SUBJECT: Greenhill Avenue Storm Drainage Study (PW08064) - (Ward 5)
Public Works Committee, Outstanding Business List Item

RECOMMENDATION:

(a) That the General Manager of the Public Works Department be authorized and directed to file the Greenhill Avenue Storm Drainage Study as per the Municipal Class Environmental Assessment (October 2000 as amended in 2007), on the public record with the Municipal Clerk for a thirty day public review;

(b) That upon the completion of the thirty day public review and period final approval, the General Manager of the Public Works Department be authorized and directed to include the projects identified in the Greenhill Avenue Area Storm Drainage Study as part of 2009 Capital Budget submissions;

(c) That the General Manager of the Public Works Department be authorized and directed to implement the Maintenance and Operations procedures recommended within Greenhill Storm Avenue Area Storm Drainage Study Report PW08064;

(d) That the General Manager of the Public Works Department be authorized and directed to implement that all future sub-divisions be designed in accordance with the approved City of Hamilton Storm Drainage Policy (May 2004);

(e) That the item relating to “Greenhill Neighbourhood Flooding” be removed from the Outstanding Business List on the Public Works Committee Agenda.

Gerry Davis
Acting General Manager
Public Works
EXECUTIVE SUMMARY:

The primary cause of the flooding that occurred as a result of the December 1\textsuperscript{st}, 2006 rainfall event in the Greenhill Avenue Area Storm Drainage Study study area was determined to be the blockage of the Battlefield Creek culvert. This blockage resulted in the spill of a large volume of water from the Battlefield Creek catchment to the Greenhill subdivision via the Canadian Pacific Railway (CPR) right of way and Greenhill Avenue. The volume of these flows greatly exceeded the capacity of the Greenhill area drainage systems. It is concluded that reducing the risk of blockage at this culvert is the first priority for dealing with the flooding problem.

There were also a number of contributing factors that added to the severity of the flooding. Of these contributing factors, a number are deemed to be significant and should be addressed as part of a comprehensive solution. These are:

- Erosion in Battlefield Creek;
- Insufficient capacity at the Centennial Parkway culvert;
- Re-grading of CPR Ditches;
- Insufficient capacity of the CPR culverts at Greenhill Ave; and
- Lack of continuous overland flow route in the subdivision.

The recommended flood control measures should be implemented on a priority basis. The recommended implementation sequence is:

1. Structural measures at the Battlefield Creek culvert, including access roads.
2. Upstream sediment removal on Battlefield Creek.
3. Additional inlets in the Greenhill subdivision.
4. New CPR culverts at Greenhill Avenue.

Estimated budgeted cost to implement all the recommended flood control measures is $370,000. This cost estimate includes contract administration, permitting/approvals and construction supervision cost figures. The City will engage CPR for any cost sharing opportunities.

While these measures are being implemented, the following non-structural measures will be initiated by Operations and Maintenance, and Public Works Department:

1. Monitoring sediment accumulation
2. Development of a coordinated emergency response plan for flooding in urban neighbourhoods

This overall strategy will mitigate the local flood risk of the Greenhill Avenue Area Storm Drainage Study area in the future.

BACKGROUND:

The information/recommendations contained within this report primarily affects Ward 5.

On December 1, 2006, severe flooding was experienced in the subdivision west of Greenhill Avenue and north of the CPR right of way (R.O.W.) in the City of Hamilton. The location of the study area and the flooding locations are shown in Figure #1 of Appendix A. The flooding occurred during a prolonged low-intensity rainfall event. Observations that were made during the event by local residents, City staff and CPR
staff indicate that significant flows were diverted into the subdivision via Greenhill Avenue and the CPR R.O.W. due to a debris blockage of the Battlefield Creek culvert under Centennial Parkway at the base of the escarpment. The flood flows collected to a significant depth in sag locations on National Drive and Ellen Avenue and to a lesser extent on Chert Avenue and Derek Drive.

A previous flooding event occurred in the area during snowmelt runoff conditions in April 2005 in which the spill from the Battlefield Creek culvert under Centennial Parkway damaged the CPR tracks and caused flooding in the Old Webster Road area north of the CPR right of way.

The purpose of this study was to carry out an analysis of the drainage systems in the study area to identify the causes of the flooding that occurred on December 1st, 2006 and to prepare recommendations for remedial measures to minimize the risk of future flooding. Specifically, the study has addressed:

- An assessment of the rainfall event on November 30 - December 1st, 2006;
- The capacity of the stormwater conveyance systems within the Greenhill Avenue Study area;
- Identification of any deficiencies in the drainage system;
- Identification of the causes of the flooding on December 1st, 2006; and
- Recommendations for an appropriate stormwater management and flood control strategy.

The study will be a support document for the City’s future capital planning for stormwater drainage infrastructure.

**ANALYSIS/RATIONALE:**

This screening of options to address the flood risk to the study area was based on the Preliminary Screening Matrix (Please see Table #1 of Appendix A) which resulted in a short list of sixteen (16) options being carried forward for a more detailed evaluation. These included the following list of items:

**Upstream (Battlefield Creek) Culvert Improvements**
1. Enlarge and improve culvert entrance
2. Debris trap at entrance
3. Raise overflow elevation

**Maintenance**
4. Monitor Sediment Accumulation
5. Improve Maintenance Access
6. Improve Sediment Disposal
7. Revise maintenance schedule

**Erosion & Sediment Control**
8. Upstream sediment removal

**Conveyance Systems (CPR Drainage and Greenhill Avenue)**
9. Restore CPR drainage ditch to Battlefield Creek
10. Improve north ditch and north Culvert at Greenhill Avenue
11. Enlarge south culvert at Greenhill Avenue
12. Major system inlets on Greenhill Avenue

Local Improvements (in Subdivision)

13. Increase Inlet Capacity

Emergency Response

14. Set up City-wide response protocol for flood events
15. Expand resources, personnel and communication

Drainage Design Policy

16. Future subdivision be designed in accordance with the approved City of Hamilton Storm Drainage Policy (May 2004)

These measures were evaluated against a number of criteria, organized in the following categories:

- Effectiveness in Reducing Flooding
- Social / Community Impacts
- Natural Environment Impacts
- Cost

The detailed evaluation matrix is shown in Table #2 of Appendix A. The assessment for each criterion has been made qualitatively based on a high, medium low rating, as outlined below:

- Score A - Most Preferred (high effectiveness / low impact / low cost);
- Score B - Moderate Preference (Medium effectiveness / medium impact / medium cost); and
- Score C - Least Preferred (Low effectiveness / high impact / high cost).

The recommended flood control strategy was developed from this assessment. The general strategy for flood control is based on prioritizing the remediation from upstream to downstream. Since the local drainage system in the Greenhill area is adequate for the local flows, the first priority is to minimize potential inflows from the external area. Improvements in the local drainage systems can then be designed to mitigate local deficiencies only.

The works are also prioritized according to cost-effectiveness and reliability. Those that achieve immediate benefit should be implemented in the short term followed by long term programs.

**Recommendation #1 - Battlefield Creek Culvert**

The Battlefield Creek culvert is the focal point of the flooding problem. The debris blockage led to flows from an adjacent watershed entering into the Greenhill Area neighbourhood catchment. Improvements to the performance of this culvert will have a direct and immediate benefit in reducing the flood risk. The proposed works also have a high degree of reliability, providing both increased capacity in the culvert and a reduction in the potential for blockages in the future. The recommended measures are:

1. Structural improvements to the culvert inlet are illustrated in Figure #3 of Appendix A. These measures include:
An enlarged inlet structure that will double the area of the opening to 2.0m high by 4.5 m wide;

- Raising the overflow elevation above the culvert inlet by approximately 1.8m using an earth berm to provide sufficient headwater to pass the 100-year flow before a spill could occur; and

- Provide a sediment trap structure at the inlet of the culvert to capture and store sediment and rocky debris from the upstream watercourse to facilitate clean-out and provide additional security against sudden accumulations between scheduled clean-outs.

2. Provide a sediment trap at the upstream culvert on Battlefield Creek at the "falls" (Figure #2B in Appendix A) location (partially completed).

Costs for the associated works are estimated at $240,000 including contract administration, permitting/approvals and construction supervision.

Recommendation #2 - CPR Right Of Way (ROW) and Greenhill Avenue

Even with the improvements at the Battlefield Creek culvert, there is still a small possibility of spills due to extreme rainfall events (i.e., greater than the 100-year flow) and partial blockages due to unusually high or sudden debris loading from the watercourse. It is also noted that the CPR culverts at Greenhill Avenue are under-sized for the local drainage area. This could lead to a flood condition from the local runoff alone. To mitigate these possibilities, the following measures are recommended:

1. Re-grade the south CPR ditch on the west side of Centennial Parkway to convey as much of the ditch flow as possible to the east to discharge to Battlefield Creek (Please see Figure #4 in Appendix A). This will restore the historical drainage divide at this location. It will also reduce the drainage area to the Greenhill Avenue culverts and divert a significant portion of any spill that might occur from the upstream culvert.

2. Increase the size of the culverts in the CPR ditches at Greenhill Avenue. The south ditch culvert size would be a 1.0 m x 2.0 m concrete box culvert while the north ditch culvert could be enlarged to a 0.75 m x 1.0 m CSP. These changes would provide sufficient capacity for the local drainage area and additional security against overflows to Greenhill Avenue. This work is not on City property and requires the cooperation of the CPR. (Please see Figures #5A & 5B in Appendix A)

The associated costs for these works are estimated at $100,000 including contract administration, permitting/approvals and construction supervision.

Recommendation #3 - Local Subdivision

It was determined that the subdivision drainage system has been adequately designed to accommodate the 100-year flows from the local drainage area. However, because there is no major system overland flow route, there is an increased risk of flooding from extreme or unusual conditions such as those that occurred during the event on December 1, 2006. There is also a potential for flooding from local events if the catch basins in the sags become blocked during a significant rainfall event. To mitigate this potential flooding risk, it is recommended that two additional double catch basins (DCB) be installed at both of the sag locations on National Drive and Ellen Avenue.
Associated costs for these works are estimated at $30,000, including contract administration, permitting/approvals and construction supervision.

Other Recommendations

In addition to structural measures discussed above, a number of general measures were identified during the study that would address the concerns noted in the Study Area. These other recommendations relate to maintenance and operation procedures, emergency response and drainage design policy.

Maintenance and Operation

A number of measures related to maintenance and operation procedures are recommended. These include the following items:

1. Monitor and document the accumulation of sediment at the Battlefield Creek (Please See Figure #2 in Appendix A) culvert. This data can be used to adjust maintenance schedules at this and other culverts with similar conditions.
2. Modify the sediment clean out protocol based on experience and monitoring to provide a higher degree of reliability against blockages.
3. Construct a permanent access road for inspection and cleanout equipment.
4. Provide a sediment storage area away from the entrance to the Battlefield Creek culvert. Alternatively, provide for the disposal of the material off-site.

Emergency Response

To provide more timely and effective response to flooding in the future, it is recommended that the City review the protocols and resources provided through Emergency Management Services (EMS) for dealing with flooding events such as occurred in the Greenhill subdivision. This would entail defining responsibilities and procedures as well as internal and external contacts. The staffing and communications equipment should also be reviewed.

The Storm Event Response Group (SERG) should be considered as a possible vehicle for this function. The SERG committee is already involved in emergency response situations for flood control in the City. The Greenhill area should be added to their list of priority locations to be monitored and flooding response protocols should be developed/communicated for this location.

Drainage Design Policy

Going forward, all subdivisions should be designed in accordance with and identified as a policy objective in the City of Hamilton Storm Drainage Policy (May 2004).

ALTERNATIVES FOR CONSIDERATION:

Alternative 1: Implement one of the other listed remedial measures screened through the process

Under this alternative, the City of Hamilton’s Greenhill Avenue Storm Drainage Study report would need to be revised, and an additional point of public contact would be required to obtain public feedback on the new preferred alternative/recommendations. An example of one such remedial measure has been provided (Please see Figure #6 in Appendix A). Staff would report back to the Public Works Committee in late fall of 2008.
with the results of the public consultation, and to request authorization to file the report on the public record.

This alternative is not recommended. Significant analysis has gone into finding a remedial solution that addresses the environmental, social, and economic and safety concerns. Remedial measures screened out involve potential for undesirable levels of discomfort and disruption to area residents if implemented. Moving forward with implementation of preferred remedial measures and not delaying construction would offset concerns already existing.

**Alternative 2: Do not endorse the Greenhill Avenue Storm Drainage Study**

Under this alternative, the City of Hamilton’s Greenhill Avenue Area Storm Drainage Study report is not approved by Council and not filed for a 30 day review period as per the Municipal Class Environmental Assessment process.

This alternative is not recommended. Significant analysis and public consultation has been conducted into finding a remedial solution that addresses the concerns of the residents of the Greenhill Avenue Storm Drainage Study area neighbourhoods. Delaying possible remedial measures could see possible re-occurrences of the flooding experienced in the past as well as leaving the City exposed to possible litigation and continuous insurance claim reimbursements scenarios.

**FINANCIAL/STAFFING/LEGAL IMPLICATIONS:**

**Financial Implications:**

The estimated budgeted cost to implement all the recommended flood control measures is $370,000. This cost estimate includes contract administration, permitting/approvals and construction supervision cost figures. This would involve but not limited to the following list of works:

1. Structural measures at the Battlefield Creek culvert, including access roads.
2. Upstream sediment removal on Battlefield Creek.
3. Additional inlets in the Greenhill subdivision.
4. New CPR culverts at the Greenhill Avenue.

Costs for these projects would be included in the 2009 Capital Budget submission.

**Staffing Implications:**

None

**Legal Implications:**

Municipal undertakings such as road improvements, stormwater, water and wastewater projects are subject to Ontario’s Environmental Assessment Act. The Act allows for the approval of Class Environmental Assessments and the municipality has the option of following the planning process set out in the Municipal Engineers Association Class Environmental Assessment (October 2000 as amended in 2007). This study has followed Master Plan Approach 2 in Appendix 4 - Master Plans, of the Municipal Engineers Association Municipal Class Environmental Assessment document (October 2000 as amended in 2007). The Master Plan Class EA document for this study has been completed and will fulfill Phases 1 and 2 of the Class EA process. The City is required to file the report on the public record for a minimum thirty day review period.
Only Schedule B projects and not the Master Plan itself will be subject to the Part II Order appeal process (bump-up). Schedule C projects must complete Phases 3 and 4 of the Class EA process, prior to filing on public record.

**POLICIES AFFECTING PROPOSAL:**

Implementation of Greenhill Avenue Area Storm Drainage Study will require permits from the DFO and HCA (Hamilton Conservation Authority - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, NEC (Development Permit), the MOE (Permit to Take Water), and permit approvals from the CPR for works within their right of way. Remedial measures proposed reflect the objectives of the overall Citywide Stormwater Master Plan (May 2007) and satisfy recommendations set out by the Independent Community Panel (ICP- September 2006) report. The Public Works Strategic Plan Vision for 2017 is a document which affects this proposal; this project would be aligned with the Communities Vision driver under the priority to be a leader in the “greening” and stewardship of the City by addressing flooding concerns and functionality of watercourse channels and aesthetics of the Greenhill Avenue Area Storm Drainage Study.

**RELEVANT CONSULTATION:**

Public consultation is one of the key components of the Municipal Class EA process. Points of formal contact were made with the public during the course of this Class EA Study to: i) provide notification of the Study Initiation and Public Information Centre; and ii) review the problem being addressed and preliminary analysis and evaluation of the alternatives at the Public Information Centre. Upon completion of this report, a notification of completion of the Project File Report will be provided with details regarding the opportunity to review the report.

An advertisement was placed in the Hamilton Spectator and all relevant Brabant Circulations to notify the public that the study had been initiated by the City of Hamilton. The notice also provided details for the Public Information Centre.

Although this Study was not classified as Class EA study, the Class EA guidelines were utilized during the course of the Study to identify subsequent Class EA requirements. Many of the principles of the Class EA process were also adopted during the course of the Study, particularly as they related to documentation of alternatives and public consultation. Consultation with the public had been on-going since the start-up of the Study. An advisory committee comprised of area residents was also incorporated into the study team. The following summarizes the means for public input:

- **Notice of Study Initiation** (with City/Consultant contact information)
- **On-going communication** (by phone, e-mail, site visits)
- **Notice of Public Information Centre** (with City/Consultant contact information)
- **Two Public Information Centre’s (PIC’s)**
- **Stakeholder meetings with the Advisory Committee**

Notices were published in the Hamilton Spectator and Stoney Creek News and were distributed to Greenhill Avenue Area Storm Drainage Study area residents. The Notice of Study Commencement for the overall Study was published in July 2007. Copies of
the notices and correspondence with the public are included in the appendices of the final Greenhill Avenue Area Storm Drainage Study report.

A first Public Information Centre (PIC#1) was held on Wednesday July 18th, 2007 at Bishop Ryan School. The purpose of this PIC was to:

- Provide general information regarding the study;
- Present the study objectives, purpose and scope;
- Discuss the severity of the December 1st, 2006 storm event;
- Present a preliminary understanding of existing drainage conditions;
- Solicit public input regarding current storm drainage related problems; and
- Invite the public to comment on potential measures that could be implemented to mitigate or remediate problem areas.

A total of ten attendees signed the sign-in sheet. Comment sheets were distributed to all attendees. Members of the Study Team discussed the Study informally with attendees and encouraged attendees to describe concerns and to make suggestions. Attendees were also encouraged to provide comments on any aspect of the Study. Identified concerns are summarized in the appendices of the Greenhill Avenue Area Storm Drainage Study Report. Only one e-mail comment was received prior to PIC#1. The concerns raised by the resident involved areas that were observed to be carrying flows at the time of the storm event of December 6, 2006 and possible remedial measures. These comments were incorporated into the Study as anecdotal information.

The second Public Information Centre (PIC#2) was held on Thursday November 15th, 2007 at Bishop Ryan School. The results of the technical analysis were presented which included the causes of flooding from the December 1, 2006, rainfall event. The evaluation and screening of alternatives/options was also provided whereby a preliminary conclusion on potential preferred remedial measures was determined.

A total of seventeen attendees signed the sign in register for this occasion. Members of the Study Team discussed the results from the analysis with the attendees informally and encouraged attendees to submit comments with the comments sheets provide upon entry. Three comment sheets and one e-mail correspondence was returned as a result of PIC#2. Most of the comments centered on the design and maintenance of the culverts. These comments were adequately addressed within the remedial options presented at the PIC#2.

In addition, copies of the handout material that was distributed at the PIC were made available electronically via the City of Hamilton Website.

Internal consultation and discussion occurred with City Staff members from the Strategic Planning Section, Environmental Planning Section, Roads Operations and Maintenance, and Ward 5 Councillor Chad Collins. Risk Management was also consulted throughout the process. No concerns regarding the recommendations brought forward were expressed at present.

Other internal communication also took place with the Emergency Management Services (EMS) section. Concerns raised by residents during the course of the study regarding emergency response procedures were discussed at subsequent Storm Event Response Group (SERG) committee and Hazard Identification and Risk Assessment
(HIRA) meetings. A SERG representative has been placed on the HIRA roster on a permanent basis. Consultation with these groups is ongoing.

**CITY STRATEGIC COMMITMENT:**

This project meets the City’s strategic commitment to a Healthy, Safe and Green City through putting forward a strategy that addresses issues related to our natural environment, including water quality and the health of aquatic resources. The project also meets the Public Works Strategic plan through vision driver 2- People, skilled teams ready for any situation. People are engaged: workers trained, mentored and involved in decision making processes to find solutions to systemic issues. The Greenhill Avenue Area Storm Drainage Study supports the goals of the Vision 2020 Sustainable plan by addressing water quality impacts, impacts on aquatic and terrestrial habitat, mitigate erosion concerns and strategy for flood control resulting from new and existing development.

In order to assess the alternatives, an evaluation system has been used to determine the suitability of each alternative, against appropriate “evaluation factors”. Each factor consists of an evaluation category defined by specific evaluation criteria. The evaluation categories are as follows:

By evaluating the “**Triple Bottom Line**”, (community, environment, and economic implications) we can make choices that create value across all three bottom lines, moving us closer to our vision for a sustainable community, and Provincial interests.

- **Community Well-Being is enhanced.** ☑ Yes ☐ No
  By addressing impacts/issues relating to the interaction of the community/neighbourhood with the implementation of the proposed alternatives.

- **Environmental Well-Being is enhanced.** ☑ Yes ☐ No
  By addressing impacts that an alternative may have on how a system is intended to work, including how it would address impacts on flooding, water quality, and erosion, aquatic and terrestrial habitat.

- **Economic Well-Being is enhanced.** ☑ Yes ☐ No
  By addressing immediate and future costs and cost-benefit of the alternatives presented including maintenance. The ease of construction and accessibility for machinery and the potential impact of construction techniques and access on the private property.

- **Does the option you are recommending create value across all three bottom lines?** ☑ Yes ☐ No
  Alternatives were screened and evaluated with respect to the following factors; long-term stability, constructability, aesthetics, risk to public safety, and costs. Recommended alternatives were identified and evaluated to determine their ability to address the channel stability and trail crossing concerns.

- **Do the options you are recommending make Hamilton a City of choice for high performance public servants?** ☑ Yes ☐ No
  Project recommendations that meet the triple bottom line requirements and accomplish project objectives reinforce the City of Hamilton as a high performance work environment.
Appendix “A” - Figure 2A: Map Depicting Relative Flow Route and Depression Locations

Appendix “A” - Figure 2B: Aerial View of Study Area and Contributing Catchments
### Appendix “A” - Table 1: Preliminary Screening Matrix

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Applicability</th>
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<tbody>
<tr>
<td><strong>UPSTREAM (Battlefield Creek)</strong></td>
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<tr>
<td><strong>Culvert Improvements</strong></td>
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</tbody>
</table>
| 1 Enlarge and improve culvert entrance | • Increase height and width of opening  
• Add Trash rack bars | High  
Consider further |
| 2 Debris trap at entrance | • Basin in front of entrance to capture rock and debris  
• May include grill to catch large debris | High  
Consider further |
| 3 Raise overflow elevation | • Berm d/s of culvert entrance | High  
Consider further |
| 4 Relief culvert | • Add new flood relief culvert under Centennial Pkwy with berm (or sealing of roadbed embankment) to prevent by-pass to north | Low |
| 5 Seal road bed and base of ponding area | • Place low-permeability liner (graded filter material) on road embankments and ponding area | Low |
| **Maintenance** | | |
| 6 Monitor Sediment Accumulation | • Monitor and document rates of debris accumulation to confirm maintenance schedule | High  
Consider further |
| 7 Improve Maintenance Access | • Construct permanent access road for clean out machinery | High  
Consider further |
| 8 Improve Sediment Disposal | • Disposal location for sediment removed from culvert | High  
Consider further |
| 9 Revise maintenance schedule | • Modify maintenance schedule and procedures based on monitoring and experience | High  
Consider further |
| **Erosion & Sediment Control** | | |
| 10 Stabilize stream channel | • Erosion control structures in upstream channel | Low |
| 11 Upstream sediment removal | • Sediment traps at upstream culverts | High  
Consider further |
| **CONVEYANCE SYSTEMS (CPR Drainage and Greenhill Ave.)** | | |
| 12 Restore CPR drainage ditch to Battlefield Creek | • Re-grade a portion of the south CPR ditch from west of Centennial Pkwy to flow east | High  
Consider further |
| 13 Restore overflow to Webster Ave. | • Remove berm on north side of CPR  
• Provide safe conveyance of flows on Webster Ave. | Low |
| 14 Improve north ditch and north Culvert at Greenhill Ave. | • Restore and deepen ditch on north side of CPR | Moderate  
Consider further |
| 15 Enlarge south culvert at Greenhill Ave. | • Enlarge the south CPR culvert to optimize the use of the south ditch capacity. | High  
Culvert under-sized.  
Consider further |
| 16 Lower Greenhill Road Profile at CPR | • Construct sag in Greenhill Ave. south of the tracks to increases conveyance of flood flows to the CPR ditches to the west | Low |
| 17 Major system inlets on Greenhill Ave. | • Install high capacity inlets on both sides of Greenhill Ave. connected to the CPR ditches to the west side | High  
Consider further |
| **LOCAL IMPROVEMENTS (in Subdivision)** | | |
| 18 Increase Inlet Capacity | • Add inlets at sag locations on National Drive and Ellen Ave. | Moderate  
Consider further |
| 19 New Storm Sewer Outlet Capacity | • New outlet from National Drive and Ellen Ave. to creek to the west | Low |
| **GENERAL MEASURES** | | |
| **Emergency Response** | | |
| 20 Set up City-wide response protocol for flood events | • Provide clear responsibilities of staff and protocol for contacting departments and external agencies.  
• Can be added to existing SERG group responsibilities | High  
Consider further |
| 21 Expand resources and personnel | • Staffing and communications equipment for emergency response capability | Moderate  
Consider further |
| **Drainage Design Policy** | | |
| 22 Provide secure major system outlets | • Require a continuous major system flow path (i.e. overland flow) to be provided in all subdivision designs | High  
Consider further |
## Appendix "A" - Table 2: Comparative Evaluation Matrix - Short List of Options

<table>
<thead>
<tr>
<th>Option No.</th>
<th>Measure Description</th>
<th>Performance (Normal, extreme event, winter)</th>
<th>Reliability</th>
<th>Public Safety</th>
<th>Construction Impacts (access, noise, traffic)</th>
<th>Aesthetics</th>
<th>Water Quality &amp; Hydrology</th>
<th>Aquatic Habitat</th>
<th>Terrestrial Habitat</th>
<th>&quot;Permitability&quot;</th>
<th>Capital</th>
<th>Operating</th>
<th>Maintenance/Replacement</th>
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<td>Debris trap at entrance</td>
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<td>Improve maintenance access</td>
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<td>Improve Sediment Control</td>
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<td>CONVEYANCE SYSTEMS (CPR Drainage and Greenhill Ave.)</td>
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**Relative Scoring Criteria**

- **A** = Most Preferred (High Effectiveness / Low Impact / Low Cost)
- **B** = Moderate Preference (Medium Effectiveness / Medium Impact / Medium Cost)
- **C** = Least Preferred (Low Effectiveness / High Impact / High Cost)
Appendix “A” - Figure 3: Centennial Parkway Culvert Improvements

Appendix “A” - Figure 4: CPR South Ditch Improvement
Appendix “A” - Figure 5A: CPR at Greenhill Avenue Improvements

Appendix “A” - Figure 5B: CPR at Greenhill Avenue Improvements
Appendix “A” - Figure 6: Screened Out Storm Outlet Proposed within Greenhill Area Neighbourhood