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North of 7 Master Plan

Environmental Assessment Addendum

February 10, 2020

Prepared for: Town of Perth

80 Gore St East
Perth, Ontario
K7H 1H9

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1. Introduction

In October 2013, an Infrastructure Master Plan for Area North of Highway 7 was completed by Dillon Consulting for the Corporation of the Town of Perth. This study found the preferred stormwater management (SWM) system to be a conventional pipe-and-pond system complete with a mechanical pump station to lift water into the centralized wet pond before discharging to Blueberry Creek. It was noted that this system would incur significant life-cycle costs, estimated at more than $10,000,000 over the next 40 years, which may render development of the land uneconomical.

Jp2g Consultants was contracted to review the Environmental Assessment prepared by Dillon and determine if consideration of alternative, potentially more economical, stormwater management solutions would make it worth re-opening. This assessment found that it would be appropriate to reopen the EA to review SWM alternatives. In this addendum, Jp2g proposes a storage-based system consistent with Low Impact Development (LID) principles, using low-slope swales with massive under-drainage capable of providing quantity and quality treatment without the need of a lift station. This approach is estimated to require significantly lower life-cycle costs due to lower operational and energy requirements.

This report describes the reanalysis of the conclusions of the DEA, considering this alternative approach.

2. Background

2.1. Dillon Environmental Assessment

The Infrastructure Master Plan for Area North of Highway 7 (Dillon, 2013, referred to herein as DEA) found the preferred alternative for stormwater management in the North of Seven development would be to collect water via conventional catchbasins and storm sewers, and then pump the collected stormwater into a conventional stormwater management pond. Figure 2-1 shows the preferred alternative.

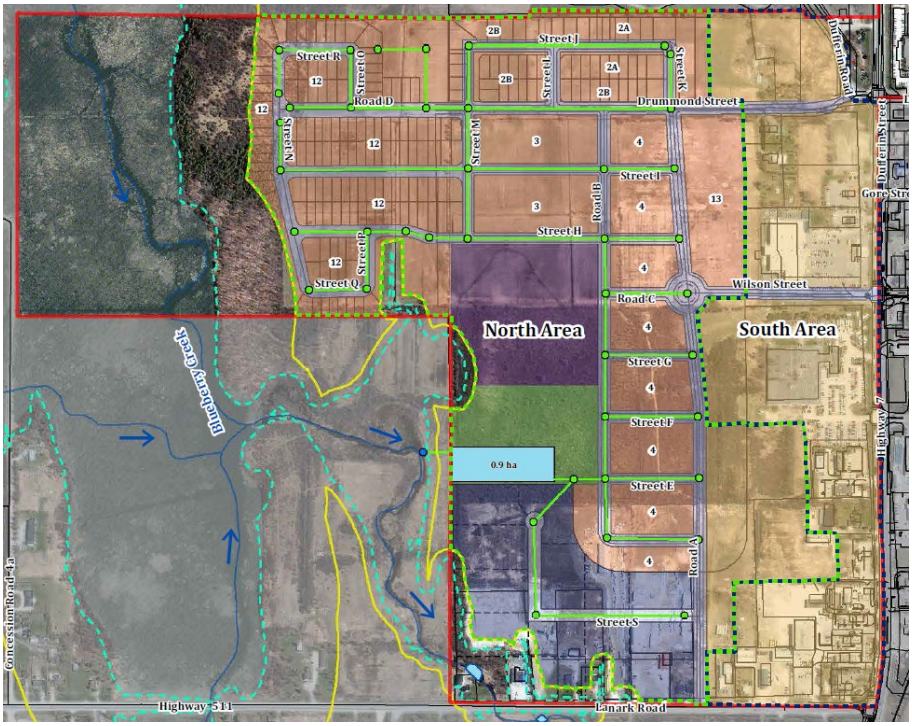

Figure 2-1. Preferred Alternative from the DEA Report

The decision matrix for stormwater management from the DEA (Table 23) is reproduced below in Table 2-1. It is separated to North Area and South Area where appropriate. '+' represents an assessment that is positive, while '0' represents an assessment that is neutral, and '-' represents a negative assessment. 'P' indicates the preferred alternatives for each set of alternatives. Appendix A includes the relevant sections of the DEA relating to stormwater management.

Table 2-1. Dillon Decision Matrix

Criteria	**Lot level controls**			**Conveyance**		**Treatment**	
	Bioret'n (1)	Infiltr'n (2)	Special det'n (3)	Veg'd swale (4)	Trad. Sewer (5)	Wet pond (6)	OGS (7)
				Technical			
Feasibility	S + N -	S + N -	S + N -	S - N +	S + N +	S - N +	S + N -
Compatibility	+	+	+	-	+	+	+
Constructability	+	S + N -	S + N -	-	+	S - N +	+
Maintainability	-	-	+	-	-	-	+
				Environmental			
Terrestrial	+	0	0	+	0	+	0
Aquatic	+	-	-	+	0	+	0
Groundwater	+	+	0	+	0	+	0
Surface water	0	0	0	0	+	0	0
Water Quality	+	-	-	+	0	+	+
				Socio-economic			
Displacement	-	0	0	-	+	S - N -	0
Disruption	-	-	0	-	+	-	-
Aesthetics	+	0	-	+	0	+	0
Capital cost	-	-	+	-	+	+	-
Operating cost	-	-	+	-	+	-	+
				Summary			
South area	P	P	P	-	P	-	P
North area	-	-	-	-	P	P	-

2.2. Jp2g Peer Review

Appendix B contains letters to the Town of Perth dated 26 of October 2016, describing how it was determined that reopening the EA would be appropriate, and discussion of potential criteria for an atypical SWM system to be assessed by regulatory agencies. Extracted from that letter is the summary of actions to be taken, provided in Table 2-2 below.

Table 2-2. Summary of Actions

Actions to be addressed	
Developer driven action	**Town driven action**
	Determine Impact of Intake Protection Zone
	Channel Stability Assessment
	Determine Release Criteria
EIS / HIA required	
Revise development boundaries	
Prepare conceptual Stormwater Management Plan	
	Revise Table 23 with all costs, impacts
	Reassess preferred alternative

This addendum to the Environmental Assessment is intended to address the actions required to be completed by the Town.

2.3. Additional Constraints

Review by the RVCA has indicated that, in addition to the HIA and EIS indicated in Table 2-2 above, there will be a requirement as part of the subdivision process for the developer to perform a Headwater Drainage Feature Assessment on the existing drainage courses on the site that would be affected by each phase of development, and that the conclusions of that study will be used to guide the design of the planned infrastructure.

3. Analysis of Actions Required by the Town

This section will address the Town's action items from Table 2-2.

3.1. Intake Protection Zone

The site is within the Intake Protection Zone (IPZ) 8 of the Town of Perth Water Treatment Plant. Certain sewer works are considered a significant drinking water threat per the Mississippi-Rideau Source Protection Plan. Discharges from a stormwater management facility into an IPZ 8 would not be considered a Significant Threat if the use is predominantly residential, or if industrial, not greater than 100 ha. Subsurface storage of sewage, such as in a sanitary pumping station, would not be considered a significant threat.

In the Town of Perth Official Plan contains a list of prohibited land use activities within IPZ 8. These include:

- Sewage treatment plant effluent discharges
- Industrial effluent discharges
- Combined sewer discharges
- Sewer treatment plan bypass discharge
- Waste disposal sites

Further, certain site-specific land uses may require management measures, and be subject to development regulation. These include:

- Agricultural manure storage
- Large-scale drainage management projects or facilities
- Major construction projects (such as ... residential subdivision...)

In the Lanark County Official Plan indicates that prohibited uses will not be permitted through the Planning process and it supports lower-tier municipalities regulations.

The subject site is predominantly residential, and the industrial portion is 17 ha, much smaller than the 100 ha threshold. There are no sewage treatment plan effluent discharges, industrial effluent discharges, combined sewer discharges, sewer treatment plant bypasses, or waste disposal sites. Therefore, there is no significant threat to the IPZ8 of the Town of Perth Water Treatment Plant as a result of conceptual plan.

3.2. Channel Stability Assessment

Access to the receiving watercourse is within private property limits, making a slope stability assessment contingent on receiving site access permission. Adjacent downstream landowners were contacted by letter and by phone but were unwilling to allow investigation of the downstream channel. Consequently, a proper physical evaluation is not possible at this time. Therefore, a review of existing and anticipated flow rates was performed.

The published hydraulic model for Blueberry Creek (RVCA 2010) shows that the peak flow downstream of the PSW during the 1:2 year (similar to the channel defining flow) is constant at 5.0 m^3/s. This flow drains from a 3676 ha drainage area that is then captured in a 1400 ha wetland complex. The study area (85 ha) does not have a meaningful impact on the timing or magnitude of the peak flows of Blueberry Creek during channel-forming events, due to the comparatively negligible contributory area and a difference in runoff response timing such that the peak site runoff does not coincide with Blueberry Creek's peak flows. This suggests that the flows coming from the PSW will govern the channel stability downstream. Although this cannot be verified due to the site access restriction, it is assumed that the channel stability is adequate in existing conditions. Therefore, in developing lands within the study area, care should be taken to match post-development flows with existing conditions to avoid downstream channel erosion or instability.

3.3. Release Criteria

Water quality release targets are set to 80% TSS removal. No other quality criteria are identified by regulatory or approval authorities. Water quantity release targets are set to match pre-development flow rate reaching Blueberry Creek, in the locations it currently reaches the creek. That means the release from the existing highway, commercial, and industrial areas along the west of the site into Blueberry Creek just upstream of Highway 511 must be considered separately from the release of stormwater from the residential areas into the creek downstream of the outlet from the PSW.

3.4. Conceptual Stormwater Management Plan (SWM)

A conceptual Stormwater Management plan requires an understanding of the development pressures being experienced and is typically produced by the developer at the Subdivision stage of the planning process, after the EA is completed. At this time, it is appropriate for the Town to undertake a preliminary design of the grading and drainage for the entire site, in support of this EA Addendum, but a concept-level report must be coordinated with the specific developers and is to be completed at a future date.

This EA update includes a Functional SWM Plan for an alternative method of controlling site runoff and discharge. This option was not evaluated in the DEA and is therefore described further in Appendix C, including functional hydrologic and hydraulic modeling output. The proposed system would use a system of shallow-sloped enhanced grass swales with substantial underdrainage (unconventional LID). This approach requires a modification to the road network design but eliminates the need of a conventional

pipe-and-pond SWM system while providing sufficient quality and quantity control. The proposed layout is shown in Figure 3-1.

For the purposes of this study, two approaches have been considered using the LID system – one draining all of the land via the LID system, and the other draining a quarter of the site using a conventional sewer and pond system described in the original DEA, and the remainder of the site using the LID system.

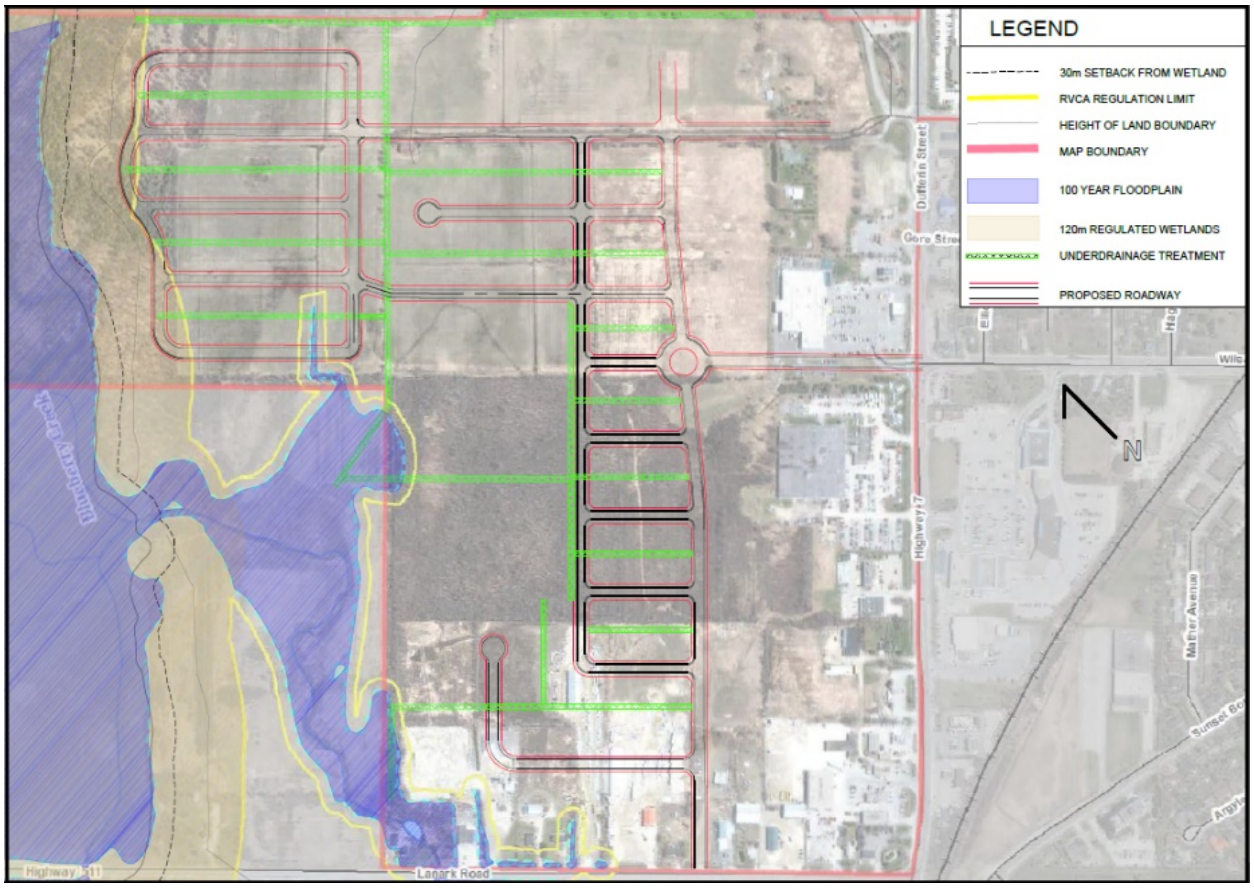

Figure 3-1. Alternative Functional SWM layout

3.5. Revise DEA Table 23

Table 23 is the decision matrix for stormwater from the DEA and is reproduced above as Table 2-1. Jp2g noted the following deficiencies in the methodology: local context is not considered in costing the SWM alternatives (e.g. vegetated swales having a capital cost four times that of an underground pipe network with lift station); costs associated with pumping station operation are not included; and a LID approach to SWM is not considered. This section will describe Jp2g's re-evaluation methodology and present a revised Table 23 for comparison.

3.5.1. Adjust the existing scoring

The pump station costs from the DEA report are taken as is. However, if no other storage is provided, then the piping would require to be installed as a 'super pipe', which would cost roughly double regular piping. This was not explicitly addressed in the Dillon report, therefore a 'superpipe' system has been added to include this option as well. Note that this Superpipe option was not added to the SWM Alternatives but is

presented for sake of completeness and can be incorporated into estimates or design at a later date, if required. Catch basin clean-out has been assigned to the piped system as an annual cost based on current costs paid by the Town for this maintenance. The DEA report also did not include capital or operation and maintenance costs for the required pump station with a traditional underground sewer system.

Table 3-1 shows the updated component costing.

Table 3-1. Costs used in assessment

Item	Description	Capital Cost	Annual O&M
1	Vegetated Swale	$5.5M	$8k
2	Piped System	$2.3M	$25k
3	SuperPipe System	$4.6M	$25k
4	Wet pond	$940k	$8k
5	OGS	$1.6M	$12k
6	Pump Station	$5.7M	$9k
7	LID System	$3.6M	$29k

Note that each of the above costs are for individual components of a SWM system. Table 3-2 combines these components into different SWM alternatives. Annual capital cost is assumed to be 5% of capital cost and accounts for depreciation and financing.

Table 3-2. Cost Combinations

SWM Alternative	Components	Description	Capital Cost	Annual Capital Cost	Annual O&M Cost	Total Annual Cost
A	1+4	vegetated swale & wet pond	$6.4M	$320k	$21k	$341k
B	2+4+6	pipe-and-pond c/w PS	$8.9M	$445k	$42k	$487k
C	1+5	vegetated swale c/w OGS	$7.1M	$355k	$20k	$375k
D	2+5+6	piped to PS c/w OGS	$11.9M	$595k	$46k	$641k
E	7	storage-based LID system	$3.6M	$180k	$29k	$209k
F	7 for ¾ of site, 2+4 for ¼ of site	Hybrid system	$3.51M	$176k	$30k	$206k
AVERAGE COST:			**$6.9M**	**$345k**	**$31k**	**$376k**

Assessment - The costs have been assessed as a comparison to the average costs, both of capital costs and operation/maintenance costs.

- Less than 60% of average price = +1
- Between 60% and 80% of average price = +0.5
- Between 80% and 100% of average prices = 0
- Between 100% and 150% of average price = -0.5
- More than 150% of average price = -1

Thus, the DEA preferred approach (Alternative B) would score -0.5 for the annual O&M, and -0.5 for capital cost. The LID system (Alternative E) would score +1 and 0, and the hybrid system (Alternative F) would score +1 and 0.

The feasibility of Alternative A is revised because the combination of vegetated swales and a wet pond would not be expected to be able to be installed with adequate grade for the system to perform effectively. The site is generally too flat for this to be expected to work.

The displacement of people during construction with Alternative C and D (vegetated swale c/w OGS, and pipe-pump-OGS) was revised because the combination of swales and OGS or pipe, OGS, and pump station, would be effectively the same impact on existing or future residents.

The LID system is scored to be as feasible as any other method. It is just as compatible, but construction can be significantly more complex. Due to the need to use small equipment on a somewhat frequent basis to maintain, it would be somewhat comparable to the less frequent but more substantial maintenance required with a pipe-and-pond system.

With the LID system, terrestrial ecosystems are impacted somewhat more than there would be with a pipe system alone, and somewhat less than with a pond. Aquatic ecosystems are expected to be improved over existing conditions due to the cool water discharge and baseflow augmentation. Groundwater is enhanced due to the long contact time. Surface water quantity is expected to be improved over existing conditions due to a slower storm response. Surface water quality is expected to be enhanced due to a reduction is sediment transport.

The LID system is expected to minimize displacement of existing and future stake holders, by combining the municipal infrastructure – pathways, green space, and stormwater management – in the same corridor. This 'spine' of the corridor occupies development land, but the 'ribs' do not – there is no change in the number of lots or the amount of infrastructure if the ribs are in place or not. Servicing the LID system is expected to be individually less disruptive than servicing a pipe-and-pond system, but more frequent, and is thus both score 0. The aesthetics of the LID system is considered to be similar to the aesthetics of the vegetated swale system. The capital costs of the LID system is expected to be less than 60% of the average of the systems reviewed, and the operating cost is similar to the average of the systems reviewed.

3.5.2. Introduce Additional Criteria

In addition, stake-holders have indicated that additional criteria should be assessed than what was included in the original IMP. Specifically, these are Design, Approvals and Timing, Risk, and Land Use Efficiency. These additional criteria will be assessed only for the DEA preferred alternative, and the new alternatives (E and F).

Design – The MECP has had a LID design guideline in draft form for several years, is expected to remain as a draft for at least another year, and it does not provide sufficient design guidance to establish a methodology of design that would apply in all situations. Recently, the City of Ottawa published a summary document of the various design guides that have been developed. Many agencies have produced guidance materials in the absence of MECP leadership, but primarily CVC and TRCA, relying their experience in Southern Ontario. The data shows that most LID projects in Ontario are proposed in areas that would be considered 'suspect', such as this site.

Because of the lack of guidelines, the Town of Perth produced a set of design criteria that was circulated to and commented on by both a peer reviewer with extensive experience with LIDs, and the Rideau Valley Conservation Authority. The performance criteria are attached in Appendix D.

A detailed hydraulic model has been prepared as part of the functional Stormwater Management Report found in Appendix C, beyond what would be normally expected at this stage of planning. This model has been subjected to a peer review, and the comments received are included in Appendix B.

The pipe and pond system would be fairly conventional, and rely on storm sewer design sheets, MOE guidance on pond sizing, and the rational method. The DEA preferred approach includes a stormwater pump station, as well. The addition of the stormwater pump station increases the design complexity substantially.

Assessment – The DEA preferred approach scores 0. Both Alternative E and F would score +1.

Approvals – The MECP has confirmed that their approval process is no different for a LID system or a more conventional approach, and that they will not review the project even at a functional level at the EA stage, or at a conceptual level at the time of draft plan of subdivision. At the time of the detailed design, they will take an average of 9 months to review and approve any design for stormwater management, drinking water storage, and for the sanitary pump station. They will rely on the local Conservation Authority to demonstrate their concurrence with the design and approach, and they will use any locally developed performance criteria in addition to their own. They will check to see that the application is consistent with the approved Master Servicing Plan (which, at this time, is the pipe/pump/and pond proposed by Dillon).

The Conservation Authority has provided their support to the LID concept, with detailed comments on expectations and requirements of performance. They and the County will review the conceptual designs at the draft plan of subdivision and the detailed designs at each phase of construction, and they will confirm that the proposal is consistent with the Master Planning documents, including any Subwatershed Plans, Master Servicing Studies, etc.

The Town has recently passed their Development Charges Bylaw 4839, and it presupposes the LID approach throughout the North of Seven development area. If some other approach to development is to be considered, this Bylaw would have to be reopened. This is likely to introduce delays, although it is not clear that it would affect the critical path.

The duration that the DEA preferred alternative is taken as a baseline. Any adjacent subdivision stormwater design would require a minimum of preliminary design work to be undertaken to establish grades and pipes sizes for the development to connect to. Then the MECP ECA process can process in parallel to the subdivision design process, so that subdivision approval can occur in 2 to nearly 3 years.

The LID system is expected to require the same preliminary design work, though the detailed design required for the ECA process for the subdivision and the town-built portion of the LID system would each be expected to require less effort than the stormwater pump station. The draft plan of subdivision would require some conceptual design based on the preliminary design, and the detailed design could proceed as deliverables were received by the Town. Overall, it is expected the whole design approval process would take a little longer than the DEA approach.

The Hybrid system is expected to not need to have a preliminary design to ensure that the subdivision would be able to connect with the downstream infrastructure – there would be no town-designed infrastructure downstream of the subdivision. This speeds the process slightly. However, because of the additional effort that would be required by the approval authorities to address an approach that is not consistent with how planning has proceeded since December 2018, it is expected that obtaining conditions for the Draft Plan of Subdivision will require additional time. 2 to 4 months is assumed to be required to re-write the Development Charges Bylaw and hold the required public meetings and include the appeal process, but there is significant uncertainty in that range of durations.

Assessment – The DEA preferred approach scores 0. For alternative E and F, the score would come from the sum of the fraction of the estimated range of time to complete the approval process for the alternative, as compared to the median of the estimated median time of the DEA preferred approach. For the Hybrid system, the score is weighted by areal fraction for each component. The expected durations and the scoring are shown in Table 3-3.

Table 3-3. Approvals estimated durations (months)

Task	DEA		LID			Pipe & Pond		75% LID + 25% P&P
	ECA	Subdv'n	ECA LID	ECA sub.	Subdv'n	ECA	Subdv'n	
Prelim. design	2		2					
Concept. design		3-6			3-6		3-6	
Draft plan		6			6		8-10	
Detailed design	9-12	6	6-12	6-12	6	6-12	6	
Subd'n approval		6-12			9-12		6-12	
MECP approval	9		9	9		9		
Total Time	20-23	23-32	17-23	17-23	26-32	15-21	23-34	
+ score	(27.5-23)/(32-23)=0.5		(27.5-26)/(32-26)=0.25			(27.5-23)/(34-23)=0.41		
- score	(27.5-32)/(32-23)=-0.5		(27.5-32)/(32-26)=-0.75			(27.5-34)/(34-23)=-0.59		
Net Score	0		-0.5			-0.18		-0.42

Risk – A conventional pipe-and-system is a very well understood approach to stormwater management. There is little risk during construction, and little with operation. Maintenance is required regularly, but it is generally simple maintenance, and due to the Town of Perth's Infrastructure Asset Management Plan, it can be generally assumed that the system will be proactively serviced in a way to minimize risk of failure.

If using a pump station in addition to a pipe-and-pond, significant costs are incurred to minimize risk, but at all times there is a risk that the pumps will fail and overland drainage of untreated storm water will reach the receiving stream. Overland drainage routes must be maintained to carry even minor events, in the event of failure of the pump. This is perceived to be the riskiest approach.

The LID system would be expected to require more monitoring, and more frequent maintenance but less substantial maintenance. The risks come during construction and in the winter. Localized sediment

loads before the vegetation is fully established can contaminate the filter, and ice accumulation can limit the rate of infiltration. A clean out would be installed along the full length of the structure to minimize the risk of sediment accumulation within the clear stone. And 20 years of cold-climate facility data has shown that the right choice of soil matrix can effectively address the risk of frost accumulation. In the long term, they have shown to be both cheaper to operate and maintain than conventional SWM systems, and as such, the MECP has indicated that with their next edition of their Stormwater guidance will include mandatory LID utilization. This is considered to produce effectively comparable levels of risk as the pipe-and-pond.

Assessment – The DEA preferred alternative would score 0, while both the Alternative E and F would score +1.

Land Use Efficiency – The preferred approach from the DEA sets aside 2.1 ha of development land for stormwater management. The hybrid system would set aside approximately 2.05 ha of development land, depending somewhat on the required sinuosity and setbacks from the water course. The LID system would require 0.9 ha of development land throughout the site, plus an additional 0.5 ha that is within development land but produces no reduction in the number of sellable lots or tax revenue.

Assessment – The DEA preferred approach and the Hybrid approach would both score 0. The difference in the LID system and the Hybrid system is 0.7 ha of usable land, which is subtly less than 1% of the available land. With the assumed configurations, that amounts to about 13 lots. This is not a significant difference, but it would produce a score slightly higher than 0.

3.5.3. Revised Assessment Matrix

Table 3-4 below looks only at the North Area and shows changes from Table 23 in light blue. When a combination has both positive and negative assessments, it is taken as neutral. When a combination includes a neutral, and a positive or negative assessment, it is taken as half of positive or negative. Combination F is taken as 75% of Combination E, plus 12.5% of the scoring of a pipe system and 12.5% of the scoring of a pond from the DEA, except where shown (changes from DEA are highlighted in green, new assessment highlighted in blue). The asterisk shown in Alternative E Land Use indicates a score that is very slightly greater than the number shown.

Table 3-4. Revised Decision Matrix – adapted from DEA Table 23

Criteria	SWM Combinations					
	A	B	C	D	E	F
Technical						
Feasibility	-	++	+-	+-	+1	+1
Compatibility	-+	++	-+	++	+1	+1
Constructability	-+	++	-+	++	-1	-1/2
Maintainability	--	--	-+	-+	-1	-1
Natural						
Terrestrial	++	-+	+-	--	0	+1/8
Aquatic	++	-+	+-	--	+1	+7/8
Groundwater	++	-+	+0	-0	+1	+7/8
Surface water	00	+0	00	+0	+1	+3/4
Water Quality	++	-+	++	-+	+1	+7/8
Socio Economic						
Displacement	--	+-	0	0	+1	+3/4
Disruption	--	+-	--	+-	0	0
Aesthetics	++	0+	+0	00	+1	+7/8
Capital cost	0	-0.5	-0.5	-1	+1	+1
Operating cost	0.5	-0.5	0.5	-0.5	0	0
Additional						
Risk		0			+1	+1
Design		0			+1	+1
Approvals		0			-0.5	-0.42
Land Use		0			0*	0
Summary						
Total +	5.5	4	2.5	2.5	11*	10 1/8
Total -	4	2	1.5	4	2.5	1.92
Balance	+1.5	+2	+1	-1.5	+8.5*	+8.20
Ranking					**1 (P)**	**2**

3.6. Sensitivity Analysis

A sensitivity analysis is typically performed to determine how differences in assumptions could affect the outcome of an assessment, and to then to focus on acquiring additional information to reduce the uncertainty. The scoring of the 2 new alternatives is very close, so that the conclusions are sensitive to the assumptions being made and the 'coarseness' of the scoring. For example, the costs have a wide range of possible values, but the assessment done there is fairly grainy, so that even if the costs of construction and/or operation were 10% higher or lower, it would not amend the scoring. The score is not sensitive to cost.

Of all of the criteria, the one that has the greatest range of potential scoring is Approvals. There is some uncertainty with one of the steps in the Hybrid approach, that would require that the Town of Perth revises some of the planning that they have already undertaken. The score for the Hybrid system for "Approvals" is currently -0.42, by assuming this work must be done at the very beginning of the

subdivision approval process. If the work that the Town would have to do can be done in parallel to or in advance of the application for draft plan of subdivision and thus no time to the whole process, this would score -0.26. If the work that the Town would have to do would take twice as long as expected, to be 4 to 8 months, the Hybrid system would score -0.53. Thus the range of scores for the Hybrid system could be between +8.34 and +8.09, or about 0.25.

It is possible that using the simple approach of assessing the Hybrid System (combination F) as being 75% of the score of Combination E + 12.5% item 5 and 12.5% of item 6 from table 2-1 may be somewhat arbitrary. Adjusting the weighting from 0% of item 5 and 25% of item 6, through to 25% item 5 and 0% item 6, produces a range of scores between 8.08 and 8.33 – again a magnitude of impact on the overall score of 0.25, but insufficient by itself to change the preferred approach.

Therefore, the sensitivity analysis suggests no individual variance from the weightings assigned or the assumptions made will change the score sufficiently the change the ranking of the alternatives.

3.7. Preferred Alternative

As described above, the potential SWM solutions were re-evaluated incorporating construction feasibility; capital and operational costs of a lift station; and both a storage-based LID system and a hybrid system as alternatives. As shown in Table 3-4, this revised process resulted in a new preferred solution – a storage-based LID approach. This system scored well by achieving environmental targets with a minimum of socio-economic impacts and with a low life-cycle cost.

4. Conclusion

In accordance with the correspondence provided in Appendix B, the 2013 DEA was re-opened for an addendum for a revised stormwater management evaluation. This report discussed the Town of Perth's required actions arising from the 2013 DEA and presented an updated option evaluation. It was determined that the Intake Protection Zone and downstream channel stability should not be impacted by this development. Furthermore, it was found that a storage-based LID system is the preferred option for SWM of the proposed North of 7 development in accordance with the revised evaluation process. Finally, a Functional SWM report discussing the preferred LID approach is attached to provide more design details and serve as a basis for a future Conceptual SWM Report to be prepared by the site developer.

Please do not hesitate to contact the undersigned with any questions or comments.

Yours truly,

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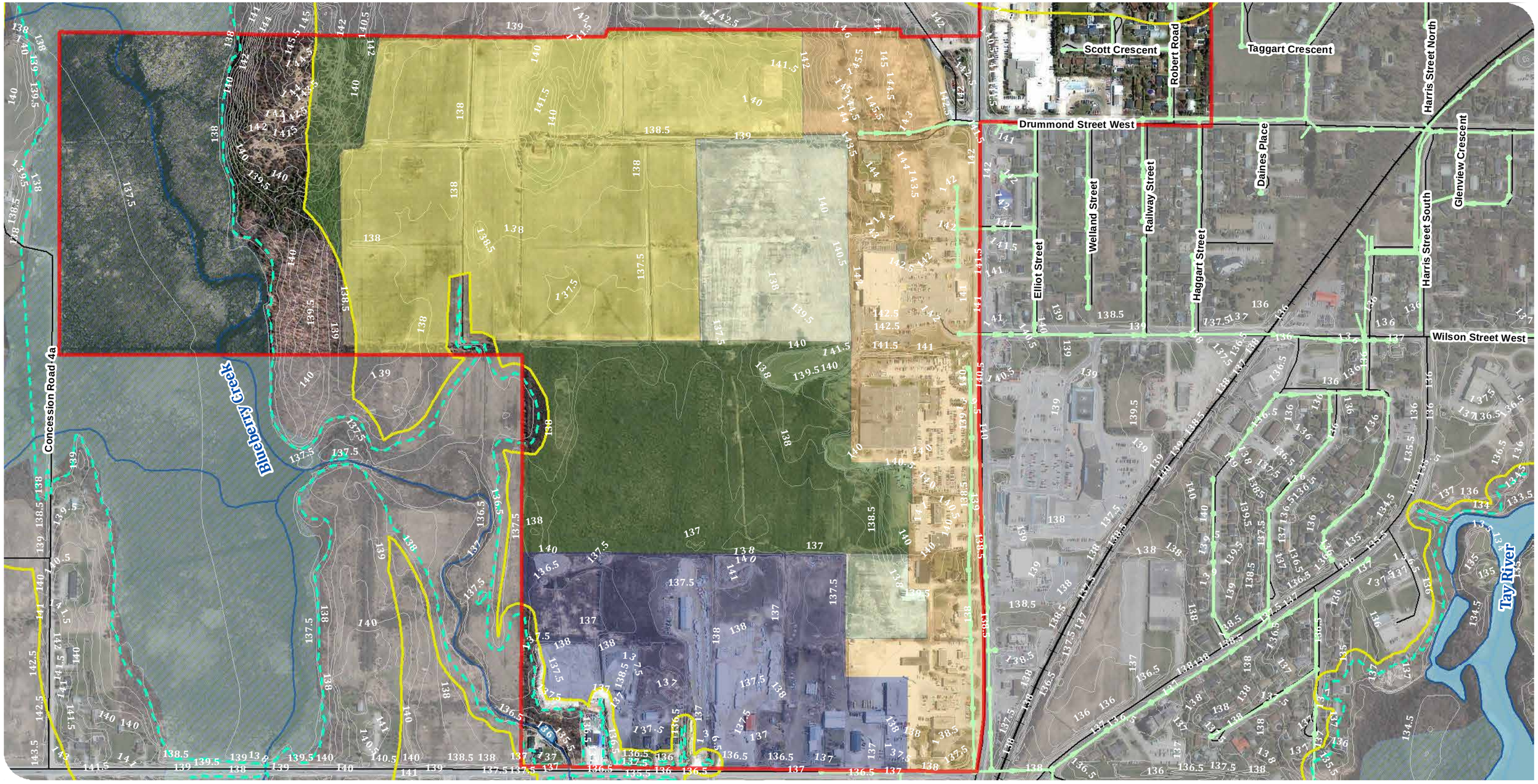
Appendix A – Excerpts from 2013 Environmental Assessment



Town of Perth
Infrastructure MasterPlan

Existing Wastewater Servicing

FIGURE 11

Study Area Boundary
RVCA Regulation Limit
Floodplain
Wetland
Waterbodies
Watercourses
Agricultural Land
Commercial Land
Industrial Area
Pasture/Lawn
Woodland
Existing Sanitary Network
Contours
Roads
Railway

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

0 45 90 180 270 360 450 Meters

1:5,500

N E S W

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2010\103930\Design_GIS\MXDs

PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013

Conditions in Greenly's Corners

Greenly's Corners is located south of Highway 7 and is bound by Drummond Street to the west, Robert Road on the south and the extension of Garden Avenue on the east. This area is outside the primary study area, but was included in the study to address existing issues with the pump station**.** The *Robert Road Sanitary Sewer Pump Station (Robert Road SSPS)* is located at the east end of Robert Road and services 26 residences located along Robert Road and Ridgeview Place. This pump station operates with only one pump and has a history of overflowing on at least three occasions in the past. This is primarily due to the lack of a dedicated electric generator for use during power outages. This pump station is a hundred percent utilized. Based on this information it is projected that this pump station is adequate for its current use, but would need extensive reconstruction to become a part of the sanitary sewer upgrades for the areas north of Highway 7.

5.4 Stormwater Management and Drainage

5.4.1 Existing Stormwater Management Conditions

Surface Drainage

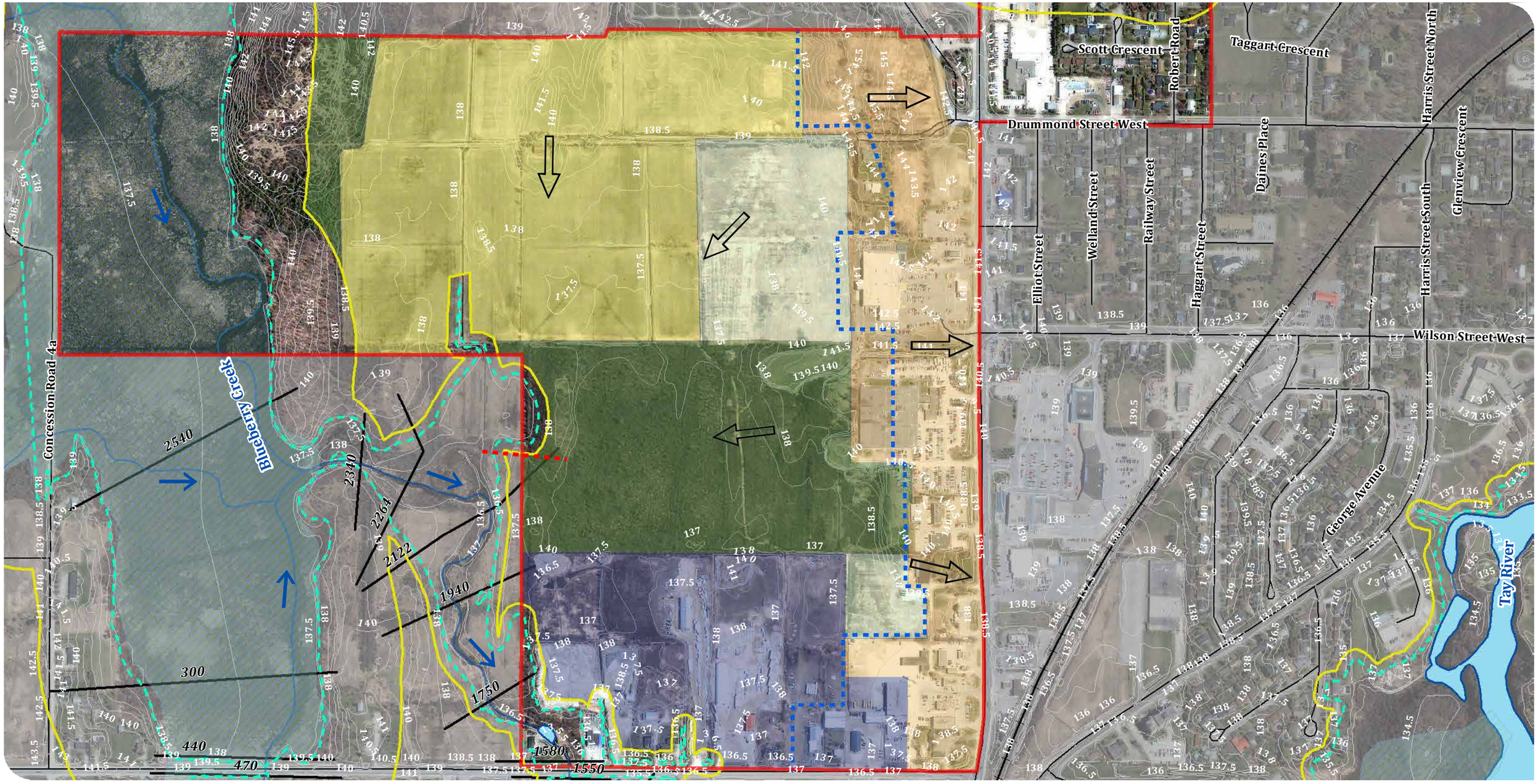
The study area lies within the 820 km^2 watershed of the Tay River. While the Tay River watercourse is located south of Highway 7, the study area is bound by its tributary Blueberry Creek in the north. Topography indicates that a small ridge, parallel to Highway 7, traverses the study area and divides the surface drainage. The portion north of the ridge gently slopes northwest towards Blueberry Creek, while the southern area drains south-easterly to Highway 7 and ultimately to the Tay River. **Figure 12** shows the existing drainage divide conditions.

The area south of the ridge is comprised mostly of a commercial strip fronting Highway 7. These commercial sites drain to the south through underground storm sewer or by surface sheet drainage to the existing Highway 7 drainage system. This Highway 7 drainage system is comprised of a combination of open ditches and culverts. This system drains southwest along Highway 7 to Lanark Road where it then drains northwest to Blueberry Creek. These systems are small private systems and have been identified as being at capacity and cannot accommodate additional runoff. In essence, any re-development within the south area commercial district would require appropriate *Stormwater Management (SWM)* measures that would address meeting SWM criteria and ensuring capacity is not exceeded for the Highway 7 drainage system.

In contrast, the area north of the ridge currently drains north-westerly towards Blueberry Creek via overland flow and ditches along the perimeter or field boundaries, as there is no other stormwater system within this portion of the study area. There are no surface waterbodies or storage ponds within the study area under existing conditions.

Blueberry Creek Floodplain

A majority of the undeveloped land north of the ridge drains north-westerly towards Blueberry Creek. The 38.5 km^2 Blueberry Creek sub-watershed is a part of the Tay River watershed. Blueberry Creek is a tributary of the Tay River. It is approximately 11 km in length and ultimately drains into the Tay River at the confluence of the two watercourses just south of Dufferin Street. Based on the *Blueberry Creek Flood Risk Mapping Report* produced by the RVCA (July 2011), a spill point adjacent to the study area has been identified and is situated at a location on Blueberry Creek approximately 2122 m upstream from the Tay River confluence. During the 1:100 year flood event, the *Regulatory Flood Level (RFL)* in this location is between 137.44 m and 137.55 m (RVCA, October 2011) and water is expected to spill over and spread south and/or southeast across into an existing low-lying area within the study boundary.



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Existing Conditions Stormwater Drainage

FIGURE 12

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Study Area Boundary	Agricultural Land	Woodland	Flood Model Cross Sections	Contours
RVCA Regulation Limit	Commercial Area	Waterbodies	Existing Drainage Divide	Roads
Floodplain	Industrial Area	Watercourses	Drainage Direction	Railway
Wetland	Pasture/Lawn	Direction of Flow	Spill Zone	

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MAP CREATED BY: KR
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Soils

The 1967 Soil Survey of Lanark County classified the subsurface geology as a limestone plain consisting of Pre-Cambrian igneous and metamorphic rock with a band of Cambrian limestone intruding through portions of this area in a northerly direction. The Cambrian Limestone is primarily located in the vicinity of Greenly's Corners. The underlying bedrock surfaces at several locations, mostly in ridges running roughly southwest to northeast, almost parallel to Dufferin Street along the north face of the ridge and along Blueberry Creek shoreline.

Above the bedrock are two main types of soils classified as North Gower Clay Loam and Tennyson Sandy Loam. The North Gower Clay Loam (HSG-C) is a calcareous clay loam and clay mix. This clay loam mix is further typically classified as Humic Gleysol and exhibits poor drainage characteristics. During wet seasons these soils tend to be saturated with surface ponding due to its poor drainage characteristics. The Tennyson Sandy Loam (HSG-A) is a calcareous sandy loam derived from grayish limestone and sandstone and generally further classified as Grey-Brown Podzolic till that are generally well draining soils. The sandy loam is found in depths exceeding 3 feet and while it has low fertility and not very suitable for agriculture, it is well suited for development. **Figure 13** illustrates the soil characteristics of the study area.

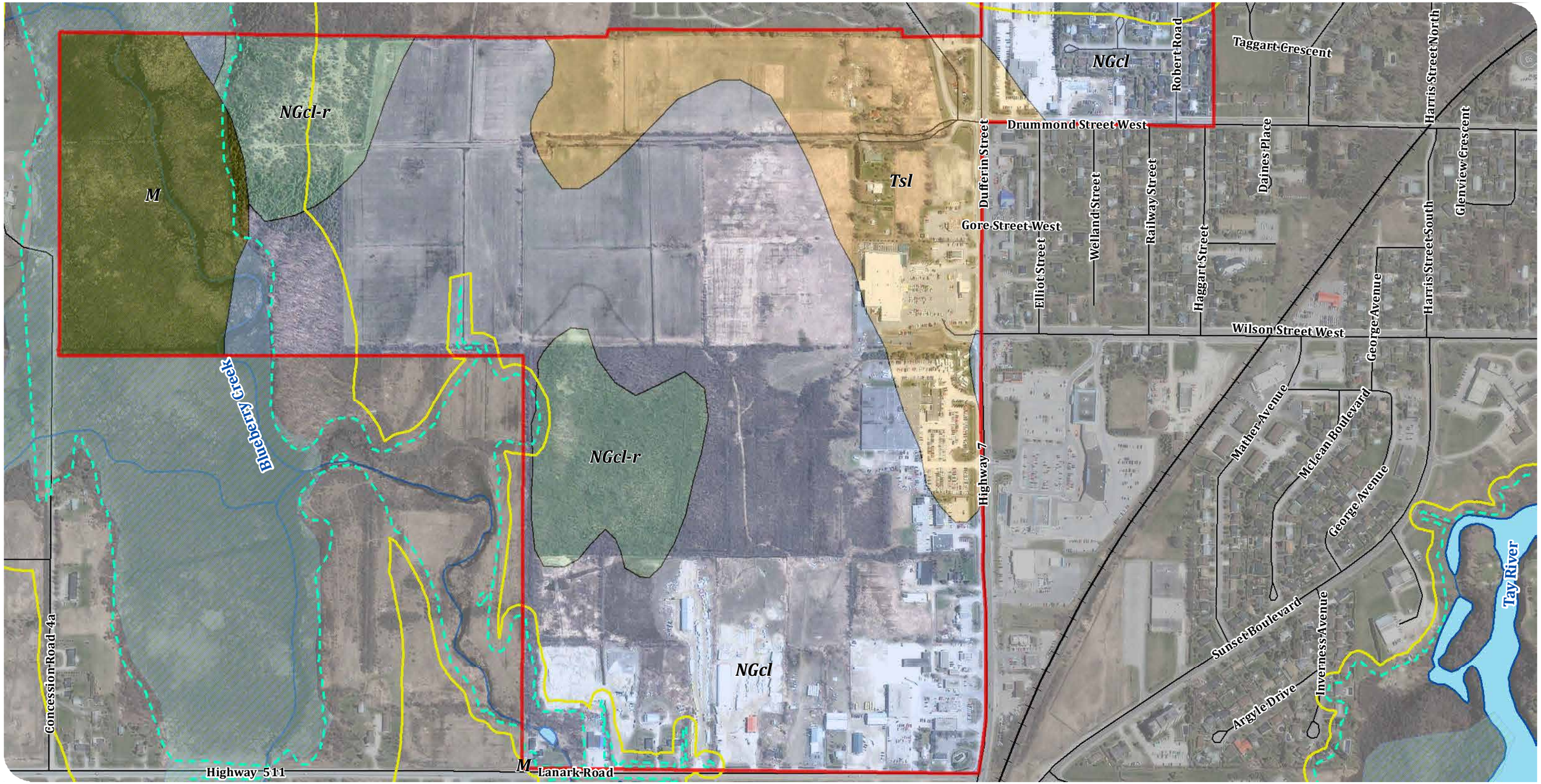
Runoff Characteristics

Except for the existing commercial strip fronting, Highway 7 and some industrial properties along Lanark Road, the majority of the study area is currently undeveloped area consisting of either farm fields in cultivation for fodder crops, abandoned fields in the early stages of success (i.e. 50 years old or less), hedgerows along field boundaries, or ornamental plantings associated with former farmsteads. There are also several areas of mature trees north of the annexed lands which borders Blueberry Creek and wetland. **Table 15** summarizes the existing land use areas and their runoff coefficients.

Table 15: Existing Land Use

Land Use	Area (ha) [(1)]	Runoff Coefficient, C[(2)]
Cultivated	25.9	0.46
Pasture	8.2	0.28
Woodland	18.6	0.30
Commercial	18.2	0.80
Industrial	14.4	0.70
Roads	0.1	0.90
Total Area Subject to Development	**85.4**	**0.52**

Notes:
(1) Areas in hectare are rounded values.
(2) Runoff coefficients have been area-weighted based on their underlying soil type (clay loam and/or sandy loam) for their respective land uses.



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Soil Characteristics

FIGURE 13

Heritage PERTH

Study Area Boundary	M - Organic Material	Tsl - Sandy Loam (HSG-A)	Wetland
RVCA Regulation Limit	NGcl - Clay Loam (HSG-C)	Waterbodies	Roads
Floodplain	NGcl-r - Clay Loam - Rocky Phase (HSG-C)	Watercourses	Railway

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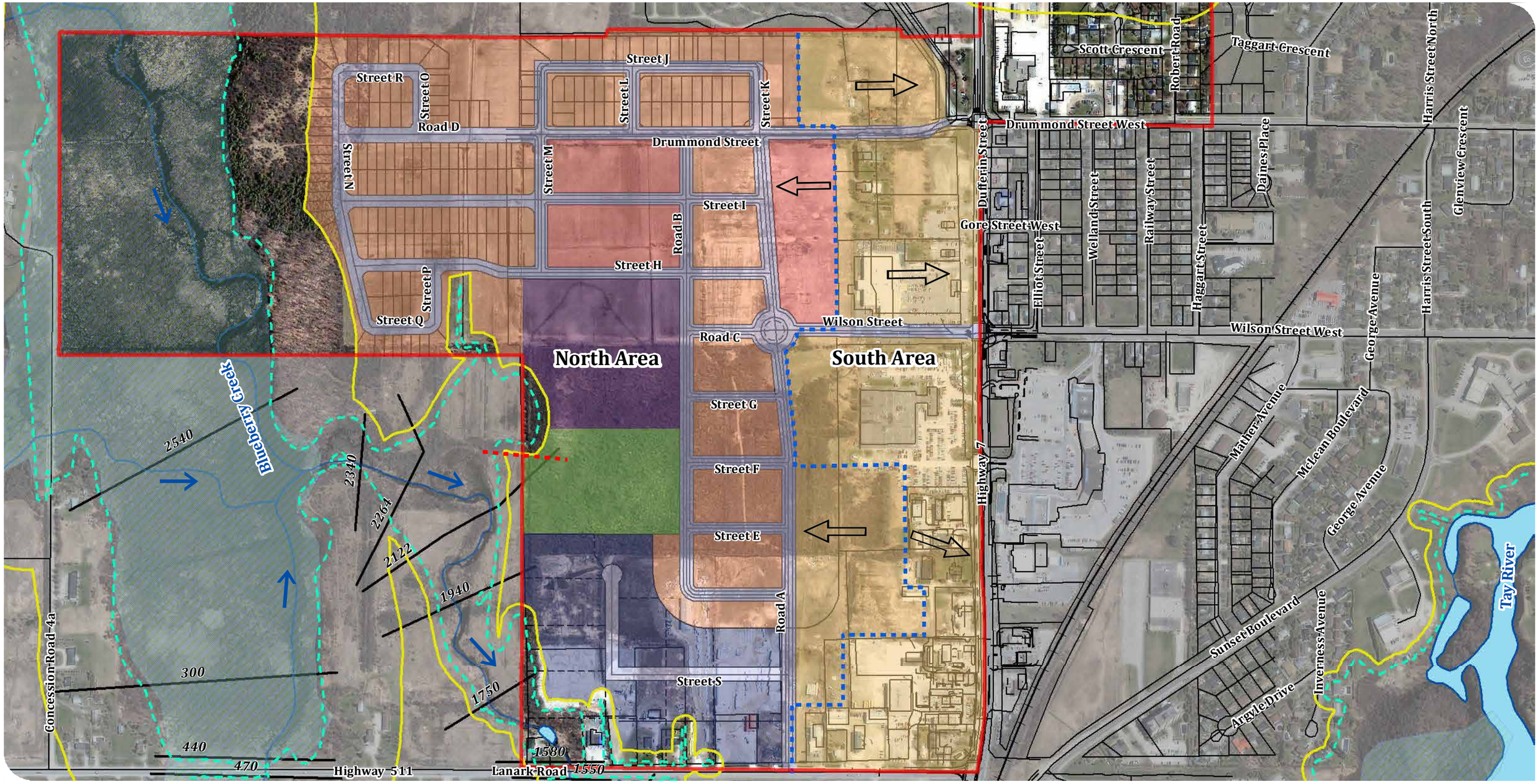
5.4.2 Planned Stormwater Management Conditions

Projected development is to maintain existing drainage patterns to the maximum extent possible, so that surface runoff north of the drainage divide will continue to flow north-westerly towards Blueberry Creek, while the south area commercial strip drains to the Highway 7 stormwater system. As the north area develops, drainage will be conveyed via a minor system (i.e., storm sewers) and a major system following the interior road network. It is anticipated that the proposed drainage pattern and stormwater system, including stormwater facilities, will continue to promote drainage north-westerly into Blueberry Creek. **Figure 14** presents the Proposed Conditions Stormwater Drainage.

Based on the information provided by RVCA, the volumetric rate of the spill if it is to occur is insignificant relative to the total flow in Blueberry Creek and has not been accounted for in the in the delineation of the flood plain limits along the creek.. RVCA has noted that that the existing grades in the low-lying area within the study area adjacent to the spill zone are generally lower than the 1:100 year flood level of Blueberry Creek. RVCA also concluded that development in the area that may be subjected to shallow flooding can proceed without adversely impacting the control of flooding. Development may proceed if proposed grading changes would effectively prevent spills from Blueberry Creek into the low-lying area or if buildings are flood-proofed to the appropriate flood elevation and drainage infrastructure is designed accordingly with the spill zone maintained. Since RVCA has deemed it acceptable to develop this area and has allowed filling and the placement of new structures in the low lying area, presumably there is no impact to flood levels in this reach and no impacts to downstream areas. Grading changes in this zone are to be carefully assessed if the possibility of spill continues after development in order to ensure that conveyance of flood flow through the spill zone to Blueberry Creek is maintained. It is likely this can be accommodated in the drainage systems and low use areas such as parks and green space. No additional overland flow routes or spill zone are to be created between the Blueberry Creek Floodplain and the lands to the southeast.

Some of the annexed lands near at the northern limit of the study area are located within the Blueberry Creek Floodplain and will not have development under projected conditions. This also applies to the northwest corner east of Lanark Road where the watercourse floodplain slightly overlaps the study area.



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Proposed Conditions Stormwater Drainage

FIGURE 14

Study Area Boundary	Proposed Drainage Divide	Low Density Residential	Watercourses	Spill Zone
RVCA Regulation Limit	Business Park	Medium Density Residential	Direction of Flow	Roads
Floodplain	Institutional	Retail	Flood Model Cross Sections	Railway
Wetland	Park	Waterbodies	Drainage Direction	

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Under projected conditions, development is anticipated to have a combination of land uses including residential, institutional, commercial, industrial, and parkland. **Table 16** summarizes the projected land use areas and their runoff coefficients.

Table 16: Projected Land Use

Land Use	Area (ha) [1]	Runoff Coefficient, C
Parkland	3.6	0.20
Low Density Residential [2]	22.9	0.49
Medium Density Residential [2]	5.9	0.53
Commercial	34.97	0.80
Institutional	5.0	0.60
Roads	13.1	0.90
Total Area Subject to Development	**85.4**	**0.67**

Notes:
(1.) Areas in hectare are rounded values.
(2.) Low density residential area contains a mix of low, medium and high density
Residential with a majority (60% +) being low density. Medium density residential area contains a majority (70%) of medium density homes.

of the study area, best maintenance options and redundancy for the system. The pump station should have a wet well with a working volume of 8 m3. Each pump should be able to pump approximately 27 L/s against a total head of 20 m. Two operating pumps will provide sufficient capacity for the full development of the study area.

Neither the Robert Road area nor the proposed upgrades of the sanitary sewer infrastructure in that area are affected by the proposed alternatives recommended. The present sewage pumping station near Robert Road is dedicated to the Greenly's Corners area. This pump station is presently at capacity and experiences some operation issues according to Town staff. The proposed servicing north of Highway 7 will discharge to the sewer on Drummond Street upstream of the Robert Road pump station and is not expected to contribute to the Greenly's Corners collection area. Therefore the Robert Road pump station will not be impacted by the proposed development in the study area

Extension of the central sewage system into the study area will require build-out of a sewer network as development proceeds. The sewer network and pumping station is developed at a functional level to meet the sewage production rates projected on the basis of land use and density. Sizing calculations for the proposed sanitary sewer system is included in **Appendix C**.

7.5 Stormwater Management and Drainage

Typical Stormwater Management System

In any developed area there is a need to deal with storm water runoff generated during storm events to provide protection from increased runoff due to an increase in hard impervious areas. To accomplish this requires the development of a storm water management plan which can take on many forms. Generally the most common is to have a minor system to handle runoff from minor storm events in the order of ten year or less rain events, and a major system to handle storm events larger than minor system is designed to handle. The minor system generally consists of a system of underground pipes connected to the surface by catch basins. This system drains by gravity to some point that it discharges to a natural body of water. In the process it is generally subjected to some form of water quality management in the forms of a water quality pond.

As described in Section 5.4, a ridge generally cuts the study area in the east-west direction and divides its surface drainage. Under projected conditions, the north area containing most of the proposed new development and land use changes will continue to drain northerly to Blueberry Creek. The south portion with mostly existing commercial lots will carry on draining southerly to the storm system along Highway 7. With the objective to maintain existing drainage patterns to the maximum extent possible while accommodating new developments, the drainage divide under projected conditions follows closely to that of existing, with only some minor modifications. Overall, the size of the north and south drainage areas under existing and proposed conditions are relatively similar.

As described in Section 5.4, the SWM requirements for the two distinct drainage areas are different due to the nature of their receiving watercourse and/or storm sewer system. The south area requires quantity and quality treatment prior to discharging runoff into the storm system along Highway 7. The north drainage area, on the other hand, will need only quality/erosion control before to outletting to Blueberry Creek. A list of stormwater management measures has been considered and evaluated to determine the most appropriate controls needed to meet these SWM requirements.

There are seven alternative solutions for stormwater management for the study area. Each Alternative is described below.

Source / Lot Level Controls

Source/lot level controls involve intercepting and treating stormwater on-site before runoff reaches the conveyance system (e.g. storm sewers, grass swales, ditches, etc.). These may include structural and non-structural BMPs. Non-structural BMPs for source controls are techniques applied onsite by minimizing runoff generation. This differs from the goal of structural BMPs, which is to help mitigate stormwater related impacts after they have occurred. Some typical non-structural source control measures applicable for this study area may include:

- Disconnecting roof leaders where applicable;
- Diverting rainwater downspouts onto grassed or vegetated areas away from residential buildings to avoid infiltration into foundation drains and maximize infiltration opportunities;
- Use of rainwater harvesting to intercept, convey and store rainfall for future use; and
- Reducing impervious surfaces onsite by increasing pervious areas and/or by means of cluster development.

There are three Alternative solutions in the category of Source / Lot Level controls:

Alternative 1: *Bioretention / Rain Gardens* – Bioretention areas, often called rain gardens, are shallow surface depressions planted with specially selected native vegetation to temporarily capture, treat and infiltrate runoff. They are used typical to manage stormwater on a lot-by-lot basis. Depending on the native soil and physical constraints, the system may be designed without an underdrain for infiltration purposes (quantity and quality control) or, with an underdrain, to allow for filtration only (quality control). The primary component of a bioretention system is the filter bed which composes of a mixture of gravel/sand, fines, and organic material, as well as a mulch ground cover topped with vegetation adapted to the conditions of the SWM practice.

Alternative 2: *Infiltration Chambers* – Infiltration chambers or galleries are subsurface infiltration/storage structures typically installed underground. They create large void spaces for the temporary storage of runoff under parking or landscaped areas. Structures typically have open bottoms, perforated side walls and optional underlying granular stone reservoirs to allow infiltration into underlying native soil and/or provide storage for

quantity control. They are especially well suited to sites where available space for other types of BMPs is limited, or where minimal surface footprint is desired.

Alternative 3: *Special Detention Areas – Rooftops, Parking Lots* – Special detention areas such as rooftops and parking lots can be designed and used effectively to control release rates and meet municipality requirements. They are also useful in attenuating flow that drains to subsequent downstream BMPs and thereby increase their performance. Rooftop runoff storage can be achieved by restricting flow at scuppers, drains, and parapet wall openings etc. Parking lots can utilize depressed areas as storage to control flow at stormwater inlets and/or by using raised curbing.

Conveyance Controls

Conveyance controls are typically implemented as part of the stormwater conveyance system to provide quantity and/or quality treatment. There are two Alternatives in this category, both are described below:

Alternative 4: *Vegetated Swales (Bio-Swales) / Grassed Swales* – Vegetated swales are shallow, broad, earthen channels that are densely planted with a variety of grasses, shrubs, and/or trees designed to slow, filter, and infiltrate runoff. A layer of permeable soil is typically placed beneath the grass/vegetation or an aggregate layer can also provide significant quantity control. Water is filtered through the soil to under drains and the swale is quickly dewatered, preventing standing water. In addition, check dams can often be employed to enhance infiltration capacity, decrease runoff volume rate and velocity, and promote additional filtering and settling of pollutants. They are an excellent alternative to conventional curb and gutter conveyance because they provide pre-treatment and can distribute flows to subsequent BMPs.

Alternative 5: *Traditional Underground Storm Sewer System* – Is the traditional enclosed underground pipe network which collects storm runoff at localized low point such as catch basins. This system drains by gravity to some point that it discharges to a natural body of water. This type of system has the disadvantage that it does not provide any type of water quality and generally concentrates the storm runoff to a central location. Because of this these systems are generally required to initially discharge to an End-of Pipe Control system which provides at the least water quality controls and may provide quality control. Sizing calculations for the proposed underground stormwater system is included in **Appendix D**.

End-of-Pipe Controls

End-of-pipe BMPs considered to be potentially effective for quality control in this study area include:

Alternative 6: *Wet Ponds / Artificial Wetlands* – Wet ponds and artificial wetlands are detention basins designed to temporarily store, attenuate, and treat stormwater runoff. Wet ponds not only include permanent pools for water quality treatment but also have the additional capacity above the permanent pools for temporary storages if quantity control is so required. As well, the active storage component can also provide erosion protection. With innovative designs, wet ponds can also provide aesthetic and wildlife benefits. Similarly constructed

wetlands are shallow marsh system planted with emergent vegetation designed to treat stormwater runoff and are highly effective for pollutant removal. They provide aesthetic values and wildlife benefits but require a relatively large amount of space. Sizing calculations for the proposed stormwater management ponds is included in **Appendix D.**

Alternative 7: *Oil-Grit Separators – Oil-Grit Separators (OGS)* are water quality devices designed to remove pollutants as stormwater flows through the system. They are generally proprietary, commercially available units that can remove sediment, debris, and pollutants bound to particulate solids. OGS are highly adaptable to ultra-urban and retrofit situations, where they can be installed beneath most surface infrastructures such as roads and parking spaces. As well, they are useful in existing or proposed conveyance systems that have or are expected to have significant levels of sediment or at pollutant hot spots such as gas stations, golf courses, streets, driveways, parking lots and at material handling industrial or commercial sites. Long term maintenance, however, will be required when considering these devices.

Evaluation of Alternatives

The evaluation of these alternatives was based on an assessment of potential impacts for the set of criteria outline in Table 17. For each alternative, the existing conditions data was used to assess the potential implications and the alternative that provided the most benefits with the least disadvantages was identified as the preferred alternative or a part of the final preferred solution. In other words, the preferred solution can be a combination of several alternative(s). All criteria / criteria groups were considered of equal importance to the overall decision.

Table 23: Evaluation of Stormwater Alternatives

	Source / Lot Level Controls			Conveyance Controls		End-Of-Pipe Controls	
	Alternative 1: Bioretention	**Alternative 2: Infiltration Chambers**	**Alternative 3: Special Detention Areas (Rooftop, Parking Lot)**	**Alternative 4: Vegetated Swales / Ditches**	**Alternative 5: Traditional Underground Storm Sewer System**	**Alternative 6: Wet Ponds/ Artificial Wetlands**	**Alternative 7: Oil-Grit Separators (OGS)**
Technical Considerations							
Technical Feasibility to address SWM criteria (Quantity, Quality & Erosion), including space requirement and soil constraints	South: + Addresses quality criteria but for limited drainage area North: - Addresses quality criteria at lot level only and not road drainage	South: + Addresses quantity criteria North: - Addresses quality criteria at lot level only and not road drainage	South: + Addresses quantity criteria North: - Does not address water quality criteria	South: - Limited water quantity control North: + Addresses quality criteria	South: + North: +	South: - Addresses criteria but for limited drainage area and potential space constraints North: + Addresses water quality criteria for entire drainage area	South: + Addresses quality criteria North: - Addresses quality criteria only and for limited drainage area
Compatibility with Other Infrastructure Alternatives (Water, wastewater, road, etc.)	+ Compatible with other infrastructure	+ Compatible with other infrastructure	+ Compatible with other infrastructure	- Not compatible with road	+ Compatible with other infrastructure	+ Compatible with other infrastructure	+ Compatible with other infrastructure
Ability to construct	+ Conditions are suitable for construction both on private commercial properties or public property in residential areas. May require underdrain system where soils are less permeable	South: + Conditions are suitable for construction North: - Requires multiple locations, likely on private residential properties	South: + Conditions are suitable for construction North: - Requires large parking lot areas and flat roof	- Not compatible with road design and may require underdrain system where soils are less permeable	+ Conditions are suitable for construction	South: - Space constraints limit constructability North: + Conditions are suitable for construction	+ Conditions are suitable for construction
Potential need for maintenance	- Relatively frequent, labour intensive maintenance	- Relatively frequent, labour intensive maintenance, confined space access may be required	+ Limited maintenance required	- Relatively frequent, labour intensive maintenance	-	- Pond cleanout required (in approximately 10 years), special sediment disposal may be required	+ Frequent maintenance required but easily performed from surface
Natural Environment							
Impact on terrestrial environment (plant life and wildlife)	+ Creates habitat	0 Not applicable	0 Not applicable	+ Creates habitat	0	+ Creates habitat	0 Not applicable
Impact on fisheries and aquatic life	+ Creates habitat for macroinvertbrates and promotes infiltration (maintain baseflow)	- Provides no water quality treatment and has potential to impact fish and aquatic habitat	- Provides no water quality treatment and has potential to impact fish and aquatic habitat	+ Creates habitat for macroinvertbrates and aquatic vegetation, and promotes infiltration (maintain baseflow)	0 If it discharges through some form of End-of-Pipe Control or "-" if not	+ Creates habitat for macroinvertbrates, aquatic vegetation and fish habitat	0 Provides water quality treatment of runoff and does not impact fish habitat
Impact on groundwater	+ Promotes infiltration	+ Promotes infiltration	0 No impact or benefit	+ Promotes infiltration	0	0 No impact or benefit	0 No impact or benefit

Table 23: Evaluation of Stormwater Alternatives

	Source / Lot Level Controls			Conveyance Controls		End-Of-Pipe Controls	
	Alternative 1: Bioretention	**Alternative 2: Infiltration Chambers**	**Alternative 3: Special Detention Areas (Rooftop, Parking Lot)**	**Alternative 4: Vegetated Swales / Ditches**	**Alternative 5: Traditional Underground Storm Sewer System**	**Alternative 6: Wet Ponds/ Artificial Wetlands**	**Alternative 7: Oil-Grit Separators (OGS)**
Impact on surface drainage	0 Designed to maintain surface drainage patterns	0 Designed to maintain surface drainage patterns	0 Designed to maintain surface drainage patterns	0 Designed to maintain surface drainage patterns	+	0 Designed to maintain surface drainage patterns	0 Designed to maintain surface drainage patterns
Impact on water quality	+ Provides water quality treatment of runoff and promotes infiltration (maintain baseflow)	- Provides no water quality treatment	- Provides no water quality treatment	+ Provides water quality treatment of runoff and promotes infiltration (maintain baseflow)	0 If it discharges through some form of End-of-Pipe Control or "-" if not	+ Provides water quality treatment of runoff, can mitigate warming effects with bottom draw outlet	+ Provides water quality treatment of runoff
Socio-Economic Environment							
Potential for displacement of residents, businesses, institutions or community features	- Potential displacement of private space/parking area	0	0	- Potential reduction in lot fabric	+	South: - North: -	0
Potential for disruptions of residents, businesses, institutions or community features	- Potential disruption during construction	- Potential disruption during construction	0	- Potential disruption during construction	+	- Potential disruption during construction	- Potential disruption during construction
Aesthetics	+ Greening of paved areas, including rain gardens improve aesthetics	0 Not applicable	- Potential for nuisance surface flooding	+ Greening of paved areas to improve aesthetics	0 Not applicable	+ Creates public amenity and recreation space	0 Not applicable
Cost							
Relative capital cost (relative costs were estimated based on per hectare of drainage area treated)	- Highest cost (approximately $100K per hectare drainage area treated)	- Moderate cost (approximately $40K per hectare drainage area treated)	+ Limited additional cost beyond parking lot and roof costs	- Highest cost (approximately $100K per hectare drainage area treated)	+ Low cost (approximately $25.6K per hectare drainage area treated)	+ Low cost (approximately $17K per hectare drainage area treated)	- Moderate cost (approximately $30K per hectare drainage area treated)
Relative operating/maintenance cost	- Labour/resources required	- Labour/resources required	+ Limited maintenance	- Labour/resources required	+ Limited maintenance	- Labour/resources and disposal costs	+ Limited labour and resource costs
Summary of Evaluation							
South Area (Draining to Stormwater System on Highway 7)	Part of the preferred solution	Part of the preferred solution	Part of the preferred solution	Eliminated	Part of the preferred solution	Eliminated	Part of the preferred solution
North Area (Draining to Blueberry Creek)	Eliminated	Eliminated	Eliminated	Eliminated	Preferred solution	Preferred solution	Eliminated

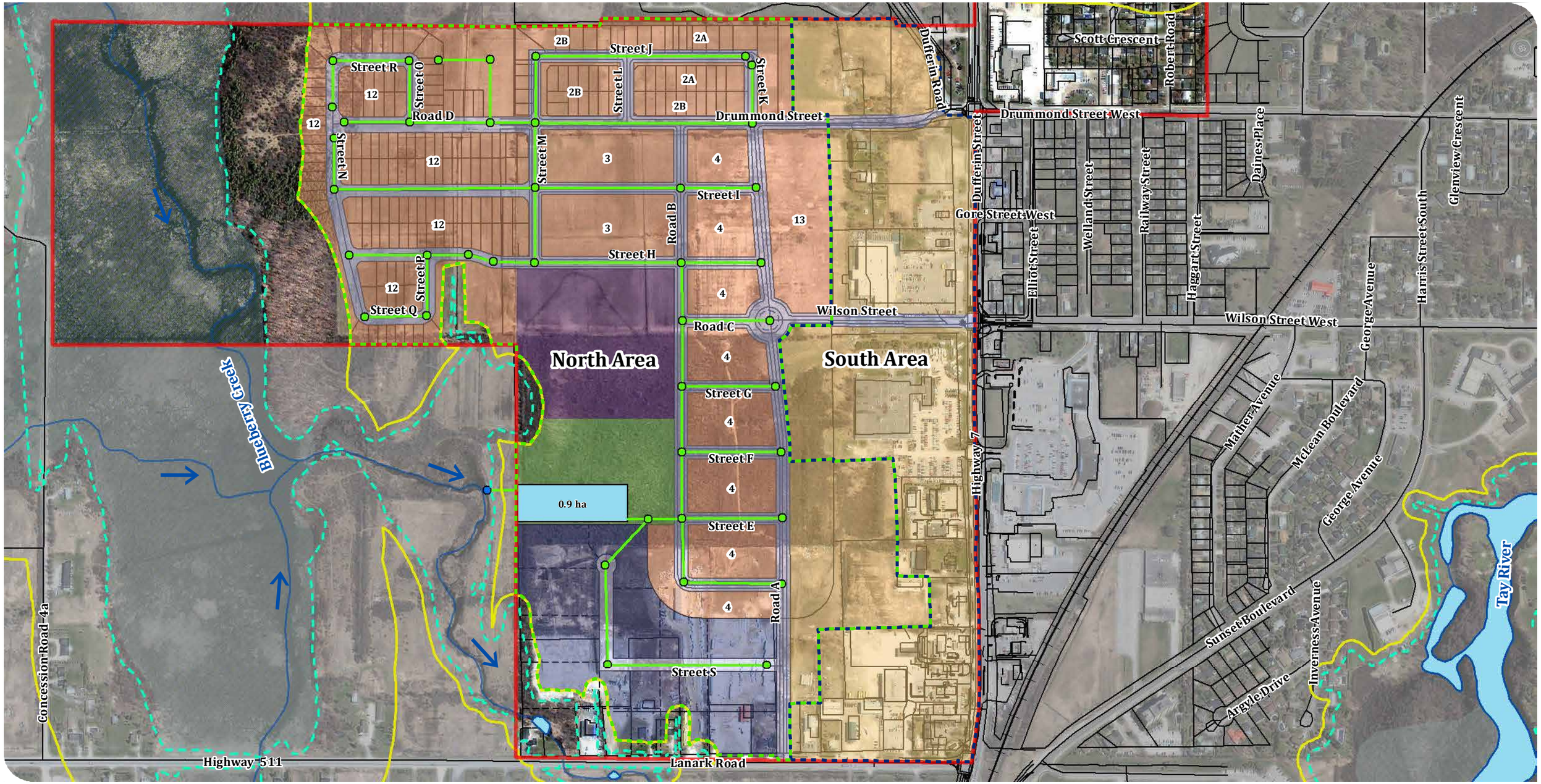
** South = South Area (Draining to Stormwater System on Highway 7); North = North Area (Draining to Blueberry Creek)*

Preferred Solution

Based on the evaluation, the preferred solution for the north and south areas is summarized below in **Table 24**. A combination of several alternatives makes up the preferred solution.

Table 24: Preferred Solution - Stormwater Management Components

Drainage Catchment	Preferred Solution - SWM Components
South Area (Require quantity and quality control)	A combination of the following alternatives (Alt) forms the preferred solution for the south area to meet both the quantity and quality requirements. • **Alt 1: bioretention** in retail parking lots where applicable (provides quality control) • **Alt 2: Infiltration chambers** underground of parking areas where applicable (provides quantity control) • **Alt 3: Special detention areas – Rooftops** of retail buildings & Storage in depression areas in parking lots where applicable (provides quantity control) • **Alt 5: Traditional Underground Storm Sewer System** – minimal impact on development in the study are and is compatible with the existing soil conditions • **Alt 7: Oil-grit separators (OGS)** – To be placed at site-specific locations at end of treatment train before discharging to stormwater system on Highway 7 (provides quality control) As the south area is currently comprised of retail lots, site-specific combination of Alt 1, 2, 3 and 7 can be used where applicable to meet quantity and quality criteria.
North Area (Require quality and erosion control)	The following alternative(s) form(s) the preferred solution for the north area to meet both the quality and erosion criteria. • **Alt 5: Traditional Underground Storm Sewer System** – for up to 5 year storm events and has minimal impact on development in the study are and is compatible with the existing soil conditions combined with major overland flow network to handle storm events of greater than 5 year events. • **Alt 6: Wet Pond(s)** – centralized pond(s) to treat runoff from the north drainage area (provides quality and erosion control). Two location layouts are potentially feasible and are summarized below: - **Option 6A**: One (1) centralized pond located in the parkland adjacent to Blueberry Creek. See **Figure 18.** - **Option 6B**: Two (2) but smaller ponds to service the north area. One located in the parkland and one south of the annex land. See **Figure 19.** Option 6A with one centralized pond occupies a larger footprint at a single location than Option 6B. However, Option 6B with two smaller ponds requires two pump stations (instead of 1 pump station for Option 6A) and additional maintenance. Hence, Option 6A is preferred.



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Option 6A: Stormwater Pond Location

FIGURE 18

Heritage PERTH

Study Area Boundary	Proposed Storm Network	Stormwater Pond	Retail	Waterbodies	Roads
RVCA Regulation Limit	Storm Manhole	Park	Residential	Watercourses	Railway
Floodplain	Outlet Location	Business Park	North Area Boundary	Direction of Flow	
Wetland		Institutional	South Area Boundary	Proposed Layout	

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MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

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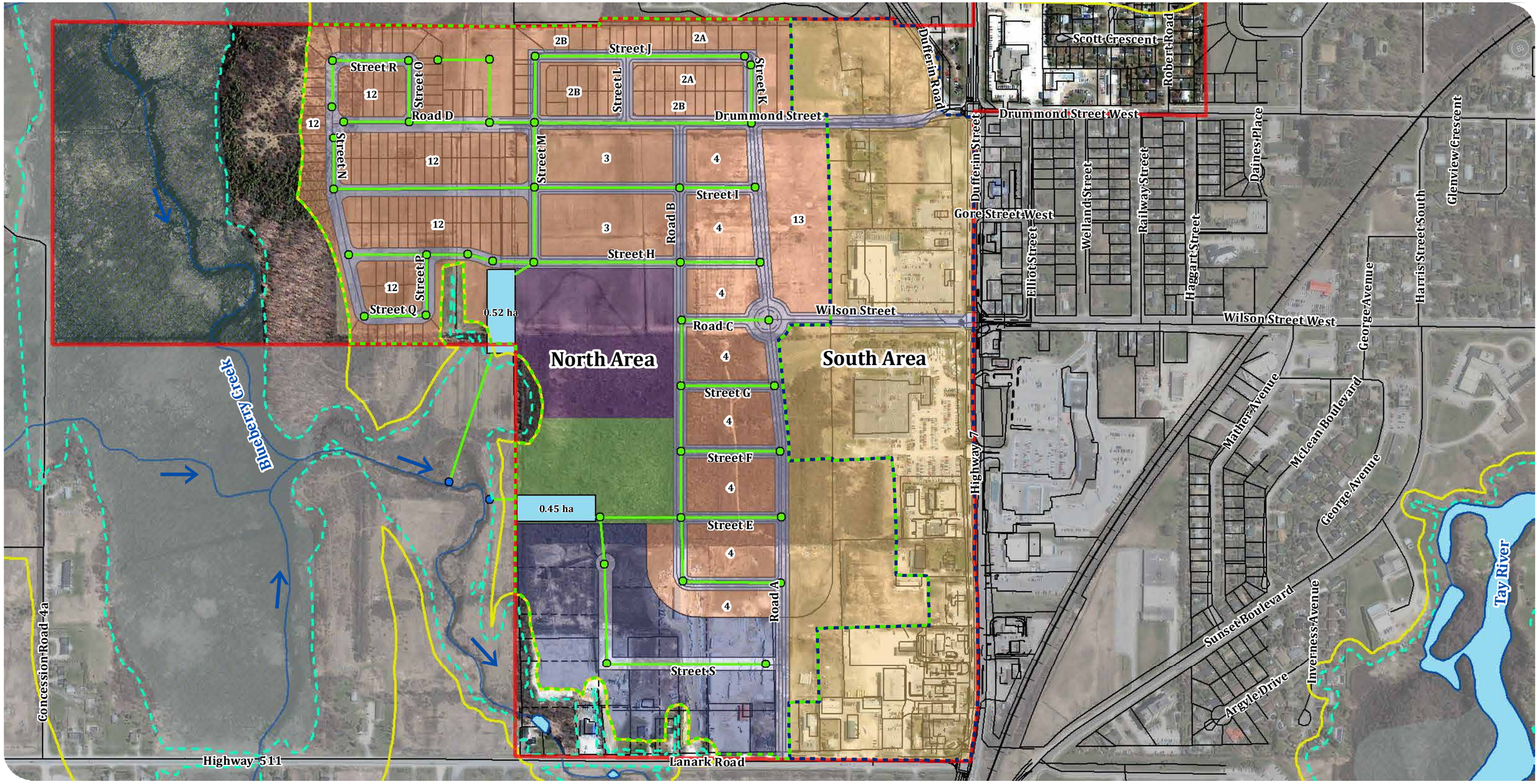

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Infrastructure Master Plan

Option 6B: Stormwater Pond Location

FIGURE 19

Study Area Boundary	Proposed Storm Network	Stormwater Pond	Retail	Waterbodies	Roads
RVCA Regulation Limit	Storm Manhole	Park	Residential	Watercourses	Railway
Floodplain	Outlet Location	Business Park	North Area Boundary	Direction of Flow	
Wetland		Institutional	South Area Boundary	Proposed Layout	

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

0 45 90 180 270 360 450 Meters

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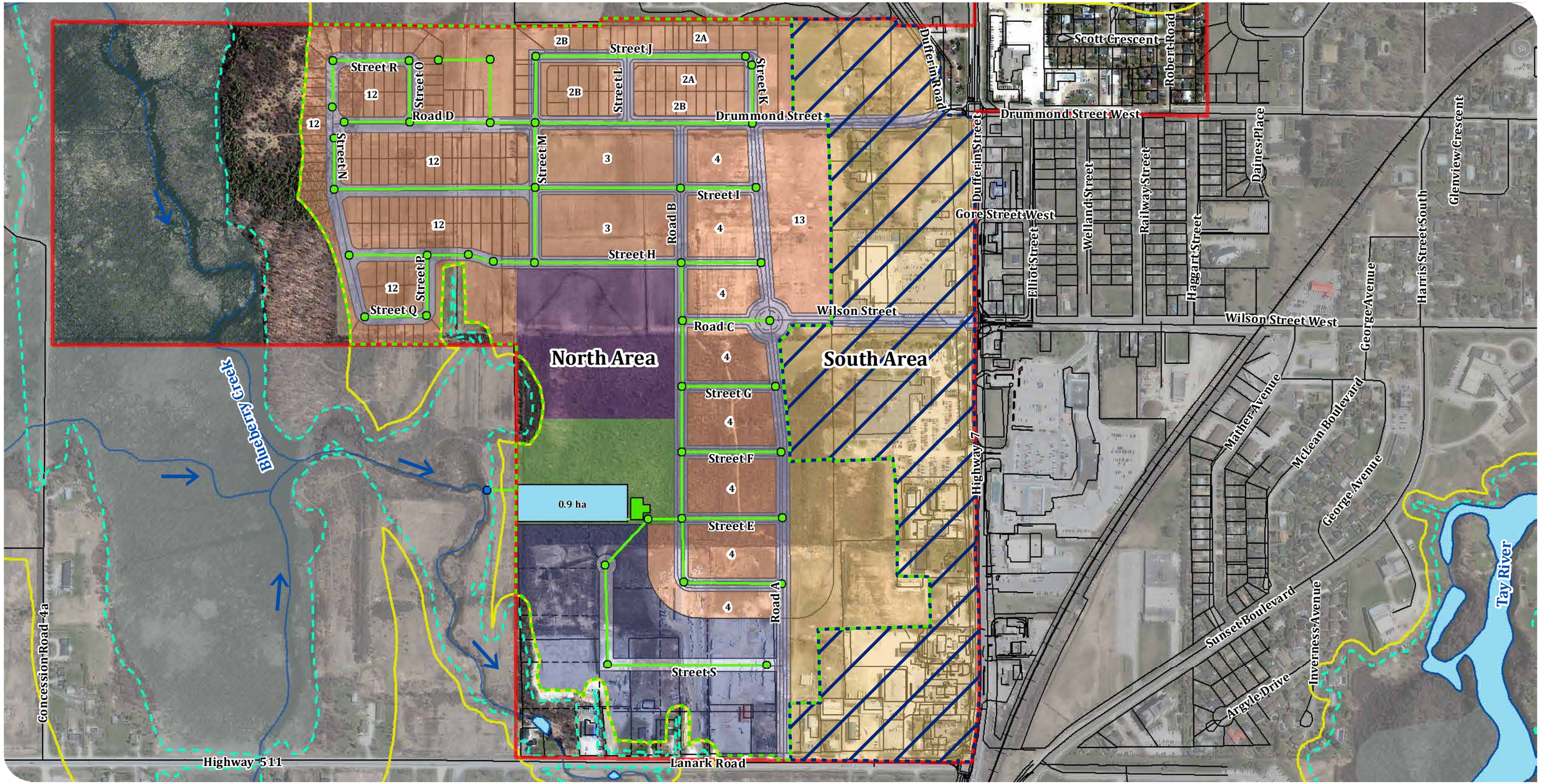
PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013

The preferred solution for the south area is a combination of on-site bioretention, underground infiltration chambers, rooftop/parking detentions, and OGS units. The commercial strip in the south area has retail properties with site-specific drainage characteristics. Hence, a combination of any or all of the above control measures, where applicable, can be used to meet quantity and quality criteria. Underground infiltration chambers and rooftop/parking detentions are commonly used for quantity control on retails properties where footprint is to be minimized. OGS units are often needed for quality control. If applicable, bioretention, such as parking lot rain gardens, can be used to further reduce runoff at the source and to provide aesthetic value. The centralized wet pond alternative was eliminated from this preferred solution in the south area because available space is limited for a facility that would service the can be serviced and meet the SWM criteria for the entire south area.

For the north area, a combination of alternatives is required to make up the preferred solution. These consist of Alternative 5 (traditional underground storm sewer system for minor storm flows and major overland flow network for Major storm events) combined with Alternative 6A, where a centralized wet pond is proposed to service the north catchment. Source control measures such as bioretention/rain gardens and infiltration chambers at individual residential lots are likely to require more maintenance and coordination with private property owners. In addition, lot level bioretention and infiltration chambers do not address road drainage, and if used, will require separate SWM measures to treat road runoff (e.g. vegetated swales or wet ponds). The alternative of vegetated swales along roads was also eliminated because this conventional BMP for rural roads would not be compatible with the proposed urban sections.

Based on the evaluation of wet pond locations, the preferred option would be Option 6A where one wet pond would be situated in the parkland close to Blueberry Creek. This location is favourable for discharge as it is close to the watercourse. The storm sewer network would collect runoff from the north area and drain into the wet pond via a pump station.

Figures 20, 21, and 22 show the preferred stormwater management solution.



Town of Perth
Infrastructure Master Plan

Preferred Solution for Stormwater Management
FIGURE 20

Study Area Boundary
RVCA Regulation Limit
Floodplain
Wetland
Stormwater Pond
Stormwater Pond Pumping Station
Proposed Storm Network
Storm Manhole
Outlet Location
Park
Business Park
Institutional
Retail
Residential
Waterbodies
Watercourses
Direction of Flow
North Area Preferred Solution : Centralized Wet Pond
South Area Preferred Solution : Combination of Bioretentions, Infiltration Chanmbers, Roof/Parking Detention, Oil and Grit Separators
Proposed Layout
Roads
Railway

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

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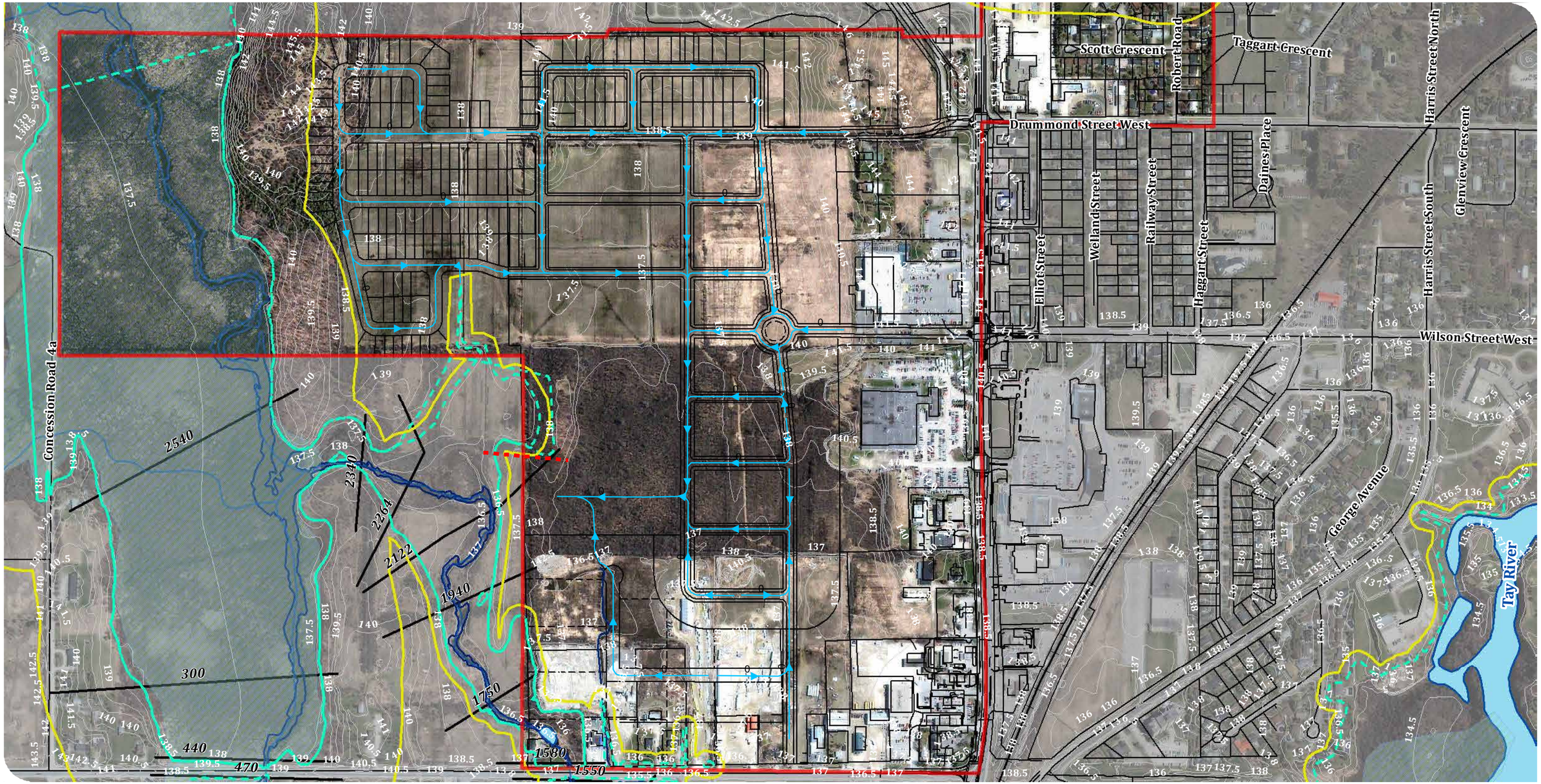
PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013



Town of Perth
Infrastructure Master Plan

Major Overland Storm Flows

FIGURE 21

Heritage PERTH

Study Area Boundary	Agricultural Land	Woodland	Flood Model Cross Sections	Contours
RVCA Regulation Limit	Commercial Area	Waterbodies	Existing Drainage Divide	Roads
Floodplain	Industrial Area	Watercourses	Drainage Direction	Railway
Wetland	Pasture/Lawn	Direction of Flow	Spill Zone	

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MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

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N E S W

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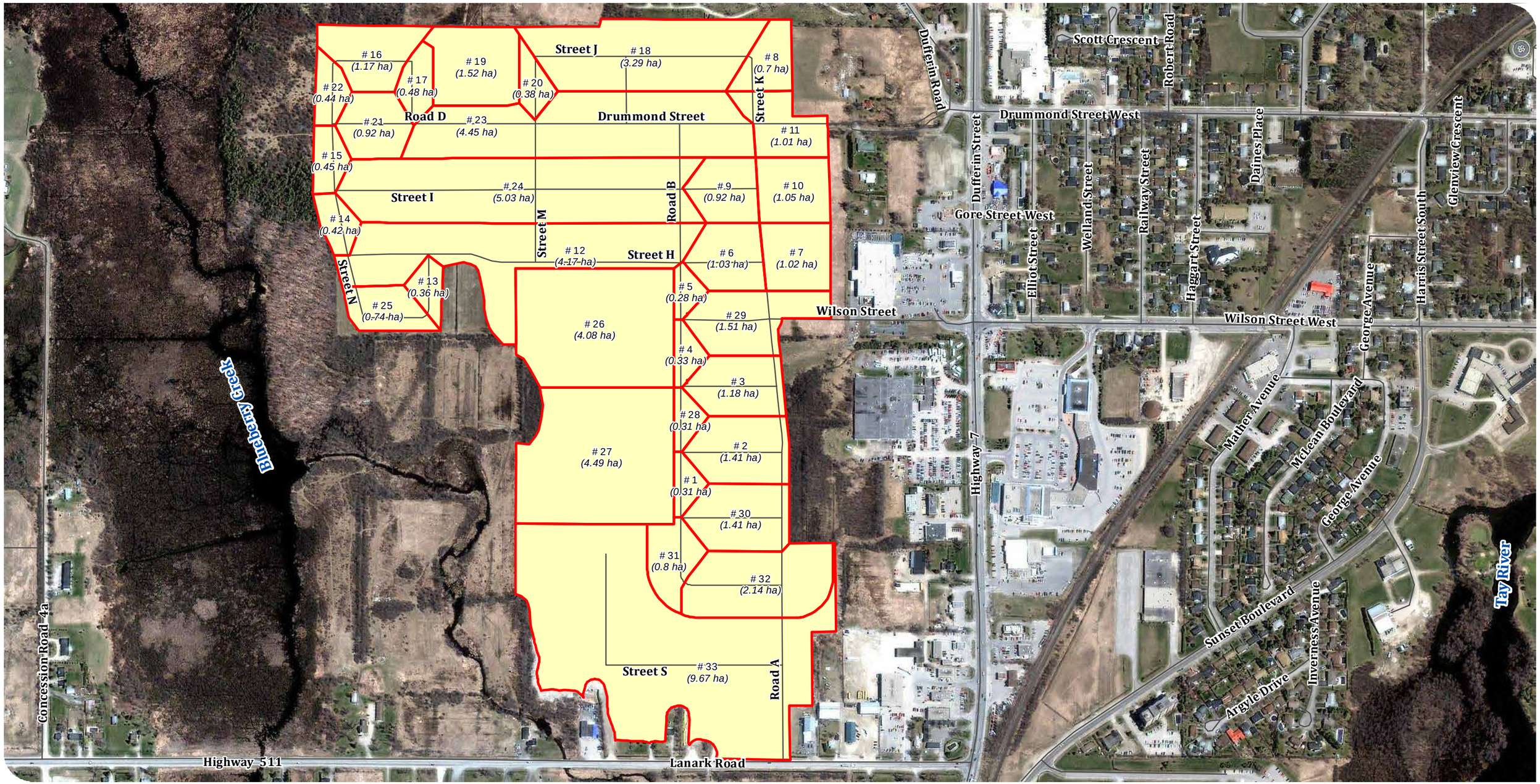
PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013



Town of Perth
Infrastructure Master Plan

Suggested Catchment Area Map

FIGURE 22

Study Area Boundary	Catchment Area Boundary	Stormwater Pond	Retail	Waterbodies	Roads
RVCA Regulation Limit	Proposed Storm Network	Park	Residential	Watercourses	Railway
Floodplain	Storm Manhole	Business Park	North Area Boundary	Direction of Flow	
Wetland	Outlet Location	Institutional	South Area Boundary	Proposed Layout	

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

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PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013

Appendix B – Correspondence

Jp2g Consultants Inc.
ENGINEERS ▪ PLANNERS ▪ PROJECT MANAGERS
1150 Morrison Drive, Suite 410, Ottawa, ON K2H 8S9
T 613-828-7800, F 613-828-2600, www.jp2g.com

Jp2g No. 2161774A

Oct 26, 2016 (Draft)

Town of Perth
80 Gore Street East
Perth, ON K7H 1H9

Attention: Eric Cosens
Director of Development and Protective Services

Re: Infrastructure Master Plan
For the Area North of Highway 7
Peer Review

Dear Eric:

JP2G was retained by the Town of Perth to provide a Peer Review for the Infrastructure Master Plan for the area north of Highway 7 and east of Lanark Road that was prepared by Dillon in 2013.

When providing a Peer Review of a study completed under the Municipal Class Environmental Assessment (Class EA), it is important to limit the review to specific questions to determine if there is a sufficient rationale to re-open the Class EA to consider either a broader inventory of environmental conditions or to seek additional alternatives and determine their impacts on a broader inventory. The Peer Review is not intended to supercede the Class EA process, but rather to determine any if significant modification to the project or change in the environmental setting has been identified or occurred after filing the Infrastructure Master Plan.

These questions include:

- Is the project description adequate to determine the scope of what is being proposed?
- Is the purpose and need sufficiently defined to allow for a full range of possible solutions?
- Have all of the natural, social and economic conditions been inventoried?
- Have all of the reasonable alternatives that address the project's need and purpose been considered?
- Have the impacts of alternatives been adequately described?
- Is the preferred solution demonstrated as having the least adverse impacts?

A thorough review of the Master Plan has provided answers to these questions..

1. Is the project description adequate to determine the scope of what is being proposed?
Yes. Section 2.2 of the Master Plan reads:

The Master Plan has been initiated to support and advance the OPA #10 and Secondary Plan process through the provision of infrastructure services including the annexed area.

2. Is the purpose and need sufficiently defined to allow for a full range of possible solutions?
Yes. Section 1.2 of the Master Plan reads:

This Master Plan is being completed to ensure that appropriate and cost effective servicing is in place to accommodate growth and development in this area, to identify potential effects to the environment as a result of this servicing and development, and to identify mitigation measures for those potential effects.

3. Have all of the natural, social and economic conditions been inventoried?

No. Approximate social and economic conditions have been inventoried in Section 4.0. A number of natural heritage or public health and safety features have been misrepresented or omitted.

Omission/Weakness	Action Required	Action By
The RVCA regulation limit is shown as 15m from the 1:100 year flood line and 120m from the PSW. The preferred solution concept plan shows the regulated lands as a Moderate Constraint. This is not the intent of the regulation limit.	HIA required to revise development limit. Follow RVCA policy to place fill in flood plain.	Developer
Catchment area of Wetland should be shown distinct from Creek, to allow for consideration of different criteria for releases. Releases to the PSW would have to demonstrate no impact on the hydrologic function of the wetland. Releases to the creek would have to demonstrate post-to-pre peak flow, and no impact on channel stability.	Revise catchment boundaries	Developer
Candidate ANSI not discussed or considered as an ecological constraint.	EIS required within ANSI limits	Developer
Planning restrictions due to the Intake Protection Zone (IPZ) is not discussed. This may not have been available at the time of developing the Master Plan, but those restrictions are present today. The County of Lanark Amendment No. 3 was approved by MMAH October 16, 2015 which implemented source water protection policies.	Discuss implications of IPZ, and determine if IPZ acts as constraint.	Town
The stability of the downstream Blueberry Creek, and therefore its capacity to accept changes in flows related to urban development, has not been identified. Release rates from area have been established, but it has not been shown if these release rates are appropriate.	Channel stability assessment of Blueberry Creek	Town

4. Have all of the reasonable alternatives that address the project's need and purpose been considered?

No.

Omission/Weakness	Action Required	Action By
Stormwater Management (Section 6.4) has not considered specific variants on conveyance and quantity controls (LIDs). Specifically, a grassed swale with ample underdrainage can be used in the place of a conventional pipe-and-pond system in providing conveyance, treatment, and storage.	Conceptual master drainage plan will have to be developed.	Town and Developer

5. **Have the impacts of alternatives been adequately described?**
   No.

Omission/Weakness	Action Required	Action By
Capital and operating costs of different components not fully described in Table 23, artificially increasing the costs of the grassed swale option. Pump station not included with cost of SWM facility.	Include all capital and operating costs into the decision matrix.	Town
Post-development channel stability should be considered prior to sizing the pond.	Channel stability assessment of Blueberry Creek	Town

6. **Is the preferred solution demonstrated as having the least adverse impacts?**
   No.

Several of the required actions can be deferred to a future stage of the subdivision planning process, and some need to be addressed prior to subdivision planning. Specifically, those actions that would impact the fundamental development concept would have to be revisited as part of the Infrastructure Master Plan, and would therefore require reopening the Environmental Assessment.

Developer driven action	**Town driven action**
	Determine impact of IPZ
	Channel stability assessment
	Determine release criteria
EIS / HIA required	
Revise development boundaries	
Prepare conceptual Stormwater Management plan	
	Revise Table 23 with all costs, impacts
	Reassess preferred alternative

Actions to address:

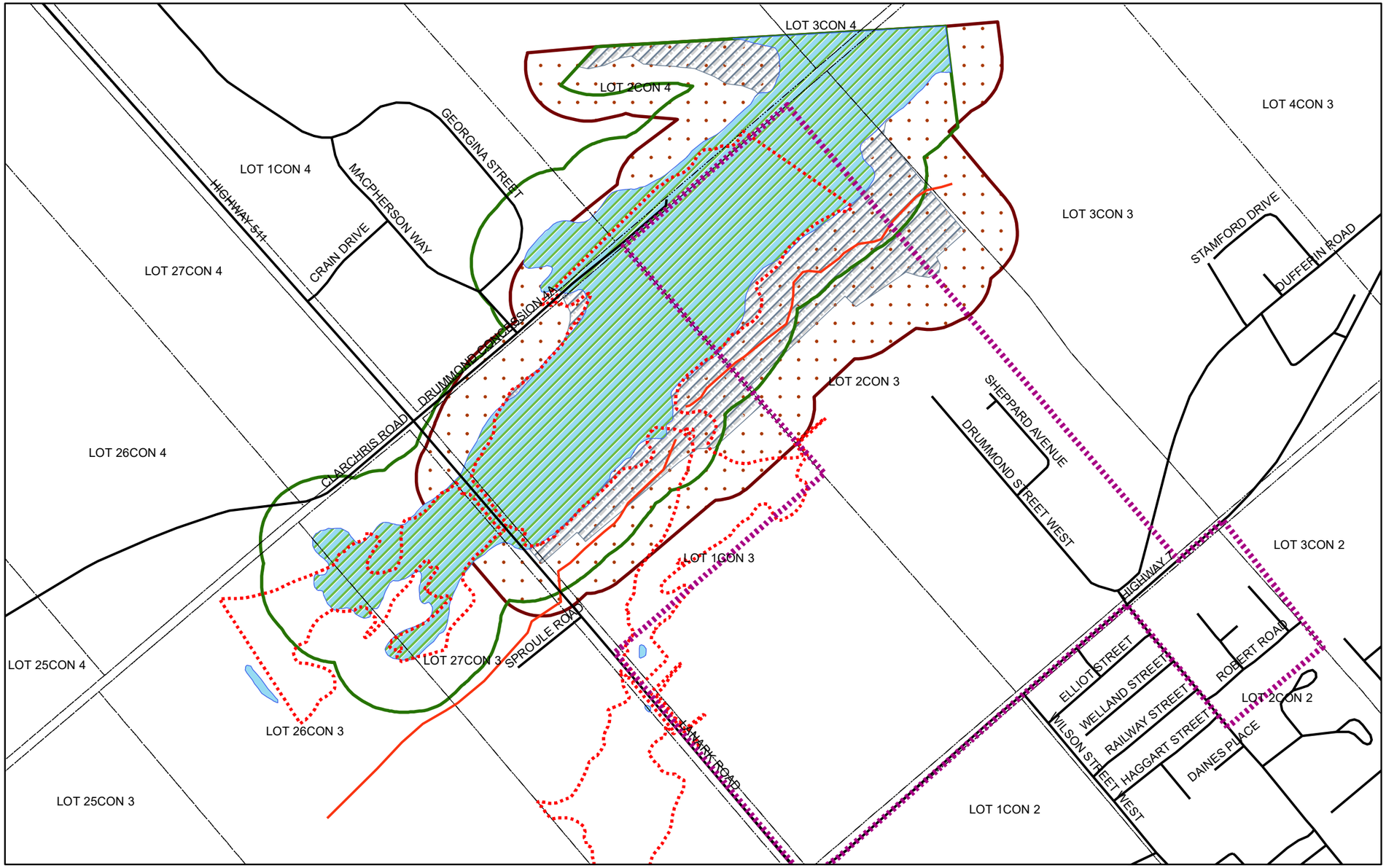
Revise development boundary

There are a number of constraints that may affect the development boundary that will affect the servicing required.

Some of the site area drains to the PSW, and the area that drains to the PSW out to 120m from the boundary is the 'adjacent land'. Development is only allowed in the adjacent land if it can be shown through an EIS that there will be no negative impacts on the wetland's natural features or ecological functions, and through a Hydrological Impact Assessment (HIA) that there will be no impact on the hydrological function of the wetland. A general Terms of Reference for an HIA has been included in Appendix A.

Much of the site area draining to Blueberry Creek is covered by an ANSI boundary and/or the adjacent area of influence. Development is only allowed in the ANSI or its adjacent land if it can be shown through an Environmental Impact Statement (EIS) that there will be no negative impacts on the natural features or the ecological functions for which the area is identified. EIS requirements are included in Appendix B.

If a revised boundary will change the servicing requirements for the development, then the terms of reference for the associated studies would be required to be defined as part of the Class EA, in order to determine the servicing requirements. The attached Figure 1 Revised Environmental Constraints shows the following environmental constraints to development, in comparison to Figure 6 in the Master Plan:



Notes:
1. Height of Land interpreted from hillshade mapping
2. 100 year flood boundary from Rideau Valley Conservation Authority
3. PSW/ANSI from Town based on County mapping
4. 120m setbacks applied

Jp2g Consultants Inc.
ENGINEERS · PLANNERS · PROJECT MANAGERS

Infrastructure Master Plan
Area North of Highway 7
Peer Review

1:10,000

Project: 2161774A

Figure - 1
Revised Environmental Constraints

Drawn By: PJ

Checked by: DN

Date: July 2016

a) The Blueberry Creek 1:100 Flood Elevation based on the RVCA Flood Risk Mapping July 2, 2010 on both figures.

b) The limits of the Blueberry Marsh PSW based on the County and Town Official Plan on both figures.

c) The 120m area of influence on adjacent lands from the PSW based on the County and Town Official Plan policies Section 5.5.1.6 and Section 8.6.4b.3 respectively is on both figures.

d) The limits of the Candidate Perth Blueberry Marsh ANSI based on the County Official Plan is shown on Figure 1.

e) The 120m area of influence on adjacent lands from the ANSI based on the County policy Section 5.5.3.2 is shown on Figure 1.

f) The height of land is shown on Figure 1 which defines the surface water flow in the vicinity of the wetland and creek.

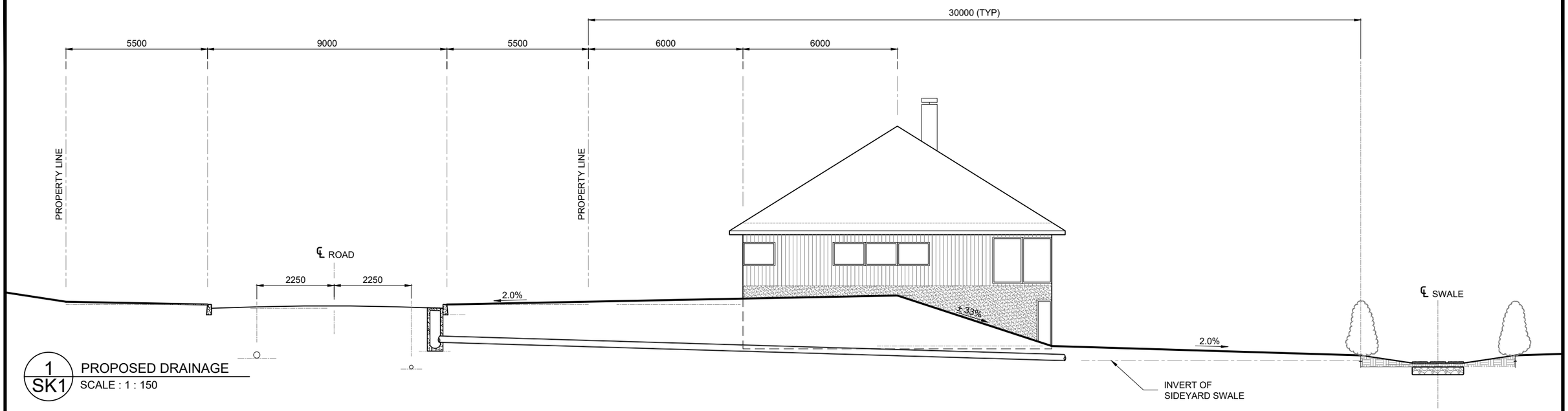
For the purposes of the Class EA, which is intended to evaluate the potential infrastructure requirements, the developable land can be assumed to be the largest reasonably possible developable area. When the EA is reopened, the consultant will determine if the PSW or ANSI setbacks are appropriate for this stage in the planning process. At the time of an application for Subdivision for the area, the proponent will be required to demonstrate through both EIS and HIA what the appropriate setback to development would be within the Subdivision.

Determine if the site is constrained by IPZ
The site is within the Intake Protection Zone (IPZ) 8 of the Town of Perth Water Treatment Plant. Certain stormwater management facilities are considered a significant drinking water threat per the Mississippi-Rideau Source Protection Plan. See Policy: SEW -10-LB-PI-MC, and Appendix B (pg 167). Demonstrate that the IPZ is considered in the servicing of the site.

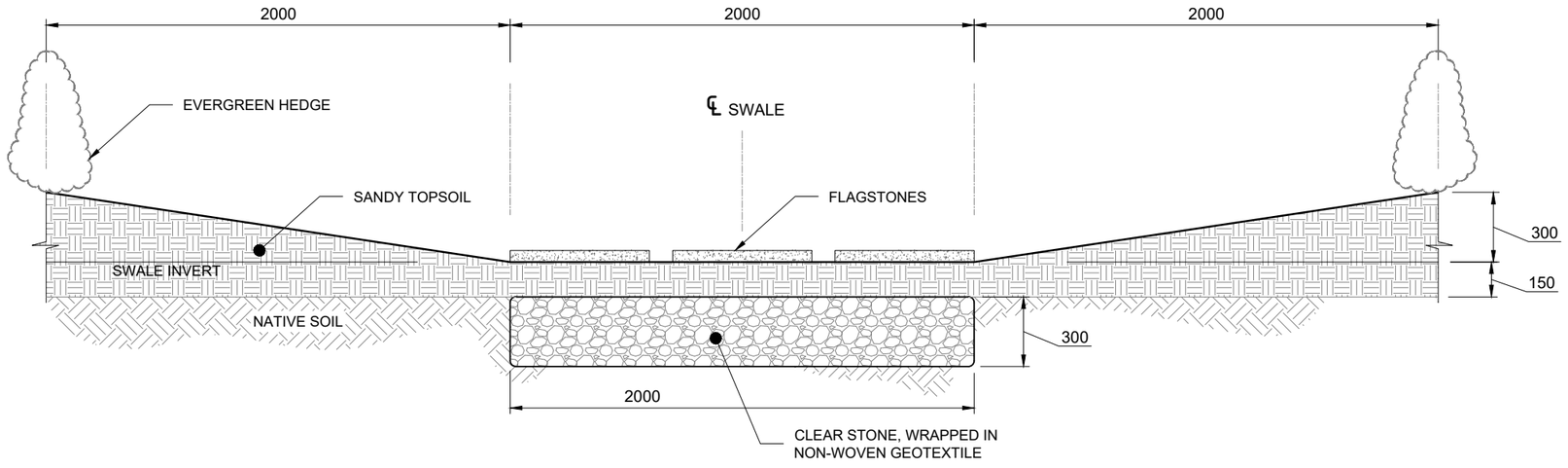
Consider the downstream channel's ability to accept changes in flow quality and quantity prior to setting storm discharge targets.
Using the methods available in MOE SWM Planning and Design Manual, or an equivalent method, determine if additional controls beyond 'match post- to pre-' is required to develop stormwater management release target rates to Blueberry Creek. This needs to be done prior to any development directing a change of flows to Blueberry Creek.

Consider grassed swale with underdrainage as a means of addressing quantity and quality treatment for the residential portion of the site.
A grassed swale at the rear of the lots, collecting runoff from the roads and lots, can provide quantity and quality treatment with a minimum of fill. The lots would tend to have 'walk-out basements', but would otherwise be effectively the same as currently being considered. Sufficiently sized, they have been shown in 'semi-rural' settings to be very cost effective and low maintenance.

The swale would include a clear stone subdrain that would be capable of capturing the runoff from the road and lots from the 1:2 year event, or the first 30 minutes of a 1:5 year event. Surface storage and conveyance would provide all additional required storage to reach the discharge targets developed in the previous step. A trapezoidal swale with a wide flat bottom, with not more than 3:1 side slopes, and 0.2% longitudinal slope, underlain by a clear stone subdrain of fairly uniform cross-section, could provide the require quantity and quality treatment, without the need for a pond or pumping station. This would limit the amount of required fill, and maximize the developable area of the subject site. See Figure 2 for an example.



1 / SK1 PROPOSED DRAINAGE
SCALE : 1 : 150



2 / SK1 TRENCH DETAIL
SCALE : 1 : 25

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INFRASTRUCTURE MASTER PLAN
AREA NORTH OF HIGHWAY 7
PEER REVIEW

DESIGNED: D.N.		PROJECT No.:	2151774A
DRAFTED: E.A. / R.M.		REVISION DATE:	SEP 20, 2016
CHECKED: D.N.	APPROVED: D.N.	REVISION No.:	.
SCALE: NOTED		FIGURE:	2

DWG NAME: O:\DOCS\1 - CIVIL\ACTIVE\2161774A - PERTH MASTER PLAN CLASS EA\07 DRAWINGS\ONGOING\SK1 - PROPOSED DRAINAGE - SECTION (SEP 20, 2016).DWG LAYOUT: SK1
(11X17) SAVED ON Tuesday, September 20, 2016 BY BRYANS

Long term performance is expected to exceed expected quantity and quality targets. When infiltration rates decline over time, removal and replacement of the cover material can be done with conventional equipment available to most municipalities. Expectations of servicing would be between every 5 years to every 20 years, depending on the quantity and type of winter road maintenance being done.

Other Low Impact Designs (LIDs) may be considered at a subdivision design stage. Data from various sources suggests that LIDs have similar construction costs and lower operating costs than the equivalent 'hard' infrastructure that would be commonly used today.

Compare capital and operating costs of the existing preferred solution with the capital and operating costs of the grassed swale with underdrainage.
The existing EA does not include the costs associated with construction, operation, and maintenance of the existing stormwater system as a whole – Capital costs are shown for pipe and pond, but not pump; no costs are provided for pipe, pond, or pump operation and maintenance. The EA should provide an analysis that compares all of the costs associated with the proposed system, and with grassed swales and subdrains.

For example:

Technology	Land $/ha	Construction $/ha	Expected lifespan (years)	Operating $/ha/year	Maintenance $/ha/year	Annual cost ($/ha)
Concrete pipe		40000	60		800	1466
Pumping station		80000	25	50	1586	4809
Pond	1500	4000	100	50		105
Swale	3400	25000	100		400	724

Note that these values are for example only, and the consultant that will re-open the Class EA would be required to develop prices that are current and local.

While all of these actions will be required prior to proceeding with development, not all of these action items are required at the same time, but rather can be addressed by the developer as part of the requirements of an Official Plan Amendment and/or Application for Plan of Subdivision to permit development of this land.

Town Action Items:

Determine if the site is constrained by the IPZ. The degree of constraint may govern water quality treatment requirements and allowable catchment boundaries.

Determine the downstream channel's capacity to receive a change in flow. The allowable release rate will be determined for the stormwater system to limit flows in the channel to be the lesser of the erosion threshold of the channel, and the pre-development peak flow rate within the channel.

A functional stormwater management plan is to be developed using the allowable release rates and any restrictions to discharge quality assigned by the IPZ. The plan will demonstrate the costs of the proposed system from the Dillon Report, together with the costs of an unconventional or LID approach to stormwater management. Grades will be established to ensure positive drainage and sufficient storage/infiltration is available. Land requirements for stormwater blocks and drainage easements will be determined. The developer may play a role in the development of this plan.

Developer Action Items:

The development boundary can be assumed to be the largest possible at this time, and any developer would be required to demonstrate what limit of development that the HIA and EIS supports. This will slightly oversize the infrastructure, which can then lead to the potential of higher densities if a significant area of 'adjacent land' is not available for development.

A conceptual stormwater management plan, using the most cost effective approach to SWM that meets the allowable release rates and quality targets, will be developed for the undeveloped area in support of the required Official Plan Amendment and/or Application for Plan of Subdivision. The conceptual plan will design crossings, rough lot grading, storage volumes and release rates for various events.

Other issues:

It was noted during this review that the conclusion of the need for a Domestic Water tower is likely the most appropriate solution to the problem of water supply and demand within the North of Seven development boundary. It is not clear that this is the most appropriate solution based on changing system conditions for the whole of Perth. We would recommend that the water network be analysed as a whole to consider all proposed development within Perth. This would be outside of the scope of the Environmental Assessment.

Yours very truly,
Jp2g Consultants Inc.
ENGINEERS ■ PLANNERS ■ PROJECT MANAGERS

Doug Nuttall, P.Eng.
Project Manager

Kevin Mooder, MCIP RPP
Project Planner

Appendix A - PSW

At the Environmental Assessment stage of planning, the Official Plans of both the County of Lanark and the Town of Perth, and the Conservation Authorities Act and associated regulations and policies, will apply in those areas adjacent to wetlands and riverine systems.

Section 5.5.1.6 of the County of Lanark Sustainable Communities Official Plan reads:

> *Development or site alteration within 120 metres of a designated wetland may be permitted, if it can be demonstrated that there will be no negative impacts on the wetland's natural features or ecological functions. An Environmental Impact Statement (EIS) will be required except for established agricultural uses. In accordance with provincial regulation, approval from the applicable conservation authority is required for all development and site alteration within 120 metres of a wetland designated in this Plan or any local Official Plan*

Section 8.6.4b.3 of the Town of Perth Official Plan reads:

> *Significant Wetlands and significant wildlife habitat are designed on Schedule "A", Lane Use Plan as part of the Environment Protection Area Designation with appropriate labeling to differentiate these areas from flood prone lands. For the purposes of this policy, adjacent lands to significant wetlands, habitat of endangered species and threatened species, and significant wildlife habitat include an area extending 120m (397 ft.) from the identified wetlands or habitats and may be shown on Schedule "A", Land Use Plan. In addition to satisfying Section 8.5.4 e., EIS any new development or site alternation proposed on adjacent lands shall also satisfy the land use policies of the underlying land use designation as shown on Schedule "A", Land Use Plan.*

The Conservation Authorities Act, and Ontario Regulation 174/06, provides the restrictions to development that are expected in the land that is adjacent to the Blueberry Marsh Provincially Significant Wetland. Specifically:

> 2. (1) Subject to section 3, no person shall undertake development or permit another person to undertake development in or on the areas within the jurisdiction of the Authority that are,
> (d) wetlands; or
> (e) other areas where development could interfere with the hydrologic function of a wetland, including areas within 120 metres of all provincially significant wetlands and wetlands greater than 2 hectares in size, and areas within 30 metres of wetlands less than 2 hectares in size. O. Reg. 174/06, s. 2 (1); O. Reg. 78/13, s. 1 (1, 2).
>
> Permission to develop
>
> 3. (1) The Authority may grant permission for development in or on the areas described in subsection 2 (1) if, in its opinion, the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development. O. Reg. 174/06, s. 3 (1).

In the absence of a more advanced policy for development within 120m of a PSW from the RVCA regulation policies, an Environmental Impact Statement is required to demonstrate that:

- The ecological function of the adjacent land has been evaluated
- The development would not produce a negative impact on the wetland or its ecological functions
- The development would not interfere with the hydrologic function of the wetland
- The control of flooding, erosion, pollution, and conservation of land will not be affected by the development.

The hydrologic function of a wetland relates specifically to the hydrologic cycle in and around a wetland, as illustrated in this figure from the U.S. Geological Survey Water-Supply Paper 2425 "National Water Summary on Wetland Resources":

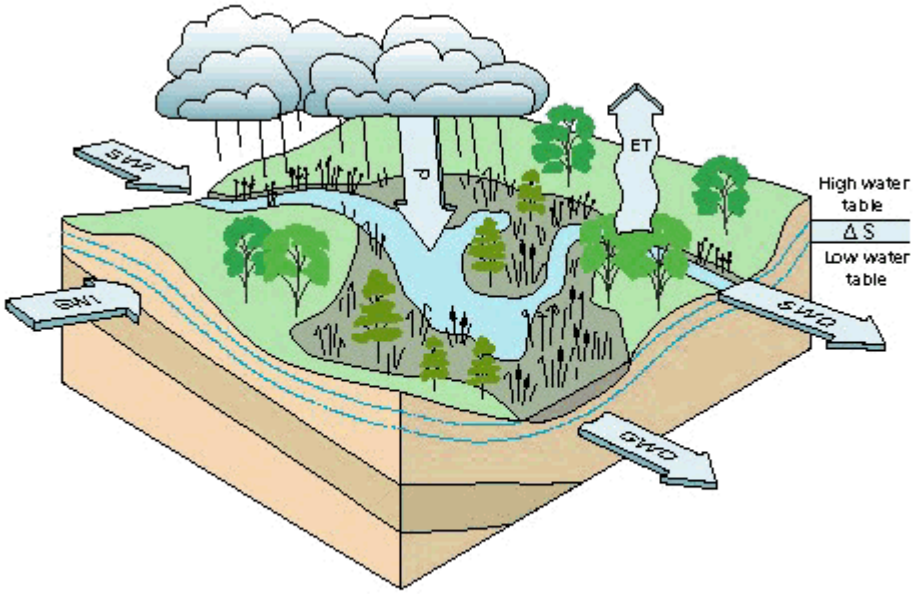

Figure 18. Components of the wetland water budget. (P + SWI + GWI = ET + SWO + GWO + ΔS, where P is precipitation, SWI is surface-water inflow, SWO is surface-water outflow, GWI is ground-water inflow, GWO is ground-water outflow, ET is evapotranspiration, and ΔS is change in storage.)

To confirm that there is no negative impact on the hydrologic function of a wetland, the following 3-step process may be used. The need to advance to the next step depends only on failing to satisfy the current step. If any step is satisfied, the hydrologic function of the wetland will have been demonstrated to not be negatively impacted.

1. There is no significant change in the landuse of the catchment of the watershed.
    - It has been shown that any more than a limited amount of urbanization within a catchment of a wetland will produce an observable impact on the wetland species. In 'How Much Habitat is Enough', 4% imperviousness was shown to not be expected to produce a measurable impact on the wetland species.
    - If there will be less than 4% imperviousness within the catchment of a wetland in a post-development condition, then negative impacts are not expected to be experienced on the wetland as a whole. Local impacts will have to be considered at discharges.
    - 4% imperviousness is approximately equal to estate residential development on 1 Ha. lots using private services.

2. There is no change in the quality or quantity of water that is entering or leaving the wetland by surface or groundwater.
    - Note that in the water budget, P, ET, and ΔS are not directly affected by development in the adjacent lands, and do not have to be assessed if all of SWI, GWI, SWO and GWO can be shown to be unchanged as a result of development, in both quantity and quality.
    - Note also that a significant change in the location of the inputs (eg, concentrations of flow to new outlets) has the potential to change these values for different parts of the wetland. Care should be made to ensure that the same water flow occurs to the same locations in the wetland.
    - Discussion with the local Conservation Authority will be required to establish the required level of quality treatment. 80% quality treatment for the 90%ile event would typically be considered sufficient.

3. There is no change in the storage of water or water chemistry within the wetland
    - If any of SWI, SWO, GWI or GWO change as a result of this development, it must be balanced against a different component of the hydrologic cycle, so it can be shown that ΔS does not change.
    - Any modelling would have to be done on a daily or monthly basis, and be compared to actual measured water levels.
    - The site would have to be discretised sufficiently to find all unique combinations of soil and land cover – site averaging will not provide sufficient confidence that the predicted daily results are meaningful.

The ecological function of a wetland and the adjacent lands to the wetland can be determined by doing a conventional EIS, including a SAR study. There will be a setback from the wetland that is somewhat below the local height of land and within the 120m adjacent land to the PSW where it will be able to be shown that the development will not cause a negative impact on the wetland or its ecological functions.

Appendix B - ANSI

At the Environmental Assessment stage of planning, the Official Plan of both the County of Lanark and the Town of Perth apply policies in those areas adjacent to Areas of Natural and Scientific Interest (ANSI).

Section 5.5.3.2 of the County of Lanark Sustainable Communities Official Plan reads:

> *Development may be permitted in significant areas of natural and scientific interest (ANSIs), or on adjacent lands within 120 meters, only if it has been demonstrated through an Environmental Impact Statement (EIS) that there will be no negative impacts on the natural features or on the ecological functions for which the area is identified.*

The Town of Perth does not specifically speak to the Blueberry Marsh ANSI, but does provide guidance in Section 8.6.4.

> *These features are intended to be protected over the long term as a legacy to future generations. This intent shall be given due consideration in the development, redevelopment and alternation of land within and adjacent to identified areas. The delineation of these areas may be determined or refined through preparation of a detailed Environmental Impact Study (EIS).*

And it continues:

> *From time-to-time, other natural heritage features and areas may be identified which are not identified on the Schedules to this Plan. Such features will nonetheless be subject to the policies of this Section.*

As this ANSI is not specifically identified in the Town Official Plan Schedules, the feature and the surrounding land are subject to the policy, and require an EIS prior to identifying development potential. The distance from the ANSI to be considered 'adjacent land' is not specified. Currently the County is considering an Official Plan Amendment which applies different distances for 'adjacent lands' to different classifications of ANSI.

Life Science – 120m setback
Earth Science – 50m setback
Candidate – EIS required at request of the municipality

The details of this EIS are provided in the Town of Perth Official Plan, section 8.6.4.h.3, which is reproduced below:

3. The components of the EIS shall be tailored to the scale of development and may range from a simplified assessment (scoped assessment) to a full site assessment. For example, a single detached dwelling may only require a scoped assessment while a subdivision, multiple unit residential complex, major commercial or industrial development, golf course etc. will require a full site assessment. Council may consult with the Conservation Authority in determining information requirements and the type and content of an EIS. The following is intended to provide a guideline on the potential scope of an EIS.

    i. Providing background information for the proposed development that describes the planning aspects (i.e., description/purpose of proposal, draft site and grading/drainage plan, features of full build-out), and the existing environmental conditions (i.e., surface and subsurface soils, local landform types, catchment boundaries of surface water features, infiltration capabilities of the site).

    ii. Identifying and describing the natural heritage feature(s) and area(s) affected by the development proposal (i.e., mapping of the feature, describing the significance, habitat requirements, relationship between features, linkages to off-site features, methodology used for field studies).

iii. Analyzing the ecological functions of the feature(s) affected by the development proposal on the site and adjacent property(ies) including: examination of the features and functions present and their ecological sensitivity; explanation of the methods used to determine the effects of the proposed development; information to demonstrate that proposed mitigation measures intended to protect key features or functions are measurable and outcomes are predictable or manageable; assessment of habitat changes; identification of indicator, keystone or flagship species that could be considered in assessing habitat conditions; identification of features or functions, including existing or new movement linkages or habitat corridors that contribute significantly to the integrity or function of the natural heritage system).

iv. Identifying the diversity and connectivity that supports the natural heritage system by recording existing habitats and lists of existing species, and evaluating aquatic, riparian and terrestrial linkages where they exist or can be enhanced, particularly through enabling natural succession processes *(based on S.R. Aug 2013 re MMAH comments) and S.R. Mar 2014*

v. Outlining potential impacts of the development proposal on natural heritage features and their ecological functions and potential mitigation measures.

vi. Assessing the potential negative impacts both direct and indirect in quantitative and qualitative terms.

vii. Identifying mitigation measures and residual impacts with a preference at avoiding impacts. Residual impacts must be assessed as to whether they are negative impacts, their significance, severity and longevity.

viii. Identifying monitoring needs, a monitoring program and a contingency plan in the event that the results indicate that there are negative impacts.

ix. Recommendations resulting from the assessment that will assist the Town in making a decision on whether the application should be approved modified, refused and what measures may or should be required for mitigation and monitoring.

4. Proponents are expected to utilize the *Natural Heritage Reference Manual, MNR, Second Edition, March 2010* (and any subsequent editions) in undertaking the preparation of an EIS. An EIS must be undertaken by a qualified professional. The cost of an EIS and any peer review shall be borne by the proponent of the development. Council may consult with a public authority, such as the Conservation Authority, to assist with the technical review and findings of an EIS or may engage a qualified, independent professional to undertake a peer review.

August 20, 2019
Ref. No. 66574

To: **Grant Machan**
Director of Environmental Services
Corporation of the Town of Perth
80 Gore Street East
Perth, ON, K7H 1H9

From: **Chris Denich, M.Sc., P.Eng., Meaghan Dustin, E.I.T., Aquafor Beech Ltd.**

Re: **North of 7 Master Plan, Functional Stormwater Management Plan (December 18, 2018) – Peer Review**

1 Introduction

Aquafor Beech was retained by the Town of Perth to conduct a peer review of the North of 7 Master Plan, Functional Stormwater Management Plan (December 18, 2018). Douglas Nuttall, P.Eng., Senior Civil Engineer, Jp2g Consultants Inc. was advised on the peer review through telephone communication by Aquafor Beech on April 25, 2019 prior to undertaking this review.

2 Project Information

Aquafor Beech staff have reviewed the documents as prepared by Jp2g Consultants for the Functional Stormwater Management Plan for the North of 7 study, as provided by Grant Machan, Director of Environmental Services for the Town of Perth and Douglas Nuttall, P.Eng., Senior Civil Engineer, Jp2g Consultants Inc.

The Project includes stormwater management associated with an 85ha proposed development, consisting of a storage-based system consistent with LID principles, using low-slope swales with under-drainage capable of providing quantity and quality treatment. It is understood that the subject Project was completed as a review to the Environmental Assessment (EA) prepared by Dillon for this site in 2013 to determine if consideration of alternative, potentially more economical, stormwater management solutions that would eliminate the requirements for a stormwater lift station and therefore make re-opening the EA feasible.

The subject of this peer review includes the proposed LID solutions and stormwater management approaches. Note: the 2013 Environmental Assessment (EA) prepared by Dillon was not reviewed as part of this assignment.

Aquafor Beech Limited has completed the review of the provided resources and prepared the following memo for submission to the Town of Perth which details the results of our

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review of the proposed LID and stormwater management approach for the North of 7 Study.

3 List of Documents Reviewed

The following documents have been reviewed as part of this assignment:

1. North of 7 Master Plan Functional Stormwater Management Plan, Jp2g, December 18, 2018
2. No7 Storm Design (inc ex Meadowview) (version2) Excel Spreadsheet Model (email transmission)
3. No7 Storm Design (inc ex Meadowview) (version2a) Excel Spreadsheet Model (email transmission)

4 General Comments

Aquafor Beech supports the comprehensive use of LID techniques and are pleased with the overall concept of LID approach being considered for the subject area. The successful use of a similar approaches in concept was employed in the Westminster Woods development in the City of Guelph, Ontario and has been in operation for 10+ years (see **Appendix A**).

5 Functional Stormwater Management Plan and Excel Spreadsheet Models

In regards to the review of the Functional Stormwater Management Plan and associated excel models the following has been identified:

1. The infiltration rate identified in Table 3: Detailed Design Criteria (Page 4 of 6) for the LID analysis was assumed to be 50mm/hr. It ic unclear if this rate is assumed for the "blast-rock and engineered fill" noted in Section 3.2 or for the native soils per the Appendix B – Letter dated Oct 26, 2016, Figure 2. It is also unclear in what strata the LIDs would be founded. Geotechnical or hydrogeological studies were not provided in support of the assumed 50mm/hr infiltration rate. Based on the available existing Soil Map of Lanark County (Soil Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, 1966) the soil in this area is mainly clay loam with some sandy loam and is consistent with Section 3.2 of the report. Clay loam and sandy loam typically have infiltration rates in the range of 5-10mm/hr and 20-30mm/hr.

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Therefore, it is recommended that:

a) To accurately model the existing and proposed conditions of the study area, infiltration testing should be completed as part of a preliminary geotechnical investigation. Borehole permeameter, Guelph permeameter, Double-ring infiltrometer or other test as outlined in the Low Impact Development Stormwater Management Planning and Design Guide (LIDSWM-PDG) (STEP, wiki format - wiki.sustainabletechnologies.ca.) be conducted to confirm assumed infiltration rate;
or

b) The assumed infiltration rate should be reduced to reflect the appropriate in-situ conditions based on published literature.

In addition, a safety factor (minimum of 2.5) should be applied to the infiltration rate. If more permeable "blast-rock and engineered fill" as noted in Section 3.2 is placed above the less permeable native soils, the safety factor should be increased to account for a stratified soil condition and the effect of the less permeable native soils acting as a limiting layer, as described within the LIDSWM-PDG Wiki.

The LIDSWM-PDG Wiki is accessible here: https://wiki.sustainabletechnologies.ca/wiki/Design_infiltration_rate#Safety_correction

2. It is recommended that the design criteria targets be reconfirmed based on the revised infiltration rate, including:
   - Storage and/or infiltration of the 90th percentile rainfall event to achieve 80% or better quality treatment;
   - All runoff from the 1:2 year event can infiltrate within the clearstone trench; and,
   - Peak flow rates for 1:2 to 1:100-year events are not greater than the pre-development conditions.

3. The 90th percentile rainfall event identified Table 3: Detailed Design Criteria (Page 4 of 6) is stated as 19.3mm of rainfall. Per the MECP Low Impact Development (LID) Stormwater Management Guidance Manual (2018 Draft) the 90th percentile

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for the Town of Perth and surrounding area is 27mm. It is recommended that the ability to achieve the stated water quality criteria be revaluated and confirmed using revised infiltration rates and groundwater conditions as required. In addition the proposed LID must comply with Policy SEW-10-LB-PI-MC, that "new stormwater management facility be built to Enhanced Level Protection Standards as described in the Stormwater Management Planning and Design Manual, MOECC 2003"

4. Groundwater monitoring has not been completed at this site and no indication of groundwater level has been provided. It has been noted in the report that 'a high groundwater elevation is expected' and the reviewed soil map of the area also indicates high groundwater in the general area. High groundwater and/or a lack of separation from the invert of the LID facilities (recommended min. 1m separation) can prevent infiltration and significantly reduce the effectiveness of the proposed LIDs.

   Groundwater monitoring should be undertaken to ensure a recommended vertical separation of 1m between the invert of the facility and the seasonally high groundwater elevation exists.

   a. If the 1m offset cannot be accommodated a hydrogeological and/or groundwater mounding analysis is recommended.
   b. The duration that the groundwater elevations is at or above the proposed facility invert should be confirmed.
   c. An assessment of the seasonal groundwater effects on the proposed infiltration facility, specifically on the storage and infiltration losses should be completed.
   d. Based on a) to c) above, confirm if the proposed facility in its current configuration and depth is appropriate for this site or if design modifications are required.

5. Modelling

   a) The spreadsheet models as provided by Jp2g Consultants Inc. represent the general LID facility design and functionality, however key parameters

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(infiltration rate, 90th percentile event etc.) are based on the aforementioned assumptions. It recommended that the modelling be revised based on the above noted recommendations and the functionality be reassessed.

b) In addition, it is recommended that hydrologic and hydraulic modelling be completed using a software that has been designed to represent LID measures appropriately, such as PCSWMM, EPA SWMM or the LID Treatment Train Tool (LID TT Tool). While PCSWMM is a proprietary product that must be purchased, EPASWMM and the LID TTT Tool are free user software packages which run the SWMM engine and are available from:
   - EPASWMM: https://www.epa.gov/water-research/storm-water-management-model-swmm
   - LID TTT Tool: https://sustainabletechnologies.ca/low-impact-development-treatment-train-tool/

Models which use the SWMM engine are a dynamic rainfall-runoff simulation models that can be used for single event or long-term (continuous) simulations. SWMM tracks the quantity of runoff generated within each catchment, and the flow rate and depth in each drainage feature during a simulation period comprised of multiple time steps. The aforementioned models also have dedicated LID Control modules in the runoff model that streamlines the LID setup in the model and incorporates LID into the overall design as well as runoff volume, flow rate, and load reduction. SWMM also permits the use of site-specific soil parameters for use in the determination of infiltration volumes (see previous comments).

6. An analysis has not been completed to determine the influence of the Blueberry Creek 100-year floodplain and/or backwater effect on the surface conveyance of the low gradient (0.1% slope) swales/infiltration trenches. Since the swales/infiltration trenches outlet to this Creek (per Figure 2), it is recommended that a hydraulic analysis (SWMM or HEC-RAS platforms) be completed to determine/confirm the following:
   - The impact of the 100-year storm on the proposed LID features; and,

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- Any potential backwater effect from Blueberry Creek on the proposed features.

7. Based on the 100-year event analysis it is assumed that the surface conveyance of the swales/infiltration trenches will form a component of the major system (Jp2g Consultants Inc. to confirm). As such, a minimum 0.3m freeboard should be provided. Table D-5: SSA Model Output for Clear Stone Trenches (100yr event) demonstrates this freeboard is not achieved in all segments. It is recommended that the infiltration trenches be increased in size and/or depth to achieve a minimum freeboard in all locations.

8. Additional detail is required in regards to sediment a management, specifically pre-treatment methods, sediment collection and removal.

Additional Comments:

9. The incorporation of LID measures in the rear of private property is not a new concept, however it requires planning and coordination to ensure the measures are appropriately maintained. The Westminster Woods subdivision in Guelph, Ontario, is an existing subdivision with a linear 100-year 'Greenway' infiltration trenches system located in the rear of the mixed-use development (primarily single family residential). The Greenways are managed as condominium elements and are maintained by the condominium committee/board. Each homeowner pays a fee towards the maintenance of the stormwater components, enhanced landscaping and other features. This has been outlined in Facilitating Maintenance of Stormwater Devices on Communally Owned Land (See **Appendix A**). It is recommended that a maintenance plan for the proposed stormwater management system be to be examined as a part of the evaluation of the LID alternative.

10. Approvals required through the MECP and RVCA will be required for the proposed stormwater management (swales/infiltration trenches) as there is proposed development within the 100-year floodplain.

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6 Conclusions:

Following the review of the provided documentation the following conclusions are put forward for consideration by the Town of Perth.

1. A geotechnical investigation of the site or inclusion of suitable background information, which is recommended to including infiltration testing and groundwater monitoring are recommended to ensure infiltration feasibility on-site. Specific areas of inquiry include:
    i. If the 1m offset cannot be accommodated a hydrogeological and/or groundwater mounding analysis is recommended.
    ii. Determination of the duration that the groundwater elevations is at or above the proposed facility invert.
    iii. An assessment of the seasonal groundwater effects on the proposed infiltration facility, specifically on the storage and infiltration losses.
    iv. Based on a) to c) above, determination if the proposed facility in its current configuration and depth is appropriate for this site or if design modifications are required.

2. Additional hydrologic and hydraulic modelling is recommended using a software that is able to represent LID measures appropriately, such as PCSWMM, EPASWMM or the LID TTT Tool. This modelling should incorporate the results of the geotechnical investigation.

3. Additional hydraulic modelling is recommended to examine possible backwater effects from Blueberry Creek, as well as flood impacts from the 100-year storm on the proposed infrastructure.

4. The size of the swales/infiltration trenches should be revised based on:
    i. the results of the geotechnical investigation;
    ii. The updated modelling hydrologic and hydraulic model; and,
    iii. the required freeboard (minimum 0.3m).

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Based on this review, further analysis of this alternative is recommended to determine whether this is a feasible alternative to the existing EA document.

Sincerely,
AQUAFOR BEECH LIMITED

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Appendix A: Facilitating Maintenance of Stormwater Devices on Communally Owned Land

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FACILITATING MAINTENANCE OF STORMWATER DEVICES ON COMMUNALLY OWNED LAND

J. Dixon, M. van Roon, Department of Planning and Centre for Urban Ecosystem Sustainability, University of Auckland; A. Dupuis, School of Social and Cultural Studies, Massey University, Albany, Auckland.

Paper presented at (and in the Proceedings of) the New Zealand Water and Waste Association, 4th South Pacific Conference on Stormwater and Aquatic Resource Protection, Carlton Hotel, Auckland, New Zealand, 4 – 6 May, 2005.

ABSTRACT

The location of low impact stormwater features on individually or communally-owned private land is regarded as a potential solution to reducing ecological and economic costs of public infrastructure. Currently in New Zealand, bodies corporate, created under the Unit Titles Act 1972, are usually responsible for management of stormwater features on communally-owned property. However, alternative models are increasingly being put in place by developers for freehold sites where provision needs to be made for management of common property.

This paper explores the various models for management of communally-owned property in three countries, New Zealand, Canada and Australia, where stormwater features are being managed by owners and residents. It compares the relevant legislation across the three jurisdictions and reviews key features of the entities that can be established to manage communally-owned properties. Four types of New Zealand entities, namely bodies corporate, incorporated societies, residents' associations and companies are then considered in more detail. The paper draws on interviews with New Zealand property lawyers, developers and council staff who have relevant experience in the establishment and operation of these entities. Preliminary findings are presented and some critical issues raised.

KEYWORDS

Multi unit housing, incorporated societies, bodies corporate, joint venture, stormwater, low impact design

ACRONYMS

ICS Incorporated Societies Act 1908
UTA Unit Titles Act 1972

1 INTRODUCTION

New Zealand district and city councils express concern about the maintenance, practicality and liabilities of low impact stormwater devices and corridors located on individually or communally-owned private land. These concerns lead some councils to avoid a 'low impact' approach to the design and construction of stormwater systems as this approach requires source control of stormwater on these private landholdings. At the same time however, councils are burdened by the necessary construction and maintenance of required stormwater systems on public land. The latter could be substantially reduced by source control.

In Auckland, particularly, there has been a rapid increase in the extent of multi-unit housing in the last decade. Most multi-unit housing comes under a form of title called strata titles, created under the Unit Titles Act (UTA) 1972. With a strata title bodies corporate become the governing vehicle to deal with the administration and management of communally-owned property. Bodies corporate are thus usually responsible for the management of stormwater devices, should these be located on communally-owned property. However, for freehold sites, the body corporate model does not apply. Thus developers constructing multi-unit and single lot dwellings in gated or non-gated developments which includes land in freehold title need to find alternative management mechanisms for new owners. In Ontario, Canada similar stormwater systems, on communally owned private

land, are managed under the Condominium Act 1998 while in Victoria, Australia, bodies corporate arrangements are used, similar to New Zealand.

Preliminary research indicates that these newer alternative mechanisms in New Zealand include incorporated societies, residents' associations and companies. Recently the operation of bodies corporate has undergone particular scrutiny and criticism leading to a review of the Unit Titles Act 1972 that is now underway (Dupuis et al., 2002; Department of Building and Housing, 2004; Glaister Ennor and Auckland Regional Council, 2003) while in Australia the Victorian State Government is also conducting a review of provisions in the Subdivision Act 1988 for bodies corporate (Consumer Affairs Victoria, 2004). However, the alternative mechanisms now being established in New Zealand are largely untested.

This paper reports on the variety of mechanisms used to manage communally-owned housing where stormwater devices are located. As a basis for our exploration, we look at five sites, three in Auckland, New Zealand, one in Guelph, Canada, and the fifth in Melbourne, Australia, and highlight commonalities and differences with respect to the different types of entities put in place to manage stormwater devices. We then look in more detail at four entities being used in New Zealand to manage communally-owned property that may include requirements to manage stormwater devices. While there is a significant amount of information regarding the operations of bodies corporate, there is little information readily available in respect of incorporated societies, residents' associations and companies. We report on interviews undertaken in the preliminary stages of this research with several property lawyers, developers, professional advisors and council staff. We conclude by raising issues that need to be considered by policy makers and other stakeholders as these private arrangements become more commonplace.

2 DESCRIPTION OF SITES

In this section of the paper, we describe fives sites containing multi-unit and stand alone housing where stormwater devices are being managed by the owners and residents. We outline the arrangements on these sites that are either proposed or are in place for managing communally-owned property that include provisions for managing stormwater devices. This section provides a basis for subsequent discussion on the types of arrangements being put in place.

2.1 REGIS PARK, FLAT BUSH, MANUKAU CITY

Regis Park is a low-density residential housing estate under construction in headwater subcatchments of Otara Stream in Flat Bush, Manukau City, New Zealand[1]. The designers and developers of this estate are intent on demonstrating a unique development style that includes many low impact design features and follows sound 'integrated catchment management' principles (van Roon, in review). The pre-construction site is steep and vegetated in pastoral grasses with exotic trees in stream gullies.

The design (Figure 1) includes the clustering of 66 houses in order to free open space for indigenous re-vegetation, source control of stormwater within rain gardens (on every lot) and wetlands, community sewage treatment and collection of rainwater for domestic supply. Sewage effluent will be discharged to vegetated areas on-site. Open space areas and communal facilities will be owned and managed jointly by residents. Of a total land area of 34 ha, 19.5 ha will be re-vegetated, mainly within ecological corridors, to aid evapotranspiration of stormwater, plus indigenous biodiversity and landscape enhancement (van Roon, in review).

Another design objective aimed at improving both ecological and economic sustainability has been earthworks minimisation and the exclusion of steep lands from the area developed. During the design of Regis Park difficulties were experienced with the presence of pre-existing road patterns delineated on cadastral maps. The council gave exemptions to road-gradient restrictions so that earthworks could be minimised (Scott, pers. comm., 2004). Road patterns are typically intensified during the conversion of land from rural to rural-residential. Therefore, the application of low impact principles at this stage may avoid the above difficulties.

[1] The Auckland metropolitan region comprises four cities; Auckland, Manukau, North Shore and Waitakere

Currently the proposed structure for the management of the commonly-owned land is to be an Incorporated Society which would include a Residents' Society responsible for the costs and operation of the stormwater management system. It is possible that a management company, similar to those administering bodies corporate, could be employed to assist with management of the system. However, it is unlikely that the current body corporate management industry has the necessary expertise to manage the low impact design systems being put in place. As yet, no rules have been drafted up (Mason, pers. comm., 2005). It is not expected that housing construction will begin until spring 2005.

Figure 1 Layout of Regis Park, Flat Bush (plan courtesy of Denis Scott)

2.2 GOODLAND COUNTRY ESTATE, RODNEY DISTRICT

The Goodland Country Estate comprises 63 individual house lots, located on 95.6 hectares (Figure 2). Most of the property is farmed as an operational unit. Along with the farm, particular features include the management of communal facilities (tennis court, petanque court, community centre, barbeque area, children's playground), and a community wastewater facility. Stormwater features include swales, riparian planting, detention tanks and wetlands. The development is an example of where an alternative to unit titles and a body corporate has been established in a rural setting. The Estate comprises 63 individual house lots (fee simple titles) that are individually owned. Covenants have been placed on each title that require each owner to become and remain a member of the Goodland Country Estate Joint Venture (Joint Venture Agreement, 2004). The farm property of around 70 hectares is owned by the Joint Venture comprising all the owners of the individual lots.

Figure 2 Goodland Country Estate (Plan courtesy of Goodland Group)

The Property of the Joint Venture is held in trust by the Goodland Country Estate Trustee Company Ltd. It is a bare trustee company only.[2] It is not the manager of the Joint Venture, it has no financial dealings of its own and only exists to hold property for the Joint Venture members as tenants in common. This trustee company is controlled by its share holders who are the five elected members of the Joint Venture's management committee.

[2] A holding company for property that does not trade or have financial activities in its own right

The Joint Venture meets the costs of maintaining the farm property, owns and administers the community wastewater system and is entitled to farm income from the lease of the farm property. Profit and losses are shared on a proportional basis by the members of the Joint Venture (lot owners) The actual management of the Estate is carried out by Goodland Country Estate Management Ltd a company incorporated to manage the Joint Venture and to separately administer the farm property and the community waste water system. There is also a separate agreement between Goodland Estate Trustee Company as trustee for the Joint Venture and the Management Company employed to manage the property and designated common areas of the development (Management Agreement, 2004).

There is a set of rules in place to manage the community wastewater facility that requires compliance by each member/owner with the wastewater management plan (Rules for the Use of the Community Wastewater Facility). Rules require owners, individually and collectively, to maintain, repair and replace wastewater equipment, including the desludging of any interceptor tank if required. The rules make it clear that maintenance and repair is the financial responsibility of owners. There are no specific rules referring to maintenance of swales. The Joint Venture agreement sets out rules governing administration, setting of fees, meeting procedures, powers of the Joint Venture, roles of the manager and wastewater manager. There is, in addition, the provision during the development phase for a Principal Member (Developer) as part of the Joint Venture. The Principal Member in effect has total control under the Agreement's provisions until the project is finished and the developer no longer owns any land in the project which could be long term. This prospect is also common within bodies corporate.

2.3 POINT RIDGE, ALBANY, NORTH SHORE CITY

This development is of interest in that it is most likely New Zealand's largest, purpose-built gated community to be established to date. The developer, Urban Developments Ltd, has resource consent to construct 186 units on a six hectare site. The management of communally-owned property will be undertaken by several bodies corporate and a residents' committee with a resident, on-site manager. While only a draft set of rules have been written (Body Corporate Rules, BC No 346275), the final set of rules is expected shortly, with the granting of titles for the first stage of the development. The first group of residents will be moving in shortly. It is expected that several bodies corporate will be established as the development is being constructed in several stages. Thus owners and residents will take up occupation over a period of several years.

Photo 1: Housing Construction at Point Ridge, North Shore (photo courtesy of Penny Lysnar)

The current plan is for the on-site manager to live in one of the stage one units, and be responsible for the renting out of any units in the development, as well as running a local shop and facilitating the body corporate. A staff member on site suggested that facilitating the body corporate, a residents' committee and letting of apartments in the first stage of the development would be a matter of trial and error. The 'residents committee' will be used as an umbrella group to encompass the members of the different bodies corporate once established as well as those residents who live in the complex but who rent rather than own.

The development plan for Point Ridge approved by North Shore City as part of the resource consent process includes provision for several swales, rain gardens, underground stormwater tanks and a stormwater pond. However, this plan is being modified as development (Photo 1) of the site proceeds (Nagels, pers. comm., 2005). The draft rules for the body corporate require compliance with the specific drainage requirements of North Shore City Council as follows (Body Corporate Rules, BC No 346275, 3):

2.2 (e) Comply with the specific drainage requirements of the North Shore City Council (NSCC) as to :

- Swales and raingarden areas – purpose, maintenance (keep weed free and allow grasses to grow to a reasonable height of 150mm). Keep foot traffic and motor vehicles off swales and landscaped areas.

- Drainage system – the network of drains are common private drains and the responsibility of the Body Corporate.

- Counterfort drains – maintenance is the responsibility of the Body Corporate. Inspection points must be kept accessible.

- Permeable areas – grassed lawns, landscaping – these areas are to be kept permeable to allow rainwater infiltration and maintain coolness. Planting with native plants is recommended (Photo 2).

- Raintanks – purpose, maintenance (Photo 2).

2.2 (f) Provide the NSCC with the method of registration of drainage maintenance needs. This registration is to state that the council has the right to inspect, and the costs of these inspections are to be met by the Body Corporate.

Photo 2 Example of Permeable Areas and a Rain Tank, Glenfield (photo courtesy of Peter Nagels)

2.4 WESTMINSTER WOODS, CITY OF GUELPH, CANADA

Westminster Woods comprises a series of subdivisions providing for up to 1378 residential dwelling units, both townhouse and standalone housing (Photo 3). It is located on the urban fringes of the City of Guelph. It is likely to cater for between 3500 to 5500 people. The development is being phased in over a number of years and the developers anticipate that the demand for a particular lot size will change over time.

A stormwater management plan provides at source filtration (rear yard infiltration trenches), water quality treatment (oil/grit separators, sediment forebays), water quantity control up to the 100 year storm, and enhanced infiltration. There are five main open spaces that function to manage and treat 'stormwater'. These spaces (Photo 4) are also utilized for public trails and enhanced landscape features (Photo 4). The project utilizes a system of greenways and infiltration galleries. The greenways have no direct outlet to a watercourse but rather collect rainwater and are constructed to encourage infiltration back into the ground. Likewise, infiltration galleries are constructed at the rear of most lots which promote infiltration rather than carry the water to some

receiving watercourse. Prior to entering the infiltration galleries, stormwater is pre-treated through a 'stormceptor" manhole. This device separates oil and grit sediments from the water before discharge. There is no treatment of water from the individual lots as this water would be deemed to be clean. The City of Guelph has zoning regulations on the affected lots which prohibit structures over the galleries. The greenways are landscaped to further encourage uptake of water.

Under previous Condominium legislation there was no effective way of involving homeowners in the administration, maintenance and repair of features such as paving, irrigation systems and stormwater systems. Hence some municipalities have been reluctant to approve developments with upgraded features (Robson, undated). The Condominium Act 1998 provides for four types of condominiums, including standard (which includes the unit itself) and 'common elements' (which includes everything beyond the unit boundaries). Owners of parcels of land share control and ownership of a piece of land that form the 'common elements' (that is, those external features owned by all unit owners) in what is termed the 'common elements condominium'. Each owner shares an undivided percentage ownership interest in the common elements as a tenant in common with all other unit owners (Anon., 2003). Unlike the standard condominium, a common elements condominium does not comprise any units.

Photo 4 Greenway with swales on Westminster Woods Site

As development of Westminister Woods will take place over several years, there will be a number of plans of subdivision. One 'common elements condominium' will be registered with each plan of subdivision. The developer has utilized the provisions of the Act so that each 'common elements condominium' will create a corporation that will own the features and collect shares of costs from owners. The corporation will be managed by a 'mutual use committee' that has powers of decision-making and representation from each of the condominiums, each of whom has a number of votes equal to the number of homes. The standard and common elements condominiums will share control of City owned lands for the most part pursuant to a license agreement with the City (Artinger, 2004). This will ensure that each homeowner pays a fee towards the maintenance of the stormwater components, enhanced landscaping and other features. While there are other management models nearby, such as Pineridge, where the City maintains the stormwater facilities, the development company advised that they did not have the confidence that the City would look after the greenways to the standard they would expect (Artinger, 2004). They also advised that sales rates to date suggested that the concept is acceptable to the public and the residents are committed to it.

2.5 INKERMAN OASIS DEVELOPMENT, CITY OF PORT PHILLIP, AUSTRALIA

Inkerman Oasis development is a housing re-development of the former City of St Kilda Municipal depot site in Melbourne. It comprises 237 units between three to five levels in six buildings and incorporates a range of ecologically sustainable design features **(**Figure 4). Half of the development is completed, that is three out of six buildings. It is a demonstration project for developers and is a joint venture between the City of Port Phillip and a private developer, Inkerman Developments Pty. Ltd (City of Port Phillip, 2003). It has received several awards in recognition of its environmentally sustainable design. Stormwater and greywater is treated on the site and recycled for toilet flushing and garden irrigation. Much of the system is underground and thus not visible, except for a view through a transparent observation dome (Photo 5). The design of the wetland has been modified to enable integration into a confined courtyard.

Key design features include:

- Hair and lint traps located in the greywater diversion pit
- Activated-sludge (aeration) tank
- Vertical and horizontal sub-surface flows wetlands
- Sand filter
- Membrane micro filtration and UV treatment system

In the Inkerman Oasis development, a body corporate will manage the communally-owned property. The body corporate owns the treatment plant and is responsible for on-going maintenance and servicing of the integrated water management scheme. However, for the first six years, South East Water has agreed to maintain the treatment plant. In turn, the body corporate will make an annual lump sum payment for their services. The body corporate could not readily close down the treatment plant if for any reason it was dissatisfied with performance or cost.

> *There is a section 173 Agreement under the Planning and Environment Act 1987 (Victoria) with the body corporate protecting the operation and access to the system and another with the developer, Inkerman Developments Pty. Ltd. setting out project deliverables including the system plus a planning permit referring to the system. So it is very well locked in. As the central Environmentally Sustainable Design feature, Council will not allow the Body Corporate to just revert to conventional mains water and sewer (*Spivak, pers. comm., 2005*).*

Figure 4 Layout of Inkerman Oasis Development (William Boag Architects in City of Port Phillip, 2003)

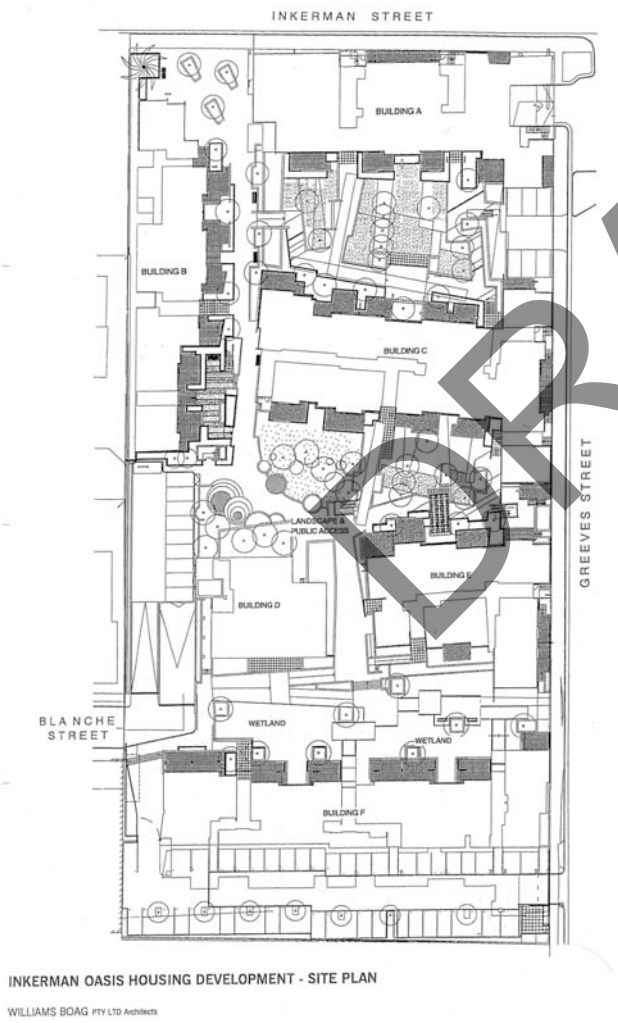

Photo 5 Transparent Greywater System Observation Dome on Inkerman Site

3 LEGAL FRAMEWORKS

Urban growth and expansion in many countries is leading to the provision of new housing forms, which involve ownership and management of collectively-owned property. While some of these arrangements have been in place for many years, for example, leasehold in England (Blandy et al., 2005), others are more recent, such as the

establishment of purpose-built gated or non-gated communities with private governance structures to manage commonly-owned property. The types of residential developments which contain some portion of commonly-owned property are quite varied. They may comprise high rise apartments in inner-cities or a mix of stand alone housing and intensive housing in suburban areas. In addition, there is a growing trend in countries such as New Zealand and Australia where rural-residential and/or coastal properties are being established with housing clustered on suburban size residential sites. Owners own a share of adjacent open land used for farming or recreation purposes, such as golf courses and canal developments.

A comparison of the three jurisdictions in which the five sites are located (Table 1) shows that each has a similar approach to establishing private governance of communally-owned property. A statute provides the broad framework, sometimes with schedules setting out standard rules and separate regulations covering governance issues in more detail. Within these legal frameworks, private entities are established by developers with a set of rules, usually managed by committees or boards of owners. There is provision for the setting of additional rules, although changing rules can be difficult without unanimous or near unanimous support of owners. The reason for this is that changing rules may alter the property rights of individual owners who do not support proposed rule changes. Common features covered in the legislation or regulations usually include: how the entity is to be managed; structures for decision-making by the owners, including provisions for meetings; the role and obligations of the board or committee administering the development; making and changing rules; resolving disputes; enforcement; requirements for maintenance; and obligations for financial reporting.

What is also apparent in all three jurisdictions is that the development of new forms of communal ownership of property and management of related features, such as stormwater management systems, is considerably ahead of what has been envisaged by legislation. Reviews of relevant legislation pertaining to the private management of housing have been or are underway in a number of countries as the need for greater consumer protection and clarity of the roles and obligations of various stakeholder groups becomes apparent (Blandy, Dixon and Dupuis et al., 2005; Consumer Affairs Victoria, 2004; Department of Building and Housing, 2004; Ministry for Consumer and Business Services, 2005).

In New Zealand the Unit Titles Act 1972 is being reviewed for the first time by government, following pressure from the Auckland Regional Council (Glaistor Ennor and Auckland Regional Council, 2003) and other groups. While the number of bodies corporate is considerably fewer than Australia, it is estimated that by 2050 in Auckland there is likely to be 500,000 people living in unit titled property (Waghorn, 2004). Commentators have observed that wholesale problems with bodies corporate in the Auckland region could deter potential buyers of multi-unit housing thereby undermining the region's growth strategy of which intensification forms a critical element (Dixon and Dupuis, 2003). The government acknowledges that the Act has major deficiencies (Department of Building and Housing, 2004, 4). A discussion paper has been released by the Department of Building and Housing which addresses the three broad areas of technical and legal aspects of unit titles, bodies corporate, and other forms of shared ownership such as cross lease and flat owning companies (Department of Building and Housing, 2004). The review is not considering alternatives to bodies corporate that are now being used or put in place to manage communally-owned property which include freehold title.

The review being undertaken by the Victorian State Government in Australia is intended to improve the effectiveness of the current regulatory system, provide for secure and prudent management of body corporate funds, and improve mechanisms for dispute resolution (Consumer Affairs Victoria, 2004, 1). Particular proposals canvassed include provision of education and advice, together with improving the means for dispute resolution, financial reporting, professional standards for body corporate managers and disclosure requirements for developers for 'off the plan' sales. Underpinning the review are public policy objectives intended to balance the private and public interest, promote sustainable communities, and provide effective and practical solutions to promote self governance that are flexible and not overly prescriptive (Consumer Affairs Victoria, 2004, 2).

In Ontario the Condominium Act 1998 replaced the 1967 Act that was recognized as no longer meeting present day needs (Ministry of Consumer and Business Services, 2005). The purpose of the new Act was to improve the quality of information disclosed to purchasers, clarify balance of rights and responsibilities within condominium corporations, provide increased protection for consumer investments, and allow new kinds of development on leased land, vacant land and common element condominiums. There were 6000 condominium corporations, with some 500,000 units at the time the legislation was enacted (Ministry of Consumer and Business Services, 2005).

Table 1 compares a selection of some of the common features in the three jurisdictions. What is readily apparent is that the New Zealand Unit Titles Act is deficient in the lack of provision for dispute resolution, requires

matters to be taken to the High Court rather than a lower court, has no provisions for long term maintenance, and inadequate provisions for financial reporting. There has been a stronger need in Australia and Canada to review their legislation earlier than New Zealand, as the uptake of intensive housing in New Zealand has been much later. However, despite having different institutional arrangements in place, issues that arise in the ownership and management of communally-owned property are quite similar (see Consumer Affairs Victoria and Department of Building and Housing, 2004). Comparison of research undertaken of gated communities in England and intensive housing developments in New Zealand also revealed compelling commonalities (Blandy, Dixon and Dupuis, 2005).

Table 1: International Comparison of Legal Entities for Managing Communally-Owned Property

	New Zealand, bodies corporate	**Melbourne, Victoria, bodies corporate**	**Guelph, Ontario, Condominium Corporations**
Statute	Unit Titles Act 1972	Subdivision Act 1988, State of Victoria	The Condominium Act 1998, Ontario
Jurisdiction	High Court	Magistrates Court	Superior Court of Justice
Decision making and management	Body corporate (usually owners committee)	Committee	A Condominium Board is established for each standard or common elements condominium
Membership	Owners automatically members	Owners automatically members	Owners of Parcels of Tied land automatically become members
Obligations of Members	Specified in Act	Not specified in Act but in regulations	Not specified unless stated in declaration (constitution which sets out what interest each owner has in the common elements and financial contributions)
Enforcement of rules	Body corporate secretary then High Court	Body Corporate, then Magistrates Court	Condominium Board, then Ontario Superior Court of Justice
Ease of changing rules	Difficult- Mixture of unanimous and 80% approval	Moderate- Regulations set out standard rules and enable body corporate to make rules.	Moderate- Bylaws can be changed by more than 50 % owners but Board must institute a by law change. However must not contravene Declaration which requires 80-90% approval
Dispute resolution	No formal provisions, other than High Court	Act provides for disputes to be arbitrated by a Magistrates Board; also provides for appointment of an administrator to replace a body corporate	Act provides for mandatory mediation and arbitration, which if fails, can go to Court
Long term maintenance	No specific provision for sinking fund or maintenance plan	No explicit powers to plan, upgrade or maintain essential services	Act requires a reserve fund study to be done within one year of registration and updated every 3 years
Financial reporting	Minimal provisions but can be specified in First Schedule	Minimal provisions	Specific provisions

Source: Condominium Act 1998, Ontario Province, Canada; Subdivision Act 1988 and Regulations, State of Victoria, Melbourne; Unit Titles Act 1972, New Zealand

It is clear from the above comparison that New Zealand lags some way behind Victoria and Ontario in addressing some key operational issues in respect of ownership and management of communally-owned property. Certainly, Ontario seems most advanced in dealing with the management arrangements of communally-owned features such as stormwater devices. However, as its legislation is relatively new, it will be some time before it can be determined how well this model will work in practice.

4 GOVERNANCE AND MANAGEMENT

This section looks in more detail at the issues surrounding four types of entities in use or being created to manage communally-owned property in New Zealand, namely bodies corporate, incorporated societies, residents associations and companies. Table 2 (see subsection 4.4) provides a comparative assessment of some features that are important for effective operation of these entities. The material we are presenting in this paper is preliminary and subject to further modification.

4.1 BODIES CORPORATE

The recent proliferation of intensive housing, particularly in Auckland has highlighted the outdated nature of the legislation governing bodies corporate. The problems that exist now have been created unintentionally by legislation introduced in an era when the implications of a shift from individual to a form of communal ownership were not fully appreciated (Dupuis and Dixon, 2005). Particular problems relating to the operation of bodies corporate have been well documented and include (Dupuis et al., 2002; Dupuis and Dixon, 2005; Glaistor Ennor and the Auckland Regional Council, 2003):

- No oversight by a government agency and provision of education and advice for buyers and owners
- inadequate clarification of the roles and responsibilities of various stakeholders such as developers, the body corporate, owners committee, body corporate management company or managers
- difficulty of changing rules which requires unanimous or near-unanimous support of owners
- embedded power of developers and body corporate managers in long term contracts to the disadvantage of owners
- No provision for dispute resolution which means that ultimately cases may need to go the High Court for a decision
- No regulation or oversight of professional body corporate managers
- No provisions for education of owners in the operations of owners committees and responsibilities for the management of features such as swales, rainwater gardens, ponds and so on.

As previously noted, the review of the Unit Titles Act should lead to a significant improvement in the future operations of bodies corporate or whatever new entity that may emerge for much of multi-unit housing. A key challenge is to establish the right legislative and regulatory environment without being overly prescriptive (Dupuis and Dixon, 2005). However, it is clear that many of the current problems are occurring because of inadequate clarity in law and insufficient safeguards for owners. A second challenge is that New Zealanders need to become used to new forms of housing arrangements whereby they take on new responsibilities for on-site administration and management of communally-owned property.

4.2 INCORPORATED SOCIETIES

The establishment of incorporated societies under the Incorporated Societies Act (ISC) 1908 as an alternative to bodies corporate is occurring where developments include property on freehold title. In some cases developments may include property on strata title as well as freehold so that a common set of rules may be required to include all the titles and residents (including residential and/or commercial residents) who own, lease, rent, work, or live at the development. In any of the above instances, the body corporate rules that exist and operate in relation to one unit title within the development have no authority over residents or workers who occupy any other title within the development. Currently, there is a paucity of information on how well incorporated societies work as models for managing communally-owned property. Several issues have been raised in interviews undertaken to date for this research.

First and importantly, Paul states the purpose of the current ISC Act "is primarily the protection of members' interests" (Paul, 1996,5) rather than property. One property lawyer interviewed suggested that the UTA deals largely with property issues (i.e. subdivision and stratum estates, provisions relating to leasehold lands, and proprietors' duties and obligations with regard to commonly owned property), whereas the ISA focuses mainly

on the rules and regulations pertaining to the running of the group. In this respect it can be argued that the ISA does not deal with or provide any guidance in relation to how common property issues should be adequately managed, operated or dealt with. Another property lawyer commented:

> *I really couldn't see the point of an incorporated society as an equivalent to the body corporate under the Unit Titles Act - because incorporated societies are general sorts of things. You have sports clubs, charitable associations, business associations, purely social clubs like the Naval Officers' Association - that sort of thing - or Ex Naval Mens' Association- there's a whole range of things - what we need here is a framework that is a lot more geared to living in a physically defined small community - it's not like the Ratepayers' Association at all - an incorporated society is the ideal thing for Ratepayers' Association but I think it is not specific enough…so you then…for each one, if you incorporate under the Incorporated Societies Act, for each one, you are going to have to make very, very specific rules and lawyers being lawyers there will be a totally different set of rules that each law firm will want to have for each one that it does. So all you end up with maybe 300 different likely sets of rules - which is just hopeless, just hopeless.*

A second issue relates to membership of an incorporated society. Another property lawyer stated that it was not possible to force someone to join an incorporated society, regardless of whether they shared in the ownership of common property. This is just one instance where certain aspects of an incorporated society could be considered ultra vires (that is, outside the law). The property lawyer also stated that various rules of incorporated societies may well be ultra vires. He had looked at the incorporated rules of an intensive housing development some twelve years ago that he regarded as strongly questionable, despite the fact the rules had been drafted by a well known law firm.

A third issue of significance for the operation of any entity managing communally-owned property is the need for regular and transparent financial reporting. While the ISA states that every incorporated society must deliver a set of financial statements to the Registrar annually (section 23), there is no provision in the ISA for the accounts of the incorporated society to be audited. In comparison, the second schedule rule of the UTA s (which can only be amended by a unanimous vote) do contain a provision for the accounts of the body corporate to be audited annually by an independent auditor (rule 12(d)). It would be possible, however, to draw up a set of second schedule rules under the UTA that contained a provision that an independent auditor was not required (though it could be argued that such an act was ultra vires). Correspondingly, it would be possible to write a rule for an incorporated society that made provision for the annual accounts of the society to be inspected by an independent auditor.

A fourth issue is that rules may be too easy to change. In this respect, compared with rule changes under the UTA, rule changes under the ISA are easier to effect. Though any change in rules must be lodged with the Registrar, and must conform with the Act itself (sections 6(2), 21(2) and 21(3)), it is left to each incorporated society to prescribe the mode in which the rules of their society may be altered, added to or rescinded (section 6(e)). Though it is often argued that it is unnecessarily difficult to change rules in the second schedule of the UTA, it can also be argued that it is too easy to change rules under the ISA, thereby creating a sense of uncertainty or instability within an incorporated society. Related to this is the point that as with the second schedules under the UTA, it would not be difficult for the developer to write and set up the rules in a way that gives the developer or manager undue advantage over future owners.

Another important dimension for sound management is the need for a mechanism to resolve disputes, interpret and enforce rules. If an incorporated society experiences problems or disputes about the way in which rules are being interpreted or applied, the Registrar appointed under the Act is not empowered to intervene in such a situation. While the ISA gives the Registrar the power to investigate breaches of the ISA by an incorporated society, the Registrar has no power over members who breach the rules of their incorporated society (section 34A. and 34B). In instances where there is a dispute within an incorporated society, the authority lies with the High Court.

There are, however, some benefits of an incorporated society compared with a body corporate. First, information is more accessible. Second, as mentioned above, rules are easier to change. Third, some legal specialists interviewed are supportive of incorporated societies as revealed in this quote:

> *I have never been a fan of bodies corporate as they operate on, in my opinion, now outdated concepts of participatory democracy. Many people don't have time to attend AGMs or stand for election to executive*

positions. That is why there has been the development of body corporate companies who carry out the dog work…… For governance models, I am leaning towards combining the principles of incorporated societies with those of trusts. The benefit of this model is that you can get the best of both worlds. I annex the constitution of the [name of]… trust which is an example of this approach.

Another model for a rural hamlet drawn to our attention included unit title and fee simple titles and convenants that feature a management structure with three commercial companies, one management company and a ratepayers association (incorporated). It is clear that a variety of models are now being set in place to accommodate the needs of particular developments. One professional told us that in respect of rural and coastal property there are as many models being created as developments proposed (Scott, 2005).

4.3 RESIDENTS' ASSOCIATIONS

Residents' associations are many and varied and exist for multiple reasons. A common type of residents' association is that which is set up in relation to residential 'areas' such as streets, or small suburbs or perhaps (un)protected wetlands or areas requiring protection by interested parties who may live in the vicinity. For instance 'The Styx Residents Group Incorporated' exists as an entity that promotes and maintains the interests of residents in the area. However a distinctly different residents' group, The Styx Mill Country Club Incorporated, also exists, but relates specifically to The Styx Mill Country Club development and those who live in the development, rather than the wider Styx area.

While many residents' associations exist as 'incorporated societies' this is not mandatory by law. However it does provide a group or association with a legal entity and its members with protection from personal liability for legal costs should they be taken to court. A residents' association may also be referred as a 'precinct society' [3] and can exist along with one or more bodies corporate that have been set up in relation to a unit title or titles (under the UTA). In fact one of the reasons for the existence of a residents' association or precinct society relates to the fact that a development may be made up of more than one body corporate, and so the precinct society allows members other than body corporate owners/proprietors. In such an instance the developer of the site could be a member of the precinct society or residents' association, as well as the on-site manager, and perhaps those who may lease private or commercial premises owned by the body corporate or developer.

A property lawyer who was interviewed for the project stated that if a residents association was not registered as an incorporated society, or under the umbrella of a body corporate, such an association would only be protected by the Privacy Act (in the case of a not-for-profit organization) or the Fair Trading Act (if the association has a fee-paid manager). While the Privacy Act comes under the jurisdiction of the Privacy Commissioner (who can only give a 'ruling'), the Fair Trading Act comes under the jurisdiction of the District Court. For comparison, both the UTA and the ISA come under the jurisdiction of the High Court.

4.4 COMPANIES

In this research, we have not investigated companies, trusts or joint ventures (in relation to communally-owned property) to the same extent as incorporated societies and residents' associations. However, setting up companies, trusts and/or joint ventures in relation to commonly owned property may allow for opportunities that are not so readily available for incorporated societies. In the instances of larger developments (e.g. rural hamlet type developments, or urban mixed use developments) where situations for profit making exist (e.g. developments including farming and rural residential properties, or developments with a mix of shops, and/or resort/time share units and private residential units) a company, trust and/or joint venture is in a better position to utilize profit (and tax) opportunities.

[3] As in the Viaduct Harbour Precinct Society Inc- Melview Developments, Auckland

Table 2: Comparison of New Zealand entities for Managing Communally-Owned Property

	Bodies corporate	**Incorporated Societies (including incorporated Residents' Associations)**	**Companies**
Statute	Unit Titles Act 1972	Incorporated Societies Act 1908	Companies Act 1993
Jurisdiction	High Court	High Court	High Court
Decision making and management	Body corporate	Committee	Board of Directors
Membership	Owners automatically members	Voluntary but often made compulsory	Voluntary but often made compulsory
Obligations of Members	Specified in Act	Not specified Unless stated in rules for Inc Societies	Specified in Act
Enforcement of rules	Body corporate secretary then High Court	Association itself, then High Court	Board of Directors, then High Court
Ease of changing rules	Difficult- Mixture of unanimous and 80% approval	Easy- resolution 50%	Moderate- mix of resolution and special resolution
Dispute resolution	No formal provisions, other than High Court	No formal provisions unless provided for in rules	Formal mechanisms through company voting procedures
Long term maintenance	No specific provision for sinking fund or maintenance plan	Nothing specified as Act is designed to protect member interests	Companies Act is not about property management. Would need to be specified in agreements. Financial reserves can be provided for
Financial reporting	Minimal provisions but can be specified in First Schedule	Act acknowledges financial planning but no directive	Act requires disclosure to shareholders and for public inspection of records

Source: Unit Titles Act 1972, Incorporated Societies Act 1908, Companies Act 1993

5 REFLECTIONS AND CONCLUSIONS

Our research suggests that the development of alternative models to the body corporate is at an early stage in New Zealand. The cases examined for our research project are in the process of being established and it is too soon to determine how well the models will work in practice, in respect of day to day management of stormwater features. However, we can draw out a number of general observations. First, there is wide variation. Given the diversity in site conditions and ecological complexities, this is not necessarily problematic. However, there is little information readily available on what are established 'good practice models' for developers proposing to construct agreements, as well as for consumers looking at buying into developments. Thus, buyers are overly reliant on legal advice when purchasing properties. Similarly, developers are heavily dependent on the expertise of their advisors when setting up these arrangements.

Second, there is no systematic oversight of the creation of these models so that there is no independent assessment of how well they address the needs of owners. While the body corporate model is far from perfect, it is a mechanism that has been created for the specific purpose of property management, for example containing rules in Schedules. The other models discussed here are being drawn from legislation constructed for other purposes and have deficiencies as noted above.

Third, it is clear that the development industry in New Zealand is creating models in response to the particular management needs of their developments and using the mechanisms available under several statutes which may not always be appropriate. One lawyer working for a development company described the lack of statutory backing and the question of how to limit liability in these situations as "a time bomb waiting to happen". In his view, all the potential options for use (such as bodies corporate and incorporated societies) were fairly blunt instruments. Whatever model is used, however, considerable scrutiny has to be given to the rights of owners which can be easily undermined by contracts and agreements put in place by developers, often in conjunction with body corporate management companies (Blandy, Dixon and Dupuis, 2005).

Finally, the real test lies in the implementation of any model through day-to-day operations once the development has been constructed and residents taken up occupation. In respect of management of stormwater features on communally-owned land (whatever model is in place), interviewees have raised some potential difficulties, which have also been identified in the research on bodies corporate (Dupuis et al., 2002). First, there is the key issue of the need to educate owners and how to ensure that they are aware of their responsibilities regarding management of rainwater gardens, stormwater ponds and rainwater tanks. One professional commented that on a visit to a housing site a member of a body corporate committee was completely unaware of the purpose of the rainwater tanks and associated reticulation pipes, then reprimanded the Council for the shoddy job of landscaping which was on private land and the responsibility of the developer. Owners frequently blame councils for failing to inform them of the need to maintain stormwater features. However, these issues should be disclosed when purchasing a property. Second, it is not uncommon for developers to renegotiate provisions for stormwater once they have obtained consent, for example to remove rain tanks or reduce the number of swales, thereby undermining the effectiveness of the stormwater system. Third, several professionals commented on the sheer complexity of consents and the difficulties for councils to follow through on active and timely monitoring, particularly when already faced with heavy workloads. Fourth, contractors may be unaware of the impacts of their work activities, as demonstrated by filling up rain gardens with rubbish, parking on swales and damaging concrete paving and drains. Finally, some new owners are of the view that in a new development they should not have to be concerned with issues relating to infrastructure management (Nagels, pers. comm., 2005).

As new models for private land management proliferate, some critical questions remain such as: what type or types of legal entities are best suited to encouraging landowners to take responsibility for management of stormwater features; who should be responsible for educating owners and other stakeholders about long term management and maintenance of stormwater features; how should rights of individual owners be protected in relation to those of the entity put in place in respect of changing rules; will councils be able to monitor conditions effectively and enforce remedial action if required; what happens if the various types of models put in place do not work in the long term? Where there is more than one body corporate on site, how do disputes in relation to stormwater management get resolved? What happens if the costs become disproportionate between the entity and community, or between the entities where there is more than one? Who picks up the costs when liability cannot be clearly identified? Achieving equity in the complex web of relationships and accountabilities in these situations requires a careful balance of public and private rights and responsibilities. Given the potential for considerable difficulties that can arise, it is an issue worthy of much closer scrutiny by policy makers, councils and other stakeholders.

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Jp2g No. 2161774B

September 10, 2019

Via e-mail

Grant Machan
Director of Environmental Services
Corporation of the Town of Perth
80 Gore Street East
Perth, ON, K7H 1H9
(613) 267-3311x2233
gmachan@perth.ca

Attention Grant Machan, Director of Public Works

Re: North of 7 Master Plan, Functional Stormwater Management Plan
Peer Review Comments

We have received a letter from Chris Denich, P.Eng. of Aquafor Beech Ltd. that provides his peer review of the Functional Stormwater Management Plan for the North of Seven development, as part of the EA addendum process.

In his review, he has provided 10 points that need to be addressed. This letter to you provides both his points and our responses to his concerns.

1. The infiltration rate identified in Table 3: Detailed Design Criteria (Page 4 of 6) for the LID analysis was assumed to be 50mm/hr. It ic unclear if this rate is assumed for the "blast-rock and engineered fill" noted in Section 3.2 or for the native soils per the Appendix B – Letter dated Oct 26, 2016, Figure 2. It is also unclear in what strata the LIDs would be founded. Geotechnical or hydrogeological studies were not provided in support of the assumed 50mm/hr infiltration rate. Based on the available existing Soil Map of Lanark County (Soil Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, 1966) the soil in this area is mainly clay loam with some sandy loam and is consistent with Section 3.2 of the report. Clay loam and sandy loam typically have infiltration rates in the range of 5-10mm/hr and 20-30mm/hr.

To provide clarity, the 50mm/hr is the expected infiltration rate of the sandy topsoil filter layer at the surface of the swale, into the clear stone trench. We expect it to be designed similar to what TRCA recommends with their LID guidance. The clear stone trench is not expected to be an impediment to infiltration. The trench will be constructed generally above the existing ground, except where connection to offsite flows or where positive drainage requires additional grading. The design does not expect any exfiltration out of the clear stone trench, except to the receiving stream. The properties of the soil are not expected to be influential in the performance of the system.

2. It is recommended that the design criteria targets be reconfirmed based on the revised infiltration rate, including:

- Storage and/or infiltration of the 90th percentile rainfall event to achieve 80% or better quality treatment;
- All runoff from the 1:2 year event can infiltrate within the clearstone trench; and,

- Peak flow rates for 1:2 to 1:100-year events are not greater than the predevelopment conditions.

The criteria have been revised to incorporate the comments in the peer review. The revised criteria have been attached to this letter. The revised criteria have been reconfirmed, and it is believed that all can be achieved given what is currently known about the site.

3. The 90th percentile rainfall event identified Table 3: Detailed Design Criteria (Page 4 of 6) is stated as 19.3mm of rainfall. Per the MECP Low Impact Development (LID) Stormwater Management Guidance Manual (2018 Draft) the 90th percentile for the Town of Perth and surrounding area is 27mm. It is recommended that the ability to achieve the stated water quality criteria be revaluated and confirmed using revised infiltration rates and groundwater conditions as required. In addition the proposed LID must comply with Policy SEW-10-LB-PI-MC, that "new stormwater management facility be built to Enhanced Level Protection Standards as described in the Stormwater Management Planning and Design Manual, MOECC 2003"

The criteria have been revised to incorporate the comments in the peer review. The revised criteria have been attached to this letter. The revised criteria have been reconfirmed, and it is believed that all can be achieved given what is currently known about the site.

4. Groundwater monitoring has not been completed at this site and no indication of groundwater level has been provided. It has been noted in the report that 'a high groundwater elevation is expected' and the reviewed soil map of the area also indicates high groundwater in the general area. High groundwater and/or a lack of separation from the invert of the LID facilities (recommended min. 1m separation) can prevent infiltration and significantly reduce the effectiveness of the proposed LIDs.

As exfiltration from the clearstone trench is not proposed, the presence or absence of groundwater is not expected to influence the performance of the system. As the trench is expected to be above existing ground, groundwater entering the trench would be unexpected.

5. Modelling
   a) The spreadsheet models as provided by Jp2g Consultants Inc. represent the general LID facility design and functionality, however key parameters (infiltration rate, 90th percentile event etc.) are based on the aforementioned assumptions. It recommended that the modelling be revised based on the above noted recommendations and the functionality be reassessed.
   b) In addition, it is recommended that hydrologic and hydraulic modelling be completed using a software that has been designed to represent LID measures appropriately, such as PCSWMM, EPA SWMM or the LID Treatment Train Tool (LID TT Tool). While PCSWMM is a proprietary product that must be purchased, EPASWMM and the LID TTT Tool are free user software packages which run the SWMM engine and are available from:

- EPASWMM: https://www.epa.gov/water-research/storm-watermanagement-model-swmm
- LID TTT Tool: https://sustainabletechnologies.ca/low-impactdevelopment-treatment-train-tool/

As exfiltration from the clearstone trench is not proposed, the presence or absence of groundwater is not expected to influence the performance of the system. Likewise, the event that was utilized in the model

presented (the 48mm 24h event) is in excess of the 90%ile event. We concur that a more sophisticated modelling exercise will be required for a more detailed design, and PCSWMM would be an appropriate model to use.

6 An analysis has not been completed to determine the influence of the Blueberry Creek 100-year floodplain and/or backwater effect on the surface conveyance of the low gradient (0.1% slope) swales/infiltration trenches. Since the swales/infiltration trenches outlet to this Creek (per Figure 2), it is recommended that a hydraulic analysis (SWMM or HEC-RAS platforms) be completed to determine/confirm the following:

- The impact of the 100-year storm on the proposed LID features; and,
- Any potential backwater effect from Blueberry Creek on the proposed features.

The analysis was undertaken with a downstream hydraulic grade line equal to the 1:100 year event at the point of connection (137.50 mASL) and the invert of the clear stone is above bankfull (137.00m). The clear stone is expected to be in the order of a meter thick and 6m wide where it discharges to the receiving stream. The backwater effect from the receiving stream has already been considered in the spreadsheet analysis.

7 Based on the 100-year event analysis it is assumed that the surface conveyance of the swales/infiltration trenches will form a component of the major system (Jp2g Consultants Inc. to confirm). As such, a minimum 0.3m freeboard should be provided. Table D-5: SSA Model Output for Clear Stone Trenches (100yr event) demonstrates this freeboard is not achieved in all segments. It is recommended that the infiltration trenches be increased in size and/or depth to achieve a minimum freeboard in all locations.

Yes, the surface and subsurface conveyance will form both the major and minor system. 0.3m freeboard to the underside of footing will be required. Table D-5 shows that for the segment draining the cemetery, 1.3m of head is required to drive the flow into the swale. This is an artifact of the coarseness of the modelling that was done – a single catchment was modelled for the un-developed portion of the cemetery lands and area upstream. The existing ground plus the depth of rain are not 1.3m above the invert of the swale, so this is not possible to produce this effect in reality. With less than 0.3m of depth, a significant offsite storage volume would be available. When this is modelled at the detailed design stage, the actual flow path in the off-site property will need to be more carefully understood, and the presence of storage will have to be considered. The clearstone trenches will be sized to carry the flow that infiltrates and is conveyed subsurface.

8 Additional detail is required in regards to sediment a management, specifically pre-treatment methods, sediment collection and removal.

Treatment will come from the infiltration process, leaving suspended solids trapped in the topsoil matrix, as the water (and some of the silts and clays) will pass into the clearstone trench. Vegetation will grow through the deposition in most places, stabilizing it rapidly. In those specific locations where catch basin leads are discharging to the swale, it is expected that a sediment delta will form. This can be mitigated by use of something like a Catch Basin Shield, which would retain 60% of the sediment at the catchbasin. While the CBS units are not specifically part of this functional design, they would be considered to be a good idea for the town to implement. Sediment collection and removal should be able to be done by driving within the Town-owned property with a small service vehicle, and the use of hand tools should allow the removal of accumulated sediment while minimizing damage to the planting and landscaping. Sediment traps, if they are used, would be accessed by suction-truck from the culvert crossings.

9 The incorporation of LID measures in the rear of private property is not a new concept, however it requires planning and coordination to ensure the measures are appropriately maintained. The Westminster Woods subdivision in Guelph, Ontario, is an existing subdivision with a linear 100-year 'Greenway' infiltration trenches system located in the rear of the

mixed-use development (primarily single family residential). The Greenways are managed as condominium elements and are maintained by the condominium committee/board. Each homeowner pays a fee towards the maintenance of the stormwater components, enhanced landscaping and other features. This has been outlined in Facilitating Maintenance of Stormwater Devices on Communally Owned Land (See Appendix A). It is recommended that a maintenance plan for the proposed stormwater management system be to be examined as a part of the evaluation of the LID alternative.

This is an interesting idea. It is agreed that SWM management and maintenance at the neighbourhood and individual lot level should be proactively addressed in the planning, development, and approvals processes. This project is expected to be constructed by the Town, with landscaping, pathways, and the SWM facility all owned by the Town. Maintenance is expected to performed on an 'as-needed' basis, using the monitoring station to indicate when performance is declining, until such a time as there is sufficient experience to be able to be proactive in the maintenance activities.

10 Approvals required through the MECP and RVCA will be required for the proposed stormwater management (swales/infiltration trenches) as there is proposed development within the 100-year floodplain.

This is understood. It is quite likely that a balanced cut and fill will be required to place infrastructure within the floodplain. At the very least, a low, wide channel that is the extension of the clear stone trench will be constructed in the over-bank of the creek to provide an overland flow path into the stream. MECP will be required to approve all SWM facilities through their ECA process.

Trusting this is satisfactory.

Yours truly,

Douglas Nuttall, P.Eng.
Senior Civil Engineer

cc

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Jp2g No. 2161774A

September 10, 2019

Town of Perth

Delivered by email

Attention: Mr. Grant Machan

Re North of Seven EA

Jp2g Consultants has been contracted to develop design criteria for developing a Stormwater Management system for the North of Seven (N.7) project. This is expected to be approved by the Town of Perth and the Rideau Valley Conservation Authority for inclusion into the Environmental Assessment (EA) of the North of Seven Master Plan.

Ultimately, it is expected that future development within the N.7 could use a novel approach to stormwater management that is not specifically addressed by existing Ministry of the Environment, Conservation, and Parks (MECP) guidelines. As such, design criteria would have to be accepted by the Town and the Conservation Authority as the design criteria to be used in the development, to allow the MECP to check any given Environmental Compliance Application to see that it conforms to the criteria.

The innovative drainage concept would rely on grassed swales with massive underdrainage to capture and filter all of the minor events, and convey major events, to provide enhanced quality treatment and ensure post-development flow rates to not exceed pre-development flow rates. A version of this was considered in the original N.7 EA, and discarded as being too expensive. Once all of the costs associated with the more conventional stormwater management system of the preferred alternative are considered, the costs associated with a grassed swale system become more acceptable.

The specific key design elements are:

- The invert of the downstream limit of the clear stone trench shall be set at the Blueberry Creek at bankfull.
- The 1:100 year hydraulic grade line of the open swale where it receives water from the upstream cemetery shall be set to be the existing bankfull elevation at the downstream limit of the cemetery property.
- The surface of the open swale over the clear stone under-drainage will be constructed with a ‘saw-tooth’ profile, to ensure as much water as possible is trapped and forced to infiltrate and trap sediment.
- The depth of the open swale will not be less than 0.3m, and not more than 0.45m. Sediment traps may be considered upstream of box culverts if they can be adequately serviced by town staff.
- The hydraulic grade line of the 1:100 year event will be a minimum of 0.3m below the underside of footings.
- Discharge from the existing outlet of the Meadows subdivision will be to a basin that is designed to capture the flow from the pipe network during the 1:5 year event and hold it for sufficient time to allow it to infiltrate into the clearstone. The design of the basin and downstream channel is to ensure the hydraulic gradeline within the pipe network is not increased for all events in excess of the 1:5 year event.
- Excavation for the clear stone trench is to be minimized for construction of the ‘spine’. Grading to ensure positive drainage, and sufficient excavation to provide for the other criteria, is expected.
- Fill that is required in the flood plain is minimized, and a balanced cut-and-fill assessment shall be undertaken on a 0.15m vertical interval.
- The design of the system shall assume a static water elevation of the receiving stream at the 1:100 year water level.
- Discharge from the clear stone trench into the receiving stream shall be controlled in a manner to prevent water from carrying aggregates out of the trench.

- The topsoil filter will be designed to provide better than 80% quality treatment. This will require a specific soil mixture, and a specific thickness, to be determined by the designer.
- It can be assumed that there is effectively no infiltration into the underlying soils due to the clay content and the high groundwater elevation. This assumption can be checked and revised.

If the EA process determines that the surface drainage system is the preferred alternative, then the costs of constructing it will be very dependent on the criteria used to design it. The criteria, and the list of tasks that are expected to be required to meet these criteria, are included below. If a developer intends to meet the criteria using a different approach, the alternate method should be cleared with both the Town and the Conservation Authority as part of the Conceptual Stormwater Management Plan.

In general, this list of criteria is a more specific list than the typical '80% TSS Removal, Match Post- to Pre-, and Maintenance Requirements', that is often part of a Conceptual Stormwater Management Plan. This list of criteria includes comments made by Aquafor Beech as part of their Peer Review.

Criteria:

1. Show that for the 90%ile rainfall event (27mm in 24hr), an average of 80% or better quality treatment is achieved along the entire length of the system.
2. Show that the during the 1:2 year event, all of the runoff from the site can infiltrate into the clearstone trench during the event without producing runoff from the system, when the ditch is due for cleanout.
3. Show that during the 1:2, 1:5, 1:10, 1:25, and 1:100 year events, the peak flow rate reaching the creek via any and all paths when the site is in post-development conditions is not greater than the peak flow rate reaching the creek in pre-development conditions.
4. Show that during the 1:2, 1:5, 1:10, 1:25 and 1:100 year events will have no ponded water within 24 hours of the end of the event.
5. Show that the sediment accumulation within the treatment swale can be reasonably managed with spot treatment accessed by small vehicles (2.4m wide access) and/or local ditch clean out upstream of the road crossings.
6. Show that the sediment accumulation within the clearstone trench can be reasonably managed with spot treatment accessed by small vehicles so that the expected lifecycle of the system would be a minimum of 40 years.
7. Demonstrate predicted performance by ongoing monitoring in multiple locations
8. Use a qualified peer review to ensure the design can be expected to achieve the designated targets.

Yours truly,

Jp2g Consultants Inc.
Engineers • Planners • Project Managers

Doug Nuttall, P.Eng.
Civil Engineer

DN/jlp

cc. Phil Mosher, RVCA

APPENDIX A
Work Plan

The expected work plan to ensure that the criteria can be met would be to demonstrate:

1) Show that for the 90%ile rainfall event (27mm in 24 hr), an average of 80% or better quality treatment is achieved along the entire length of the system.
   For the chosen soil mixture and dept, find:
   a) the infiltrated volume for the 90%ile event
   b) the runoff volume for the 90%ile event
   c) the portion of the infiltrated sediment that will be retained within the clearstone
   d) the combination of the remaining sediment in the infiltrated flow and in the overland flow will not exceed 20% of the original sediment load (thus 80% TSS removal)

2) Show that the during the 1:2 year event, all of the runoff from the site can infiltrate into the clearstone trench during the event without producing runoff from the system, when the ditch is due for cleanout.
   Find:
   a) the rate of infiltration into the clearstone trench under ideal conditions (using Horton or an equal method of estimating infiltration rates)
   b) the rate of infiltration into the clearstone trench assuming the swale is due for a clean-out
   c) the rate of water reaching the swale during a design event (1:2 event), using the City of Ottawa IDF curve, for a variety of event durations up to 24 hours in duration, considering the reduction of catchment area during events shorter than the time of concentration. The ratio of reduced area/actual area is equal to the ratio of event duration/time of concentration, up to the time of concentration.
   d) the instantaneous runoff rate, less the infiltration rate, is the rate of surface storage. The cumulative storage volume will not exceed the volume of the swale (without overtopping) during the 1:2 year event.

3) Show that during the 1:2, 1:5, 1:10, 1:25, and 1:100 year events, the peak flow rate reaching the creek via any and all paths when the site is in post-development conditions is not greater than the peak flow rate reaching the creek in pre-development conditions.
   Find:
   a) the pre-development peak flow rates for each post-development catchment for all design events.
   b) the rate of infiltration into the clearstone trench, and the depth of flow within the swale, as a time series
   c) the velocity of flow within the clearstone trench, based on stone size distribution and expected void sizes.
   d) the flow rate within the swale, over the clear stone trench, throughout the duration of the event for all design events.
   e) the flow rate draining from the site via a route other than through the clearstone trench or swale, throughout the duration of the event for all design events.
   f) the exfiltration rate from the trench. If the exfiltration rate is expected to be less than 3% of the total runoff volume, then it can be ignored.
   g) the post-development peak combined flow rate reaching the creek, compared to the pre-development peak flow rate, for all design events.

4) Show that during the 1:2, 1:5, 1:10, 1:25 and 1:100 year events will have no ponded water within 24 hours of the end of the event.
   Find:
   a) the ponded volume at the end of the event.
   b) the saturated infiltration rate of the soil.
   c) the rate of overland flow throughout the 24 hours following the end of the event.
   d) the rate of infiltration, considering the HGL of the swale and the HGL of the clearstone, throughout the 24 hours following the end of the event.

5) Show that the sediment accumulation within the treatment swale can be reasonably managed with spot treatment accessed by small vehicles (2.4m wide access) and/or local ditch clean out upstream of the road crossings.
   Find:
   a) what volume of sediment is expected to be transported to the swale via catch basins
   b) what volume of sediment is expected to be transported to the swale via yard runoff
   c) the potential for sediment transport within the swale system
   d) the potential for erosion within the swale system
   e) the sediment that will be captured within trapped lows in the swale system

f) the efficacy of a settling basin on the upstream side of road crossings as a means of reducing sediment transport.
g) the size of such a settling basin so that it requires annual (or less frequent) cleaning.
h) the expected frequency of full cleanout.
i) the expected maintenance activities required to maintain infiltration.

6) Show that the sediment accumulation within the clearstone trench can be reasonably managed with spot treatment accessed by small vehicles so that the expected lifecycle of the system would be a minimum of 40 years.
   Find:
   a) The volume of sediment expected to be retained within the clearstone trench annually
   b) The volume of voids within the clearstone trench after 40 years
   c) The required capacity and configuration of additional subdrainage (eg, Big-O with sock or equal), assuming local failure of the geotextile filter surrounding the clearstone trench, to ensure that subsurface flow is still sufficient to provide for no ponded water on the surface within 24 hours.
   d) Internal structure that prevents substantial migration of fines throughout the system.
   e) The expected annual maintenance activities required to maintain conveyance within the system.

7) Monitoring – demonstrate predicted performance by ongoing monitoring in multiple locations
   a) Establish 1 test site per block that includes, at a minimum, continuous monitoring of flow, TSS, turbidity, temperature, conductivity, within a catch basin lead.
   b) Collect 12 grab samples from that catch basin lead during one year to be tested at an accredited water testing laboratory. Use this data to calibrate monitored turbidity and TSS to laboratory TSS concentrations under different conditions of temperature and conductivity.
   c) Establish 1 test site downstream of all confluences that includes, at a minimum, continuous monitoring of flow, TSS, turbidity, temperature, conductivity, in both the surface flow and the subsurface flow.
   d) Collect 12 grab samples from each of the surface water (if possible) and subsurface water during one year to be tested at an accredited water testing laboratory. Use this data to calibrate monitored turbidity and TSS to laboratory TSS concentration under different conditions of temperature and conductivity.
   e) Predict from the continuous monitoring: mass of TSS reaching the system in a year, total volume of water reaching the system in a year, average TSS reaching the system over a year, mass of TSS leaving the system in a year, volume of water leaving the system in a year, and average TSS leaving the system over a year.
   f) Calculate the annual average removal rate.
   g) Using a rainfall time series over the same year, calculate the decile rainfall and runoff events.
   h) For each decile of rainfall and runoff event, calculate the observed TSS removal rates.
   i) Compare actual TSS removal rates to the target TSS removal rate (80% removal from 90%ile rainfall).

8) Second Opinion – use a qualified peer review to ensure the design can be expected to achieve the designated targets
   a) As part of the conceptual design process, a peer review from a second consulting firm on the expected performance of the system is required. This would be in addition to and occur before any review by the approval authorities.
   b) The consulting firm would be selected by and paid by the municipality
   c) This peer review is intended to provide a second opinion that agrees that the expected targets can be achieved through a detailed design process based on the conceptual design.
   d) Any particular issues that must be addressed in the detailed design that have not been identified in the conceptual design will be identified by the peer review.

McINTOSH PERRY

December 18, 2019

Tracy Zander, M. Pl., MCIP, RPP
Town of Perth
80 Gore Street East
Perth, ON
K7H 1H9

Dear Tracy:

Re: EA Master Plan Addendum for the North of Highway 7 Lands – response letter

In response to the request for comment regarding the draft EA Master Plan Addendum for the North of Highway 7 Lands, we're writing to express concern with the approach, timing and cost associated with the current and draft addendum to the Town of Perth's (Town) anticipated form of development north of Highway 7. The following letter provides a brief explanation and summary of points raised in multiple meetings with staff and members of council over the past 5-7 years as well as the most recent meeting held at the Town office December 4, 2019 with Town staff and consultants (ZanderPlan and Jp2g). Following the meeting, a letter received from you dated December 10, 2019 suggested that any comments relating to the EA Master Plan Addendum for the North of Highway 7 lands be brought forward in writing prior to December 20, 2019 – as such, the following has been prepared for your consideration.

1.0 HISTORY OF THE MEADOWS OF PERTH DEVELOPMENT

In order to provide adequate context to the concerns raised regarding the North of Highway 7 municipal servicing, we have prepared a brief overview of the design principles used, construction completed and success of the previous two phases of the development. While early stages of the development were relatively slow to start, the subdivision has developed into a very successful community of upscale homes. The last remaining homes will be sold by this spring when completed. The success of constructing the subdivision and creating a local, family-owned home building business has sparked the desire grow both components of the business. The future subdivision lands located north of the current development will continue to be the base of operation for this growth which relies on a wide variety of trades and suppliers throughout the Town of Perth and County of Lanark (County).

Over the course of the previous two phases of development, designs were prepared by McIntosh Perry that relied on the use of temporary stormwater storage areas that would ultimately be replaced with a downstream permanent wet pond to accommodate stormwater quantity and quality control objectives before the outlet to Blueberry Creek, through an existing adjacent watercourse. Registration of the subdivision was based on current, industry standard design principles and criteria which were reviewed and approved by the Town, Rideau Valley Conservation Authority (RVCA) and Ministry of Environment, Conservation and Parks (MECP). As such, detailed financial pro-formas, schedules and expectations for the future subdivision lands have been developed under these same principles.

When the original Master Servicing Plan for Lands North of Highway 7 was being developed it followed the Secondary Plan that maximized land use and translated into a mandate of one treatment pond for the entire area. McIntosh Perry on behalf of Mr. Brownlee, have continuously and consistently expressed concerns over the recommendations brought forward for stormwater management which recommended a single, large, pumped stormwater pond to service all the development lands North of Highway 7 requiring significant design, construction and operational costs. Recognized as being unrealistic the Town retained the services of another engineering firm to review recommendations noted in the study Doug Nuttall, P. Eng. (Jp2g), has instead recommended an LID based solution to form part of the EA Master Plan Addendum for North of Highway 7 Lands.

Extensive communication and coordination with the Town's previous two Directors of Development and Protective Services has taken place over the last few years regarding Mr. Brownlee's future development lands including delivering concept plans for Phase III and future phases which utilized industry standard stormwater management solutions. We have consistently delivered the message that we do not believe that an LID based solution was appropriate or necessary for these lands while reminding Town staff that an LID based solution has never been implemented for a development of this size and type. Furthermore, we have voiced concerns of how the local conservation authorities and Ministry who provide approval for these works do not have the guidelines in place in order to review these designs. When we were told that the Town would be proceeding with an LID based solution we requested the design criteria necessary to prepare the relevant technical studies. In May 2019 a formal pre-consultation meeting took place with representatives from the Town, County and RVCA in anticipation of an upcoming submission for Draft Plan of Subdivision to the County. At that time, it was clearly communicated that once the County's Population Growth Study was completed and the Town's Official Plan was updated that an application for Draft Plan of Subdivision would be considered. As such, Mr. Brownlee worked with the Town and County to keep apprised of the progress. Each group was working toward a September submission date; however delays were introduced when the Town was unable to provide specific design criteria for the potential LID system. Without the necessary design criteria, final adjustments to the lot fabric, stormwater and servicing design and planning rationale could not be completed and therefore a submission was never made.

We were informed that the Town would be advertising a Request for Proposal that would continue to develop on the LID solution and provide additional site specific details by way of a geotechnical investigation, topographic survey and so on. September 9, 2019, Mr. Brownlee met with Mayor Fenik and the then Director, Mr. Symon, to formally inform discuss our position prior to the Town spending additional money on the LID approach. Many of the points mentioned in this letter were expressed at the meeting. On October 22 Mr. Symon met with Mr. Brownlee to inform him that sole response to the RFP was $130,000 over the $150,000 budgeted for the work however, he was intending to request council for the additional funds that evening.

In the days following that council meeting, staff holding the position of Director of Development and Protective Services as well as the Chief Administrative Officer were vacant. Immediately following the announcement, Mr. Brownlee requested a meeting with Mayor Fenik to communicate the importance and timely nature of our request to proceed with an application for Draft Plan of Subdivision on remaining development lands using an industry standard and broadly accepted stormwater management solution.

2.0 DRAFT ADDENDUM TO THE MASTER SERVICING STUDY (LID APPROACH)

While we completely agree that Low Impact Development (LID) has a place in stormwater management planning, we do have reservations employing these measures widely across a development of this type, scale and location. The benefits of LIDs within residential development are vast and impact both construction and maintenance cost. The idea of introducing LIDs and in-turn reducing the size of downstream conveyance and end-of-pipe facilities is exciting, however, as with most new technologies, there is also apprehension when it comes to design, construction and future maintenance and/or warranties.

The following is brief overview of specific concerns we have from a designer, developer and builder perspective. Please note, however, despite the concerns raised below, it is our intent to introduce LIDs and Best Management Practices throughout a development north of Meadows of Perth subdivision, at a "lot level". The list of concerns can be divided into design / approvals and risk when it comes to maintenance and warranty for the developer, builder, purchasers and the Town.

Design / Approvals

Prior to submitting for Draft Plan of Subdivision, an opportunities and constraints plan is prepared in order to determine the amount of developable land available. This approach incorporates any known constraints such as wetlands, servicing capacity and access limitations among other things. As part of this process, a conceptual lot and road fabric is developed using policies within the Town's Official Plan and Zoning By-Law, in addition to other supporting studies like the Town's Master Servicing Study and Transportation Master Plan. The proposed lot sizes are determined based on the Town's zoning as well as the marketability of the homes as is the assortment of single-family homes versus townhomes and semis. Lastly, Blocks of land are sectioned off to be used for high density development, parkland and infrastructure such as pumping stations and stormwater management facilities.

The entire conceptual layout approach is based on current legislation, regulations and policies. Similarly, throughout the approvals process, designs are reviewed by approval and commenting agencies against the same documents. A specific document that applies to the discussions to date and potential addendum to the EA Master Plan for North of Highway 7 Lands is the Ministry's Stormwater Management Planning and Design Manual. In absence of the Ministry's updated manual, peer review engineers for the Town and County as well as engineers at RVCA and eventually the MECP use the current manual for the basis of their review. When a developer or their design consultant proposes stormwater management solutions outside of those described in the current guidelines such as LIDs, review agencies are reluctant to provide comment or approval on the designs. Our experience has been that additional onus is put on the developer and consultant to demonstrate to the approval agencies that the proposed LID measures will function as intended.

As it stands, through our research, it was found that the RVCA and MECP would continue to review development applications against the current stormwater guidelines. As such, even though the Town may amend the Master Servicing Plan to incorporate the need for LIDs we are not confident that RVCA and MECP will approve or have adequate design parameters available to approve a Conceptual Stormwater Management Report used to support a Draft Plan of Subdivision application.

The draft EA Master Plan Addendum for North of Highway 7 Lands provided to us by the Town continues to lack sufficient detail for a designer to implement the proposed LIDs into a subdivision layout or design. It is our understanding that additional studies are underway to establish the topographic and geotechnical details that will help form the applicable design criteria but the conclusion to those studies and ultimately approval by RVCA and MECP of the same does not align with our anticipated schedule. Furthermore, collectively, we are all unsure how the completion of the Town's addendum will align with the Ministry's future guidelines, both from a timing and technical perspective.

Risk

Given the unproven technology, especially in areas outside of southern Ontario, the proposed LID approach introduces an added level of risk in comparison to all other standard forms of stormwater management such as piped conveyance systems and wet pond end-of-pipe facilities. The risk associated with this approach on a development of this size goes beyond the Town as the operating authority. As a designer, we are reluctant to propose a stormwater management solutions where the specific design criteria is not supported by industry standards published by the applicable approval authorities. In comparison, standard wet pond design and construction is completed following guidelines that are accepted amongst municipal staff, conservation authorities and the Ministry.

From the developer and builder's perspective, the risk is twofold. During construction, sourcing and installing the various materials required to construct the necessary infiltration trenches is uncommon, especially at this scale. The unknown and added risk associated with construction costs is difficult to incorporate into the subdivision's financial pro-forma, especially when the specific design criteria has yet to be established. Secondly, the need to warranty installation and operation or function of unproven LIDs will undeniably result in added construction costs by contractors to offset potential warranty claims post-construction. Similarly, the home builder inherits the added risk when conveying the final product to the purchaser. Any future operational issues such as unsightly ponding in rear yards will result in complaints or claims against the builder when the issue itself could very well be tied to the technology – not the actual installation. In short, requiring this unproven technology will be placing unnecessary liability and risk on the developer and builder.

Lastly, from the Town's perspective, we are concerned that the risks associated with this type of infrastructure have not yet been clearly identified and presented to staff and members of council. The currently overtaxed staff resources lacking any relevant experience maintaining similar infrastructure introduces a complex issue when reviewing the frequency and importance of ongoing maintenance of a system that relies heavily on continued infiltration – regardless of temperature, snow/rain fall, etc.

Beyond the design and risk concerns, there are a couple of major obstacles associated with the Town's current approach to servicing the lands north of Highway 7. One of the most notable issues we see is the ability to construct the downstream infrastructure including any sewers, ponds or ditches on neighbouring lands. As we understand the situation, easements have not been negotiated with downstream land owners which can result in significant costs and delays. The current approach requires theses be resolved prior to any development.

Throughout Ontario, LIDs are being included in stormwater designs as an added beneficial feature to help mitigate downstream peak flows and increase quality control – however, in most instances the LID features are being provided as an additional measure. Should they not operate as intended or are not maintained frequently, the standard stormwater conveyance and treatment systems have been in place to manage quality and quantity control. It is our opinion that, at this point, reliance on LIDs for the primary system for high frequency design storms introduces a level of risk of maintenance issues and possible localized flooding that has yet to be calculated and incorporated into the decision-making process.

3.0 PROPOSED APPROACH / NEXT STEPS

Since the Town's proposed addendum to the Master Servicing Plan schedule is unknown as a result of uncertainty obtaining approval from review agencies (design issues) and neighbouring landowners (construction, easement issues) – we have developed our own timeline that could be achieved should the Meadows of Perth lands be excluded from the LID approach to stormwater management and servicing. In this case the development would proceed as original intended through the previously completed technical studies and approvals obtained. The following is a high-level summary of the design and approvals process that could take place independent of the ongoing EA Master Plan Addendum for North of 7 Lands.

Using the submission requirements provided at the formal pre-consultation meeting held last May, we would compile the necessary technical studies and submit an application for Draft Plan of Subdivision by spring 2020. The package would include a Conceptual Storwmater Management Report and Preliminary Servicing Options Study that will provide justification for deviation from the Town's current Master Servicing Study. Once deemed complete, the supporting studies will be circulated to the applicable commenting/review agencies prior to obtaining Draft Plan Approval by fall 2020. Mr. Brownlee has confirmed that it is his intent to proceed with detailed design prior to obtaining Draft Plan Approval, therefore, it is expected that registration could take place as early as spring 2021. This would allow for road construction to follow and home construction over summer 2021 – which happens to align with the original schedule anticipated at the pre-consultation meeting in May.

This submission would rely on current municipal, conservation authority and provincial design guidelines – a predictable, cost effective and reasonable method for land development.

4.0 ADDITIONAL INFORMATION REQUESTED

A few items were referenced in your December 10, 2019 letter requesting that additional information be provided as it relates to:

1. *Land Use Efficiency (setbacks from open ditch to property line);*
   In regard to the location of the existing watercourse, we understand from the RVCA that the ideal build out scenario would maintain the existing open ditch / watercourse alignment. As such, the proposed approach would be to have an open ditch remain and possible realign it to maximize the developable land while enhancing the vegetation alongside the watercourse and creating a

meandering trail along the same. The linear park could form part of the required parkland contribution instead of occupying developable land located further north of the watercourse.

2. *General Grading Concepts (difference in elevation between road and ditch);*

   The future development lands will be transitioning from a 'fill' site to a combination 'cut/fill' site. Therefore, the approximate 2.0-2.5 fill at the existing cul-de-sac will begin transitioning down, closer to the existing grade as it approaches the watercourse crossing and additional development lands to the north. At this point, it is expected that the crossing will be approximately 2.0m which will provide sufficient cover over the proposed stormwater sewer extension from the cul-de-sac – as per the previous design intent.

   Additional conceptual grading of the future development lands can be made available in January once the Town has provided confirmation that there will be an opportunity to proceed independent of the current LID stormwater management approach, in principle. Furthermore, the conceptual grading will be somewhat dependent on the outcome of the sanitary pump station location both horizontal and vertical.

3. *Total Developable Area (land area required for ditch, ponds, pathways);*

   The extents of the developable land are dependent on the floodplain mapping of Blueberry Creek, however, at a minimum it is expected that approximately 9-11ha is available north of the existing watercourse and east of the potential floodplain. As discussed during our December 4, 2019 meeting, to date we have been anticipating that the western 2-3ha of land may be subject to floodplain and/or environmental setbacks from Blueberry Creek.

   In order to maximize the possible developable land, it is our intent to negotiate with RVCA and MNRF through the conclusions of the EIS to potentially propose a wet-pond inside a portion of the regulated area that is currently occupied by a vegetated hay field. The intent would be to replace a portion of the hayfield with a wet-pond, surrounded by enhanced plantings resulting in a net gain or net environmental benefit for the immediate area.

   The area required to maintain the open ditch will be tied to a proposed maintenance platform that will double as a pedestrian connection alongside the meandering watercourse which will also act as a natural buffer between the watercourse and future development.

4. *Conceptual Costs (construction and municipal maintenance); and*

   Although actual costs for the construction and maintenance of any proposed wet-pond and necessary conveyance system is proportional to the scale of development. That being said, it allows for a lower initial investment which is better suited for a relatively low growth municipality, when compared to nearby Carleton Place or Almonte. This affords the developer to manage upfront expenses over the lifespan of the project and limits the Town's risk of long term maintenance for infrastructure that could possibly be constructed long before it is required.

   In terms of long term operation and maintenance of a standard wet-pond, maintenance is limited to excavating sediment accumulated over 8-15 years. This is a simple exercise requiring only an excavator and dump trucks to haul the surplus material offsite. Different from the LID maintenance

operations, this site would not require entering into the rear yards of urban development to remove and likely replace filter media consisting of varying sizes of granular material.

5. *Any existing geotechnical information.*
   Unfortunately, the only geotechnical information available and known for the area was obtained informally by excavating test pits through the site. Our investigations have found a relatively consistent shallow bedrock (approximately 0.6 – 0.9m below existing) and high ground water table (between 0.0 – 0.3m below existing) – neither observation plays well into infiltration trenches or most LID technology.

5.0 CONCLUSION / RECOMMENDATIONS

Given the information provided to date, communicated through the previous two Directors of Development and Protective Services along with the information contained in this letter, we respectfully request that Town staff, your engineering consultant and members of council:

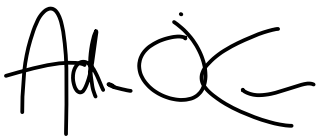
1. *exclude the Meadows of Perth lands from the LID stormwater management approach to the Master Servicing Study;*

2. *allow the Meadows of Perth development to proceed with 'approval in principle' using typical and industry standard stormwater design guidelines when applying for a Draft Plan of Subdivision; and*

3. *appreciate the significant local financial impact of deferring any decision on the matter as it relates to the future construction and sale of homes north of Highway 7, generating substantial Development Charges, property taxes and economic spin-off for local businesses.*

As this is a high priority item for both Mr. Brownlee and staff at McIntosh Perry, we will make ourselves available at your convenience to discuss the information provided.

Yours truly,



Adam, O'Connor, P. Eng.
Assistant Vice President, Land Development

cc. Brent Brownlee, Meadows of Perth

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Jp2g No. 2161774B

January 10, 2020

Town of Perth
80 Gore Street East
Perth, ON
K7H 1H9

Attention: Tracy Zander, M. Pl., MCIP, RPP

Re **EA Master Plan Addendum for the North of Highway 7 Lands**
Response to Comments re: Meadows Development by McIntosh Perry

Dear Tracy:

We are responding to the letter (herein referred to as 'letter') dated December 18, 2019, prepared by McIntosh Perry on behalf of the Meadows Subdivision.

The Environmental Master Planning process is intended to be a community-driven, transparent decision-making process to identify the best choices that can be made for future infrastructure investments. It requires input from all concerned stake holders to ensure that unforeseen surprises are minimized or eliminated.

The Dillon report, dated October 2013, made several conclusions that were questioned, and in 2016, Jp2g started the process of determining if the EA should be reopened to consider other information, and if so, if there was a better alternative. In December 2018, the information gathered was presented as a Draft EA Master Plan Addendum, which has since undergone a peer review and revision. Further comments are expected from the Peer Reviewer, which prevents finalizing the document and submitting the final report.

Because the EA Masterplan Addendum is not actually 'closed', this provides the opportunity for additional comments to be received and assessed. Such comments were received from the design team of the Meadows Development on December 18, 2019 in the aforementioned letter. These are the first comments we have on record that were provided by Meadows Development as part of the Dillon EA or the JP2g EA Addendum – this is probably an oversight in the original report, considering the communication that has occurred between Town staff and the developer's agents. No other written comments were received by our office on this topic from this developer.

Several issues were raised that need to be considered as part of the EA decision matrix. They can generally be considered Design, Approvals & Timing, Risk. In addition, Land Use Efficiency is also

considered. Each is discussed below, and then how those issues compare between the various alternatives, and are then scored, are discussed and displayed in a revised decision matrix.

Design – The MECP has had a LID design guideline in draft form for several years, is expected to remain as a draft for at least another year, and it does not provide sufficient design guidance to establish a methodology of design that would apply in all situations. Recently, the City of Ottawa published a summary document of the various design guides that have been developed. Many agencies have produced guidance materials In the absence of MECP leadership, but primarily CVC and TRCA, relying their experience in Southern Ontario.

The data shows that most LID projects in Ontario are proposed in areas that would be considered 'suspect', such as this site.

Because of the lack of guidelines, the Town of Perth produced a set of design criteria that was circulated to and commented on by both a peer reviewer with extensive experience with LIDs, and the Rideau Valley Conservation Authority. The revised performance criteria have been available for use since September 2019.

EA documentation is intended to provide a functional level of design guidance. It is understood that this proposed concept in the Jp2g Addendum is unusual and would require additional supporting material. A detailed model has been prepared, beyond what would be normally expected at this stage of planning. This model has been subjected to a peer review, and the comments have been responded to. We await their final comments.

Because the existing Meadows design has existing inverts and HGLs, any proposed design downstream of it is obligated to work with the existing grades as constraints. Any future designs tying into some downstream work would be obligated to work with the same existing grades. As long as the future downstream designs have an HGL that isn't above the existing design, and any future upstream designs have an HGL that isn't below the existing design, the system will be able to be safely designed in components

Approvals – The MECP has confirmed that their approval process is no different for a LID system or a more conventional approach – they will not review the project even at a functional level at the EA stage, or at a conceptual level at the time of draft plan of subdivision. At the time of the detailed design, they will take an average of 9 months to review and approve any design for stormwater management, drinking water storage, and for the sanitary pump station. They will rely on the local Conservation Authority to demonstrate their concurrence with the design and approach, and they will use any locally developed performance criteria in addition to their own. They will check to see that the application is consistent with the approved Master Servicing Plan (which, at this time, is the pipe/pump/and pond proposed by Dillon).

The Conservation Authority has provided their support to the concept, with detailed comments on expectations and requirements of performance. They and the County will review the conceptual designs at the draft plan of subdivision and the detailed designs at each phase of construction, and they will confirm that the proposal is consistent with the Master Planning documents, including any Subwatershed Plans, Master Servicing Studies, etc.

The Town has recently passed their Development Charges Bylaw 4839, and it presupposes the LID approach throughout the North of Seven development area. If some other approach to development is to be considered, this Bylaw would have to be reopened. This is likely to introduce delays, although it is not clear that it would affect the critical path.

Risk – All untried technologies are risky. Conveniently, what is being proposed is not an untried technology. It is essentially a very long French drain, without any expected exfiltration. All of the stormwater flow is expected to enter into the top of the swale, where a saw-toothed design creates trapped lows that ensure that the 1:5 year event infiltrates during the rainfall event. The void space is sufficient to contain a 24 hour 1:5 year event, and the flow rate through the clear stone is much, much slower than the flow rate in an open ditch. And it will discharge in the same location and at the same elevation as the current ditch drains to. The 1:100 year event would flow overland at low velocity, and discharges from the site with a hydraulic grade line above the 1:100 year flood level in Blueberry Creek.

The most significant risks are that sediment will accumulate within the stone, and be unable to be removed. This can be mitigated through choice of soil medium, planting, and underlaying the stone with a clean-out made of modular stormwater storage units with access ports. These may add to the design effort, but should not increase the cost of construction, as the cost of stored water is approximately for both modular units or blast rock.

An obvious risk is that winter will cause the topsoil to accumulate ice and become impossible to infiltrate. We have strange freeze-thaw cycles, and we often have to steam out culverts and catch basins, so it is obvious that this could also be a problem in this application. Concerns relating to LIDs in cold climates have been studied for 20 years to address just this problem. Experience from TRCA indicates that up to 30% of void space within the frost layer can accumulate ice over a winter, without decreasing the performance of the system. It is very important to have a minimum of clays in the topsoil layer, and to have sufficient organic material. There has to be sufficient underdrainage below the frost line to carry the winter flows (roughly half of the summer flows). Pathways would have to be installed above the ponding depth that would be expected with a restricted percolation rate and winter flows to avoid ice accumulation on the pathway beyond freezing rain events themselves.

There exists a risk at the time of construction, when adjacent properties are being developed prior to the vegetation fully establishing. Part of the role of the vegetation is to prevent clogging of the filter media – growth keeps flow paths open. This is why the Town intends to construct the first phase of the work themselves, to ensure that it is constructed and maintained properly during construction. But if adjacent properties experience sediment releases during construction, the developer is exposed to liability. This can be mitigated to some extent by ensuring that the underdrainage has the capacity to be cleaned out by installing hydraulic conduit below the stone. If sediment reaches the stone, it can be flushed out.

Land Use Efficiency – There is currently 11 ha to the north west of the existing ditch that drains toward the ditch on the land owned by the Meadows Development. It is suggested in the letter that there will be between 0 and 2 ha used in pathways, parks, and ponds. The existing ditch is 460m long, and the existing pond is 0.12 ha. There is likely to be a setback of 15m on either side of an open ditch, setting aside approximately 1.4 ha of land that can't be used for development.

The proposed pond would have a drainage area of about 9 ha. At 190 m3/ha, 1700m3 of operating range for quality treatment, and perhaps another 500m3 would be required to treat for quantity to ensure that the 1:100 year event is managed. At a 1.5m deep operating range, about 0.25 ha is required for the pond (depending somewhat on geometry). The remaining development land along Drummond would require an expansion to the existing pond – adding perhaps 70% (or bringing it to 0.2 ha)

Thus about 1.75 ha of land would be set aside for the ponds and creek. More land may be required, based on the details of the grading plan. This is consistent with the expectations in the letter, and we will assess on this basis.

For reference, the LID system that has been proposed would use 0.6 ha of development land – a difference of approximately 13 lots. A 20m right of way and 30m deep lots produce an 80m+ wide corridor for each double fronted road. At 460m, there is room for 5, but not 6, double fronted roads from east to west. That leaves about 60m to be distributed between the 5 roads – 6 meters per lot. So the lots could typically be 36m long. While large and comfortable, they would not tend to generate a higher assessed value or a higher sale price than a 30m deep lot. Taking 3m from the rear of each lot to be a municipal pathway and stormwater management system does not displace any development land, income, or tax revenue. The existing pond would be converted to an infiltration basin that would then drain into an underdrainage layer, storing a peak of 3000m3 during the 1:100 year event – requiring about 0.35 ha adjacent to the proposed LID. The 'spine' would require 6m width of development land, 460m long (less a number of road crossings, and the portion of the spine already considered in the infiltration basin)

Costs –The probable presence of shallow bedrock suggests the predicted construction costs may be low to construct a wet pond that can drain by gravity to Blueberry Creek, but in the absence of better information, we will continue to use the values shown in our Draft EA addendum. These are derived from the Dillon report, or superseded where indicated.

Revised Assessment

Initially, the information in the letter is used to confirm the scoring that has been done to date on the other approaches. There was nothing added that would change any of the existing scoring done by Dillon, or in our previous Draft. The inclusion of the underdrain adds marginally to the LID system, but this doesn't affect the scoring.

To add more nuance, in case that makes a difference, the costs have been assessed with both positive and negative 0.5 values possible using this approach:

- Less than 0.6 of average price = 1
- Between 0.6 and 0.8 of average price = 0.5
- Between 0.8 and 1 of the average price = 0
- Between 1 and 1.5 of the average price = -.5
- More than 1.5 of the average price = -1

To assess the use of a different drainage approach for the Meadows Development we have created a new option – Alternative F – that includes an LID system for the majority of the site, and a pipe-and-pond system for the Meadows Development.

Modifying Table 3.1 would require splitting out the areas – 11 ha undeveloped land northwest of the ditch, 3 ha undeveloped land along Drummond, 2.5 ha undeveloped land southeast of the ditch, and 4.3 ha of currently developed land along Sheppard Ave., vs a total development area of 85 ha. That amounts to 25% of the entire site. Using 25% of the costs for #4 and 75% of the costs for #7, Alternative F would have a Capital cost of $3.5 million, and an operating cost of $30 thousand/year. This would score +1 for each Capital and Operating costs, the same as the LID approach.

Using 75% scoring for the LID system, and 25% of the net scoring for #4, the total score for the Hybrid system comes to 7 3/8 positive, 1.5 negative, for a net of 5 7/8 positive attributes (effectively identical to the LID system, which has 8 positive and 2 negative attributes, overall of 6), without considering the additional criteria that have been suggested. The direction we have received from Town Staff is to proceed with the plans that have been in place since December 2018, unless another option is clearly better. In the absence of these other criteria, the Hybrid option is not clearly better.

To address those criteria, specifically Risk, Design, Approvals, Land Use Efficiency, we will compare them to the preferred alternative from the Dillon EA as the baseline. Results similar to the Preferred Alternative from Dillon would receive a score of 0, those much better than the Preferred Alternative would score +1, and those much worse than the Preferred Alternative would score -1.

For Risk, the concept of pumped stormwater always incurs some inherent risk. Both the LID system and the suggested alternative would have significantly less risk to both the Town and the Developer. Risk for the LID can be reduced to be comparable to a pipe and pond by ensuring the underdrainage has the capacity to be cleaned out. Both the LID and the suggested alternative would score +1

For Design, the complexity of a pump station, and ensuring that both the storm pump station and sanitary pump station can be both operated during severe events increases complexity, ensures that both the LID system and the combination of LID and conventional pipe-and-pond are significantly better. Both would score +1.

For Approvals, the expected timing of approvals is considered specifically. Scoring would be based on a comparison with the Dillon preferred alternative, it's median expected duration, and the spread of expected durations. The fraction of the range of uncertainty in the assessed alternative that is more than the median of the Dillon alternative scores negatively, and the fraction of the range of uncertainty that is less than the median of the Dillon alternative scores positively, and the sum provides the score. Thus, an alterative that covers the probable range of timing and effort that is the same as the Dillon alternative would score 0, while one that would have the shortest end of the range that is longer than the Dillon median duration would score -1, and one that would have the longest end of the range that is shorter than the Dillon median would score +1.

The Dillion approach, with pipe, pump, and pond, would require extensive design and front end costs. All development after the current condition would be contingent on the Town (or a developer with the capacity) to up-front the pump station design, approval, and construction costs. The critical path of the approval process would then be along 2 parallel tracks – the planning process through the County, and the sewer servicing process through MECP. The conceptual stormwater design, conceptual sanitary design, and conceptual water design would have to be completed for the portion of the subdivision upstream of the pond, even if those specific phases weren't being constructed yet. The preliminary

design of all of the infrastructure (2 months) would have to be completed prior to the conceptual design of the portion between the pond and phase 1 (3 to 6 months). This would be part of the submission to the County, which would then issue conditions for Draft Plan of subdivision (6 months). It generally takes a developer 6 months to a year to complete the required studies to clear those conditions, and then construction will take 6 months to a year, depending on scale. So optimistically, the Dillon approach would have taken more than 2 years to complete to a point of selling lots. The ECA process through MECP can be done somewhat in parallel. After the preliminary design, a detailed design of the water, sanitary, and storm systems, including the pump stations and pond, have to be completed over 9 months to a year. This is then submitted to MECP for approval, which takes another 9 months. Construction can begin prior to all of the approvals being received, but that would have to be established in the conditions of the subdivision approval.

The LID system would require a third parallel track. Preliminary design of the trunk of the LID system being constructed by the Town would be required to be completed prior to the developers beginning their conceptual design for the subdivision. It would still be 6 months to get draft plan approval, 6 months to a year to clear conditions, and 6 months to a year of construction. The LID system, because it is novel, can be expected to need to receive approval from the MECP as part of the conditions of Draft Plan of Subdivision.

The hybrid system would allow the ECA for the LID system to be taken out of consideration during the next phase of development. To do this, the Town would have to reopen their Development Charges bylaw to ensure that the servicing costs being shared by all of the developers North of Seven are being assigned an equal and fair distribution of the costs. While it is not clear that the Town would be prepared to do this, if they were so prepared, this is not expected to take less than 3 months to complete. This extra time has been added to the Draft Plan of Subdivision process.

This is summarized in Table 1, below:

Task	Dillon		LID system			Hybrid system	
	ECA	Subd.	ECA LID	ECA Subd	Subd.	ECA	Subd.
Preliminary design	2		2				
Conceptual design		3-6			3-6		3-6
Draft plan of subdivision		6			6		8-10
Detailed design	9-12	6	6-12	6-12	6	6-12	6
Subdivision approval		6-12			9-12		6-12
Infrastructure approval	9		9	9		9	
Total time (months)	20-23	23-32	17-23	17-23	26-32	15-18	23-34
Score		0			-0.5		-0.18

Table 1: Time estimate for approvals (months)

The Dillon preferred approach would take a median of 27.5 months to complete. Additional design time is included for submission for the ECA due to the amount of off-site works required. The LID system would require a median of 29 months, and the spread indicates a score of -0.5. The Hybrid system has a

median of 28.5 months to complete, while assuming that additional time is required to revise the Development Charges Bylaw. The timing of such a process is uncertain, and we have used an additional 2-4 months as an educated guess. The range of probable durations is 23 to 34 months, producing a score of -0.18. If it is possible that revising the development charges could be concurrent to the conceptual design, the expected duration would be 21 to 30 months, and would therefore score +0.44.

For land use efficiency, the pipe-pump-and pond expected a single pond and some kind of open-space block in the area of the existing pond, for 2.1 ha of un-developable land. The LID uses 0.6 ha of development land within the Meadows Development, and 0.3 ha in the rest of the site, for a total of 0.9 ha – a difference from the Dillon approach of 1% of the entire site. The hybrid system uses 1.75 ha on the Meadows Development, and 0.3 ha on the rest of the site, for a total of 2.05 – effectively the same as the Dillon approach. Thus the hybrid system scores 0, while the LID scores some small value greater than 0. Due to the limitations of developable land within the Town boundaries, a difference of approximately 20 possible lots is non-trivial.

The Town staff have provided additional input, including indicating a reluctance to have multiple ponds if they can be avoided, a reluctance to reopen the Development Charges Bylaw, and a reluctance to have to develop operational policies for multiple types of SWM facilities (they currently have none). While these are not being specifically scored in the decision matrix, they remain considerations.

	Comb. 1	Comb. 2	Comb. 3	Comb. 4	LID	Hybrid
Feasibility	-	++	+-	+-	+1	+1
Compatibility	-+	++	-+	++	+1	+1
Constructability	-+	++	-+	++	-	-1/2
Maintainability	--	--	-+	-+	-	-1
Terrestrial	++	-+	+-	--	0	0
Aquatic	++	-+	+-	--	+1	+7/8
Groundwater	++	-+	0	0	+1	+7/8
Surface water	0	0	0	0	+1	+7/8
Water Quality	++	-+	++	-+	+1	+7/8
Displacement	--	+-	0	0	0	0
Disruption	--	+-	--	+-	0	0
Aesthetics	++	0+	0	0	+1	+7/8
Capital cost	0	-0.5	-0.5	-1	+1	+1
Operating cost	0.5	-0.5	0.5	-0.5	0	0
Risk		0			+1	+
Design		0			+1	+
Approvals		0			-0.5	-0.18
Land use efficiency		0			0+	0
Total +	5.5	4	1.5	2	10+	9 3/8
Total -	-4	-2	-1.5	-3.5	-1	-1.68
Balance	1.5	2	0	-1.5	9+	7.69

Table 2: Revised decision matrix

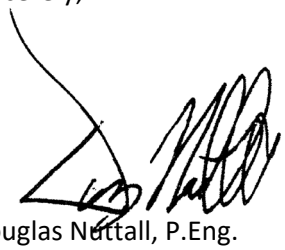
In Table 2, the combinations 1 through 4 are the combinations found in the Draft EA Addendum. The LID system is what is found in the Draft EA Addendum, but including the underdrain mentioned above. Combination 2 is the recommended solution from the original Dillon EA and includes a pump station, and the LID is the preferred solution in the Jp2g Draft EA Addendum. The Hybrid system considers 75% of the site draining through LID, and 25% draining through pipe-and-pond (pump station excluded). Thus the scoring for the Hybrid system assume 25% of Combination 2 (w/o PS), and 75% of LID.

Cells highlighted in blue were adjusted from the original Dillon EA, due to the synergies of the combinations. Cells highlighted in green were adjusted from the original Dillon EA, due to the methodology used to score costs. Cells highlighted in grey are revised from the Draft EA Addendum as a result of the changes in scoring for costs.

Both the LID and Hybrid approaches are substantially better than the original options. If the alternative approach was taken, with concurrent Development Charge Bylaw amendments and Conceptual Design, the Hybrid system would score +9.81 and -1.8, for a balance of +8.32. Thus, the Hybrid system does not score as well as the LID system, regardless of approach.

As such, we will still recommend that the LID system be implemented throughout the North of Seven development area.

Sincerely;



Douglas Nuttall, P.Eng.

Senior Civil Engineer

cc. Adam O'Connor

January 6, 2020
Ref. No.
66574

To: **Grant Machan**
Director of Environmental Services
Corporation of the Town of Perth
80 Gore Street East
Perth, ON, K7H 1H9

From: **Chris Denich, M.Sc., P.Eng., Alison Gingrich Regehr, MASc, Aquafor Beech Ltd.**

Re: **North of 7 Master Plan, Functional Stormwater Management Plan (December 18, 2018) – Peer Review, Response to Jp2g Consultants Comments (September 10, 2019)**

1 Introduction

Aquafor Beech was retained by the Town of Perth to conduct a peer review of the North of 7 Master Plan, Functional Stormwater Management Plan (December 18, 2018). An initial peer review was submitted to the Town of Perth on August 20, 2019, with two memos prepared in response by Jp2g Consultants Inc. dated (September 10, 2019). Aquafor Beech has reviewed these two documents, and has prepared the following memo for submission to the Town of Perth which details the results of our review.

2 List of Documents Reviewed

The following documents have been reviewed as part of this assignment:

1. North of 7 Master Plan Functional Stormwater Management Plan Peer Review Comments, Jp2g, September 10, 2019 (No. 2161774B)
2. Re: North of Seven EA, JP2G, September 10, 2019 (No. 2161774A)

The following documents were reviewed in the initial peer review, and referenced in the subsequent comments below:

3. North of 7 Master Plan Functional Stormwater Management Plan, Jp2g, December 18, 2018 (No. 216177B)
4. No7 Storm Design (inc ex Meadowview) (version2) Excel Spreadsheet Model
5. No7 Storm Design (inc ex Meadowview) (version2a) Excel Spreadsheet Model

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3 Functional Stormwater Management Plan and Excel Spreadsheet Models

To maintain continuity with the previous peer review documents, the same numbering scheme has been maintained. No further comments are provided for items 2, 3, 8, and 10.

1 & 4. Although no expectation of exfiltration out of the clear stone trench was assumed or required for the design, some exfiltration will nevertheless occur as the trench is lined with a permeable geotextile liner. Although it was assumed "that there is effectively no infiltration into the underlying soils due to the clay content and the high groundwater elevation" (Jp2g No. 2161774A) these assumptions were not confirmed. Clay content in soil does not preclude infiltration; clay loams typical to the area can have infiltration rates from 5-10 mm/hr. These assumptions can influence:

a) The dimensions of the drainage infrastructure. Taking infiltration rates into consideration may allow for smaller dimensions of the clear stone trench.
b) Groundwater mounding and quality. Exfiltration from the clear stone trench may cause groundwater mounding. This higher groundwater elevation may negatively impact surrounding infrastructure. Additionally, a 1m vertical separation between the invert of the facility and the seasonally high groundwater elevation is recommended. This recommendation is not just to mitigate the influence of groundwater on the LID facility, but also to protect groundwater quality by providing additional filtration through the vadose zone.
c) The post-development water balance. Despite having clayey soils, the pre-development water balance would have an infiltration component. The proposed urban development will reduce infiltration, which may be mitigated by the infiltration from the clear stone trenches.

It is therefore recommended that as part of detailed design:

a) Infiltration testing be completed as part of a preliminary geotechnical investigation as part of detailed design. Borehole permeameter, Guelph permeameter, double-ring infiltrometer or other test as outlined in the Low Impact Development Stormwater Management Planning and Design Guide (STEP, wiki format – wiki.sustainabletechnologies.ca) should be conducted to confirm the native soil infiltration rate. In addition, a safety factor (minimum of 2.5) should be applied to the infiltration rate. If more permeable "blast-rock and engineered fill" as

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noted in Section 3.2 is placed above the less permeable native soils, the safety factor should be increased to account for a stratified soil condition and the effect of the less permeable native soils acting as a limiting layer, as described within the LIDSWM-PDG Wiki: https://wiki.sustainabletechnologies.ca/wiki/Design_infiltration_rate#Saf.

b) Groundwater monitoring should be undertaken as part of detailed design to ensure there is a recommended vertical separation of 1m between the invert of the facility and the seasonally high groundwater elevation.
    a. If the 1m offset cannot be accommodated, a hydrogeological and/or groundwater mounding analysis is recommended.
    b. The duration that the groundwater elevations is at or above the proposed facility invert should be confirmed.
    c. An assessment of the seasonal groundwater effects on the proposed facility, specifically on the storage and infiltration losses should be completed.
    d. Based on a) to c) above, confirm if the proposed facility in its current configuration and depth is appropriate for this site or if design modifications are required.

5. The modelling does not currently take into consideration the native soil infiltration rate. If volume loses are to be counted towards reduced dimensions of the drainage infrastructure as part of detailed design, it is recommended that the modelling be revised to consider the results of the infiltration testing recommended above.

6. There is lack of clarity regarding the SSA model outputs provided in Appendix D of the SWMP:
    a) The element IDs from Table D-5 are not correlated to the figures or spreadsheet model, so it is unknown which segment listed in Table D-5 is draining the cemetery, as discussed by the Jp2g response.
    b) Table D-5 indicates swale depths from 1.63m to 2.24m, which are far greater than the maximum swale depth of 0.3 to 0.45m indicated in the specific key design elements from September 10, 2019 (No. 2161774A).
    c) The maximum depth for Stor-35 in Table D-5 was 3.65m, which is 1.65m greater than the depth of swale (2.0m).

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Prior to detailed design, it is recommended to clarify the correlation between the spreadsheet and SSA model outputs, including a figure to indicate the location of each element ID. It is also recommended to confirm swale depths, and increase the trench size and/or depth to achieve the maximum swale depth and minimum freeboard in all locations.

9. Ongoing monitoring was mentioned in the SWMP, and the Jp2g Peer Review Response (No. 2161774B) indicates that the performance results from the monitoring station will be used to trigger maintenance. It is therefore recommended that a monitoring plan be developed in addition to the maintenance plan to determine when maintenance is necessary. This monitoring plan should include personnel time for analyzing the monitoring data in a timely manner.

4 Conclusions:

Based on this review, we conclude the following:

1. The comments as provided by Aquafor Beech (August 20, 2019) have been sufficiently address at the current level of detail/ analysis of Jp2g's feasibility assessment.

2. The 'novel approach to stormwater' as proposed by Jp2g, is a not by definition a specific type of LID practice per the LIDSWM-PDG (2010 or Wiki) and would more accurately be defined as an "alternative drainage system". However, the Jp2g's proposed approach does share some similarity and components of various LID approaches such as Bioswales, Enhanced Swales and Soakaway Pits. Care should be taken to both justify:
    - the guidance referenced and applied in detailed design; and
    - the various components of the system to ensure functionality given the stated criteria as outlined by Jp2g.

3. As an "alternative drainage system" a detailed monitoring plan is recommended to demonstrate compliance with the stated design criteria, to ensure the long-term performance and to inform and advance the state of the practice.

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4. We are satisfied that this alternative is a feasible alternative to the existing EA document, however, further analysis of this alternative is required as part of subsequent detailed design - as detailed within the above and Appendix A and B

Sincerely,
AQUAFOR BEECH LIMITED

Chris Denich., M.Sc., P.Eng.
Director of Water Resources and Green Infrastructure
Phone: 519-224-3744;
email: denich.c@aquaforbeech.com

LICENSED PROFESSIONAL ENGINEER
JAN 10/20
C. J. DENICH
100134582
PROVINCE OF ONTARIO

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Appendix A: Aquafor Beech Peer Review (August 20, 2019)

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Appendix B: Jp2g Consultants Peer Review Response (No. 2161774A and 2161774B, September 20, 2019)

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From:	Phil Mosher
To:	Doug Nuttall
Cc:	Evelyn Liu; Grant Machan
Subject:	RE: North of Seven EA addendum
Date:	Thursday, February 6, 2020 3:31:35 PM
Attachments:	image011.png Marine_Clay_Maps.pdf

Hi Doug,

Please see our comments below:

1. RVCA supports the peer review undertaken by Aquafor Beech dated September 10, 2019 and January 6, 2020. It should be noted that our office was circulated the most recent peer review from January 6, 2020 on January 28, 2020 and requested to provide comment by February 7, 2020. We specifically support the following statements:

    a. Section 3 (Functional Stormwater Management Plan and Excel Spreadsheet Models),

        i. Points 1 & 4. Technical review staff also had concerns with depth to the water table. We therefore support the recommendation for groundwater monitoring.

        ii. Point 6. Technical review staff within our office also had comments related to the depth of swales and general ditching/swale plan. We therefore support the recommendation for confirmation of swale depths and increasing the trench size and/or depth to achieve the maximum swale depth and minimum freeboard in all locations.

        iii. Point 9. Technical review staff within our office also had questions about maintenance of the proposed LID facility. Therefore, we support a monitoring station, or test pilot location, which will be used to trigger maintenance. We further support a monitoring plan being submitted to demonstrate the details of monitoring as well as the maintenance plan.

    b. Section 4 (Conclusions)

        i. Technical staff in our office have a general knowledge of LID practices, therefore we appreciate the more specific review and conclusions by Aquafor Beech.

        ii. We support conclusion 4, that the alternative is feasible to the existing EA, but that further analysis is also required as part of future detailed design.

2. Our office also has some general comments regarding the EA addendum:

    a. A general map should be provided showing the general location of all features mentioned in the addendum. These include: ditches (on and off site), major roads, Blueberry Creek, the wetland, the locations of outfall #1 and #2, and where flow will be “leaving the site”.

b. On Page 4, Table 3 of the EA addendum, it should be confirmed that system performance will appropriately account for the 1:2, 1:10, 1:25 and 1:50 year events in addition to the 1:5 and 1:100 events.
c. The areas “A”, “B”, and “C” in Appendix C, Table C-1, C-2a and C-2b, if they are existing catchments, should be shown on the map for existing conditions.
d. Confirmation on the draw down time for the proposed clearstone trenches should be provided.
e. Overland flow routes should be confirmed and shown in the map.

3. As previously discussed with representatives from Jp2g, our office recommends an analysis of the existing watercourses (headwater drainage features) be completed in advance of development.

4. Recently, our office has been identifying sensitive marine clays, as these are a hazard recognized by the PPS. It has come to our attention that these clays are present within the vicinity of the North of 7 EA area. Therefore, our office recommends that geotechnical investigations be undertaken in advance of development to confirm that these hazards can be mitigated. We have attached a map showing the extent of these hazards.

Phil Mosher
Planner RPP, MCIP
phil.mosher@rvca.ca, ext. 1181 (Manotick) 613-267-5353 x 131 (Tay Valley)

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From: Doug Nuttall <dougn@jp2g.com>
Sent: Friday, January 31, 2020 3:32 PM
To: Phil Mosher <phil.mosher@rvca.ca>
Subject: RE: North of Seven EA addendum

“Hope for end of February” is not good.

We’ve received comments from RVCA 3 times, and used those comments to establish the criteria and scoring – the comments received did not change either the criteria or scoring that was used in the original North of Seven Infrastructure Master Plan (not surprising, since the CA’s concerns were included from the beginning, and the CA concerns don’t tend to change much with time), but added consideration for source water protection, downstream channel morphology, etc. Now that we have

the Peer Review (the last thing that RVCA had asked for to be included), we intend to wrap up the report before Friday February 7. You will have to let me know before then if you have something that is going to change the criteria or scoring.

In our last discussion in December, I asked specifically about the existing ditch being a HDF. This was not raised previously, in part because it was not part of the RVCA approach back in 2012. Now it is. When I do a back-of-the-envelope assessment, it comes out as maybe: Hydrology = Contributing functions, Riparian = Limited, Fish habitat = Contributing, Terrestrial habitat = Limited. That would come out as 'Mitigation'. Due to the flat terrain and clay soils, this is the 'lowest' score it could receive.

'Mitigation' has a recommended management that includes LID stormwater management, but also speaks of replicating or enhancing ecological functions. In Table 9 of the guide, it says that Natural Channel Design would not be required, but the channel must remain open, and the ecological function of the system is to be replicated downstream of the treatment facilities.

Either of the two approaches being considered right now (LID system intercepting offsite flows and conveying it subsurface to Blueberry Creek floodplain, or pipe-and-pond system, with offsite flows being maintained in the existing ditch, and all urban flows being treated by individual ponds on either side of the ditch) would be constrained by a simple interpretation of the HDF guideline. The storm ponds would have to be placed significantly upstream of the Blueberry Creek flood plain to allow room for those enhanced ecological functions, or the use of an LID system would prevent the existing channel from remaining 'open'.

If a) you think that this ditch should be considered as a HDF, and b) you perceive that there is a simple resolution to the issues I mention above, then say so in writing this week coming, and we will finalize the EA by adding "Section 2.3 Additional Constraints", and we will say something like "Review by the RVCA has indicated that, in addition to the HIA and EIS indicated in Table 2.2 above, there will be a requirement as part of the subdivision process to perform a Headwater Drainage Feature Assessment on the existing drainage courses crossing the site, and that the conclusions of that study will be used to guide the design of the planned infrastructure".

If not a), then we're good. Report stands as is.

If 'yes' to a) but 'no' to b), then you expect that we will still be working at finding a resolution after the 7th, and we will issue the EA addendum without reference to the HDFs (since we have no correspondence relating to them on this site at this time), and then you will have the opportunity to provide any further comments during the review period (30 calendar days? 45? I dunno what it's supposed to be).

I can't really hold this up – the developer is champing at the bit that this wasn't finalized in September (the original timeline), and if you're not going to say something that is going to change the preferred alternative, then I can't justify waiting for your comments.

Douglas Nuttall, P.Eng.

Senior Civil Engineer

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C: 613-281-8762
40 Sunset Drive, Suite 40, Perth, Ontario, K7H 2Y4

Jp2g Consultants Inc.
ENGINEERS · PLANNERS · PROJECT MANAGERS

From: Phil Mosher <phil.mosher@rvca.ca>
Sent: Friday, January 31, 2020 2:17 PM
To: Doug Nuttall <dougn@jp2g.com>
Subject: RE: North of Seven EA addendum

Hi Doug,

I will commence review next week and follow-up with Evelyn. We will hope to have any comments by the end of February.

Phil Mosher
Planner RPP, MCIP
phil.mosher@rvca.ca, ext. 1181 (Manotick) 613-267-5353 x 131 (Tay Valley)

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From: Doug Nuttall <dougn@jp2g.com>
Sent: Tuesday, January 28, 2020 11:11 AM
To: Phil Mosher <phil.mosher@rvca.ca>
Subject: North of Seven EA addendum

I am attaching the Peer Review that we received on the 20th of January for the above noted project.

Can I get any comments you have as soon as possible? I am trying to wrap up the report. Thus far, we have verbal comments from Martha (2016), written comments (March 9, 2018), verbal comments

fall of 2019. We now have the peer review comments, which will be incorporated in the report you've already seen (edits being made this week).

Maybe you can forward Evelyn's comments to me as a 'draft', so I can start making edits, without finalizing until we have a final version of your comments?

Maybe you can compare Evelyn's comments to the Peer review comments, and see if there are differences that matter – if not, we're done. If there are difference that matter, then maybe have Evelyn revise her comments with consideration of the Peer Review's comments.

Douglas Nuttall, P.Eng.
Senior Civil Engineer

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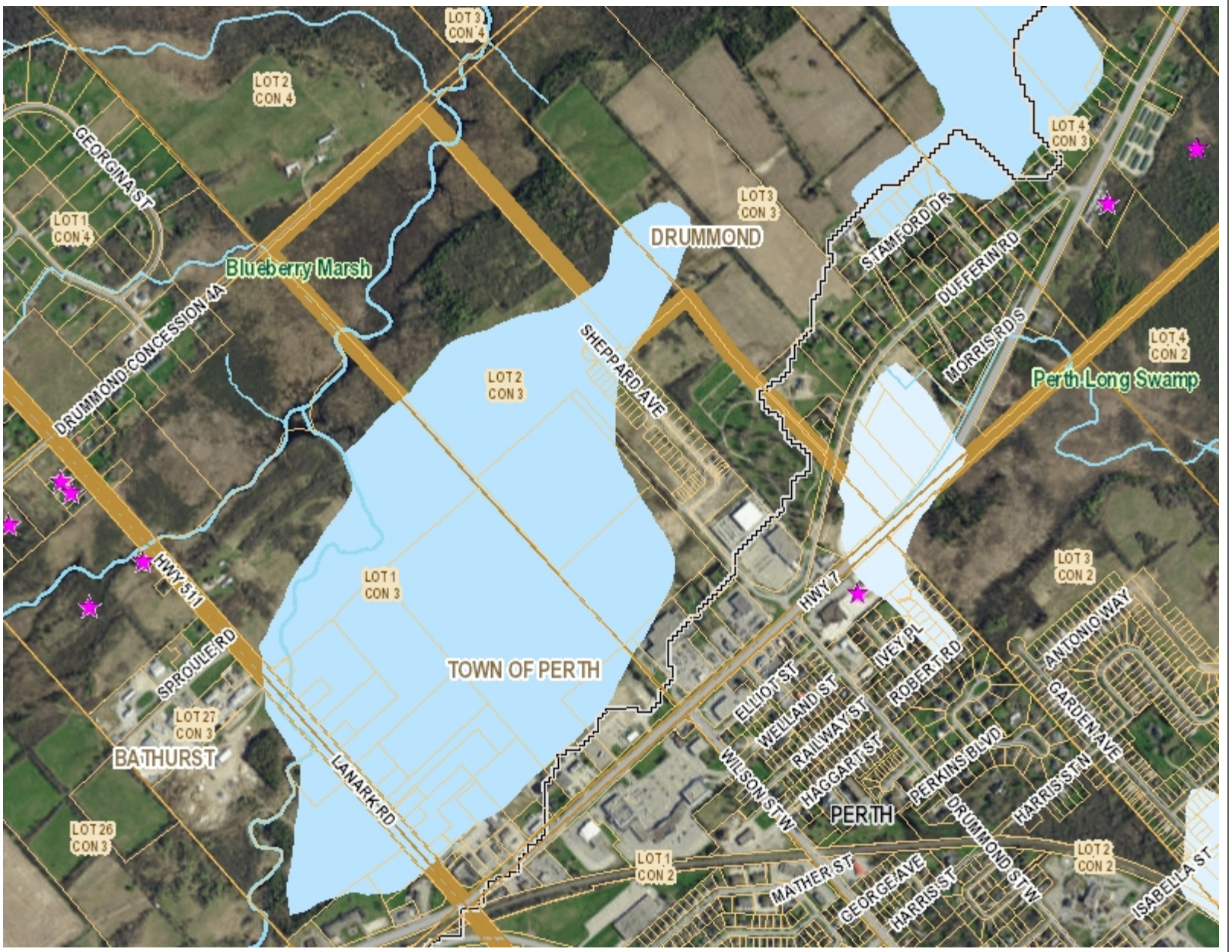
GSC marine clays

RIDEAU VALLEY CONSERVATION AUTHORITY



Legend

- Parcel Activity
- Parcel - Assesment
- Lot
- RVCA Sub-Watersheds
- RVCA Catchments
- Landslides
- Landslides, propable
- Landslides, possible
- Landslides, former site of
- Sediment Genesis - colluvium
- Sediment - clay or silt
  - clay
  - silt

Notes

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648.6 0 324.29 648.6

Meters

Map created: 2/6/2020

N

1: 12,767.37

Map Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

Appendix C – Functional SWM Plan

Submitted by:
Jp2g Consultants Inc.
1150 Morrison Drive
Ottawa, ON K2H 8S9
T 613.828.7800
Jp2g Project Number: 216177B

North of 7 Master Plan

Functional Stormwater Management Plan

December 18, 2018

Prepared for: Town of Perth

80 Gore St East
Perth, Ontario
K7H 1H9

Contents

1. Introduction

In October 2013, an Infrastructure Master Plan for Area North of Highway 7 was completed by Dillon Consulting for the Corporation of the Town of Perth. This study found the preferred stormwater management (SWM) system to be a conventional pipe-and-pond system complete with a mechanical pump station to lift water into the centralized wet pond before discharging to Blueberry Creek. It was noted that this system would incur significant life-cycle costs, estimated at more than $10,000,000 over the next 40 years, which may render development of the land uneconomical.

Jp2g Consultants was contracted to review the Environmental Assessment (EA) prepared by Dillon and determine if consideration of alternative, potentially more economical, stormwater management solutions would make it worth re-opening. This assessment found that it would be appropriate to reopen the EA to review SWM alternatives. In this addendum, Jp2g proposes a storage-based system consistent with Low Impact Development (LID) principles, using low-slope swales with massive under-drainage capable of providing quantity and quality treatment without the need of a lift station. This approach is estimated to require significantly lower life-cycle costs due to lower operational and energy requirements.

This report provides a functional stormwater design report that describes the proposed system and presents preliminary modeling results to demonstrate proof-of-concept performance.

2. Background

2.1. Previous Reports

Appendix A includes the relevant sections of the Dillon Environmental Assessment (EA) relating to stormwater management. Appendix B contains letters to the Town of Perth, describing how it was determined that reopening the EA would be appropriate, and discussion of potential criteria for an atypical SWM system to be assessed by regulatory agencies.

2.2. SWM Constraints

The study area is bounded by existing development to the south and east, undeveloped land and the Elmwood Cemetery to the north and east, and the Blueberry Creek floodplain to the west, which also serves as the system outlet. Offsite flows will come from the existing cemetery, which is approximately 0.6 m above the flood plain and 700 m upstream of confluence with Blueberry Creek. With a conventional pipe system, the pipe diameter increases down the line while matching obverts; in this case, such a system would produce a pipe invert significantly below the bank-full elevation and require a pumping station and pond system to outlet above the downstream bankfull elevation of 137.0 m.

The proposed system will utilize oversized subsurface trenches of clearstone to provide quality and quantity control while outletting to the Blueberry Creek floodplain at an invert of 137.0 m.

3. Stormwater Management

3.1. Existing conditions

The site is an 85 ha parcel that is bordered by the existing highway commercial development along Highway 7 to the south, and the Blueberry Creek and Blueberry Creek Provincially Significant Wetland (PSW) to the north, the existing Highway Commercial/Industrial development along Highway 511 to the west, and the Elmwood Cemetery to the east, as shown in Figure 1 below.

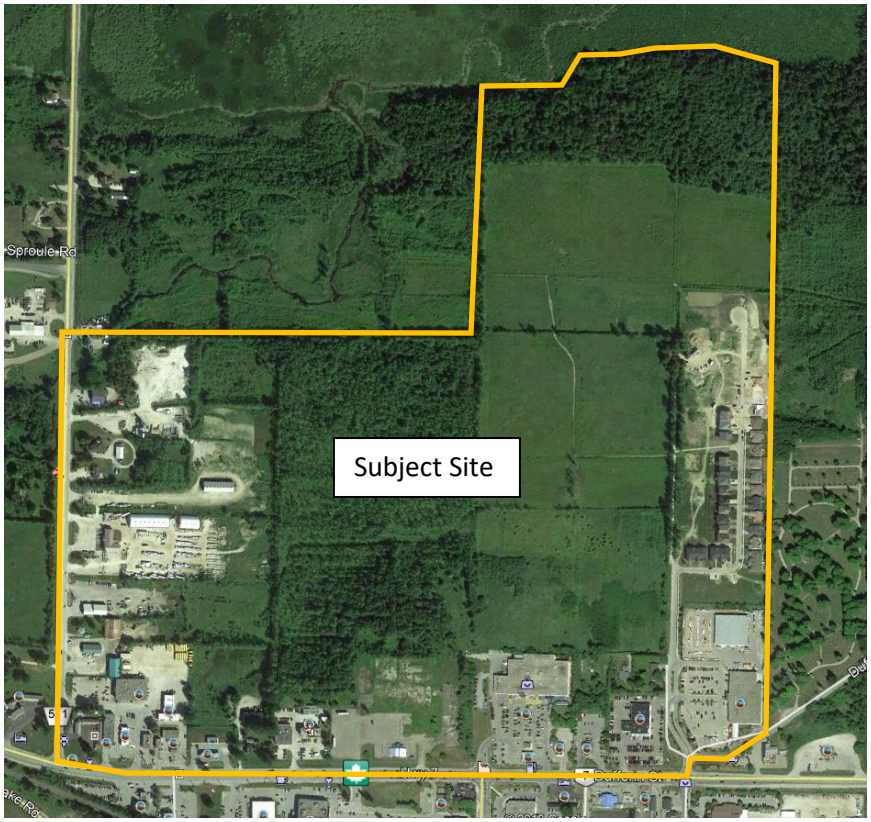

Figure 1. Existing Conditions

The land is fairly low, rising to the east and south. Most of the subject land is vacant, but the planning boundary includes the existing Meadows development along the eastern limit of the site and highway commercial/industrial along Highway 511. A 4 m high berm exists between the site and the PSW – the top of this approximately 60 m from the wetland proper.

The area's soils are clay with a very low slope and sparse vegetation cover. A high groundwater elevation is expected, and a portion of the site is part of a 'spill area' of the Blueberry Creek flood plain. Contours indicate this spill is trapped, so while some of the site may become inundated during flooding events, there is no conveyance downstream.

It is assumed the time of concentration is governed by the flow within the ditching on site and off. It is assumed because of the clayey soils and low slopes, that the predevelopment runoff coefficient is 0.3 for the 1:5 year event, and 0.375 for the 1:100 year event. The Meadows site has been modeled previously, and the runoff rates have been taken from the Conceptual SWM Report for that Subdivision proposal (McIntosh Perry 2016). Offsite areas, estimated to be about 20 ha, drain from the east through this site and into Blueberry Creek. The land there is level, lightly forested meadow, and it is assumed to have a Time of Concentration of 15 minutes to reach the ditching, and a runoff coefficient of 0.3 for the 1:5 year event and 0.375 for the 1:100 year event. Runoff from offsite drains through an existing ditch that is 700

m long and has a slope of 0.1%. The values shown in Table 1 were developed using the method described in the City of Ottawa Sewer Use Guideline.

Table 1. Runoff Flows in Existing Condition [cms]

Rain Event	Offsite	Meadows	Outfall 1	Outfall 2
1:5 year	0.98	0.21	1.06	0.53
1:100 year	2.08	0.44	1.33	0.67

3.2. Proposed Development

Using a setback of 30 m from the existing PSW, the proposal would be to develop 52.7 ha of residential and open space, and 9.34 ha of industrial/commercial adjacent to Highway 511. The remainder of the site (14.4 ha) would remain undeveloped along the PSW and the 30 m setback from the PSW. Much of the site would be filled with blast-rock and engineered fill to provide grading for servicing and drainage. Please refer to Figure 2 below for a concept layout.

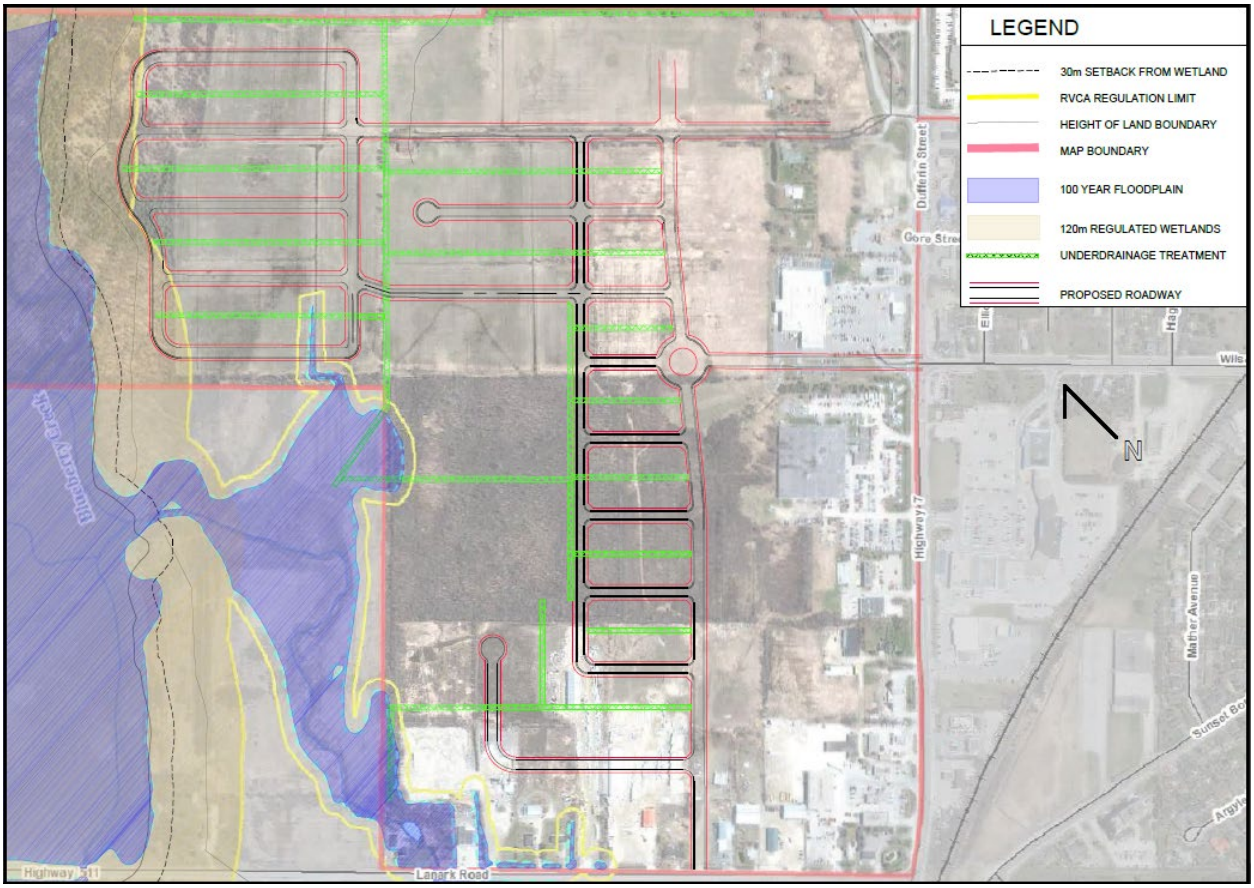

Figure 2. Proposed Development

The southern part of the site will be serviced from the existing infrastructure along Highway 7. The northern portion of the site will require a sanitary pump station while storm water will drain by gravity to Blueberry Creek. This has been simplistically modelled using the Rational Method, assuming open ditches with 0.1 % longitudinal slope, 3:1 cross fall, and without ponding behind roadway culverts. The results in Table 2 show that quantity treatment is required. See Appendix C for the Stormwater Design Sheets.

Table 2. Post-Development Flows – without treatment [cms]

Rain Event	Offsite	Meadows	Leaving site	Allowable
1:5 year	0.98	0.21	2.98	1.59
1:100 year	2.08	0.44	4.14	2.00

3.3. Quality and Quantity Treatment

The proposed open swale system would have an overall slope of approximately 0.1 % in order to drain from the upstream cemetery to the downstream confluence on Blueberry Creek without a lift station. It should be noted that such a flat system may be prone to undesirable sediment accumulation and ponding and the depth, duration, and velocity of overland flow must be carefully managed to protect public health and property. The criteria for the proposed system was developed in consultation with the Town of Perth and were selected to meet industry-standard Best Management Practices (BMPs).

Appendix B contains a list of criteria that are expected to be met with any detailed design of the Stormwater Management system. The system has been modeled to confirm that these criteria are able to be met. It is understood that during the conceptual and detailed design, all of these will have to be tested and confirmed. Table 3 shows the list of criteria to be met in the detailed design stages.

Table 3. Detailed Design Criteria

Criteria	System Performance (Functional Design Level)	Achievable in Detailed Design?
For the 90%ile rainfall event, an average of 80% or better quality treatment is achieved along the system.	90%ile event is 19.3mm of rainfall. System can capture runoff from 48mm event.	Yes.
During the 1:2 year event, all of the runoff from the site can infiltrate into the clearstone trench during the event without producing runoff.	Infiltration rate is expected to be 50mm/hr, sufficient to infiltrate more than the 1:2 year event without overland flow.	Yes.
During the 1:2, 1:5, 1:10, 1:25, 1:50 and 1:100 year events, the peak flow rate reaching the creek in post-development conditions is not greater than that in pre-development conditions.	Demonstrated for 1:5 and 1:100. Peak post-development flows are significantly less than pre- development flows.	Yes.
Show that the sediment accumulation within the treatment swale can be reasonably managed with spot treatment accessed by	Sediment accumulation will average 2 T/ha/year, based on Perth average. This would	Expected. Should be tested.

small vehicles (2.4m wide access) and/or local ditch clean out upstream of the road crossings	produce 0.1 m depth of sediment annually upstream of the road crossings	
Show that the sediment accumulation within the clearstone trench can be reasonably managed with spot treatment accessed by small vehicles so that the expected lifecycle of the system would be a minimum of 40 years.	Literature suggests 95% quality treatment is reasonable, and much of what passes will be colloidal. Assuming 5% of original TSS settles within the stone (0.15 m^3/yr per 'rib') it would fill 1 cm of the stone trench over 40 years.	Expected. Should be tested.
Demonstrate predicted performance by ongoing monitoring in multiple locations.	N/A	To be evaluated.
Use a qualified peer review to ensure the design can be expected to achieve the designated targets.	This document is to be circulated to peer reviewer for comment.	Expected.

4. Hydrologic and Hydraulic Model

The proposed SWM system was modeled in Autodesk's Storm and Sanitary Analysis (SSA) 2019 using the SCS TR-55 hydrology method. Each 'rib' of the SWM system, representing a section of clearstone trench collecting along the backyards and discharging to a central 'spine', was modeled as a storage node and outlet link. These storage nodes represent the quantity treatment provided by the clearstone, while the 'spine' provides the conveyance required to disperse overland flow. The SSA plan is shown in Figure 3 below.

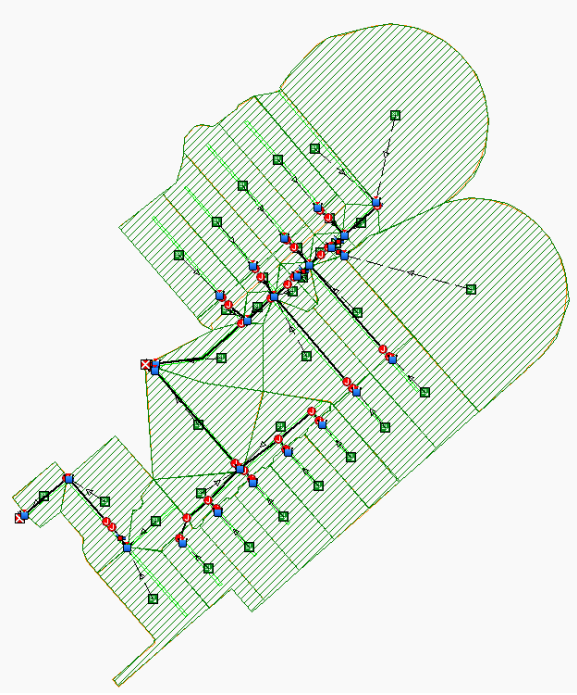

Figure 3. Autodesk SSA Schematic

The model was simulated with the 1:5 and 1:100 year events using the SCS 24-hour cumulative rainfall storms and historical 24-hour rainfall data for the Perth area from Environment Canada. Table 4 summarizes the proposed SWM system output at two outfalls into Blueberry Creek at 137.0 m.

Table 4. Outfall Rates to Blueberry Creek (cms).

Rain Event	Outfall 1 Pre-dev	Outfall 2 Pre-dev	Outfall 1 Post-dev	Outfall 2 Post-dev
1:5 year	1.06	0.53	0.11	0.01
1:100 year	1.33	0.67	0.92	0.08

Detailed output tables for the SSA model are available for reference in Appendix D.

5. Conclusion

This functional SWM report demonstrates that the 1:5 and 1:100 year rainfall events can be managed effectively with a wide clear stone trench underlying surficial swales, obviating the need for a cost- and resource-intensive lift station. Comparison of Tables 1 and 4 demonstrates that the proposed storage-based system can achieve post-development runoff rates at or below the pre-development rates at a conceptual level. Further detailed design and modeling will be required to prove constructability and provide more detail on quality and quantity control.

Prepared By:

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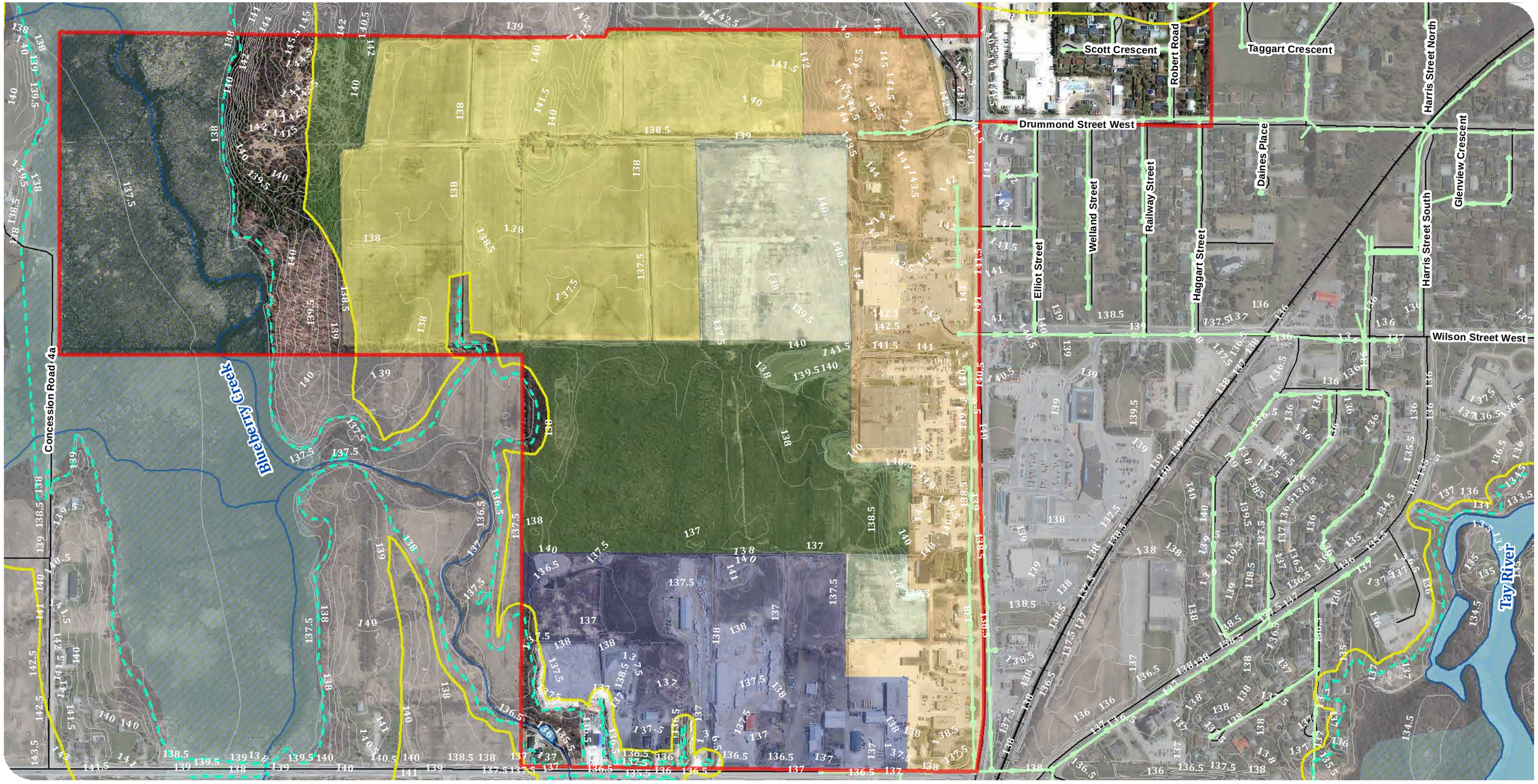
Appendix A – Excerpts from 2013 Environmental Assessment



Town of Perth
Infrastructure MasterPlan

Existing Wastewater Servicing

FIGURE 11

Study Area Boundary
RVCA Regulation Limit
Floodplain
Wetland
Waterbodies
Watercourses
Agricultural Land
Commercial Land
Industrial Area
Pasture/Lawn
Woodland
Existing Sanitary Network
Contours
Roads
Railway

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

0 45 90 180 270 360 450 Meters

1:5,500

N E S W

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2010\103930\Design_GIS\MXDs

PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013

Conditions in Greenly's Corners

Greenly's Corners is located south of Highway 7 and is bound by Drummond Street to the west, Robert Road on the south and the extension of Garden Avenue on the east. This area is outside the primary study area, but was included in the study to address existing issues with the pump station**.** The *Robert Road Sanitary Sewer Pump Station (Robert Road SSPS)* is located at the east end of Robert Road and services 26 residences located along Robert Road and Ridgeview Place. This pump station operates with only one pump and has a history of overflowing on at least three occasions in the past. This is primarily due to the lack of a dedicated electric generator for use during power outages. This pump station is a hundred percent utilized. Based on this information it is projected that this pump station is adequate for its current use, but would need extensive reconstruction to become a part of the sanitary sewer upgrades for the areas north of Highway 7.

5.4 Stormwater Management and Drainage

5.4.1 Existing Stormwater Management Conditions

Surface Drainage

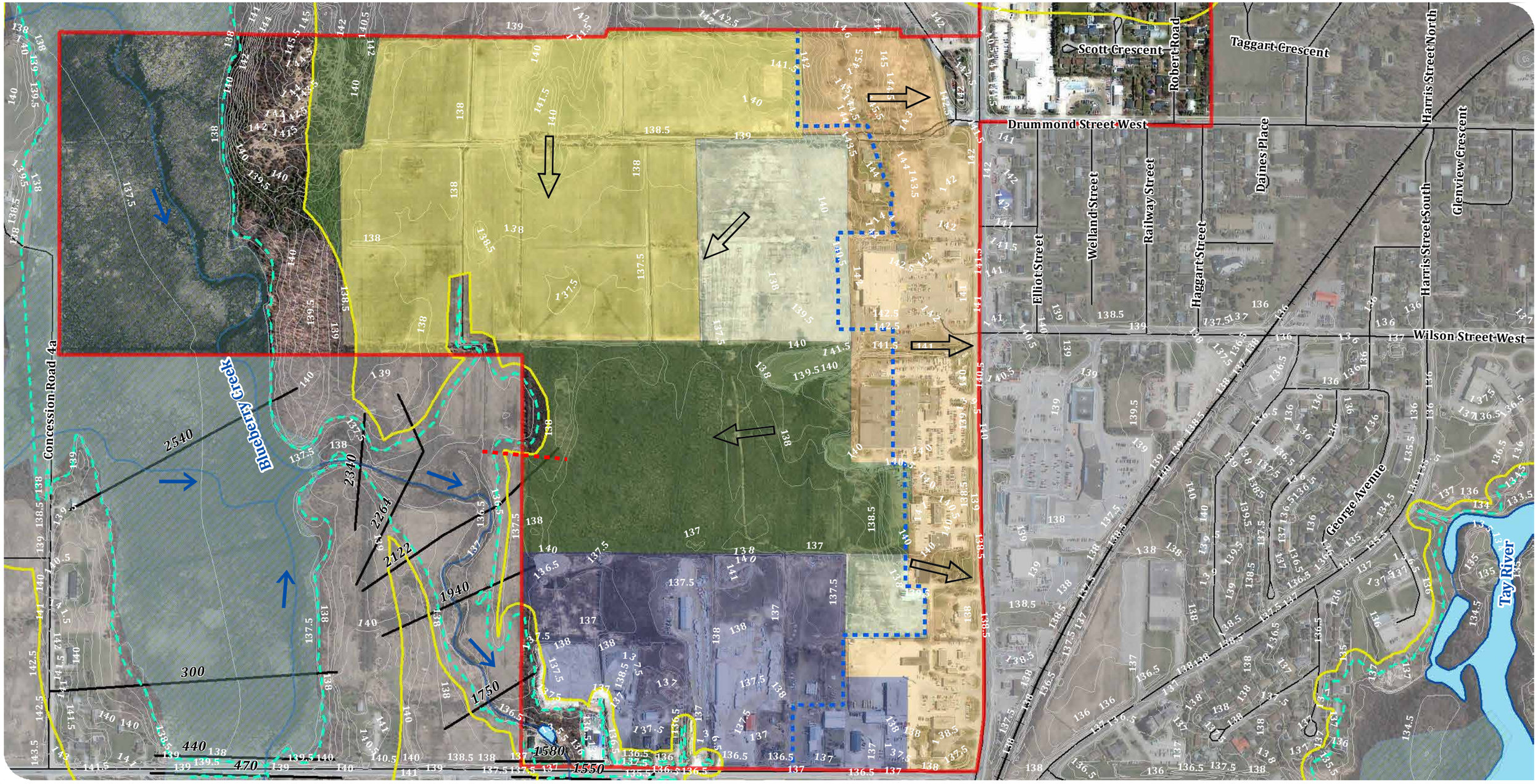
The study area lies within the 820 km^2 watershed of the Tay River. While the Tay River watercourse is located south of Highway 7, the study area is bound by its tributary Blueberry Creek in the north. Topography indicates that a small ridge, parallel to Highway 7, traverses the study area and divides the surface drainage. The portion north of the ridge gently slopes northwest towards Blueberry Creek, while the southern area drains south-easterly to Highway 7 and ultimately to the Tay River. **Figure 12** shows the existing drainage divide conditions.

The area south of the ridge is comprised mostly of a commercial strip fronting Highway 7. These commercial sites drain to the south through underground storm sewer or by surface sheet drainage to the existing Highway 7 drainage system. This Highway 7 drainage system is comprised of a combination of open ditches and culverts. This system drains southwest along Highway 7 to Lanark Road where it then drains northwest to Blueberry Creek. These systems are small private systems and have been identified as being at capacity and cannot accommodate additional runoff. In essence, any re-development within the south area commercial district would require appropriate *Stormwater Management (SWM)* measures that would address meeting SWM criteria and ensuring capacity is not exceeded for the Highway 7 drainage system.

In contrast, the area north of the ridge currently drains north-westerly towards Blueberry Creek via overland flow and ditches along the perimeter or field boundaries, as there is no other stormwater system within this portion of the study area. There are no surface waterbodies or storage ponds within the study area under existing conditions.

Blueberry Creek Floodplain

A majority of the undeveloped land north of the ridge drains north-westerly towards Blueberry Creek. The 38.5 km^2 Blueberry Creek sub-watershed is a part of the Tay River watershed. Blueberry Creek is a tributary of the Tay River. It is approximately 11 km in length and ultimately drains into the Tay River at the confluence of the two watercourses just south of Dufferin Street. Based on the *Blueberry Creek Flood Risk Mapping Report* produced by the RVCA (July 2011), a spill point adjacent to the study area has been identified and is situated at a location on Blueberry Creek approximately 2122 m upstream from the Tay River confluence. During the 1:100 year flood event, the *Regulatory Flood Level (RFL)* in this location is between 137.44 m and 137.55 m (RVCA, October 2011) and water is expected to spill over and spread south and/or southeast across into an existing low-lying area within the study boundary.



Town of Perth
Infrastructure Master Plan

Existing Conditions Stormwater Drainage

FIGURE 12

Heritage PERTH

Study Area Boundary	Agricultural Land	Woodland	Flood Model Cross Sections	Contours
RVCA Regulation Limit	Commercial Area	Waterbodies	Existing Drainage Divide	Roads
Floodplain	Industrial Area	Watercourses	Drainage Direction	Railway
Wetland	Pasture/Lawn	Direction of Flow	Spill Zone	

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED FROM DILLON FIELD SURVEY

MAP CREATED BY: KR
MAP CHECKED BY: AZ
MAP PROJECTION: NAD83, Zone 18

0 45 90 180 270 360 450 Meters

1:5,500

N E S W

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2010\103930\Design_GIS\MXDs

PROJECT: 10-3930 STATUS: FINAL DATE: MAY 2013

Appendix B – Correspondence

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Jp2g No. 2161774A

Oct 26, 2016 (Draft)

Town of Perth
80 Gore Street East
Perth, ON K7H 1H9

Attention: Eric Cosens
Director of Development and Protective Services

Re: Infrastructure Master Plan
For the Area North of Highway 7
Peer Review

Dear Eric:

JP2G was retained by the Town of Perth to provide a Peer Review for the Infrastructure Master Plan for the area north of Highway 7 and east of Lanark Road that was prepared by Dillon in 2013.

When providing a Peer Review of a study completed under the Municipal Class Environmental Assessment (Class EA), it is important to limit the review to specific questions to determine if there is a sufficient rationale to re-open the Class EA to consider either a broader inventory of environmental conditions or to seek additional alternatives and determine their impacts on a broader inventory. The Peer Review is not intended to supercede the Class EA process, but rather to determine any if significant modification to the project or change in the environmental setting has been identified or occurred after filing the Infrastructure Master Plan.

These questions include:

- Is the project description adequate to determine the scope of what is being proposed?
- Is the purpose and need sufficiently defined to allow for a full range of possible solutions?
- Have all of the natural, social and economic conditions been inventoried?
- Have all of the reasonable alternatives that address the project's need and purpose been considered?
- Have the impacts of alternatives been adequately described?
- Is the preferred solution demonstrated as having the least adverse impacts?

A thorough review of the Master Plan has provided answers to these questions..

1. Is the project description adequate to determine the scope of what is being proposed?
Yes. Section 2.2 of the Master Plan reads:

The Master Plan has been initiated to support and advance the OPA #10 and Secondary Plan process through the provision of infrastructure services including the annexed area.

2. Is the purpose and need sufficiently defined to allow for a full range of possible solutions?
Yes. Section 1.2 of the Master Plan reads:

This Master Plan is being completed to ensure that appropriate and cost effective servicing is in place to accommodate growth and development in this area, to identify potential effects to the environment as a result of this servicing and development, and to identify mitigation measures for those potential effects.

3. Have all of the natural, social and economic conditions been inventoried?

No. Approximate social and economic conditions have been inventoried in Section 4.0. A number of natural heritage or public health and safety features have been misrepresented or omitted.

Omission/Weakness	Action Required	Action By
The RVCA regulation limit is shown as 15m from the 1:100 year flood line and 120m from the PSW. The preferred solution concept plan shows the regulated lands as a Moderate Constraint. This is not the intent of the regulation limit.	HIA required to revise development limit. Follow RVCA policy to place fill in flood plain.	Developer
Catchment area of Wetland should be shown distinct from Creek, to allow for consideration of different criteria for releases. Releases to the PSW would have to demonstrate no impact on the hydrologic function of the wetland. Releases to the creek would have to demonstrate post-to-pre peak flow, and no impact on channel stability.	Revise catchment boundaries	Developer
Candidate ANSI not discussed or considered as an ecological constraint.	EIS required within ANSI limits	Developer
Planning restrictions due to the Intake Protection Zone (IPZ) is not discussed. This may not have been available at the time of developing the Master Plan, but those restrictions are present today. The County of Lanark Amendment No. 3 was approved by MMAH October 16, 2015 which implemented source water protection policies.	Discuss implications of IPZ, and determine if IPZ acts as constraint.	Town
The stability of the downstream Blueberry Creek, and therefore its capacity to accept changes in flows related to urban development, has not been identified. Release rates from area have been established, but it has not been shown if these release rates are appropriate.	Channel stability assessment of Blueberry Creek	Town

4. Have all of the reasonable alternatives that address the project's need and purpose been considered?

No.

Omission/Weakness	Action Required	Action By
Stormwater Management (Section 6.4) has not considered specific variants on conveyance and quantity controls (LIDs). Specifically, a grassed swale with ample underdrainage can be used in the place of a conventional pipe-and-pond system in providing conveyance, treatment, and storage.	Conceptual master drainage plan will have to be developed.	Town and Developer

5. **Have the impacts of alternatives been adequately described?**
   No.

Omission/Weakness	Action Required	Action By
Capital and operating costs of different components not fully described in Table 23, artificially increasing the costs of the grassed swale option. Pump station not included with cost of SWM facility.	Include all capital and operating costs into the decision matrix.	Town
Post-development channel stability should be considered prior to sizing the pond.	Channel stability assessment of Blueberry Creek	Town

6. **Is the preferred solution demonstrated as having the least adverse impacts?**
   No.

Several of the required actions can be deferred to a future stage of the subdivision planning process, and some need to be addressed prior to subdivision planning. Specifically, those actions that would impact the fundamental development concept would have to be revisited as part of the Infrastructure Master Plan, and would therefore require reopening the Environmental Assessment.

Developer driven action	**Town driven action**
	Determine impact of IPZ
	Channel stability assessment
	Determine release criteria
EIS / HIA required	
Revise development boundaries	
Prepare conceptual Stormwater Management plan	
	Revise Table 23 with all costs, impacts
	Reassess preferred alternative

Actions to address:

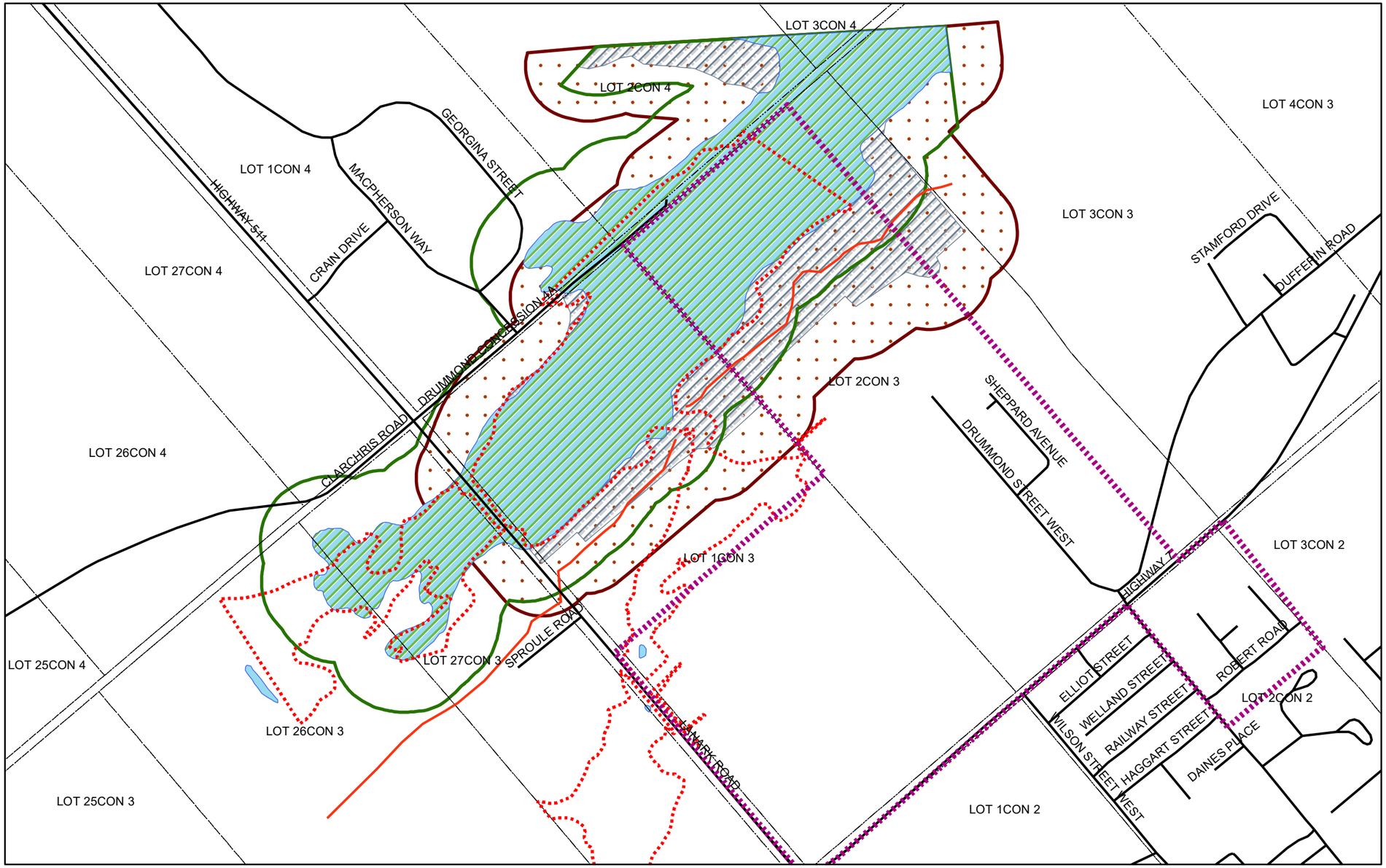
Revise development boundary

There are a number of constraints that may affect the development boundary that will affect the servicing required.

Some of the site area drains to the PSW, and the area that drains to the PSW out to 120m from the boundary is the 'adjacent land'. Development is only allowed in the adjacent land if it can be shown through an EIS that there will be no negative impacts on the wetland's natural features or ecological functions, and through a Hydrological Impact Assessment (HIA) that there will be no impact on the hydrological function of the wetland. A general Terms of Reference for an HIA has been included in Appendix A.

Much of the site area draining to Blueberry Creek is covered by an ANSI boundary and/or the adjacent area of influence. Development is only allowed in the ANSI or its adjacent land if it can be shown through an Environmental Impact Statement (EIS) that there will be no negative impacts on the natural features or the ecological functions for which the area is identified. EIS requirements are included in Appendix B.

If a revised boundary will change the servicing requirements for the development, then the terms of reference for the associated studies would be required to be defined as part of the Class EA, in order to determine the servicing requirements. The attached Figure 1 Revised Environmental Constraints shows the following environmental constraints to development, in comparison to Figure 6 in the Master Plan:



Notes:
1. Height of Land interpreted from hillshade mapping
2. 100 year flood boundary from Rideau Valley Conservation Authority
3. PSW/ANSI from Town based on County mapping
4. 120m setbacks applied

Jp2g Consultants Inc.
ENGINEERS · PLANNERS · PROJECT MANAGERS

Infrastructure Master Plan
Area North of Highway 7
Peer Review

1:10,000

Project: 2161774A

Figure - 1
Revised Environmental Constraints

Drawn By: PJ

Checked by: DN

Date: July 2016

a) The Blueberry Creek 1:100 Flood Elevation based on the RVCA Flood Risk Mapping July 2, 2010 on both figures.

b) The limits of the Blueberry Marsh PSW based on the County and Town Official Plan on both figures.

c) The 120m area of influence on adjacent lands from the PSW based on the County and Town Official Plan policies Section 5.5.1.6 and Section 8.6.4b.3 respectively is on both figures.

d) The limits of the Candidate Perth Blueberry Marsh ANSI based on the County Official Plan is shown on Figure 1.

e) The 120m area of influence on adjacent lands from the ANSI based on the County policy Section 5.5.3.2 is shown on Figure 1.

f) The height of land is shown on Figure 1 which defines the surface water flow in the vicinity of the wetland and creek.

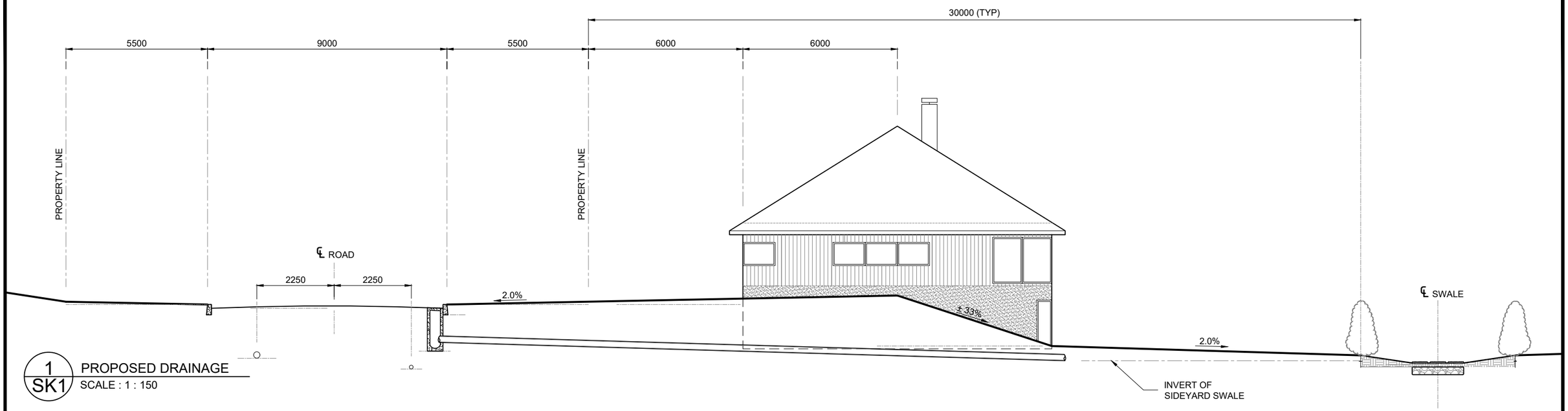
For the purposes of the Class EA, which is intended to evaluate the potential infrastructure requirements, the developable land can be assumed to be the largest reasonably possible developable area. When the EA is reopened, the consultant will determine if the PSW or ANSI setbacks are appropriate for this stage in the planning process. At the time of an application for Subdivision for the area, the proponent will be required to demonstrate through both EIS and HIA what the appropriate setback to development would be within the Subdivision.

Determine if the site is constrained by IPZ
The site is within the Intake Protection Zone (IPZ) 8 of the Town of Perth Water Treatment Plant. Certain stormwater management facilities are considered a significant drinking water threat per the Mississippi-Rideau Source Protection Plan. See Policy: SEW -10-LB-PI-MC, and Appendix B (pg 167). Demonstrate that the IPZ is considered in the servicing of the site.

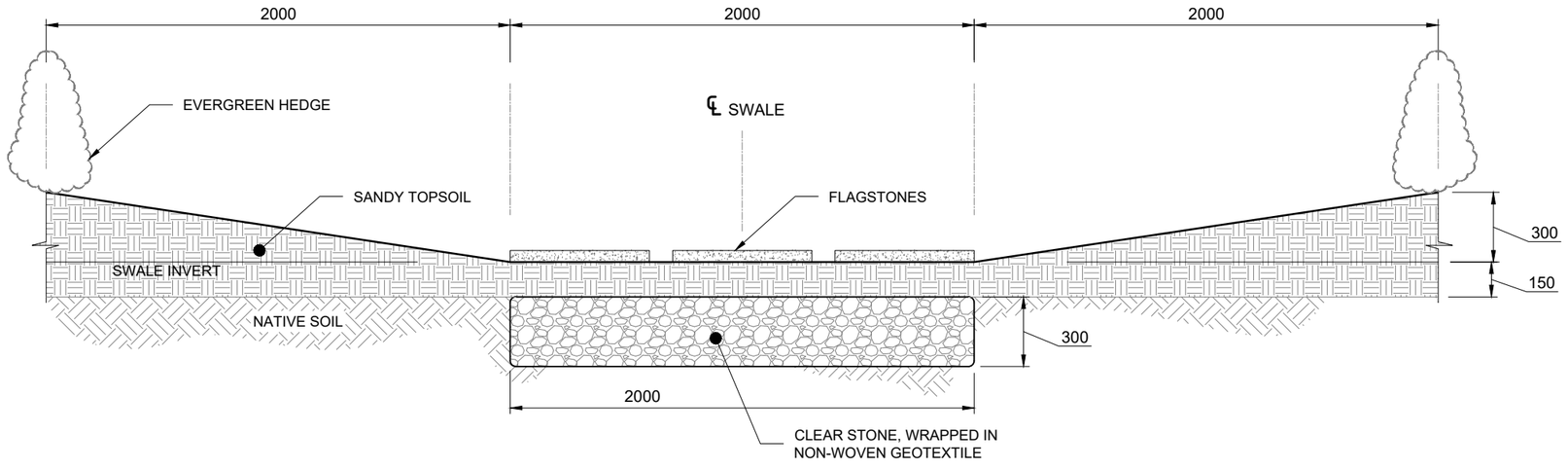
Consider the downstream channel's ability to accept changes in flow quality and quantity prior to setting storm discharge targets.
Using the methods available in MOE SWM Planning and Design Manual, or an equivalent method, determine if additional controls beyond 'match post- to pre-' is required to develop stormwater management release target rates to Blueberry Creek. This needs to be done prior to any development directing a change of flows to Blueberry Creek.

Consider grassed swale with underdrainage as a means of addressing quantity and quality treatment for the residential portion of the site.
A grassed swale at the rear of the lots, collecting runoff from the roads and lots, can provide quantity and quality treatment with a minimum of fill. The lots would tend to have 'walk-out basements', but would otherwise be effectively the same as currently being considered. Sufficiently sized, they have been shown in 'semi-rural' settings to be very cost effective and low maintenance.

The swale would include a clear stone subdrain that would be capable of capturing the runoff from the road and lots from the 1:2 year event, or the first 30 minutes of a 1:5 year event. Surface storage and conveyance would provide all additional required storage to reach the discharge targets developed in the previous step. A trapezoidal swale with a wide flat bottom, with not more than 3:1 side slopes, and 0.2% longitudinal slope, underlain by a clear stone subdrain of fairly uniform cross-section, could provide the require quantity and quality treatment, without the need for a pond or pumping station. This would limit the amount of required fill, and maximize the developable area of the subject site. See Figure 2 for an example.



1 / SK1 PROPOSED DRAINAGE
SCALE : 1 : 150



2 / SK1 TRENCH DETAIL
SCALE : 1 : 25

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Phone: (613)828-7800, Fax: (613)828-2600

INFRASTRUCTURE MASTER PLAN
AREA NORTH OF HIGHWAY 7
PEER REVIEW

DESIGNED: D.N.		PROJECT No.:	2151774A
DRAFTED: E.A. / R.M.		REVISION DATE:	SEP 20, 2016
CHECKED: D.N.	APPROVED: D.N.	REVISION No.:	.
SCALE: NOTED		FIGURE:	2

DWG NAME: O:\DOCS\1 - CIVIL\ACTIVE\2161774A - PERTH MASTER PLAN CLASS EA\07 DRAWINGS\ONGOING\SK1 - PROPOSED DRAINAGE - SECTION (SEP 20, 2016).DWG LAYOUT: SK1
(11X17) SAVED ON Tuesday, September 20, 2016 BY BRYANS

Long term performance is expected to exceed expected quantity and quality targets. When infiltration rates decline over time, removal and replacement of the cover material can be done with conventional equipment available to most municipalities. Expectations of servicing would be between every 5 years to every 20 years, depending on the quantity and type of winter road maintenance being done.

Other Low Impact Designs (LIDs) may be considered at a subdivision design stage. Data from various sources suggests that LIDs have similar construction costs and lower operating costs than the equivalent 'hard' infrastructure that would be commonly used today.

Compare capital and operating costs of the existing preferred solution with the capital and operating costs of the grassed swale with underdrainage.
The existing EA does not include the costs associated with construction, operation, and maintenance of the existing stormwater system as a whole – Capital costs are shown for pipe and pond, but not pump; no costs are provided for pipe, pond, or pump operation and maintenance. The EA should provide an analysis that compares all of the costs associated with the proposed system, and with grassed swales and subdrains.

For example:

Technology	Land $/ha	Construction $/ha	Expected lifespan (years)	Operating $/ha/year	Maintenance $/ha/year	Annual cost ($/ha)
Concrete pipe		40000	60		800	1466
Pumping station		80000	25	50	1586	4809
Pond	1500	4000	100	50		105
Swale	3400	25000	100		400	724

Note that these values are for example only, and the consultant that will re-open the Class EA would be required to develop prices that are current and local.

While all of these actions will be required prior to proceeding with development, not all of these action items are required at the same time, but rather can be addressed by the developer as part of the requirements of an Official Plan Amendment and/or Application for Plan of Subdivision to permit development of this land.

Town Action Items:

Determine if the site is constrained by the IPZ. The degree of constraint may govern water quality treatment requirements and allowable catchment boundaries.

Determine the downstream channel's capacity to receive a change in flow. The allowable release rate will be determined for the stormwater system to limit flows in the channel to be the lesser of the erosion threshold of the channel, and the pre-development peak flow rate within the channel.

A functional stormwater management plan is to be developed using the allowable release rates and any restrictions to discharge quality assigned by the IPZ. The plan will demonstrate the costs of the proposed system from the Dillon Report, together with the costs of an unconventional or LID approach to stormwater management. Grades will be established to ensure positive drainage and sufficient storage/infiltration is available. Land requirements for stormwater blocks and drainage easements will be determined. The developer may play a role in the development of this plan.

Developer Action Items:

The development boundary can be assumed to be the largest possible at this time, and any developer would be required to demonstrate what limit of development that the HIA and EIS supports. This will slightly oversize the infrastructure, which can then lead to the potential of higher densities if a significant area of 'adjacent land' is not available for development.

A conceptual stormwater management plan, using the most cost effective approach to SWM that meets the allowable release rates and quality targets, will be developed for the undeveloped area in support of the required Official Plan Amendment and/or Application for Plan of Subdivision. The conceptual plan will design crossings, rough lot grading, storage volumes and release rates for various events.

Other issues:

It was noted during this review that the conclusion of the need for a Domestic Water tower is likely the most appropriate solution to the problem of water supply and demand within the North of Seven development boundary. It is not clear that this is the most appropriate solution based on changing system conditions for the whole of Perth. We would recommend that the water network be analysed as a whole to consider all proposed development within Perth. This would be outside of the scope of the Environmental Assessment.

Yours very truly,
Jp2g Consultants Inc.
ENGINEERS ■ PLANNERS ■ PROJECT MANAGERS

Doug Nuttall, P.Eng.
Project Manager

Kevin Mooder, MCIP RPP
Project Planner

Appendix C – Stormwater Design Sheet

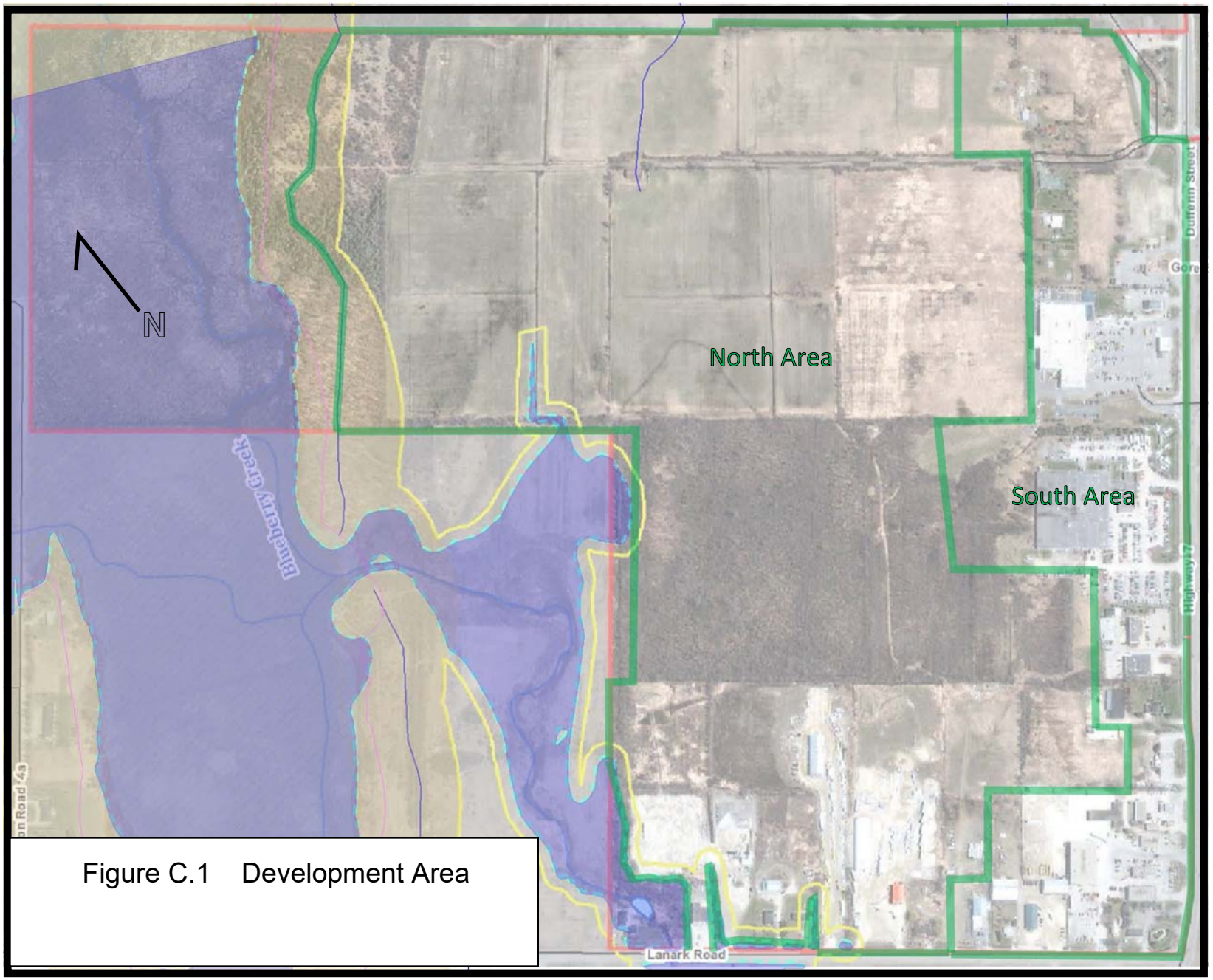

Figure C.1 Development Area

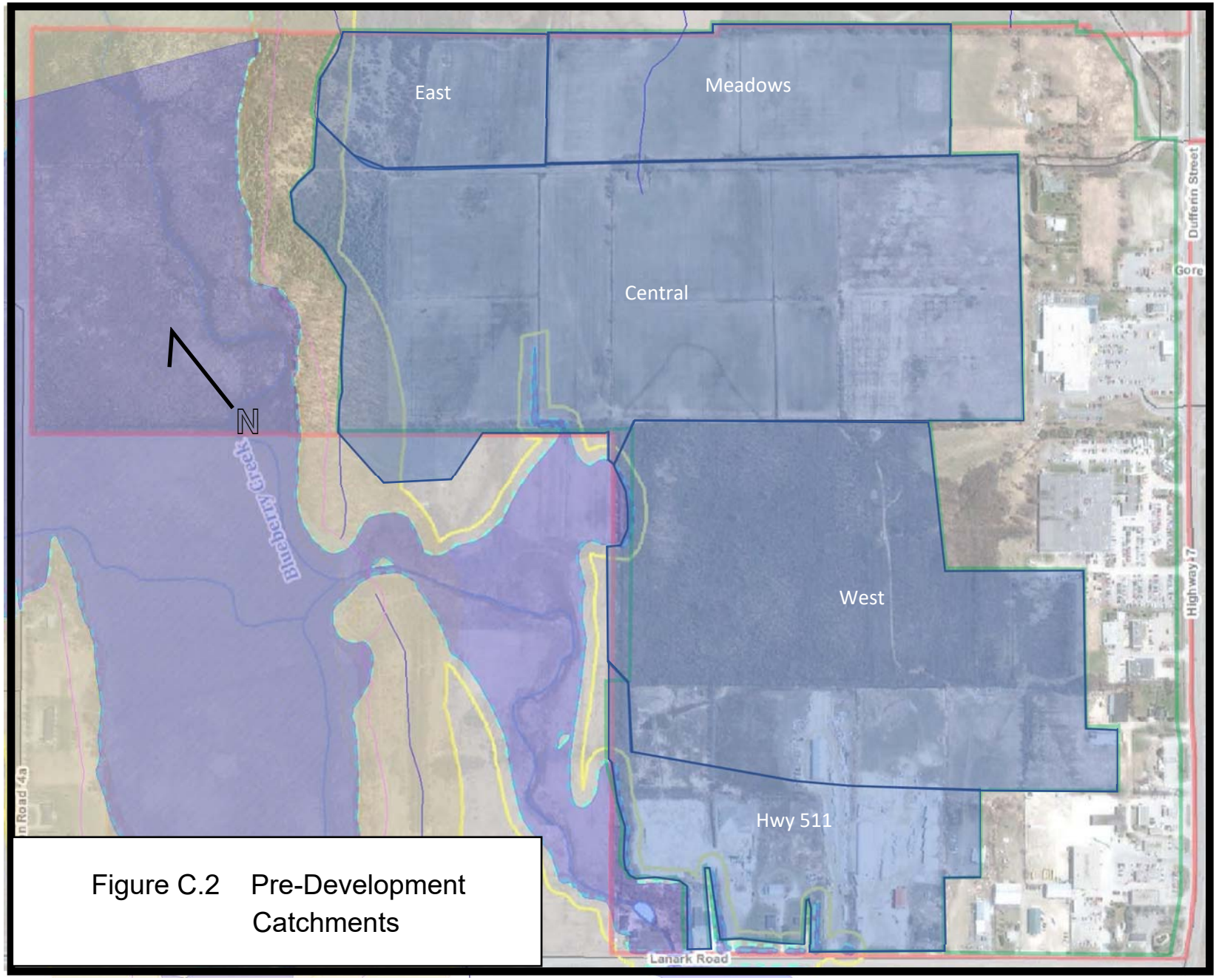

Figure C.2 Pre-Development Catchments

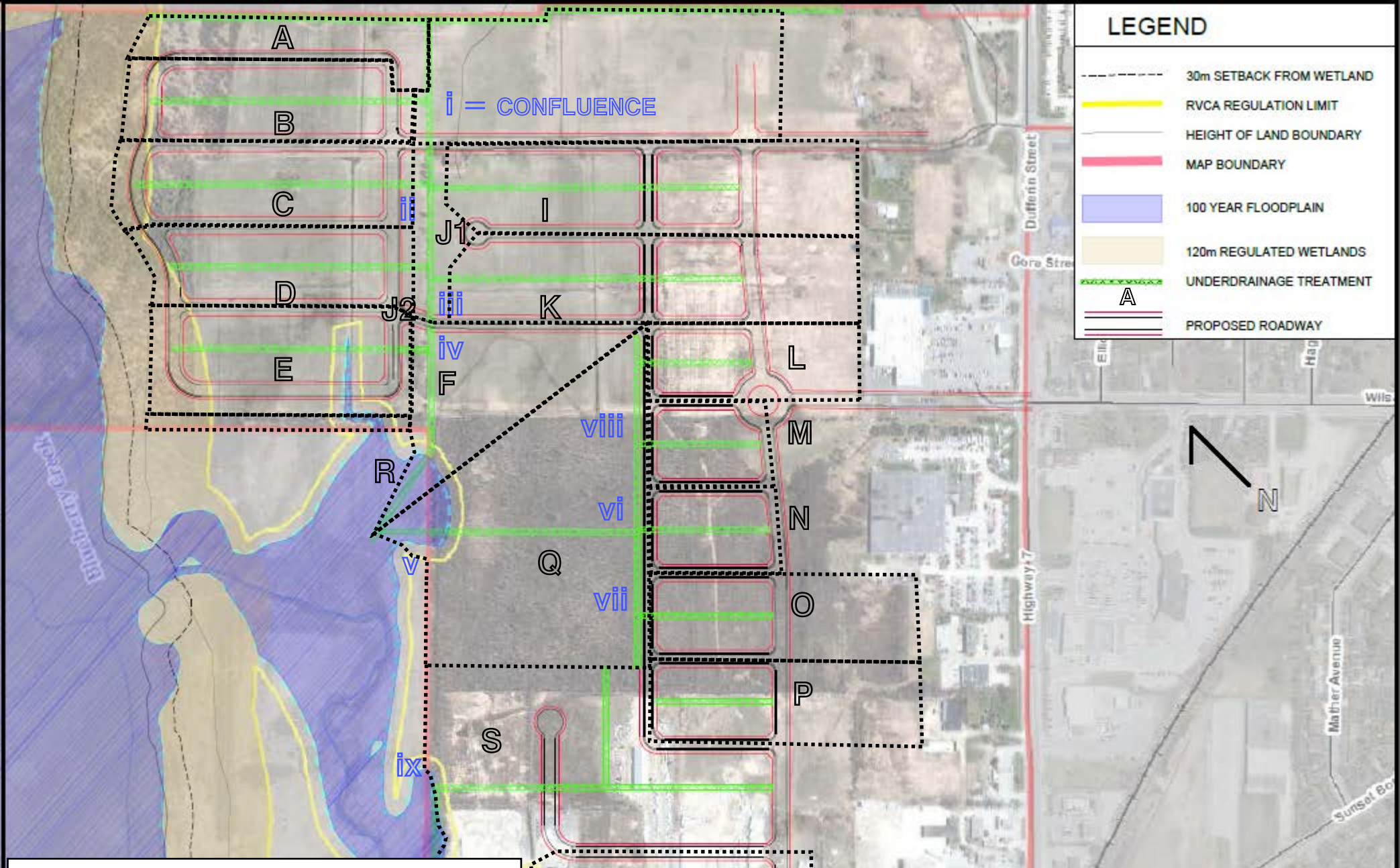

Figure C.3 Post-Development Catchments & Nodes

Jp2g Consultants Inc.
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TABLE C-1: NORTH OF 7 STORMWATER DESIGN SHEET - EXISTING CONDITION

1:5 year IDF	
A	998.071
B	6.053
C	0.814

Manning's N pipe 0.0125
Manning's N ditch 0.035

LOCATION					CONTRIBUTING AREA				FLOW			STORM SEWER DESIGN										
1	2	3	4	5	6	7	8	9	10	11	12	13	16	17a	17b	17c	17	18	19	20	21	22	23
Catchment	FROM	TO	AREA ID	SEWER TYPE (Pipe or Ditch)	AREA (A)	RUNOFF COEFF. (C)	SECTION (C*A)	ACC. (C*A)	TIME OF CONCEN. (Tc)	RAINFALL INTENSITY (I)	ACTUAL FLOW 2.78x(8)x(10)	LENGTH	SLOPE	SIDE SLOPE	DEPTH OF FLOW	DITCH VELOCITY	DIA.	FULL FLOW CAPACITY	FRACTION FULL	FULL FLOW VELOCITY	ACTUAL FLOW VELOCITY	TIME OF FLOW IN PIPE	TIME OF CONCEN AFT. PIPE
					(ha)	(--)	(ha)	(ha)	(min)	(mm/hr)	(L/s)	(m)	(%)	(:1)	(m)	(m/s)	(mm)	(m^3/s)		(m/s)	(m/s)	(min)	(min)
Meadows	Meadows	A	X1	Pipe	2.41	0.48	1.15	1.15	79.16	26.78	0.09	180	0.25%				0.53	0.22	38.3%	1.03	0.96	3.13	82.29
Offsite	Offsite	A	X2	Ditch	20	0.25	5.00	5.00	74.18	28.12	0.39	180	0.10%	3	0.58	0.38						7.82	82.00
East		A	X3	Ditch	5.8	0.30	1.74	1.74	30.00	53.93	0.26	50	0.10%										30.00
Central	A	B	X4	Ditch	18.45	0.30	5.54	13.43	82.29	26.00	0.97	200	0.10%	3	0.82	0.48						6.93	89.22
West	B	outlet	X5	Ditch	7.09	0.30	2.13	15.55	89.22	24.45	1.06	200	0.10%	3	0.85	0.49						6.78	96.00
Hwy511		outlet	X6	Ditch	17.4	0.25	4.35	19.90	96.00	23.12	1.28												96.00

1:100 year IDF	
A	1735.688
B	6.014
C	0.82

Manning's N pipe 0.0125
Manning's N ditch 0.035

LOCATION					CONTRIBUTING AREA				FLOW			STORM SEWER DESIGN										
1	2	3	4	5	6	7	8	9	10	11	12	13	16	17a	17b	17c	17	18	19	20	21	22	23
Catchment	FROM	TO	AREA ID	SEWER TYPE (Pipe or Ditch)	AREA (A)	RUNOFF COEFF. (C)	SECTION (C*A)	ACC. (C*A)	TIME OF CONCEN. (Tc)	RAINFALL INTENSITY (I)	ACTUAL FLOW 2.78x(8)x(10)	LENGTH	SLOPE	SIDE SLOPE	DEPTH OF FLOW	DITCH VELOCITY	DIA.	FULL FLOW CAPACITY	FRACTION FULL	FULL FLOW VELOCITY	ACTUAL FLOW VELOCITY	TIME OF FLOW IN PIPE	TIME OF CONCEN AFT. PIPE
					(ha)	(--)	(ha)	(ha)	(min)	(mm/hr)	(m^3/s)	(m)	(%)	(:1)	(m)	(m/s)	(mm)	(m^3/s)		(m/s)	(m/s)	(min)	(min)
Meadows	Meadows	A	X1	Pipe	2.41	0.60	1.44	1.44	79.16	26.78	0.11	180	0.25%				0.53	0.22	47.9%	1.03	1.01	2.97	82.13
Offsite	Offsite	A	X2	Ditch	20	0.31	6.25	6.25	74.18	28.12	0.49	180	0.10%	3	0.63	0.41						7.40	81.58
East		A	X3	Ditch	5.8	0.38	2.18	2.18	30.00	53.93	0.33	50	0.10%										30.00
Central	A	B	X4	Ditch	18.45	0.38	6.92	16.78	82.13	26.04	1.21	200	0.10%	3	0.89	0.51						6.55	88.67
West	B	outlet	X5	Ditch	7.09	0.38	2.66	19.44	88.67	24.56	1.33	200	0.10%	3	0.92	0.52						6.40	95.08
Hwy511		outlet	X6	Ditch	17.4	0.31	5.44	24.88	95.08	23.29	1.61												95.08

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TABLE C-2A: NORTH OF 7 STORMWATER DESIGN SHEET - PROPOSED CONDITIONS WITHOUT QUANTITY TREATMENT - 1:5 YEAR IDF

1:5 year IDF			
A	998.071	Manning's N pipe	0.0125
B	6.053	Manning's N ditch	0.035
C	0.814		

LOCATION					CONTRIBUTING AREA				FLOW			STORM SEWER DESIGN											
1	2	3	4	5	6	7	8	9	10	11	12	13	16	17a	17b	17c	17	18	19	20	21	22	23
Catchment	FROM	TO	AREA ID	SEWER TYPE (Pipe or Ditch)	AREA (A)	RUNOFF COEFF. (C)	SECTION (C*A)	ACC. (C*A)	TIME OF CONC'N. (Tc)	RAINFALL INTENSITY (I)	ACTUAL FLOW	LENGTH	SLOPE	SIDE SLOPE	DEPTH OF FLOW	DITCH VELOCITY	DIA.	FULL FLOW CAPACITY	FRACTION FULL	FULL FLOW VELOCITY	ACTUAL FLOW VELOCITY	TIME OF FLOW IN CONDUIT	TIME OF CONC'N AFT. PIPE
					(ha)	(--)	(ha)	(ha)	(min)	(mm/hr)	(m^3/s)	(m)	(%)	(:1)	(m)	(m/s)	(mm)	(m^3/s)		(m/s)	(m/s)	(min)	(min)
Meadows	Meadows	i	X1	Pipe	3.704	0.47	1.73	1.73	79.16	26.78	0.13	180	0.25%				0.53	0.22	57.7%	1.03	1.06	2.84	82.00
Offsite	Offsite	i	X2	Ditch	20	0.25	5.00	5.00	74.18	28.12	0.39	180	0.10%	3	0.58	0.38						7.82	82.00
A		i	P1	Ditch	0.83	0.73	0.60	0.60	20	70.25	0.12	300	0.10%	3	0.37	0.28						17.59	37.59
B		i	P2	Ditch	2.32	0.46	1.07	1.07	20.00	70.25	0.21	300	0.10%	3	0.46	0.33						15.26	35.26
	i	ii		Ditch				8.41	82.00	26.07	0.61	94	0.10%	3	0.69	0.43						3.66	85.66
C		ii	P3	Ditch	2.65	0.48	1.28	9.69	20.00	70.25	1.89	300	0.10%	3	1.05	0.57						8.79	28.79
I		ii	P4	Ditch	4.82	0.51	2.47	2.47	20.00	70.25	0.48	350	0.10%	3	0.63	0.40						14.43	34.43
	ii	iii		Ditch				12.16	85.66	25.22	0.85	103	0.10%	3	0.78	0.47						3.68	89.34
D		iii	P5	Ditch	2.61	0.50	1.31	1.31	20.00	70.25	0.26	300	0.10%	3	0.50	0.34						14.51	34.51
J		iii	P6	Ditch	1.35	0.51	0.69	0.69	15.00	83.56	0.16	74	0.10%	3	0.42	0.31						4.02	19.02
K		iii	P7	Ditch	4.80	0.51	2.45	2.45	20.00	70.25	0.48	350	0.10%	3	0.63	0.40						14.46	34.46
	iii	iv		Ditch				16.61	89.34	24.42	1.13	82	0.10%	3	0.87	0.50						2.74	92.08
F		iv	P8	Ditch	1.17	0.60	0.71	0.71	15.00	83.56	0.16	300	0.10%	3	0.42	0.31						16.19	31.19
E		iv	P9	Ditch	2.60	0.50	1.29	1.29	20.00	70.25	0.25	300	0.10%	3	0.49	0.34						14.55	34.55
R		iv	P10	Ditch	2.82	0.30	0.84	0.84	25.00	60.90	0.14	265	0.10%	3	0.40	0.30						14.81	39.81
	iv	v		Ditch				19.45	92.08	23.87	1.29	230	0.10%	3	0.91	0.52						7.42	99.49
G		v	P11	Ditch	0.81	0.25	0.20	0.20	15.00	83.56	0.05	25	0.10%	3	0.26	0.23						1.85	16.85
L		viii	P12	Ditch	2.03	0.57	1.16	1.16	15.00	83.56	0.27	225	0.10%	3	0.51	0.35						10.73	25.73
M		viii	P13	Ditch	2.29	0.55	1.27	1.27	15.00	83.56	0.29	130	0.10%	3	0.52	0.36						6.06	21.06
N		vi	P14	Ditch	2.30	0.54	1.24	1.24	15.00	83.56	0.29	130	0.10%	3	0.52	0.36						6.10	21.10
P		vii	P15	Ditch	2.22	0.52	1.16	1.16	15.00	83.56	0.27	225	0.10%	3	0.51	0.35						10.74	25.74
O		vii	P16	Ditch	2.31	0.54	1.24	1.24	15.00	83.56	0.29	130	0.10%	3	0.52	0.36						6.10	21.10
	vii	vi		Ditch				2.40	25.74	59.74	0.40	90	0.10%	3	0.59	0.39						3.89	29.63
	viii	vi		Ditch				2.43	25.73	59.75	0.40	90	0.10%	3	0.59	0.39						3.88	29.61
Q	vi	v	P17	Ditch	6.38	0.30	1.92	7.98	29.63	54.38	1.21	290	0.10%	3	0.89	0.51						9.51	39.14
S		ix	P18	Ditch	9.33	0.30	2.80	2.80	15.00	83.56	0.65	370	0.10%	3	0.71	0.44						14.16	29.16

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TABLE C-2B: NORTH OF 7 STORMWATER DESIGN SHEET - PROPOSED CONDITIONS WITHOUT QUANTITY TREATMENT - 1:100 YEAR IDF

1:100 year IDF			
A	1735.688	Manning's N pipe	0.0125
B	6.014	Manning's N ditch	0.035
C	0.82		

LOCATION					CONTRIBUTING AREA				FLOW			STORM SEWER DESIGN											
1	2	3	4	5	6	7	8	9	10	11	12	13	16	17a	17b	17c	17	18	19	20	21	22	23
Catchment	FROM	TO	AREA ID	SEWER TYPE (Pipe or Ditch)	AREA (A)	RUNOFF COEFF. (C)	SECTION (C*A)	ACC. (C*A)	TIME OF CONC'N. (Tc)	RAINFALL INTENSITY (I)	ACTUAL FLOW	LENGTH	SLOPE	SIDE SLOPE	DEPTH OF FLOW	DITCH VELOCITY	DIA.	FULL FLOW CAPACITY	FRACTION FULL	FULL FLOW VELOCITY	ACTUAL FLOW VELOCITY	TIME OF FLOW IN CONDUIT	TIME OF CONC'N AFT. PIPE
					(ha)	(--)	(ha)	(ha)	(min)	(mm/hr)	(m^3/s)	(m)	(%)	(:1)	(m)	(m/s)	(mm)	(m^3/s)		(m/s)	(m/s)	(min)	(min)
Meadows	Meadows	i	X1	Pipe	3.704	0.59	2.17	2.17	79.16	26.78	0.16	180	0.25%				0.53	0.22	72.1%	1.03	1.11	2.70	81.86
Offsite	Offsite	i	X2	Ditch	20	0.31	6.25	6.25	74.18	28.12	0.49	180	0.10%	3	0.63	0.41						7.40	81.58
A		i	P1	Ditch	0.83	0.91	0.76	0.76	20	70.25	0.15	300	0.10%	3	0.40	0.30						16.63	36.63
B		i	P2	Ditch	2.32	0.58	1.34	1.34	20.00	70.25	0.26	300	0.10%	3	0.50	0.35						14.43	34.43
	i	ii		Ditch				10.51	79.88	26.59	0.78	94	0.10%	3	0.75	0.46						3.44	83.32
C		ii	P3	Ditch	2.65	0.60	1.60	12.11	20.00	70.25	2.36	300	0.10%	3	1.14	0.60						8.32	28.32
I		ii	P4	Ditch	4.82	0.64	3.09	3.09	20.00	70.25	0.60	350	0.10%	3	0.69	0.43						13.65	33.65
	ii	iii		Ditch				15.20	79.88	26.59	1.12	103	0.10%	3	0.87	0.50						3.44	83.32
D		iii	P5	Ditch	2.61	0.63	1.63	1.63	20.00	70.25	0.32	300	0.10%	3	0.54	0.36						13.72	33.72
J		iii	P6	Ditch	1.35	0.64	0.86	0.86	15.00	83.56	0.20	74	0.10%	3	0.45	0.32						3.80	18.80
K		iii	P7	Ditch	4.80	0.64	3.07	3.07	20.00	70.25	0.60	350	0.10%	3	0.68	0.43						13.68	33.68
	iii	iv		Ditch				20.76	79.88	26.59	1.53	82	0.10%	3	0.97	0.54						2.53	82.41
F		iv	P8	Ditch	1.17	0.76	0.89	0.89	15.00	83.56	0.21	300	0.10%	3	0.46	0.33						15.31	30.31
E		iv	P9	Ditch	2.60	0.62	1.62	1.62	20.00	70.25	0.32	300	0.10%	3	0.54	0.36						13.76	33.76
R		iv	P10	Ditch	2.82	0.38	1.06	1.06	25.00	60.90	0.18	265	0.10%	3	0.43	0.32						14.01	39.01
	iv	v		Ditch				24.32	79.88	26.59	1.80	230	0.10%	3	1.03	0.56						6.83	86.71
G		v	P11	Ditch	0.81	0.31	0.25	0.25	15.00	83.56	0.06	25	0.10%	3	0.29	0.24						1.75	16.75
L		viii	P12	Ditch	2.03	0.67	1.37	1.37	15.00	83.56	0.32	225	0.10%	3	0.54	0.36						10.30	25.30
M		viii	P13	Ditch	2.29	0.65	1.50	1.50	15.00	83.56	0.35	130	0.10%	3	0.56	0.37						5.82	20.82
N		vi	P14	Ditch	2.30	0.64	1.46	1.46	15.00	83.56	0.34	130	0.10%	3	0.55	0.37						5.85	20.85
P		vii	P15	Ditch	2.22	0.62	1.38	1.38	15.00	83.56	0.32	225	0.10%	3	0.54	0.36						10.29	25.29
O		vii	P16	Ditch	2.31	0.64	1.47	1.47	15.00	83.56	0.34	130	0.10%	3	0.55	0.37						5.85	20.85
	vii	vi		Ditch				2.84	25.29	60.44	0.48	90	0.10%	3	0.63	0.40						3.72	29.01
	viii	vi		Ditch				2.86	25.30	60.42	0.48	90	0.10%	3	0.63	0.40						3.71	29.02
Q	vi	v	P17	Ditch	6.38	0.38	2.39	9.56	29.02	55.15	1.47	290	0.10%	3	0.96	0.53						9.06	38.08
S		ix	P18	Ditch	9.33	0.38	3.50	3.50	15.00	83.56	0.81	370	0.10%	3	0.77	0.46						13.40	28.40

Appendix D – Modeling Parameters & Output

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Table D-3: SSA Model Output for Clearstone Trenches (5 year event)

Element ID	Inlet Invert (mASL)	Top of Swale (mASL)	Depth of Swale (m)	Channel Slope (%)	Peak Inflow (cms)	Peak Outflow (cms)	Max HGL Elevation (mASL)	Max Depth (m)
Stor-002	138.20	140.20	2.00	0.10	0.24	0.01	139.00	0.80
Stor-003	138.23	140.23	2.00	0.10	0.26	0.00	138.63	0.40
Stor-004	137.77	139.77	2.00	0.10	0.21	0.00	138.09	0.32
Stor-005	137.50	139.50	2.00	0.10	0.26	0.00	137.92	0.42
Stor-007	138.41	140.41	2.00	0.10	0.23	0.00	138.76	0.35
Stor-008	138.40	140.40	2.00	0.10	0.20	0.00	138.69	0.29
Stor-07	137.00	139.24	2.24	0.10	0.20	0.08	138.52	1.52
Stor-08	137.16	139.40	2.24	0.10	0.10	0.09	138.69	1.53
Stor-10	137.48	139.72	2.24	0.10	0.09	0.08	138.70	1.22
Stor-11	137.68	139.92	2.24	0.10	0.31	0.09	139.23	1.55
Stor-12	137.91	140.15	2.24	0.10	0.38	0.08	139.01	1.10
Stor-13	137.95	140.19	2.24	0.10	0.09	0.03	138.30	0.35
Stor-16	137.24	139.48	2.24	0.10	0.38	0.09	138.77	1.53
Stor-22	137.90	139.90	2.00	0.10	0.17	0.00	138.13	0.23
Stor-23	137.60	139.60	2.00	0.10	0.20	0.00	137.87	0.27
Stor-24	137.50	139.50	2.00	0.10	0.19	0.00	137.77	0.27
Stor-25	137.60	139.60	2.00	0.10	0.19	0.00	137.87	0.27
Stor-26	137.70	139.70	2.00	0.10	0.17	0.00	137.93	0.23
Stor-28	137.30	138.93	1.63	0.10	0.21	0.03	137.65	0.35
Stor-30	137.00	139.24	2.24	0.10	0.41	0.06	137.70	0.70
Stor-31	137.51	139.51	2.00	0.10	0.36	0.03	137.86	0.35
Stor-32	137.12	139.12	2.00	0.10	0.29	0.04	137.54	0.42
Stor-33	137.00	139.00	2.00	0.10	0.08	0.01	138.29	1.29
Stor-35	138.04	140.04	2.00	0.10	0.84	0.03	139.64	1.60

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Table D-4: SSA Model Output for Post-Development Subcatchments (5 year event)

Subbasin ID	Area (ha)	Weighted CN	Average Slope (%)	Total Rainfall (mm)	Total Runoff (mm)	Peak Runoff (cms)	Time of Concentration (d hrs:min:sec)
Sub-002	2.62	77.00	2.0	72.60	24.74	0.24	0 00:10:58
Sub-003	2.87	77.00	2.0	72.60	24.74	0.26	0 00:10:58
Sub-004	2.38	77.00	2.0	72.60	24.74	0.22	0 00:10:58
Sub-005	2.95	77.00	2.0	72.60	24.74	0.27	0 00:10:58
Sub-007	2.57	77.00	2.0	72.60	24.74	0.23	0 00:10:58
Sub-008	2.23	77.00	2.0	72.60	24.74	0.20	0 00:10:58
Sub-05	0.57	77.00	2.0	72.60	24.74	0.05	0 00:10:58
Sub-06	0.42	77.00	2.0	72.60	24.74	0.04	0 00:10:58
Sub-07	0.44	77.00	2.0	72.60	24.74	0.04	0 00:10:58
Sub-08	0.43	77.00	2.0	72.60	24.74	0.04	0 00:10:58
Sub-11	2.73	77.00	2.0	72.60	24.74	0.25	0 00:10:58
Sub-12	3.36	77.00	2.0	72.60	24.74	0.31	0 00:10:58
Sub-13	0.54	77.00	2.0	72.60	24.74	0.05	0 00:10:58
Sub-14	0.25	77.00	2.0	72.60	24.74	0.02	0 00:10:58
Sub-15	0.19	77.00	2.0	72.60	24.74	0.02	0 00:10:58
Sub-16	0.28	77.00	2.0	72.60	24.74	0.03	0 00:10:58
Sub-17	0.42	77.00	2.0	72.60	24.74	0.04	0 00:10:58
Sub-18	0.35	77.00	2.0	72.60	24.74	0.03	0 00:10:58
Sub-19	2.26	77.00	2.0	72.60	24.74	0.21	0 00:10:58
Sub-20	4.44	77.00	2.0	72.60	24.74	0.41	0 00:10:00
Sub-21	1.83	77.00	2.0	72.60	24.74	0.17	0 00:10:00
Sub-22	2.09	77.00	2.0	72.60	24.74	0.19	0 00:10:00
Sub-23	2.09	77.00	2.0	72.60	24.74	0.19	0 00:10:00
Sub-24	2.12	77.00	2.0	72.60	24.74	0.20	0 00:10:00
Sub-25	1.80	77.00	2.0	72.60	24.74	0.17	0 00:10:00
Sub-26	1.06	77.00	2.0	72.60	24.74	0.10	0 00:10:00
Sub-27	1.22	77.00	2.0	72.60	24.74	0.11	0 00:10:00
Sub-28	1.16	77.00	0.5	72.60	24.74	0.11	0 00:11:02
Sub-29	2.91	77.00	0.5	72.60	24.74	0.26	0 00:11:02
Sub-30	0.90	77.00	0.5	72.60	24.74	0.08	0 00:11:02
Sub-31	3.21	77.00	0.5	72.60	24.74	0.29	0 00:11:02
Sub-32	1.59	77.00	0.5	72.60	24.74	0.14	0 00:11:02
Sub-33	12.37	72.00	0.5	72.60	18.42	0.73	0 00:14:18

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Table D-5: SSA Model Output for Clearstone Trenches (100 year event)

Element ID	Inlet Invert (mASL)	Top of Swale (mASL)	Depth of Swale (m)	Channel Slope (%)	Peak Inflow (cms)	Peak Outflow (cms)	Max HGL Elevation (mASL)	Max Depth (m)
Stor-002	138.20	140.20	2.00	0.10	0.60	0.01	139.48	1.28
Stor-003	138.23	140.23	2.00	0.10	0.66	0.01	139.45	1.22
Stor-004	137.77	139.77	2.00	0.10	0.55	0.01	138.73	0.96
Stor-005	137.50	139.50	2.00	0.10	0.68	0.01	138.77	1.27
Stor-007	138.41	140.41	2.00	0.10	0.59	0.01	139.46	1.05
Stor-008	138.40	140.40	2.00	0.10	0.51	0.01	139.29	0.89
Stor-07	137.00	139.24	2.24	0.10	0.82	0.81	138.88	1.88
Stor-08	137.16	139.40	2.24	0.10	0.80	0.80	139.04	1.88
Stor-10	137.48	139.72	2.24	0.10	0.74	0.74	139.34	1.86
Stor-11	137.68	139.92	2.24	0.10	0.81	0.74	139.56	1.88
Stor-12	137.91	140.15	2.24	0.10	0.78	0.70	139.75	1.84
Stor-13	137.95	140.19	2.24	0.10	0.44	0.40	139.67	1.72
Stor-16	137.24	139.48	2.24	0.10	0.99	0.79	139.11	1.87
Stor-22	137.90	139.90	2.00	0.10	0.42	0.01	138.60	0.70
Stor-23	137.60	139.60	2.00	0.10	0.50	0.01	138.44	0.84
Stor-24	137.50	139.50	2.00	0.10	0.49	0.01	138.33	0.83
Stor-25	137.60	139.60	2.00	0.10	0.49	0.01	138.43	0.83
Stor-26	137.70	139.70	2.00	0.10	0.43	0.01	138.41	0.71
Stor-28	137.30	138.93	1.63	0.10	0.55	0.07	138.28	0.98
Stor-30	137.00	139.24	2.24	0.10	1.05	0.44	138.73	1.73
Stor-31	137.51	139.51	2.00	0.10	0.94	0.07	138.53	1.02
Stor-32	137.12	139.12	2.00	0.10	0.76	0.08	138.35	1.23
Stor-33	137.00	139.00	2.00	0.10	0.23	0.08	138.67	1.67
Stor-35	138.04	140.04	2.00	0.10	2.44	0.38	141.69	3.65

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Table D-6: SSA Model Output for Post-Development Subcatchments (100 year event)

Subbasin ID	Area (ha)	Weighted CN	Average Slope (%)	Total Rainfall (mm)	Total Runoff (mm)	Peak Runoff (cms)	Time of Concentration (d hrs:min:sec)
B01	2.62	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B02	2.87	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B03	2.38	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B04	2.95	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B05	2.57	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B06	2.23	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B07	0.57	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B08	0.42	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B09	0.44	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B10	0.43	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B11	2.73	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B12	3.36	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B13	0.54	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B16	0.25	77.00	2.0000	121.00	61.62	61.62	0 00:10:58
B17	0.19	77.00	2.0000	121.00	61.62	61.62	0 00:10:58
B18	0.28	77.00	2.0000	121.00	61.62	61.62	0 00:10:58
B19	0.42	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B20	0.35	77.00	2.0000	121.00	61.62	61.62	0 00:10:58
B21	2.26	77.00	2.0000	121.00	61.65	61.65	0 00:10:58
B22	4.44	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B23	1.83	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B24	2.09	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B25	2.09	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B26	2.12	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B27	1.80	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B28	1.06	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B29	1.22	77.00	2.0000	121.00	61.65	61.65	0 00:10:00
B30	1.16	77.00	0.5000	121.00	61.65	61.65	0 00:11:02
B31	2.91	77.00	0.5000	121.00	61.65	61.65	0 00:11:02
B32	0.90	77.00	0.5000	121.00	61.65	61.65	0 00:11:02
B33	3.21	77.00	0.5000	121.00	61.65	61.65	0 00:11:02
B34	1.59	77.00	0.5000	121.00	61.65	61.65	0 00:11:02
B35	12.37	72.00	0.5000	121.00	51.26	51.26	0 00:14:18

Appendix D – Performance Criteria

The expected work plan to ensure that the criteria can be met would be to demonstrate:

1) Show that for the 90%ile rainfall event (27mm in 24 hr), an average of 80% or better quality treatment is achieved by the outlet.
   For the chosen soil mixture and dept, find:
   a) the infiltrated volume for the 90%ile event
   b) the runoff volume for the 90%ile event
   c) the portion of the infiltrated sediment that will be retained within the clearstone
   d) the combination of the remaining sediment in the infiltrated flow and in the overland flow will not exceed 20% of the original sediment load (thus 80% TSS removal)

2) Show that during the 1:2 year event, all of the runoff from the site can infiltrate into the clearstone trench during the event without producing runoff from the system, even when the ditch is due for cleanout.
   Find:
   a) the rate of infiltration into the clearstone trench under ideal conditions (using Horton or an equal method of estimating infiltration rates)
   b) the rate of infiltration into the clearstone trench assuming the swale is due for a clean-out
   c) the rate of water reaching the swale during a design event (1:2 event), using the City of Ottawa IDF curve, for a variety of event durations up to 24 hours in duration, considering the reduction of catchment area during events shorter than the time of concentration. The ratio of reduced area/actual area is equal to the ratio of event duration/time of concentration, up to the time of concentration.
   d) the instantaneous runoff rate, less the infiltration rate, is the rate of surface storage. The cumulative storage volume will not exceed the volume of the swale (without overtopping) during the 1:2 year event.

3) Show that during the 1:2, 1:5, 1:10, 1:25, and 1:100 year events, the peak flow rate reaching the creek via any and all paths when the site is in post-development conditions is not greater than the peak flow rate reaching the creek in pre-development conditions.
   Find:
   a) the pre-development peak flow rates for each post-development catchment for all design events.
   b) the rate of infiltration into the clearstone trench, and the depth of flow within the swale, as a time series
   c) the velocity of flow within the clearstone trench, based on stone size distribution and expected void sizes.
   d) the flow rate within the swale, over the clear stone trench, throughout the duration of the event for all design events.
   e) the flow rate draining from the site via a route other than through the clearstone trench or swale, throughout the duration of the event for all design events.
   f) the exfiltration rate from the trench. If the exfiltration rate is expected to be less than 3% of the total runoff volume, then it can be ignored.
   g) the post-development peak combined flow rate reaching the creek, compared to the pre-development peak flow rate, for all design events.

4) Show that during the 1:2, 1:5, 1:10, 1:25 and 1:100 year events the swale will have no ponded water within 24 hours of the end of the event.
   Find:
   a) the ponded volume at the end of the event.
   b) the saturated infiltration rate of the soil.
   c) the rate of overland flow throughout the 24 hours following the end of the event.
   d) the rate of infiltration, considering the HGL of the swale and the HGL of the clearstone, throughout the 24 hours following the end of the event.

5) Show that the sediment accumulation within the treatment swale can be reasonably managed with spot treatment accessed by small vehicles (2.4m wide access) and/or local ditch clean out upstream of the road crossings.
   Find:
   a) what volume of sediment is expected to be transported to the swale via catch basins
   b) what volume of sediment is expected to be transported to the swale via yard runoff
   c) the potential for sediment transport within the swale system
   d) the potential for erosion within the swale system
   e) the sediment that will be captured within trapped lows in the swale system

f) the efficacy of a settling basin on the upstream side of road crossings as a means of reducing sediment transport.
g) the size of such a settling basin so that it requires annual (or less frequent) cleaning.
h) the expected frequency of full cleanout.
i) the expected maintenance activities required to maintain infiltration.

6) Show that the sediment accumulation within the clearstone trench can be reasonably managed with spot treatment accessed by small vehicles so that the expected lifecycle of the system would be a minimum of 40 years.
   Find:
   a) The volume of sediment expected to be retained within the clearstone trench annually
   b) The volume of voids within the clearstone trench after 40 years
   c) The required capacity and configuration of additional subdrainage (eg, Big-O with sock or equal), assuming local failure of the geotextile filter surrounding the clearstone trench, to ensure that subsurface flow is still sufficient to provide for no ponded water on the surface within 24 hours.
   d) Internal structure that prevents substantial migration of fines throughout the system.
   e) The expected annual maintenance activities required to maintain conveyance within the system.

7) Monitoring – demonstrate predicted performance by ongoing monitoring in multiple locations
   a) Establish 1 test site per block that includes, at a minimum, continuous monitoring of flow, TSS, turbidity, temperature, conductivity, within a catch basin lead.
   b) Collect 12 grab samples from that catch basin lead during one year to be tested at an accredited water testing laboratory. Use this data to calibrate monitored turbidity and TSS to laboratory TSS concentrations under different conditions of temperature and conductivity.
   c) Establish 1 test site downstream of all confluences that includes, at a minimum, continuous monitoring of flow, TSS, turbidity, temperature, conductivity, in both the surface flow and the subsurface flow.
   d) Collect 12 grab samples from each of surface water (if possible) and subsurface water during one year to be tested at an accredited water testing laboratory. Use this data to calibrate monitored turbidity and TSS to laboratory TSS concentration under different conditions of temperature and conductivity.
   e) Predict from the continuous monitoring: mass of TSS reaching the system in a year, total volume of water reaching the system in a year, average TSS reaching the system over a year, mass of TSS leaving the system in a year, volume of water leaving the system in a year, and average TSS leaving the system over a year.
   f) Calculate the annual average removal rate.
   g) Using a rainfall time series over the same year, calculate the decile rainfall and runoff events.
   h) For each decile of rainfall and runoff event, calculate the observed TSS removal rates.
   i) Compare actual TSS removal rates to the target TSS removal rate (80% removal from 90%ile rainfall).

8) Second Opinion – use a qualified peer review to ensure the design can be expected to achieve the designated targets
   a) As part of the conceptual design process, a peer review from a second consulting firm on the expected performance of the system is required. This would be in addition to and occur before any review by the approval authorities.
   b) The consulting firm would be selected by and paid by the municipality
   c) This peer review is intended to provide a second opinion that agrees that the expected targets can be achieved through a detailed design process based on the conceptual design.
   d) Any particular issues that must be addressed in the detailed design that have not been identified in the conceptual design will be identified by the peer review.