2.0 NATURAL ENVIRONMENT

2.1 Fisheries and Aquatic Ecosystems

2.1.1 Field Investigations

This Chapter outlines the specific field investigations and analyses undertaken to augment the information gathered previously during the planning phases and reported in the *Highway 7 & 8 Transportation Corridor Planning and Class EA Study- Report F (Part 1): Working Paper- Environmental Conditions and Constraints* (July 2007;TSH). Included in this analysis is a description of the existing fish and fish habitat conditions and sensitivity at each watercourse crossing.

The overall objective of the fish and fish habitat work was to ensure that fish and fish habitat, and particularly significant and sensitive features, were comprehensively identified and integrated during development and evaluation of alternatives. The fish and fish habitat related objective during the generation of alternatives is to ensure that alternatives avoid or minimize potential impacts to aquatic features, and particularly sensitive and high quality features, to the extent possible while still meeting the technical planning design objectives and requirements. Since the watercourse features generally drain perpendicular to the alignment options, many must be crossed by any given alternative.

Under the MTO/DFO/MNR Fisheries Protocol (2006), MNR has a role in interpreting the sensitivity of fish and fish habitat. Prior to conducting field investigations, existing fisheries information was obtained from MNR and the Conservation Authorities. Included in this exercise was a request to MNR for fish and fish habitat sensitivity of watercourses within the study area. Although fisheries data was obtained from these resource agencies, fish and fish habitat sensitivity was not available for the specific reaches of interest. For this reason, the preliminary determination of fish and fish habitat was made by fisheries assessment specialists based on a review of the recent field data collected in the vicinity of most watercourse crossings along the preferred corridor.

Field investigations were completed, where feasible based on property access, to ensure the database was sufficiently detailed to address any gaps in the fisheries data.

Fish habitat assessments and qualitative community sampling was conducted (where applicable) at each sampling station. Sampling sites were selected based on proximity to the center of the corridors on the “short list” and the availability of access. For this reason, many of the sites used to determine habitat sensitivity were located beyond the limits of the preferred corridor.

As the purpose of this sampling was to collect fish and fish habitat information to support a preliminary determination of sensitivity, sampling sites were identified according to the Ontario Stream Assessment Protocol (OSAP) protocol (MNR, 2005). Where possible, a sampling site was generally defined as a section of stream at least 40 m long, beginning and ending at crossover points and including at least one riffle-pool sequence. MTO Field Collection Forms were completed for each station unless they were dry, or if sites were swales (i.e., lacked riffle-pool sequence), isolated pools, ponds and/or wetlands. In addition, habitat features at each site were mapped and photographed.

Where historical fish community data was not available or was greater than five years old, fish collections were completed where possible (i.e. permission to enter was obtained and water was present). Streams were electrofished (where conditions allowed) and open water was sampled using seine nets, hoop nets and/or minnow traps. Not all open water features were sampled: open water deemed agricultural, landscaped, isolated (no direct connection to fish habitat) were not sampled. At open water sites where inflow and/or outflow was occurring, the inflow or outflow were electrofished rather than sampling the pond itself. Also, areas that were "wet" but did not contain substantial amounts of open water were not sampled. These areas are more appropriately evaluated as terrestrial resources using Ecological Land Classification (ELC) rather than through aquatic sampling techniques.

In addition to fish collection, all sites where water was present were visually inspected for mussels. Live mussels were photographed and replaced while empty shells were collected, bagged and brought back for reference.

2.1.2 Assessment of Sensitivity

The application of the evaluation criteria to determine sensitivity of aquatic resources was undertaken using the *MTO/DFO/MNR Protocol for Protecting Fish and Fish Habitat on Provincial Transportation Undertakings* (MTO 2006). This protocol uses the risk management framework developed by Fisheries and Oceans Canada (DFO). This process requires the determination of fish and aquatic habitat sensitivity using the attributes prescribed in the risk management framework. It is anticipated that sensitivity ratings may be further refined, through further consultation with MNR and additional field work, once the preferred new route and widening alternatives are selected.

This preliminary determination of sensitivity generally followed Section 5 of the Guide and DFO's Risk Management Framework using these attributes and encompassing fish species and habitat and their interrelationships and dependencies, to the extent that these were known at the time. Using the habitat information that was obtained through secondary source material and field investigations, each site was evaluated according to the following four indicators: 1) species sensitivity; 2) species dependence on habitat; 3) rarity of habitat/species; and, 4) habitat resilience. The basis of this evaluation is outlined below in **Exhibit 2-1**.

Exhibit 2-1:
Fish and Aquatic Habitat Indicators and Associated Sensitivity Rating System

Assessment	Attribute
Species Sensitivity	➤ **N/A** • Not applicable/No fish present ➤ **Tolerant** • Resilient to change • Generalist fish community (e.g., most minnows) ➤ **Intermediate** • Ability to withstand some environmental change • Most warmwater fish communities (e.g., bass, pike) ➤ **Intolerant** • Highly sensitive to change and perturbation • Certain warmwater fish communities (e.g., redhorse) • Cool or Coldwater fish community (e.g., brook trout, brown trout)
Species Dependence on Habitat	➤ **N/A** • Not fish habitat ➤ **Contribute to fish habitat downstream** ➤ **Seasonal** ➤ **Feeding/rearing habitat** ➤ **Spawning/Critical to survival**
Rarity	➤ **Common** • Habitat/species is/are prevalent ➤ **Uncommon/Limited Distribution** • Habitat/species is/are confined to small areas ➤ **Special Concern/To Be Listed/Species At Risk Act** • Rare • Species is listed as Special Concern by COSEWIC[1], is protected by the Species at Risk Act or is to be listed on the Species at Risk Act in the near future
Habitat Resiliency	➤ **N/A** • Thermal regime unsuiExhibit to any fish species, and/or • Highly altered, and/or • Insufficient flow to support direct fish use ➤ **Low Susceptibility** • Warmwater systems suitable for cyprinids, and/or • Species present are resilient to change and perturbation (e.g., many cyprind species) ➤ **Moderate Susceptibility** • Coolwater and/or coldwater systems that can buffer temperature changes, and/or • System is somewhat suitable and resilient to change and perturbation ➤ **High Susceptibility** • Coldwater systems which cannot easily buffer temperature changes, and/or • System not resilient to change and perturbation

Note: 1. COSEWIC – Committee on the Status of Endangered Wildlife in Canada

The recommended preferred corridor crosses two primary watersheds, encompassed within the jurisdictions of the Grand River Conservation Authority (GRCA) and the Upper Thames River Conservation Authority (UTRCA). Within these two larger watersheds the preferred corridor crosses six watercourses located in the Grand River watershed and 18 watercourses located in the Upper Thames watershed for a total of 24 watercourse crossings (**Exhibit 2-2**).

Each watershed is briefly described below, providing a general discussion of major watercourses and tributaries, stream thermal classification and the fish and fish habitat sensitivity within the corridor.

2.1.3 Grand River Watershed Fisheries and Aquatic Ecosystem Conditions

The analysis area covers two sub-watersheds within the Grand River watershed, the Nith River, and Horner Creek.

The Grand River is the largest inland river system in southern Ontario and the largest tributary flowing into Lake Erie on the Canadian side. The Grand River is approximately 300 km long. It flows from the headwaters near Dundalk to Port Maitland, where it empties into Lake Erie. The Grand River watershed is about 6,800 km^2.

The Grand River has been designated a Heritage River by the Canadian Heritage Rivers System (CHRS). The Grand River is an extremely valuable resource with over 82 species of fish in the watershed. This number is more than 50% of all the fish species found in Canada. The Grand River is a high quality fishery supporting significant populations of sport fish such as northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieu*), and walleye (*Sander vitreus*). The river also supports a seasonal run of migratory rainbow trout (*Oncorhynchus mykiss*) from Lake Erie upstream to the Caledonia dam, well downstream of the analysis area.

Many of the Grand River tributaries contain high quality, self-sustaining coldwater salmonid populations. Brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) are found in various tributaries throughout the analysis area. The cold-water tributaries that support the native brook trout are fed primarily from groundwater discharge areas, both as diffuse seepages and by point source springs (MNR/GRCA 1998).

2.1.3.1 Nith River

The Nith River enters the Grand River at the town of Paris and forms the western boundary of the Grand River watershed. The Nith River and its main tributaries, Wilmot and Silver Creek, are predominantly warmwater fisheries that support resident warmwater sport fish and migratory rainbow trout. However, within the analysis area the Nith River, and Wilmot Creek are designated as cool water fisheries. This designation is supported by the gravelly deposits and sandy tills within the analysis area that would provide groundwater discharge. The New Hamburg Dam, located in the town of New Hamburg, is a warmwater fishery and has a fishway for fish migration.

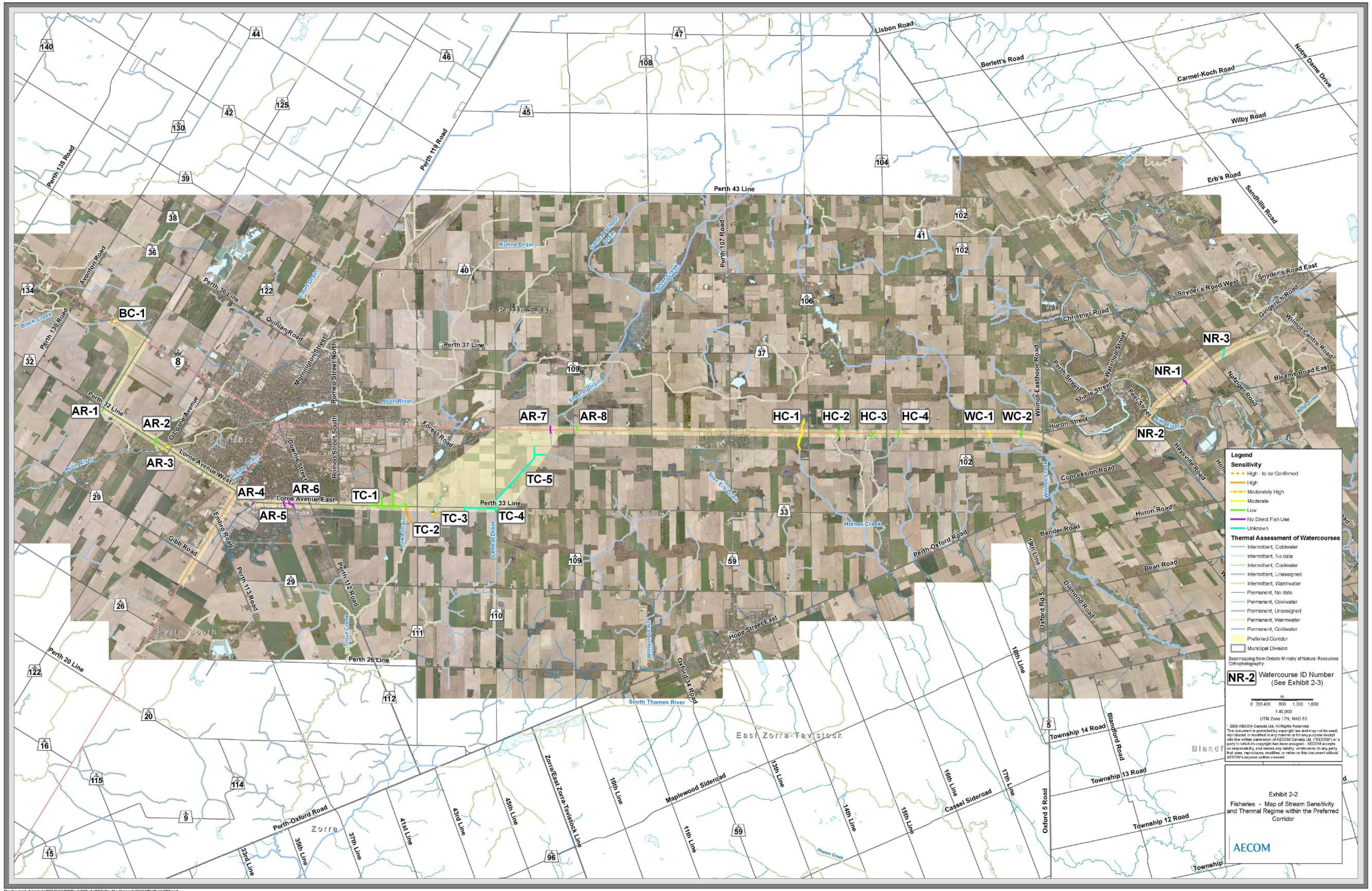
BC-1
AR-1
AR-2
AR-3
AR-4
AR-5
AR-6
AR-7
AR-8
TC-1
TC-2
TC-3
TC-4
TC-5
HC-1
HC-2
HC-3
HC-4
WC-1
WC-2
NR-1
NR-2
NR-3
Legend
Sensitivity
High - to be Confirmed
High
Moderately High
Moderate
Low
No Direct Fish Use
Unknown
Thermal Assessment of Watercourses
Intermittent, Coldwater
Intermittent, No data
Intermittent, Coolwater
Intermittent, Unassigned
Intermittent, Warmwater
Permanent, No data
Permanent, Coolwater
Permanent, Unassigned
Permanent, Warmwater
Permanent, Coldwater
Preferred Corridor
Municipal Division
Basemapping from Ontario Ministry of Natural Resources Orthophotography
NR-2 Watercourse ID Number (See Exhibit 2-3)
m
0 200 400 800 1,200 1,600
1:40,000
UTM Zone 17N, NAD 83
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Exhibit 2-2
Fisheries - Map of Stream Sensitivity and Thermal Regime within the Preferred Corridor
AECOM

Summary statements regarding the six watercourses are provided below

- Of the six watercourse crossings within this watershed, one has been classified as having High fish and fish habitat sensitivity, with both Brown trout and Rainbow trout present historically, one as moderate sensitivity, with SAR mussel species presence at least historically, one as low sensitivity, and the last two either with no direct fish use or unknown sensitivity.

- The main reach of the Nith River (NR-2) crossed by the preferred corridor is classified as high sensitivity as historically brown trout and rainbow trout have been caught here (MNR, 2000-2001). Currently the river in this section supports permanent flow and resident baitfish use. The New Hamburg Dam fishway is located approximately 2.4 km upstream.

- The reach classified as moderate sensitivity (Wilmot Creek, WC-1) crossed by the preferred corridor is classified as a permanent coolwater system with evidence of groundwater discharge (presence of watercress throughout stream reach). The habitat consists of gravel/cobble substrates with emergent vegetation throughout the reach. Fish species known to be present in this reach are moderately sensitive baitfish species. There are also mussel species listed under SARA located within Wilmot Creek but not within the limits of the preferred corridor. .

- The tributary of Wilmot Creek (WC-2) crossed by the preferred corridor is classified as low sensitivity. It supports intermittent flow, with disconnected and isolated pools and possibly used as a migratory corridor by warmwater baitfish community. The reaches through the main ROW are surrounded by agricultural use, and during low flow conditions the lip of the culvert acts as a barrier to fish passage.

- The three remaining tributaries of the Nith River (NR-1, NR-3 and NR-4) are grassy drainage swales which support intermittent or ephemeral flow with unknown or no direct fish use. These features are poorly or variably defined with limited to no morphological development and fine substrates, with mixed, typically cultural riparian cover.

2.1.3.2 Horner Creek

Coldwater streams are present in this sub-watershed, some of which serve as nursery areas for game fish. Within the analysis area the main channel of the South Branch is designated a warmwater fishery, while the smaller headwater streams are coolwater fisheries.

Summary statements regarding the four watercourses are provided below

- Of the four watercourse crossings within this watershed, one has been classified as having moderate fish and fish habitat sensitivity, while the remaining three as low.

- The tributary of Horner Creed (HC-1) crossed by the preferred corridor, is classified as moderate. The stream is classified as a permanent, coolwater system, with evidence of groundwater discharge (watercress present) throughout the reach. The stream supports a baitfish community, with cobble and gravel substrates and abundant stream shading.

- The two reaches classified as low sensitivity (HC-2, and HC-3) crossed by the preferred corridor are classified as permanent coolwater systems with evidence of groundwater discharge (presence of watercress) at HC-4. Both systems support a baitfish community. The last reach (HC-4) crossed by the preferred corridor is classified as low sensitivity. This system is an intermittent coolwater system that supports a baitfish community. Substrates consist of cobble and gravel with highly vegetated banks.

2.1.4 Thames River Watershed Fisheries and Aquatic Ecosystem Conditions

The Thames River is the second largest watershed in southern Ontario and one of Canada's most southern watercourses. It is approximately 273 km long and drains approximately 5,285 km^2.

The post-glacial landscape, the dynamic physical features, fluctuating water levels, pools and riffles, high nutrient levels, the presence of both coldwater and warmwater streams contribute to the river's biological diversity (Cudmore *et al*., 2004). The Thames River has been designated a Heritage River by CHRS. The Thames River and its many tributaries are rich in aquatic life, with approximately 90 species of fish and 30 species of freshwater mussels. This assemblage constitutes 58% of all the fish species found in Canada.

The Thames River is divided into three major branches: North, Middle, and South. Sub-watersheds of the North and South branches in the Upper Thames watershed are located within the analysis area. The South branch arises to the west of Tavistock, continues through Woodstock and then converges with the North Thames branch in London at the Forks of the Thames. The North branch originates north of Mitchell, in London at the Fork of the Thames. The Middle branch arises southwest of Tavistock and joins the South branch near Thamesford.

Above the Forks of the Thames (North, South and Middle branches) the river is called the Upper Thames. The river below the Fork of the Thames is known as the Lower Thames. The river flows in a southwesterly direction to Lake St. Clair, which drains into Lake Erie.

To date, 72 of the 90 fish species recorded in the Thames River have been recorded in the Upper Thames watershed. Seven fish species and six mussel species that are designated Species-at-Risk are found in the Upper Thames sub-watersheds that are within analysis area.

Three sub-watersheds within the North Branch (2GD05) are located within the analysis area. These are: Avon River (2GD09), Trout Creek (2GD08), and Black Creek (2GD10).The North Woodstock (2GB01) sub-watershed in the South Branch of the Upper Thames watershed is also located within the analysis area.

2.1.4.1 Thames River - North Branch

The North Branch of the Thames River is comprised of a variety of coolwater and warmwater streams. The North Branch watershed occupies two small portions of the southwest corner of the analysis area. Three main tributaries of the North Branch watershed are within the analysis area: Avon River, Trout Creek, and Black Creek.

The Avon River traverses the town of Stratford and vast agricultural land before entering the North Branch near St. Marys, outside the analysis area. The main channel of the Avon is designated a warmwater fishery. However, there are smaller headwater streams that are coolwater fisheries. Coldwater streams have also been identified in the Avon River watershed. There have been 34 species of fish recorded in the Avon watershed including smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*).

Summary statements regarding the eight Avon River crossings are provided below:

- The reach of the moderately high sensitivity (AR-3) stream crossed by the preferred corridor is classified as a permanent warmwater system. Historical fish records indicate a high diversity of fish species, including the Greenside darter (*Etheostoma blennioides)* which is listed as Special Concern under the Species at Risk Act (SARA).
- The reaches of the low sensitivity watercourses (AR-1 and AR-2) crossed by the preferred corridor are tributaries to the Avon Creek. Both channels are surrounded by agricultural areas and have been channelized. They are dominated by grasses and consist of gravel and fine substrates. Fish community information is not known at this time, further investigation is required.
- The preferred corridor crosses three drains (AR-4, AR-5 and AR-6) that are classified as no direct fish use.

Trout Creek is predominantly a warmwater system. Stream conditions are variable with some healthy coldwater streams that are known to support brook trout populations, along with degraded channelized watercourses upstream of Wildwood Reservoir (Maaskant, 2001).

Summary statements regarding the five Trout Creek crossings are provided below:

- The main reach of Trout Creek was classified into two different sensitivity classifications (TC-1 and TC-2) . There are two grassy, modified channels which serve as agricultural drainage that flow into a ditch that runs parallel with Perth Line 33. These two channels supply water to the downstream reach of Trout Creek. This area was classified as low for this reason. The channel then crosses under the road and becomes a permanent warmwater system. During the fish survey at AECOM station UT-13 (downstream approximately 2.6 km), one juvenile Northern pike (*Esox lucius*) was captured. This reach of Trout Creek was classified as moderately high sensitivity, due to its contribution to downstream habitat.
- The reach of the Trout Creek tributary (TC-3) crossed by the preferred corridor supports feeding/rearing habitat for Northern pike. The tributary is classified as intermittent coolwater system, with evidence of groundwater discharge (watercress present). The tributary is

straightened with substrates consisting of clay with silt bottom which is heavily vegetated. For these reasons the tributary is classified as moderate sensitivity.

- Two tributaries of Trout Creek (TC-4 and TC-5) have been classified as unknown. Further investigation is required.

Black Creek originates in the Ellice Swamp, north of Stratford, and extends through the town of Sebringville before flowing into the North Branch of the Thames River. Black Creek is a warmwater fishery with known smallmouth bass (*Micropterus dolomieu*) and rock bass (*Ambloplites rupestris*) populations. Much of the subwatershed's headwater area is comprised of degraded channelized watercourses.

Summary statements regarding the one Black Creek crossing are provided below:

- The reach of the Black Creek tributary (BC-1) that is located with the preferred corridor is classified as High sensitivity-to be confirmed. This watercourse crossing was an additional extension of the Highway 7 & 8 corridor after the initial field investigation was completed. This stream is classified as permanent coldwater (based on MNR stream classification) with evidence of groundwater discharge (watercress present). Fish community information is not known at this time, further investigation is required.

A summary of watersheds and the associated fish and fish habitat sensitivities of the watercourses are presented in **Exhibit 2-3**.

Exhibit 2-3
List of Watersheds and the Watercourses Crossed by the Preferred Corridor

	Name of Watercourses	Sensitivity
Grand River	Tributary of Nith River- NR-1	No direct fish use
	Nith River – NR-2	High
	Tributary of Nith River – NR-3	Unknown
	Wilmot Creek - WC-1	Moderate
	Tributary of Wilmot Creek-WC-2	Low
	Tributary of Horner Creek – HC-1	Moderate
	Tributary of Horner Creek – HC-2	Low
	Tributary of Horner Creek – HC-3	Low
	Tributary of Horner Creek – HC-4	Low
Upper Thames	Black Creek –BC-1	High-to be confirmed
	Tributary of Avon River – AR-1	Low
	Tributary of Avon River –AR-2	Low
	Avon River – AR-3	Moderately high
	Tributary of Avon River – AR-4	No direct fish use
	Tributary of Avon River – AR-5	No direct fish use
	Tributary of Avon River – AR-6	No direct fish use
	Sheerer Drain-Tributary of Avon River – AR-7	No direct fish use
	Sheerer Drain-Tributary of Avon River – AR-8	Low
	Lowe Drain-Trout Creek - TC-1	Low
	Lowe Drain-Trout Creek – TC-2	High
	Lowe Drain-Trout Creek – TC-3	Moderately high
	Central Drain-Trout Creek - TC-4	Unknown
	Central Drain-Trout Creek - TC-5	Unknown

2.1.5 Significance and Sensitivity

Species are designated 'at risk' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The Minister of Environment then determines if legal protection under the Species at Risk Act (SARA) is warranted.

Based on the SAR mapping provided by Fisheries and Oceans Canada (DFO) seven fish species and seven mussel species that are designated Species At Risk (SAR) were identified in both the Grand River subwatershed and the Upper Thames watershed. Based on the compilation and review of existing studies and the field work completed during this study, none of these SARA species are known to occur within the study area.

There are two species of mussels (Maple leaf and Rainbow mussels) that are designated "To be Listed" within one year that are found within Wilmot Creek. Several live mussels that were found within the study area, were photographed, field identified, and returned to the stream. None of the mussels were identified to be any of the soon "To be Listed" mussel species. At the time of the survey (August 2008) these mussels were not listed, this will need to be revisited to confirm their absence from the creek.

The Natural Heritage Information Centre (NHIC) assigns 'S ranks' or sub-national (provincial) ranks to set protection priorities for rare species and natural communities in Ontario. All fish species captured were ranked S4 or S5, which indicates secure communities.

Greenside darter (*Etheostoma blennioides)* is listed as S3 species, which indicates that the Species is of Special Concern in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation. The Greenside darter has previously been found (UTRCA, 2002) in Avon Creek approximately 800 m north of the Highway 7 & 8 corridor but was not recovered within the study area during any recent collection efforts for this study.

Based on the results of the overall sensitivity analysis of the stream crossings for the preferred corridor, each site was rated unknown, no direct fish use, low sensitivity, moderate sensitivity, moderately high or high sensitivity. An overall summary is presented in **Exhibit 2-4** and each site is presented on **Exhibit 2-2**. It is important to note that if necessary, this initial sensitivity analysis will be refined after preferred highway alignment has been chosen and additional detailed field work along the proposed alignment is completed.

Exhibit 2-4: Summary of Overall Fish and Fish Habitat Sensitivity

Overall Sensitivity	Number of Sites
Unknown	4
No direct fish use	5
Low	8
Moderate	2
Moderately high	2
High	2
High- to be confirmed*	1
Total	**24**

2.2 Terrestrial Ecosystems

2.2.1 Wildlife

2.2.1.1 Birds

Methodology

Breeding bird surveys were conducted on June 5, 2009. Late May to early July is the time when most songbirds sing and can be readily identified by their song. Non-songbird species are also on territory at this time. Bird surveys are conducted from 5:30 to 11:00 am. Weather conditions were clear sky, wind calm to Beaufort Scale 1 and temperatures were 12 to 18° C. Since lands are private where permission to access had not been obtained, surveys were conducted primarily from roadsides and within rights of way. Conducting two surveys at the same location increases the likelihood of obtaining a complete record of breeding species present and a second visit is planned.

Surveys were conducted along areas where woodlots, wetlands or successional habitat occurred generally within 100 m either side of the proposed highway alignment (which in most areas is the existing Highway 7&8). Agricultural fields, gardens, hedgerows, very narrow strips of natural habitat along creeks, and most patches of meadow and thicket were not surveyed. These habitats typically contain common, disturbance-tolerant species. The surveyor is within about 100 m of habitat which is the distance at which most bird song can be heard. Birds were primarily detected by song. Relative abundance is also recorded as part of this method. All birds seen or heard are recorded by location on an air photo and are assumed to be breeding unless they are:

- flying high above the site, or
- species known to forage far from breeding locations and no breeding habitat is identified. In this case, the species is recorded as foraging only.

Results

A total of 45 bird species were encountered during the breeding bird survey (see **Appendix A**). This is a moderate species richness consisting primarily of birds which are adapted to human altered landscapes or that can survive in small and isolated habitat patches. All but three of these were assumed to be breeding species. The non-breeding species including Turkey Vulture (*Cathartes aura*), Ring-billed Gull (*Larus delawarensis*) and Great Blue Heron (*Ardea herodias*) were likely foraging in the area. Since surveys were generally not conducted within the woodlot interiors, it is likely a few additional species occur, particularly those whose calls do not carry far distances.

None of the species are considered to be Species at Risk, provincially rare or regionally rare species and none are indicated on the NHIC database for the corridor (2009)

The majority of the study area consists of active agricultural lands and small patches of natural habitat, mostly woodlots, and some wetlands. Woodlots are predominantly small and agricultural lands generally support few breeding birds. There is little field habitat of any size.

Regionally Rare Species

No bird status list is available for Perth County. Many of the species listed as uncommon in the Hamilton and Waterloo lists (21-200 pairs/element occurrence and 21-100 pairs/element occurrence, respectively) are shown in the species list are included for reasons such as area-sensitivity. For a few of the species listed as uncommon in Waterloo, there are likely more than 100 occurrences in the region (e.g. Ovenbird (*Seirus aurocapillus*), Scarlet Tanager (*Piranga olivacea*), American Redstart (*Setophaga ruticilla*).

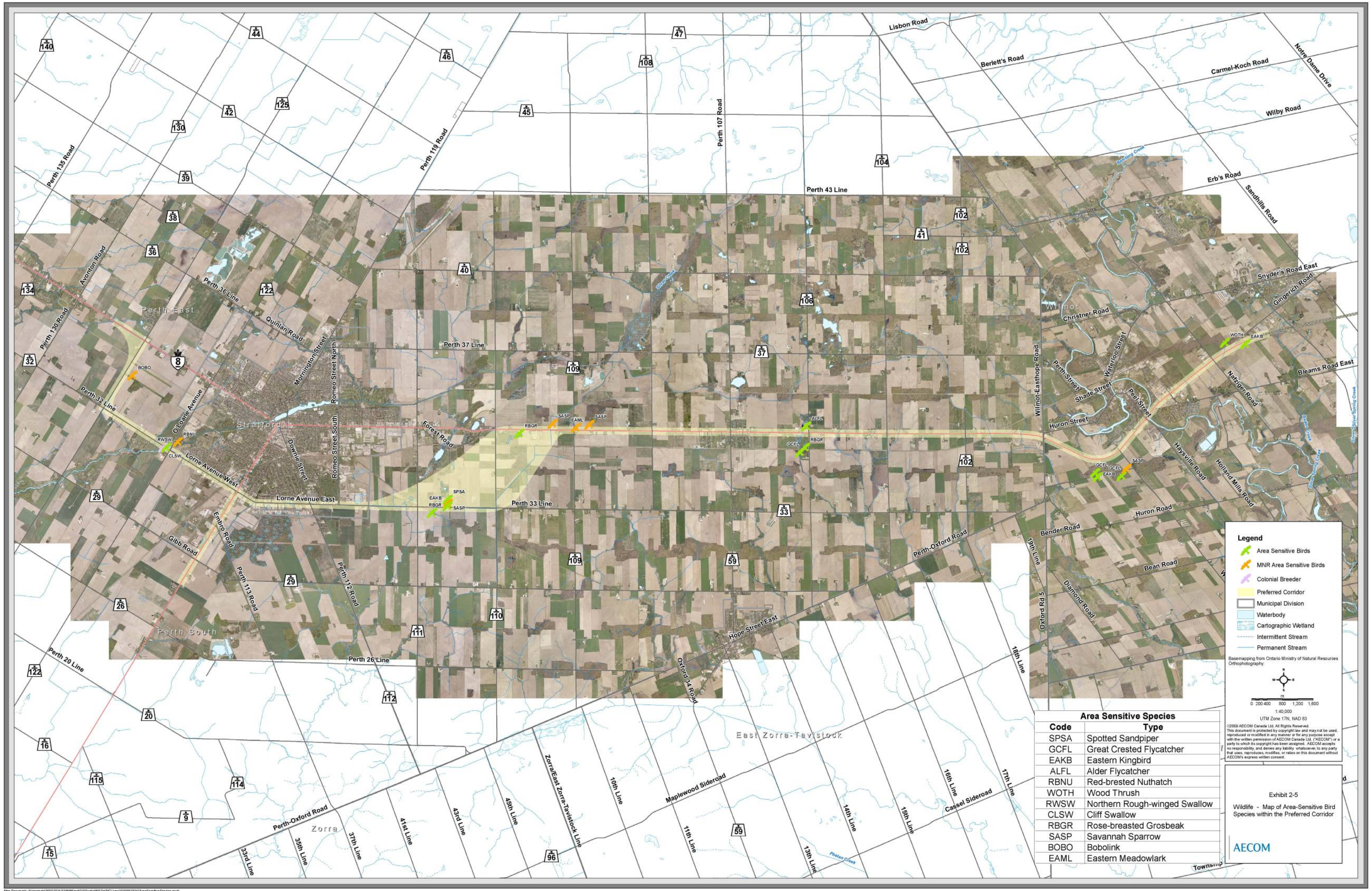
Forest Area-sensitive Species

Only four species of area-sensitive species as recognized by MNR (20000) were recorded and three of those are grassland species: Eastern Meadowlark (*Sturnella magna*), Bobolink (*Dolichonyx oryzivorus*) and Savanna Sparrow (*Passerculus sandwichensis*) (**Exhibit 2-5**).None of the grassland areas encountered in the study area are very extensive. Although MNR considers Savannah Sparrow to be area-sensitive, we would consider it at the low end of sensitivity as it often is present in meadows of only a few hectares. The single Bobolink and Eastern Meadowlark were in small patches of field habitat.

The only forest area sensitive species was Red-breasted Nuthatch (*Sitta canadensis*). This is a coniferous species that often occurs in coniferous plantations. It too is at the low end of area sensitivity. It was recorded along the Avon River where some mature spruce and pines were present. This location was not a large tract of forest and the presence of only a single forest area-sensitive species indicates that this function is quite low, either require large patches of habitat to breed, or breed in higher densities in large patches. Ontario Ministry of Natural Resources (2000) is used as a reference for area-sensitive species. Generally, larger numbers of area-sensitive species in a forest patch indicate that the patch is of relatively high quality and is undisturbed. Low quality patches may be younger, may be a plantation, or may be disturbed by grazing, selective logging, trail-clearing or other human disturbances. Some other species encountered are considered area-sensitive species by some other authorities such as Freeman et al. have been recorded and these have been mapped on **Exhibit 2-5**. These include: Alder Flycatcher (*Empidonax traillii*), Eastern Kingbird (*Tyrannus tyrannus*) and Wood Thrush. These species have also been shown on **Exhibit 2-5**. There are disagreements over which species truly are area-sensitive, the MNR (2000) is more conservative and is what we consider most accurate.

Birds of Other Habitats

Bird communities in wetlands are generally of two types: swamps and open wetland bird communities. Birds of swamps tend to be similar to forest bird communities and have been discussed above.


Lisbon Road
Berlett's Road
Carmel-Koch Road
Notre Dame Drive
Wilby Road
Erb's Road
Sandhills Road
Snyder's Road East
Gingerich Road
Bleams Road East
Perth 43 Line
Perth 107 Road
Perth 119 Road
Perth 135 Road
Perth 130 Road
Perth 36 Line
Perth 37 Line
Perth 32 Line
Perth 33 Line
Perth 26 Line
Perth 20 Line
Avonton Road
Quinlan Road
Mornington Street
Romeo Street North
Romeo Street South
Downie Street
Ontario Avenue
Lorne Avenue West
Lorne Avenue East
Forest Road
Embro Road
Gibb Road
Perth 111 Road
Perth 112 Road
Perth East
Perth South
Stratford
Wilmot
Christner Road
Wilmot-Easthope Road
Perth Street
Waterloo Street
Shade Street
Peel Street
Huron Street
Nafziger Road
Haysville Road
Holland Mills Road
Huron Road
Bender Road
Bean Road
Diamond Road
19th Line
Oxford Rd 5
Perth-Oxford Road
Hope Street East
Oxford 34 Road
East Zorra-Tavistock
Zorra
Zorra/East Zorra-Tavistock Line
Maplewood Sideroad
Cassel Sideroad
Township
33rd Line
35th Line
37th Line
41st Line
43rd Line
45th Line
10th Line
11th Line
13th Line
14th Line
15th Line
16th Line
17th Line
18th Line
Legend
Area Sensitive Birds
MNR Area Sensitive Birds
Colonial Breeder
Preferred Corridor
Municipal Division
Waterbody
Cartographic Wetland
Intermittent Stream
Permanent Stream
Basemapping from Ontario Ministry of Natural Resources Orthophotography.
N
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1:40,000
UTM Zone 17N, NAD 83
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Area Sensitive Species
Code Type
SPSA Spotted Sandpiper
GCFL Great Crested Flycatcher
EAKB Eastern Kingbird
ALFL Alder Flycatcher
RBNU Red-brested Nuthatch
WOTH Wood Thrush
RWSW Northern Rough-winged Swallow
CLSW Cliff Swallow
RBGR Rose-breasted Grosbeak
SASP Savannah Sparrow
BOBO Bobolink
EAML Eastern Meadowlark
Exhibit 2-5
Wildlife - Map of Area-Sensitive Bird Species within the Preferred Corridor
AECOM

Birds of open wetlands include marsh birds such as rails, bitterns and Pied-billed Grebe, as well as Spotted Sandpiper (*Actitis macularia*), Swamp Sparrow (*Melospiza georgiana*), Red-winged Blackbird (*Agelaius phoenicus*) and waterfowl species including ducks, geese and swans. Virginia Rail (*Rallus limicola*) and Sora (*Porzana carolina*) are also shown as Species of Interest on Exhibits 10 to 17. Although they are fairly common in southern Ontario they are restricted to marsh areas.

Neither AECOM nor Ontario Ministry of Natural Resources has recorded any heron colonies in the study area.

Ten Cliff Swallow (*Petrocheldon pyrrhonota*) nests were noted under the Lorne Avenue Bridge over the Avon River, and several others appeared to be under construction. Approximately 25 birds were flying around the bridge. Some were observed gathering mud from the nearby edge of the river to build their nests. The Cliff Swallows are noteworthy in that they are a colonial species that that are nesting under the bridge and as such are generally afforded higher consideration for avoidance.

Significance and Sensitivity

Because of the low amount of fragmented habitat cover in the study area, the breeding bird community consists of species which are adapted to human environments and therefore not particularly sensitive. The area sensitive species which have been recorded are at the low end of sensitivity.

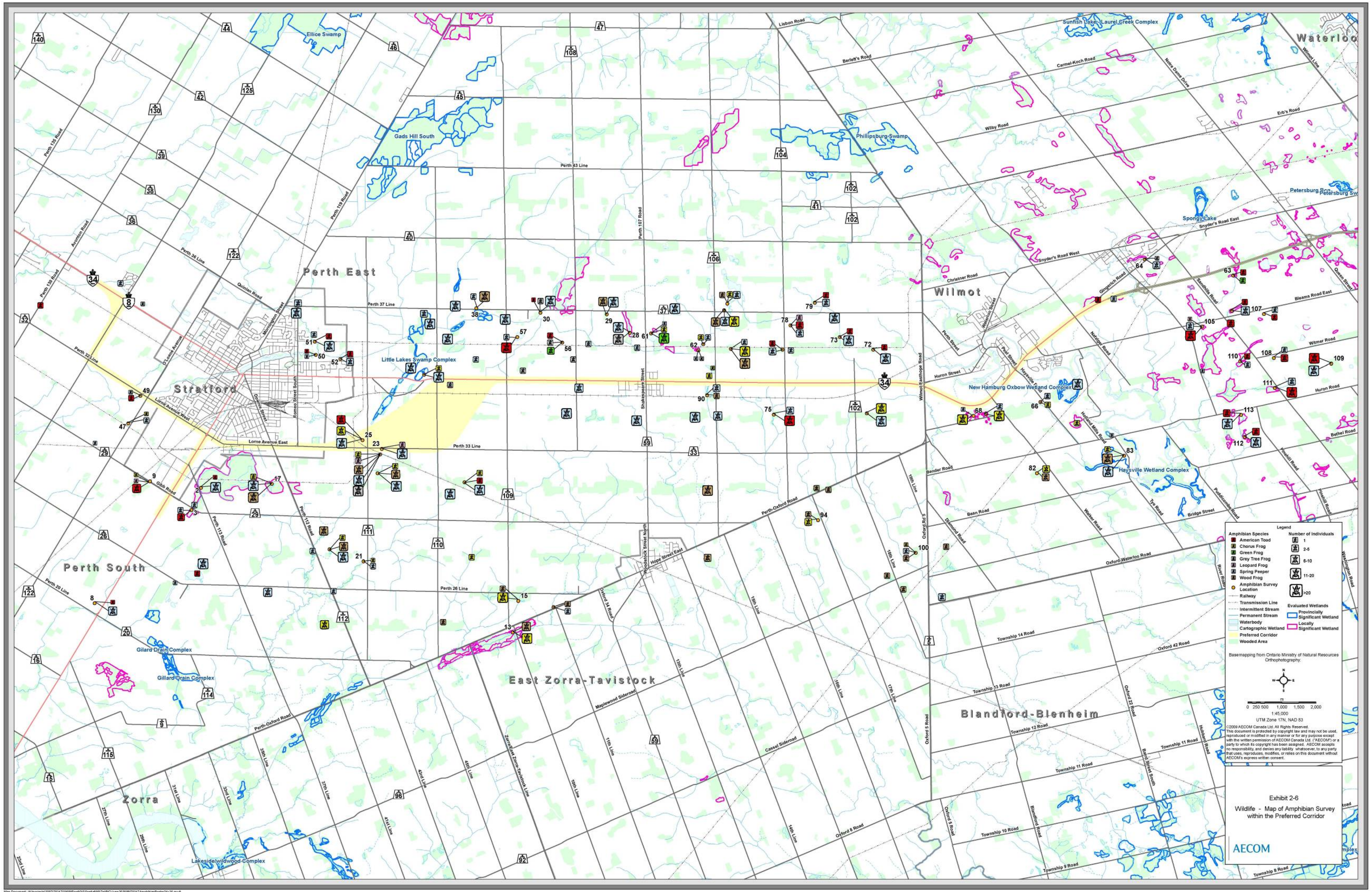
The Cliff Swallows are noteworthy in that they are a colonial species that is nesting under the bridge. Any work on the bridge that would disturb nesting, needs to occur outside the nesting season (May 1 to July 30), since the active nest are protected under the Migratory Bird Convention.

2.2.1.2 Amphibians

<u>Methodology</u>

Breeding frogs were assessed using an adaptation of the Environment Canada Marsh Monitoring Program method (Weeber, 2000). The study area was surveyed twice, once at the end of April 2008, and the second time in the middle of June 2008, using calling surveys. Further surveys were completed in the same time frame during 2009. Two surveys are needed in order to record species that call at different times of the year. Numbers of calling amphibians of each species were noted. Where numbers are not possible to estimate due to a large number of calling frogs a ‘chorus’ is recorded and approximate numbers are used. Approximate locations of calling amphibians were determined from the road as permission to enter private lands was not available at the time of the surveys (**Exhibit 2-6**).

Sampling for other amphibians (i.e. salamanders) was only conducted on an incidental observation basis.


Waterloo
Perth East
Wilmot
Stratford
Perth South
East Zorra-Tavistock
Blandford-Blenheim
Zorra
Ellice Swamp
Gads Hill South
Phillipsburg Swamp
Little Lakes Swamp Complex
New Hamburg Oxbow Wetland Complex
Haysville Wetland Complex
Gillard Drain Complex
Lakeside/Wildwood Complex
Sunfish Lake - Laurel Creek Complex
Exhibit 2-6
Wildlife - Map of Amphibian Survey within the Preferred Corridor
AECOM

Results

Frogs and Toads

A total of five frog or toad species were recorded within the corridor by AECOM during amphibian surveys (**Exhibit 2-7**). None of the species are considered nationally or provincially rare. However, due to recent declines of the Western Chorus Frog (*Pseudacris triseriata*), the COSEWIC (2008) Assessment and Update Status Report indicates that the populations located in the Great Lakes/St. Lawrence and Canadian Shield are Threatened.

The most common species found within the corridor were Spring Peeper (*Pseudacris crucifer*), followed by American Toad (*Bufo americanus*), Western Chorus Frog (*Pseudacris triseriata*), Leopard Frog (*Rana pipiens*) and Grey Tree Frog (*Hyla versicolor*).

Spring Peepers were the most widely distributed throughout the corridor in four separate locations. The American Toad was also distributed throughout the corridor in three separate locations. The Western Chorus Frog, Grey Tree Frog and Leopard Frog were all found in only one location each (**Exhibit 2-7**)

No incidental salamander observations were noted during field investigations.

Exhibit 2-7:
Frog and Toad Species Recorded in the Preferred Corridor

Species	Scientific Name	Number of AECOM Stations With Species Recorded	Approximate number of individuals (all stations)
American Toad	*Bufo americanus*	4	10-20
Spring Peeper	*Pseudacris crucifer*	3	25-45
Grey Tree Frog	*Hyla versicolor*	1	1
Western Chorus Frog	*Pseudacris triseriata*	1	6-10
Leopard Frog	*Rana pipiens*	1	1

Significance and Sensitivity

The majority of the recorded amphibian breeding sites occur outside the preferred corridor (Exhibit 2-6). One amphibian, the Western Chorus Frog, found at one location within preferred corridor has recently become a threatened species according to an updated status report by COSEWIC (2008). Although provincially, they are still considered an S4, their populations have been on a continuous decline over the past decade.

2.2.1.3 Other Wildlife and Wildlife Habitat Assessment

Methodology

No active collection of reptiles and mammals was undertaken as part of this study. Background information was relied upon for presence of reptiles and mammals within the Preliminary Study Area, as well as incidental observations of wildlife by biologists while in the field.

A search of the NHIC database provided no documented records of rare or endangered reptiles within the corridor and no reptiles were observed within the corridor during field work.

Exhibit 2-8 lists the mammal species that were incidentally observed by AECOM staff during field work. All are common species throughout Southern Ontario.

Exhibit 2-8:
Incidental Mammals Observed in the Highway 7&8 Corridor

Common Name	Scientific Name
Eastern Chipmunk	*Tamias striatus*
Eastern Grey Squirrel	*Sciurus carolinensis*
Northern Raccoon	*Procyon lotor*
White-tailed Deer	*Odocoileus virginianus*

2.2.2 Wetlands

Significant wetlands within the preferred corridor are shown in **Exhibit 2-9**

2.2.2.1 Provincially Significant Wetlands (PSW)

The Provincially Significant designation is assigned to wetlands and/or complexes of wetlands evaluated under OWES (Ontario Wetland Evaluation System) to represent a high level of wetland function and perceived value relative to other wetland systems throughout Ontario.

There are no Provincially Significant Wetlands within the preferred corridor. However, the “Little Lakes Swamp Complex” is located directly adjacent to the corridor. The Little Lakes Swamp Complex is made up of seven individual wetlands, composed of two wetland types (85% swamp and 15% marsh). The Little Lakes Swamp complex is approximately 29% palustrine and 71% riverine. Moore and Robinson (1995) report 21% clay/loam and 79% humic/mesic substrates. Swamp communities are dominated by Green Ash (*Fraxinus pennsylvanica*), Silver Maple (*Acer saccharinum*), White Elm (*Ulmus americana*), Black Willow (*Salix nigra*), Trembling Aspen (*Populus tremuloides*), Yellow Birch (*Betula alleghaniensis*), Hemlock (*Tsuga sp*.), Eastern White Cedar (*Thuja occidentalis*), Largetooth Aspen (*Populus grandidentata*), Poplar (*Populus sp*.), Balsam Poplar (*Populus balsamifera*), Red-osier Dogwood (*Cornus stolonifera*), Silky Dogwood (*Cornus amomum*), willow species (*Salix sp*.), Highbush Cranberry (*Viburnum trilobum*), Skunk Cabbage (*Symplocarpus foetidus*), Sensitive Fern (*Onoclea sensibilis*), Virginia Creeper (*Parthenocissus quinquefolia*), jewelweed (*Impatiens sp*.), Stinging Nettle (*Urtica*

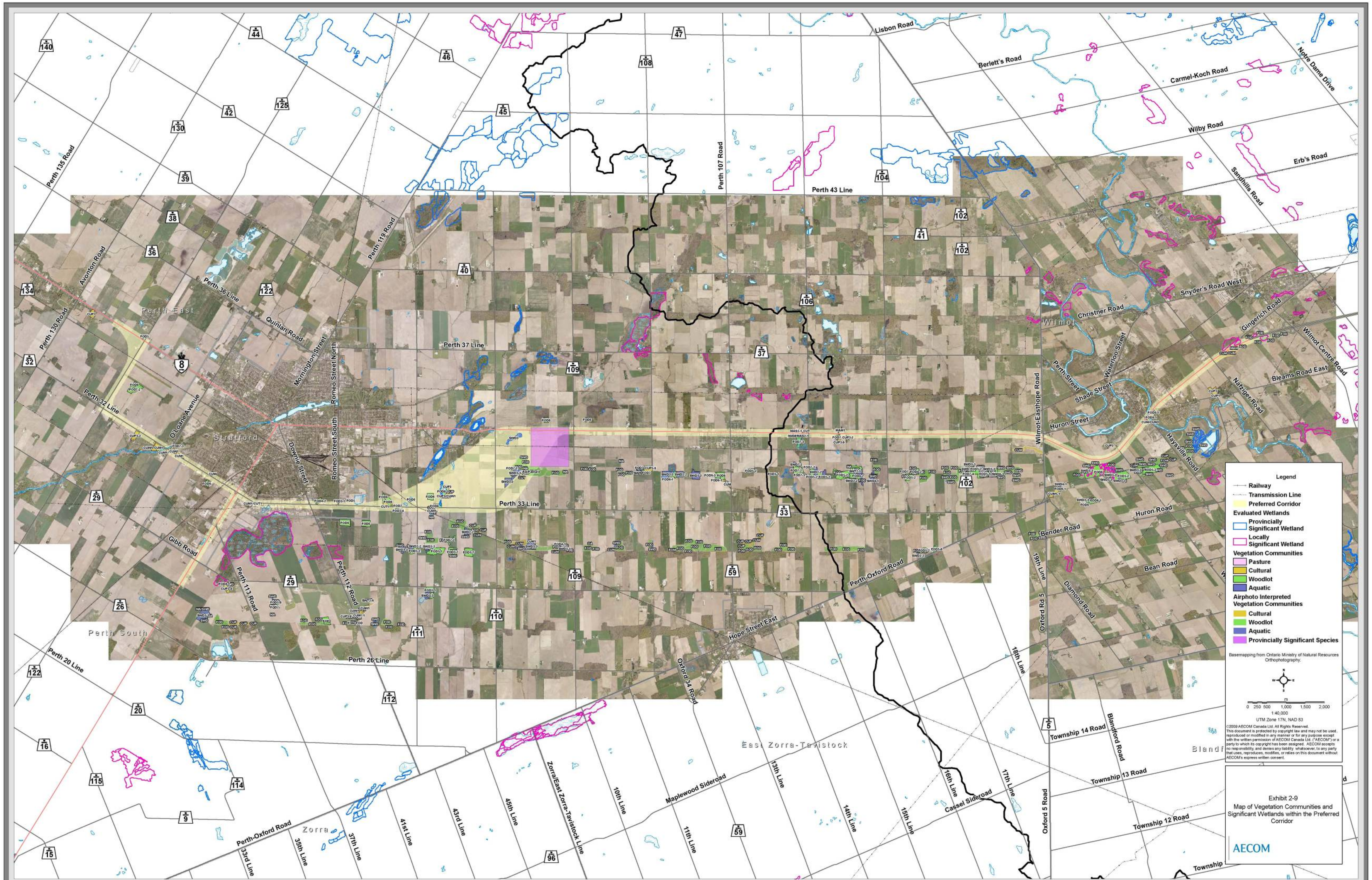

Legend
Railway
Transmission Line
Preferred Corridor
Evaluated Wetlands
Provincially Significant Wetland
Locally Significant Wetland
Vegetation Communities
Pasture
Cultural
Woodlot
Aquatic
Airphoto Interpreted Vegetation Communities
Cultural
Woodlot
Aquatic
Provincially Significant Species
Basemapping from Ontario Ministry of Natural Resources Orthophotography.
N
W
E
S
m
0 250 500 1,000 1,500 2,000
1:40,000
UTM Zone 17N, NAD 83
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Exhibit 2-9
Map of Vegetation Communities and Significant Wetlands within the Preferred Corridor
AECOM
Stratford
Perth East
Perth South
Wilmot
Zorra
East Zorra-Tavistock
Perth 37 Line
Perth 33 Line
Perth 43 Line
Perth 26 Line
Perth-Oxford Road
Hope Street East
Lisbon Road
Berlett's Road
Carmel-Koch Road
Wilby Road
Erb's Road
Snyder's Road West
Christner Road
Huron Street
Huron Road
Bender Road
Bean Road
Township 14 Road
Township 13 Road
Township 12 Road
Cassel Sideroad
Maplewood Sideroad

dioica), and Deadly Nightshade (*Atropa belladonna*). Marsh communities support Reed Canary Grass (*Phalaris arundinacea*), Swamp Milkweed (*Asclepias incarnata*), cattails (*Typha sp*.), jewelweed (*Impatiens sp*.), Horsetail (*Equisetum arvense*), dogwood species (*Cornus sp*.), willow species (*Salix sp*.), and a variety of free-floating plants and submergent plants.

2.2.2.2 Locally Significant Wetlands (LSW)

LSW are wetland units and/or complexes evaluated under OWES that did not meet the requirements for a Provincially Significant designation. However, these wetlands provide unique or specialized function within the context of the local landscape, including maintenance of critical ecosystem function, moderation of storm flows and water quality, protection for rare species, as well a number of social benefits. LSW are protected by various policies administered by the local planning authorities, including Municipal Official Plans (OP) and the *Conservation Authorities Act*.

The expansion of Highway 7&8 at the east end (east of New Hamburg) has the potential to affect two small LSWs located within the corridor alongside the existing roadway. South of New Hamburg and immediately south of Highway 7&8 is a series of LSWs that although are not within the corridor, are directly adjacent to the highway. The Stratford Complex LSW located south of Stratford is not within the corridor; however it is in close proximity to Highway 7&8 and worthy of mention as it relates to indirect effects during later stages of planning and design.

2.2.3 Forests

2.2.3.1 Interior Forest Habitat

Interior forest habitat is a sheltered environment away from the influence of forest edges and open habitats. The presence of forest interior is a sign of woodland health, and is directly related to the woodland’s size and shape. Large woodlands with round or square outlines have the greatest amount of forest interior. Narrow, linear woodlands are less likely to support interior forest habitat. Most authors recognize the interior forest habitat located more than 100 m away from the forest edge (Riley and Mohr, 1994). An estimate of interior forest habitat within the analysis area was identified by applying the 100 m rule to all woodland identified for the study area. Approximately 7,700 ha of forest was identified for the analysis, 1173.5 ha of which was identified as interior forest.

The corridor overlays interior forest at one location west of Shakespeare (**Exhibit 2-9**). The corridor encompasses a large portion of this woodlot, and depending on the location of the route alignment could potentially remove all interior forest habitat within this unit. Avoidance of this forested unit should be considered an important issue during subsequent planning and design phases.

2.2.4 Vegetation

2.2.4.1 Methodology

Vegetation cover throughout the study corridor has been described to Community Series (broad vegetation community) as described by the Ecological Land Classification Manual for Southern Ontario (Lee et al.1998). Interpretation of stereo-pair aerial-photography was conducted to delineate vegetation polygons that would later be investigated on the ground. Stereo-pair photography that had been prepared in spring 2000 at a scale of 1:20,000 was used.

The field program was undertaken by refining vegetation classification from Community Series to Ecosite and Vegetation type as described by the ELC manual. The level of refinement was dependant upon permission to enter properties to directly access vegetation polygons or whether windshield surveys were used.

Plant species significance was determined according to the national and provincial status rankings appearing on the Natural Heritage Information Centre database (2009). Significance at the regional and local level was based on a review of existing plant species status lists for nearby Waterloo (Regional Municipality of Waterloo, Significant Species List Native Vascular Plant Component, 1999). Two separate plant lists were created based on dividing the corridor into two unique physiological sub-regions based on existing knowledge of the soils, surficial geology, landforms and professional judgement.

2.2.4.2 Results

The two physiographic regions identified within the corridor in the “East Region” located East of Wilmot-Easthope Road is comprised primarily of Glaciolacustrine-derived silty to clayey till, while the “West Region” located West of Wilmot-Easthope Road is composed of Stone-poor, carbonate-derived silty to sandy till and Massive-well laminated Glaciofluvial deposits. The variations in the surficial geology of the subject lands have created areas that generally deviate from each other in terms of local landform, soil type and soil permeability, resulting in landscape scale variations to the vegetation cover.

The vegetation communities within the preferred corridor are shown in **Exhibit 2-9**.

The total area of natural vegetation within corridor is summarized below in **Exhibit 2-10**.

Exhibit 2-10:
Summary of vegetation cover (in hectares) within the Corridor

Community Series	Area affected within the corridor (in hectares)
Cultural Meadow (**CUM**)	12.3
Cultural Plantation (**CUP**)	4.1
Cultural Thicket (**CUT**)	4.0
Cultural Woodlot (**CUW**)	4.0
Deciduous Forest (**FOD**)	34.5
Mixed Forest (**FOM**)	6.2
Meadow Marsh (**MAM**)	2.3
Shallow Marsh (**MAS**)	0.2
Deciduous Swamp (**SWD**)	10.7
Swamp Thicket (**SWT**)	0.2
Open Water (**OA**)	0.2
Total (All Community Series)	**78.7**

A total of 11 broad vegetation communities (Community Series) were identified throughout the corridor. Vegetation communities were further refined from Community Series to Ecosite and Vegetation Type based on soil characteristics and dominant plant species present. All Community Series identified are described in greater detail in the following pages.

Deciduous Forest (FOD) Community Series

Deciduous forest communities are treed vegetation units characterized by a dominance of deciduous tree vegetation forms greater than 60% cover (Lee et al. 1998). Deciduous forest comprises the majority of the vegetation cover located within the corridor, representing approximately 34.5 hectares. Sugar Maple (*Acer saccharum ssp. Saccharum)* deciduous forest communities formed the most common associations in the corridor.

Mixed Forest (FOM) Community Series

Mixed forest communities are treed vegetation units characterized by a co-dominance of deciduous tree vegetation forms greater than 25% cover and coniferous tree vegetation forms greater than 25% cover (Lee et al. 1998). Approximately 6.2 hectare of mixed forest is found within the corridor.

Cultural Meadow (CUM) Community Series

Cultural Communities are typically created or maintained by anthropogenic influences (i.e. agricultural, mowing, substrate extraction, recreational use). Cultural meadows are vegetation units with less than 25% tree cover and less than 25% shrub cover and often have large portions of non-native plant species (Lee et al. 1998). This is the most common cultural vegetation unit within the corridor, with approximately 12.3 hectares.

Cultural Plantation (CUP) Community Series

These plantation communities are treed vegetation units with >60% tree cover and can be formed of either deciduous, coniferous or a mix of the two (Lee et al. 1998). Approximately 4.1 hectares of cultural plantations are found within the corridor, the most common type of plantation being coniferous.

Cultural Thicket (CUT) Community Series

These communities are comprised of less than or equal to 25% tree cover and greater than 25% shrub cover (Lee et al. 1998). This vegetation community is not very widespread throughout the corridor with approximately 4.0 hectares documented.

Cultural Woodlot (CUW) Community Series

These treed vegetation units are characterized by a dominance of either deciduous or coniferous forms of between 35% and 60% cover (Lee et al. 1998). These vegetation units are widespread throughout the corridor representing 4.0 hectares.

Meadow Marsh (MAM) and Shallow Marsh Community Series

Meadow Marsh communities are dominated by emergent hydrophytic macrophytes (species less tolerant of prolonged flooding) with variable flooding regimes and water depths less than 2 meters (Lee et al. 1998). While shallow marshes are dominated by the same features, but with different species associations, typically found in standing water for much or all of the growing season (Lee et al. 1998). Both communities are not commonly found within the corridor, with meadow marsh comprising (2.3 hectares) and shallow marsh at (0.2 hectares).

Deciduous Swamp (SWD) Community Series

Dominated by deciduous tree cover greater than 25% and at least 5 meters in height (Lee et al. 1998). This is a common vegetation unit found within the corridor (10.7 hectares); with Swamp Maple (*Acer x freemanii*) deciduous swamp communities forming the most common associations in the corridor.

Swamp Thicket (SWT) Community Series

These units are characterized by tree or shrub cover greater than 25% and dominated by hydrophytic species (Lee et al. 1998). This is a very uncommon vegetation unit with 0.2 hectares being found within the corridor.

Open Water (OA) Community Series

Characterized by no macrophyte vegetation, and no tree or shrub cover; water depth greater than 2 meters (Lee et al. 1998). Only 0.2 hectares is found within the corridor.

Flora

East Region

Field investigations in the East Region identified 143 species of vascular plants of which 26 are non-native, representing approximately 18% of the species recorded. Introduced species are most abundant in the cultural communities. A complete vascular plant species list appears in **Appendix B**.

Three species are considered Regionally Rare in the area. One nationally and provincially endangered Butternut (S3) (*Juglans cinerea*) was encountered in a locally significant wetland, but was outside of the corridor.

West Region

Field investigations in the West Region identified 166 species of vascular plants of which 28 are non-native, representing approximately 17% of the species recorded. Introduced species are most abundant in the cultural communities. A complete vascular plant species list appears in **Appendix B**.

Five species are considered Regionally Rare in the area. No nationally or provincially rare species were encountered in the West Region. However, according to the NHIC database (2009), Showy goldenrod S1 (Solidago speciosa) is found within the corridor, with the last recorded date 1972-09-01. *S. speciosa* is a prairie species found only definitely on Walpole and Squirrel Islands in the extreme southwest of Ontario; i.e., Semple and Ringius (1983) were unable to confirm the occurrence of *S. speciosa* in Perth County in their preparation of The Goldenrods of Ontario.

Significance and Sensitivity

Field investigations found no provincially rare vegetation communities within the corridor. Only one identified nationally and provincially endangered plant species, Butternut (S3) was found, however it was outside of the corridor and not currently impacted. A record of Showy Goldenrod (S1) dated in 1972 is located within the corridor and requires further investigation to determine if the record is still viable.

Field investigations found a total of 7 Regionally Rare species within the study area. Rare species are noted in **Exhibit 2-11** by physiographic region.

Exhibit 2-11:
Regionally Rare Vegetation Species

Scientific Name	Common Name	East Region	West Region
Pruns Americana	Wild Plum	X	
Menispermum canadense	Moonseed	X	X
Lysimachia quadrifolia	Whorled Loosestrife	X	
Picea mariana	Black Spruce		X
Lilium philadelphicum	Wood Lily		X
Cypripedium reginae	Showy Lady-slipper		X
Elymus canadense	Canada Wild-Rye		X

2.2.5 Designated/Special Areas

Although there are no ANSIs found within the corridor, the Little Lakes Bog and Swamp Forest ANSI is directly adjacent to a segment of the corridor least of Stratford (**Exhibit 2-9**). This ANSI is a 135 ha mixture of swamp forest that is dissected by a hydro corridor, the Avon River flowing through the forest, and three kettle lakes. The ecosystem complex is made up of seven community types consisting of open water, floating sphagnum mat, cattail pockets, tamarack swamp, silver maple swamp, hemlock-cedar swamp, and beech-maple forest. One of the lakes is divided in half by fill, and one lake is separated from the other two by Highway 7&8 and a railroad corridor.

2.3 Groundwater

The influence of groundwater on the natural and built environment is an important aspect of any environmental assessment. This chapter deals with the significance and sensitivity of ecological groundwater function and of groundwater as a resource, to the proposed widening, construction and operation of Highway 7&8. Specific subsections deal with:

- Areas of groundwater recharge and discharge;
- Wellhead protection areas for municipal wells;
- High volume wells;
- Private wells; and
- Groundwater sensitive ecosystems.

The following subsection provides a description of the methodology used to provide a basis for analysis. This is followed by five subsections that deal with each of the five aspects listed above. Each of these subsections is further split to deal with first the results and then the significance and sensitivity for each aspect.

2.3.1 Methodology

The methodology with which the groundwater field inventory was conducted can be separated into two topic areas. Section 2.3.1.1 discusses the methodology employed for groundwater influenced natural environments, and includes areas of groundwater recharge and discharge plus groundwater sensitive ecosystems. Section 2.3.1.2 provides the methodology used for each of municipal and private water supply wells and includes wellhead protection areas, large volume wells and private wells.

2.3.1.1 Methodology for Groundwater Influenced Environments

The original assessment of the analysis study area for groundwater conditions was conducted by way of a desktop study as documented in the F1 report. This desktop study included review of published information including:

- Ontario Geological Survey mapping (Karrow, 1993); and
- Ontario Base Mapping (MNR, 2006c).

A Geographic Information System (GIS) platform enabled spatial data sets to be overlain so that relations among different variables could be detected and sensitive areas identified.

Subsequently a groundwater field reconnaissance visit was conducted along the preferred corridor to both confirm the results of the background study and to locate any previously unidentified areas of hydrogeological significance along this specific corridor. Areas of hydrogeological significance, for the purposes of this environmental assessment include zones of groundwater recharge or discharge and groundwater sensitive ecosystems such as Provincially Significant Wetlands (PSWs) and groundwater fed streams and lakes.

Methods used during the reconnaissance consisted of:

- Visual reconnaissance along publicly accessed roads for observations of a geological nature, e.g., observing road cuts for soil materials or terrains for the presence of diagnostic landforms;
- Estimates of stream flow at selected creek crossings;
- Observations of stream bed and cut-bank geology, surrounding vegetation and land use patterns at selected creek crossings;
- Measurements of water and air temperature at selected watercourse crossings;
- Shallow soil augering (typically to 0.2 to 0.5 m depths) in and/or near selected creek crossings or wetlands; and
- Visual reconnaissance within and near selected wetlands and selected creek crossings for indicators of groundwater discharge, e.g., active seeps, springs.

Reconnaissance for geological features was performed to confirm surficial geology results of the existing conditions study. Vegetative patterns dependant upon groundwater were observed by ecological staff to identify potential areas of shallow water table. Streambed geology, air and water temperatures, and stream-flow estimates were collectively used to identify potential areas of groundwater upwelling. The latter determination was possible as streams that are groundwater fed tend to a have a lower water temperature than the air temperature in summer (and vice-versa in winter). In addition, the identification of potential groundwater discharge areas was assisted by observations of obvious groundwater seeps or springs, and/or hydrophilic vegetation such as watercress (*Nasturtium sp.*). Results indicating the presence of groundwater upwelling in surveyed creeks were cross-referenced with findings of the aquatic survey which documented cold water species.

In summary, hydrogeologically sensitive areas related to groundwater discharge/recharge and environmentally sensitive ecosystems are identified on the basis of surficial geology, water-air temperature differences and indicators of groundwater discharge such as seeps and water cress. Since potential groundwater discharge areas for the most part coincide with groundwater sensitive ecosystems along the preferred corridor they are shown together on **Exhibit 2-12**.

2.3.1.2 Water Supply Wells Methodology

The original assessment for groundwater supply wells within the analysis study area was conducted by way of a desktop study as documented in the F1 report. This desktop study included review of published information including:

- Ontario Geological Survey mapping (Karrow, 1993);
- Ministry of the Environment (MOE) water well records (MOE, 2006); and
- Available wellhead protection information (Perth and Oxford Counties, Waterloo Region) and historical consulting reports.

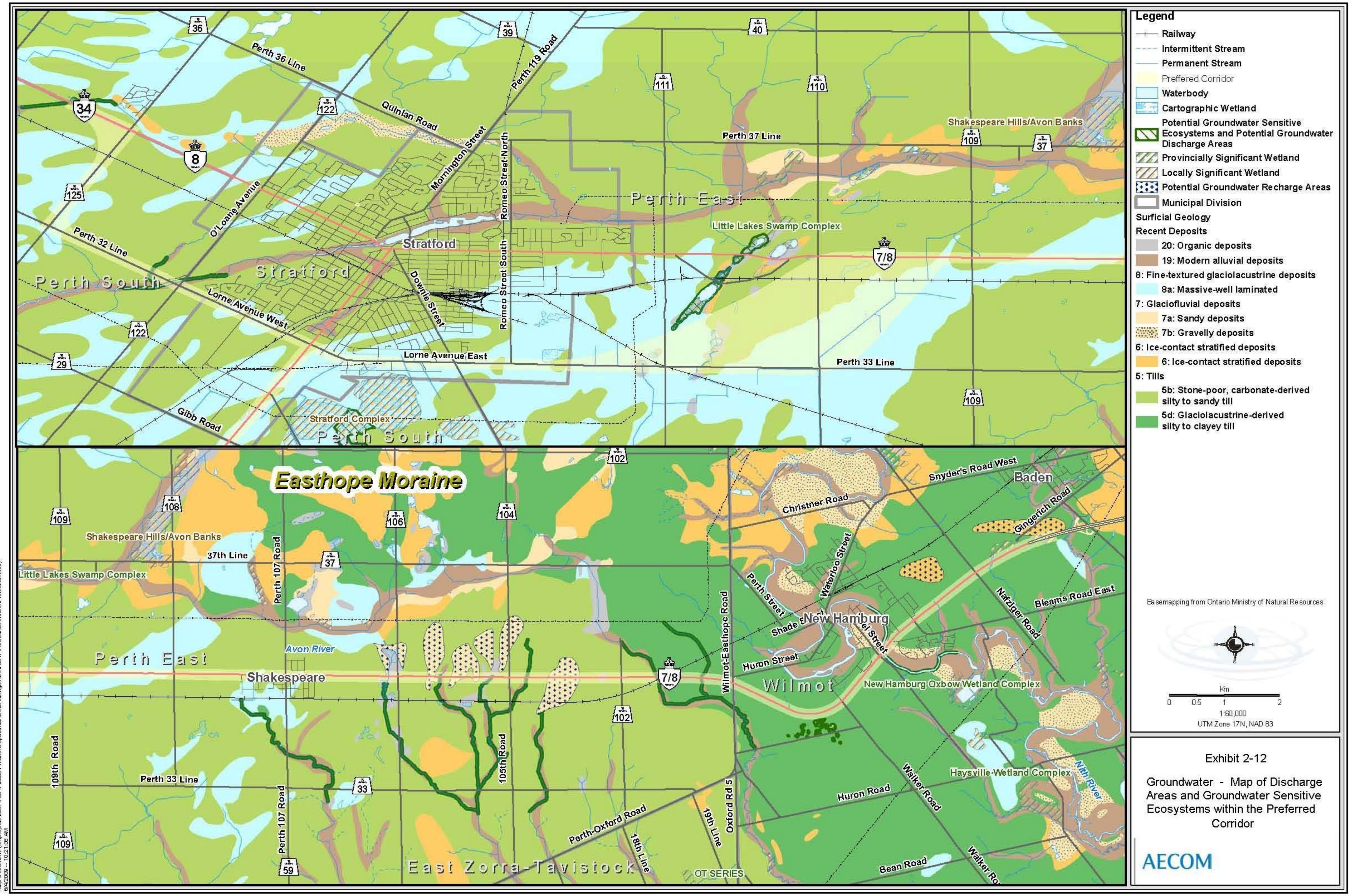
A Geographic Information System (GIS) platform enabled spatial data sets to be overlaid so that relations among different variables could be detected and sensitive areas identified.

Subsequently a groundwater field inventory was conducted along the preferred corridor to both confirm the results of the background study and to locate any previously unidentified areas of hydrogeological significance along this specific corridor. Areas of hydrogeological significance, for the purposes of this environmental assessment include groundwater source and well head protection areas, large volume wells and private wells.

Methods used during the inventory consisted of:

- Visual reconnaissance of surficial geology along the preferred corridor;
- Review of existing water well records along the preferred corridor; and
- Review of existing municipal wellhead protection plans along the preferred corridor.

Reconnaissance for geological features was undertaken through a windshield survey with stops along the preferred corridor, to confirm surficial geology results of the existing conditions study. A review of existing water well records along the preferred corridor was also completed to examine the depth and geologic composition of both the material in which is screened (aquifer) as well as the material above the screen (aquitard). The rationale for this is based on the fact that wells that are either installed less than 20 feet deep or are installed within an un-confined aquifer are typically potentially more sensitive to highway construction and subsequent road salting. A review of existing municipal wellhead protection plans was undertaken along the preferred corridor to determine the depth of well installation, the geologic material in which the wells are screened and the accepted location of wellhead protection zones in relation to the preferred corridor. This was done to determine whether the proposed corridor crosses any wellhead protection zones and if so would there be any potential impacts.


Legend
Railway
Intermittent Stream
Permanent Stream
Preffered Corridor
Waterbody
Cartographic Wetland
Potential Groundwater Sensitive Ecosystems and Potential Groundwater Discharge Areas
Provincially Significant Wetland
Locally Significant Wetland
Potential Groundwater Recharge Areas
Municipal Division
Surficial Geology
Recent Deposits
20: Organic deposits
19: Modern alluvial deposits
8: Fine-textured glaciolacustrine deposits
8a: Massive-well laminated
7: Glaciofluvial deposits
7a: Sandy deposits
7b: Gravelly deposits
6: Ice-contact stratified deposits
6: Ice-contact stratified deposits
5: Tills
5b: Stone-poor, carbonate-derived silty to sandy till
5d: Glaciolacustrine-derived silty to clayey till
Basemapping from Ontario Ministry of Natural Resources
Km
0 0.5 1 2
1:60,000
UTM Zone 17N, NAD 83
Exhibit 2-12
Groundwater - Map of Discharge Areas and Groundwater Sensitive Ecosystems within the Preferred Corridor
AECOM
Stratford
Perth South
Perth East
Shakespeare Hills/Avon Banks
Little Lakes Swamp Complex
Stratford Complex
Easthope Moraine
Shakespeare
Avon River
New Hamburg
Wilmot
Baden
New Hamburg Oxbow Wetland Complex
Haysville Wetland Complex
Nith River
East Zorra-Tavistock

Hydrogeologically sensitive areas are identified on the basis of thickness and composition of protective geologic layers, locations of municipal and/or large production (commercial) wells and the type/depth and location of private water wells in relation to the preferred corridor. The locations of all wells are shown together on **Exhibit 2-13**.

2.3.2 Areas of Groundwater Recharge and Discharge

The result of the field reconnaissance for areas of groundwater recharge and discharge are discussed in Section 2.3.2.1, and significant and sensitive areas are described in Section 2.3.2.2.

2.3.2.1 Results: Areas of Groundwater Recharge and Discharge

Groundwater within the preferred corridor supports both the natural and human environment.

Aquatic habitat, in both streams and wetlands, is often dependent on specific groundwater conditions if the geologic setting is conducive. Certain fish species require a specific thermal regime, which may be influenced by groundwater upwelling. In such cases the substrate must be sufficiently permeable to allow enough groundwater to discharge and influence the greater stream temperature. Certain wetland vegetation requires a uniform moisture regime. Others can be highly sensitive to changes in groundwater quality. Wetlands, rivers, and streams are commonly associated with groundwater discharge.

The study area is largely a recharge area which not only feeds ground water that supports groundwater discharge to ecologic features, but also feeds the aquifers which society relies upon for water supply. Most of the Perth County, which covers a major part of the preferred corridor, is considered a bedrock recharge area (Waterloo Hydrogeologic, 2003). The rate of recharge is restricted by surficial clay or dense glacial till deposits, but given the large contributing area, more than enough volume is produced to sustain ecologic and human needs. Significant localized recharge occurs through the more permeable surficial sand and gravel deposits. For example in the Gads Hill and Easthope moraines[1] are deposits of granular materials on high ground north of the preferred corridor. (Even these areas are prone to reduced recharge, for example the low permeability capped soils of the Gads Hill Moraine.) Typically areas of thin drift over bedrock also provide significant recharge, although such features are rare in the study area. Local recharge areas also occur where lacustrine or outwash sands overly the low permeability tills located east of Shakespeare (**Exhibit 2-12**). Generally, the surficial sand accepts significant recharge and acts as a storage reservoir feeding the downward leakage through the silt and clay below.

Where creeks cut into these sediments, some local groundwater discharge occurs where there is lateral flow and discharge occurs from these horizontally layered deposits. Other groundwater discharge areas were found along the preferred corridor. These are predominantly limited to wetlands, such as the Little Lakes Swamp Complex and McCarthy Lake east of

[1] *The Easthope Moraine is shown on Exhibits 2-12 and 2-13. The Gads Hill Moraine is further north and west of Shakespeare and is outside of the immediate study area for the preferred corridor shown on these exhibits.*

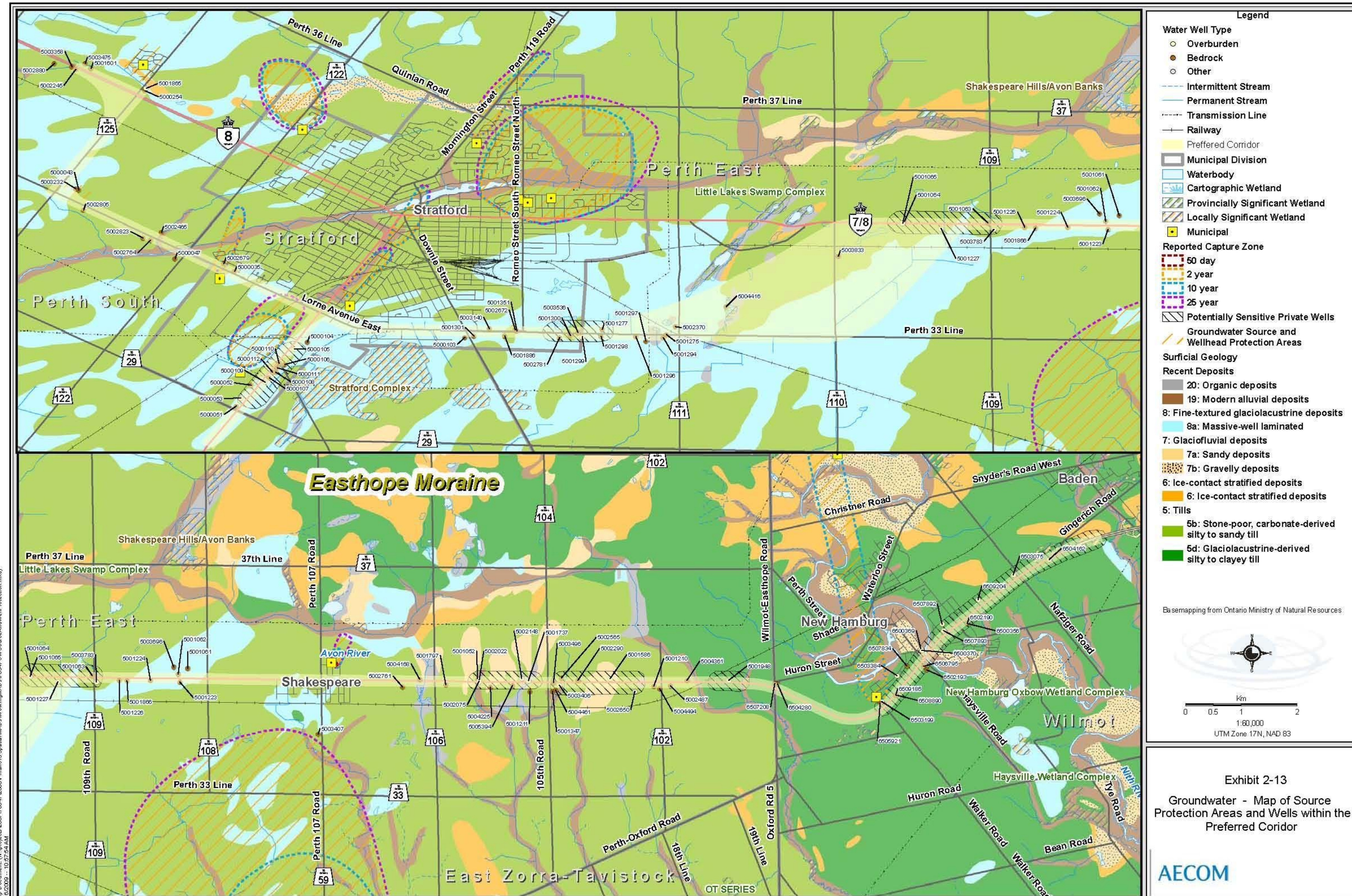


Exhibit 2-13
Groundwater - Map of Source Protection Areas and Wells within the Preferred Coridor

AECOM

Stratford (top panel of (**Exhibit 2-12**). This is also true for the New Hamburg Wetland Complex at the big curve in the alignment around New Hamburg. Some locally significant wetlands are found near Stratford. Groundwater discharge areas have also been identified in the river/stream valley of the Nith River and its tributaries between Shakespeare and New Hamburg.

2.3.2.2 Groundwater Recharge and Discharge Areas Significance and Sensitivity

Areas of Discharge

Based on observations of flow, temperature and vegetation, four areas of potential groundwater upwelling have been identified. Areas at this stage are identified as *potential discharge regions* because further data (e.g., monthly measurements of hydraulic gradients) are required to confirm the areas as discharge zones. The collection of these data is planned during future phases of the EA process.

The potential discharge areas identified are clearly marked on **Exhibit 2-12** by black hatches. Secondary source data, such as that collected for the aquatic inventory and the existing conditions report, were used to infer the potential for groundwater discharge at these locations. Areas of potential discharge highlighted include the Provincially Significant Little Lakes Swamp Complex and McCarthy Lake, and the locally significant Stratford Wetland immediately south of Lorne Avenue in Stratford. The potential long term effects on groundwater discharge at the Little Lakes Swamp Complex and McCarthy Lake are low as they are located upgradient of the preferred corridor. However the Stratford Wetland complex is located downgradient of the proposed corridor and will require further monitoring to determine the effect of highway construction on groundwater discharge at this location.

Other areas of potential discharge along the preferred corridor included surficial sands east of Shakespeare contributing to small tributaries that flow ultimately to the Nith River. Cool water is present downstream at several aquatic sites in this area. It is likely the product of mixing of the groundwater discharge surface water with distance downstream. The long term potential effects of highway construction in these areas are also low. However, short term effects may occur during the construction particularly if dewatering or deep cuts are required. Monitoring and mitigative measures may be required to ensure no effects to groundwater discharge quality or quantity occur.

The locally significant New Hamburg Oxbow Wetland Complex, and the surficial alluvial and sandy deposits in which the Nith River is located, have been identified as potential groundwater discharge areas. The potential for the reduction in groundwater discharge within the New Hamburg Wetland Complex is low. However, temporary reduction in groundwater discharge during highway construction while crossing the Nith River is likely should dewatering be required for bridge pier construction.

All potential discharge areas along creek beds and within wetlands were delineated based on the presence of visible seeps and springs, air-water temperature differentials, hydrophilic vegetation such as watercress and jewel weed, and surficial soils of sand and gravel or peaty deposits. Although some aquatic inventory sites had temperature differentials suggestive of groundwater upwelling, these were not included in the delineated potential discharge areas due to the presence of low permeability surficial soils.

Areas of Recharge

Recharge will occur over the entire study area, albeit at slow rates due to the dominantly low permeability soils over most of the area. Such areas are not considered as sensitive due to the low permeability soils which protect the underlying aquifers. Locally, areas of permeable soil will infiltrate more water acting as local recharge areas. Of particular sensitivity and significance are areas of highly permeable soil such as ice contact stratified drift deposit sands and gravels. These areas may be prone to water quality changes. This soil type is limited to the east end of the study area where the Easthope moraine outcrops at surface or is covered by only a thin drift of overburden **(Exhibit 2-12)**. Recharge will also occur in areas of granular well drained soils, i.e. sand and gravel located at surface and in modern river valleys. Surficial sands can be found immediately to the east of Shakespeare and are also potentially sensitive recharge areas, given the proximity of the Nith tributary headwaters.

2.3.3 Groundwater Source and Well Protection Areas

The results of the field reconnaissance for groundwater source and well protection areas are discussed in section 2.3.3.1 below. Significant and sensitive areas outlined in section 3.3.3.2.

2.3.3.1 Groundwater Source and Well Protection Areas

People living in the rural areas obtain their drinking water from wells, and numerous industries rely on groundwater for commercial and industrial use. Aquifers may supply farmers with water for irrigation, livestock watering and to develop their products for commercial distribution. As such source and well head protection is an important for communities and rural population alike.

Within the study area multiple discontinuous aquifers of varying lateral extent exist. Unconfined systems, such as the surficial sand and gravel deposits to the northeast, can provide sufficient yield for private and municipal water supply wells. However, within the study area and along the preferred corridor, over 60% of drilled wells are completed in bedrock, indicating that the bedrock is an important regional aquifer. The bedrock aquifers in the area are generally of large lateral extent with well defined fracture zones in the upper layers making it the main target formation for municipal water supply and residential wells alike.

A total of 42 municipal operate within or around the full analysis area, however only 10 of these are close to the preferred corridor. All of the municipal wells throughout the Perth County pump water from the bedrock (Waterloo Hydrogeologic, 2003)[2]. The distributions of these municipal wells and their interpreted zones of influence were used to approximate areas of significance. **Exhibit 2-13** shows a series of wellhead protection areas (WHPAs) that were identified around and within Stratford, Shakespeare and New Hamburg. Wells outside the analysis area

2. *Some municipal wells that are located in Kitchener-Waterloo in the northeast part (eskers and kame areas) are drilled in overburden but are not within the immediate study area and located further to the east of the preferred corridor.*

(Tavistock) have been included in this analysis because their WHPAs extend into the study domain and in close proximity to the preferred corridor near Shakespeare. These wells operate on a continuous or intermittent basis depending on seasonal demand. The anticipated zone of influence for these wells currently extends beneath the preferred corridor only in Stratford.

2.3.3.2 Groundwater Source and Well Protection Areas Significance and Sensitivity

Based upon the current findings, well head protection areas at this stage are identified as *potential sensitive regions* because further data (e.g., well construction details and municipal pumping records) are required to confirm that these areas are not affected by highway construction. Of particular significance are the four municipal wells located in Stratford. The zones of influence for two of these wells extend beneath the preferred corridor. (see **Exhibit 2-13**). The Tavistock municipal well is located to the south of Shakespeare; however the preferred corridor is outside of the 25 year time of travel to the well.

Based on the fact that all municipal wells within the study area are screened within the bedrock, which is overlain by thick till or lacustrine silts and clays, it is highly unlikely that highway construction will cause any ill effect to the quality or quantity of water in these wells.

2.3.4 Large Volume Wells

The result of the field reconnaissance for large volume wells are discussed in section 2.3.4.1. Significant and sensitive areas are provided in section 2.3.4.2.

2.3.4.1 Large Volume Wells Results

The only large volume wells within the area are municipal water supply wells described in the previous section plus three communal wells located around the communities of Stratford and Shakespeare. The majority of these wells are located to the north of the proposed corridor. However, four municipal wells for the city of Stratford are located immediately south or adjacent to the proposed corridor. Two of these wells are located close to the proposed corridor as well but draw their water from the north (**Exhibit 2-13**).

Large commercial industries within the study area and along the preferred corridor, such as FAG Bearings and KSR International, are assumed to be receiving municipal water supply. However, confirmation of this will be required via a water well survey, which will be conducted at a later stage of the EA process. In addition, several large farms currently operate outside of the communities of Stratford, Shakespeare and New Hamburg, which may also require large volume wells to either irrigate crops or provide water for livestock. Further data are also required via a water well survey to confirm the current amount of groundwater use at each of these farms.

2.3.4.2 Large Volume Wells Significance and Sensitivity

Large volume wells at this stage are also indentified as *potential sensitive regions* because further data (e.g., field inventory and potentially water quality samples prior to, during, and after construction) are required to confirm that these areas are not likely affected by construction. Of particular significance and sensitivity are the four municipal wells located in Stratford, and MOE well 5003232 located at Road 125 as the zones of influence for all these wells extend beneath the preferred corridor and all have pumping rates in excess of 100 gallons per minute. However, it is highly unlikely that any effects will be felt as all of these wells are located within the bedrock aquifer, which is overlain by approximately 20 metres low permeability till and lacustrine silts and clays. In addition, two municipal wells located in New Hamburg are potentially sensitive as they are situated within the clay till covered Easthope moraine. Little to no effects are however anticipated to be observed at these wells as they are both screened approximately 75 metres below ground surface and pump water from the bedrock aquifer at this depth. The distributions of all wells described above are shown on **Exhibit 2-13**.

2.3.5 Private Wells

The result of the field reconnaissance for private wells is discussed in section 2.3.5.1. The significant and sensitive areas are outlined in section 2.3.5.2.

2.3.5.1 Private Wells Results

The local extent of the private well supply aquifers cannot be clearly defined with a field inventory. This matter will be better defined through the field investigations planned for future phases of the EA process. However, examination of the water well database reveals a total of 2,718 reliably located wells on record within the analysis area (MOE, 2006). Of these, 105 are located within 200 metres of the proposed corridor as shown on **Exhibit 2-13**. Of these 105 wells 23 are screened in the overburden and 82 are screened in bedrock. Of the 23 overburden wells, 15 are dug wells, screened mainly within the shallow overburden units of till and sand and gravel. These wells are of particular interest, as they are more likely to be affected by highway construction.

Of the 83 bedrock wells, 82 are finished in the upper 30 m of the bedrock surface. This is because the upper bedrock layers have usually undergone the most physical weathering and show evidence of significant vertical joints and fractures, often enhanced by millennia of dissolution.

2.3.5.2 Private Wells Significance and Sensitivity

Areas of significance to maintaining healthy aquifers include zones where residential wells are set in shallow surficial soils of sand, gravel, bedrock at surface, or thin drift covered bedrock. These areas have been identified within the study area by black cross-hatching on **Exhibit 2-13** and occur mainly around the east half of the preferred corridor. Of particular interest and sensitivity are dug wells. Dug wells are typically of large diameter, drilled to shallow depths in moderately low permeability soils, and rely on the well storage to provide enough water for single family use. These wells are more sensitive to surface contamination (i.e., road salt) than the majority of drilled wells within the study area. Thus areas with shallow dug wells should be avoided to prevent any potential ill effect to residential water quality.

Most bedrock wells within the study are in confined aquifers, protected by low permeability overburden aquitards and are not sensitive to road construction. However, where there is only thin drift, such as in eskers, kames and moraine areas, the number of bedrock wells respond as unconfined systems and are not as well protected making them more prone to potential effects from highway construction. This scenario is possible within the eastern portion of the study area near the town of New Hamburg. These areas are identified by cross hatching on **Exhibit 1.3.2**.

2.3.6 Groundwater-Sensitive Ecosystems

The results of the field reconnaissance for groundwater sensitive ecosystems are discussed in section 2.3.6.1. Significant and sensitive areas outlined in section 2.3.6.2.

2.3.6.1 Groundwater-Sensitive Ecosystems Results

Groundwater-sensitive ecosystems within the study area include Provincially Significant Wetlands (PSWs) and groundwater fed streams/lakes. The majority of these areas are located around the town of New Hamburg and to east of the town of Shakespeare. However some small areas to the east of Stratford are also present. Potential groundwater supplied ecological features of note within these areas include the Little Lake Swamp Complex, the Stratford wetland, the New Hamburg Wetland Complex, the Nith River and a number of its tributaries between Shakespeare and New Hamburg.

The majority of the streambeds with clay or silt bottoms were dry in the summer months indicating ephemeral conditions. Visible flow was observed at locations that were either underlain by sand and gravel and to some extent silt and clay. Sites with active flow underlain by silt and clay were found on the toe of the Easthope Moraine indicating conveyance of discharge water over the low permeability soils.

Differentials between air and water temperatures, suggestive of groundwater upwelling were noted at sites that are part of the Nith River system, a recognized habitat for coldwater fish species. During the aquatic field investigations, springs were observed within private lands surrounding the Nith River System, and to the east of Shakespeare.

Vegetation such as watercress (*Nasturtium sp.*) and jewelweed (*Impatiens sp.*) are common in areas with shallow water tables and in some instances, groundwater upwelling. Throughout the study area such vegetation was noted at sites located south of and between Shakespeare and New Hamburg along tributaries of the Nith River. One occurrence of watercress was observed in a tributary of the Avon River immediately south of Stratford. No other vegetation indicating groundwater inputs to streams in the area of Stratford was observed. Watercress was consistently observed on organic or sand and gravel steam substrates, and jewelweed was observed on organic soils.

Wetlands and lakes within the preferred corridor included the Stratford wetland, the Little lake swamp complex (including McCarthy Lake) and the New Hamburg wetland complex. These are identified as areas were potential groundwater upwelling is occurring as well.

2.3.6.2 Groundwater-Sensitive Ecosystems Significance and Sensitivity

Areas of significance to maintaining groundwater-sensitive ecosystems include zones where streambed soils are highly permeable (i.e., sand and gravels), stream temperature/air temperature differentials are great, in stream vegetation such as watercress and jewelweed exist, plus wetland complexes. These areas have been identified within the study area by black cross-hatching on **Exhibit 2-12**.

Of particular significance and sensitivity are the Stratford Wetland, the New Hamburg Wetland Complex and the Nith River and its tributaries between Shakespeare and New Hamburg. The provincially significant Little Lake Swamp Complex and McCarthy Lake are significant areas of groundwater discharge but should not be affected by highway construction as they are located upgradient of the proposed corridor. These New Hamburg Wetland, the Stratford Wetland, the Nith River and it tributaries between Shakespeare and New Hamburg between nodes 3-5 and 3-6 are more sensitive to road construction than other streams and wetlands in the area as they show potential indication of groundwater inputs and are either located close to or downgradient of the proposed corridor. The potential long term effects of highway construction on the quantity and quantity of groundwater inputs to these areas is low. Short-term effects could be significant if construction dewatering is anticipated. Thus, all efforts should be made to avoid or, if un-avoidable, mitigate the effects to these features during construction.

2.3.7 Summary and Recommendations

Analysis of field inventory data reveals several key results, which should be considered preliminary given the scope of field work completed to date:

- Much of the preferred corridor is along areas of low permeability soils. The permeable recharge areas of the Easthope Moraine have been avoided. Crossing of most wetlands has been avoided as well.
- The study area contains a number of potential discharge areas that are considered hydrogeologically significant. These are restricted to the granular deposits bordering the tributaries of the Nith River between the towns of Shakespeare and New Hamburg and one occurrence along a tributary of the Avon River.
- Significant recharge areas within the study area are limited to areas surficial granular materials. Such materials can be found along the crest of the Easthope Moraine near New Hamburg and along the current Highway 7 and 8; along the toe of the Easthope Moraine between New Hamburg and Shakespeare; and within surficial granular deposits to the east of Shakespeare.
- Likely areas of shallow unconfined aquifers occur throughout the study area, where residential wells are present in surficial soils of sands, gravels, bedrock or thin drift covered bedrock.

It is recommended that every effort be made to mitigate any potential impacts to the identified hydrogeologically significant areas should they be potentially affected by the selected new route and widening alternatives.

2.4 Surface Water

2.4.1 Watershed / Sub-Watershed Drainage Features/Patterns

The analysis area is divided by the Grand River watershed and the Thames River watershed. Watercourses on the west side of the study area flow southwest to the Thames River while watercourses on the east side of the study area flow southeast toward the Grand River. The watercourse crossings of the preferred corridor are shown on **Exhibit 2-2**, and named in **Exhibit 2-3**. A brief description of the watercourses is provided below.

2.4.1 Grand River Watershed

2.4.1.1 Nith River

The Nith River flows primarily through lands that are under heavy agricultural use and are extensively drained. Some gravel deposits provide groundwater discharge, but the system through the analysis area show evidence of poor water quality and sedimentation.

2.4.1.2 Horner Creek

Horner Creek crosses through an area that is heavily drained for agricultural purposes, however some localized deposits of sand and gravel are present that contribute small amounts to baseflow.

2.4.1.3 Upper Grand River

This area is primarily a headwaters area and exhibits groundwater discharge that generates substantial baseflow.

2.4.2 Thames River Watershed

2.4.2.1 Avon River

Land use in this area is mainly agriculture, with tile drainage present. Majority of this watercourse has been altered (UTRCA, 2007).

2.4.2.2 Trout Creek

Trout Creek traverses through lands that are mainly agriculture. Approximately half the area is artificially drained.

2.4.2.3 Black Creek

This watercourse travels through mainly agricultural lands. The majority of the area is artificially drained.

2.4.2.4 Whirl Creek

Whirl Creek is located in an area that is predominantly agriculture, with the majority of the area is artificially drained. Nearly the entire creek has been channelized.

2.4.2.5 North Woodstock Subwatershed

Land use in the North Woodstock subwatershed is mainly agriculture. Over half the area has retained its natural drainage system. The majority of this area has had some alterations carried out. The preferred corridor does not cross any of the watercourses within the watershed.