spill occurs through the Park to the Bay. The City reports that nuisance flooding occurs in this area and, therefore, flow controls upstream should ensure that existing flooding conditions do not worsen.

3.3.4 Design Flows

The following components are considered to be key infrastructure within the Basin and are presented from upstream to downstream.

- (2) 1050 x 800 mm CSP (Somers St and 19th St W) – The culverts provide a combined capacity of about 1.7 m³/s, capable of conveying the 1:100 year flow.
- 1200 mm Ø CSP (Carney Street, north of 20th St W) – Capacity of about 1.8 m³/s, capable of conveying the 1:100 year flow.
- 800 mm Ø CSP (8th Ave W and 22nd St W) – Capacity of about 0.65 m³/s, capable of conveying all design storm flows.

- 2700 x 1500 mm box culvert (and (2) 1500 mm Ø CSP) (6th Ave W, between 21st St W and 22nd St W) – Limiting capacity of about 6.2 m³/s, capable of conveying all design storm flows.
- 3200 x 1000 mm box culvert (21st St W, between 5th Ave W and 6th Ave W) – Capacity of about 4.48 m³/s, capable of conveying the 1:100 year flow.
- 600 mm Ø CSP (6th Ave W, between 19th St W and 20th St W) – Capacity of about 0.32 m³/s, capable of conveying the 1:2 year flow.
- 2740 x 1220 mm box culvert (29th St W, between 4th Ave W and 5th Ave W) – Capacity of about 5.069 m³/s, capable of conveying the 1:50 year flow.
- 1500 mm Ø (Outlet to Owen Sound Bay) – Capacity of about 1.712 m³/s, insufficient to convey all design storms modelled.

3.3.5 Definition of Problem(s)

The following problems have been identified within Basin A3.

- Runoff from Georgian Bluffs carries eroded materials from the ravine systems east of Carney Street to a common watercourse about 7th Ave W. The flat channel gradient within this watercourse, downstream to 20th St W, reduces flow velocity and causes sedimentation to occur, which leads to reduced channel capacity and nuisance flooding on the surrounding residential properties.
- The 1500 mm Ø outlet to this system, through Kelso Beach Park, has insufficient capacity to convey the 1:2 year design flow under existing conditions. Nuisance flooding conditions at the outlet should not worsen under ultimate development conditions.

The “Do Nothing” alternative would not address the problem(s) identified and, therefore, alternative solutions to the identified problem(s) are investigated in the following sections.

3.3.6 Review of Alternative Solutions

In February, 1992, G&M prepared a report entitled “Detention Pond Alternatives, Drainage Area A-3”, for the former Township of Sarawak, and is provided in Appendix “E” for reference. That report reviewed runoff hydrographs resulting from the 1:5 year and 1:100 year return storms, under existing development, 20-year development and ultimate development conditions, to determine the volume of surface water detention, and approximate land area required. The report concluded that, in order to reduce the overall peak flow from Basin A3 to existing (1990) conditions, a storage volume of about 5100 m³ would be necessary for the 20-year development condition, and about 10400 m³ would be necessary for the ultimate development condition. Three optional detention pond scenarios were considered, with the recommended option being the construction of a stormwater detention pond west of Carney Street, between 20th St W and 22nd St W.

We note that under natural conditions, watercourses can erode, transport and deposit a sediment load. The level of development within Basin A3 in Georgian Bluffs has contributed to increased activity of these mechanisms, the degree of which is difficult to accurately quantify and, thus difficult to allocate shared maintenance and construction costs appropriately. Therefore, an alternative which provides a clear separation of responsibilities is considered to be more favourable than one which does not.

A summary discussion for the three optional SWM pond scenarios is presented in the following Sections 3.3.6.1 to 3.3.6.3. Additional alternative solutions are discussed in Sections 3.3.6.4 to 3.3.6.5. A decision framework is presented in Section 3.3.6.6, which directs a recommended solution.

3.3.6.1 Alternative 1 – Option 1 – SWM Pond West of Carney Street

The Carney Street location, located west of Carney Street between 20th St W and 21st St W, is predominantly within an existing ravine feature, which would need to be enhanced to accommodate the required storage volume. There are no known natural, cultural, or built environmental constraints at this location.

Potential social environment considerations include the following:

- The lands are privately owned. The Township would need to acquire sufficient lands through negotiated easement or purchase, or expropriation,
- The lands are located in a highly visible and residential area. The Township would need to consider aesthetics and public safety in the design of a SWM ponding facility, and
- Sediment removal and water quality protection / enhancement features could be designed into this facility.
- The outlet to the system at Kelso Beach would need to be upgraded to achieve a 1:5 year flow capacity.

Economic environment considerations include land acquisition costs, construction costs and annual maintenance costs.

3.3.6.2 Alternative 1 – Option 2 – SWM Pond West of 8th Ave W (Albert Street)

The 8th Ave W (Albert Street) location is predominantly within an existing ravine feature, which would need to be enhanced to accommodate the required storage volumes. There are no known natural, cultural or built environmental constraints at this location, although the construction of a large berm, or dam would be required to achieve the storage volumes required.

Potential social environment considerations include the need for the Township to acquire sufficient lands through negotiated easement or purchase, or expropriation. The aesthetics of the facility may not be as important, since it would not be located in a highly visible area. Sediment removal and water quality protection / enhancement features could be designed into this facility. This facility would require the construction of a dam and the use of an un-opened road allowance. The outlet to the system at Kelso Beach would need to be upgraded to achieve a 1:5 year flow capacity.

Economic environment considerations include land acquisition costs, construction costs and annual maintenance costs.

3.3.6.3 Alternative 1 – Option 3 – Combined SWM Facilities

This alternative considers the construction of smaller SWM ponds at each of the Carney Street and 8th Ave W (Albert Street) locations. Construction could be staged to coincide with the need based on development.

Considerations regarding natural, social, cultural and built environments are the same as previously discussed. However, since this alternative would involve land acquisition, construction and maintenance at two locations, the implementation costs would be compounded. The outlet to the system at Kelso Beach would need to be upgraded to achieve a 1:5 year flow capacity.

3.3.6.4 Alternative 2 – Modify or Upgrade City Storm Sewer System

There are no known natural, social, or cultural environmental considerations.

Other than the outlet through Kelso Beach, the City storm sewer system has adequate capacity to convey the 1:5 year pre-development flows from the Township lands within Basin A3. No upgrades would be required, other than to support development within the Township. Therefore, costs would be solely at the expense of the Township.

The estimated construction cost to modify or upgrade the City storm sewer system would be in excess of \$1M and, therefore, this option is not considered further.

3.3.6.5 Alternative 3 – Modify Existing Channel and Upgrade Outlet

This option considers the potential to improve the existing channel capacity between 20th St W and 21st St W, and to upgrade the outlet storm sewer capacity at Kelso Beach Park.

The channel modifications would include removing accumulated sediments and broadening the channel width to provide 1:100 year design flow capacity, and providing a low flow channel. The required channel section would be about 11 metres wide, which would not fit well within the available land area between the existing 6th Ave W road and the adjacent house at 21st St W. Although the GSCA has verbally agreed to the concept of permitting sediment removal from this channel reach for routine maintenance purposes, we expect the extent of work considered under this option would be considered a Harmful Alteration Disturbance or Destruction (HADD) to fish habitat, and would not likely be permitted.

The area from the storm sewer outlet to the Bay was reviewed by G&M in July, 2005. The area is considered by the GSCA to be fish habitat, and any dredging or re-aligning of the channel, downstream from the storm sewer outlet, would be a HADD. Relatively minor aesthetic improvements and erosion control measures were planned at that time, which had the support of the GSCA. The estimated cost of these improvements is \$25,000.

To achieve a 1:5 year outlet capacity the existing 1500 mm Ø CSP storm sewer should be replaced with a 1500 mm Ø CP storm sewer at an estimated cost of \$100,000.

3.3.6.6 Decision Framework

The following Table 3-4 provides a decision making framework for the review of the alternatives discussed for Basin A3. Each alternative is ranked preferentially, within each environmental consideration, with a score of 1 for least desirable and 6 for most desirable. The highest scoring identifies the recommended alternative.

Table 3-4 – Basin A3 Decision Framework

Description	Environmental Considerations					
	Natural	Social	Cultural	Built	Economic	Total
Do Nothing	1	1	6	1	6	15
(1.1) SWM Pond west of Carney Street	6	6	3	6	5	26
(1.2) SWM Pond West of Albert Street	5	4	2	5	4	20
(1.3) Combined SWM Facilities	2	3	1	4	2	12
(2) Upgrade City Storm Sewer System	4	2	4	2	1	13
(3) Modify Ex. Channel and Upgrade Outlet	3	5	5	3	3	19

Based on the above results, construction of a SWM pond west of Carney Street emerges as the recommended solution.

3.3.7 Recommendations

Based on the foregoing, recommendations are made for improvements to the Drainage Basin A3 system in the following Table 3-5.

Table 3-5 – Basin A3 Recommended Improvements

Description	Cost	Priority
Acquire property or easements over watercourses west of Carney Street, which convey municipal drainage.	-	High
Acquire land immediately upstream from Carney Street for purposes of stormwater management.	-	High
Construct a 10,000 m ³ stormwater management pond upstream from Carney Street, or modify existing channel profiles to store 10,000 m ³ to reduce downstream peak flows and erosion.	\$250,000	High
Acquire property or easement over the channel west of 6 th Ave W.	-	High
Provide rip rap erosion protection at the intersection of channels west of 6 th Ave W.	\$6,500	High
Remove existing sediments from channel west of 6 th Ave W.	\$10,000	High
1) Replace ex. box culvert structures at 6 th Ave W and at 21 st St W. 2) Reconstruct 6 th Ave W., North of 21 st St W (full services) 3) Place additional box sections between road crossings (North of 21 st St W) * *Consider restoring natural channel section. Additional land may be required, or the road may be shifted.	1) \$120,000 2) \$350,000 3) \$160,000	High
Acquire an easement over the channel upstream from 20 th St W to 21 st St W, between 5 th Ave W and 6 th Ave W.	-	High
Remove existing sediments from channel upstream from 20 th St W.	\$15,000	High

Redirect 7 th Ave W storm sewer between 22 nd St W and 23 rd St W easterly on 22 nd St W and connect to existing storm sewer within Basin A4. To be completed when 7 th Ave W is scheduled for full road replacement. (approx. 60m)	\$150,000	Low
Remove and replace existing 600 mm Ø CSP (6 th Ave W, between 19 th St W and 20 th St W) with larger 750 mm Ø PE.	\$6,500	Medium
Construct minor improvements to outfall area within Kelso Beach Park, as outlined in G&M Drawing No. C-6460-1.	\$25,000	Medium
Improve Kelso Beach outlet to achieve 1:5 year flow capacity.	\$100,000	Low

Implementation of the stormwater management pond recommended as part of this alternative would be a Schedule B activity under the Municipal Class EA, which would require a Notice of Project Initiation, Public Review and a Notice of Completion.

3.4 BASIN A4

3.4.1 Preamble

Drainage Basin A4 covers 98.1 ha of land within Georgian Bluffs, and 29.5 ha within the City of Owen Sound. The Georgian Bluffs portion includes two sub-basin areas. The smaller, southerly area (A4-1) outlets to a ravine feature within the City of Owen Sound. The larger, northerly area (A4-2) outlets along the southerly ditch of 24th St W Street to a storm water management pond at the south west corner of the intersection with 8th Ave W (Albert Street), and includes Keppel Sarawak School.

At the corner of West Street and 24th St W, two (2) 450 mm Ø culverts convey flow across West Street. The culverts are about the same elevation. It appears that the northerly culvert was intended to direct local runoff westerly across West Street, to the southerly 450 mm Ø culvert, which drains easterly in the south ditch on 24th St W to the Fromager SWM pond, within Basin A4. It appears that the northerly ditch on 24th St W, just east of West St, was recently lowered to re-direct this flow easterly in the north ditch, and into Basin A5. The effect is the diversion of drainage from about 24 ha from A4 to A5.

An outlet control structure is in place to limit the discharge from the SWM pond at 30 ft³/s (0.85 m³/s), to the City storm sewer on 24th St W. A secondary outlet, or overflow, exits the SWM pond at the south east corner and drains down a ravine to 4th Ave W, south of 24th St W. This flow, and other flows from other City storm sewers, confluence at 24th St W and 3rd Ave W, and outlet via a 1200 mm Ø CP on 24th St W, through the yacht club to Owen Sound Bay.

3.4.2 Boundary Conditions

Flooding issues at the intersection of 24th St W and 8th Ave W are recorded in G&M files as dating back to 1974. In 1979, to alleviate flooding problems, the City of Owen Sound and the Township of Sarawak agreed to cost share the construction of a storm sewer along 24th St W from 8th Ave W to Owen Sound Bay. In that agreement, the Township secured 30 ft³/s (0.85 m³/s) capacity within the storm sewer system. A berm along the south side of the southerly ditch, west of 8th Ave W, was intended to divert flows in excess of 30 cfs into the Fromager Pond.

In 1985, the Grey Sauble Conservation Authority engaged Henderson, Paddon & Associates Ltd. (HPA) to review the existing drainage system within the area, and to assess system capacities based on land use planning from the Grey Owen Sound Official Plan, North Grey Secondary Plan, June 1980. The final report concluded “that the existing stormwater system in the area of 24th St W and 8th Ave W and downstream provides a satisfactory level of protection for the public and private property and that no remedial works are required.” Design flows calculated by HPA, to the intersection of 24th St W and 8th Ave W, were 0.89 m³/s and 3.55 m³/s, for the 1:5 year and 1:100 year storms, respectively.

In 1991 G&M prepared a Master Drainage Study for the Township of Sarawak, as part of the preparation of a new Official Plan. Updated design flows were prepared for existing and future development conditions, based on updated land use planning at that time. Design flows calculated by G&M, to the intersection of 24th St W and 8th Ave W, were 1.77 m³/s and 3.73 m³/s, for the 1:5 year and 1:100 year storms, respectively, under ultimate development conditions.

In 1994, the Township of Sarawak engaged Ainley and Associates Limited to update the design and approvals for the SWM pond to accommodate the expected ultimate development condition. Stormwater runoff from sub-basin A4-1, up to the 1:5 year flow condition, was to be routed easterly beyond the pond to maintain base flows within the existing ravine in the City of Owen Sound. Flows exceeding the 1:5 year design flow in A4-1 are designed to spill into the SWM pond. An orifice control plate was placed on the inlet to the Owen Sound 24th St W storm sewer system to limit flows to a maximum 0.85 m³/s. The design provides that flows exceeding the capacity of the orifice will backup and store within the pond. The pond was designed to overflow south-easterly to the existing ravine for the 1:10 year design flow and beyond, under ultimate development conditions, such that the combined flows entering the two Owen Sound drainage systems would not exceed existing (1990) flow rates.

3.4.3 Outlet Conditions

The outlet from the Fromager Pond to the City’s 24th St W storm sewer is controlled by a steel plate over the outlet pipe from the manhole on the north west corner of the intersection of 24th St W and 8th Ave W. The outlet to this system is a 1200 mm Ø CP on 24th St W, through the yacht club to Owen Sound Bay. The capacity of this outlet is 4.932 m³/s at 1.6% grade.

A secondary system by-passes the Fromager pond and drains south-easterly to a 600 mm Ø CSP culvert across 8th Ave W, then down through a ravine to the rear of lots fronting onto 4th Ave W. Flow enters a 900 mm Ø storm sewer on the west side of 4th Ave W, between 23rd St W and 24th St W, across 4th Ave W, then across private properties to 3rd Ave W. We recommend that, as funding permits, this storm sewer be re-routed along 4th Ave W, southerly to 23rd St W, then easterly on 23rd St W to 3rd Ave W, then northerly to reconnect at the same location. Alternatively, an easement should be acquired to facilitate maintenance of the existing storm sewer.

3.4.4 Design Flows

The following components are considered to be key infrastructure within the Basin and are presented from upstream to downstream.

- 450 mm Ø CSP (south of West St and 24th St W intersection) – Capacity of about 0.15 m³/s, capable of conveying the 1:5 year flow.
- 1200 mm Ø CSP (Park St and 24th St W) – Capacity of about 1.8 m³/s, capable of conveying the 1:100 year flow.
- 900 mm Ø CSP (Park St and 24th St W) – Capacity of about 0.9 m³/s, capable of conveying the 1:100 year flow.
- 1600 x 1200 mm CSPA (Somers St and 24th St W) – Capacity of about 2.3 m³/s, capable of conveying the 1:100 year flow.
- 1450 x 900 mm CSPA (Finden St and 24th St W) – Capacity of about 1.500 m³/s, capable of conveying the 1:25 year flow.
- 825 mm Ø CSP (inlet to City of Owen Sound Storm Sewer at 8th Ave W and 24th St W) – Capacity of about 0.850 m³/s, capable of conveying all design storms due to excess flows backing up into the SWM pond.
- 900 mm Ø (4th Ave W, between 23rd St W and 24th St W) – Capacity of about 1.835 m³/s, capable of conveying the 1:100 year flow. This system drains overflows from the Fromager Pond.
- 1200 mm Ø CP (outlet to Owen Sound Bay) – Capacity of about 4.932 m³/s, capable of conveying the 1:100 year flow.

3.4.5 Definition of Problem(s)

We are not aware of any current flooding problem, which would require further assessment at this time. A review of alternative solutions is, therefore, not warranted.

3.4.6 Recommendations

Based on the foregoing, the recommendations for drainage improvements within Basin A4 are provided in the following Table 3-6.

Table 3-6 – Basin A4 Recommended Improvements

Description	Cost	Priority
Remove the northerly 450 mm Ø culvert at the intersection of West Street and 24 th St W, and replace the southerly 450 mm Ø culvert with a 600 mm Ø culvert, to prevent the diversion of flows into A5.	\$15,000	High
Place stone rip rap protection at critical locations within ditch between top of bluff to Park Street. (Consider future storm sewer)	\$10,000	High
Replace the existing 600 mm Ø culvert across 8 th Ave W (between 23 rd St W and 24 th St W) with a 900 mm Ø culvert, to reduce overland flow events and protect adjacent dwellings.	\$32,500	Low
Replace existing 450 mm Ø storm sewer on 3 rd Ave W (between 23 rd St W and 24 th St W) with 900 mm Ø storm sewer (approx. 150m).	\$500,000	Medium
Re-route the 900 mm Ø storm sewer, which currently crosses private property, along 4 th Ave W and 23 rd St W. (approx. 250m)	\$820,000	Low
Provide a stormwater treatment unit on the southerly storm sewer, upstream from the outlet to the yacht club.(All urban area flows)	\$75,000	Low

These recommendations are Schedule A activities under the Municipal Class EA.

3.5 BASIN A5

3.5.1 Preamble

Drainage Basin A5 covers 102.1 ha of land within Georgian Bluffs, and 32.3 ha within the City of Owen Sound. The Georgian Bluffs portion includes six (6) smaller sub-basin areas, which outlet across 8th Ave W (Albert Street). A-5-1 to A-5-3 confluence within the City at the intersection of 6th Ave W and 27th St W, where a 1350 mm Ø concrete pipe inlets to the 1050 mm Ø CSP storm sewer on 27th St W to Owen Sound Bay. Under high flow conditions, a 450 mm Ø CSP on Finden Street at Maitland Street allows spill to occur from A5-3 to Drainage Basin A6.

Sub-basins A5-4 to A5-6 drain via a series of culverts and ravines across 8th Ave W (Albert Street) to the former CN Rail line. Three culverts convey flow across the rail line to the storm sewer system of an apartment building complex and, ultimately, to a 900 mm Ø CSP storm sewer on 28th St W.

A 450 mm Ø CSP storm sewer on 29th St W provides for local drainage within the City (sub-basin A5c), between 6th Ave W and Owen Sound Bay.

3.5.2 Boundary Conditions

Six (6) sub-basin areas drain 102.1 ha of land, which comprises Drainage Area A5 within Georgian Bluffs:

- A5-1 drains 3.5 ha of land from north of Keppel Sarawak School to a 750 mm Ø CSP inlet to the 750 mm Ø storm sewer on 26th St W. This storm sewer outlets to the north side of 26th St W at 7th Ave W. Flows from this storm sewer traverse a wide ravine to a 1350 mm Ø concrete pipe inlet to the 27th St W storm sewer.
- A5-2 drains 14.7 ha of land to two (2) 600 mm Ø CSP culverts located between 26th St W and 27th St W. Flow from these culverts converge into one 450 mm Ø concrete pipe on the east side of 8th Ave W. This pipe outlets to a ravine behind houses which front onto the east side of 8th Ave W. Flow then traverses the ravine to the 1350 mm Ø concrete pipe inlet to the 27th St W storm sewer.
- A5-3 drains 78.5 ha of land along the south side of Maitland Street to a 600 mm Ø CSP inlet to the 450 mm Ø CSP storm sewer west of the former CN Rail line on 27th St W. The 450 mm Ø CSP storm sewer discharges via a 600 mm Ø CP immediately upstream of the 1350 mm Ø concrete pipe inlet to the 27th St W storm sewer. At the intersection of Finden Street and 27th St W, a 600 mm Ø CSP culvert conveys flow easterly across Finden Street toward the outlet. Additionally, a 450 mm Ø CSP culvert spills some flow to Drainage Area A6 across 27th St W to the westerly roadside ditch on Finden Street. The 450 mm Ø culvert is elevated about 100 mm above the ditch bottom, and spill at this location only occurs under heavy runoff conditions.
- A5-4 to A5-6 drain 5.5 ha of land across 8th Ave W to the former CN Rail line via a 300 mm Ø CSP immediately north of 27th St W and two open channels between 28th St W and 29th St W. Flow eventually enters the 28th St W storm sewer system.

The capacities of the outlets, at the boundary between Georgian Bluffs and Owen Sound, from the six (6) sub-basin areas within Drainage Basin A5 are summarized in the following Table 3-7.

Table 3-7 – A5 Boundary Condition Outlet Capacities

	A5-1	A5-2	A5-3	A5-4	A5-5	A5-6
Outlet Size	750Ø	450Ø	600Ø	300Ø	Open Channel	Open Channel
Outlet Capacity (m ³ /s)	0.55	0.15	0.32	0.06	-	-

A smaller area within Drainage Basin A5 (Basin A5c, in the City of Owen Sound) drains to the 29th St W storm sewer system and outlets via a 450 mm Ø CSP.

3.5.3 Outlet Conditions

The outlet capacities of the existing storm sewers within the City are summarized in the following Table 3-8.

Table 3-8 – A5 Outlet Conditions

	27 th St W	28 th St W	29 th St W
Outlet Size (mm)	1200 Ø	1200 Ø	450 Ø
Outlet Grade (%)	6.0	5.7	5.8
Outlet Capacity (m ³ /s)	5.17	5.06	0.69

3.5.4 Design Flows

- 450 mm Ø CSP (north of West St and 24th St W intersection) – Capacity of about 0.15 m³/s, capable of conveying the 1:5 year flow.
- 1050 x 800 mm CSP (Somers St and 27th St W) – Capacity of about 0.85 m³/s, capable of conveying the 1:25 year flow.
- 450 mm Ø CSP (Finden St and 26th St W) – Capacity of about 0.15 m³/s, capable of conveying the 1:2 year flow.
- 600 mm Ø CSP (Finden St and 27th St W) – Capacity of about 0.32 m³/s, capable of conveying the 1:2 year flow.
- 750 mm Ø CSP (8th Ave W and 26th St W) – Capacity of about 0.55 m³/s, capable of conveying flow from all modelled return storm conditions.
- 450 mm Ø CP (8th Ave W, between 26th St W and 27th St W) – Capacity of about 0.15 m³/s, insufficient of conveying all design flows.
- 1350 mm Ø CP (27th St W and the former CN Rail line) – Capacity of about 2.4 m³/s, capable of conveying the 1:50 year flow.
- 1050 mm Ø CSP (27th St W, between 4th Ave W and 5th Ave W) – Capacity of about 1.4 m³/s, capable of conveying the 1:5 year flow.
- 1200 mm Ø CP (former CN Rail line, between 26th St W and 27th St W) – Capacity of about 1.8 m³/s, capable of conveying flow from all modelled return storm conditions.
- 1200 mm Ø CSP (27th St W outlet to Owen Sound Bay) – Capacity of about 5.173 m³/s, capable of conveying flow from all modelled return storm conditions.
- 1400 mm Ø CP (CN Rail between 28th St W and 29th St W) – Capacity of about 2.6 m³/s, capable of conveying flow from all modelled return storm conditions.

- 1000 x 1000 mm box culvert (CN Rail between 28th St W and 29th St W) – Capacity of about 1.4 m³/s, capable of conveying flow from all modelled return storm conditions.
- 375 mm Ø CSP (Inlet to 28th St W storm sewer, west of 6th Ave W and 29th St W) – Capacity of about 0.198 m³/s, capable of conveying the 1:2 year flow.
- 1200 mm Ø CSP (28th St W outlet to Owen Sound Bay) – Capacity of about 5.055 m³/s, capable of conveying flow from all modelled return storm conditions.

3.5.5 Recommendations

Based on the foregoing, the recommendations for drainage improvements within Basin A5 are made in the following Table 3-9.

Table 3-9 – Basin A5 Recommended Improvements

Description	Cost	Priority
Eliminate the spill from A5 to A6 at Finden Street and 27 th St W.	\$5,000	Medium
Remove and replace existing 450 mm Ø CSP (Finden St and 26 th St W) with a 600 mm Ø CSP.	\$15,000	Medium
Remove and replace existing 400 mm Ø CSP (Park St, between 24 th St W and 25 th St W) with a 600 mm Ø CSP.	\$6,500	Medium
Remove and replace existing 600 mm Ø CSP (currently beginning to undercut downstream bank) (Finden St and 27 th St W) and replace with larger 900 mm Ø.	\$15,000	Medium
Georgian Bluffs should acquire easement or ownership over the watercourse west of 8 th Ave W.	-	Medium
Intercept flows on W side of 8 th Ave W, from south of 26 th St W (A5-1), at 26 th St W (A5-2) and north of 26 th St W (A5-3) and construct 600 mm Ø and 900 mm Ø storm sewers to direct these flows northerly to 27 th St W. Provide for drainage from the north west corner of 8 th Ave W and 27 th St W (A5-4) southerly to the 27 th St W storm sewer (Remove existing 300 mm Ø CSP crossing 8 th Ave W). (150 m incl. one lane of road)	\$250,000	Medium
Reconstruct the 27 th St W storm sewer from 8 th Ave W to the Rail Trail, with a 900 mm Ø storm sewer. Continue to discharge to ravine, then outlet to existing 1050 mm Ø storm sewer (200m incl. full road)	\$500,000	Medium
Eliminate the 750 mm Ø culvert across the Rail Trail, north of 27 th St W and direct flows southerly to the proposed drainage enhancement at the north west corner of the Rail Trail and 27 th St W. Provide for drainage from the north west corner of the Rail Trail and 27 th St W to the 27 th St W storm sewer.	\$10,000	Medium
Remove and replace existing 375 mm Ø CSP (Inlet to 28 th St W storm sewer, west of 6 th Ave W and 29 th St W) with a larger 450 mm Ø pipe.	\$25,000	Medium
Construct a new 26 th St W storm sewer from 8 th Ave W to 3 rd Ave W and connect to existing (2) 450 mm Ø outlet which currently drains local runoff on 26 th St W from 3 rd Ave W to Owen Sound Bay.	\$650,000	Low
Eliminate the storm sewers across private property.	-	Low

These recommendations are Schedule A activities under the Municipal Class EA. The diversion of flows on 8th Ave W, away from the ravine system may affect Riparian property owners, who should be consulted in advance of this project implementation.

3.6 BASIN A6

3.6.1 Preamble

Drainage Basin A6 covers 38.2 ha of land within Georgian Bluffs, and 7.8 ha within the City of Owen Sound. The Georgian Bluffs portion includes a single catchment area, which outlets across 8th Ave W (Albert Street) via a ravine system, which drains through a 1000 x 1000 mm concrete box culvert under the former CN Railway line to an open channel along the 30th St W road allowance to Grey Road 1, where a 1830 x 1120 mm CSPA culvert outlets flow across Grey Road 1 to Owen Sound Bay. Under high flow conditions, a 450 mm Ø CSP on Finden Street at Maitland Street allows spill to occur from A5-3 to Drainage Area A6.

3.6.2 Boundary Conditions

Flow across the boundary between Georgian Bluffs and the City is via an open channel, at the Rail Trail

3.6.3 Outlet Conditions

The capacity of the existing 1830 x 1120 mm CSPA outlet culvert across Grey Road 1 is 2.60 m³/s.

3.6.4 Design Flows

- (2) 600 mm Ø CSP (Somers St and 28th St W) – Capacity of about 0.64 m³/s, capable of conveying the 1:100 year flow.
- 900 mm Ø CSP (Finden St and 29th St W) – Capacity of about 0.9 m³/s, capable of conveying the 1:100 year flow.
- 550 mm Ø CSP (Finden St and 29th St W) – Capacity of about 0.25 m³/s, capable of conveying the 1:10 year flow.
- 1000 x 1000 mm box culvert (former CN Rail line, between 29th St W and 20th St W) – Capacity of about 1.4 m³/s, capable of conveying the 1:50 year flow.
- 1830 x 1120 mm CSPA (Basin A6 outlet to Owen Sound Bay) – Capacity of about 2.6 m³/s, capable of conveying the 1:100 year flow.

3.6.5 Definition of Problem(s)

Erosion of the steeper sections of the A6 watercourse, especially within the reach which spans from the Rail Trail easterly to Grey Road 1, has been accelerated due to development and by channelization of flow within the upper reaches. Left unchecked, these conditions will continue to deteriorate as development progresses and runoff increases.

3.6.6 Review of Alternatives

In February, 1992, G&M undertook a review of drainage options within Drainage Basin A6. Eight alternative drainage schemes were investigated to determine their effectiveness in

preventing further degradation of the outlet channel. Three of the schemes were deemed to warrant further consideration:

- i) Construction of a storm sewer from the Rail Trail to Owen Sound Bay,
- ii) Construction of an erosion resistant channel, lined with rip rap and filter fabric, from the Rail Trail to Owen Sound Bay, and
- iii) Construction of a stepped ponding system.

That report identified an enclosed storm sewer as the preferred solution. A copy of that report is provided as Appendix “E”. Considering that 30th St W is the boundary road between Georgian Bluffs and Owen Sound, and that almost all water generated comes from Georgian Bluffs, the construction of a lined channel on the Georgian Bluffs side of the right of way would be more cost effective and maintain consistency of ownership.

3.6.7 Recommendations

Based on the foregoing the following Table 3-10 makes recommendations for drainage improvements within Basin A6.

Table 3-10 – Basin A6 Recommended Improvements

Description	Cost	Priority
Replace existing collapsed (2)600 mm Ø concrete pipes downstream of Finden St and 29 th St W intersection.	\$10,000	High
Georgian Bluffs should acquire easement or ownership over the watercourse west of Grey Road 1.	-	Medium
The reach below the Rail Trail should be lined with rip rap over filter cloth. Consideration should be given to re-aligning the watercourse in this area to accommodate the possible construction of 30 th St W.	\$215,000	Medium
The 4 th Ave W storm sewer should be re-routed to flow southerly to the 29 th St W storm sewer outlet, to ensure a clear separation of responsibility for this watercourse.	\$225,000	Low

These recommendations are Schedule A, or A+ activities under the Municipal Class EA. Schedule A+ activities require public advisement prior to project implementation.

3.7 BASIN A7

3.7.1 Preamble

Drainage Basin A7 covers 45.5 ha of land within Georgian Bluffs, and does not drain through the City of Owen Sound. Basin A7 includes a single catchment area, which drains through a 1000 x 600 mm concrete box culvert under the former CN Railway line to an open channel north of the City limits to Grey Road 1, where a 1090 x 690 mm CSPA culvert outlets flow across Grey Road 1 to Owen Sound Bay. The outlet capacity of the 1090 x 690 mm CSPA is 0.75 m³/s, however the culvert can convey 1.40 m³/s at Hw/D=1.7 (970mm depth of water at the inlet).

3.7.2 Design Flows

- 900 mm Ø PE (Carney St and 30th St W) – Capacity of about 0.9 m³/s, capable of conveying the 1:100 year flow.
- 400 mm Ø CSP (Gale St (Range Rd) and 30th St W) – Capacity of about 0.12 m³/s, insufficient of conveying the 1:2 year flow.
- 1000 x 600 mm box culvert (former CN Rail line, north of 30th St W) – Capacity of about 0.65 m³/s, capable of conveying the 1:2 year flow. Sufficient head exists at this location to allow a capacity of about 2.8 m³/s, capable of conveying all design storm flows.
- 1090 x 690 mm CSPA (Basin A7 outlet to Owen Sound Bay) – Capacity of about 0.75 m³/s, capable of conveying the 1:2 year flow. A headwater/diameter ratio of 1.7 provides a capacity of about 1.40 m³/s, capable of conveying the 1:10 year flow.

3.7.3 Recommendations

Based on the foregoing recommendations are made for drainage improvements within Basin A7 in the following Table 3-11.

Table 3-11 – Basin A7 Recommended Improvements

Description	Cost	Priority
Remove and replace existing 400 mm Ø CSP (north of 30 th St W at Gale St (Range Rd)) with larger 750 mm Ø pipe.	\$7,500	High
Georgian Bluffs should acquire easement or ownership over the watercourse west of Grey Road 1.	-	Medium
The reach below the Rail Trail should be lined with rip rap over filter cloth.	\$275,000	Low

These recommendations are Schedule A, or A+ activities under the Municipal Class EA. Schedule A+ activities require public advisement prior to project implementation.

4.0 SUMMARY OF RECOMMENDATIONS

Recommendations provided above have been consolidated into more convenient tables below for each municipality based on priority sequence. Coinciding projects have been ‘linked’ via reference number.

Table 4-1 – Township of Georgian Bluffs – High Priority (0-5 Years)

Ref#	Description	Cost	Priority
-	A1 – Replace existing catchbasin grates on 14 th St W with bird cage style inlet grates, or other appropriate inlet to reduce plugging potential, to allow leaves to inlet to the sewer, rather than collecting and plugging at the inlet.	\$5,000	High
-	A3 – Acquire property or easements over watercourses west of Carney Street, which convey municipal drainage.	-	High
-	A3 – Acquire land immediately upstream from Carney Street for purposes of stormwater management.	-	High

-	A3 – Construct a 10,000 m ³ stormwater management pond upstream from Carney Street, or modify existing channel profiles to store 10,000 m ³ to reduce downstream peak flows and erosion.	\$250,000	High
-	A4 – Remove the northerly 450 mm Ø culvert at the intersection of West Street and 24 th St W, and replace the southerly 450 mm Ø culvert with a 600 mm Ø culvert, to prevent the diversion of flows into A5.	\$15,000	High
-	A4 – Place stone rip rap protection at critical locations within ditch between top of bluff to Park Street. (Consider future storm sewer)	\$10,000	High
-	A6 – Replace existing collapsed (2)600 mm Ø concrete pipes downstream of Finden St and 29 th St W intersection.	\$10,000	High
-	A7 – Remove and replace existing 400 mm Ø CSP (north of 30 th St W at Gale St (Range Rd)) with larger 750 mm Ø pipe.	\$7,500	High
	Total	\$297,500	0-5 Yrs.

Table 4-2 – Township of Georgian Bluffs – Medium Priority (5-10 Years)

Ref#	Description	Cost	Priority
-	A2 – Remove and replace existing (2) 450 mm Ø CSP (Park St, between 13 th St W and 14 th St W) with (2) 600 mm Ø CSP	\$15,000	Medium
-	A2 – Remove and replace existing 450 mm Ø CSP (16 th St W, between Somers St and Carney St) with (2) 600 mm Ø CSP	\$15,000	Medium
-	A5 – Eliminate the spill from A5 to A6 at Finden Street and 27 th St W.	\$5,000	Medium
-	A5 – Remove and replace existing 450 mm Ø CSP (Finden St and 26 th St W) with a 600 mm Ø CSP.	\$15,000	Medium
-	A5 – Remove and replace existing 400 mm Ø CSP (Park St, between 24 th St W and 25 th St W) with a 600 mm Ø CSP.	\$6,500	Medium
-	A5 – Remove and replace existing 600 mm Ø CSP (currently beginning to undercut downstream bank) (Finden St and 27 th St W) and replace with larger 900 mm Ø.	\$15,000	Medium
-	A5 – Georgian Bluffs should acquire easement or ownership over the watercourse west of 8 th Ave W.	-	Medium
1	A5 – Intercept flows on W side of 8 th Ave W, from south of 26 th St W (A5-1), at 26 th St W (A5-2) and north of 26 th St W (A5-3) and construct 600 mm Ø and 900 mm Ø storm sewers to direct these flows northerly to 27 th St W. Provide for drainage from the north west corner of 8 th Ave W and 27 th St W (A5-4) southerly to the 27 th St W storm sewer (Remove existing 300 mm Ø CSP crossing 8 th Ave W). (150 m incl. one lane of road)	\$250,000	Medium
-	A6 – Georgian Bluffs should acquire easement or ownership over the watercourse west of Grey Road 1.	-	Medium

-	A6 – The reach below the Rail Trail should be lined with rip rap over filter cloth. Consideration should be given to re-aligning the watercourse in this area to accommodate the possible construction of 30 th St W.	\$215,000	Medium
-	A7 – Georgian Bluffs should acquire easement or ownership over the watercourse west of Grey Road 1.	-	Medium
	Total	\$536,500	5-10 Yrs.

Table 4-3 – Township of Georgian Bluffs – Low Priority (10+ Years)

Ref#	Description	Cost	Priority
-	A1 – Reconstruct 14 th St W (350 m), including replacing the existing 450 mm Ø CSP with a larger diameter storm sewer (600 mm Ø), with a sufficient number of inlets, to improve flow hydraulics, increase capacity and facilitate maintenance, and improving roadside ditches to drain road granulars, direct surface flows to appropriate inlets, and reduce nuisance flooding.	\$385,000	Low
-	A2 – Place stone rip rap protection at critical locations within the ravine system and at the outlet to the Pottawatomie River.	\$6,500	Low
-	A4 – Replace the existing 600 mm Ø culvert across 8 th Ave W (between 23 rd St W and 24 th St W) with a 900 mm Ø culvert, to reduce overland flow events and protect adjacent dwellings.	\$32,500	Low
-	A7 – The reach below the Rail Trail should be lined with rip rap over filter cloth.	\$275,000	Low
	Total	\$699,000	10+ Yrs.

Table 4-4 – City of Owen Sound – High Priority (0-5 Years)

Ref#	Description	Cost	Priority
-	A3 – Acquire property or easement over the channel west of 6 th Ave W.	-	High
-	A3 – Provide rip rap erosion protection at the intersection of channels west of 6 th Ave W.	\$6,500	High
-	A3 – Remove existing sediments from channel west of 6 th Ave W.	\$10,000	High
-	A3 – 1) Replace ex. Box culvert structures at 6 th Ave W and at 21 st St W. 2) Reconstruct 6 th Ave W., North of 21 st St W (full services) 3) Place additional box sections between road crossings (North of 21 st St W)* *Consider restoring natural channel section. Additional land may be required, or the road may be shifted.	1) \$120,000 2) \$350,000 3) \$160,000	High
-	A3 – Acquire an easement over the channel upstream from 20 th St W to 21 st St W, between 5 th Ave W and 6 th Ave W.	-	High

-	A3 – Remove existing sediments from channel upstream from 20 th St W.	\$15,000	High
	Total	\$661,500	0-5 Yrs.

Table 4-5 – City of Owen Sound – Medium Priority (5-10 Years)

Ref#	Description	Cost	Priority
-	A3 – Remove and replace existing 600 mm Ø CSP (6 th Ave W, between 19 th St W and 20 th St W) with larger 750 mm Ø PE.	\$6,500	Medium
-	A3 – Construct minor improvements to outfall area within Kelso Beach Park, as outlined in G&M Drawing No. C-6460-1.	\$25,000	Medium
-	A4 – Replace existing 450 mm Ø storm sewer on 3 rd Ave W (between 23 rd St W and 24 th St W) with 900 mm Ø storm sewer (approx. 150m).	\$500,000	Medium
1	A5 – Reconstruct the 27 th St W storm sewer from 8 th Ave W to the Rail Trail, with a 900 mm Ø storm sewer. Continue to discharge to ravine, then outlet to existing 1050 mm Ø storm sewer (200m incl. full road)	\$500,000	Medium
1	A5 – Eliminate the 750 mm Ø culvert across the Rail Trail, north of 27 th St W and direct flows southerly to the proposed drainage enhancement at the north west corner of the Rail Trail and 27 th St W. Provide for drainage from the north west corner of the Rail Trail and 27 th St W to the 27 th St W storm sewer.	\$10,000	Medium
-	A5 – Remove and replace existing 375 mm Ø CSP (Inlet to 28 th St W storm sewer, west of 6 th Ave W and 29 th St W) with a larger 450 mm Ø pipe.	\$25,000	Medium
	Total	\$1,066,500	5-10 Yrs.

Table 4-6 – City of Owen Sound – Low Priority (10+ Years)

Ref#	Description	Cost	Priority
-	A2 – Create an overland flow route from the existing ditch inlet catchbasin to 7 th Ave W in the Hunters Run subdivision.	\$6,500	Low
-	A3 – Redirect 7 th Ave W storm sewer between 22 nd St W and 23 rd St W easterly on 22 nd St W and connect to existing storm sewer within Basin A4. To be completed when 7 th Ave W is scheduled for full road replacement. (approx. 60m)	\$150,000	Low
-	A3 – Improve Kelso Beach outlet to achieve 1:5 year flow capacity.	\$100,000	Low
-	A4 – Re-route the 900 mm Ø storm sewer, which currently crosses private property, along 4 th Ave W and 23 rd St W. (approx. 250m)	\$820,000	Low
-	A4 – Provide a stormwater treatment unit on the southerly storm sewer, upstream from the outlet to the yacht club.(All urban area flows)	\$75,000	Low

-	A5 – Construct a new 26 th St W storm sewer from 8 th Ave W to 3 rd Ave W and connect to existing (2) 450 mm Ø outlet which currently drains local runoff on 26 th St W from 3 rd Ave W to Owen Sound Bay.	\$650,000	Low
-	A5 – Eliminate the storm sewers across private property.	-	Low
-	A6 – The 4 th Ave W storm sewer should be re-routed to flow southerly to the 29 th St W storm sewer outlet, to ensure a clear separation of responsibility for this watercourse.	\$225,000	Low
	Total	\$2,026,500	10+ Yrs.

5.0 PUBLIC COMMENTS

A public meeting was held on June 23, 2008 from 6:00 pm to 8:00 pm at the Keppel Sarawak Elementary School to update the public on the study findings, allow for public comment, and to answer specific questions related to individual properties or the study area as a whole. A sign-in sheet was provided and is included in Appendix “F”. Comment sheets and meeting minutes containing comment’s received verbally at the public meeting are included for reference in Appendix “F”.

The following is a summary of public comments received.

Public Meeting Verbal Comments

- A resident on 21st St W, just east of 6th Ave W inquired if something could be done to clean the channel abutting their and their neighbours property as this past spring’s flooding came close to flooding his neighbours house. The neighbour also spoke indicating that they have lost many mature trees due to the nuisance flooding, and two sheds and some contents have been damaged due to the high water on their property. The neighbour also inquired about who will clean up the dead trees and if they will be replaced.
- A resident of the area noted that in 1992 Sarawak completed a similar study, and that no action had been taken. The resident suggested that something be done now so that another 20 years does not pass by without implementing recommended solutions.
- A property owner in the area noted that the 21st St W channel has filled in over the years and has ‘moved’ as well.
- Another resident inquired regarding the stormwater retention pond proposed and if there are any other options under consideration.
- An inquiry was made regarding how many years until action will take place on the study’s recommended solutions, and if the A3 channel would be maintained in the mean time.
- A resident inquired if there could be another public meeting in six months to provide an update to the process; this was supported by various residents in attendance.
- A resident on 24th St W between West Street and Park Street noted that ditches on the south side of 24th St W are eroded and that driveways and front yards are at risk for future erosion/washouts. Upstream improvements could result in a greater volume of water flowing through this ditch, and may result in increased erosion/washout potential.

Public Meeting Comment Sheets, Faxes, and E-Mails

- Another public meeting in six months should be held.
- Objection to the removal of (2)600Ø CP culverts with no replacement culverts proposed just east of Finden Street and 29th St W as this is a right of way to allow public access along 29th St W to private property.
- Clean out channel west of 6th Ave W at 21st St W or place SWM facility at this location rather than at Carney Street. A SWM facility at this location is not cost effective and may need to be filled in (due to drownings, smell, etc).
- Provide flooding relief as it happens, clean culverts twice a year, and maintain roads over culverts.
- A writer noted that driveway washout conditions occurred within the vicinity of 27th St W and 8th Ave W.
- It would be nice to have something done to correct some of the areas that need help so badly.
- Disagree with the proposed removal of (2)600Ø CP culverts downstream of Finden Street and 29th St W. Culverts should have been maintained to prevent failure. Culverts should be replaced and maintained in the future.
- Severe flooding in backyard (21st St W and 6th Ave W) has resulted in the loss of 45 to 50 mature trees. Major damage to two storage sheds due to flooding and from a dead tree falling on one. Over time, water levels from rainstorms continually get closer to basement door. Dead trees should be removed and replaced, and the damaged sheds repaired or replaced.
- Location of watercourse west of Finden Street at 26th St W should be on 26th St W road allowance. Hazard land designation on Drawings No. 3 is a surprise.

Field Investigation Public Comments

- A resident adjacent to the Pottawatomie River on 14th Street West (Basin A1) noted that the storm sewer inlets were insufficient to collect runoff from Basin A1 Southeast toward the Pottawatomie River. The resident explained that runoff frequently flows over his property to the Pottawatomie River due primarily to clogging of the catch basin inlets.
- A resident in Georgian Bluffs noted that many ditches within the study area have been ditched lower than the outletting culvert, creating many unsightly ponding areas within roadside ditches.

These comments have been provided to assist the Township of Georgian Bluffs and the City of Owen Sound in their decision making processes for the noted recommendations this report has provided.

All of which is respectfully submitted.

GAMSBY AND MANNEROW LIMITED

Per:

David Reid, E.I.T.

John Slocombe, P.Eng.
Principal

**BROOKE AREA STORMWATER MANAGEMENT STUDY
CITY OF OWEN SOUND
TOWNSHIP OF GEORGIAN BLUFFS
FINAL REPORT**

FIGURES

- Figure No. 1 – General Study Area
 - Figure No. 2 – Drainage Areas
 - Figure No. 3 – Class EA Process
 - Figure No. 4 – Georgian Bluffs Municipal Zoning By-law
No. 6-2003, as amended January, 2007
-

**BROOKE AREA STORMWATER MANAGEMENT STUDY
CITY OF OWEN SOUND
TOWNSHIP OF GEORGIAN BLUFFS
FINAL REPORT – CD**

FIGURES

- Figure No. 1 – General Study Area
- Figure No. 2 – Drainage Areas
- Figure No. 3 – Class EA Process
- Figure No. 4 – Georgian Bluffs Municipal Zoning By-law No. 6-2003, as amended January, 2007

DRAWINGS

- Drawing No. 1 – General Plan
- Drawing No. 2 – Drainage Areas – Existing Conditions
- Drawing No. 3 – Development Plan
- Drawing No. 4 – Drainage Areas A1 & A2 – Existing Design Flows
- Drawing No. 5 – Drainage Areas A3 & A4 – Existing Design Flows
- Drawing No. 6 – Drainage Areas A5, A6 & A7 – Existing Design Flows
- Drawing No. 7 – Drainage Areas A1 & A2 – Proposed Capital Works
- Drawing No. 8 – Drainage Areas A3 & A4 – Proposed Capital Works
- Drawing No. 9 – Drainage Areas A5, A6 & A7 – Proposed Capital Works
- Drawing No. 10 – Drainage Areas A1 & A2 – Proposed Capital Works Design Flows
- Drawing No. 11 – Drainage Areas A3 & A4 – Proposed Capital Works Design Flows
- Drawing No. 12 – Drainage Areas A5, A6 & A7 – Proposed Capital Works Design Flows

APPENDIX “A”

Statistical Rainfall Data (IDF)
MIDUSS Results - Chicago Rainfall Parameters
Timmins Regional Storm Characteristics

APPENDIX “B”

Sydenham River Table of Annual Extremes of Discharge
MIDUSS Results for Sydenham River Peak Flows

APPENDIX “C”

Culvert Capacity Design Charts

APPENDIX “D”

MIDUSS Computer Model Output

APPENDIX “E”

30th Street West Drainage Study – Drainage Area A6 – G&M, February, 1992
Detention Pond Alternatives – Drainage Area A3 – G&M, February, 1992
Stormwater Management Study – Township of Sarawak – G&M, September, 1990
24th Street SWM Project Final Design Report – Ainley and Associates Ltd., August, 1994
24th Street SWM Project EA Report Schedule ‘B’ – Ainley and Associates Ltd., June, 1994

APPENDIX “F”

Public Meeting Sign-In Sheets
Public Meeting Comment Sheets
Public Meeting Minutes – June 23, 2008

(attach CD here)