Subwatershed Study - Phase 2: Impact Assessment

Smithville Subwatershed Study and Stormwater Management Plan
Township of West Lincoln
TPB198161

Prepared for:

Township of West Lincoln
318 Canborough Street, Smithville, ON L0R 2A0

2/24/2023

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1.0 Introduction

1.1 Study Overview

The Township of West Lincoln (The Township) has initiated a Master Community Planning Study to plan for future growth in the Community of Smithville. The Master Community Plan is being developed under the Planning Act and supporting infrastructure planning is being conducted in accordance with the requirements of the Municipal Engineers Association's Municipal Class Environmental Assessment (EA) for Water, Wastewater and Roads (as amended in 2015) Master Plan. This process includes the preparation of a Subwatershed Study (SWS), as a companion study being conducted in parallel with the Master Community Plan Study and Servicing Studies. The overall purpose of this SWS is to:

a. Inventory, characterize and assess natural hazard, natural heritage and water resource features and functions within the study area (i.e., constraints to development);

b. Provide recommendations for the protection, conservation and management of natural hazards, natural heritage, and water resource features within the study area;

c. Provide sufficient detail to support the designation of NHS in Secondary Plans, through the refinement of the Regional NHS; and

d. Provide recommendations for a management strategy, implementation and monitoring plan to be implemented through the Secondary Plan(s) and future site/area specific studies.

The results of the SWS will be essential for informing the future Secondary Plan(s). The SWS will inform land use decision making so that it allows for urban systems to be integrated with natural systems in an area that is transitioning from predominantly rural to urban uses.

1.1.1 Planning Process for Community of Smithville

The Study Area for the Subwatershed Study is located along the perimeter of the existing urban boundary of the Community of Smithville, and is generally bounded by Young Street to the north, the North Creek to the south, S. Grimsby Road 6 to the west, and S. Grimsby Road 2 to the east (ref. **Figure 1.1.1**).

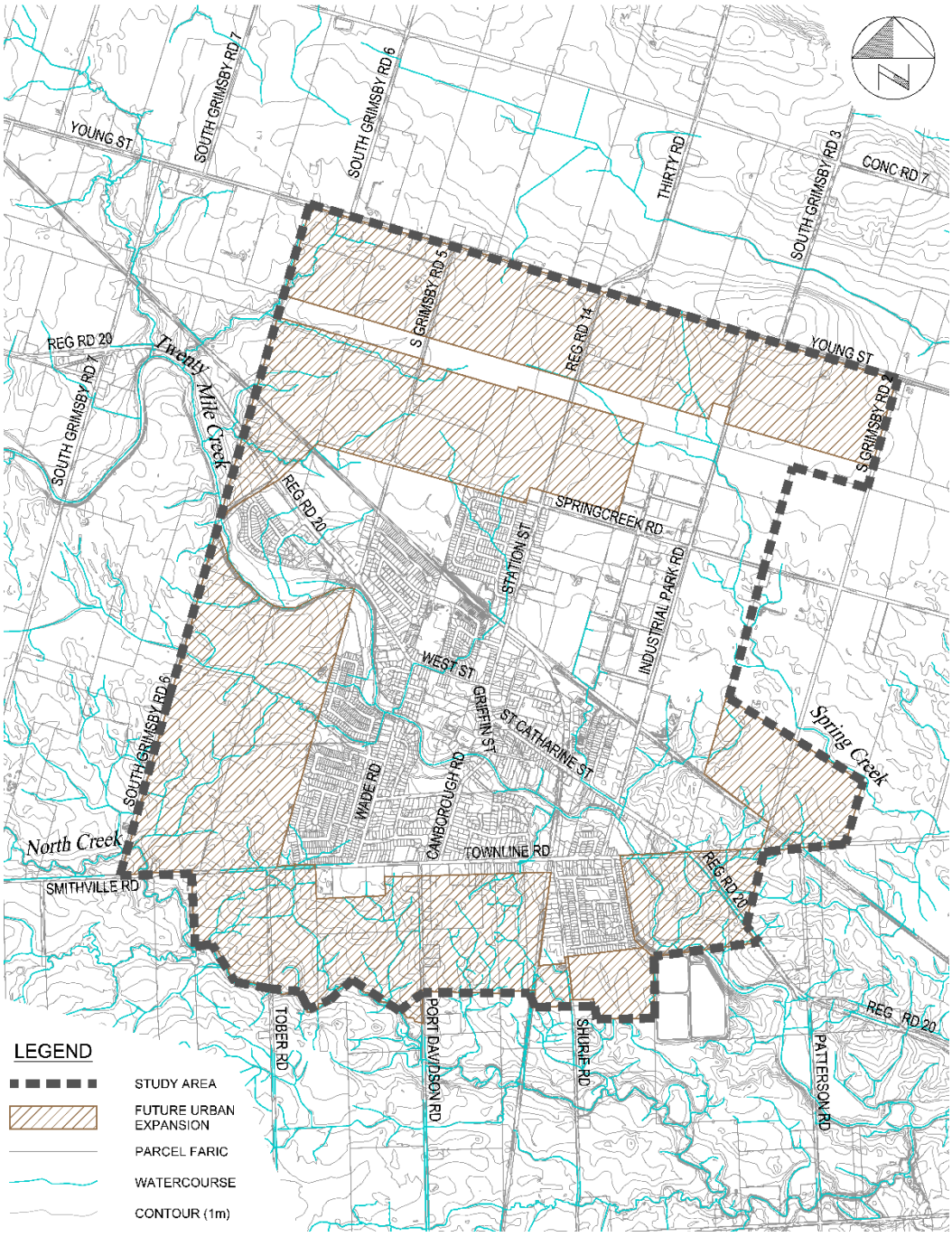

Figure 1.1.1. SWS Study Area Location Plan

As noted, the planning process includes the preparation of a Subwatershed Study, Master transportation and servicing studies, and high-level land use studies, as the basis for developing the Master Community Plan. The Master Community Plan provides a high-level community structure and the planning context for the future development of more detailed Secondary Plan(s) for smaller geographic areas including in the future the companion Master Environmental Servicing Plans (MESPs). The SWS is being undertaken collaboratively and concurrently with the Master Transportation and Servicing Studies and the preparation of the Master Community Plan. The linkage between the various Subwatershed Study phases and the companion studies is depicted graphically in **Figure 1.1.2**.

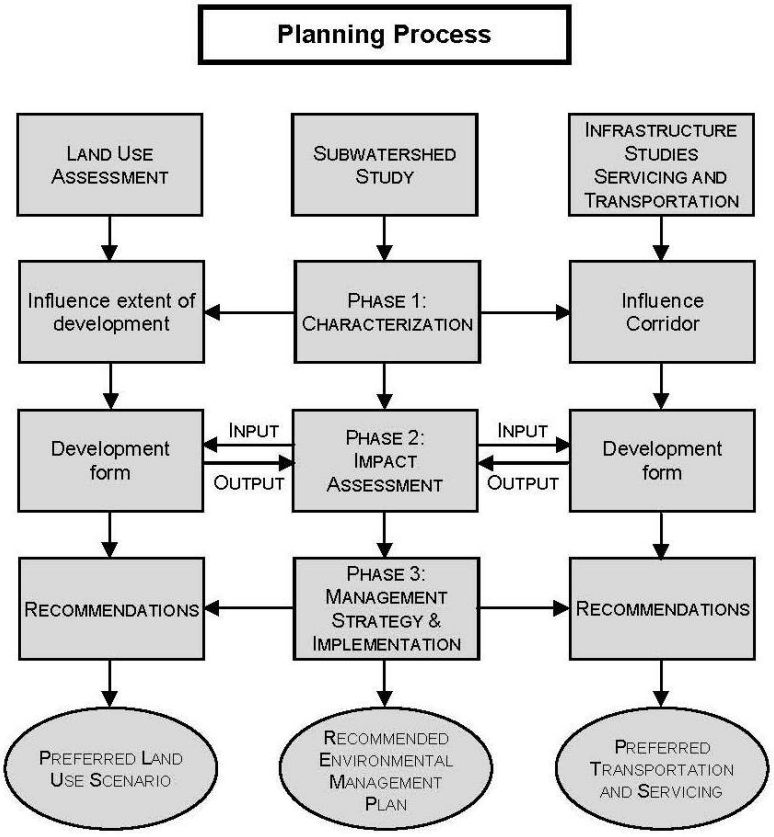

Figure 1.1.2. Integrated Land Use, Subwatershed and Servicing Plan Process

The SWS is being administered through a Steering Committee as part of the overall Master Community Plan process, and also guided by a Technical Advisory Committee (TAC). The Steering Committee is comprised of Senior Management in planning and engineering from the Township of West Lincoln, as well as senior representatives from the Region of Niagara, Niagara Peninsula Conservation Authority (NPCA), and area Landowners. The Technical Advisory Committee is comprised of representatives from the Subwatershed Study Team and relevant technical staff from the Township of West Lincoln, Region of Niagara, NPCA, and Landowner Representatives, with expertise in hydrology, hydraulics, hydrogeology, water quality, fluvial geomorphology, terrestrial, aquatics and land use planning.

1.2 Subwatershed Study Process

The SWS must ensure that all applicable Provincial, Regional and Municipal land use planning requirements, including Conservation Authority regulations, are achieved.

The initial step in the SWS process involved the collection and review of available data from the TAC. The data were then reviewed for completeness and quality, and a gap analysis conducted to identify deficiencies in the available data. The Gap Analysis lists the available data and provides an assessment of data gaps and the degree to which the available data can and/or should inform the SWS. This has been done in consultation with the TAC. The findings of this gap analysis were used to refine the SWS Work Plan, to allow for the collection of any supplemental data to inform the SWS process. As a parallel initiative to the data collection and gap analysis, the Township, in cooperation with the Landowner Representatives, secured Permissions To Enter (PTE) to allow fieldwork to be completed on properties of

interest within the study area. The Work Plan was finalized April 21, 2020, shortly following commencement of the fieldwork.

Following the gap analysis and Work Plan refinement, a preliminary constraint assessment was completed. This assessment was undertaken based on the interpretation of the data provided by the TAC, and was intended to provide initial high-level guidance for the land use planning process, to allow both initiatives to continue to proceed in parallel.

The core Work Plan of the SWS process has been structured to be carried out in three (3) phases, which will result in three (3) documents/reports, as follows:

- Phase 1: Subwatershed Characterization and Integration,
- Phase 2: Impact Assessment (this document),
- Phase 3: Management, Implementation and Monitoring Plan,

The purpose of Phase 1 (Subwatershed Characterization and Integration) of the SWS is to gain a better understanding of the state, health and general character of the subwatershed. Reviews of existing studies and reports, fieldwork and, where appropriate, modelling has been undertaken, in order to understand the baseline of conditions related to the following key components: Hydrology/Hydraulics, Hydrogeology, Karst Features, Water Quality, Stream Morphology and Aquatic and Terrestrial Resources. These components have been considered and assessed as part of this report to characterize the Subwatershed area's of interest.

Phase 2 (Impact Assessment – this report) involves evaluating the impacts of future planned urbanization of the land use plan, as prescribed by the Master Community Plan. This initial evaluation is intended to provide direction to the Land Use Team, who will then refine the Land Use Plan in accordance with the direction from the first iteration of testing. The refined Land Use Plan (after some integrated consultation amongst all team members) is then advanced for a second round of testing and assessment, as required, as part of Phase 3. Working Targets and preliminary management strategies to address potential impacts associated with future development, as related to the natural environment and stormwater, have been developed. Watercourses and natural heritage features have been assessed and given a constraint ranking, followed by an overall net rating. Any refinements to the Region's NHS have been identified and discussed through this phase.

Phase 3 (Management, Implementation and Monitoring Plan) formalizes the recommendations for water management, including traditional and low impact development practices, as well as specifics related to environmental management, including parameters for stream stability and terrestrial and aquatic system protection and enhancement. This process also includes developing an implementation and monitoring plan, to provide further direction on the implementation procedures related to the plan recommendations, including priorities, specific policies, need for follow-on studies and related study requirements.

In addition to the foregoing, the study includes the preparation of a Stormwater Management Master Plan for the future intensification and infill areas within urban Smithville. This component of the study has built upon the insight and guidance from the three phases of the Subwatershed Study, and has developed the stormwater management plan specific to the future intensification and infill areas, tailored to address local constraints within existing receiving infrastructure in Smithville.

At the conclusion of the SWS, the final reports are to be adopted by Township Council.

2.0 Summary of Phase 1 Characterization and Integration

2.1 Summary of Discipline Findings

2.1.1 Hydrogeology

The study area lies within the Haldimand Clay Plain physiographic region. The larger region generally consists of stratified clay related to glacial Lake Warren although the northern area, including Smithville, may consist of an intermixture of stratified clay and till.

The bedrock underlying the study area consists of a sequence of bedded dolostones and shales, generally sloping from north to south with an elevation range of approximately 25 m in the area of the proposed urban expansion (Drawing GW-3). Elevated bedrock areas exist south of Twenty Mile Creek in the southwestern portion of the urban expansion area and in the northern portion of the urban expansion area, as well further north beyond the urban expansion area. Twenty Mile Creek tends to follow a bedrock depression just west of, and through the Community of Smithville.

The surficial geology consists primarily of fine-grained sediments characterized by the glaciolacustrine clay and silt throughout the majority of the urban expansion area with minor areas of clay to clayey silt till (Halton Till). Stream deposits are predominately clay and silt with some sand and gravel. The Eramosa dolostone is exposed in bedrock outcrops along portion of Twenty Mile Creek and areas northeast of the urban expansion area.

The overburden is less than 6 m thick throughout the majority of the urban expansion area, with the least amount of overburden correlating with the bedrock highs and bedrock outcrops (Drawing GW-3). Overburden thickness generally increases south of the urban expansion area in a southerly direction correlated with the slope of the bedrock (Drawings GW-5a, GW-5b).

Fractures occur in lateral bedding planes and as vertical and sub-vertical fractures (joints) above and below the bedding planes. Joint spacing is noted to be more frequent in the uppermost portions of the bedrock and decreases with depth and exhibits preferential orientations.

Groundwater flow within the bedrock is governed by the horizontal and vertical hydraulic gradients as well as the general characteristics of the fracture network and solution channels. Groundwater flow moves from the bedrock surface vertically through the vertical fractures (joints) to the bedding planes where the joints are connected. The vertical flux through the upper bedrock will depend on the spatial frequency of the joints, and their size, particularly related to the history of dissolution, and the water made available from ground surface through the overburden. The combined bedding plane/joint network provides for significant lateral groundwater flow and less frequent vertical flow conduits.

Groundwater flow within the upper bedrock is considered to be the primary flow pathway that is potentially connected to Twenty Mile Creek and the majority of the domestic wells. Groundwater flow in the upper bedrock generally flows from northwest to the southeast but within the Town of Smithville flow is directed towards Twenty Mile Creek from the north and from Townline Road in the south northward to Twenty Mile Creek. There is a strong correlation between the horizontal flow direction in the shallow bedrock and the bedrock topography. It is expected that more local shallow groundwater flow will be controlled to varying extents by the fractured nature of the bedrock and particularly the larger solution channels and conduit flow. The orientation of these features may direct flow in directions not consistent with the larger scale hydraulic gradients.

Twenty Mile Creek is known to have no flow through the study area at various periods in the summer months. Groundwater discharge may occur seasonally when the more regional groundwater levels are higher, thus feeding some amount groundwater discharge. Pools along Twenty Mile Creek also exist in

the summer months indicating varying amounts of local discharge, likely through the discrete fracture/solution channel network. Substantive spring flow (S1) contributes to Twenty Mile Creek in the vicinity of Canborough Street and its source is related to a significant conduit connected to the Smithville Cave along with Additional springs (S2, S3, S4) in the vicinity of Rock Park (**Figure 2.1.1**)

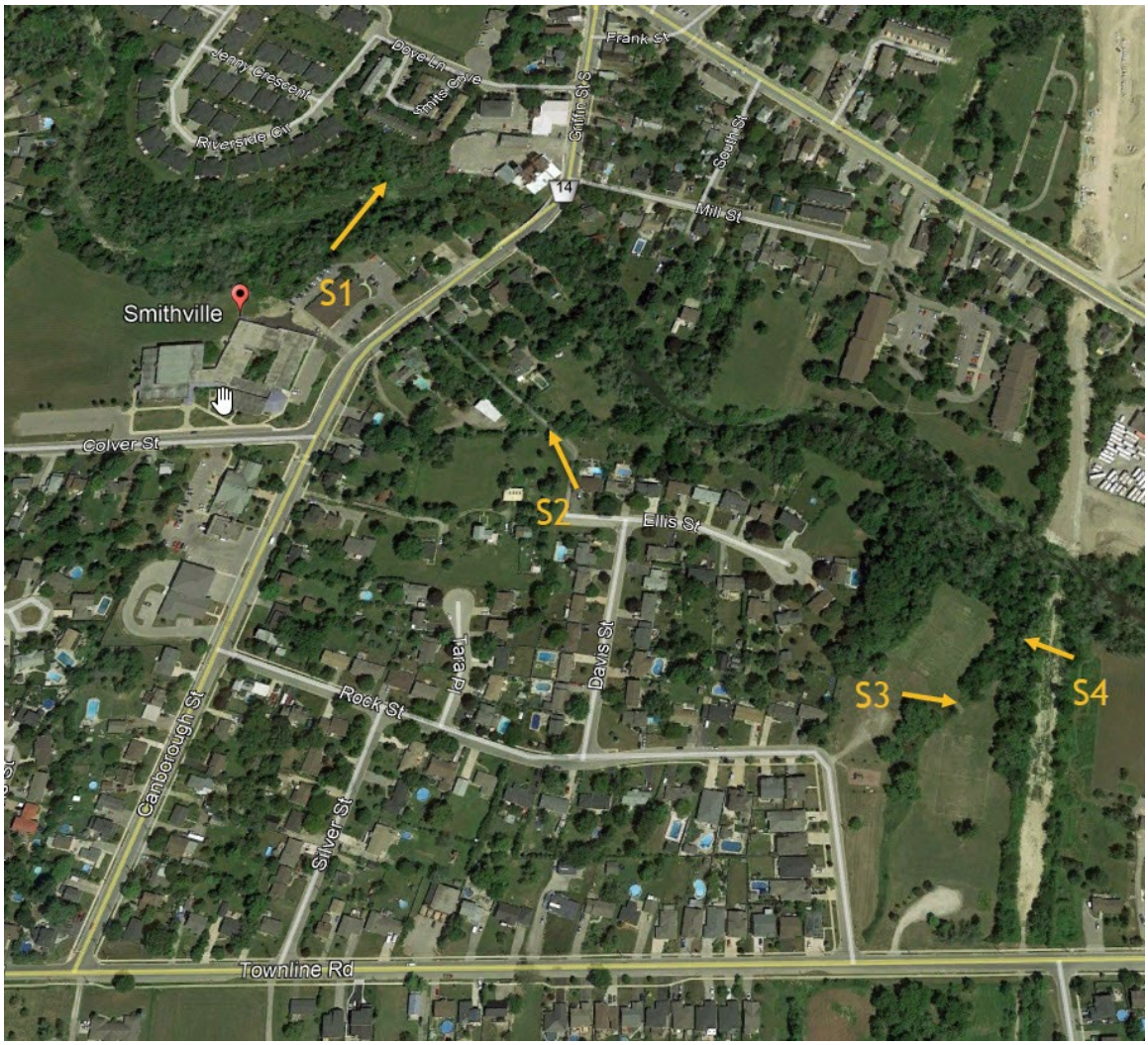

Figure 2.1.1. Locations of Springs

The local wetlands within the study area are currently not considered to have any significant functional groundwater discharge associated with them consistent with observations and the characteristics of the low permeability overburden groundwater flow system.

The municipal water supply for the Community of Smithville is a lake-based supply. Outside of the existing urban area, individual water supplies are provided through domestic wells that generally get their water from the fractures and solution channels that are more common in upper 15 metres of the bedrock.

Areas referred to as Highly Vulnerable Aquifer (HVA) have been developed through the Source Water Protection study. The NPCA used an overburden thickness of less than 5 m to delineate these areas as the thinner overburden offers less protection of contaminants migrating to the shallow bedrock aquifers related to the Eramosa Member and the Guelph Formation. These HVA areas correlate well with the areas of overburden less than 6 m thick shown on Drawing GW-5b. This current subwatershed study presented

that an overburden thickness of less than 6 m represents a more accurate value hydrogeological sensitivity related to contaminant migration to the underlying bedrock aquifer. This 6m overburden thickness value is based on site specific work done within the Phase IV CWML study which includes the assessment of water residence time within the overburden and observations from test pits excavated to the bedrock.

2.1.2 Karst

Karst investigations undertaken in support of the Phase 1 characterization study have included the following:

- Review of the available karst and hydrogeology literature;
- Reconnaissance area visit with a karst expert familiar with the area on December 24th, 2019;
- Detailed orthophoto and stereo aerial photo analysis (1:10,000 scale) of the entire study area and immediate surroundings using a 2X-10X Wild Mirror stereoscope;
- Reconnaissance of selected air photo targets on March 10, 2020;
- Six days of site surveys on March 25th and 26th, April 24th and 25th, and May 7th, 2020 and March 17th, 2021; and
- Investigation of previously identified karst features.

Reconnaissance and detailed site investigations focused on known and potential karst features but also involved observing water flow in ditches and surface channels as well surface ponding during rain events and spring snowmelt.

Surface water observations in December 2019 and March 2020, during rain and snowmelt did not provide indications of significant karst capture in road-side ditches or along several streams. Significant surface ponding was observed during 2020, particularly in northern portions of the study area between Young Rd and the southern boundary of the hydro right-of-way. Surface pondings in the northern area did not demonstrate reductions in area from March 10 through March 26, 2020 and many wet ponds and saturated soils continued into early May of the same year.

A total of 11 karst features were investigated and documented. Seven of the features were located within the study area of which 6 were distinct sinkholes and the other a short stream reach that appeared to be gradually losing flow in the downstream direction and is likely not karstic.

In general, the largest most significant karst features occur in the western portion of the study area adjacent to South Grimsby Road 6 in the vicinity of the rail road (NW area) and west of Wade Road (SW area). Of these features, 2 appear to be the result of man-made factors such as an under-sized culvert beneath the rail line resulting in upstream flooding (NW 1) and, possibly consequences of forest clearing prior to agricultural tilling (SW 1). All features are within about 500 m of Twenty Mile Creek , averaging 330 m.

Karst hazard assessments are required by the Provincial Policy Statement (PPS) under policy 3.1.1(c) (Karst Hazardous Sites). Hazardous sites are also regulated under the Conservation Authorities Act and the NPCA's specific regulation for development in these areas is Ontario Reg. 155/06. The specific hazard defined by the PPS is "unstable bedrock" related to solution and removal of bedrock potentially creating a geophysical hazard to development and/or the public. However, development in and around Karst Hazardous Sites can also result in problems associated with flooding (change in recharge capacity of the sinkhole/karst conduit) and/or loss of flow to connected springs. The latter situation is the most common in SW Ontario and also has the potential to create ecological impacts.

In this regard, the assessment of hazard constraints depends on the size/depth of the karst solution, rate of soil sloughing, and the capacity of the conduits to transport surface flows underground. Mitigation

ranges from leave in place and buffer to accommodate potential flooding to complete removal and by-pass of the feature. In all cases, development should not result in increased flows to the feature. Depending on water balance/flow dynamics, the feature may be subject to excavation and grouting.

An assessment of constraint level was completed for each karst feature in the study area. Low (green) indicates the potential for the feature to be removed (excavated and grouted) and/or by-passed by runoff/stormwater. Medium level constraint (yellow) means the feature may require additional study including water balance analysis and potential dye tracing. A high constraint (red) indicates that development should avoid the feature and be buffered by 50 m from the upper rim of the depression(s), subject to direction from the NPCA. It is also recommended that a 50 m setback be applied to sinkhole SW 1 pending further studies due to active soil sloughing into the main sinkpoint. It should be pointed out that only 2 of the sinkholes (NW 3 and SW 2) are recharged sufficiently to facilitate dye tracing. The others are mostly dry with the exception of the immediate snowmelt period.

Shallow overburden over bedrock represents a broad constraint. The silt-clay glaciolacustrine deposits in the study area generally restrict significant infiltration, particularly in the area of the hydro line right-of-way, along Young Street, and in the SW (Townline RD and South Grimsby Rd 6).

All karst features occur with about 500 m straight line distance of Twenty Mile Creek, the longest (NW 2) being about 550 m. No surface karst was observed in the northernmost portion of the study area including along the hydro line and towards Young Rd. This suggests that the hydraulic gradient provided by the creek valley is playing a role in the initiation and development of the karst. Smithville Cave is known to be connected to the creek in terms of taking water directly from the creek (SW 4) and discharging within the creek valley (SW 5).

The Eramosa Formation within the study area is a karst aquifer. This conclusion is principally defined on the basis of relatively high hydraulic gradients, the presence of at least one large cave, and several sinkholes.

2.1.3 Hydrology and Hydraulics

The urban expansion area and the existing urban area fall within three watersheds – Twenty Mile Creek Watershed, North Creek Watershed, and Spring Creek Watershed. The main branch of Twenty Mile Creek runs west to east across the existing urban area. The main branch of North Creek runs west to east along the south boundary of the urban expansion area. A major tributary of Spring Creek runs northwest to southeast outside of the urban expansion area and through the existing urban area towards the east. The urban expansion area is characterized with mainly headwater drainage features (HDFs) along with several regulated watercourses. The existing urban area is characterized with open ditches and storm sewer drainage systems, overland flow drainage systems, and stormwater management facilities (SWMFs).

Soils within the urban expansion area and the existing urban area have been characterized based upon a review of the surficial geology mapping information (Ontario Ministry of Energy, Northern Development and Mines, 2020). The soils are noted to consist of 93% of glaciolacustrine clay and silt, 4.7% of diamicton (predominantly clay to clayey silt), 1.9% of stream deposits (predominantly clay and silt), and 0.4% of paleozoic bedrock. Stream deposits and Lockport Formation are concentrated along Twenty Mile Creek (ref. Drawing WR3). Overall, the soils are with low permeability and low infiltration potential, with high potential for generating runoff. The surface slopes within the urban expansion area and the existing urban area tend to be moderate between 1 and 2% (1.7% ave. +/-). There are slightly steeper areas along Twenty Mile Creek (3%+/-).

The land use conditions within the urban expansion area and the existing urban area have been characterized based on the available aerial imagery. Within the urban expansion area, the land use

conditions are primarily agricultural lands with headwater drainage features. Within the existing urban area, the land use conditions are a mixture of median to high density residential areas, park areas and open lands, industrial areas (along Industrial Park Road), and commercial areas (along West Street and St. Catherines Street).

A field monitoring program was implemented to collect streamflow data to support the validation of the hydrologic modelling. The gauges were installed on April 2, 2020 at three sites proximate to the study area. The loggers collected continuous water level data at 15-minutes time intervals until November 27, 2020 at which time the loggers were removed prior to freeze-up. In addition, a rain gauge was installed on March 20, 2020 at the Smithville Arena. The rain gauge collected continuous rainfall amount data at 15-minutes time intervals until November 27, 2020 at which time it was also removed from the field. The hydrologic responses during the monitoring period were low potentially due to the influence of low seasonal rainfall, karst features, evaporation, and evapotranspiration due to area wetlands.

The hydrologic responses during the monitoring period were low potentially due to the influence of low seasonal rainfall, karst features, evaporation, and evapotranspiration due to area wetlands. A PCSWMM model has been developed for the urban expansion area and the existing urban area at the local level. The continuous simulation and the design storms simulation result in relatively lower peak flows and runoff volumes compared with the NPCA's HEC-HMS model. Overall, the PCSWMM model and the refined HEC-HMS model generate representative results considering the differences in subcatchment sizes, as well as modelling and parameterization approaches.

The erosive flows occurred for 0.5% of the 22 years along the Twenty Mile Creek tributary, 0.6 to 0.8% of the 22 years along the North Creek, and 1.0 to 1.3% of the 22 years along the Spring Creek reach.

HEC-GeoRAS hydraulic models have been developed for the regulated watercourses within and downstream of the study area. The resulting 100 year floodplain (Regulatory) is contained within the current flood hazard defined by NPCA, hence the current 100 year floodplain developed by NPCA is considered to govern.

2.1.4 Fluvial Geomorphology

The Phase 1 characterization included a desktop and field based analyses. The desktop analysis used available digital mapping and air photos to complete a historical assessment, identify and delineate reaches for watercousres and headwater drainage features (HDFs). The historical assessment noted that while many reaches appear to have been previously altered, many alterations (apart from dredging and maintenance) occurred before 1934. Generally, riparian cover has improved along mainstem watercourses since the earliest photograph date, while vegetative cover near HDFs has remained poor.

Using topographical data, watercourse reaches were identified as unconfined, partially confined, and confined. Based on their degree of confinement, meander belt and stable top of slope hazards were delineated accordingly based on channel planform and/or valley geometry, aerial photography, surface contours, and base mapping. This was completed at a high-level for the purpose of characterizing the subwatershed study area, and developing an initial characterization of area hazards.

Field Investigations were completed to fill data gaps, and confirm and/or update the desktop results. Watercourses underwent Rapid Field Assessments (RGA/RSAT) and detailed geomorphic reach surveys (**Table 2.1.1**). The rapid assessments noted that stream reaches were mainly in a state of "transition", or "in regime" (stable). The RGA was not applicable to several reaches.

Detailed field surveys were completed for 3 reaches to characterize the system and develop threshold values for particle entrainment (i.e. erosion thresholds) which highlights the channel capacity to mobilize the median particle size (**Table 2.1.2** and **Table 2.1.3**).

Table 2.1.1. Channel Characteristics for the Detailed Geomorphic Field Sites

Parameter	NC5	SC1(2)	TM4(6)1-1
Representative Channel Width (m)	10.8-11.8	3.8	2.2-3.0
Maximum Channel Width (m)	16.0	4.0	4.8
Representative Channel Depth (m)	1.1-1.3	0.3	0.43-0.54
Maximum Channel Depth (m)	1.5	0.5	0.6
Channel Width: Depth	9.1 – 9.8	12.7	5.1 – 5.5
Cross sectional Area (m^2)	6.71 - 7.86	0.77	0.62 – 1.03
Wetted Perimeter (m)	13.10 – 12.92	4.96	3.22 – 3.35
Hydraulic Radius (m)	0.40 - 0.61	0.16	0.19 - 0.31
D_{50} (mm)	2	<1	<1
Bed material	Clay, silt, sand and gravel	Clay and silt	Clay, silt and sand
Bank material	Clay soil, densely vegetated	Clay soil, densely vegetated	Clay soil, moderate vegetation density

Table 2.1.2. Bankfull Hydraulics for the Detailed Geomorphic Field Sites

Parameter	NC5	SC1(2)	TM4(6)1-1
Bankfull or 'Channelfull' Discharge (m^3/s)	1.59 – 3.99	0.12	0.57 - 1.31
Estimated Gradient (m/m)1	0.0008	0.0014	0.0096
Bankfull Velocity (m/s)	0.38 – 0.51	0.16	0.92 - 1.28
Stream Power (W/m)	12.53 – 31.33	1.65	53.24 - 123.57
Stream Power per unit Width (W/m^2)	1.26 – 2.65	0.34	18.06 - 41.81
Shear Stress (N/m^2)	3.13 – 4.78	2.14	17.86 - 28.94

[1]Values from DEM

Table 2.1.3. Threshold Characteristics Estimated for the Detailed Geomorphic Field Sites

Parameter	NC5	SC1(2)	TM4(6)1-1
Bankfull Channel Geometry			
Channel Width (m)*[1]	10.8-11.8	3.8	2.2-3.0
Channel Depth (m)*[1]	1.1-1.3	0.3	0.43-0.54
Gradient (m/m)[2]	0.0008	0.0014	0.0096
Bed Material			
D_{50} (mm)	2	<1	<1
D_{84} (mm)	17	<1	<1
Manning's 'n'	0.04	0.07	0.035
Bankfull Channel Hydraulics			
Channel Discharge (m^3/s)	1.59 – 3.99	0.12	0.57 - 1.31
Channel Velocity (m/s)	0.38 – 0.51	0.16	0.92 - 1.28
Average Shear Stress (N/m^2)	3.13 – 4.78	2.14	17.86 - 28.94
Thresholds			
Recommended Critical Discharge (m^3/s)	0.472	0.385	0.159
Percent of Channel Discharge (%)	30 – 12	320	28 – 12
Critical Velocity (m/s)	0.28	0.22	0.71
Critical Shear Stress (N/m^2)	2	3.5	12
Critical Flow Depth (m)	0.54	0.47	0.22
Sources	Fischenich Permissible Shear Stress: Alluvial Silt = 2.2 N/m^2 Shields modified by Miller (1997): D50 (2.2mm) = 1.6 N/m^2 Chow (1959): Loose clay soil = 2.8 N/m^2	Fischenich Permissible Shear Stress: Firm Loam = 3.6 N/m^2 Chow (1959): Fairly compact clay soil = 3.4 N/m^2	Fischenich Permissible Shear Stress: Alluvial colloidal silt = 12.4 N/m^2 Fischenich Permissible Shear Stress: Stiff clay = 12.4 N/m^2 Chow (1959): Compact clay soil = 12.0 N/m^2

*Channel dimensions of selected representative cross sections
[1]Values based on detailed topographic survey
[2]Values from DEM

HDFs within the Study Area were first identified through a review of NPCA watercourse mapping and recent aerial photography. Potential HDF features were identified by overlaying the NPCA 2k Hydrography and Contemporary Watercourse Mapping map sets and selecting the features that had been screened out of the Contemporary Watercourse Mapping, as well as by selecting features that were classified in the Contemporary Mapping layer as swales, agricultural drainage, or agricultural drainage. A detailed field study of HDFs was completed following the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* (TRCA/CVC, 2014).

HDFs are found predominantly in agricultural settings within the Study Area. Previously unmapped HDFs were identified on most properties that were visited. Several HDFs identified during the desktop study were reclassified as watercourses based on field observations, and were included in the Rapid Assessments. The spring of 2020 was fairly dry, without a pronounced freshet. Consequently, many features were dry or contained standing water during the early spring site visit. All of the HDFs assessed were dry by the third site assessment in August of the same year. Feature types included channelized and ditched features, swales, wetlands, naturally defined features with sorted sediment and features that were poorly defined.

Several HDF features provide linkages to provincially significant wetlands (PSWs). In addition, several HDFs appear to be seasonally fed by small wetland pockets that are found in the middle of tilled agricultural fields (such as TM4(2)3-3, TM4(2)3-1a). In general, there were more wetland connections to HDFs in the northwest and northeast parts of the Study Area, in the Twenty Mile Creek and Spring Creek subwatersheds respectively. Several HDFs within the study area were also found to be connected to karst features. For instance, karst feature NW2 is connected to HDFs TM4(5)1-4 and TM4(5)1-3, and karst feature SE2 is located on HDF TM3(1)6-2. In several cases where HDFs were dry but showed evidence of recent flow, such as fresh erosion or sorted sediment, the features were classified as Mitigation to provide a conservative recommendation.

2.1.5 Surface Water Quality

The water quality monitoring samples received from NPCA indicate that the concentrations of typical contaminants in the proximity of the study area are generally in comparable ranges with relatively higher levels compared with similar land uses in other study areas. High concentrations of organics, nutrients, and metals are noted for Twenty Mile Creek and North Creek. The existing land use conditions are largely agricultural. Therefore, the high concentrations and exceedances are considered largely attributable to intensive farming activities and lack of formal water quality measures.

2.1.6 Aquatic Resources

The watercourses occurring within the study area are located within the Twenty Mile Creek, North Creek, and Spring Creek subwatersheds. Most of the watercourses lie within the Twenty Mile Creek subwatershed and functionally collect and convey the majority of water from within the study area to the main branch of Twenty Mile Creek. Watercourses within the southern portion of the study area, and generally south of Smithville, flow south to North Creek. The northeast corner of the study area occurs within the Spring Creek subwatershed, which collects and diverts flow southeast toward Spring Creek, which lies outside of the study area boundary.

The aquatic resources assessment provided a characterization of the aquatic ecology along the open watercourses and streams within the study area. Existing natural heritage information on aquatic resources was gathered and reviewed to identify key natural heritage features and species that are reported from the study area, and compared to relevant policies and legislation. Field work, consisting of spring and late summer aquatic habitat assessments and fish community surveys, was undertaken in 2020. Watercourses were classified as Critical, Important, and Marginal habitats and were assigned a cold, cold-cool, cool, cool-warm, or warm water designations based on summer temperature measurements and fish presence.

The information collected through this analysis provided insight regarding the significance and contributions of the watercourses and streams toward supporting and sustaining aquatic habitat within and downstream of the study area, as well as watercourse and stormwater management plans for the future development, including integration with the NHS.

Three watercourses were confirmed as permanent within the study area: 1) main channel of Twenty Mile Creek, 2) main channel of North Creek, and 3) a small portion of an inflowing tributary to Twenty Mile Creek, located south of Twenty Mile Creek in Rock Street Park. Portions of Twenty Mile and North Creeks are intermittently dry, isolating the wetted portions of each feature. Twenty Mile Creek contains many areas of exposed bedrock and its flows are influenced heavily by karst features in the area. Twenty Mile Creek is confirmed fish habitat, providing a cool-warm water thermal regime. North Creek also provides direct fish habitat, and a cool water thermal regime. The small watercourse in Rock Street Park, identified as TM3(1)1, provides indirect fish habitat and coldwater contribution to Twenty Mile Creek throughout the year.

The study area contains intermittent watercourses and small ponds, as well as HDFs, as discussed in the section on Fluvial Geomorphology.

During 2020 field surveys, 19 fish species were observed within the study area, including one new species for the area: Iowa Darter (*Etheostoma exile*). The fish community is considered fairly diverse and is characterized by a variety of small-bodied and larger-bodied fish, including recreationally valuable species. The highest fish diversity (17 species) and abundance was observed within the main channel of Twenty Mile Creek, which is the largest watercourse of the three, and which provided the most habitat. One species of Special Concern, Grass Pickerel (*Esox americanus vermiculatus*), has the potential to occur in Twenty Mile Creek and North Creek, but this species was not observed during field investigations. Critical Habitat for the species (DFO 2019) is not found within the study area.

Map NH-4 shows the aquatic stations that were monitored in 2020. Maps NH-8 and NH-9 identify fish habitat and the watercourse thermal regime, respectively.

2.1.7 Terrestrial Resources

The study area consists primarily of agricultural fields and rural properties surrounding the Community of Smithville, within Ecoregion 7E. Isolated natural heritage features are found distributed through the study area, and along Twenty Mile Creek, which bisects the Community of Smithville. The study area borders numerous residential subdivisions, industrial and commercial lands comprised within the Community of Smithville. The natural features within the study area consist of woodlands, wetlands, and watercourses. The wetlands are generally part of the Lower Twenty Mile Creek Provincially Significant Wetland (PSW) Complex (Map NH-1A). Map NH-1B shows the existing Region's and Township's Core Natural Heritage Systems (ROP, 2014; TOWL 2019).

The information collected through this analysis provided insight regarding the significance and connectivity between ecological systems and terrestrial features on the landscape, as well as the movement of wildlife through the study area and its environs. This understanding provided the foundation for developing a preliminary Natural Heritage System (NHS) and for informing the management of surface water and groundwater systems, in order to achieve an integrated and ecologically sustainable development.

Existing natural heritage information was gathered on terrestrial resources and reviewed to identify key natural heritage features and species that are reported from the study area. Surveys were conducted in 2020 for breeding birds, mammals, herpetofauna, insects, and vascular flora (monitoring locations are shown on Map NH-2). The terrestrial resources assessment provided a characterization of the terrestrial ecology and natural heritage features within the study area and their sensitivity to anthropogenic disturbance in order to inform land use planning and identify areas to be protected. Vegetation communities are shown on Maps NH-3A to 3F.

In regard to vegetation, 3 SCC were observed, including Black Gum (*Nyssa sylvatica*), Lizard's Tail (*Saururus cernuus*), and Slightly Hirsute Sedge (*Carex hirsutella*), 13 regionally rare vegetation species, and 19 species that are considered uncommon. In total, 27 species were documented that are indicative of high quality intact habitats.

Two bird SAR were observed in the study area: Bobolink (*Dolichonyx oryzivorus*) and Eastern Meadowlark (*Sturnella magna*). Bobolink and Eastern Meadowlark may be breeding within the study area, depending on the crop and management of the agricultural fields. Species of Special Concern, Eastern Wood-Pewee (*Contopus virens*) and Barn Swallow (*Hirundo rustica*) are present in the study area; Barn Swallow was downlisted from Threatened to Special Concern in January 2023. Eastern Wood-Pewee is likely nesting in many of the woodlands. Nesting habitat for Barn Swallow is present within the broader study area in the form of barns, outbuildings, garages, houses, and culverts. Barn Swallow was observed primarily foraging over agricultural fields.

Field investigations confirmed the presence of 12 herpetofaunal species, including 5 species of anurans that were noted as generally well-distributed throughout the study area; 3 species of snakes; 2 turtle species (including the SCC Snapping Turtle); and 1 salamander species. Other wildlife observations included 12 species of mammal; 9 butterfly species (including the SCC Monarch); and 13 odonate species.

2.1.8 Wildland Fire Screening

A Wildland Fire Screening was conducted for the subject lands and no areas were identified to pose a high threat for wildland fire within the study area. The MNRF wildland fire screening map is shown on Map NH-5.

2.2 Integration Approach

The foregoing investigations and discussions of the existing natural systems proceeded on a discipline-specific basis, working toward an integrated characterization and assessment of the features, functions and form related to the existing systems. This integration allows for a fuller understanding of the fundamental environmental components and systems within the study area. An integrated characterization and assessment of each study discipline generally occurs on two levels, namely: i) integrated characterization to validate or confirm the findings of respective disciplines, and ii) an integrated characterization of key environmental features and systems to define the functions, attributes, and interdependencies, and to thereby provide guidance for establishing management opportunities and requirements based on future land uses.

Primary environmental elements stemming from the discipline-specific characterization work described in the previous report sections include:

- Natural Heritage (including wetlands and woodlands)
- Watercourses (including headwater drainage features)
- Recharge and Discharge Areas, including Karst

Each of these elements to varying degrees requires an integrated assessment in order to establish the significance and associated sensitivity of the features, particularly in the context of the proposed urbanizing setting; the following provides some associated guidance in this regard:

i. Natural Heritage Units
   - diversity and significance of species (flora and fauna)
   - potential for corridor linkage and benefits to key biota
   - presence/absence of fluvial unit
   - local catchment area (size and land use)

- groundwater influence to sustain habitats and functions
- feature size, plant community diversity, and proximity to other features

ii. Watercourses and Headwater Drainage Features
- presence/absence of form/stability
- baseflow/intermittent/permanent
- groundwater discharge (reach specific)
- presence/absence of riparian corridor vegetation
- presence/absence of karst features and associated functions
- bankfull/riparian/flood flows
- floodplain
- sediment transport
- fish habitat (direct/indirect)
- temperature/water quality

iii. Recharge and Discharge Areas
- rate of infiltration/recharge
- location of functional recharge areas
- influence of karst features
- functional relationship to watercourse, wetland or terrestrial feature
- quantity of groundwater flux

The foregoing factors/considerations (and others) have been summarized as they relate to the respective environmental features and systems. The following sections provide insight regarding these features and systems, which has ben used in subsequent study stages to inform the land use and infrastructure (road and services) planning process in an iterative manner.

2.3 Principles of Integration

The field work and accompanying assessments, associated with the subwatershed characterization, has been used to establish various principles, unique to the overall study area. These principles reflect the properties and characteristics of the respective subwatersheds in the study area, which depending on their nature, have implications related to future impact management.

The following sections have been organized by discipline and the integration principle is stated, followed by the management implications, where relevant (italics). It should be noted that by their very nature there are overlaps between the respective disciplines, which essentially lead to the integrated understanding of how the subwatersheds function.

2.3.1 Groundwater Characterization and Functions

The study area is covered with a varying thickness of a clay overlying bedrock. The clay reduces the amount of water that can move downwards to the bedrock except where open fractures, rooting channels and animal burrows allow for greater movement of water. These pathways are more prevalent where the clay is less than 6 m thick which allows for more 'recharge' to bedrock. The underlying bedrock consists of a network of vertical and horizontal fractures and solution channels. The solution channels form when water moving through the fractures dissolves the rock. Water that moves through the clay enters into the bedrock flow system through these fractures and solution channels, generally moving horizontally from north to south in the shallow bedrock with a limited amount of groundwater discharging to Twenty Mile Creek. Groundwater also moves vertically to the deeper bedrock and follows similar fractures and solution channels. The fractures and solution channels that are more common in upper 15 m provide the

water for the majority of the household wells outside of the existing urban area. Stream reaches and wetlands that sit on top of the clay receive very limited amounts of groundwater compared to overland flow and direct precipitation. Areas where the clay is thin, 6 m or less, allow for a greater potential for water born contaminants from ground surface to enter the bedrock groundwater system

i. The fractured nature of clay/silt overburden provides the main pathway for infiltration and movement of groundwater to the bedrock throughout the majority of the study area. A reduction in infiltration can reduce the local groundwater levels and available groundwater for storage and potential discharge where it exists. Infiltration can be reduced through urbanization by increased impervious area and compaction of the shallow till and glaciolacustrine silt/clay.

   Maintain or enhance infiltration where functionally significant and minimize compaction of the shallow overburden.

ii. Reduced water levels may impact terrestrial communities dependent on a high water table and reduce groundwater discharge where it exists in stream reaches and effect aquatic resources.

   Maintain or enhance infiltration where functionally significant. Also implement best management practices for underground servicing to minimize water table lowering.

iii. A reduction in recharge may reduce available water in local water wells.

   Maintain or enhance infiltration where functionally appropriate and minimize compaction of the shallow overburden.

iv. The fractured nature of the clay/silt overburden can provide an additional capacity to infiltrate and store precipitation when the shallow water levels are sufficiently low and may buffer runoff for rainfall events.

   Compaction or removal of the shallow overburden may reduce this buffering capacity.

v. Smaller scale depressional topography can focus local shallow groundwater and may increase local recharge.

   Efforts should be made to maintain or create depressional topography where functionally important.

vi. Shallow groundwater levels adjacent to terrestrial features may act to buffer the amount of infiltration/recharge out of these features as part of the natural water balance.

   Maintaining infiltration within the buffer areas surrounding these features may maintain the natural groundwater levels and local groundwater balance.

vii. The upper fractured bedrock network and its associated karstic features allow for localized discharge to Twenty Mile Creek and contributes to baseflow.

   The interception storage function of certain karst features should be appropriately managed by protecting key karst features or replicating the function within the drainage system. The water balance function of the karst features and the contributing drainage area should be appropriately managed to ensure the groundwater functions where necessary.

viii. The upper fractured network within the Eramosa Member and Guelph Formation provides groundwater flow to Twenty Mile Creek and the majority of the local water wells. Installation of various infrastructure within this unit may occur where the overburden is thin and groundwater flow system impacts are possible with respect to the quantity and direction of groundwater flow.

Infrastructure trenches should be designed using best management practices to minimize water table lowering and redirection of shallow flows.

2.3.2 Surface Water Characterization and Functions

i. Drainage systems located within or adjacent to terrestrial units to be protected, such as woodlots and wetlands, may contribute overland drainage to the terrestrial units on a frequent basis; therefore, depositing sediments and nutrients is important for sustainability.

Drainage features with floodplains that include woodlots and wetlands should continue to contribute drainage, sediments and nutrients by appropriately managing the existing alignment or by being realigned in a manner that does not impact the terrestrial unit.

ii. Wetlands and woodlots provide temporary flood storage when located within drainage system floodplains.

The flood storage function of the area wetlands and woodlots should be appropriately managed either within the terrestrial units or replicated locally within the drainage system. The water balance function of the area wetlands should be preserved to ensure the hydrological and ecological form and functions are maintained to pre development conditions. The use of woodlots that do not currently provide flood storage should not be considered for flood storage, unless it is demonstrated that there will be no implications to the hydrologic period, water quality and habitat quality/health.

iii. Certain karst features within and downstream of the study area intercept surface runoff and convey it directly to subsurface systems, thereby reducing peak flows and runoff volumes downstream.

The interception storage function of certain karst features should be appropriately managed by protecting key karst features or replicating the function within the drainage system. The water balance function of the karst features and the contributing drainage area should be appropriately managed to ensure the hydrological form and functions are maintained to pre-development conditions.

iv. If unmitigated, the conversion of agricultural lands to urban land uses will increase the rate and volume of storm runoff locally, and potentially further downstream.

Stormwater management systems should be implemented to manage the increased rate and volume of runoff from future development with no increase water levels within identified downstream flood-prone properties.

v. Drainage systems contribute runoff to riparian vegetation along the drainage system corridor, therefore contributing to the formation and sustainability of the riparian vegetation.

Existing drainage systems, whether altered through realignment, form or other alterations, should be appropriately managed to maintain and improve upon existing riparian vegetation communities.

vi. The watercourses within the study area exhibit moderate erosion potential.

The flow regime within the channel system post-development should be managed to mitigate potential impacts to the channel system stability. Stormwater management and natural channel design techniques will be required to provide for long-term and sustainable channel stability. Source controls should be implemented on-site to appropriately manage groundwater recharge and work toward replicating pre-development water budget.

In addition to the above, an integrated assessment has been completed to identify the components of the water resource system within the study area and its environs. The components of the water resource system are defined by Provincial Policy, specifically the 2020 Growth Plan for the Greater Golden Horseshoe and the 2017 Greenbelt Plan. The requirement for a Water Resource System (WRS) includes the identification of features and functions which are necessary for the ecological and hydrological integrity of a watershed and include:

- Groundwater features
- Hydrological functions
- Natural heritage features and areas
- Surface water features including shoreline areas

In particular, the Growth Plan for the Greater Golden Horseshoe provides the following definitions for key hydrologic features and key hydrologic areas:

Key hydrologic features: "Permanent streams, *intermittent streams*, inland lakes and their littoral zones, *seepage areas and springs*, and *wetlands*."

Key hydrologic areas: "*Significant groundwater recharge areas*, *highly vulnerable aquifers,* and *significant surface water contribution areas* that are necessary for the ecological and hydrologic integrity of a *watershed*."

Identifying the water resource system provides for the long-term protection the key hydrologic features and key hydrologic areas, and their functions. The key hydrologic features requiring protection within the study area consist of the watercourses, terrestrial features (i.e. wetlands and woodlots), and karst features identified as representing a high constraint which require protection in-situ based upon the findings from the discipline-specific and integrated characterization. While other key hydrologic features may not require protection in-situ, it is nevertheless recognized that the function of the hydrologic, hydraulic, and ecological function of the feature is to be replicated post-development.

Similarly, it is recognized that the function and contributions of the key hydrologic areas are to be recognized in developing the drainage and stormwater management plan for the future development.

2.3.3 Watercourse and Headwater Drainage Feature Characterization and Functions

i. Channel erosion is a necessary natural process; however anthropogenic pressures, such as uncontrolled stormwater runoff, may adversely accelerate and exacerbate natural erosional processes, resulting in loss of property, threats to infrastructure and environmental degradation

   Erosion thresholds can be applied to provide insight regarding the capacity of each watercourse system to accommodate an altered flow regime. Application of appropriate thresholds as stormwater best management practice targets should limit rates of erosion to pre-development conditions. This extends to areas downstream of the proposed Urban Expansion Area.

ii. Land use changes such as the removal of headwater drainage features or vegetation and increases in imperviousness, will increase flow discharges, and diminish the development of resisting forces.

   Maintaining appropriate hydrologic and sediment regimes will be necessary to preserve the function of the headwater channels and their role in maintaining stream health in downstream areas. Twenty Mile Creek, North Creek, Spring Creek, and most watercourse tributaries are protected by

the Natural Heritage System; it will be necessary to ensure that unprotected tributaries and headwater drainage features are appropriately managed to maintain or enhance the natural functions within the overall system.

iii. Maintenance of existing riparian vegetation within the stream corridor acts to stabilize the banks, reduce flow velocities, and provides inputs of organic material and debris to streams which aid in creating a diverse morphology and habitat.

Riparian corridor protection/enhancement through the development of the Natural Heritage System along streams is a key element of a management strategy to manage and provide enhancement of form and function within a subwatershed.

iv. The delineation of natural hazard limits associated with river and valley systems allows for the lateral and downstream migration of unconfined features though the floodplain, and the estimated stable top of slope for confined valleys. Planning around such hazards allows for natural stream form and function to continue, while avoiding risk to property or infrastructure.

The meander belt width and stable top of slope, plus associated setbacks represent a constraint to development and land use planning.

2.3.4 Water Quality Characterization and Functions

i. Existing water quality is generally of moderate quality, with several PWQO exceedances.

Based on future land use conditions within the study area, stormwater management infrastructure should be designed to provide stormwater quality control for future developments in accordance with MECP Enhanced standard of treatment and potentially improve the current water quality conditions to the greatest extent possible.

ii. The headwater areas provide a hydrologic function, nutrients, sediment, and/or particulate matter and organic matter to the downstream aquatic habitat.

The headwater area aquatic habitat support function should be maintained through implementing a drainage system that can include the use of Low Impact Development best practices, open swales and ditching or other mitigation in a strategic manner consistent with the management guidance for Headwater Drainage Features.

iii. The main permanently flowing watercourses support diverse fish communities.

Stormwater management practices that maintain the quality of the permanently flowing watercourses should be implemented within the study area.

2.3.5 Aquatic Ecology Characterization and Functions

Twenty Mile Creek and North Creek provide critical year-round habitat for the local fish community, but were noted to have relatively long stretches of channel that were dry in the summer. Several intermittent watercourses and HDF were noted to hold fish in the spring, indicating a likely connection to Twenty Mile Creek and North Creek, and were therefore characterized as important. Watercourses were identified by thermal regime and fish habitat.

i. Spring Creek, North Creek, and Twenty Mile Creek support a fairly diverse fish community.

Use stormwater management practices that manage the groundwater, surface water, and water balance of the study area to maintain the fish community within all three watercourses, as well as

their tributaries. This must consider water quantity and water quality, including temperature. The thermal regime of each watercourse must be maintained.

ii. Watercourses and HDFs located within or adjacent to woodlots and wetlands contribute overland drainage to the terrestrial units, thereby depositing sediments and nutrients.

Drainage features that include woodlots and wetlands should continue to contribute drainage, sediments and nutrients by appropriately managing the existing alignment or by being realigned in a manner that does not impact the terrestrial unit.

iii. Land use changes such as the removal of headwater drainage features or vegetation and increases in imperviousness, will increase flow discharges, and diminish the development of resisting forces.

Preserve the function of headwater channels and their role in maintaining stream health in downstream areas. Ensure that tributaries and headwater drainage features that are not protected within the Natural Heritage System are appropriately managed to maintain or enhance the natural functions within the overall system.

iv. Maintenance of existing riparian vegetation within the stream corridor acts to stabilize the banks, maintain water quality, and provide fish habitat.

Riparian corridor protection and enhancement through the development of the Natural Heritage System along streams is a key element to manage and provide enhancement of form and function of each watercourse.

v. The fractured nature of overburden, including karst, provides infiltration and movement of groundwater to the bedrock within the study area. A reduction in infiltration can reduce groundwater levels and groundwater discharge. Infiltration may be reduced through urbanization by increased impervious area and compaction of the surficial soils.

Maintain or enhance infiltration where functionally significant and minimize compaction of the shallow overburden.

2.3.6 Terrestrial Ecology Characterization and Functions

The Lower Twenty Mile Creek PSW Complex includes several large wetland features within the study area. The PSW boundary within the study area was refined through field surveys in 2020 based on vegetation community mapping. Wetlands vary in size, ranging from small pockets of approximately 0.06ha to larger features of approximately 17.97ha. Wetland boundaries were not surveyed.

Most of the woodlands within the study area are significant based on the Township's criteria as listed above, predominately because of their size and their connection to a watercourse or PSW.

The following Significant Wildlife Habitat (SWH) was identified in the study area, as shown on Map NH-7A to 7C:

- Turtle Wintering Area SWH (confirmed)
- Reptile Hibernacula SWH (confirmed)
- Deer Winter Congregation Areas SWH (confirmed)
- Bat Maternity Colonies SWH (candidate)
- Raptor Wintering Area (candidate)
- Amphibian Breeding Habitat – Wetland SWH (confirmed)
- Turtle Nesting Area SWH (candidate)
- Habitat for Species of Conservation Concern (confirmed) – Black Gum, Lizard's Tail, Slightly Hirsute Sedge, Eastern Wood-Pewee, Barn Swallow, Snapping Turtle, and Monarch

- Terrestrial Crayfish SWH (confirmed)
- Animal Movement Corridor SWH (confirmed)

The East Smithville Slough Forest regionally significant Life Science ANSI is located less than 50m east of the study area (Map NH-1A).

Bobolink and Eastern Meadowlark are Threatened in Ontario and were confirmed from the study area. It is also likely that Endangered bats are found within the study area based on their extent through southern Ontario and the presence of potentially suitable habitat within the study area.

i. Significant wetlands and significant woodlands are connected within the study area through an agricultural matrix and along watercourses. Through development of the agricultural areas, natural heritage features may become isolated and their functions become reduced.

   Maintain and enhance connectivity between isolated woodlands and wetlands by identifying linkages and connecting features within a Natural Heritage System. SWH must also be connected to ensure its continued presence. The main ecological connections through the study area are provided by the Twenty Mile Creek and North Creek valleylands.

ii. Wetlands and woodlots provide temporary flood storage when located within drainage system floodplains.

   The flood storage function of the area wetlands and woodlots should be appropriately managed. The water balance function of the area wetlands should be preserved to ensure the hydrological and ecological form and functions are maintained to pre development conditions. The use of woodlots that do not currently provide flood storage should not be considered for flood storage, unless it is demonstrated that there will be no implications to the hydrologic period, water quality and habitat quality/health.

iii. Reduced water levels may impact terrestrial communities dependent on a high water table, especially wetlands.

   Maintain or enhance infiltration where functionally significant. Maintain the groundwater levels through the development process to ensure continued functioning of the woodlands and wetlands. Appropriately sized ecological buffers surrounding natural heritage features will help maintain the water balance of the natural heritage features.

iv. Small woodlands and wetlands provide some limited functions.

Small, isolated features, not protected within the proposed Natural Heritage System, should be studied further to document their functions and be protected if necessary and where possible. This may include habitat for Species at Risk.

2.3.7 Natural Heritage System

A preliminary NHS was delineated through the Draft Phase 1 stage, based on provincial direction and a review of local policies, as well as the identification of significant and sensitive features based on field surveys. The preliminary NHS for Smithville includes Significant Wetlands, Significant Woodlands, Significant Valleylands, SWH, fish habitat, and habitat for endangered and threatened species, as well as linkages between these core features and restoration areas.

i. Significant Wetlands, Significant Woodlands, Significant Valleylands, SWH, fish habitat, and habitat for endangered and threatened species are connected within the study area through an agricultural matrix and along watercourses. Through development of the agricultural areas, natural heritage features may become isolated and their functions become reduced.

Identify a Natural Heritage System to ensure connectivity between otherwise isolated features. Ensure the system is sustainable into the future.

ii. The current levels of natural cover and wetland cover within the study area fall below literature-based thresholds that would support optimal terrestrial, wetland, and hydrological functions in watersheds located in southern Ontario.

Despite fairly low natural cover, certain high quality habitats are present that provide a diverse set of flora and fauna, including rare and significant species. Ensure the water budget of these features is maintained to sustain them post development. Provide robust ecological buffers to protect the features and its functions. Provide restoration areas to contribute to the natural heritage cover within the Community of Smithville in order to meet or approach natural cover targets.

iii. A Natural Heritage System may not be sustainable if it does not include robust ecological buffers or solid linkages between existing natural heritage features. Development surrounding the Natural Heritage System may negatively impact they system indirectly following construction or through use of the system.

Ensure the Natural Heritage System is robust enough to withstand impacts from adjacent developments. The Natural Heritage System should be comprised of existing natural heritage features, robust ecological buffers, linkages connecting existing natural areas, and restoration areas where the additional natural lands will provide enhancement to individual natural heritage areas, as well as the system as a whole. A robust Natural Heritage System will be sustainable into the future, contribute towards a complete community, and provide climate change mitigation and resiliency.

3.0 Overview of Master Community Planning Process

Building on the input received during the initial community consultation, a review of opportunities and constraints, and requirements of Provincial, Regional and Township planning policies, two initial Concept Plans were developed for Smithville's future growth and expansion. Each concept explored different arrangements of land use and street layouts within the Study Area. These concepts were evaluated and the Phase 1: Subwatershed Characterization and Integration report was completed in January 2021, and presented to the Technical Advisory Committee (TAC) during a meeting on February 19, 2021. The findings from the Phase 1 assessment were used in combination with evaluation of the initial Concept Plans and the findings from the other supporting studies for the land use and infrastructure planning processes to develop a Preliminary Preferred Concept Plan for testing. The land use concept for the Preliminary Preferred Concept Plan is presented in **Figure 3.1.1**. This land use concept was provided in May 2021 for completing the first phase of the Impact Assessment (i.e. Phase 2a), whereby the impacts of future development, in the absence of mitigation strategies, were analyzed in detail, and a high-level review of alternatives to mitigate the impacts were identified.

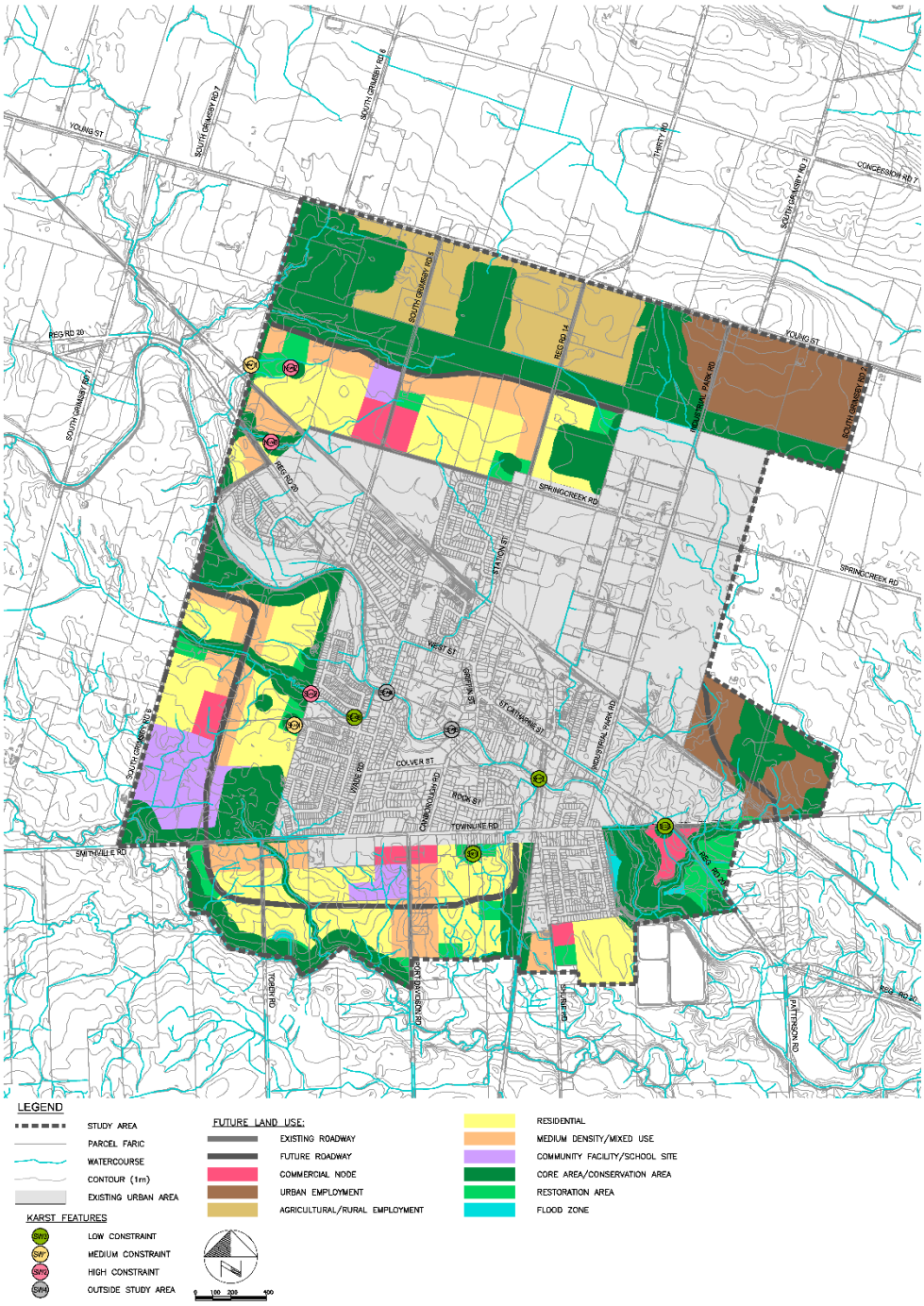

Figure 3.1.1. Preliminary Preferred Concept Plan – Land Use

Subsequent to the completion of Phase 2a of the Impact Assessment, the Preliminary Preferred Concept Plan was revised based upon the findings from the Phase 2a assessment, and further consultation through the land use planning process. The revised Preliminary Preferred Concept Plan is presented in **Figure 3.1.2**.

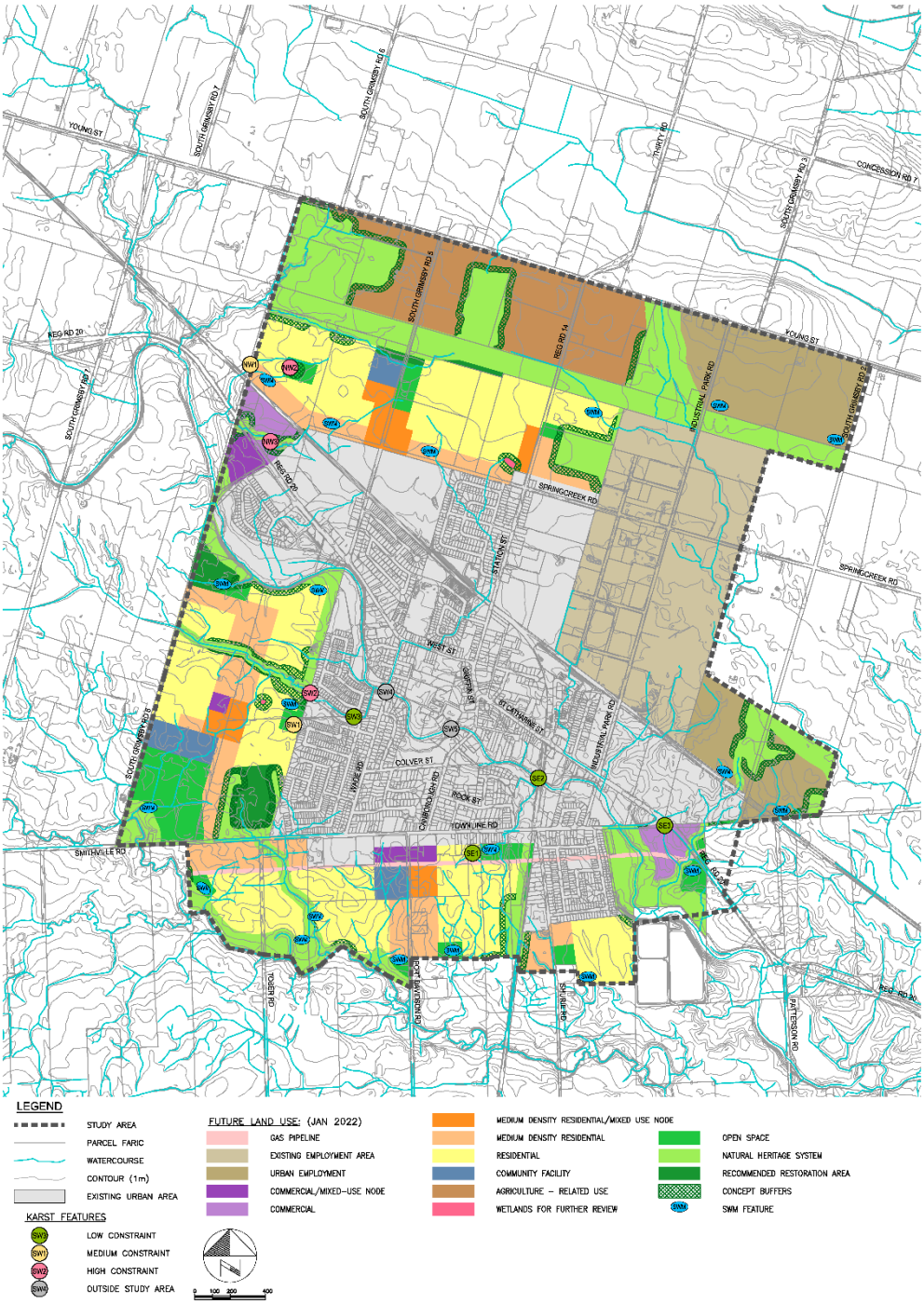

Figure 3.1.2. Revised Preliminary Preferred Concept Plan – Land Use

The revised Preliminary Preferred Concept Plan was then used to test management alternatives and develop a recommended environmental and stormwater management plan for the future development area in the community of Smithville, and to complete the Phase 2 Impact Assessment for the Subwatershed Study.

4.0 Phase 2 Impact Assessment

4.1 Hydrogeology

An increase in impervious surfaces reduces the natural infiltration of groundwater and when unmitigated generally leads to a subsequent decrease in groundwater levels and potential decrease to groundwater discharge to wetlands and stream reaches where it may occur. The integrated groundwater, aquatic and terrestrial characterization indicates a lack of significant groundwater connection supporting the related ecological functions with limited groundwater input, and as such the potential ecological impacts related to groundwater are expected to be limited and more related to potential changes to overland flow.

This reduction in infiltration may also lead to a potential decrease in recharge to the deeper water producing units and more specifically to the shallow fractured dolostone. The potential reduction in recharge to the bedrock is expected to be greater where the overburden is thinner and hydraulically more connected to the bedrock. As has been characterized, the areas of greater hydraulic connection to the bedrock can occur where the overburden is less than 6 metres thick (Drawing GW-5b).

Where there are direct overland flow inputs to karst features, the local groundwater levels appear to respond quickly and more dramatically with regard to water quantity. Changes to the quantity and quality of water directed to any karst sinkholes will result in potential changes to the local recharge quantity and quality the upper bedrock groundwater flow system.

The installation of water and sewer infrastructure can lead to the interception of the shallow water table altering shallow groundwater flow paths and creating leakage into sanitary and storm sewers. Installation of infrastructure below the water table leads to the potential need for dewatering during construction and post construction and a decrease in groundwater levels. The potential infrastructure groundwater impacts would be greater and more prevalent in geologic units that have a greater hydraulic conductivity, particularly the shallow fracture bedrock or areas where there is sand and gravel at the bedrock contact.

Groundwater flow within the overburden where it is less than 6 m thick and groundwater flow within the shallow fractured bedrock allow for a greater potential for contaminant movement. Any existing domestic wells within the development area can provide a direct conduit from ground surface to the open portion of the well for contaminants to enter the groundwater flow system. Additionally, monitoring wells can provide the same short-circuiting pathway if they are not maintained.

4.2 Karst

4.2.1 Impact Assessment

As noted in Section 2.1.2.4, karst sinkholes have the potential to impact development via bedrock instability and flooding. The PPS (Section 3.1.1[c]) defines “Karst Topography” as having the potential to be a “Karst Hazardous Site” which could impact development. The NPCA regulates karst features under Regulation 155/06 which requires an evaluation of each feature. The NPCA Policy Document (May 2020, Section 7.2.3.1) does not specify setbacks/buffers to all karst features, but those deemed to be a Karst Hazardous Site (KHS) require buffers of 50 m pending further studies.

Of the 7 karst features mapped within the study area, three have been evaluated as having a high constraint (NW 2, NW 3 and SW 2) based factors such as size, positon in the landscape, and hydrological/hydrogeological role. These are all considered to be KHS’s with a requirement to buffer by 50 m. Feature SW 1, although classed as a moderate constraint, should also be considered to be a KHS principally because, although relatively small, is very active having rapidly sloughing, vertical walls leading into the sinkhole’s throat which could present a human hazard.

NPCA policies pertaining to KHS's are as follows:

a) Applicable provincial standards related to floodproofing, protection works and access can be met and are implemented;
b) Vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
c) Existing hazards are not aggravated;
d) New hazards are not created;
e) There are no negative impacts on ecological features or functions; and
f) All other relevant site development concerns are addressed to the satisfaction of the NPCA.

Most of the sinkholes are located in or adjacent to open fields without significant flow during most of the year. Features NW 3 and SW 2, however, have a more regular flow regime and lie within naturally vegetated valleys which has greater consideration for above policy 'e' pertaining to ecolgical features or functions.

Karst feature NW 1, as noted previously, was likely formed due to back flooding from an undersized culvert beneath the rail line. Although this feature does not pose significant structural or flooding hazards, its location within the Right-of-Way of South Grimsby Road 6 could pose minor flooding issues for the road. The best mitigation for this would be to re-size the culvert.

Karst features SE 1 and SE 3 also do not pose significant structural or flooding hazards and could be left or by-passed.

Feature SE 2, the losing stream, is probably not a karst feature. It most likely represents shallow soil groundwater conditions along the small creek.

4.3 Hydrology

4.3.1 Hydrologic Impact Assessment

Hydrologic analyses have been completed in order to assess the impacts of the proposed change in land use per the Preliminary Preferred Concept Plan, in the absence of stormwater management controls for erosion and flood control as a baseline. This assessment has been undertaken using the Preliminary Preferred Concept Plan presented in Figure 3.1.1 and provided guidance for the subsequent revisions to the land use plan. The PCSWMM hydrologic model representing existing land use conditions has been used for this assessment, and updated to represent the future land use condition as per the Preliminary Preferred Concept Plan. For the purpose of this assessment, the subcatchment boundaries per the existing land use conditions have been retained, and the subcatchment impervious coverages have been determined by areally weighting the impervious coverage for each land use with the proportion of each land use within the subcatchment. The impervious coverages, as per the Preliminary Preferred Concept Plan are presented in **Table 4.3.1**.

Table 4.3.1. Impervious Coverages for Preliminary Preferred Concept Plan

Land Use	Imperviousness (%)
Existing Road ROW	85
Agricultural and Rural Employment	30
Medium Density Residential	70
Proposed Road ROW	85
EP – Non-Developable	5
Light Density Residential	60
Open Space	20
Urban Employment	80
Community Node	85
Community Facility	60
MDS – Non-Developable	20

The PCSWMM hydrologic model for future uncontrolled land use conditions has been executed for the 2, 5, and 100 year return periods using the 12 hour AES storm distributions. The simulated peak return period flows are presented in **Table 4.3.2**, and the percent difference compared to existing conditions results presented in the Phase 1 report is presented in **Table 4.3.3**.

Table 4.3.2. Simulated Return Period Peak flow Under Future Uncontrolled Land Use Conditions – PCSWMM Assessment for Local Hydrology (m^3/s)

PCSWMM Reference Node	Location	Drainage Area	Future Flows (Return Period (Years))		
		(ha)	2	5	100
Twenty Mile Creek Tributary					
N52	west of S Grimsby Rd 6	56.41	0.51	0.81	1.62
WC41	Grimsby Rd 6; 400m+/- north of CNR	62.84	0.63	0.97	1.85
WC17	Confluence; north of CNR	119.25	1.13	1.77	3.47
WC18	South of West St; 414 m +/- East of S Grimsby Rd 7	158.77	1.47	2.34	4.63
JS20D	East of S Grimsby Rd 6; D/S of CNR	33.36	0.56	0.81	1.43
JS21D	D/S of West Street, West of S Grimsby Rd 6	44.37	0.65	0.94	1.72
WC20	Confluence; South of West Street	60.58	0.89	1.29	2.41
N57	U/S of Twenty Mile Confluence; west of S Grimsby Rd 6	64.87	0.96	1.39	2.57
N86	U/S of Twenty Mile Confluence; east of S Grimsby Rd 6	17.61	0.27	0.40	0.72
JS38D	D/S of S Grimsby Rd 6; 1230m+/- south of West Street	84.41	0.65	1.07	2.25
WC116	810m+/- West of S Grimsby Rd 6	130.42	1.10	1.74	3.52
JS36D	between Forestview Ct and Golden Acres Dr	130.42	0.98	1.57	3.25
WC30	125m+/- u/s of Oakdale Blvd	163.36	2.77	3.71	5.96
JS32D	D/S of Townline Road	29.97	0.48	0.70	1.27
N24	U/S of Twenty Mile Confluence; 274m+/- north of Townline Rd	43.1	0.72	1.04	1.85
N45	U/S of Twenty Mile Confluence; 390m+/- south of St Catherines St	79.2	0.87	1.20	1.89

PCSWMM Reference Node	Location	Drainage Area	Future Flows (Return Period (Years))		
		(ha)	2	5	100
N3	U/S of Twenty Mile Confluence; 530m+/- west of Patterson St	4.26	0.13	0.20	0.38
North Creek Tributary					
WC104	west of Smithville Sports Complex	25.95	0.49	0.69	1.19
OF2	317m+/- west of Tober Rd	7.71	0.14	0.21	0.36
OF3	D/S of Tober Rd Crossing	13.25	0.23	0.34	0.61
OF4	East of Tober Rd	47.37	0.64	0.94	1.82
OF5	west of Port Davideson Rd	35.09	0.63	0.90	1.59
OF6	east of Port Davideson Rd	21.28	0.33	0.48	0.88
OF7	west of Shurie Rd	5.18	0.07	0.10	0.19
OF8	east of Shurie Rd	7.37	0.10	0.15	0.30
Spring Creek					
JS29D	Industrial Park Road	129.24	1.56	2.34	4.38
JS30D	Spring Creek Road	186.05	1.93	3.46	6.22
WC15	200m+/- S/E of South of Spring Creek Rd	263.33	2.51	4.15	8.16
WC38	520m+/- S/E of South of Spring Creek Rd	263.33	2.48	4.11	8.04
WC14	690m+/- S/E of South of Spring Creek Rd	314.79	2.86	4.63	8.71

Table 4.3.3. Percent Change in Return Period Peak Flow Under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions

PCSWMM Reference Node	Location	Drainage Area	% Difference		
		(ha)	2	5	100
Twenty Mile Creek Tributary					
N52	west of S Grimsby Rd 6	56.41	49.3%	27.1%	12.7%
WC41	Grimsby Rd 6; 400m+/- north of CNR	62.84	103.5%	60.9%	28.7%
WC17	Confluence; north of CNR	119.25	76.1%	45.2%	21.2%
WC18	South of West St; 414 m +/- East of S Grimsby Rd 7	158.77	67.3%	42.0%	19.9%
JS20D	East of S Grimsby Rd 6; D/S of CNR	33.36	144.1%	96.4%	59.3%
JS21D	D/S of West Street, West of S Grimsby Rd 6	44.37	149.8%	87.7%	47.0%
WC20	Confluence; South of West Street	60.58	112.1%	68.1%	43.2%
N57	U/S of Twenty Mile Confluence; west of S Grimsby Rd 6	64.87	112.8%	66.0%	39.4%
N86	U/S of Twenty Mile Confluence; east of S Grimsby Rd 6	17.61	69.0%	42.6%	29.0%
JS38D	D/S of S Grimsby Rd 6; 1230m+/- south of West Street	84.41	50.0%	29.3%	13.2%
WC116	810m+/- West of S Grimsby Rd 6	130.42	68.5%	38.0%	17.6%
JS36D	between Forestview Ct and Golden Acres Dr	130.42	74.6%	38.1%	15.3%

PCSWMM Reference Node	Location	Drainage Area	% Difference		
		(ha)	2	5	100
WC30	125m+/- u/s of Oakdale Blvd	163.36	49.5%	37.0%	19.4%
JS32D	D/S of Townline Road	29.97	49.4%	40.4%	28.0%
N24	U/S of Twenty Mile Confluence; 274m+/- north of Townline Rd	43.1	46.2%	38.7%	20.3%
N45	U/S of Twenty Mile Confluence; 390m+/- south of St Catherines St	79.2	42.7%	29.3%	13.6%
N3	U/S of Twenty Mile Confluence; 530m+/- west of Patterson St	4.26	28.8%	23.1%	11.4%
North Creek Tributary					
WC104	west of Smithville Sports Complex	25.95	158.5%	103.2%	63.3%
OF2	317m+/- west of Tober Rd	7.71	105.9%	71.9%	43.6%
OF3	D/S of Tober Rd Crossing	13.25	65.2%	48.0%	26.3%
OF4	East of Tober Rd	47.37	93.4%	56.7%	38.8%
OF5	west of Port Davideson Rd	35.09	89.5%	60.8%	41.9%
OF6	east of Port Davideson Rd	21.28	119.0%	78.0%	48.9%
OF7	west of Shurie Rd	5.18	68.3%	23.5%	19.5%
OF8	east of Shurie Rd	7.37	29.4%	28.5%	16.2%
Spring Creek					
JS29D	Industrial Park Road	129.24	89.8%	47.8%	23.4%
JS30D	Spring Creek Road	186.05	114.6%	95.5%	21.9%
WC15	200m+/- S/E of South of Spring Creek Rd	263.33	107.2%	78.7%	34.0%
WC38	520m+/- S/E of South of Spring Creek Rd	263.33	110.5%	80.3%	33.3%
WC14	690m+/- S/E of South of Spring Creek Rd	314.79	102.6%	71.5%	30.6%

Further, and in order to assess the impacts of the proposed land use change on a watershed-scale, the HEC-HMS model which was refined for the existing land use conditions assessment as part of the Phase 1 report, has been updated to represent the proposed land use conditions within the future development area per the Preliminary Preferred Concept Plan. Consistent with the methodology applied for the existing conditions assessment, the HEC-HMS model has been executed for the 2, 5, and 100 year return periods using the 12 hour AES storm distribution, to assess impacts at the broader watershed scale for Twenty Mile Creek. Peak flows have been extracted at key locations for the respective synthetic design storms. The simulated peak return period flows for the watershed-scale assessment are presented in **Table 4.3.4**, and the percent difference compared to existing conditions is presented in **Table 4.3.5**.

Table 4.3.4. Simulated Return Period Peak Flow Under Future Uncontrolled Land Use Conditions – HEC-HMS Assessment for Watershed-Scale Hydrology (m^3/s)

HEC-HMS Reference Node	Location	Drainage Area (km^2)	Future Development Area (km^2)	Return Period (Years)		
				2	5	100
Twenty Mile Creek						
J-Tw-17	65m+/- South of West Street	162.05	0	13.1	28.2	93.8
J175	south of West St; 414 m +/- East of S Grimsby Rd 7	163.63	0.88	13.3	28.3	94.1
J174	west of S Grimsby Rd 6	164.28	1.32	13.4	28.4	94.3
J20586	east of S Grimsby Rd 6	165.03	1.48	13.4	28.4	94.4
J218	west of Wade Rd	168.65	2.13	13.8	28.7	95.2
J138	Canborough St	169.22	2.41	13.9	28.8	95.3
J136	280m+/- north of Shurie Rd	170.34	2.62	14.0	28.9	95.6
J150	Twenty Mile Creek at Townline Rd	171.36	2.70	14.1	29.0	95.9
J157	530m+/- west ofPatterson St	172.89	3.49	14.2	29.1	96.1
J-Tw-13	Twenty Mile Creek and North Creek Confluence	211.43	3.49	30.7	57.7	149.7
North Creek						
PRJ178	west of S Grimsby Rd 6	19.24	0.26	10.6	18	39.3
J192	North Creek 410m+/- west of Tober Rd	28.29	0.37	14.4	25.2	56.9
J193	365m+/- west of Tober Rd	28.97	1.01	14.3	25.2	57.0
J180	west of Port Davideson Rd	29.32	1.30	14.4	25.3	57.1
J1821	178m+/- east of Port Davidson Rd	29.53	1.46	14.4	25.2	57.0
J2032	155m+/- east of Shurie Rd	29.72	1.55	14.3	25.2	56.9
Spring Creek						
J144	Industrial Park Road	1.29	1.04	1.0	1.6	3.5
J141	Spring Creek Road	1.86	1.26	1.5	2.4	5.1
J185	200m+/- south of Spring Creek Rd	2.64	1.56	2.1	3.3	6.8
J184	943m+/- south of Spring Creek Rd	3.5	1.74	2.6	4.2	8.9

Table 4.3.5. Percent Change in Return Period Peak Flow Under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions

HEC-HMS Reference Node	Location	Drainage Area (km^2)	Future Development Area (km^2)	Return Period (Years)		
				2	5	100
Twenty Mile Creek						
J-Tw-17	65m+/- South of West Street	162.05	0	0.0%	0.0%	0.0%
J175	south of West St; 414 m +/- East of S Grimsby Rd 7	163.63	0.88	0.0%	0.0%	0.0%
J174	west of S Grimsby Rd 6	164.28	1.32	0.8%	0.4%	0.1%
J20586	east of S Grimsby Rd 6	165.03	1.48	0.8%	0.0%	0.1%
J218	west of Wade Rd	168.65	2.13	1.5%	0.0%	0.2%
J138	Canborough St	169.22	2.41	1.5%	0.3%	0.1%
J136	280m+/- north of Shurie Rd	170.34	2.62	1.4%	0.3%	0.2%

HEC-HMS Reference Node	Location	Drainage Area (km^2)	Future Development Area (km^2)	Return Period (Years)		
				2	5	100
J150	Twenty Mile Creek at Townline Rd	171.36	2.70	1.4%	0.3%	0.2%
J157	530m+/- west of Patterson St	172.89	3.49	1.4%	0.3%	0.2%
J-Tw-13	Twenty Mile Creek and North Creek Confluence	211.43	3.49	3.7%	0.9%	0.5%
North Creek						
PRJ178	west of S Grimsby Rd 6	19.24	0.26	0.0%	0.6%	0.0%
J192	North Creek 410m+/- west of Tober Rd	28.29	0.37	0.7%	0.0%	0.0%
J193	365m+/- west of Tober Rd	28.97	1.01	0.0%	0.4%	0.2%
J180	west of Port Davideson Rd	29.32	1.30	0.7%	0.4%	0.2%
J1821	178m+/- east of Port Davidson Rd	29.53	1.46	0.7%	0.4%	0.2%
J2032	155m+/- east of Shurie Rd	29.72	1.55	0.7%	0.8%	0.2%
Spring Creek						
J144	Industrial Park Road	1.29	1.04	42.9%	23.1%	16.7%
J141	Spring Creek Road	1.86	1.26	36.4%	26.3%	18.6%
J185	200m+/- south of Spring Creek Rd	2.64	1.56	50.0%	32.0%	17.2%
J184	943m+/- south of Spring Creek Rd	3.5	1.74	52.9%	31.3%	15.6%

The results of the above hydrologic analyses indicate that, in the absence of stormwater management, the future development within the study area would be anticipated to increase local peak flows by between 11 % and 160% along the local receiving systems, with the greatest increases occurring during the more frequent and less formative storm events. The results also indicate that the proposed change in land use would be anticipated to marginally increase peak return period flows along the main branches of the Twenty Mile Creek, North Creek, and Spring Creek, with increases generally less than 1% above existing levels. Consequently, the proposed development within the study area would be anticipated to significantly increase peak flows locally, with relatively minor residual increases occurring along the main branches of the Twenty Mile Creek, North Creek, and Spring Creek.

The PCSWMM hydrologic model representing future uncontrolled land use conditions has also been used to determine the change in erosion potential along the receiving watercourses as a result of the future development. Consistent with the approach applied for existing land use conditions, the PCSWMM hydrologic model has been executed for a 22 year continuous simulation, and duration analyses have been completed to determine the duration of critical flow exceedance in hours and as a percentage of the total simulation period. The results of this assessment have been used to determine the percent change in critical flow exceedance compared to existing conditions. The results are presented in **Table 4.3.6**.

Table 4.3.6. Change in Watercourse Erosion Potential Under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions

PSCWMM Reference Node	Location	Watercourse	Contributing Drainage Area (ha)	$Q_{critical}$ (m^3/s)	Total Hours Exceeded	Percent of Total Time	Total Volume Exceeded (m^3)
WC41	Grimsby Rd 6; 400m+/- north of CNR	Twenty Mile Creek Trib	62.84	0.159	+433	+0.2%	+311,147
OF3	130m+/- west of Tober Rd	North Creek	13.25	0.034[1]	+789	+0.4%	+147,556
OF4	365m+/- west of Tober Rd	North Creek	47.37	0.120[1]	+868	+0.5%	+523,937
OF5	west of Port Davideson Rd	North Creek	35.09	0.089[1]	+1228	+0.7%	+756,621
OF6	178m+/- east of Port Davidson Rd	North Creek	21.28	0.054[1]	+1299	+0.7%	+388,494
WC15	200m+/- S/E of South of Spring Creek Rd	Spring Creek	263.33	0.385	+663	+0.4%	+1439,993
WC38	520m+/- S/E of South of Spring Creek Rd	Spring Creek	263.33	0.385	+607	+0.3%	+1298,921
WC14	690m+/- S/E of South of Spring Creek Rd	Spring Creek	314.79	0.385	+446	+0.2%	+1216,938

Note: 1. Critical flow rate for North Creek Tributaries have been weighted based on contributing drainage areas and the critical flow rate for the Twenty Mile Creek Tributary

The results in Table 4.3.6 indicate that, in the absence of stormwater management, the future development duration of critical flow exceedance, along the receiving watercourses would be anticipated to increase by between 99% and 259% compared to existing conditions. These increases in duration would increase the percentage of time during which erosive flows would occur by between 3.6 % and 13 %, which would represent unacceptable increased erosion potential along the receiving watercourses.

Lastly, the results of the 22 year continuous simulation have been used to determine the change in water budget at the high and medium constraint karst features, as identified in the Phase 1 report. This assessment focused specifically on the increased surface water volume discharging toward the features, which serves as an indicator of the increased geotechnical hazard and flood hazard for the lands immediately surrounding the feature. The results of this assessment are presented in **Table 4.3.7**.

Table 4.3.7. Change in Water Budget to Karst Features Under Future Uncontrolled Land Use Conditions Compared to Existing Land Use Conditions

Karst ID	% Imperviousness		Runoff volume (m3)		%difference
	Existing	Future	Existing	Future	
NW1	5.0%	33.5%	17845	28565	60.1%
NW2	5.0%	33.5%	4571	7318	60.1%
NW3	5.0%	48.5%	77181	175032	126.8%
SW1	5.0%	49.8%	25459	58172	128.5%
SW2	5.0%	20.8%	241958	342873	41.7%

The results in **Table 4.3.7** indicate that, in the absence of stormwater management, the future development would be anticipated to increase the surface runoff volume toward the high and medium constraint karst features by between 41.7 % and 129 % compared to existing levels, thus representing an increased flood risk for the lands surrounding the feature, and a potentially increased geotechnical hazard.

4.3.2 Preliminary Stormwater Management

Hydrologic analyses have been completed to establish stormwater management criteria for the future development within the study area, and to develop a stormwater management plan for the future development areas accordingly. As part of this process, the HEC-HMS and PCSWMM hydrologic models which were developed to represent the Preliminary Preferred Concept Plan have been updated to represent the future development per the Revised Preliminary Preferred Concept Plan. The impervious coverages by the respective land uses within the Revised Preliminary Preferred Concept Plan are summarized in **Table 4.3.8**.

Table 4.3.8. Impervious Coverages for Revised Preliminary Preferred Concept Plan

Land Use	Imperviousness (%)
Existing Road ROW	85
Agriculture - Related Use	30%
Commercial	85%
Commercial / Mixed Use Node	85%
Community Facility	60%
Medium Density	70%
Medium Density / Mixed Use Node	70%
Natural Heritage System (NHS)	5%
Open Space	20%
Recommended Restoration Area	5%
Residential	60%
Urban Employment	80%

Compared with the information presented in **Table 4.3.1** for the Preliminary Preferred Concept Plan, the information in **Table 4.3.8** indicates that the types of future land use and/or associated terminology have been revised through the development of the Revised Preliminary Preferred Concept Plan. Nevertheless, the types of land uses within the Revised Preliminary Preferred Concept Plan are considered generally consistent with those applied in planning studies for other municipalities and jurisdictions, and the impervious coverages applied for the land uses per the Revised Preliminary Preferred Concept Plan are likewise considered consistent with those from other jurisdictions and are comparable to the coverages applied for the assessment of the Preliminary Preferred Concept Plan.

The subcatchment boundaries within the future development area have been refined to represent anticipated drainage boundaries toward future stormwater management facilities. The updated subcatchment boundary plan for the Revised Preliminary Preferred Concept Plan is presented in Drawing WR-1.

4.3.2.1 Erosion Control Criteria

Hydrologic analyses have been completed in order to determine the sizing criteria for end-of-pipe stormwater management facilities which would be required to mitigate the hydrologic impacts of the future development, specifically related to increased erosion potential along the receiving watercourses. The PCSWMM hydrologic model, updated to represent the future development per the Revised Preliminary Preferred Concept Plan, has been revised to incorporate storage elements at the outlet of the subcatchments representing the future development areas, to represent proposed end-of-pipe facilities / control points within the future development area. The locations of the storage elements representing stormwater management facilities are provided on Drawing WR-2. It should be noted that the facility locations presented in Drawing WR-2 are conceptual in nature, and may be revised as part of subsequent stages of planning and environmental study. The unitary storage and discharge criteria for erosion control have been iteratively adjusted until the requisite erosion control has been achieved (i.e. <5% residual increase in duration and volume of critical flow exceedance, and facility drawdown times generally five days or less). The unitary volumes have been adjusted by incremental multiples of 25 m^3/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary critical erosion flow corresponding to the downstream erosion site along the receiving system (i.e. the tributary of Twenty Mile Creek, and the Spring Creek). For the drainage areas to the North Creek, the unitary erosion thresholds for the tributaries of Twenty Mile Creek and Spring Creek have been applied to establish erosion control criteria for the tributaries of the North Creek, since areally-weighting the unitary criteria for the main branch of the North Creek was determined to be overly-conservative resulting in anomalously high drawdown times (i.e. greater than 12 days). The resulting unitary storage and discharge criteria under this stormwater management scenario (end-of-pipe only) are summarized in **Table 4.3.9**. The results of the duration analyses are presented in **Table 4.3.10**, and the change compared to existing conditions is summarized in **Table 4.3.11**.

Table 4.3.9. Unitary Storage and Discharge Criteria for Erosion Control

Node	Location	Erosion	
		Unity Volume (m3/imp.ha)	Unitary flow (m3/s/ha)
Twenty Mile Creek			
JS26D	Young Street	400	0.001
WC17	confluence; north of CNR	400	0.001
WC20	trib, South of West Street	400	0.001
WC116	810m+/- West of S Grimsby Rd 6	400	0.001
JS43US; DICBMH_418	Las Road; Nornak Road	400	0.001
JS32D	D/S of Townline Road	400	0.001
WC11; WC12	130 m+/- U/S of Hwy 20; 140 m+/- D/S of Hwy 20	400	0.001
North Creek			
OF6	east of Port Davideson Rd	400	0.001
OF7 +OF15	trib, west of Shurie Road	400	0.001
Spring Creek			
WC15	200m+/- S/E of South of Spring Creek Rd	400	0.001

Table 4.3.10. Duration Analysis for Erosion Assessment of Future Land Use Conditions with SWM

PSCWMM Reference Node	Location	Watercourse	Contributing Drainage Area (ha)	$Q_{critical}$ (m^3/s)	Total Hours Exceeded	Percent of Total Time	Total Volume Exceeded (m^3)
WC41	Grimsby Rd 6; 400m+/- north of CNR	Twenty Mile Creek Trib	62.84	0.159	769	0.4%	412,620
OF3	130m+/- west of Tober Rd	North Creek	13.25	0.034[1]	863	0.5%	126,080
OF4	365m+/- west of Tober Rd	North Creek	47.37	0.120[1]	769	0.4%	355,320
OF5	west of Port Davideson Rd	North Creek	35.09	0.089[1]	1146	0.6%	595,180
OF6	178m+/- east of Port Davidson Rd	North Creek	21.28	0.054[1]	571	0.3%	135,190
WC15	200m+/- S/E of South of Spring Creek Rd	Spring Creek	263.33	0.385	1987	1.1%	3,124,800
WC38	520m+/- S/E of South of Spring Creek Rd	Spring Creek	263.33	0.385	1950	1.0%	3,023,000
WC14	690m+/- S/E of South of Spring Creek Rd	Spring Creek	314.79	0.385	2477	1.3%	4,272,300

Note: 1.Critical flow rate for North Creek Tributaries have been weighted based on contributing drainage areas and the critical flow rate for the Twenty Mile Creek Tributary

Table 4.3.11. Change in Erosion Potential Under Future Land Use Conditions with SWM Compared to Existing Land Use Conditions

PSCWMM Reference Node	Location	Watercourse	Contributing Drainage Area (ha)	$Q_{critical}$ (m^3/s)	Total Hours Exceeded	Percent of Total Time	Total Volume Exceeded (m^3)
WC41	Grimsby Rd 6; 400m+/- north of CNR	Twenty Mile Creek Trib	62.84	0.159	-205	-0.1%	-76,107
OF3	130m+/- west of Tober Rd	North Creek	13.25	0.034[1]	-578	-0.3%	-109,422
OF4	365m+/- west of Tober Rd	North Creek	47.37	0.120[1]	-391	-0.2%	-158,769
OF5	west of Port Davideson Rd	North Creek	35.09	0.089[1]	-231	-0.1%	+160,811
OF6	178m+/- east of Port Davidson Rd	North Creek	21.28	0.054[1]	-595	-0.3%	-99,652
WC15	200m+/- S/E of South of	Spring Creek	263.33	0.385	-11	-0.0%	-260,532

PSCWMM Reference Node	Location	Watercourse	Contributing Drainage Area (ha)	$Q_{critical}$ (m^3/s)	Total Hours Exceeded	Percent of Total Time	Total Volume Exceeded (m^3)
	Spring Creek Rd						
WC38	520m+/- S/E of South of Spring Creek Rd	Spring Creek	263.33	0.385	-20	-0.0%	-271,963
WC14	690m+/- S/E of South of Spring Creek Rd	Spring Creek	314.79	0.385	+52	+0.0%	-259,756

Note: 1. Critical flow rate for North Creek Tributaries have been weighted based on contributing drainage areas and the critical flow rate for the Twenty Mile Creek Tributary

The information in **Table 4.3.9** indicates that the unitary storage and discharge criteria for erosion control would be uniformly applied throughout the study area, as a result of similar geomorphological conditions along the local tributaries and receiving watercourses. The application of this unitary criteria would result in facility drawdown times generally less than five days, with maximum drawdown times of 7.5 days within the more intensive areas of the future development (i.e. commercial and employment land use conditions). The information in **Table 4.3.10** and **Table 4.3.11** indicates that the application of the unitary criteria would control the duration and volume of runoff exceeding the critical flow rate to within 5% of existing levels, hence would achieve the requisite level of erosion control for the future development area. Further, as noted from the foregoing, opportunities exist to further refine the unitary sizing criteria as part of the next phases of planning and design. These refinements should also account for the application of LID BMPs, which would be anticipated to reduce the unitary sizing criteria and corresponding drawdown times compared to that presented above.

4.3.2.2 Flood Control Criteria

Hydrologic analyses have been completed in order to evaluate alternative strategies for providing the requisite flood control for the future development within the community of Smithville. These alternatives represent various combinations and applications of post-to-pre control, undercontrol, and over-control for flood mitigation. As indicated previously, the future development within the study area is anticipated to significantly increase peak flows locally within and proximate to the future development area, and would also result in residual increases along the main receiving watercourses (i.e. Spring Creek, North Creek, and Twenty Mile Creek). Consequently, the stormwater quantity control strategy is required to mitigate increased flood potential offsite and downstream of the future development area at the local, subwatershed and watershed scale.

The HEC-HMS hydrologic model representing the Preliminary Preferred Concept Plan has been updated to reflect the subcatchment boundaries and impervious coverage for the Revised Preliminary Preferred Concept Plan. Routing elements representing stormwater management facilities have been incorporated into the model at the outlet of subcatchments representing the future development areas. For the alternative assessment of stormwater management alternatives, the 100 year return period storm has been assessed, and simplified rating curves have been developed to represent the quantity control strategy for the 100 year event for the following alternatives:

- Alternative 1: Post-to-pre control for all future development areas.
- Alternative 2: Post-to-pre control for all future development areas requiring local quantity control (i.e. areas discharging to storm sewers and/or tributaries of the North Creek and Twenty Mile Creek extending through private properties outside of the development area) and no controls for future development areas discharging directly toward the North Creek and Twenty Mile Creek.
- Alternative 3: Strategic control per Alternative 2 combined with LID infiltration BMPs.
- Alternative 4: Over-control for all future development areas to reduce 100 year peak flow by 50%.

The results of the HEC-HMS modelling for the above alternatives are presented in **Table 4.3.12**.

Table 4.3.12. Assessment of Quantity Control Alternatives

Watercourse/Scenario	Simulated 100 Year Peak Flow (m^3/s)	Difference Compared to Existing
Spring Creek		
Existing	7.7	-
Future with Alternative 1 SWM	6.1	-20%
North Creek		
Existing	56.8	-
Future with Alternative 1 SWM	57	0.4%
Future with Alternative 2 SWM	56.6	-0.4%
Twenty Mile Creek		
Existing	95.9	-
Future with Alternative 1 SWM	97.4	1.6%
Future with Alternative 2 SWM	97.1	1.2%
Future with Alternative 3 SWM	96.8	0.9%
Future with Alternative 4 SWM	96.1	0.2%

The results in **Table 4.3.12** indicate that providing post-to-pre control for all future development within the Spring Creek Subwatershed would provide the requisite quantity control along the main branch of the watercourse, hence has been advanced as the recommended quantity control strategy for the future development areas within that subwatershed.

The results in **Table 4.3.12** further indicate that providing strategic post-to-pre control and uncontrolled conditions for the future development within the North Creek Subwatershed would achieve the requisite post-to-pre control along the main branch of the North Creek, whereas quantity control for all future development would result in minor residual increases along the main branch of the North Creek (i.e. 0.4% residual increase).

Lastly, the results in **Table 4.3.12** indicate that residual increases to peak flow rates along the Twenty Mile Creek Main Branch would occur under all stormwater management alternatives evaluated. This is considered attributable to the timing of peak flows from the future development relative to the timing of peak flows from the upstream drainage area along the Twenty Mile Creek Main Branch, which would be more coincident under the stormwater management alternatives evaluated. Alternative #3, comprised of strategic quantity control and uncontrolled conditions, combined with the application of LID infiltration BMPs has been advanced for further consideration, as this alternative is considered to optimize stormwater management performance and planning. Moreover, this alternative is considered consistent with recent draft guidance from the MECP and the Region of Niagara, which emphasizes integration of Green Infrastructure as part of stormwater management planning and design for future development.

Supplemental hydraulic analyses have been completed to determine whether the residual increase in 100 year peak flow rate would result in increased flood risk to downstream properties along the Twenty Mile Creek. The HEC-RAS hydraulic model which was developed by NPCA for the flood hazard mapping along the Twenty Mile Creek has been revised to incorporate the peak flows for Alternative #3, where the peak flow for that stormwater management alternative exceeded the existing regulatory peak flow along the watercourse. The results of this assessment have indicated that the minor increase in 100 year peak flow would not result in increased water surface elevation along the Twenty Mile Creek, hence would not increase the offsite flood risk to downstream properties.

Based upon the above, additional hydrologic analyses have been completed to determine the sizing criteria for stormwater management facilities which would be required to mitigate the hydrologic impacts of the future development. The PCSWMM hydrologic model, which was developed for the erosion assessment has been updated to incorporate quantity controls above the extended detention storage volume per stormwater management Alternative #3. The locations of strategic quantity control and strategic uncontrolled conditions as presented in Drawing WR-2. This assessment has applied the 22 year continuous simulation methodology and frequency analysis. The unitary storage and discharge criteria for quantity control have been iteratively adjusted until the requisite post-to-pre control has been achieved. The unitary volumes have been adjusted by incremental multiples of 25 m^3/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary frequency flows along the local tributaries of the respective watercourses. The resulting unitary storage and discharge criteria are summarized in **Table 4.3.13**. The corresponding frequency analyses and percent difference compared to existing conditions are presented in **Table 4.3.14** and **Table 4.3.15** respectively.

Table 4.3.13. Unitary Storage and Discharge Criteria for Flood Control

Node	Location	25 year		100 year	
		Cumulative Unity Volume (m3/imp.ha)[1.]	Unitary flow (m3/s/ha)	Cumulative Unity Volume (m3/imp.ha)[1.]	Unitary flow (m3/s/ha)
Twenty Mile Creek					
JS26D	Young Street	700	0.017	900	0.028
WC17	confluence; north of CNR	1000	0.017	1200	0.028
WC20	trib, South of West Street	600	0.016	900	0.037
WC116	810m+/- West of S Grimsby Rd 6	700	0.013	900	0.030
JS43US; DICBMH_418	Las Road; Nornak Road	700	0.024	1000	0.040
JS32D	D/S of Townline Road	700	0.053	950	0.095
WC11; WC12	130 m+/- U/S of Hwy 20; 140 m+/- D/S of Hwy 20	800	0.012	1000	0.017
North Creek					
OF6	east of Port Davideson Rd	800	0.025	1000	0.037
OF7 +OF15	trib, west of Shurie Road	750	0.038	950	0.081
Spring Creek					
WC15	200m+/- S/E of South of Spring Creek Rd	800	0.012	1000	0.025

NOTE: [1.] Unitary volumes are inclusive of extended detention storage for erosion control.

Table 4.3.14. Simulated Frequency Flows for Future Land Use Conditions with SWM

Node	Location	Drainage Area (Ha)	Frequency (years)						
			1.25	2	5	10	20	50	100
Twenty Mile Creek Tributary									
WC17	confluence; north of CNR	119	0.65	1.12	1.81	2.29	2.74	3.31	3.74
WC18	south of West St; 414 m +/- East of S Grimsby Rd 7	158	0.90	1.53	2.46	3.08	3.67	4.41	4.95
WC20	trib, South of West Street	65	0.39	0.74	1.27	1.62	1.94	2.33	2.61
WC19	main stream, 410 m +/- U/S of S Grimsby Rd Six	226	1.21	2.19	3.64	4.60	5.50	6.61	7.41
WC116	810m+/- West of S Grimsby Rd 6	129	0.54	0.97	1.60	2.03	2.43	2.93	3.29
JS36D	between Forestview Ct and Golden Acres Dr	129	0.49	0.87	1.45	1.83	2.18	2.63	2.95
WC30	125m+/- u/s of Oakdale Blvd	162	1.56	2.20	3.05	3.59	4.10	4.74	5.22
JS43US	Las Road	20	0.15	0.26	0.45	0.60	0.76	0.98	1.17
DICBMH_418	Nornak Road	9	0.06	0.11	0.20	0.26	0.31	0.37	0.41
JS32D	D/S of Townline Road	24	0.54	0.89	1.36	1.65	1.90	2.20	2.41
JS1D	main stream at Townline Road	922	6.36	9.20	13.28	16.07	18.80	22.41	25.19
WC11	130 m+/- U/S of Hwy 20	33	0.14	0.22	0.36	0.47	0.58	0.73	0.86
WC12	140 m+/- D/S of Hwy 20	95	0.55	0.77	1.04	1.20	1.35	1.52	1.65
OF11	east study area boundary	1095	6.92	10.24	14.82	17.82	20.66	24.28	26.97
North Creek Tributary									
OF6	east of Port Davideson Rd	21	0.14	0.25	0.45	0.60	0.77	1.00	1.19
OF15+OF7	trib, west of Shurie Road	11	0.10	0.18	0.31	0.42	0.53	0.70	0.83
Spring Creek									
JS26D	Young Street	4	0.03	0.05	0.08	0.11	0.14	0.19	0.23
WC15	200m+/- S/E of South of Spring Creek Rd	263	1.55	2.33	3.48	4.3	5.11	6.2	7.06
WC38	520m+/- S/E of South of Spring Creek Rd	263	1.19	2.03	3.26	4.09	4.87	5.85	6.57
WC14	690m+/- S/E of South of Spring Creek Rd	315	1.42	2.39	3.77	4.68	5.52	6.56	7.31

Table 4.3.15. Percent Change in Simulated Frequency Flows for Future Land Use Conditions with SWM Compared to Existing Land Use Conditions

Node	Location	Frequency (years)						
		1.25	2	5	10	20	50	100
Twenty Mile Creek Tributary								
WC41	trib, 800 m+/- west of S Grimsby Road 5	-36.2%	-28.8%	-23.2%	-20.9%	-18.9%	-17.2%	-16.5%
WC17	confluence; north of CNR	-19.8%	-19.4%	-18.8%	-18.2%	-17.5%	-17.0%	-16.3%
WC18	south of West St; 414 m +/- East of S Grimsby Rd 7	-14.3%	-14.5%	-13.4%	-12.5%	-11.4%	-10.2%	-9.3%
WC20	trib, South of West Street	-31.6%	-15.9%	-8.0%	-8.0%	-10.2%	-14.3%	-18.2%
WC19	main stream, 410 m +/- U/S of S Grimsby Rd Six	-22.4%	-17.7%	-13.7%	-11.9%	-10.6%	-9.2%	-8.4%
WC116	810m+/- West of S Grimsby Rd 6	-28.9%	-24.2%	-20.8%	-18.8%	-17.3%	-15.8%	-15.0%
JS36D	between Forestview Ct and Golden Acres Dr	-25.8%	-21.6%	-17.1%	-15.7%	-15.2%	-14.3%	-14.2%
WC30	125m+/- u/s of Oakdale Blvd	-15.2%	-13.4%	-10.6%	-9.1%	-7.4%	-5.4%	-3.9%
JS43US	Las Road	-31.8%	-25.7%	-16.7%	-10.4%	-5.0%	0.0%	+5.4%
DICBMH_418	Nornak Road	-60.0%	-52.2%	-41.2%	-35.0%	-32.6%	-30.2%	-29.3%
JS32D	D/S of Townline Road	-14.3%	-11.0%	-6.2%	-2.9%	-0.5%	+2.8%	+5.2%
JS1D	main stream at Townline Road	-4.2%	-4.6%	-4.2%	-3.7%	-3.2%	-2.6%	-2.0%
WC11	130 m+/- U/S of Hwy 20	-30.0%	-26.7%	-25.0%	-24.2%	-24.7%	-27.0%	-28.3%
WC12	140 m+/- D/S of Hwy 20	-29.5%	-25.2%	-11.9%	-8.4%	-9.4%	-5.6%	-4.6%
OF11	east study area boundary	-6.1%	-5.4%	-4.9%	-4.8%	-4.7%	-4.7%	-4.8%
North Creek Tributary								
OF6	east of Port Davideson Rd	-61.1%	-54.5%	-33.8%	-25.9%	-20.6%	-8.3%	-1.7%
OF15+OF7	trib, west of Shurie Road	-60.0%	-53.8%	-36.7%	-28.8%	-28.4%	-19.5%	-17.0%
Spring Creek								
JS26D	Young Street	-40.0%	-44.4%	-46.7%	-45.0%	-46.2%	-44.1%	-42.5%
WC15	200m+/- S/E of South of Spring Creek Rd	+1.3%	-8.3%	-12.3%	-12.4%	-11.7%	-9.9%	-7.8%
WC38	520m+/- S/E of South of Spring Creek Rd	-15.0%	-13.6%	-13.5%	-13.9%	-14.3%	-15.1%	-15.7%
WC14	690m+/- S/E of South of Spring Creek Rd	-12.9%	-11.5%	-11.1%	-11.0%	-11.3%	-11.7%	-12.0%

The above results indicate that the stormwater management facility sizing criteria would achieve the requisite post-to-pre control along the watercourses proximate to the study area (i.e. local-scale quantity control). Although the results at some locations indicate minor residual increases during the less frequent storm events (i.e. 50 year and above), a further review of the ranked annual maximum flows has indicated that the annual maximum flows for the future land use condition with recommended stormwater management sizing criteria would be at or below existing levels. As such, the residual increases noted above are considered attributable to extrapolation of the trendline for frequency analysis, and it is anticipated that full post-to-pre control would be achieved at the local-scale.

The results further indicate over-control of peak flows at certain locations. As such, opportunities exist to further refine the unitary sizing criteria as part of subsequent stages of planning and design. These refinements should account for the application of LID BMPs, which would be anticipated to reduce the unitary sizing criteria compared to that presented above.

4.3.2.3 Groundwater Recharge and Water Budget

The proposed development is anticipated to reduce groundwater recharge and increase surface runoff volume. Preliminary analyses have indicated that this would more than double the surface runoff volume to high constraint karst features, compared to existing conditions. As indicated above, maintaining existing water budget to high constraint karst features is critical, in order to manage geotechnical hazard at the feature, as well as local flood hazard at the feature.

Green infrastructure and LID BMPs are critical to maintaining water budget at karst features. This would necessarily include LID BMPs which promote infiltration, in order to maintain the groundwater recharge component of the water budget. Within west limit of study area, more passive and distributed LID infiltration BMPs are encouraged (i.e. increased topsoil thickness, bioswales), versus LID infiltration BMPs which promote enhanced permeability (i.e. sand columns) (ref. Drawing WR-3).

4.3.3 Summary

The future development within the urban expansion boundary for the Community of Smithville would result in increased local flood risk and erosion potential alond the local watercourses, and would be anticipated to decrease groundwater recharge and increase surface runoff volume to area karst features. The impacts to the development may be mitigated by implementing extended detention storage and drawdown within stormwater management plans, as well as the application of quantity controls for all future development within the Spring Creek Subwatershed, and strategic quantity controls for future development within development areas discharging toward the North Creek and Twenty Mile Creek to mitigate local flood risk as outlined herein. Unitary sizing criteria have been developed to provide the requisite erosion and flood control for the future development.. Opportunities exist to refine the unitary sizing criteria as part of future studies, which should also account for the application of LID BMPs within the overall stormwater management plan.

4.4 Water Quality

4.4.1 Impact Assessment

Urbanization of agricultural lands is recognized to generally increase the concentration and mass loadings of urban contaminants and heavy metals to the receiving watercourses. It is also recognized that urbanization results in thermal enrichment (i.e. increased water temperature) of storm runoff from paved surfaces and rooftops, as well as from wet stormwater management facilities which are exposed to sunlight (i.e. wet ponds, wetlands, hybrid facilities). It is thus anticipated that the urban development within the future development area of the Community of Smithville, in the absence of stormwater

management, would result in an increase in the concentrations and mass loadings of the various contaminants. If unmitigated, the urbanization would be anticipated to increase the concentrations and mass loadings of various contaminants compared to existing conditions, and will thereby impair the surface water quality and quality of aquatic habitat within the receiving watercourses.

4.4.2 Water Quality Criteria

The future stormwater management systems within the Twenty Mile Creek Watershed are required to provide stormwater quality treatment (TSS removal) to an Enhanced standard of treatment as described in the Stormwater Management Planning and Design Manual (Ministry of the Environment, March 2003). In addition, recognizing the presence of coolwater habitat along the Twenty Mile Creek, the stormwater management measures are required to mitigate thermal impacts to the receiving watercourses.

4.4.3 Water Quality Management Alternatives

The following technologies and practices are available to address the stormwater management criteria noted in the foregoing:

TSS removal as per current (2003) MOECC criteria and emerging guidance for providing a treatment-train for stormwater management combining controls at source and end-of-pipe:

- Wet end-of-pipe facilities (i.e. wetlands, wet ponds, hybrid facilities).
- Vegetated technologies (i.e. grassed swales, buffer strips, etc.).
- Oil/grit separators.
- Bioswales/biofilters.
- Infiltration trenches.

Thermal control as per Draft OMNRF Guidelines:

- LID infiltration BMPs
- Urban terrestrial canopy (also NHS)
- Facility shading (includes orientation and length/width ratio)
- Facility cooling trenches
- Facility bottom draws
- Stormwater management facility orientation
- Concrete Sewer System
- Underground Storage Facilities
- Green & White roofs
- Floating Islands
- Other measures

4.4.4 Summary

The future development within the future development in the Community of Smithville is anticipated to result in increased mass loadings of various water quality contaminants, including heavy metals, nutrients, and thermal enrichment. The stormwater management system within future development area is required to address Provincial standards for stormwater quality control to an Enhanced standard of treatment by adopting a treatment train approach per Provincial guidance, as well as measures to mitigate thermal enrichment of storm runoff.

4.5 Watercourses and Headwater Drainage Features

4.5.1 Impact Assessment

The Phase 2 impact assessment focuses on outlining the potential impacts to watercourses and HDFs based on the proposed land use plan. The primary impacts of urbanization to these surface water features are changes to the hydrologic regime that results from the expansion of impervious surfaces. Increased surface runoff is typically mitigated through integrated stormwater management. Other impacts include changes to the sediment regime (decreased input) with increased impervious cover, and feature realignment, relocation, or removals (such as removal of some HDFs). However, it is difficult to fully mitigate the fundamental changes to the landscape and therefore various targets are employed to ensure key elements of the fluvial system are maintained and protected to help absorb any potential impacts which may arise (**Table 4.5.1**). The objectives acknowledge the risks associated with land use change and provide direction for best management practices. To assess if these objectives are properly met by the proposed land use plan, six indicators were reviewed. The indicators and corresponding objectives are outlined in **Table 4.5.1.**

Table 4.5.1. Indicators Employed in Phase 2 and Corresponding Objectives

Indicator	Objective
Hazard corridors (confined and unconfined)	Stream corridors are protected from interference
	Natural cover maintained in stream corridors
	Minimize or eliminate risk to public and private property from channel erosion and evolution
Stream length and realignment	Maintain natural channel structure and rates of morphologic change
Road crossings	Maintain natural channel structure and rates of morphologic change
	Minimize or eliminate risk to public and private property from channel erosion and evolution
Stormwater management ponds	Maintain natural channel structure and rates of morphologic change
	Maintain critical flow exceedance at critical locations
Erosion thresholds	Work toward maintaining pre-development water budget
	Minimize or eliminate risk to public and private property from channel erosion and evolution
	Maintain natural channel structure and rates of morphologic change
	Maintain critical flow exceedance at critical locations
Sediment Regime	Maintain or replicate sediment contributions, if required. Quality of sediment produced from feature should be evaluated. E.g. fine silts and sands from agricultural fields are likely of poor quality and produce little in the way of downstream form and habitat function. Maintain or enhance downstream form and function in the context of sediment regime and channel evolution.

Erosion Hazard Corridors

The method for delineating hazard corridors within the study area differs between confined and unconfined reaches. A stable top of slope setback was defined for confined reaches whereby the valley toe was estimated from site topography, and a stable 3:1 slope setback was determined based on the average elevation difference from the floodplain to the table land. An additional toe erosion setback was applied where the watercourse was within 15 m of the valley toe, per Provincial Policy Statement (PPS) technical guidelines (MNR 2002). As well, per the NPCA Planning Document (2018), a slope stability

allowance of 7.5 metres (25 feet) was applied from the most landward location of either of the stable top of slope or the physical top of slope.

For unconfined reaches, meander belts were defined based on the central tendency of the channel planform, and due to the broad-scale nature of the study and limited evidence of migration observed in the historic assessment, a factor of safety of 20% of the meander belt width (10% applied on either side) was applied in lieu of calculating the 100-year migration rate for each reach.

These hazard corridors are intended to contain all natural meander and migration tendencies, and slope stability of a channel/valley based on historic alignment and potential future alignment. This permits geomorphic adjustment to occur without risking damage to surrounding infrastructure and property. Implementation and respect for the hazard corridor can reduce and control negative impacts which may occur. A secondary benefit of the hazard corridor width is to protect surrounding riparian vegetation. Development within a hazard corridor is strictly limited to specific low impact and localized uses, such as trails or road crossings, and therefore disturbance to the riparian habitat is minimized. Maintaining riparian vegetation ensures resiliency of the fluvial system, as proper vegetative support reduces bank erosion and widening.

Table 4.5.2 presents a list of the watercourse reaches where the erosion hazard corridor and/or Regulatory Limits are not entirely enveloped by the preliminary NHS as shown in the Land Use Plan. (**Drawing FG-1**). In general, the portions of the erosion hazard areas that lie outside the proposed NHS (per the Land Use Plan) represent a small proportion of the total erosion hazard area. In most cases, the areas outside of the NHS are encompassed by proposed Conceptual Buffers. One exception is the watercourse reach TM4(7) where approximately 40% of the erosion hazard area lies outside the NHS. Much of the area outside the NHS is within a conceptual buffer area. It is recommended that the final NHS incorporates erosion hazard corridors in their entirety.

Table 4.5.2. Erosion Hazard Corridors Not Enveloped by Preliminary NHS

	Reach ID
North Creek	NC5
Twenty Mile Creek	TM2, TM4, TM4(4)1, TM4(2)2, TM4(2)3, TM4(2)4, TM4(6)2, TM4(6)1-2, TM4(6)1-3

Stream Length and Realignment

As the erosion hazard corridor assessment indicates, most watercourses are protected by the current NHS plan. Changes in land use may result in realignments or relocation of existing medium constraint watercourses and conservation HDFs, and/or the removal of limited function headwater drainage features (HDFs) to increase the developable area, provided that required functions are maintained. Realignment of watercourses in most cases is not supported (high constraint), but it may be acceptable if the existing channel is degraded or has already been heavily modified as part of the existing land use (medium constraint). Any channel modification should be an enhancement compared to existing conditions, which, in-turn enhances the NHS. Watercourse constraint evaluation (**Appendix G** and **Drawing FG-1**) determined those reaches which may be suitable for realignment/enhancement (Medium Constraint). In these cases, the channel presents a restoration opportunity and realignment would be supported. Should realignments be proposed, stream lengths should be maintained, however, slight reductions in sinuosity may be permitted, provided it can be justified. Any realignment is subject to local constraints and additional elements proposed during the detailed design phase. Significant loss of stream length reduces aquatic habitat and reduces the fluvial system's ability to effectively convey water and sediment that maintains a state of quasi-equilibrium. Depending on the conditions, loss of stream length may increase channel slope increasing available potential energy which could lead to increased erosion. Note, localized

enhancements may be permitted for high constraint watercourses and protection HDFs, provided sufficient rationale and support from NPCA.

The existing dominant land uses in the study area are agricultural, recreational (e.g., Township lands), industrial, and transportation (e.g., Regional Roads). These land use types have a relatively low impact on surface water features compared to an urbanized landscape. The Phase 1 assessment found that most watercourse reaches have a 'Moderate' overall degree of health (based on RSAT scores) and the remainder had 'Low' overall health due to poor riparian corridors and channel function. Rapid Geomorphic Assessments found that some reaches were in a state of transition (stressed/ moderately sensitive). The preliminary land use plan has not proposed any watercourse removals or realignments. With that said, there are several opportunities for *rehabilitation* to enhance/restore banks or short segments within some watercourse reaches (refer to **Section 5.4**). High constraint streams within well-defined, confined, and semi-confined corridors should be protected as they currently exist to ensure natural function is maintained. However, high constraint watercourses can undergo minor realignment or repair to facilitate infrastructure development, or to mitigate an immediate risk. Moderate constraint streams located within agricultural parcels may be considered for potential realignment and enhancement; these are unconfined reaches. In some instances, the proposed NHS has been expanded along watercourses to provide additional linkage area and connectivity. General riparian enhancements, farm crossing removals (fords and culverts), and in-channel habitat features (e.g., wood debris) are encouraged, and would enhance the form and function of area streams and receiving reaches downstream.

Headwater Drainage Features (HDFs)

HDFs have been evaluated and have management recommendations ranging from 'no management' to 'protection', which imply different functions and requirements. This section provides a brief overview on the management implications for HDFs, while Section 5.0 provides detail on the management recommendations and opportunities for HDFs. The headwater drainage feature summary table in **Appendix G** provides an overall review of feature evaluation, recommendations, and rationale. The "Final Management" recommendation determines the strategy and opportunities for each, which may differ compared to the "HDFA Classification" (feature characterization) based on site specific rationale. Final Management recommendations were developed for some HDF reaches based on criteria described below.

HDFs within Linkages: Final Management Recommendations for HDFs that form Linkages were assigned a Conservation status to ensure the features are retained within the linkage (e.g., SC1(6)1, SC1(6)2, TM4(3)1 and TM4(3)2). For Unevaluated HDFs that form Linkages, "Conservation - Further Evaluation Required" applied as the feature should at a minimum be retained as part of the linkage but the specific hydrological, terrestrial, aquatic or riparian conditions need to be assessed in the field (e.g., SC1(7)1 and SC1(7)2)). For HDFs that do not form the ecological linkage (e.g., perpendicular to linkage) the Final Management Recommendation was not altered.

HDFs within high-constraint watercourse valleys: HDFs located within the erosion hazard limits of High constraint watercourses were assigned a Final Management Recommendation of "Protection" by virtue of presence within a higher constraint feature. New reach breaks were introduced at the lateral limit of watercourse corridors to facilitate this distinction. The Final Management Recommendations for HDFs within the meander belts of Medium Constraint watercourses were not altered. It is recommended that the downstream function of HDFs within Medium Constraint meander belts be maintained to maintain watercourse conditions.

HDFs and Karst features: Following a TAC meeting and subsequent consultation with the Township and SWS team, it was agreed that the Subwatershed Study would classify HDFs connected to karst features as mitigation or conservation (i.e., cannot be No Management), with the caveat that subsurface connections

are to be determined as part of future studies to finalize the feature classification. This is applicable to HDFs connected to Medium or High Constraint karst features. Management recommendations for HDFs connected to Low Constraint karst features were not impacted (i.e., may be No Management) as Low Constraint karst features may be filled in.

An assessment of HDFs in the context of the proposed Land Use Plan and NHS indicates that:

- *Protection* and *conservation* HDFs to be protected in place (protection) or realigned as appropriate (conservation). Most *Protection* and *conservation* features are within the current NHS plan. Three *conservation* HDFs fall entirely beyond these limits, and four *conservation* HDFs lie partially beyond these limits, generally within Concept Buffer areas **(Table 4.5.3).**
- *Conservation* HDFs may be relocated, and NHS development may identify appropriate or ideal zones for relocation. Relocation provides the opportunity to restore or enhance certain features and functions.
- Most features within the study area are either classified as *mitigation* or *no management required*.

HDF management recommendations are depicted in **Drawing FG-2**.

Table 4.5.3. Conservation HDFs Not Currently Enveloped by Preliminary NHS

	HDF ID
North Creek	NC5(3)2-2
Spring Creek	SC1(12)
Twenty Mile Creek	TM4(1-5-3) Partially outside NHS: TM4(3)2, TM4(6)1-4, TM4(6)5-1 (portion within Concept Buffer), TM4(6)1-5-4 (portion within Concept Buffer)

Road Crossings and Alignments

Road crossings are an integral part of urbanization and an important consideration in terms of impacts to watercourses. A poorly sited road crossing can result in negative impacts to the channel and higher risk to the structure itself. There are several factors which should be considered when identifying the most appropriate location for a road crossing. For a large development area, it is important to minimize the number of times the proposed road network crosses the watercourse valley. This will reduce impacts to the watercourse as well as the surrounding natural heritage features. Road crossings should not be located within close succession to each other. Providing an adequate distance between crossings allows for an area of potential adjustment if there are negative impacts to the watercourse because of the crossing structure. This minimizes the risk of compromising any additional structures located downstream. The preliminary Land Use Plan does not identify potential road alignments or crossing locations.

On a local, site-specific scale there are several risk factors which need to be considered for the individual crossings with respect to geomorphic function. These risk factors would be used to assess both crossing locations and determine appropriate structure spans and alignment these may be considered recommendations and Section 5.0 may refer to them:

- **Channel Size:** The potential for lateral channel movement and erosion tends to increase with stream size. HDFs tend to exhibit low rates of lateral migration due to the stabilizing influence of vegetation on the channel bed and banks. Erosive forces in active watercourses tend to exceed the stabilizing properties of vegetation and result in higher migration rates.
- **Valley Setting:** Watercourses with wide, flat floodplains and low valley and channel slopes tend to migrate laterally across the floodplain over time. Watercourses that are confined in narrow,

well drained valleys are less likely to erode laterally but are more susceptible to downcutting and channel widening, particularly where there are changes in upstream land use. Typically, the classification of the valley will fall into one of three categories: confined, partially confined, and unconfined.

- **Meander Belt Width:** The meander belt width represents the maximum expression of the meander pattern within a channel reach. Therefore, this width/corridor covers the lateral area that the channel could potentially occupy over time. This value has been used by regulatory agencies for corridor delineation associated with natural hazards and the meander belt width is typically of a similar dimension to the Regulatory floodplain. The use of the meander belt width of structure sizing has been established as a criterion by some regulatory agencies and represents a very conservative approach.
- **Meander Amplitude:** The meander amplitude and wavelength are important parameters to ensure that channel processes and functions can be maintained within the crossing. For the purposes of this protocol, the meander amplitude of the watercourse would be measured in the vicinity of the crossing and used as a guide to determine the relative risk to the structure. The number of meander wavelengths to be considered is both dependent on the scale of the watercourse and the degree of valley confinement.
- **Rapid Geomorphic Assessment (RGA) Score:** An RGA score is essentially a measure of the stability of the channel. Channels that are unstable tend to be actively adjusting and thus are sensitive to the possible effects of the proposed crossing. Accordingly, there is more risk associated with unstable channels. The RGA score reveals three levels of stability: 0-0.20 is stable; 0.21-0.40 is moderately stable; >0.40 is unstable.
- **100-year Migration Rates:** Using historical aerial photographs, migration rates may be quantified (where possible) for each crossing location. A higher migration rate indicates a more unstable system and higher geomorphic risk. Ideally, watercourse crossing structures should be aligned perpendicular to and centered on a straight section of channel, or at an appropriate skew that would not affect channel processes. In terms of sizing, the structure would ideally span the meander belt width to accommodate the downstream migration of meander features. In many cases, however, the costs prohibit such structure sizes. From a geomorphic perspective, larger structures are favored to minimize the long-term risk and maintenance associated with natural channel adjustment.

Stormwater Management and Erosion Thresholds

Channel erosion is a necessary natural process; however anthropogenic pressures, such as uncontrolled stormwater runoff, may accelerate and exacerbate natural erosional processes, resulting in loss of property, threats to infrastructure and environmental degradation.

Erosion thresholds can be applied to provide insight regarding the capacity of each watercourse system to accommodate an altered land use or flow regime. Application of appropriate thresholds as stormwater best management practice targets should limit rates of erosion to pre-development conditions. This also extends to areas downstream of the study area.

The erosion thresholds calculated for each of the three (3) detailed geomorphic assessment sites were prorated to upstream tributary reaches based on drainage area. At North Creek, the prorated values within tributaries were unduly conservative. As such, the site characteristics of the tributaries to North Creek were reviewed and compared with those of the Tributary to Twenty Mile Creek and the Spring Creek detailed geomorphic assessment sites to determine which might be an appropriate surrogate to prorate erosion threshold values in the North Creek tributaries. Based on similar channel morphology,

substrate and flow characteristics, the erosion threshold values from the Tributary to Twenty Mile Creek detailed site were used.

It is also noted that exceedance modelling was not extended beyond the limits of the potential urban expansion area downstream to the North Creek detailed assessment site. While potential impacts of the proposed development are likely to be limited as the development area represents a small proportion of total drainage area at that location, it is recommended that geomorphic monitoring is undertaken on North Creek to confirm that the channel is not impacted.

Discussion of the erosion assessment is provided in **Sections 2.1.4 and 2.1.5**. The following describes the outcome of this analysis:

- Volume and Duration Analyses reflect effective SWM and limited concern with respect to channel erosion.
- Modelled volume reductions may suggest further aggradation in some reaches, however, flushing flows should still regularly occur to maintain thalweg definition and sediment delivery.

4.5.2 Summary

A review of the Land Use Plan has revealed that the preliminary NHS largely protects watercourse (confined/unconfined) and HDF features (protection/conservation) and associated setbacks. The current preliminary state of the plan does not allow for further detailed analysis in terms of road crossings and grading, which should be evaluated at subsequent planning and design stages. Erosion thresholds provided in the Phase 1 report were evaluated through a duration and volume exceedance analysis, and SWM provides limited concern with respect to channel erosion or aggradation. Next steps should include:

- Incorporate erosion hazards into NHS where discrepancies exist
- Incorporate protection HDFs features into the NHS
- Develop preferred strategies for feature enhancement, and potential locations for relocation (of medium constraint watercourses or mitigation / conservation HDFs) at a high level, in development with the NHS
- Develop a post-construction monitoring plan for North Creek and potentially other watercourses to confirm no adverse adjustments downstream of the study area following build-out

4.6 Ecological Resources and Natural Heritage System

4.6.1 Key Comments Emanating From Phase 1 Characterization

The Study Team received input following the release of the Draft Phase 1 report in February 2021, specifically related to the ecological and NHS components of the Subwatershed Study. This information has been integrated into the final Phase 1 characterization, however is discussed briefly below, to provide a more fulsome documentation of the manner in which the commentary has been integrated into both the NHS and the impact assessment. The comment response matrix, letters, and emails are attached in Appendix A and Appendix B, respectively. Numerous themes are repeated throughout the comments provided, so these are addressed in one section, below.

4.6.1.1 Comments on Draft Phase 1 Report

Comments on the Draft Phase 1 report that relate to terrestrial systems and the preliminary Natural Heritage System were received from Myler Ecological Consulting March 10, 2021; NPCA April 1, 2021; Niagara Region April 6, 2021; and LCA Environmental Consultants April 6, 2021. A Comments Response Matrix was prepared and the final version is attached as Appendix A. Several meetings were held to present the Draft Phase 1 report and address specific comments and topics:

- February 19, 2021 – TAC Meeting #5 – Presentation of Draft Phase 1 Characterization Report
- February 25, 2021 – TAC Meeting #6 – Land Use Plan
- April 16, 2021 – Sub-TAC to address HDF and Ecology
- July 6, 2021 – Sub-TAC to address HDF
- July 8, 2021 – Sub-TAC to address NHS
- August 9, 2021 – Sub-TAC to address NHS
- September 8, 2021 – Meeting between Study Team and NPCA
- February 22, 2022 – Meeting between Study Team, NPCA, and Niagara Region to address woodland removal west of Shurie Road

The following changes were made to the preliminary NHS based on these meetings, as well as additional meetings with the Study Team, NPCA, and Region:

- Incorporation of NPCA floodplain layer and linkages revised to maximize overlap with the floodplain; where linkages follow a watercourse, they are no longer necessarily centered on it.
- Linkage has been removed through the developed part of Smithville.
- Linkage on the north side of Townline Road between the North Creek corridor and the U-shaped woodland (i.e. Horseshoe Woodland) was narrowed; linkage connecting the same woodland to the North Creek corridor to the south was widened.
- Buffers are identified separately from the NHS and labelled as "Conceptual Buffer."
- Small wetlands mapped by the Study Team and not previously identified as PSW are shown in a different colour from PSW and identified as "Wetland for Further Review" (an interim label "Previously Unevaluated Wetlands" was not supported).
- Restoration Areas labelled as "Recommended Restoration Area" without a solid outline; Restoration Areas are shown in a different colour outside of the Expansion Area.
- The Restoration Area on the west side of the study area along the Twenty Mile Creek corridor was refined slightly (reduced in size).
- An additional Recommended Restoration Area was added in the south, to replace a Significant Woodland that was removed.
- "Potential Restoration Areas" have been mapped with an icon to allow for some flexibility with the Land Use Plan.
- Only karst areas identified as having a high constraint are included, including the additional area of karst that was noted by Terra-Dynamics (David Slaine, June 29, 2021). These are not included in the Natural Heritage System, but mapped to provide context.

4.6.1.2 Letter from LCA Environmental Consultants, June 11, 2021 and Technical Memorandum, June 23, 2021

LCA Environmental provided a letter in response to the Comments Response Matrix provided by the Study Team, with a very similar Technical Memorandum provided soon after. LCA stated they are satisfied with the clarifications provided on the data collection methods, as well as discrepancies in the species lists. Additional comments were provided on the topics listed below. The NHS should be consistent with existing Regional mapping and policy.

Core Areas and Application of Buffers

LCA asserts that "arbitrary" buffers should not be included as a component of the NHS, but should be addressed through policy and determined at the EIS stage.

Linkages and Restoration

Although Twenty Mile Creek and North Creek are recognized as significant linkages, additional (smaller) linkages should not be identified until the EIS stage. LCA states that the identification of Restoration

Areas is contrary to Regional policy intent, and that Restoration Areas should also be determined through site-specific study. Specifically, the Restoration Area along Townline Road (i.e. U-shaped woodland) should not be identified as a Restoration Area as the woodland was cleared in 2006 "in accordance with the existing land use designation and farm practice policies and is currently actively farmed land." The Restoration Area along Twenty Mile Creek in the west is not land-locked and should not be included.

Wetlands

The many small wetland pockets identified in SWS mapping create "considerable fragmentation of the landscape that is not supported by the data presented in the Study." LCA correctly states that the OWES Manual requires a wetland evaluator to attach a Wetland Data Record with the wetland evaluation to justify inclusions of wetlands less than 2ha in size. LCA states that the small wetland units may not meet the definition of wetland defined in the Conservation Authorities Act. LCA requests that the small wetland units not be included in NHS mapping at this stage.

4.6.1.3 Response from Myler Ecological Consulting, June 18, 2021

Myler Ecological Consulting provided a response to the Comments Response Matrix directly within the matrix. The commentary reinforces their position, primarily related to removal of small wetland units, removal of two Restoration Areas (the western Restoration Area associated with Twenty Mile Creek and the Restoration Area within the U-shaped woodland), removal of amphibian breeding SWH and the associated linkage, removal of buffers, and removal of the linkage connecting North Creek to the U-shaped woodland along the north side of Townline Road.

4.6.1.4 Letter from SGL, September 13, 2021

On behalf of the Landowners Group, SGL commented on Restoration Areas, Linkages, Small Wetland Pockets, Significant Wildlife Habitat, and Karst Sinkholes. The latter is discussed in the Karst section.

Restoration Areas

According to SGL, the proposed restoration areas "are not based on a watershed or scientific approach", are "wholly inadequate", and do not meet the intent of the SWS Terms of Reference. Rather, SGL proposes a policy approach that restoration and enhancement should be considered through the Secondary Planning process and addressed over the entire watershed area, including outside of the urban area limits.

Linkages

SGL maintains that linkages identified through the SWS "do not represent [wildlife] movement corridors". Again, they suggest a policy approach, whereby linkages are to be identified at the draft plan of subdivision development stage.

Small Wetland Pockets

Mapping of small wetland pockets should be limited to ELC mapping and these areas should be recommended for "further and more detailed study and confirmation in site-specific Environmental Impact Studies."

Significant Wildlife Habitat

Concern was raised that the "application of the provincial significant wildlife habitat has been stretched in terms of the small isolated areas that are occupied by locally common species." SGL suggested policy be included at the Secondary Planning stage to require the assessment of SWH through EIS.

4.6.1.5 Letter from SGL, December 15, 2021

Stating their concerns from SGL's September 13, 2021 letter are still valid, SGL followed up with an additional letter commenting on Restoration Areas and the proposed NHS. SGL provided recommended policy to address enhancement and restoration. Their main comments are the following:

- Restoration areas are arbitrary, not based on a science, and do not contribute to a robust NHS.
- The 30% target for forest and wetland cover in the Township's Official Plan is a target for the entire Township and should not be applied to the Community of Smithville.
- The enhancement approach should be applied to the entire system, and focus on areas within and adjacent to natural features as outlined in their letter (e.g., adjacent to Core Areas where development potential is limited; lands associated with infrastructure such as SWM ponds; lands associated with hydro corridors and parks).

4.6.1.6 Letter from Jonathan Kingma, December 15, 2021

Mr. Kingma's comments pertain to the property containing the former railway line south of Townline Road, as well as a woodland. The letter requests that the NHS designation be removed from the property as it "does not reflect the current state and designation of the land." It was also requested that no restoration areas or linkages be shown on the subject property. The landowner has "maintained the land" to address flooding concerns for residents on the west side of Shurie Road and the tenant farmer. The NPCA provided approval for "proposed ditching and fencerow/brush cleanup" (Appendix B of the letter, undated). Mr. Kingma also noted that Niagara Region's 30% tree cover target is to be applied across the Region as a whole, and not specifically to the Community of Smithville.

4.6.1.7 Restoration Target Mapping

Restoration target mapping was provided by the NPCA in July 2021. The NPCA stated that this mapping should be used for information purposes only. NPCA restoration target mapping, identified as areas providing various degrees of potential ecological cumulative benefits, is shown on Map NH-10.

4.6.1.8 Study Team Response

Based on the commentary provided by the landowner group, it is understood that the approach advanced by the private landowners would reduce the natural heritage constraints on the sites that currently limit the development potential on the subject properties. This is largely a result of the landowner group's suggestion to defer the characterization of the natural heritage features on their lands to the Draft Plan of Subdivision stage, rather than undertaking these studies as part of the Subwatershed Study. However, the Study Team, supported by Niagara Region and the NPCA, maintains that the SWS is the appropriate stage to identify natural heritage features and functions, especially those that need to be considered at a landscape scale. If left to the Draft Plan of Subdivision stage, the opportunities for linkages, which often extend beyond property limits, and larger, more meaningful restoration opportunities are very limited. This includes the delineation of a NHS, which incorporates buffers, Restoration Areas, and Linkages. These features may be refined through site specific study, for instance through the completion of an EIS, as long as the intent, objectives, and targets of the overall study area met.

The Region's Niagara Official Plan update study was being completed at the same time as the SWS initial work and has now been adopted by Regional Council (ROP, 2022) and approved by the Province (November 4th 2022). The SWS used the Region's Niagara Official Plan study work for informational purposes. The SWS is independent from the Niagara Official Plan Natural Environment System and policies work but should be in compliance with the Niagara Official Plan as Regional staff participated on the tech committee reviewing SWS material. As the Regional Official Plan Policy 3.1.3.1 states, "Not all of

the features and components that make up the natural environment system can, or have been mapped as part of the schedules to this Plan. Where features or components of the natural environment system … are not mapped, detailed area-specific or site-specific studies such as an environmental impact study, hydrologic evaluation, or subwatershed study are required for their identification." Regardless, the SWS was initiated prior to the completion of the Niagara Region Official Plan update and is being undertaken in accordance with the TOR established for this study. The Region is looking to the SWS to identify the NHS within the Community of Smithville. Regional Policy 3.2.3.1 states that "A subwatershed study is required to inform the identification and refinement of the natural environment system and the development of policies to protect the natural environment system when secondary plans are prepared for designated greenfield areas and other large undeveloped areas …."

The refined Smithville NHS, in relation to other features, is shown on Map NH-11.

Restoration Areas

Concern has been raised by the area landowners with regard to two "Recommended Restoration Areas".

Twenty Mile Creek Restoration Area

The area identified as Proposed Restoration Area is currently identified as part of the provincial Growth Plan NHS. Once the Settlement Area boundary is adjusted, the Growth Plan NHS no longer applies to this area, however is still present across South Grimsby Road Six, as the Region's Natural Environment System will include the Growth Plan NHS in its entirety (Niagara Region 2022). Much of the Proposed Restoration Area falls within the Region's and the Township's current Core NHS as a Core Environmental Conservation Area. The Twenty Mile Creek corridor is a significant valleyland and an important linkage through the Community of Smithville, as well as the broader landscape. The provincially significant Fresh-Moist Black Walnut Lowland Deciduous Forest (FOD7-4) community was noted in this location along Twenty Mile Creek, which is considered SWH. By adding a Restoration Area in this location, the Twenty Mile Creek corridor will be enhanced by providing additional lands and habitats. This area also provides a transition zone from the wide Natural Environment System to the west, to the narrower Twenty Mile Creek corridor to the east. A high-constraint tributary is located on the east side of the Proposed Restoration Area, which takes drainage from the west side of South Grimsby Road Six. The Proposed Restoration Area contributes to the overall goal of attaining 30% cover through the Smithville NHS and will provide resiliency necessary to address climate change.

Horseshoe Woodland Restoration Area

The woodland is referred to as the "Horseshoe Woodland" due to its current shape. The centre of the woodland was removed in 2007 without proper authorization, although it was determined to be permissible as the property met the requirements under the Region's Tree Cutting By-law exemption, Section 4.11, as lands were cleared for "agricultural purposes" (see letter in Appendix H). The woodland and the lands central to it are currently zoned Environmental Conservation (Zoning By-law 2017-70, Schedule A, Map C5) and are part of the Region's and the Township's current Core NHS as a Core Environmental Conservation Area. The woodland is dominated by a Fresh-Moist Shagbark Hickory Deciduous Forest (FOD9-4), with wetland inclusions (Map NH-3E). The vegetation community FOD9-4 is provincially rare and is considered SWH. The woodland is also identified as SWH for deer wintering by the MNRF. A HDF flows through the area central to the woodland which has a management recommendation of Mitigation, and a management recommendation of Conservation within the woodland (Drawing FG-4j), which are subject to further investigation (refer to Section 4.5). This area has been identified as a Proposed Restoration Area, as it is part of the Region's and Township's Core NHS (ROP 2014; TOWL 2019), it was forested to 2007, it is surrounded by woodland on three sides, if restored to woodland it would

provide forest interior habitat, and it provides for climate change resiliency by contributing to the overall goal of attaining 30% cover of the Smithville NHS.

Linkages

Linkages that are ecologically functional and maintain natural interactions between plants and animals are required to maintain the ecological health of a landscape. Ideally a linkage should contain high quality habitat that is suitable for the species that are intended to use the linkage, but may also provide lesser quality habitat for movement or as a "stepping stone" to higher quality habitats. Many of the natural heritage features within the study area are isolated, but connected through an agricultural matrix, which wildlife can cross to get from one habitat unit to another. Once the area is developed, these open country connections are lost, so it is important to ensure a connected NHS is provided, prior to development. Entirely isolated features will lose their ecological integrity and degrade over time if not connected to other features. Watercourses, and to a lesser extent HDFs, provide additional connectivity between features that may be utilized to create linkages. The Twenty Mile Creek and North Creek valleylands currently provide good ecological connections through the landscape. Linkages also contribute to climate change resiliency and mitigation by adding additional greenspace and vegetation to the landscape, and allowing wildlife to move between habitats. The PPS recognizes that the linkages are to be maintained and form an integral component of NHS. Three Linkages were addressed by the Landowners Group.

Niagara Region's Natural Environment System includes "small linkages" in Settlement Areas which are to be 60-100m wide, that are to connect 'core areas' (NSEI and Meridian 2021). Although no small linkages are proposed within the Community of Smithville through Niagara Region's Natural Environment System, the Study Team has identified potential Linkages as part of Smithville's NHS, although with varying widths. New ROP (2022) Policy 3.1.17.2 states "Opportunities for additional, ecologically appropriate, linkages shall be screened for when a subwatershed study is being completed in support of a secondary plan."

Within the study area, linkages were generally mapped as Primary Linkages (200m width) and Secondary Linkages (50m width). Along high constraint watercourses, which typically require a 30m buffer, a 60m wide Linkage is shown.

Linkage 1 – Horseshoe Woodland to North Creek

Linkages connecting the Horseshoe Woodland to the North Creek corridor were proposed in the preliminary NHS through the Draft Phase 1 report. Through discussions with the NPCA since that time, the east-west Linkage was reduced to 30m wide, and the north-south Linkage along the watercourse and HDF NC5(3)3 (Conservation) was increased to 60m wide. The Linkages are required to maintain the ecological health of the woodland, that would otherwise be isolated, and will also contribute to the ecological health of the North Creek corridor. Two linkages are better than one, as they provide increased wildlife movement opportunities, especially since the prime Linkage, to the south, requires a road crossing. The precise Linkage alignments may be adjusted, as long as the connections between the Horseshoe Woodland and the North Creek corridor are maintained. Generally, the shorter and wider the Linkage, the better from an ecological perspective.

Linkage 2 – Karst Features (SW2) to Twenty Mile Creek

Karst area SW2 is a large streamsink and blind valley in the channel of an unnamed tributary to Twenty Mile Creek, west of Wade Road. The Phase 1 report noted SW2 is connected to the Smithville Cave drainage system. A secondary linkage, 50m in width, has been proposed to connect this area north to the Twenty Mile Creek corridor. The proposed linkage connects numerous significant features. At the southern end of the linkage, high constraint karst (SW2) is associated with a watercourse, direct fish

habitat, wetland, SWH (community FOD9-4), and a significant woodland. This area is included in the Region's and the Township's current Core NHS as a Core Environmental Conservation Area. Further north, SWH for Amphibian Breeding (Wetland) was identified within a small wetland associated with a HDF that has been assessed as requiring protection. In accordance with SWH criteria schedules (MNRF 2015), an associated Animal Movement Corridor SWH has been mapped with the Amphibian Breeding SWH as a 30m wide corridor to the south. As mentioned, the Twenty Mile Creek corridor is a significant valleyland and provides an important linkage through the Community of Smithville as well as the broader landscape. PSW is located along Twenty Mile Creek in the area of the proposed linkage.

An additional linkage connecting to the Horseshoe Woodland has not been included in the NHS. A linkage of any width, even if primarily a walking trail or proposed for LID practices in this location is suggested, in providing a fulsome connection across the greater landscape (Twenty Mile Creek, SWH, wetlands, woodlands, karst, North Creek) and potentially incorporating another karst feature (SW1).

Linkage 3 – Hydro Corridor

The hydro corridor running east-west through the northern portion of the Community of Smithville has been recommended for naturalization to provide a wildlife linkage. The corridor is approximately 120m wide and will connect to the Region's proposed Natural Environment System to the east and west. It is recommended that the hydro corridor be naturalized such as the Meadoway project which connects the Don Valley to Rouge Park in Toronto (TRCA 2019), although a variety of habitats within the corridor are also beneficial. A high water table throughout this area supports many amphibians.

Small Wetland Units

Field surveys undertaken for the SWS in 2020 identified additional wetland areas within the study area that are not mapped as part of the Lower Twenty Mile Creek PSW Complex. These wetland units, many of them very small, were mapped as PSW in the Draft Phase 1 report as they fall within the same wetland catchment area and meet the distance requirements as described through the Ontario Wetland Evaluation System (OWES) (MNRF 2014). The small wetland units were mapped through the ELC process as they are distinct on the landscape and are notable for their potential wildlife value. Small wetland units were mapped where they support anuran breeding, especially in relation to the HDF assessment. Wetlands were identified based on the vegetation present. Through discussion and meetings since the release of the Draft Phase 1 report, small wetland units are now mapped separately from the PSW and identified as "Wetland for Further Review." It is the intent that future site specific surveys will evaluate whether or not the small wetland units meet the Conservation Authority Act definition of wetland, survey the wetland boundaries, and assess their significance based on the revised OWES manual (MNRF 2022).

Significant Wildlife Habitat

The following SWH was identified in the Phase 1 report:

- Turtle Wintering Area (confirmed)
- Reptile Hibernacula (confirmed)
- Deer Winter Congregation Areas (confirmed)
- Bat Maternity Colonies (candidate)
- Raptor Wintering Area (candidate)
- Amphibian Breeding Habitat (Wetland) (confirmed)
- Turtle Nesting Area (candidate)
- Rare Vegetation Communities (confirmed as FOD7-4 and FOD9-4)
- Habitat for Species of Conservation Concern (confirmed for: Black Gum, Lizard's Tail, Slightly Hirsute Sedge, Eastern Wood-Pewee, Snapping Turtle, and Monarch)
- Terrestrial Crayfish (confirmed)

- Animal Movement Corridor (confirmed)

Concern was raised over the identification of Amphibian Breeding Habitat (Wetland) SWH (Map NH-7C). One such habitat was identified in the study area, which is located west of Forestview Court. This location met the SWH criteria for Ecoregion 7E (MNRF 2015) with a full chorus of American Toad and Western Chorus Frog observed in April 2020. Although it may be debated that these are common species, the SWH criteria schedules indicate that a breeding population of these species with at least 20 individuals or a call code level of 3 indicate SWH. Although anurans were abundant within the study area as a whole and often calling throughout the day, even from flooded/moist fields especially in the northern part of the study area, this one location is the only one that met the SWH criteria, indicating its importance.

Southern Woodland

A significant woodland was identified south of Townline Road, between Port Davidson Road and Shurie Road, located adjacent to a former railway line. This woodland was identified as significant for numerous reasons including: size (7.67ha), inclusion of PSW, HDF (Conservation), and SWH due to a presence of a provincially rare plant species (*Carex hirsutella*, S3) as well as a snake hibernaculum. Eastern Wood-pewee (*Contopus virens*), a species of Special Concern, was noted as a possible breeder within this woodland. Correspondence from Mr. Kingma (December 15, 2021) notes that "ditching and fencerow/brush cleanup" had occurred on the property with approval from the NPCA. Through additional correspondence and a meeting between the NPCA, Region, Township, and Study Team, it has been identified that the northern portion of the woodland has been completely removed. The northern portion of the woodland was also significant for the reasons noted above, although it did not contain PSW. In the Phase 1 report, it was noted that this woodland had been recently grubbed (i.e. prior to 2020 field work) with all young trees and shrubs reduced to mulch, but the canopy was intact with a population of the provincially rare Slightly Hirsute Sedge (*Carex hirsutella*) thriving with the reduction in competition. It appears 1.5ha of significant woodland was removed in October 2021 along with the provincially rare species and possibly snake hibernaculum.

The woodland was removed without any prior approvals, but it appears that it did not meet the definition of "woodland" according to the Region's Woodland Conservation Bylaw No. 2020-79, as it may not have met the required tree density, ironically due to the prior grubbing. Regardless, the woodland or former treed area did still meet the Regional and municipal definition of "significant woodland", as it contained two "species of concern" (Slightly Hirsute Sedge and Eastern Wood-pewee) and one or more of the "other significant natural heritage features" that comprise Environmental Protection Areas or Environmental Conservation Areas, namely PSW and SWH (Township OP, 2018, Policy 10.7.2.e).

Since this woodland has been removed, the area is now identified as a Recommended Restoration Area, as shown on Map NH-11. This area is recommended as a Restoration Area for the following reasons:

- It contained mature trees and native groundcover until October 2021
- It was identified as a significant woodland through the Phase 1 study
- The feature was contiguous with the mature woodland to the south, which is a PSW
- The feature contained a provincially rare plant species, Slightly Hirsute Sedge, which is SWH
- The feature contained (and may still contain) a snake hibernaculum, which is SWH
- The feature contained possible breeding habitat for Eastern Wood-pewee, a species of Special Concern in Ontario
- The feature contained a HDF identified for Conservation
- This area provides a connection between the North Creek and Twenty Mile Creek corridors

This Recommended Restoration Area designation is supported by the Township, Region, and NPCA.

Conceptual Buffers

Buffers within the Phase 1 report were identified as the following, and integrated with the preliminary NHS:

- 30m from all Significant Woodlands and wetlands
- 30m from Type 1 fish habitat (either side of watercourse)
- 15m from Type 2 and 3 watercourses (either side of watercourse)
- 30m from SWH

Buffers have been identified as "Conceptual Buffers" and are mapped separately from the NHS (Map NH-11). The Conceptual Buffers are still mapped at the dimensions provided above, but consistent with the proposed Regional Official Plan policy 3.1.9.10.1, buffers from natural heritage features and areas are to be "*determined through an environmental impact study and/or hydrologic evaluation at the time an application for development is made. The width of the buffer would be based on the sensitivity of the ecological functions from the proposed development, and the potential for impacts to the feature and ecological functions as a result of that change in land use*." However, in order to meet the recommended NHS target, buffers should generally be as outlined above, or larger.

30% NHS Target

A target of 30% was identified for the Smithville NHS as this aligns with the Township's Official Plan Policy 10.3.2.a) i) to "achieve 30% of its land area as forest or wetland cover". It also aligns with an often cited metric used my many municipalities as the minimum target natural heritage cover, which stems from Environment Canada's (2013) guideline document, "How Much Habitat is Enough?" which recommends 30% forest cover at the watershed scale as the minimum *forest* cover threshold. Environment Canada identifies this as a "high-risk approach", whereas 50% forest cover is recommended to achieve *healthy* aquatic systems.

Although the Draft Niagara Region Official Plan does not provide a percent cover target, Niagara Region is pursuing the most restrictive Natural Environment System option (Option 3C) and includes policies that support the approach taken in Smithville, including as stated in Niagara's Draft Official Plan Section 3.1 (Niagara Region 2022):

> "*f) **maintain wetland area** and ecological functions and **enhance wetland cover** where possible;*
>
> *g) **protect woodlands** and their biodiversity, restore ecological functions, and **enhance woodland cover through reforestation and restoration**;*
>
> *i) identify and **protect other woodlands** as a way to **maintain treed area** in the region;*
>
> *j) **screen for and evaluate enhancement areas as well as supporting features** and areas to support the long-term ecological integrity and **maintain natural cover**.*
>
> *k) **identify linkages** to protect ecological connectivity in the region;*
>
> *l) maintain **protection for woodlands that have been disturbed** to help support the maintaining of tree cover in the region*."

Although the Township's cover target is acknowledged to be for the Township as a whole, it is recommended that the Community of Smithville *aim* to achieve this target as a way to contribute to the target as a whole in the Township of West Lincoln. Through the land use planning process, natural heritage features may be protected and the NHS enhanced, which is not necessarily achievable outside of urban areas where agricultural uses will continue. The NPCA and Region have been supportive of this

target through the SWS process. A robust NHS will provide climate change resiliency for the community and provide the "green" the public loves about Smithville.

4.6.2 Natural Heritage System

The NHS has been identified based on a review of existing provincial, regional, and municipal policy as outlined in Section 4.2.7 of the Draft Phase 1 report. Since the release of the Draft Phase 1 report, Niagara Region has released preliminary mapping of its proposed Natural Environment System (see **Figure 4.6.1**), however, as stated in the draft Niagara Region policy 3.2.3.1, "*A subwatershed study is required to inform the identification and refinement of the Natural Environment System and the development of policies to protect the Natural Environment System when secondary plans are prepared*".

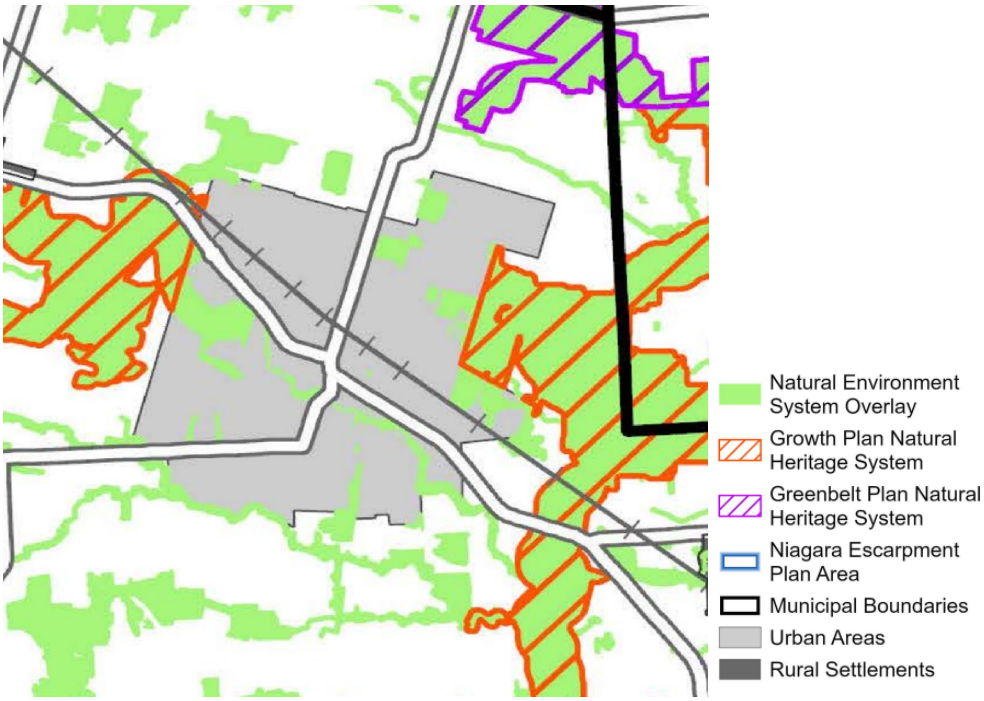

Figure 4.6.1. Niagara Region's Natural Environment System in the Smithville Area (excerpt from Niagara Region's Draft Official Plan Schedule C1)

Figure 4.6.2 and **Table 4.6.1** provide a description for many of the NHS components.

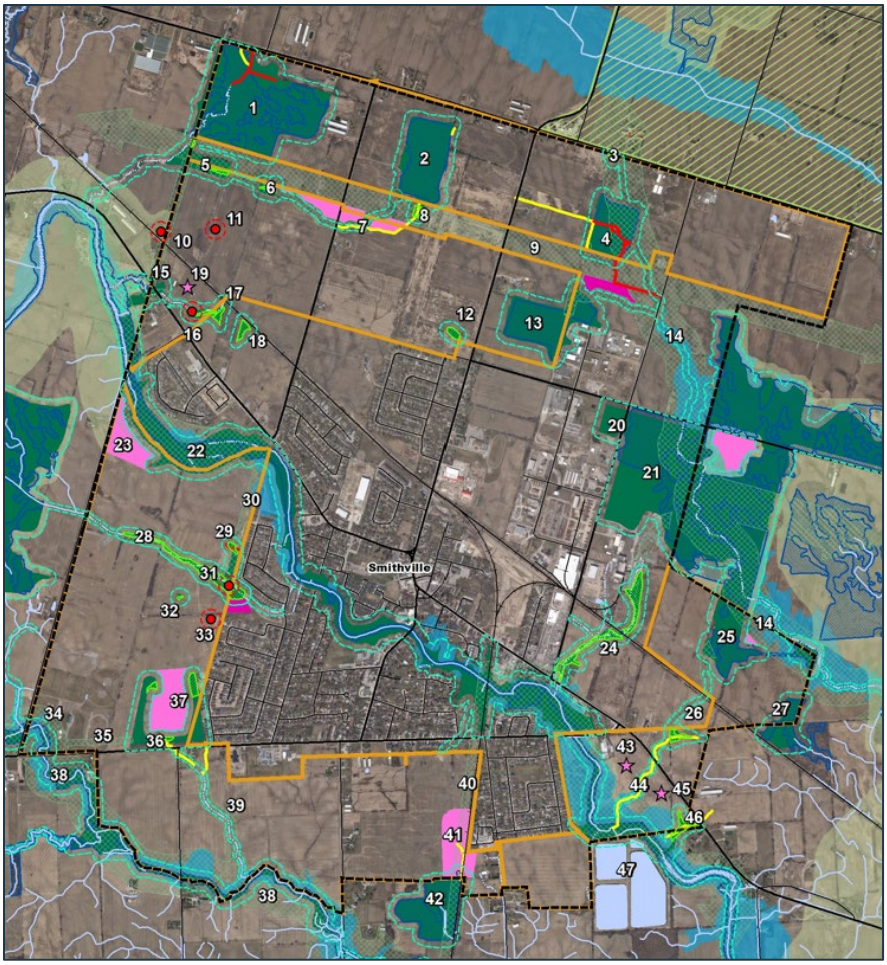

Figure 4.6.2. Smithville Natural Heritage System Areas and Other Features

Table 4.6.1. Smithville Natural Heritage System Areas and Other Features

Area	Explanation
1	PSW and significant woodland; NHS Core Area; contains watercourse and HDF (Protection and Conservation); conceptual buffer shown as 30m but cut off at Young Street
2	PSW and significant woodland; NHS Core Area; HDF (Conservation) to north and south (see #8); conceptual buffer shown as 30m
3	Other Wetland' i.e. Wetland for Further Review (MAM2-2) with conceptual buffer shown as 30m; adjacent to 'Other Woodland' (FOD9) and cultural meadow/thicket (CUM/CUM1-4); within Linkage corridor (#14) connecting Smithville NHS to Greenbelt Plan area to the north, including Spring Creek
4	PSW and significant woodland; NHS Core Area; contains watercourse and HDF (Protection and Conservation); conceptual buffer shown as 30m; contains SWH and owl nesting
5	Significant woodland and 'Other Wetland' i.e. Wetland for Further Review (MAM2-2); conceptual buffer shown as 30m
6	Significant woodland and 'Other Wetland' i.e. Wetland for Further Review (SWD); conceptual buffer shown as 30m

Area	Explanation
7	Linkage along watercourse / HDF (Conservation); secondary linkage is 50m across
8	Other Wetland' i.e. Wetland for Further Review (MAM2); HDF (Conservation); conceptual buffer shown as 30m
9	Linkage the width of hydro corridor; suggestion to create a naturalized corridor such as The Meadoway (in Toronto)
10	Karst area NW1 (medium constraint); shown with 50m buffer; not part of Smithville NHS
11	Karst area NW2 (high constraint); shown with 50m buffer; not part of Smithville NHS
12	Other Wetland i.e. Wetland for Further Review (MAM2-2); conceptual buffer shown as 30m
13	PSW and significant woodland; NHS Core Area; contains SWH; conceptual buffer shown as 30m
14	Linkage along watercourse (tributary to Spring Creek); primary linkage is 200m wide and is generally centered on creek, although it may vary to include the floodplain or natural heritage features and their buffers to the greatest extent possible
15	Significant woodland with conceptual buffer shown as 30m; high constraint watercourse runs through this area
16	Karst area NW3 (high constraint); shown with 50m buffer
17	Other Wetland' i.e. Wetland for Further Review (SWD and MAM2-2) with conceptual buffer shown as 30m; high constraint watercourse runs through this area; separated from #18 by a cultural meadow (CUM)
18	Other Wetland' i.e. Wetland for Further Review (MAM2-2) with conceptual buffer shown as 30m; separated from #17 by a cultural meadow (CUM)
19	Potential Restoration Area identified in this area which is landlocked between railway tracks and NHS. Restoring this area will add to the robustness of the NHS which is quite small/narrow in this area and contribute to the overall NHS area in Smithville
20	Significant woodland with areas of swamp; conceptual buffer shown as 30m but cut off at Spring Creek Road and Industrial Park Road
21	Part of large natural heritage complex comprised of significant woodland, PSW, and Life Science ANSI further east; SWH; Core Area; conceptual buffer shown as 30m but cut off at Spring Creek Road and Industrial Park Road; part of Township's existing Core NHS and includes Potential Corridors
22	Linkage along watercourse (Twenty Mile Creek); primary linkage is at least 200m wide and is generally centered on creek, although it may vary to include the floodplain or natural heritage features and their buffers to the greatest extent possible; 200m wide linkage is not shown through developed portion of Smithville where this width is not possible
23	Recommended Restoration Area; area currently identified as Growth Plan NHS and will connect to Growth Plan NHS/Niagara Region's Natural Environment System (NES) to west of South Grimsby Road Six once urban area is expanded; bolsters Twenty Mile Creek corridor and NHS providing for more robust system and climate change resiliency; SWH along Twenty Mile Creek (FOD7-4); includes high constraint watercourse and Mitigation HDF, whose drainage from the west needs to be considered; the Twenty Mile Creek corridor is the most important natural heritage corridor through the area and locating the Restoration Area here will provide an overall enhancement to the linkage/corridor/system
24	Other Wetland' i.e. Wetland for Further Review (MAM2-2) along intermittent watercourse shown with conceptual buffer shown as 30m

Area	Explanation
25	Part of large natural heritage complex comprised of significant woodland, PSW, and Life Science ANSI further east; SWH; Core Area; conceptual buffer shown as 30m (same area as #21); small land-locked area between woodland/PSW and Linkage is shown as a Recommended Restoration Area; part of Township's existing Core NHS and includes Potential Corridors
26	Secondary Linkage (50m) along HDF (Conservation), connecting the Twenty Mile Creek corridor with the Spring Creek natural heritage compelx (#21, #25), as well as a small 'Other Wetland' (Wetland for Further Review (MAM2))
27	PSW and significant woodland; NHS Core Area; conceptual buffer shown as 30m
28	Corridor along a medium and high constraint watercourse; contains Other Wetland (i.e. Wetland for Further Study) (MAM2-2); links a high constraint area of karst (#31) to a natural heritage complex west of South Grimsby Road Six; may integrate hedgerow into protected corridor
29	Small 'Other Wetland' (Wetland for Further Study) (MAM2), however this one met the requirements for Amphibian Wetland Breeding SWH; it is the only such wetland within the study area, making it so much more important to protect for this reason, despite it being small and likely having been formed in the area through construction works to the east; includes a short HDF (Protection); given that Amphibian Breeding Habitat (Wetland) was identified, a wildlife movement corridor must be delineated also: this has been mapped linking towards the south, to the swamp and karst feature (#31), however a linkage towards the Twenty Mile Creek corridor (#30) is also recommended; conceptual buffer around SWH shown as 30m
30	50m wide linkage shown between Amphibian Breeding SWH (#29) and the Twenty Mile Creek corridor (#22); another route to the Twenty Mile Creek corridor is more circuitous and more narrow (east of Oakdale Blvd), located between rear yards, comprised of mown grass, includes numerous trail crossings and a road crossing, and is therefore less functional; a corridor as shown should be wider, comprised of a naturalized community (such as meadow), and incorporate an amphibian crossing structure underneath any trails; includes HDF (Mitigation) which could remain open on the landscape within the linkage, as well as the cultural meadow (CUM) surrounding the wetland at #29
31	Significant woodland, including swamp (SWD4-2, 'Other Wetland'), as well as an area of karst (SW2) (high constraint); conceptual buffer shown as 30m from natural heritage features and 50m from karst; restoration in the Restoration Area shown outside the Smithville expansion boundary is being undertaken by Smithville Christian High School (Area 3, Golden Acres Park, see PD-088-2021)
32	Small treed area comprised of 'Other Wetland' i.e. Wetland for Further Review (SWD4-2) and FOD9-4 (which is SWH) with conceptual buffer from wetland shown as 30m
33	Karst area SW1 (medium constraint); shown with 50m buffer; not part of Smithville NHS; may be grouted
34	Southwest portion of Leisureplex park along North Creek corridor; PSW (SWT2, MAM2-2) shown with 30m buffer; included in a 200m wide Primary Linkage along North Creek (#38)
35	Narrow (30m wide) linkage connecting the woodland (#36) to the North Creek corridor, along the shortest route; location of Linkage can be moved north; could also replace Linkage with a Linkage to the north, connecting the woodland (#36) with karst and swamp (#33 and #31)

Area	Explanation
36	Significant woodland with small wetlands ('Other Wetland'/Wetland for Further Study) and 30m conceptual buffer; buffer has been cut off at Smithville Road
37	Recommended Restoration Area; area included in Region's and Township's Core NHS; area was woodland and was removed in August 2007; once restored to woodland, will provide interior forest habitat; centre of woodland was removed in 2007 for "agricultural purposes" and was therefore permissable at the time (see Memorandum from Township of West Lincoln dated November 8, 2007)
38	Linkage along North Creek; primary linkage is 200m wide and is generally centered on creek, although it may vary to include the floodplain or natural heritage features and their buffers to the greatest extent possible
39	Linkage (60m) along HDF (Conservation) / watercourse, connecting the significant woodland (#36) to the North Creek corridor (#38)
40	Secondary Linkage (50m) connecting significant woodland, SWH (#41), and PSW (#42) to the Twenty Mile Creek corridor (#22); connection between the North Creek and Twenty Mile Creek corridors; runs along former railway line and may be integrated with a trail in this area
41	Recommended Restoration Area; the woodland was removed in October 2021 but was identified as the following in the Draft Phase 1 SWS report (January 2021): Significand woodland, HDF (Conservation), SWH (rare species and snake hibernaculum); the woodland was grubbed (understory removed) in recent years prior to field work in 2020
42	Significant woodland, PSW, SWH; conceptual buffer shown as 30m
43	Potential Restoration Area identified in this area which may be difficult to develop given grading. Restoring this area will add to the robustness of the NHS along the Twenty Mile Creek corridor (#22), which is the most important natural heritage corridor through the area
44	Secondary Linkage (50m) along HDF (Conservation) provides a linkage to the north (#26, #25) and connects to a small Wetland for Further Review (MAM2) that is shown with a conceptual buffer of 30m
45	Potential Restoration Area identified in this area which may be difficult to develop given grading. Restoring this area will add to the robustness of the NHS along the Twenty Mile Creek corridor (#22), which is the most important natural heritage corridor through the area
46	HDF (Conservation) and 'Other Wetland' (i.e. Wetland for Further Study) (MAM2-2); conceptual buffer shown as 30m
47	Smithville Sewage Lagoons; not included in NHS; Township OP policy 4.11 requires a 150-400m buffer from these lagoons, which may be integrated with the NHS; lagoons are known as a birding hot-spot (184 species reported from the lagoons)
Overall, the proposed Smithville NHS makes up 28.5% of the Study Area, or 28.4% of the Community of Smithville. This includes the 30m conceptual buffers, Linkages, and Recommended Restoration Areas as mapped.	

The proposed Smithville NHS established by building upon various higher level policies and direction, starting with direction provided in the Township's Official Plan (2018) which identifies the components of Environmental Protection Areas and Environmental Conservation Areas (Policies 10.7.2.c and .d), as well as guidance through the PPS (2020). Core Areas are comprised of Significant Wetlands, Significant Woodlands, Significant Valleylands, SWH, fish habitat, and habitat for endangered and threatened species. Conceptual buffers are shown surrounding the Core Areas. Buffers, referred to as Vegetation Protection Zones in provincial guidance documents (e.g. Growth Plan), aid in the mitigation of impacts through the development of lands adjacent to Core Areas. Conceptual buffers in the Community of Smithville have

been mapped as 30m wide in conformity with provincial guidance documents that recommend this width for Vegetation Protection Zones where they apply, as well as in order to provide a robust NHS. Wide buffers will provide protection and enhancement of natural heritage features that have been altered and degraded through land use practices both historically, as well as recently.

Linkages were identified within the Community of Smithville to connect Core Areas in a "system … of natural heritage features and areas, and linkages" (PPS 2020, definition of Natural Heritage System p.47). Where possible, linkages were aligned along watercourses; and otherwise along HDFs that are to be conserved or protected. Elsewhere, linkages were identified to connect significant features (e.g. SWH, Significant Woodland) in order to maintain their function. Linkages serve to protect Core Areas and their functions by maintaining the ability of species to move between Core Areas in order to maintain populations (e.g. repopulation), provide genetic diversity, expand populations, as well as provide movement corridors between various habitats to meet species' life stages.

Recommended Restoration Areas were integrated into the proposed Smithville NHS in response to the direction from members of the Technical Advisory Committee (TAC), as well as guidance provided in the PPS (2020), and in order to create a robust NHS, one which is sustainable into the future and provides resiliency in a changing climate.

Table 4.6.2 identifies metrics to identify the cover percent achieved by different components of the NHS, and why the entire system is recommended for protection.

Table 4.6.2. Smithville Natural Heritage System Metrics

Feature	Area within Community of Smithville (ha)	%	Area within Study Area (ha)	%
Core Area	132.47	10.67	69.77	10.92
Recommended Restoration Area	22.52	1.81	16.87	2.64
Linkage (includes overlapping features)	186.11	14.99	86.12	13.48
Linkage (excluding Core Area and Conceptual Buffer)	89.60	7.22	39.01	6.11
Conceptual Buffer	114.14	9.20	59.94	9.38
Smithville NHS	**352.35**	**28.39**	**182.24**	**28.53**

As identified in **Table 4.6.2**, the proposed Smithville NHS does not quite meet the 30% cover target, although it comes close. The Recommended Restoration Areas, Linkages, and full 30m Conceptual Buffers are required to achieve the 28.4% NHS cover, as mapped (Maps NH-11 and NH-12). The proposed Smithville NHS has been validated by the NPCA's restoration target mapping and through conversation with their staff, as well as the Region of Niagara's official plan process, including direction to their Natural Environment System and proposed policies. Refer to Section 5.5 for additional information on the NHS Impact Assessment

4.6.2.1 Wetlands

PSWs are included in the Smithville NHS as Core Areas and are protected. Generally, PSWs require a 30m buffer. The PSW wetland boundaries are to be staked and surveyed in the field at the EIS stage with the appropriate agencies. The MNRF and NPCA should be consulted at that time. The Lower Twenty Mile Creek wetland evaluation should be updated at that time with the refined boundaries and any new information from site specific surveys.

Some small, isolated, and unevaluated wetland areas were identified through the SWS that are identified on Map NH-11 as wetlands requiring further review. At the EIS stage, these areas should be evaluated to determine whether or not they meet the Conservation Authority Act definition of wetland. The boundaries should be staked and surveyed with the appropriate agencies, and the MNRF and NPCA should be consulted. If these units are identified as wetland, they need to be evaluated to determine whether or not they are provincially significant. If they are to be protected, they will require a suitable buffer. Opportunities should be identified for connecting these otherwise isolated features with the larger NHS. Suitable linkages may be comprised of trails, open spaces such as parks or school yards, SWM including LID practices, or other opportunities.

A wetland water balance assessment should be undertaken at the detailed planning and design stage to ensure the water balance for each wetland unit is maintained to pre-development conditions.

Wetlands are shown on Maps NH-6 and NH-11.

4.6.2.2 Woodlands

Significant woodlands were identified through the SWS (Map NH-6) and are included in the Smithville NHS as Core Areas. At the EIS stage, the driplines should be staked and surveyed in consultation with the review agencies (i.e., Township and Region). Appropriate buffers from significant woodlands are to be determined through an EIS, although it is recommended that they generally be 30m wide where possible in order to meet the overall NHS target.

Some woodlands did not meet the significance criteria and were not included in the Smithville NHS. These woodlands, which are generally smaller, and may include hedgerows and small treed stands, should be assessed at the EIS stage. It is recommended that trees be retained through the development process in order to realize the many benefits trees provide including but not limited to: beautification, cooling, mitigating climate change, improving stormwater management, psychological benefits such as reducing stress and providing relaxation. This is supported by the Region's following proposed policies:

- It is the goal of this Plan that woodland cover be maintained or enhanced in the region by 2051 (Policy 3.1.25.1)
- Land stewardship that includes protection of existing tree cover and tree planting efforts (Policy 3.1.25.2.c)
- Tree and woodland protection and planting through the development approvals process (Policy 3.1.25.2.f)

4.6.2.3 Significant Valleylands

Twenty Mile Creek and North Creek valleylands were identified as significant through the SWS. The valleylands have been included within the Smithville NHS as they form primary linkages through the landscape. They have generally been protected within 200m wide Linkages. Two connections between the two valleylands are proposed, including the direct linkage through the Southern Woodland (west of Shurie Road), through Rock Street Park (see Section 4.8.1, Southern Woodland); as well as another linkage connecting through the Horseshoe Woodland (see Section 4.8.1, Linkages, Linkage 2).

4.6.2.4 Significant Wildlife Habitat

Numerous areas within the study area were identified as providing SWH (Maps NH-7A to 7C). This includes the following, either as confirmed or candidate SWH:

- Seasonal Concentration Areas: Turtle Wintering Area, Reptile Hibernaculum, Deer Winter Congregation Areas, Bat Maternity Colonies, Raptor Wintering Area
- Rare Vegetation Communities: FOD7-4 (Fresh – Moist Black Walnut Lowland Deciduous Forest) and FOD9-4 (Fresh – Moist Shagbark Hickory Deciduous Forest)
- Specialized Wildlife Habitat: Amphibian Breeding Habitat (Wetland) and Turtle Nesting Area
- Habitat for Species of Conservation Concern: Black Gum, Lizard's Tail, Slightly Hirsute Sedge, Eastern Wood-Pewee, Snapping Turtle, Monarch; and Terrestrial Crayfish
- Animal Movement Corridor

Most SWH is protected within the PSW, significant woodlands, and Twenty Mile Creek, which are protected already. The Animal Movement Corridor SWH was identified in conjunction with the Amphibian Breeding Habitat (Wetland) SWH, as per the SWH Criteria Schedule (MNRF 2015). Further study is required to assess the following:

- Raptor Wintering Areas east of Industrial Park Road and north of the rail line within the milieu of woodland, forest, meadow, and thicket habitat.
- Turtle Nesting Areas along North Creek and Twenty Mile Creek, as well as adjacent to any ponds that provide suitable habitat for turtles (e.g. pond adjacent to northern woodland east of 30 Road, identified as SAS on Map NH-3B).

Should these SWH be present, additional lands may be required to be protected as part of the Smithville NHS.

Bat Maternity Colony SWH was also identified as candidate from the study area, as this may occur in any mature deciduous or mixed woodland or swamp community where there are more than 10 large diameter wildlife trees per hectare. As significant woodlands are to be protected however, it is unlikely necessary to assess the presence of Bat Maternity Colonies. Bat Maternity Colony SWH must be considered if non-significant woodlands are proposed for removal.

Site specific surveys to be undertaken at the EIS stage may identify additional SWH.

4.6.2.5 Habitat for Endangered and Threatened Species

Barn Swallow, Bobolink, Eastern Meadowlark, Little Brown Myotis, and Northern Myotis were reported through the SWS. These species are protected by the Endangered Species Act (ESA).

Barn Swallows may nest in barns, outbuildings, garages, houses, and culverts. If such structures are to be removed through the development process, surveys for Barn Swallows and their nests must be undertaken. Barn Swallows are now addressed in Part III of Ontario Regulation 830/21 of the Endangered Species Act.

Bobolink and Eastern Meadowlark were both observed within the study area, but suitable breeding habitats were not identified. Suitable habitats may shift from year to year due to changes in agricultural practices, and both species will need to be considered under the Endangered Species Act in the future.

Bat surveys were not completed as part of the SWS, but it can be assumed that Little Brown Myotis and Northern Myotis are likely present within the study area. Where tree removal or buildings are proposed for removal, bat surveys may be necessary to determine implications under the ESA. Consultation with the MECP should be undertaken at the EIS stage.

4.6.2.6 Fish Habitat

Fish habitat (Map NH-8) has been protected within watercourses through the Smithville NHS. Generally, fish habitat has been protected within Primary or Secondary Linkages in the study area. Appropriate buffers should be identified at the through an EIS and may widen the recommended Linkage. In the case of HDF that require protection or conservation, corridor widths should be considered that are sufficient to protect fish habitat if applicable.

4.6.2.7 Smithville NHS

Overall, the proposed Smithville NHS includes additional lands beyond the identified Core Areas. This includes buffers, linkages, and restoration areas, which provide additional enhancement to the system (Map NH-11). These proposed enhancements provide for increased ecological services such as wildlife habitat and movement opportunities, increased buffering to natural heritage features, and restoration opportunities such as additional vegetation plantings. Buffer management plans are to be developed at the detailed design stage and may include the following: native species plantings, soil improvements, and habitat creation (e.g. pollinator habitat, hibernacula, nesting areas). Buffer widths may be refined at the EIS stage, but it is recommended that buffers generally be identified at the widths recommended through the SWS as this will help contribute to the NHS target. The exception to this is permitting requirements for any Endangered or Threatened species that may be applicable at the time of development.

The Smithville NHS is shown on Map NH-12.

4.6.2.8 Crossings of Smithville NHS

The crossing of roads and infrastructure through the Smithville NHS should be avoided where possible. Where necessary, the crossings should consider the following:

- aligned at the narrowest part of the NHS
- perpendicular to watercourse crossings
- minimize width of crossing
- maximize span of crossing over watercourses and consider wildlife movement under crossing
- consider wildlife road mortality and wildlife crossings
- in the case of infrastructure, consider naturalization of crossing area to the greatest extent possible and minimize maintenance requirements

4.6.2.9 Stormwater Management

Approximate areas for stormwater management facilities have been identified on the Land Use Plan. These areas should be located adjacent to the Smithville NHS if possible, to provide further buffering to the natural heritage features. Stormwater management facilities should be naturalized to the greatest extent possible and incorporate native species to the greatest extent possible as well. Invasive species should not be planted in stormwater management areas. Stormwater management facilities and LID practices may be considered within Linkages or to provide additional linkages outside of the Smithville NHS to connect otherwise isolated natural heritage features and areas. A water balance assessment may be required adjacent to wetlands, watercourses, and preserved HDFs in order to maintain the features. Stormwater discharge to natural areas must be treated and clean.

4.6.2.10 Mitigation Measures

The following provides a list of mitigation measures to avoid impact and should be implemented during the development of the study area.

The Endangered Species Act protects Endangered and Threatened species. Where Barn Swallow nests or foraging habitat is to be removed, the permitting process must be started with the MNRF. Nests are to be replaced through a new nesting structure. Removal of barns, houses, or individual trees may need to be surveyed for SAR bats or bat maternity roosts. This should be done in consultation with the MNRF. Where tree removal is to occur, agencies must also be consulted with regards to the potential for bat maternity roost SWH.

The Migratory Birds Convention Act protects migratory birds, their eggs and nests from being harmed or destroyed. It is recommended that any tree removal and vegetation clearing (including grading) be undertaken prior to May 1 or following August 31. Should vegetation clearing have to occur within this time, a nest search must be completed by a qualified biologist within 48 hours of the clearing to assess whether or not any nests are located in the area. Clearing cannot be done if an active nest is present.

Potential indirect impacts to wildlife may arise from noise and dust associated with construction activities and unnatural lighting resulting from the development. Noise associated with construction will be temporary, therefore significant effects on wildlife from noise are not expected.

Wildlife-vehicle collisions are a risk across roads and must be minimized. Mitigation measures include strategically enabling (e.g. crossing structures) or discouraging (e.g. exclusion fencing) wildlife crossings along roads.

Bird-window collisions should be minimized and building design elements should be considered and implemented through the subsequent planning process to mitigate bird collisions.

During construction, activities such as clearing and grubbing, dust can lead to changes in vegetation due to increased heat absorption and decreased transpiration; adverse effects in wildlife due to high levels of sedimentation and visual impacts. In order to suppress dust, areas of bare soil should be moistened with water during construction activities to ensure that the amount of dust within the study area is reduced. Topsoil stockpile locations should be in areas of lesser wind exposure and away from natural features. Erosion and sediment control measures should be put in place and maintained in good repair. Areas of bare soil should be seeded to reduce erosion. Best management practices should be followed with regards to topsoil storage in order to maintain the microbiota of the soil which will benefit plant growth once the topsoil is redistributed across the developed area.

Detailed lighting designs should include directional lighting for all areas of road and developments that are within 30m of the natural features to eliminate lightwash. It is recommended that guidelines from the International Dark Sky Association be considered.

It is recommended that a trail system be established to allow people access and use of the Smithville NHS. The trail system should be constructed at the start of development to give people immediate access, and discourage the establishment of footpaths. Proposed trail alignments should be developed in consultation with all agencies and the trail location should be staked in the field with all agencies present. Preference will be given for trail alignment outside of the NPCA Regulation Limit whenever possible. Proposed alignments within the Regulation Limit must conform with NPCA policies and will require a permit from the Authority. Proposed trail siting in proximity to the Smithville NHS will be requested to be aligned closer to the development area and away from the core features.

Fencing should be considered at the edge of the Smithville NHS to keep people and pets outside of sensitive areas. Specific fencing locations should be determined at the detailed design stage. Existing disturbances within natural heritage features, such as debris piles, should be removed. If possible, a plan for invasive species control should be prepared and implemented.

Areas within the Smithville NHS that are currently not natural (e.g. agricultural areas) should be naturalized and planted with native, non-invasive species. Milkweed species (*Asclepias* sp.) should be included in seeding mixes to provide habitat of Monarch. Other species beneficial to pollinators should be planted as well. It is recommended that planting and seeding plans be established at detailed design stages.

4.6.2.11 Construction and Design Related Mitigation Recommendations

The following recommendations are general in nature but are largely standard mitigation measures for development and construction. The following recommendations are provided to ensure that any potential impacts are minimized:

- Individual trees (e.g. hedgerows, surrounding residences) should be maintained and protected where possible. Where trees in fair to excellent condition have to be removed, these should be compensated for. Compensation plans are to be developed at the detailed design stage.
- No storage of equipment, materials or fill is to occur within the natural areas or their buffers.
- Maintenance of machinery during construction should occur at a designated location away from the proposed Smithville NHS.
- Sediment and erosion control measures must be installed prior to, and maintained during construction. Areas of bare soil should be re-vegetated as soon as feasible to prevent erosion of soils (within 30 days of inactivity).
- During the installation of the construction limit fencing, any hazard trees should be identified by a Certified Arborist or qualified other and removed or pruned as warranted. Cavity trees may have to be surveyed for SAR bats prior to any removal. This should be done in consultation with the MECP.
- Any areas of bare soil that arise should be graded and re-vegetated as soon as possible to avoid gullying and erosion. A suitable native seed mix is to be applied to all exposed areas of soil that are immediately adjacent to the natural areas.
- Planting of native tree and shrub species on currently un-vegetated portions of the site is recommended to enhance site conditions. Natural succession and plantings can be used to create native vegetation zones around retained natural heritage features.
- Litter and debris should be removed from the construction areas on an ongoing basis.

4.6.2.12 Monitoring Recommendations

(1) Prior to Construction

On-site inspections of the sediment and erosion control measures, as well as tree protection measures prior to construction.

(2) During Construction

- Regular monitoring of sediment and erosion control measures, as well as tree protection fencing to ensure maintenance and effectiveness.
- Pruning of any limbs or roots (of trees to be retained) disrupted during construction.
- Maintenance of Smithville NHS.
- Monitoring of groundwater levels and baseflow during dewatering activities.
- Ensure other mitigation measures are adhered to, such as fuelling of machinery at designated locations away from woodlands, wetlands, and watercourses; storage of machinery and material, fill, etc. in designated areas; and equipment movement through natural areas and setbacks to be controlled.

(3) Subsequent to Construction

The Phase 3 report will provide information with regards to monitoring following construction, however the following is likely to be included: Buffer, restoration, and compensation plantings should be monitored after installation. Following planting, it is recommended that the plantings be inspected to ensure that the correct species and number of plants were planted in accordance with the approved planting plan. Two years after planting, the plantings should be inspected again to ensure a good survival rate. Any specimens not healthy in vigorous growing condition should be replaced at that time. To increase survival, it is recommended that new plantings be maintained through watering during the first two years after installation. Tree staking is to be removed two years after installation.

4.6.3 Summary

A proposed NHS has been developed for the Community of Smithville to protect its signficant natural heritage features through a connected system that will have the greatest benefit to the ecological features. The Smithville NHS, if implemented as recommended, provides 28.4% natural cover the Community once the areas are naturalized. This includes Linkages, Restoration Areas, and Buffers that all require naturalization as they are currently comprised of active agrictultural fields for the most part.

The Smithville NHS will has been designed to be robust and sustainable into the future as the areas surrounding it develop. Additional studies are to be undertaken at the Draft Plan stage to make refinements to the NHS, including determining buffer widths, restoration and linkage area boundaries, and assess SAR and SWH further. This report has provided high-level recommendations and considerations with regards to impact avoidance and mitigation.

5.0 Summary of Management Recommendations

5.1 Hydrogeology

The potential impacts from the reduction in infiltration and subsequent reduction in groundwater levels, groundwater recharge and groundwater discharge (Section 4.1.2) are proposed to be mitigated through various stormwater management techniques where the groundwater component of the water budget is functionally significant. Employing Low Impact Development infiltration techniques will aid in maintaining existing overburden quantity and quality of recharge, associated groundwater levels, potential groundwater discharge, as well as recharge to the lower aquifers. Specific infiltration techniques will be provided depending on the characteristics of the more local surface water catachment area. These may include more passive infiltration and distributed infiltration practices, which can manage potential impacts to both groundwater quailty and quantity and are discussed in Section 5.3.

The potential local reduction to infiltration and subsequent groundwater recharge is also expected to be reduced given the more regional hydraulic connection to the bedrock aquifer within and adjacent to the study area along with the importation of lake-based water for the municipal water supply and the associated applications (i.e., irrigation) and infrastructure leakage of this water supply.

As noted in Section 4.1, the construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavated sewer and utility trenches. Over the long term, these impacts can lower the local groundwater table. To mitigate this effect, services should be constructed using best management practices to prevent redirection of the groundwater flow. Areas of excavation below the water table for housing basements should be minimized where possible. Best management practices may involve the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to prevent groundwater flow along granular bedding material and erosion of the backfill materials. It is noted that backfill for decommissioning of any existing sewer lines should consider low hydraulic conductivity material to prevent preferential groundwater flow.

Dewatering is typically expected for construction of municipal services where the excavations occur below the water table. Over much of the study area, the surficial soils encountered during servicing are expected to be predominantly silty clay till and typically this is low hydraulic conductivity material and may not produce much water. There may, however, be areas where the weathered overburden may produce more significant volumes of groundwater seepage or there may be locations where coarser-grained sand or gravel layers could be encountered. The water table in the study area can be very close to ground surface during some times of the year, and most excavations can expect to encounter wet soil conditions, particularly in the spring and fall. The dewatering requirements may vary significantly depending on the type of geologic materials encountered at the excavation, the season and climate conditions, and the depth and size of the excavations.

It is noted that dewatering systems where the volume of water collected exceeds 50,000 L/day require a Permit to Take Water (PTTW) from the MECP. Even for areas where the construction is only expected to encounter till soils, as a contingency, it is generally recommended that the contractor apply for and obtain a PTTW prior to construction activities in the event that unexpectedly high flows are encountered. The MECP will require a detailed groundwater management plan for the permit application to address local impacts to groundwater levels and for the management of the quantity and quality of the discharge water.

5.2 Karst

Hazard constraints have been applied to each feature described in sections 2.1.2 and 4.2.1 as 'high', 'moderate' or 'low' based on qualitative factors associated with size, position in the landscape, and hydrological/hydrogeological function. Section 4.2.2 provides an impact assessment for each of the 6 karst features within the study area (as noted, SE 2 is likely not a karst feature) and this informs management options.

Sinkholes NW 3 and SW 2, both defined as Karst Hazardous Sites (KHS), have significant hydrological and hydrogeologial functions and should be buffered by 50 m and left to function within the post-development landscape, subject to NPCA direction.

NW 2 is also classified as a KHS due in large part to its position in the landscape, near the local height of land which suggests it could be associated with a paleokarst formed during an earlier period. It is the Study Team's opinion that Smithville Cave, for example, is a paleokarst feature so this interpretation is not unreasonable. If so, it could point to more significant karst in the immediate vicinity. Until recently, the sinkhole was loated within an area of natural vegetation which could be restored.

SW 1 is also classed as a KHS. It does not have a significant hydrological/hydrogeological function and has likely formed since deforestation of the area. The primary hazard associated with this feature is its steep, sloughing banks which clearly create a human hazard, particularly to children. Its ecological role is likely minimal as it takes substantial sediment from the surrounding fields along with any herbicides or fertilzers that may be applied. Management options associated with SW 1 include removal (excavation and grouting) or incorporation within the NHS. Alternatively, it could be left as a componentof open space and vegetated to stabilize the feature and prevent/minimize further sediment movement.

Sinkhole NW 1 is likely the result of an undersized culvert beneath the rail line. Although not a KHS, it does have the potential to impact drainage on South Grimsby Road 6 and, thus the best management option is to re-size the culvert beneath the rail line then re-grade the feature.

All of the culverts beneath the rail line are likely undersized – there appears to be significant spring flooding upstream of each– and all should be right sized.

Sinkholes SE 1 and SE 3 do not pose significant structural or flooding hazards and could be left or by-passed.

As noted in Section 2.1.2.5, water balance studies are required for any sinkholes that are left to function in the landscape. Each has a set capacity which if/when exceeded will result in back flooding at the sinkhole. Hence, post-development flows should not exceed pre-development flow to the degree possible.

5.3 Stormwater Management

5.3.1 Stormwater Quality Management

The stormwater quality management strategy has been established to achieve stormwater quality management to an *Enhanced* standard of treatment. End-of-pipe facilities are to be constructed to provide a permanent pool volume and forebay design as per the current Provincial guidelines (ref. MOE 2003). In addition, the stormwater management facilities are to incorporate measures to mitigate thermal enrichment of runoff from future development within the study area.

The stormwater management plan for the future development also includes incorporating Low Impact Development Best Management Practices (LID BMPs), to achieve stormwater quality control and manage water budget at source. These practices, combined with the use of end-of-pipe facilities designed to current Provincial standards would further enhance the quality of storm runoff to the receiving watercourses.

5.3.2 Erosion and Quantity Control

Storage-discharge relationships for each of the conceptual off-line stormwater management facilities have been determined to control future peak flows to existing peak flows at the key comparison locations for the storm events up to and including the 100 year frequency flow condition event. The recommended stormwater management strategy is summarized as follows:

- All future development areas are to incorporate extended detention storage within the stormwater management systems for erosion control.
- All future development within the Spring Creek Subwatershed are to incorporate quantity controls as outlined herein to control post-development flows to pre-development levels for all events up to and including the 100 year frequency flow condition.
- The future development areas within the North Creek Subwatershed which drain through private properties external to the development area are to incorporate incorporate quantity controls as outlined herein to control post-development flows to pre-development levels for all events up to and including the 100 year frequency flow condition; those portions of the future development area within the North Creek Subwatershed which discharge directly to the North Creek are not required to incorporate quantity controls above the extended detention storage component of the facility.
- The future development areas within the Twenty Mile Creek Subwatershed which drain through private properties external to the development area are to incorporate incorporate quantity controls as outlined herein to control post-development flows to pre-development levels for all events up to and including the 100 year frequency flow condition; those portions of the future development area within the Twenty Mile Creek Subwatershed which discharge directly to the Twenty Mile Creek are not required to incorporate quantity controls above the extended detention storage component of the facility.
- All future development areas are to incorporate Low Impact Development Best Management Practices (LID BMPs) to maintain water budget and enhance erosion protection within the receiving watercourses.

Various technologies are available to satisfy stormwater management criteria identified herein. The specific technology/technique selected depends upon contributing land use, size of drainage area, and the stormwater management function required. **Table 5.3.1** provides a summary of various practices, and the corresponding function provided by the technology. As the summary above indicates, a variety of stormwater management objectives are required under the recommended plan, hence it is anticipated that a combination of technologies will be required for all future development areas, in order to achieve the requisite objective. White roofs represent an emerging technology to mitigate thermal enrichment of runoff by providing lighter coloured roof surfaces to reflect sunlight rather than absorb sunlight and warm the surface. This technology is also noted to contribute toward mitigating heat island effects.

Table 5.3.1. Summary of Stormwater Management Practices and Corresponding Functions

Practice	Flood Control	Erosion Control	Quality Control	Thermal Mitigation	Water Balance	Evapotranspiration	Groundwater Recharge
End-of-Pipe (Wet Pond/Wetland/Hybrid)	X	X	X	X			
Dry Pond	X	X					
Rooftop Detention Storage	X						
Parking Lot Storage	X						
Amended Topsoil		X	X	X	X	X	X
Green Roofs		X	X	X	X	X	
White Roofs				X			
Tree Trench Boxes		X	X	X	X	X	X
Oil/Grit Separators			X				
Rainwater Harvesting		X			X		
Pervious Pipes		X	X	X	X		X
Oversized Pipes	X						
Permeable Pavement		X	X	X	X		X
Soakaway Pits		X	X	X	X		X
Infiltration Trenches		X	X	X	X		X
Bioretention Bumpouts		X	X	X	X	X	X
Grassed Swales			X	X			
Biofilters/Bioswales		X	X	X	X	X	X

5.4 Watercourses

General watercourse and HDF definitions and management strategies are presented in Appendix G: Watercourse and Headwater Drainage Feature Classification. In addition to the guidance provided in Appendix G, management recommendations for watercourses include:

High Constraint Watercourses (Red streams):

- Apply management strategies/opportunities for High Constraint (Appendix G)
- Incorporate erosion hazard into NHS.

Medium Constraint Watercourses (Blue streams):

- Apply management strategies/opportunities for Medium Constraint (Appendix G)
- Incorporate existing or designed feature and setbacks into NHS. Design setbacks can be developed in the case this is realigned.
- Enhance riparian zone along agricultural fields.
- For realignments, all management recommendations, riparian corridors (appropriate buffer, regulated setbacks) to be established in future studies. Natural channel design principles to be implemented for any realignments.

Drawings FG-1 presents the erosion hazard corridors in relation to the land use plan. Appendix G details the watercourse constraints analysis and recommended reach management. This includes site specific management recommendations and opportunities beyond the general recommendations above. Drawing FG-2 presents the watercourse constraints in relation to the land use plan.

Potential watercourse crossing locations have not been identified in the current land use plan. Site specific recommendations for reaches impacted by farm crossings are included in Appendix G.

For HDFs, a modified classification and evaluation methodology to characterize and provide management recommendations for individual HDFs was used as described in the Phase 1 report. The approach first applies the guidelines set by TRCA/CVC (2014) to determine a feature classification ("**HDFA Classification**"), which may then be carried forward to "**Final Management**" or altered based on site opportunities, or other constraints that the protocol may not capture (e.g., feature protection based on location within a significant valley or terrestrial feature). The following briefly summarizes management strategies for HDFs, with details available in Appendix G:

- **Protection feature** (red-dashed features) – Protect in place and maintain contributions to and from feature, to be incorporated into the NHS. Channel adjustments may be permitted at select locations given sufficient rationale, and as approved by Regulatory Agencies.
- **Conservation feature** (yellow features) –Realignment permitted provided important ecological functions are maintained, including linkage functions if the existing feature provides a linkage function. Conservation features providing important linkage functions may be incorporated into the NHS.
- **Mitigation feature** (green features) – maintain function to downstream features. These features are typically highly modified but provide some downstream function (e.g. supply of sediment and/or water, or seasonal fish habitat). Some complexities like the function of tile drains, where important, can be replicated through LID practices, swales, or other SWM, while fish habitat may be replicated within another nearby feature, or downstream in the floodplain (e.g. pond creation).
- **No management required** (green-dashed features) – feature can be removed from the surface without any implication to the system.

Drawing FG-2 presented the final HDF management recommendations in relation to the land use plan. Full HDF management recommendations for the study area are available in Appendix G.

Some drainage features have been identified as requiring additional evaluation at the MESP stage as access (i.e. Permission to Enter) for certain locations was not available during the Subwatershed Study process, or because additional environmental study (e.g. wetland evaluations) are required to confirm and/or update their management recommendation. These features are identified in Appendix G, and Drawing FG-2.

5.5 Natural Heritage System

The proposed Smithville NHS has been identified based on a review of existing provincial, regional, and municipal policy and integration of field work conducted as part of the SWS. The Smithville NHS is comprised of Core Areas, Conceptual Buffers, Linkages, and Recommended Restoration Areas, as identified on Map NH-11. Core Areas are comprised of Significant Wetlands, Significant Woodlands, Significant Valleylands, SWH, fish habitat, and habitat for endangered and threatened species. Although there is flexibility in the precise identification of Linkages, Buffers, and Restoration Areas, the size of these as identified through this SWS is required to come close to the 30% cover target aspired to in the Township OP, as well as recommended through this SWS. As recommended in this SWS, buffers are generally recommended to be 30m wide (refer to Section 4.6.1, Conceptual Buffers). Linkages within the study area are generally mapped as Primary Linkages (200m wide) and Secondary Linkages (50m wide). High constraint watercourses typically require a buffer of 30m, thereby leading to a 60m wide Linkage. The proposed Smithville NHS is shown on Map NH-12.

Additional areas may be added to the Smithville NHS through site specific study, as in the further identification of SWH or habitat for SAR, and the integration of small wetland units, karst, floodplain, or erosion hazard sites. It is recommended that compatible land uses be situated next to the Smithville NHS that will contribute to the protection of natural heritage features and the overall enhancement of the natural environment within the community. For instance, locating stormwater management facilities, LID practices, parks, and schools next to the Smithville NHS can provide opportunities to enhance the NHS even further, while also providing the public with access to natural areas for their enjoyment, recreation, and nature appreciation. The Smithville NHS provides an opportunity to design the proposed development in an environmentally sensitive way that mitigates climate change, protects and enhances the natural heritage features, and benefits the adjacent development.

It is recommended that buffers, Linkages, and Restoration Areas (Map NH-11) be naturalized. Naturalization can occur through active restoration of these areas by planting and seeding of native species. Through the development approval processes, it is recommended that detailed planting plans be established for the restoration of these areas adjacent to the proposed development. It is recommended that the active agricultural areas identified for restoration be graded appropriately and amended with additional topsoil. A variety of habitats may be restored, depending on the adjacent natural areas, such as woodlands, wetlands, or watercourses, as well as providing some meadow and thicket habitats. Providing habitat for significant species should be considered. For instance, Milkweed should be included in most seeding plans to benefit Monarch butterfly. Native seed mixes should be used along with plantings in a range of sizes (caliper stock, whips, plugs). As noted, it is recommended that the Linkage aligned with the hydro corridor be naturalized in a similar fashion to The Meadoway (TRCA 2019).

A trail network should be considered at the outset of development. Creating a network of trails within the Smithville NHS, especially within the buffer areas, will provide residents with walking trails at the outset, which will discourage the creation of ad hoc trails. Trails will foster nature appreciation and allow for passive recreation opportunities, which is part of a sustainable community.

The Smithville NHS must be managed and maintained, which includes stewardship and management opportunities such as the following:

- Controlling access to the NHS. Rear yards backing on to the NHS should be fenced.
- Establishing a trail network through the NHS will provide for recreational opportunities and discourage footpaths and dumping.
- Removal of invasive species and control of invasive species in the future.
- Removal of trash and debris, including farm dump sites of vehicles, fencing, and farm implements.
- Nature interpretive signs for education purposes, especially along trails.
- Nest box installation for birds and bats.
- Restoration of buffers, Linkages, and Restoration Areas.
- Naturalization and stewardship of school yards, as these may be linked to the Smithville NHS in the future and will foster an appreciation of nature in children, as well as provide physical and psychological benefits.

Future studies may refine the proposed Smithville NHS by identifying additional natural heritage constraints, identifying appropriate buffers, and refining restoration areas. However, the Smithville NHS proposed through this study provides the Township with the direction it needs to create and maintain a robust, sustainable NHS that will protect and enhance existing natural heritage features, provide climate change resiliency, and provide residents with the "green" system they desire.

5.6 Climate Change

In 2014, the Intergovernmental Panel on Climate Change (IPCC) stated that "warming of the climate system is unequivocal" (IPCC, 2014). Evidence of Climate Change has amassed since that time, in the form of observed increases in temperature, rising sea levels, loss of snow and ice, and shifting precipitation patterns at the global scale. Recently, the Government of Canada issued a National Issues Report specifically related to the impacts and adaptation issues. Observed evidence of Climate Change impacts to Canada's water cycle include: melting ice, thawing permafrost, shorter duration of snow cover; increasing precipitation and a transition from snow to rain; changes in the timing of water availability; and changes in the nature of extreme events. It is projected that these impacts will impact Canada's water cycle, resulting in reduced water availability in southern basins, particularly in the summer, increasing the frequency and intensity of water-related extremes, and reducing water quality and more harmful algae blooms. Some specific impacts of anticipated changes to Canada's water cycle as a result of Climate Change are:

- Increased nutrients in water systems and incidences of harmful algae blooms.
- Increased risk that less water would be available during hotter months for energy and food production.
- Disruption to operating seasons, farming and industrial operations, and natural patterns for ecosystems.
- Increased flood events.
- Damaged infrastructure and increases operating costs.
- Increased property and casualty insurance payments.

It is widely accepted that, as warming increases, climate-related risks and impacts also increase. Higher rates and amounts of warming make it more difficult for adaptation actions to offer sufficient protection against these impacts. Consequently, significant impacts would remain despite the implementation of adaptation measures, thus limiting the effectiveness and potential of achieving adaptation. The limitations to adaptation are reached when there are no longer any practical or feasible adaptation options available, requiring that otherwise unacceptable risks must be accepted, adaptation objectives must be abandoned and/or transformation and "last resort" measures, such as relocation or retreat, must take place.

Within Niagara, the Region's Background Study Report (2019) states ""climate change is expected to result in increased variability in extreme local weather events (e.g. heavy rains and prolonged droughts) that will affect natural features, ecological functions and natural processes" and states "municipalities need to consider the potential impacts of climate change as part of natural environment planning in order to better protect the natural environment system and reduce economic costs (e.g. flood damage, effect of drought on crops, etc.)". The anticipated impacts of climate change within Niagara Region, as identified by the Region, include:

- Increase in annual average temperature
- Trend towards more days with temperatures over 30°C and more heat waves of 3 or more consecutive hot days
- Longer growing season, with May and September significantly warmer
- Increase in average number of frost-free days
- Increased numbers of freeze-thaw cycles
- Small increase in annual precipitation, with most of the increase coming in winter
- More rain and less snow in winter
- More summer droughts and dry spells
- Increase in heavy rain events.

Although the specific magnitude of impact/change remains uncertain, the anticipated impacts noted above are supported by observations and analysis and result in significant economic and health impacts.

There are important linkages between actions that reduce greenhouse gas (GHG) emissions (climate change mitigation) and actions that build resilience to deal with climate change impacts (adaptation). Co-benefits and synergies between adaptation and mitigation decisions - referred to as sustainable "win-win" approaches - can be obtained for actions that have both adaptation and mitigation objectives. These co-benefits and synergies include the use of nature-based approaches to adaptation in cities to create urban environments that are more resilient to heat waves (reducing associated health impacts) and to intense rainfall (reducing associated flooding), while also sequestering carbon and reducing energy demand. As well, it is recognized that risk trade-offs can emerge from particular actions that are designed to meet only one objective (adaptation or mitigation), but that can adversely affect the other objective, such as certain adaptation decisions which can result in an increase in GHG emissions (e.g., the increased use of air conditioners during heat events) as well as certain mitigation choices which would increase local vulnerability or risk (e.g., the increased exposure of the electricity grid to water supply shortages, which could result from expanded use of hydro-electricity). As a general practice and preference, priority should be given to minimizing or avoiding these negative consequences when planning actions to respond to climate change.

Niagara Region's proposed Official Plan policies (2022) address climate change, particularly Section 3.5. The policies "recognize the important role the Natural Environment System plays in mitigating the impacts of climate change by protecting and enhancing natural features, ecological and hydrological functions, and connections and linkages within the system."

Proposed tools include:

- a Regional Greening Initiative to restore and enhance vegetative cover that sequesters carbon to mitigate climate change
- protecting and enhancing the ecological integrity and biodiversity
- maximizing vegetation and promoting tree planting
- integrating climate change considerations into planning for parks, open space and trails, including opportunities for tree planting and low impact development

- integrating green infrastructure and low-impact development into the design of infrastructure, public works projects, public service facilities, and private development

The management recommendations presented in this Subwatershed Study are recognized to address requirements to mitigate impacts of climate change as follows:

- Incorporating Green Infrastructure (i.e. LID BMPs) into stormwater management plan to promote resiliency and enhance stormwater quality, erosion, and quantity control.
- Provision of green spaces (i.e. parks, wetlands) which reduce heat effects and provide additional opportunities for incorporating Green Infrastructure into development.
- Planning for robust Natural Heritage System, including linkages and enhancement areas, which actively reduces harmful greenhouse gas emissions, mitigates heat effects from urban development, and maintains water budget.

6.0 References

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Appendix A

Comments Response Matrix

Appendix B

Correspondence

Appendix C

Meeting Minutes

Appendix D

Surface Water Hydrology (Impact Assessment)

Appendix E

Surface Water Hydrology (Stormwater Management Plan)

Appendix F

Surface Water Hydraulics

Appendix G

Stream Morphology

Appendix H

Natural Heritage System Background Information