Final

SUBWATERSHED IMPACT STUDY
HALTON HILLS GENERATING STATION

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1.0 INTRODUCTION

This Subwatershed Impact Study (SIS) report addresses a land parcel within the 401 Corridor between 6th Line South and 5th Line South (see Figure 1-1), which encompasses the SIS site. A Scoped Subwatershed Plan (SSP) was prepared for the 401 Corridor, which established watershed policies, objectives, constraints and management techniques based on generic and/or conceptual planning information (Dillon, 2000). The Town of Halton Hills has determined that for future development of lands within the Corridor a SIS is required to provide site-specific environmental and engineering information that addresses the directives of the SSP. Halton Hills (2006) outlines the study requirements of a SIS for a proposed development within the 401 Corridor.

The SIS site consists of three properties owned respectively from east to west by:

- TransCanada Energy Ltd. (TCE)
- Giffels Associates Ltd. (Giffels)
- Lawrence Group Inc. (LGI)

An additional land parcel located just outside the SIS site (north of Steeles Avenue and west of 6th Line North) contributes to the total drainage of the SIS site. This area is included in the SIS drainage boundary only for its drainage contribution, however it is not included in the SIS site since it is not part of the developed area.

TCE, a wholly-owned subsidiary of TransCanada Corporation is developing the Halton Hills Generating Station (HHGS), in response to the Ontario Power Authority (OPA) procurement for new power generation in the Greater Toronto Area (GTA) west of Toronto. The HHGS is a natural gas-fired combined cycle facility with a generating capacity of a maximum of 683 MW of power. The HHGS will be situated in the Town of Halton Hills on a site located between Highway 401 and Steeles Avenue, west of 6th Line. The HHGS property occupies approximately 30 ha of land of which 7.5 ha will be occupied by the generating station and its associated facilities (see Figure 1-2).

The LGI development property is approximately 25 ha in area and is bounded by Steeles Avenue to the north, 5th Line South, MTO property to the west, Highway 401 and the Giffels property to the east. The proposed development will be an Industrial Park. At present, the development concept consists of four blocks to be developed with land uses as set out in the Zoning By-law (see Figure 1-2).

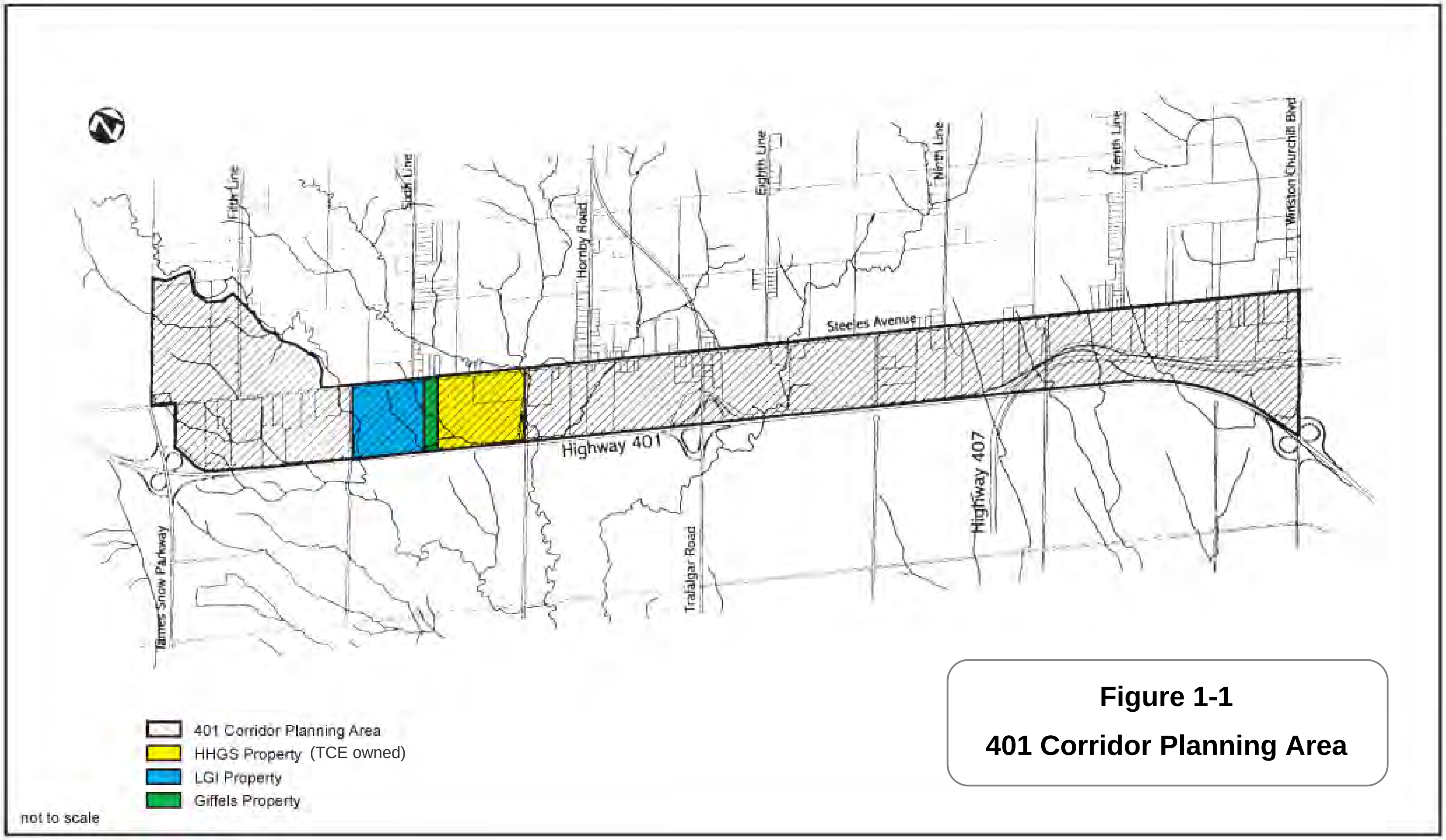
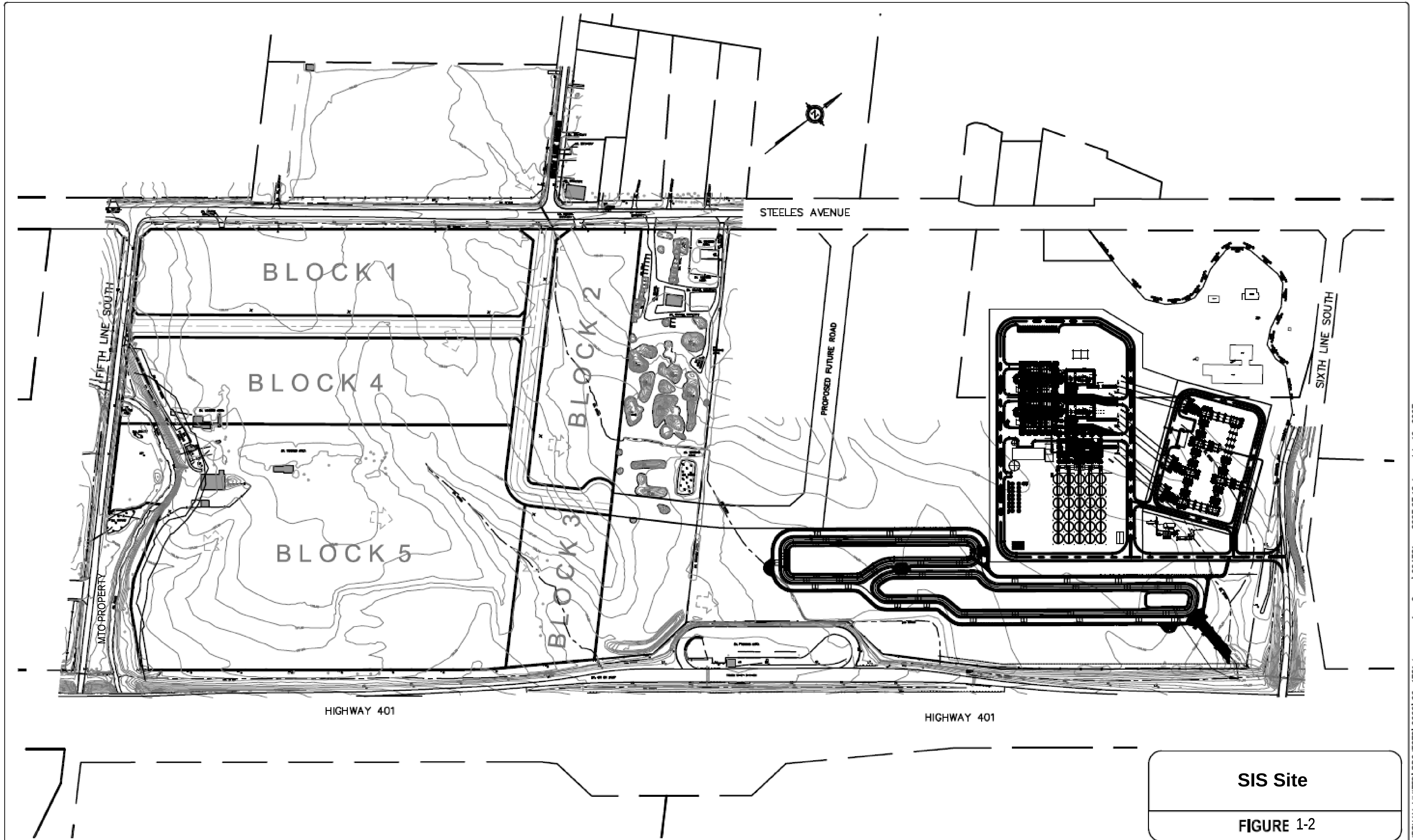


Figure 1-1

401 Corridor Planning Area



SIS Site

FIGURE 1-2

Currently there are no development plans for the Giffels property.

The proposed developments on the SIS site are compatible with the 401 Corridor Plan, incorporating on-site stormwater management facilities that will service future nearby developments. Most importantly, developments on the SIS site will ensure the permanent protection of significant valleylands and enhancement of forest composition/structure and fish habitat, and through these protection and enhancement measures provide connectivity with other natural vegetation communities.

It is intended that TCE will own and operate the proposed Stormwater Management (SWM) facility for the initial phase of operation until performance requirements are met after which time the ownership, operation and maintenance will be conveyed to the Town of Halton Hills.

1.1 FORMAT OF REPORT

This report prepared for the SIS site follows the overall guidance of and addresses all of the key items provided in the Terms of Reference (Halton Hills, 2006). The report first considers the natural attributes associated with the SIS site and efforts to ensure the maintenance of the integrity and health of the natural environment during and post development. The next section describes a conceptual design of the required SWM facility to ensure that the post-development stormwater flow is equal to or less than the pre-development flow. This section also outlines how the SWM facility will be constructed, operated and maintained including discussion of mitigation measures. Having outlined the SWM facility location and characteristics, the final section describes the grading plans to direct stormwater drainage to the facility. Each section is outlined below:

Chapter 2: Natural Environment

- Detailed assessment/treatment of open watercourse systems.
- Detailed assessment of terrestrial resources and associated ecological functions.
- Conceptual plan demonstrating a net gain in habitat and/or ecological functions.
- Preliminary environmental protection plans.
- Conceptual plan of proposed habitat/ecological function enhancement and environmental protection integrating with the Natural Heritage System (NHS) identified in the SSP.

Chapter 3: Stormwater Management Facility

- Conceptual design of stormwater management facilities.
- Operation, maintenance and monitoring considerations.
- Land ownership and cost sharing considerations.

Chapter 4: Proposed Storm Drainage

- Detailed gradients for major and minor systems.

In addition, there are a number of appendices to the report and four supporting documents:

- Supporting Document 1 - Geotechnical Investigation for the HHGS property
- Supporting Document 2 - Slope Stability Analyses for the HHGS property
- Supporting Document 3 - Hydrogeological Investigation for the HHGS property
- Supporting Document 4 - Subsurface Investigation and Slope Stability Analysis for the LGI property

2.0 NATURAL ENVIRONMENT

2.1 AQUATIC RESOURCES

2.1.1 Watershed Description

The 401 Corridor Planning Area is situated centrally within the eastern part of the Sixteen Mile Creek watershed, which encompasses a total area of 377 km^2 primarily within the Regional Municipality of Halton (Halton Region) (Dillon, 2000). The Corridor also covers a small portion of the Credit River watershed at its northeastern corner and extends to within the Region of Peel at its eastern boundary.

The Sixteen Mile Creek watershed is composed of three extensive drainage basins encompassing nine subwatersheds (see Figure 2-1):

1. the West Branch;
2. the Middle and East Branches; and
3. the downstream reaches below the confluence of the two upper drainage basins (Ecoplans Ltd., 1995; Gore & Storrie/Ecoplans, 1996).

The headwaters of the West Branch and Middle Branch occur on the Niagara Escarpment. The eastern tributaries of the Middle Branch and the East Branch arise from the South Slope physiographic region, a ground moraine with an undulating surface created by a series of irregular knolls and hollows (Chapman and Putnam, 1984). Most of the headwater tributaries are, or were historically, groundwater fed.

For the West Branch, the network of small headwater tributaries converges at the Kelso Reservoir below the escarpment. Through urban Milton, the main stream channel and a portion of a tributary flow through concrete channels. Downstream of Milton and Highway 25, the West Branch flows through predominantly rural lands to converge with the Middle Branch-East Branch system southeast of Lower Baseline Road and Highway 25.

The headwaters of Middle Branch flow down and along the base of the escarpment and through the Scotch Block Reservoir. Downstream of the reservoir, the watercourse traverses predominantly agricultural lands for crop production with scattered small rural hamlets also present. The Middle Branch and East Branch converge just upstream of the community of Drumquin in the vicinity of Britannia Road and Trafalgar Road, about 11 km upstream of the confluence with the West Branch. The Middle Branch and East Branch drain predominantly agricultural lands with flat to rolling topography.

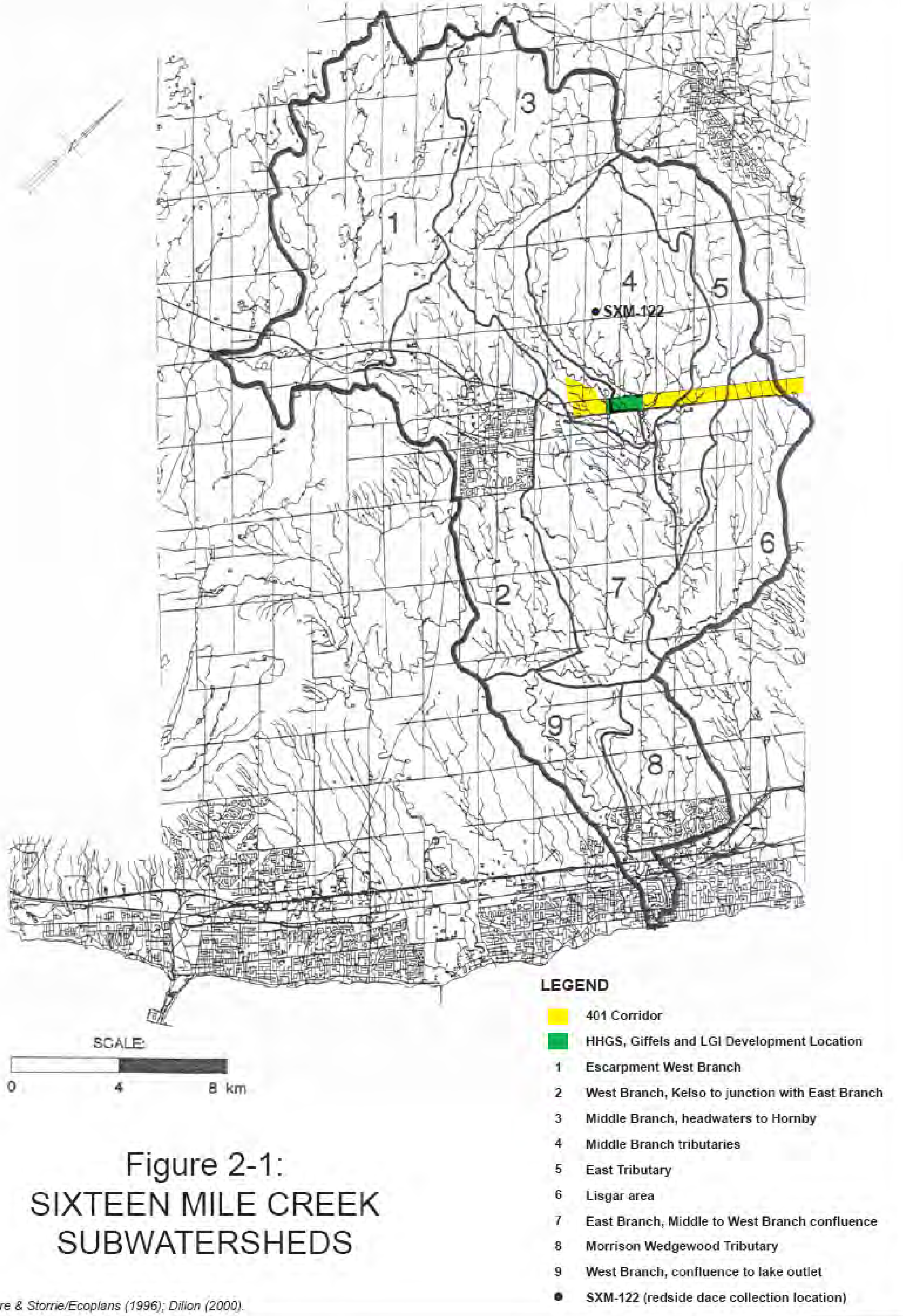


Figure 2-1:
SIXTEEN MILE CREEK
SUBWATERSHEDS

Source: Gore & Storrie/Ecoplans (1996); Dillon (2000).

Downstream of Drumquin, the Sixteen Mile Creek flows through a deep valley carved into the Trafalgar Moraine. The lower reach flows through the Town of Oakville to outlet into Lake Ontario at Oakville Harbour.

With a total area of 620 ha, the 401 Corridor bisects the lower reaches of Subwatershed 3 (Middle Branch, headwaters to Hornby) and 4 (Middle Branch tributaries), the middle reaches of Subwatershed 5 (East Tributary), as well as the upper reaches of Subwatershed 6 (Lisgar area) (see Figure 2-1). The 401 Corridor occupies only a small portion of the five subwatersheds on both an individual and collective basis.

The SIS site is limited to Subwatersheds 3 and 4. The HHGS and Giffels properties are located in Subwatershed 4 only. The LGI property is located in Subwatersheds 3 and 4.

Subwatershed 3 encompasses the Middle Branch of Sixteen Mile Creek with a drainage area of approximately 5,540 ha extending over a distance of 18 km from the headwaters on the Niagara Escarpment to its confluence with its Main Eastern Tributary in the vicinity of 6th Line South and the CP Railway System (CP) railway corridor. The Middle Branch traverses the southwestern portion of the LGI property within 80 m east of 5th Line South.

Subwatershed 4 encompasses a total area of 4,200 ha of land and forms the eastern part of the overall drainage system associated with the Middle Branch (Dillon, 2000). The main watercourses in Subwatershed 4 traversing the 401 Corridor include the Main Eastern Tributary of the Middle Branch and the Hornby Tributary, which converge within the Corridor north of Highway 401. The Main Eastern Tributary traverses the northeastern corner of the HHGS property extending upstream north of Steeles Avenue and downstream east of 6th Line South. An ephemeral drainage system traverses all three properties collecting at a ditch extending along the north side of the Highway 401 corridor and discharges to the Main Eastern Tributary. The Main Eastern Tributary converges with the Middle Branch about 1.5 km downstream of the HHGS property south of the Hydro One and CP transmission/railway corridor.

2.1.2 Hydrogeology

Regionally, there are two major aquifer systems: the overburden aquifers consisting of the Till Complex, Valley Fills and Outwash Channel Deposits aquifers, and the underlying bedrock aquifers consisting of the Amabel Dolomite aquifer and the Queenston Shale aquifer (Gore & Storrie, 1995). The majority of the water wells obtain groundwater from the bedrock, as the overburden across most of the region is generally thin and does not yield adequate quantities of water. In the Peel Plain, the wells are completed in the sand and gravel lenses in the till or in the weathered zone of the Queenston shale.

The SIS site is located on the Till Complex (mainly Halton Till) overburden aquifer system. It is highly variable in composition and is generally considered to consist of relatively low permeability sandy silt to silty clay. The hydraulic conductivity of the till ranges from 1.1 x 10^{-5} m/s to 2.2 x 10^{-5} m/s (Ostry, 1979). Groundwater is obtained primarily from sand and gravel lenses within the till. Groundwater yields from overburden are typically less than 1 L/s, which is generally suitable for domestic purposes (OMNR, 1984).

The SIS site is also located in the underlying Queenston Shale bedrock aquifer system. The shale bedrock is generally classed as a confining layer forming the base of the groundwater flow system. This aquifer system is regionally significant because of a scarcity of high-yielding overburden aquifers. The transmissivity of this aquifer is relatively low, with calculated mean values of about 6.6 x 10^{-6} m^2/s (Funk, 1979) and 4.97 x 10^{-5} m^2/s (Ostry, 1979). The yields from bedrock are also typically less than 1 L/s (OMNR, 1984). The yields in this formation depend on the fracture pattern, degree of weathering, and in some cases, the nature of the immediately overlying formation. A very few wells yield 3.2 L/s or more (Gore & Storrie, 1995).

In the 401 Corridor between 5th Line and 6th Line, static water levels are in the range of 2 to 5 m below grade, with groundwater recharge expected to be very low, typically 50 to 100 mm/y (Dillon, 2000). During HHGS property geotechnical investigations, the groundwater levels were measured in June 2006 to be 0.23 to 0.96 m below ground surface (see Supporting Document 1). A localized basal sand aquifer is present below the clay till sitting within a local bedrock depression on most of the HHGS property (Dillon, 2000). This aquifer is capable of yielding 0.7 L/s which is approximately twice the yield of wells elsewhere in the Hornby area.

Additional site-specific groundwater information is provided in Chapter 3.

2.1.3 Sixteen Mile Creek Hydrology

Historical hydrological data are available for two Water Survey of Canada (WSC) streamflow gauge locations on Sixteen Mile Creek (see Table 2-1). These data indicate that the greatest streamflows occur during the spring freshet in March and April, with lowest flows occurring during the summer and fall months of June to October.

TABLE 2-1
MONTHLY AND ANNUAL MEAN, MINIMUM AND MAXIMUM DISCHARGES (m^3/s), SIXTEEN MILE CREEK[1]

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
East Sixteen Mile Creek near Omagh[2]													
Mean	1.35	2.23	4.83	3.50	1.39	0.543	0.311	0.321	0.564	0.567	1.25	1.69	1.54
Minimum	0.038	0.078	0.832	0.564	0.150	0.067	0.010	0.019	0.017	0.026	0.087	0.058	0.531
Maximum	6.11	9.88	10.8	8.99	5.93	2.71	1.18	2.32	7.04	3.69	8.04	6.16	2.80
Sixteen Mile Creek at Milton[3]													
Mean	1.08	1.30	2.43	2.71	1.56	0.779	0.529	0.440	0.625	0.646	1.01	1.14	1.20
Minimum	0.128	0.207	0.943	0.608	0.314	0.269	0.167	0.147	0.091	0.106	0.127	0.160	0.525
Maximum	3.61	3.56	5.31	5.81	4.41	1.68	1.35	1.46	3.26	4.15	4.45	2.88	1.92

[1] Source: T. Arsenault, WSC, 2006, pers. comm.
[2] Station O2HB004; Latitude: 43°29’56”N, Longitude: 79°46’36”W; Drainage area: 199.0 km^2; Period of record: 1957 – 2004.
[3] Station O2HB005; Latitude: 43°30’50”N, Longitude: 79°52’47”W; Drainage area: 95.60 km^2; Period of record: 1957 – 2005.

2.1.4 Sixteen Mile Creek Water Quality

Ecoplans Ltd. (1995) reported that the Middle Branch of Sixteen Mile Creek downstream of the Scotch Block Reservoir is characterized by constantly changing habitat conditions, including pool and riffle sequences with suitable in-stream cover and riparian buffers through most stretches, and wide slow-moving flats devoid of cover and heavily silted through stretches surrounded by pasture and cropland. During an August 23rd 1993 survey, water temperature and dissolved oxygen (D.O.) concentration at a location just upstream of Steeles Avenue were 17.6°C and 10.46 mg/L, respectively, indicative of an oxygen saturation of 110%. This reach through pastureland was affected by unlimited cattle access to the watercourse.

Ecoplans Ltd. (1995) also reported that the Main Eastern Tributary generally exhibits characteristics associated with agricultural impacts. These characteristics include little or no overhead cover, lack of in-stream cover, silt accumulation, sluggish flow, elevated water temperatures and limited buffers. During the August 23rd 1993 survey, turbid flow was observed in the Main Eastern Tributary draining the HHGS property, near the intersection of Steeles Avenue and 6th Line (Ecoplans Ltd., 1995). The D.O. concentration of 9.78 mg/L and water temperature of 16.8°C were indicative of an oxygen saturation of 101%.

The D.O. concentrations and oxygen saturation levels at both locations on August 23rd 1993 were above the Provincial Water Quality Objectives (PWQOs) for the protection of coldwater (i.e., 6 mg/L D.O. and 54% saturation at 15°C) and warmwater (i.e., 5 mg/L D.O. and 47% saturation at 15°C) biota (MOEE, 1994).

Based on benthic macroinvertebrate community structure, the Middle Branch upstream of its confluence with the East Branch has very poor water quality (Ecoplans Ltd., 1995). The organisms present and the low Shannon-Weaver diversity index values were indicative of high nutrient and turbidity conditions and organic pollution.

Dillon (2000) provides water quality data for more parameters for the Middle Branch and its Main Eastern Tributary upstream and downstream of Steeles Avenue (see Table 2-2). The concentrations of all applicable parameters were below their respective PWQOs with the exception of pH at Station 3B, total phosphorus at Stations 3A, 3C and 4A, total coliform at Station 3A, iron at Stations 3A and 4A, and aluminum at Stations 3A, 4A and 4B (however, it is unlikely that the aluminum analysis were based on clay-free samples as required for comparison with the interim PWQO). Organochlorine contaminants were also analyzed with the concentrations well below the PWQOs.

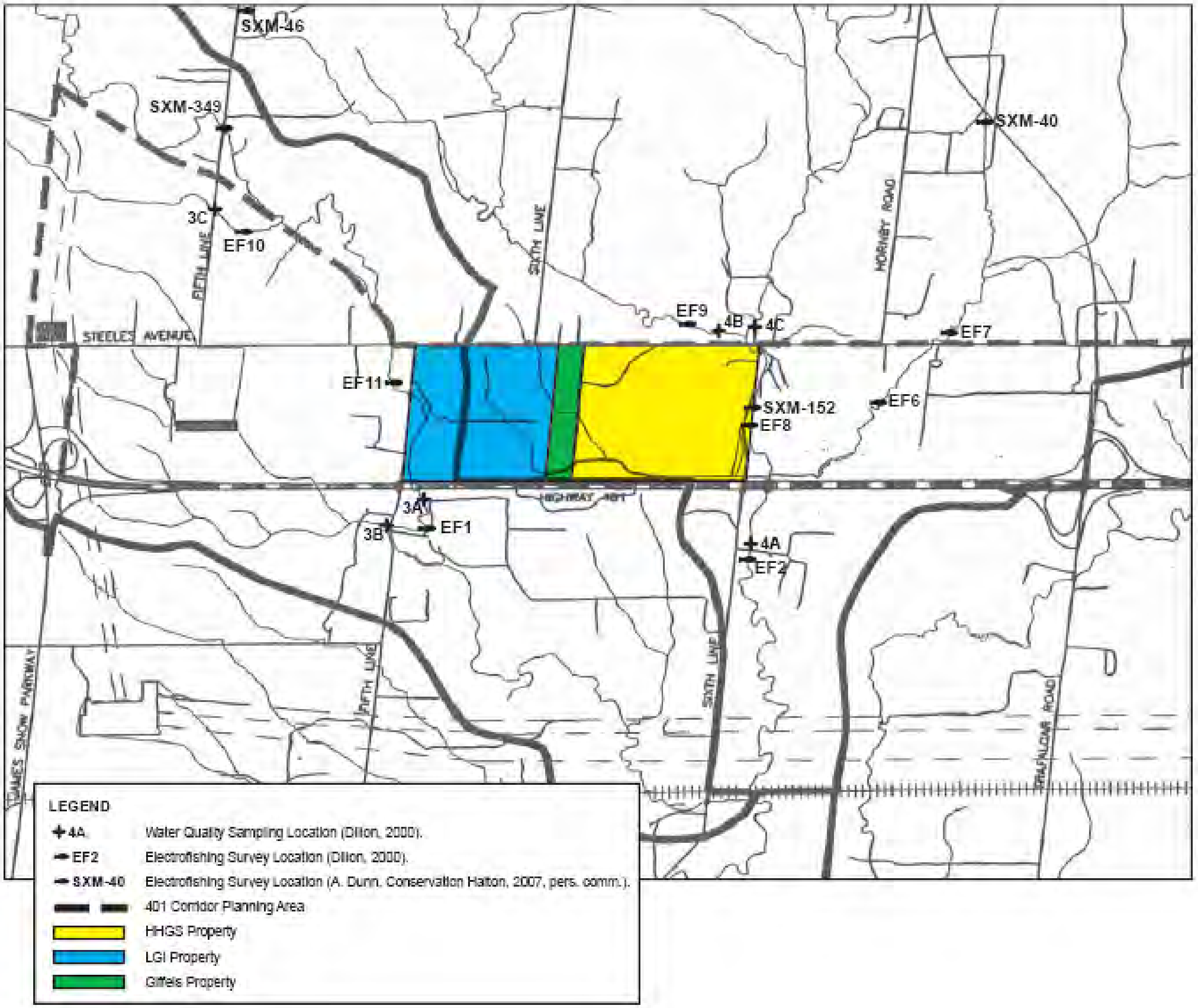
TABLE 2-2
WATER QUALITY DATA FOR THE MIDDLE BRANCH AND ITS MAIN EASTERN TRIBUTARY UPSTREAM AND DOWNSTREAM OF STEELES AVENUE[1]

Parameter	Concentration (mg/L unless otherwise indicated)						
	Station[2]						MOEE (1994) PWQO[3]
	3A	*3B*	*3C*	*4A*	*4B*	*4C*	
pH (units)	8.36	8.58	8.06	8.40	8.33	8.30	6.5-8.5
Total Dissolved Solids	320	1,736	338	386	334	261	-
Total Phosphorus	0.045	0.010	0.052	0.171	0.023	0.011	0.03[4]
Nitrate (as N)	1.0	<0.2	<0.2	2.2	1.1	3.8	-
Chloride	45.0	905.0	93.5	61.9	40.5	37.8	-
Fecal Coliform (/100 mL)	35	48	<1	24	50	27	100[5]
Total Coliform (/100 mL)	2,600	230	150	200	70	50	1,000[5]
Aluminum	0.370	0.031	0.075	0.367	0.117	0.050	0.075[6]
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.100
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.100
Cobalt	0.0003	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.0006[4]
Copper	0.0025	0.0034	0.0025	0.0025	0.0016	0.0009	0.005
Iron	0.56	<0.03	<0.03	0.65	0.23	<0.03	0.300
Lead	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	0.010
Manganese	0.086	0.023	0.01	0.083	0.062	0.029	-
Molybdenum	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.010[4]
Nickel	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.025
Silver	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Vanadium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.007[4]
Zinc	0.005	0.007	0.003	0.011	0.023	<0.002	0.030

1 Source: Dillon (2000).
2 See Figure 2-2 for sampling locations.
3 PWQO = Provincial Water Quality Objective.
4 Interim PWQO.
5 Prior to May 1st 1994, recreational water quality guidelines were based on fecal coliform and total coliform (MOE, 1984); currently, the guideline is based on *Escherichia coli*.
6 At pH > 6.5 to 9.0, the Interim PWQO is 0.075 mg/L based on total aluminum measured in clay-free samples.

Hydrologic, substrate and water quality information was compiled for the Main Eastern Tributary during a fisheries resources survey undertaken on June 26th 2006 (see Section 2.1.7). Water temperature, D.O. and conductivity were measured *in situ* using a handheld YSI model 85 multimeter, whereas pH was measured using a WTW model pH330. This information is presented in Table 2-3. At Station 2 just downstream of the eastern boundary of the HHGS

Figure 2-2: Water Quality Sampling and Fish Survey Locations



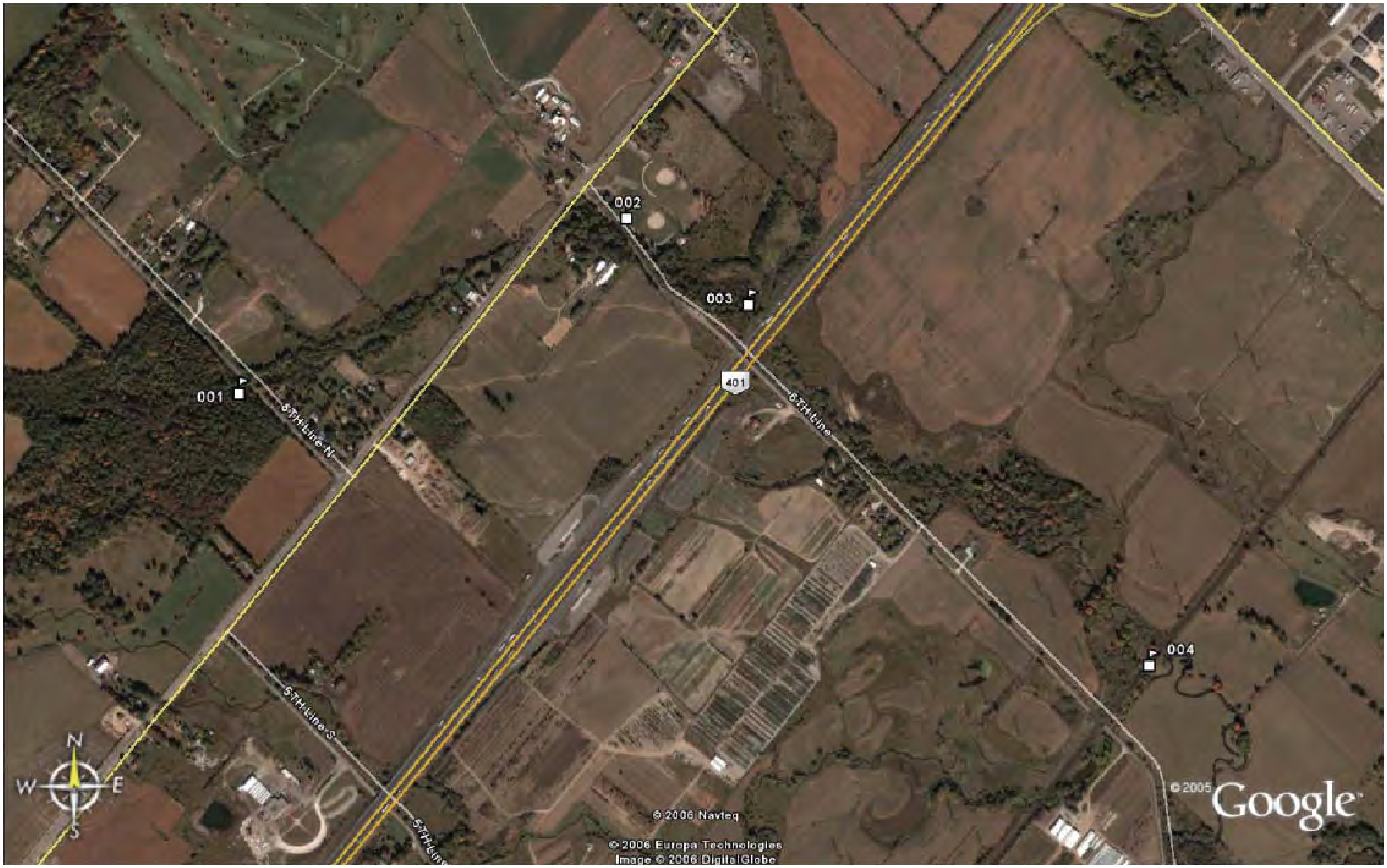
property, mean channel width was 2.5 m, mean water depth was 0.3 m and flow velocity was 0.15 m/s. The substrate was a silty sand with some gravel, cobble and boulder. The D.O. concentration was 7.69 mg/L indicative of oxygen saturation of 82%, both in compliance with the PWQOs for coldwater and warmwater biota. Conductivity was 661 µmhos/cm. The pH of 8.15 was within the PWQO range of 6.5 to 8.5. The water was turbid at this station location whereas clear water conditions occurred at the upstream and downstream station locations (see Table 2-3). Turbid waters were also observed on June 7th 2006. The source of this turbidity is upstream of Steeles Avenue and may be associated with irrigational watertaking or other agricultural activities.

TABLE 2-3
HYDROLOGIC, SUBSTRATE AND WATER QUALITY DATA FOR THE MAIN EASTERN TRIBUTARY

Parameter	Station 1[1]	Station 2	Station 3	Station 4
Flow Velocity (m/s)	0.2	0.15	0.2	0.15
Mean Width (m)	3	2.5	2.5	3.5
Mean Depth (m)	0.2	0.3	0.2	0.35
Substrate Type (%):				
Boulder	0	10	5	10
Cobble	15	5	60	20
Gravel	30	10	10	20
Sand	30	40	5	35
Silt	10	35	10	15
Clay	15	0	10	0
Water Temperature (°C)	18.9	18.1	20.3	21.0
Dissolved Oxygen (mg/L)	7.00	7.69	10.34	11.12
Oxygen Saturation (%)	76	82	110	126
Conductivity (µmhos/cm)	599	661	640	668
pH (units)	7.89	8.15	8.54	8.49
Water Colour	blue/green	blue/green	blue-green	blue-green
Water Clarity	clear	turbid	clear	Clear

1 See Figure 2-3 for station locations.

Figure 2-3: Fish Survey Sampling Locations, June 26th 2006



2.1.5 Sixteen Mile Creek Fisheries Resources

Most upstream reaches of the West Branch and Middle Branch exhibit low water temperatures associated with groundwater discharge and habitat conditions capable of supporting coldwater fisheries, e.g., brook trout (*Salvelinus fontinalis*) (Ecoplans Ltd., 1995). The upstream reaches of the East Branch also exhibit lower water temperatures. Water temperatures increase downstream from the headwater areas of all branches as they flow through agricultural and urban lands. With overhead cover lacking throughout much of the central watershed, and thermal radiation effects evident in the southern reaches of the creek, the central and lower reaches support primarily warmwater fisheries.

Much of the Sixteen Mile Creek system has been influenced considerably by surrounding land use patterns, including agriculture and urban development. Intensive agricultural practices such as cultivation and livestock grazing and urbanization of stream corridors have degraded physical stream habitat conditions and water quality, and subsequently decreased fish habitat quality. Deterioration of fish habitat quality in the Sixteen Mile Creek system is related to increases in temperature, siltation and sedimentation, as well as reduction of in-stream, overhead and riparian cover. These impacts have in turn contributed to the loss of protective stream buffers, increased nutrient loadings, and alteration of channel morphology, affecting physical habitat structure and diversity. Good quality habitat is generally confined to the escarpment and upper reaches where bedrock, topography and/or location have reduced agricultural and urban pressures.

Table 2-4 presents the 51 fish species recorded in the Sixteen Mile Creek watershed. The historical range of the native coldwater fishery (brook trout) occurred across the entire headwaters of the watershed, extending as far downstream as Milton on the West Branch and downstream to Derry Road on the Middle Branch and East Branch. Brown trout were noted historically along the West Branch downstream to Milton where they still persist. Resident brown trout and lake-run rainbow trout utilize the remnant coldwater reaches upstream of Milton to Kelso Reservoir as spawning and rearing habitat. Rainbow trout also utilize spawning and rearing habitat on the upper Middle Branch between 5th Line and the Scotch Block Reservoir. Several of the Middle Branch and East Branch tributaries draining the South Slope are groundwater fed maintaining coldwater temperatures. Some of these support redside dace, which is designated as a species of special concern federally and as a threatened species provincially.

TABLE 2-4
FISH SPECIES RECORDED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name	Scientific Name	Recorded in Middle Branch[2,3]	Recorded in Main Eastern Tributary[2,4]
Sea lamprey	*Petromyzon marinus*		
American eel	*Anguilla rostrata*		
Alewife	*Alosa pseudoharengus*		
Goldfish	*Carassius auratus*		
Redside dace[5]	*Clinostomus elongatus*	X	X
Lake chub	*Couesius plumbeus*		
Common carp	*Cyprinus carpio*	X	X
Brassy minnow	*Hybognathus hankinsoni*	X	X
Common shiner	*Luxilus cornutus*	X	X
Pearl dace	*Margariscus margarita*		
Hornyhead chub	*Nocomis biguttatus*	X	
River chub	*N. micropogon*	X	
Golden shiner	*Notemigonus crysoleucas*		
Emerald shiner	*Notropis atherinoides*	X	X
Bridle shiner	*N. bifrenatus*		
Spottail shiner	*N. hudsonius*	X	
Rosyface shiner	*N. rubellus*	X	X
Mimic shiner	*N. volucellus*		
Northern redbelly dace	*Phoxinus eos*	X	X
Bluntnose minnow	*Pimephales notatus*	X	X
Fathead minnow	*P. promelas*	X	X
Blacknose dace	*Rhinichthys atratulus*	X	X
Longnose dace	*R. cataractae*	X	X
Creek chub	*Semotilus atromaculatus*	X	X
White sucker	*Catostomus commersoni*	X	X
Northern hognose sucker	*Hypentelium nigricans*	X	X
Brown bullhead	*Ameiurus nebulosus*	X	
Yellow bullhead	*A. natalis*		
Stonecat	*Noturus flavus*	X	X
Northern pike	*Esox lucius*		
Central mudminnow	*Umbra limi*	X	
Coho salmon	*Oncorhynchus kisutch*		
Rainbow trout	*O. mykiss*	X	X
Chinook salmon	*O. tshawytsha*		
Brown trout	*Salmo trutta*		
Brook trout	*Salvelinus fontinalis*		X

TABLE 2-4 (Cont'd)
FISH SPECIES RECORDED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name	Scientific Name	Recorded in Middle Branch[2,3]	Recorded in Main Eastern Tributary[2,4]
Banded killifish	*Fundulus notatus*		
Brook stickleback	*Culaea inconstans*	X	X
Mottled sculpin	*Cottus bairdii*	X	
Rock bass	*Ambloplites rupestris*	X	X
Green sunfish	*Lepomis cyanellus*		
Pumpkinseed	*L. gibbosus*	X	X
Bluegill	*L. macrochirus*		
Longear sunfish	*L. megalotis*		
Smallmouth bass	*Micropterus dolomieu*	X	X
Largemouth bass	*M. salmoides*	X	
Black crappie	*Pomoxis nigromaculatus*	X	
Rainbow darter	*Etheostoma caeruleum*	X	X
Fantail darter	*E. flabellare*	X	X
Johnny darter	*E. nigrum*	X	X
Yellow perch	*Perca flavescens*		

[1] Source: Ecoplans Ltd. (1995).
[2] A. Dunn, Conservation Halton, 2007, pers. comm.
[3] Subwatershed 3 (see Figure 2-1).
[4] Subwatershed 4 (see Figure 2-1).
[5] Designated as a species of special concern federally by COSEWIC (2007) as well as a threatened species provincially by COSSARO (OMNR, 2006).

The lower main stream reaches support resident warmwater sportfish communities that include a diverse assemblage of sportfish, panfish and forage species. These reaches provide migratory corridors for lake-run rainbow trout to upstream spawning habitat. Chinook salmon and coho salmon also migrate upstream from Lake Ontario.

Of the 51 fish species listed in Table 2-4, 31 and 20 species have been documented in the Middle Branch and its Main Eastern Tributary, respectively. The Main Eastern Tributary joins the Middle Branch south of Highway 401 in the vicinity of the Hydro One corridor.

Historically, the Middle Branch supported brook trout from its headwaters to Steeles Avenue (Ecoplans Ltd., 1995). The construction of the Scotch Block Reservoir likely eliminated the population downstream, but it is possible that remnant populations exist in the headwater areas.

Below Scotch Block Reservoir, the Middle Branch was designated by the Ontario Ministry of Natural Resources (OMNR) as a Type 3 warmwater sportfish habitat stream based on the presence of smallmouth bass (Ecoplans Ltd., 1995). However, based on a fish survey conducted in September 1993, young-of-the-year (YOY) rainbow trout were documented in the Middle Branch from below the reservoir downstream to 5th Line, indicating successful spawning of lake-run fish in this reach of Middle Branch. As a result, the reach from Scotch Block Reservoir to Fifth Line has been designated as coldwater (Ecoplans Ltd., 1995).

Rainbow trout enter spawning streams in the Great Lakes from late October to early May and spawn from late December to late April (Dodge and MacCrimmon, 1970). The eggs are deposited in a redd (nest) dug by the female in gravel. Fry emerge from the nests from mid-June to mid-August.

Ecoplans Ltd. (1995) designated two of the headwater tributaries of the Main Eastern Tributary as potential coldwater areas because of the low baseflow temperatures. There had been unconfirmed reports of brook trout in the vicinity of the golf course immediately northwest of Hornby (Ecoplans Ltd., 1995). However, the fish community documented by Ecoplans Ltd. (1995) in this drainage area was composed largely of centrarchids (sunfish family), cyprinids (minnow family) and catastomids (sucker family) associated with warmwater conditions, including smallmouth bass, pumpkinseed, creek chub, shiners and white sucker. Subsequent surveys determined the presence of brook trout and rainbow trout in the Main Eastern Tributary (see Section 2.1.7).

Redside dace occurs in abundance about 4 km upstream of the HHGS property in the tributary draining lands near 5th Sideroad east of 5th Line (Ecoplans Ltd., 1995). The sampling site designated as SXM-122 is shown on Figure 2-1. The redside dace which was designated as a species of "special concern" federally has recently been elevated (Avril 2007) as "endangered" on Schedule 3 under the *Species at Risk Act* pending public consultation for addition to Schedule 1. As well, redside dace is considered a threatened species provincially by the Committee on the Status of Species at Risk in Ontario (COSSARO) (OMNR, 2006). Redside dace and its habitat are protected under the Ontario *Endangered Species Act.* This species inhabits pools and slow moving sections of cool, clear headwater streams with pool and riffle habitats (McKee and Parker, 1982; Parker *et al.*, 1988). Creek chub, blacknose dace and white sucker were also captured by electrofishing at this location (Ecoplans Ltd., 1995). In contrast, only creek chub and pumpkinseed were captured in the same tributary about 1 km upstream of the HHGS property.

Sampling site SXM-122 was resurveyed in September 2003 resulting in the collection of 33 redside dace, 177 blacknose dace, 76 creek chub, one brook stickleback, one pumpkinseed and 10 johnny darter (A. Dunn, Conservation Halton, 2007, pers. com.).

2.1.6 SIS Site Middle Branch Reach Fisheries Resources

The Middle Branch reach on the LGI property, i.e., downstream of Steeles Avenue east of 5th Line, is meandering with banks consisting of clay, silt and fine sand (Dillon, 2000). The channel is characterized by bank instability with undercut banks and slumping of the higher downstream left-bank throughout the reach. Bankfull channel width is approximately 10 m with an active channel width of 4 m. Well-defined pool and riffle sequences occur in-stream with pools being dominant and the riffle sections apparently created by the placement of concrete blocks, large cobble and other clast material. Overall, substrate is mainly silt and clay. During high discharge events, water in the channel can spill only onto the downstream right-bank floodplain. The riparian zone consists of herbaceous plants and grasses. Surrounding land is pasture and scrubland. At the time of the 1998 survey, goats were grazing on the bank top.

During an April 1999 survey, Dillon (2000) captured rainbow trout at a sampling location (EF11) between 5th Line and Steeles Avenue (see Table 2-5). Warmwater fish communities were encountered at sampling location EF10 upstream of Steeles Avenue and sampling location EF1 south of Highway 401.

TABLE 2-5
DILLON (2000) FISH SURVEY DATA FOR THE MIDDLE BRANCH IN THE VICINITY OF THE LGI PROPERTY

Common Name	Scientific Name	Survey Locations[1]		
		EF10	***EF11***	***EF1***
Common shiner	*Luxilus cornutus*	1	1	1
Bluntnose minnow	*Pimephales notatus*	-	-	5
Blacknose dace	*Rhinichthys atratulus*	28	18	15
Creek chub	*Semotilus atromaculatus*	5	11	12
White sucker	*Catostomus commersoni*	5	1	4
Northern hognose sucker	*Hypentelium nigricans*	-	4	2
Rainbow trout	*Oncorhynchus mykiss*	-	7	-
Brook stickleback	*Culaea inconstans*	1	-	1
Rock bass	*Ambloplites rupestris*	-	-	1
Rainbow darter	*Etheostoma caeruleum*	-	4	2
Johnny darter	*E. nigrum*	-	12	30

[1] See Figure 2-2 for survey locations.

Table 2-6 presents additional fish survey data for the Middle Branch at a location approximately 1.2 km upstream of Steeles Avenue. A similar fish community was present to that found at the downstream (Dillon, 2000) sampling locations, although longnose dace, stonecat, pumpkinseed and fantail darter were not recorded downstream, and brook stickleback was not found at the upstream location. Rainbow trout were collected at this upstream location on two of the three sampling days.

TABLE 2-6
FISH SURVEY DATA FOR THE MIDDLE BRANCH (SXM-349), APPROXIMATELY 1.2 KM UPSTREAM OF STEELES AVENUE[1,2]

Common Name	Scientific Name	Survey Date		
		07/01	*08/05*	*07/06*
Common shiner	*Luxilus cornutus*	8	-	2
Bluntnose minnow	*Pimephales notatus*	-	2	12
Blacknose dace	*Rhinichthys atratulus*	10	1	5
Longnose dace	*R. cataractae*	9	1	4
Creek chub	*Semotilus atromaculatus*	18	10	45
White sucker	*Catostomus commersoni*	23	5	14
Northern hognose sucker	*Hypentelium nigricans*	5	1	3
Stonecat	*Noturus flavus*	1	3	-
Rainbow trout	*Oncorhynchus mykiss*	-	2	1
Rock bass	*Ambloplites rupestris*	2	-	-
Pumpkinseed	*Lepomis gibbosus*	-	-	2
Rainbow darter	*Etheostoma caeruleum*	30	13	32
Fantail darter	*E. flabellare*	32	23	23
Johnny darter	*E. nigrum*	7	20	41

1 Source: A. Dunn, Conservation Halton, 2007, pers. comm.
2 See Figure 2-2 for survey location.

2.1.7 SIS Site Main Eastern Tributary Reach Fisheries Resources

For the Main Eastern Tributary, there is a convergence of two tributary branches upstream of Steeles Avenue. These branches drain primarily agricultural lands. As the branches converge and pass under Steeles Avenue, the resulting active channel width is approximately 8 m and depth is 0.1 m (Dillon, 2000). Substrate consists of silt, large cobbles and submerged aquatic vegetation. Beyond Steeles Avenue, the watercourse meanders within the northeastern corner of the HHGS property. Beyond 6th Line, the watercourse traverses Hornby Park, where the steep eastern bank is covered with rip rap. Where not lined by rip rap, the bank is undercut. Substrate consists primarily of large cobble with fine sediment filling the voids. The watercourse flows south in a 3 to 4 m wide channel, with two riffles created by the large cobble. Beyond the park, wooded overstorey vegetation becomes more abundant.

The drainage swale, with no defined bed and banks, located in the southwest corner of the HHGS property (see Figure 2-3) is intermittent and does not provide fish habitat (Dillon, 2000). This drainage swale extends upstream as two minor drainage features trending in northwesterly direction onto the LGI property. This drainage system discharges to a ditch along the northern border of Highway 401 right-of-way which flows into the Main Eastern Tributary east of 6th Line.

Based on a site-specific assessment of these swales on March 14^{th} 2007, the reach downstream of the 6th Line bridge was assessed to provide direct fish habitat (S. Watson-Leung, Conservation Halton, 2007, pers. comm.). The reach upstream of the bridge along the Highway 401 corridor (south of the HHGS property) to its entry onto the HHGS property was assessed to provide indirect fish habitat (as a minimum). The remaining upstream section of the ditch on the SIS site provides no fish habitat (but does provide a surface water conveyance function). This assessment undertaken during less than ideal high flow conditions was repeated in June 2007 (see Section 2.1.8).

During an April 1999 survey, Dillon (2000) captured a single brook trout in the Main Eastern Tributary at a sampling location upstream of Steeles Avenue, as well as one brook trout and three rainbow darter at a sampling location downstream of Highway 401. Four rainbow darter were also collected in the reach between Steeles Avenue and Highway 401. Both of these species, particularly brook trout, are indicative of coldwater habitat. Localized groundwater inputs may contribute to the necessary conditions for brook trout survival during period of high water temperatures in the summer. The Dillon (2000) fish collection data for Sixteen Mile Creek Subwatershed 4 are provided in Table 2-7.

TABLE 2-7
DILLON (2000) FISH SURVEY DATA FOR THE VICINITY OF THE HHGS

Common Name	Scientific Name	Survey Locations[1]				
		EF2	***EF6***	***EF7***	***EF8***	***EF9***
Common shiner	*Luxilus cornutus*	9		2	5	
Bluntnose minnow	*Pimephales notatus*	5	9	2	4	2
Blacknose dace	*Rhinichthys atratulus*	5	28	2	20	4
Creek chub	*Semotilus atromaculatus*	4	6	8	6	18
White sucker	*Catostomus commersoni*	9	5	2	14	2
Northern hognose sucker	*Hypentelium nigricans*	2			1	
Brook trout	*Salvelinus fontinalis*	1				1
Brook stickleback	*Culaea inconstans*		4	1	1	1
Rock bass	*Ambloplites rupestris*	3		1		
Smallmouth bass	*Micropterus dolomieui*			1		1
Rainbow darter	*Etheostoma caeruleum*	3			4	
Johnny darter	*E. nigrum*	27	9	11	14	5

1 See Figure 2-2 for survey locations.

Table 2-8 presents additional available fish survey data for the Main Eastern Tributary in the vicinity of the HHGS property. Redside dace were collected at survey location SXM-46 approximately 2.5 km upstream of the HHGS property east of 5th Line, whereas brook trout were captured downstream of the HHGS property in Hornby Park.

TABLE 2-8
ADDITIONAL FISH SURVEY DATA FOR THE VICINITY OF THE HHGS[2]

Common Name	Scientific Name	Survey Locations[2]			
		SXM-152		***SXM-46***	***SXM-40***
		08/05	***11/05***		
Redside dace	*Clinostomus elongatus*			3	
Common carp	*Cyprinus carpio*	2			
Brassy minnow	*Hybognathus hankinsoni*	1			
Common shiner	*Luxilus cornutus*			5	
Bluntnose minnow	*Pimephales notatus*	49	65	9	4
Fathead minnow	*P. promelas*			2	
Blacknose dace	*Rhinichthys atratulus*	1	4	13	35
Longnose dace	*R. cataractae*		1		
Creek chub	*Semotilus atromaculatus*	1	8	56	39
White sucker	*Catostomus commersoni*	76	29	15	2
Northern hognose sucker	*Hypentelium nigricans*		1		
Stonecat	*Noturus flavus*	1			
Brook trout	*Salvelinus fontinalis*		2		
Brook stickleback	*Culaea inconstans*	26		2	5
Rock bass	*Ambloplites rupestris*		7	3	
Smallmouth bass	*Micropterus dolomieu*	1	8		
Rainbow darter	*Etheostoma caeruleum*	10	9		13
Johnny darter	*E. nigrum*	193	19	38	45

1 Source: A. Dunn, Conservation Halton, 2007, pers. comm.
2 See Figure 2-2 for survey locations.

A fisheries survey was undertaken on June 26th 2006 at four locations in the vicinity of the HHGS property. Sampling methods followed standard operating procedures for conducting semi-quantitative fish collection based on the Ontario Stream Assessment Protocol (OSAP) screening approach sampling technique (Stanfield, 2007). The survey locations were (see Figure 2-3):

- Station 1: upstream (west) of 6th Line, north of Steeles Avenue;
- Station 2: downstream (east) of 6th Line, south of Steeles Avenue;
- Station 3: upstream (north) of Highway 401, east of 6th Line; and
- Station 4: upstream of the confluence with the Middle Branch, east of 6th Line.

Station co-ordinates were obtained using a Garmin GPSmap 60CSx.

Electrofishing was carried out under authority of Licence to Collect Fish for Scientific Purposes No. 1032583, issued by the OMNR, Aurora District.

The fish community was sampled at each stream station using a Smith-Root model 12 backpack electrofisher and dip net. One complete "sweep" was undertaken expending between 718 and 1042 seconds (s) of electrofishing time (see Table 2-9), along a stream reach of between 55 to 90 m. The level of effort required to characterize the fish community on a semi-quantitative basis was based on the habitat conditions at each location, including stream width and channel morphology, and entailed a thorough sampling of all habitats within the reach. Although effort was lower (approximately 12 to 17 minutes) than that recommended by OSAP (20 to 30 minutes), the intensity was comparable; all habitats were covered and electrofishing was continued until no new species were encountered. All collected fish were identified to species, enumerated and released live at the site of capture. Age classes were assigned (i.e., YOY, juvenile, adult) to each fish based on examination of the relative size by an experienced fisheries biologist. Species, effort, age classes and numbers of fish captured were recorded for each station on Fish Collection Forms. Additional information recorded included station number, watercourse name, coordinates, date, time, water temperature, length of stream sampled and mean channel width.

Habitat characteristics were measured or visually assessed and included flow velocity, water depth, channel width, substrate type, bank stability, stream morphology, stream gradient, channel type, canopy cover, in-stream cover, substrate, adjacent land use, presence of barriers, and aquatic and terrestrial vegetation.

Photographs of the sampling locations, stream habitat assessment forms, OMNR Field Collection Records, fish collection forms and fisheries biologist qualifications are provided in Appendix A.

This watercourse reach supports a typical warmwater fish community comprised largely of cyprinids, i.e., white sucker, blacknose dace, bluntnose minnow, creek chub and common shiner; percids, i.e., rainbow darter, johnny darter and fantail darter; and centrarchids, i.e., rock bass, pumpkinseed and smallmouth bass (Table 2-9). Two stonecat and one brook stickleback were also captured. Catch-per-unit-effort (CPUE) ranged from 6.4 to 14.5 fish per minute (Table 2-9).

YOY and/or juveniles of most species were collected indicating the presence of spawning and/or nursery habitat. Two YOY rainbow trout were also captured at Station 2. The collection of YOY rainbow trout suggests that this location provides spawning and/or nursery habitat. The presence of water cress (*Nasturtium* sp.) was also noted at this location, likely indicating groundwater inputs. Water temperature was lower at this station than at the upstream and downstream stations (see Table 2-3). With the recorded presence of brook trout (Dillon, 2000) and YOY rainbow trout, this reach of the Main Eastern Tributary provides coldwater habitat.

With the exception of redside dace, all of the fish species listed in Tables 2-5, 2-6, 2-7, 2-8 and 2-9 are considered to be common in Ontario and are not tracked by the OMNR Natural Heritage Information Centre (NHIC, 2007a).

TABLE 2-9
FISH SPECIES RECORDED IN THE MAIN EASTERN TRIBUTARY, 26 JUNE 2006

Fish Species	Station 1[1]		Station 2		Station 3		Station 4	
	Number	***Life Stage***[2]	***Number***	***Life Stage***	***Number***	***Life Stage***	***Number***	***Life Stage***
Common shiner	5	J, A					1	A
Bluntnose minnow	3	J, A	13	YOY, J, A	36	YOY, J, A	68	J, A
Blacknose dace	36	J, A	6	YOY, J, A	24	J, A		
Creek chub	17	J, A	5	YOY, J, A	3	J	6	J, A
White sucker	22	YOY, J, A	30	YOY, J, A	26	YOY, J	13	YOY, J, A
Stonecat			1	J	1	J		
Rainbow trout			2	YOY				
Brook stickleback	1	A						
Rock bass		J	5	J, A	3	J, A	16	J, A
Pumpkinseed					2	J	1	A
Smallmouth bass							2	J
Rainbow darter	33	J, A	14	J, A	48	YOY, J, A	20	J, A
Fantail darter					1	A		
Johnny darter	30	YOY, J, A	35	J, A	29	YOY, J, A	23	J, A
Total Number of Fish	147		111		173		150	
Electrofishing Effort (s)	718		1,042		718		1,004	
CPUE (no. of fish/minute)	12.3		6.4		14.5		9.0	

1 See Figure 2-3 for station locations.
2 Life stage: YOY = young-of-the-year; J = juvenile; A = adult.

2.1.8 Summary

The Middle Branch and its Main Eastern Tributary have been designated as significant valleylands in the SSP (Dillon, 2000), requiring permanent protection.

The presence of rainbow trout in the Middle Branch and brook trout and rainbow trout in its Main Eastern Tributary results in their classification as coldwater Type 1 habitat. A 30 m setback from the water channel is recommended for each side of a Type 1 watercourse (Dillon, 2000). Conservation Halton (2006) requires that any development will maintain a minimum setback of 30 m from the bankfull channel of any coldwater/coolwater watercourse and warmwater sportfish watercourse.

Due to the presence of redside dace approximately 2.5 km upstream (see Table 2-8), the OMNR has classified the watercourse section on the HHGS property as redside dace survival habitat, as part of the draft "*Redside Dace Recovery Strategy*" (S. Watson-Leung, Conservation Halton, 2007, pers. comm.). As a result, a 30 m meander belt setback was recommended to protect this habitat.

Based on a survey undertaken by SENES in June 2007, the drainage ditches (swales) on the SIS site were determined to provide no fish habitat (but do provide a surface water conveyance function). Most of the highway drain along the northern border of the Highway 401 corridor between 6th Line and 5th Line also provides no fish habitat. Indirect fish habitat occurs in the reach just upstream and downstream of the 6th Line bridge, as well as just east of 5th Line.

Additional hydrologic features include a cattail wetland (see Section 2.2.3) and groundwater discharge along the northern border of the HHGS property, providing no and indirect fish habitat, respectively. An off-line pond providing no fish habitat is present on the Giffels property.

Figure 2-4 presents the fish habitat status of the watercourses and drainage features on the SIS site, whereas Table 2-10 provides a summary of the site drainage feature characteristics. Photographs of the watercourses and drainage features are provided in Appendix B.

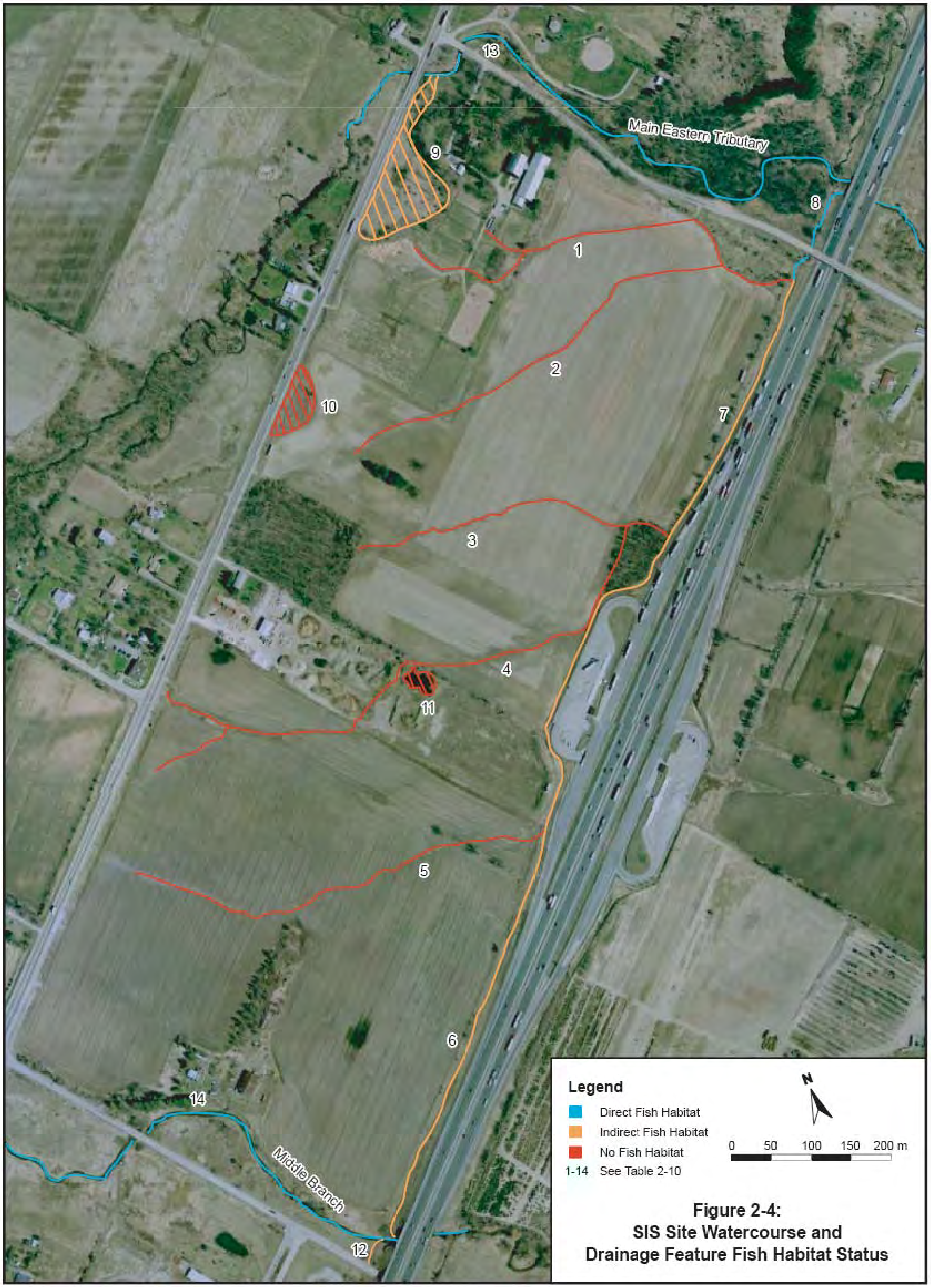


Figure 2-4: SIS Site Watercourse and Drainage Feature Fish Habitat Status

TABLE 2-10
SIS SITE DRAINAGE FEATURE CHARACTERISTICS

Watercourse	Channel Width	Water Depth	Flowing	Fish Habitat	Comments
1	0.2	nil	no	no	swale (plowed)
2	0.25	nil	no	no	swale (plowed)
3	0.5	nil	no	no	swale (plowed)
4	0.6	nil	no	no	swale (plowed)
5	0.5	nil	no	no	swale (plowed)
6	0.8	nil	no	indirect	highway drain
7	0.7	nil	no	indirect	highway drain
8	0.5	0.1	yes	direct	highway drain (intermittent pools)
9	undefined	0.1	yes	indirect	groundwater discharge
10	na[1]	nil	no	no	cattail wetland
11	na	>1m	na	no	off-line pond
12	0.5	0.1	yes	indirect	highway drain
13	3.5	0.26	yes	direct	Main Eastern Tributary
14	4	0.33	yes	direct	Middle Branch

[1] na = not applicable

2.2 TERRESTRIAL RESOURCES

2.2.1 Physiography

The western half of the 401 Corridor including the SIS site is situated on the Peel Plain (Chapman and Putnam, 1984). This physiographic region is a flat to undulating tract of varved clay soils with imperfect drainage that developed on shaley till and slopes gradually towards Lake Ontario. The eastern half of the 401 Corridor occurs on the South Slope, a ground moraine with an undulating surface created by a series of irregular knolls and hollows. Based on the geotechnical investigation (see Supporting Document 1), drift thickness on the HHGS property ranges between 10 to 15 m, consisting of Halton Till clayey silts to sandy silts. The boreholes frequently encountered a sand formation between the tills and the bedrock. Topography is generally flat with a subtle slope to the east. The topography of the LGI property is generally flat or gently rolling with an overall topographic relief of 2.5 m (see Supporting Document 4).

2.2.2 Soils

Typical soils in Halton Region are the Grey-Brown Luvisols and the Humic Gleysols (Gillespie *et al.*, 1971). The surface deposits from which the soils have developed are mainly fine-textured, resulting from the grinding action of glaciers on the Ordovician limestones and shales and subsequent deposition as the clay plain.

There are three soil types in the 401 Corridor. The Chinguacousy loam to clay loam is found throughout most of the 401 Corridor (Dillon, 2000). Oneida clay loan/Dumfries loam and Jeddo clay loam/Brisbane loam are the second most and least common soils, respectively.

The soils on the eastern one-third and northern edge of the HHGS property are Oneida silt loam developed on fine textured glacial till, largely composed of ice-ground materials from the underlying Ordovician rock formations (Gillespie *et al.*, 1971). This Brunisolic Grey-Brown Luvisol is well-drained and slightly stony with a topographic slope ranging from greater than 5% to 9%.

The soils on the remainder of the property are Chinguacousy clay loam developed in the clay and silty clay glacial till deposits, derived principally from locally occurring brown shales, sandstones and fossiliferous limestone (Gillespie *et al.*, 1971). This Gleyed Grey-Brown Luvisol (Grey-Brown Podzolic) is imperfectly drained and slightly stony with a topographic slope ranging from more than 2% to 5%. Chinguacousy clay loam is also present on the Giffels property.

Both soil types are also present on the LGI property with Oneida silt loam present on the northwestern two-thirds of the property and Chinguacousy clay loam on the remainder.

The soils on much of the SIS site are categorized as Class 1 with no significant limitations in use for crops. Soils in the eastern portion of the SIS site are categorized as 80% Class 2 and 20% Class 3 with moderate and moderately severe limitations, respectively, due to undesirable soil structure, low permeability, restricted rooting zone, low natural fertility, low moisture capacity and/or salinity. Soils on the northwestern portion of the SIS site are classified as 60% Class 1 and 40% Class 3.

2.2.3 Vegetation

The 401 Corridor is located at the transition zone between the Niagara Section of the Deciduous Forest Region (commonly referred to as the ‘Carolinian Zone’) to the south and the Huron-Ontario Forest Section of the Great Lakes-St. Lawrence Forest Region to the north (Rowe, 1972). The Deciduous Forest Region is located in southwestern Ontario and forms a narrow band along the northern shore of Lake Ontario extending to about the Presqu’ile Peninsula to the east. Its southern location allows for the presence of some tree species typical of more southerly portions of the United States. The region serves as a transition area, with representatives from many species common to both the southern Carolinian forest and the Great Lakes-St. Lawrence Forest Region to the north and northwest.

The forest communities of the Niagara Forest Section are dominated by broad-leaved trees. Characteristic tree species include sugar maple (*Acer saccharum* ssp. *saccharum*) and American beech (*Fagus americana*), with lesser representation by such species as American basswood (*Tilia americana*), red maple (*A. rubrum*), red oak (*Quercus rubra*), white oak (*Q. alba*) and bur oak (*Q. macrocarpa*). This forest section also includes the main distribution in Canada for such Carolinian forest species as black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*), swamp white oak (*Q. bicolor*) and shagbark hickory (*Carya ovata*). Other more widely distributed species include butternut (*Juglans cinerea*), bitternut hickory (*C. cordiformis*), rock elm (*Ulmus thomasii*), silver maple (*A. saccharinum*) and blue-beech (*Carpinus caroliniana*).

The oaks and hickories that are characteristic of the Carolinian Zone are well represented in wet-mesic associations on the clay plain (Peel Plain) south of Milton (Ecoplans Ltd., 1995).

The natural vegetation of the Huron-Ontario Section of the Great Lakes-St. Lawrence Forest Region is dominated by mixed wood forests (Rowe, 1972). It is a transitional type between the southern deciduous forests and the northern coniferous forests. This section is characterized by the occurrence of a number of dominant broad-leaved species such as sugar maple, red maple, American beech, red oak, white oak, bur oak, basswood, green ash (*Fraxinus pennsylvanica*) and white ash (*F. americana*). Frequently, eastern white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*) and balsam fir (*Abies balsamea*) occur with the common hardwoods, and to a lesser extent, butternut and large-toothed aspen (*Populus grandidentata*) are present. In cool, organic lowlands, eastern white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), spruce (*Picea* spp.) and balsam fir are found. Red maple, silver maple and black ash (*F. nigra*) are dominant in lowland swamps. Pockets of species common to boreal habitat are also present, including tamarack, balsam fir, eastern white cedar and yellow birch, as well as speckled alder (*Alnus incana*) and black spruce (*Picea mariana*).

Intensive agriculture and urbanization across southern and central Ontario have fragmented both forest regions, leaving smaller woodlots representative of the original communities.

The dominant vegetation community in the 401 Corridor is agricultural with primarily crop fields that are used for a rotation of corn (*Zea mays*), soybean (*Glycine max*), winter wheat (*Triticum aestivum*), hay and pasture (Dillon, 2000). Many of the agricultural fields are still in active use.

Despite the intensive agricultural use, some remnant natural forested areas remain. Moreover, some fields have well established hedgerows one to four trees in thickness, with the dominant species being bur oak, hawthorn (*Crataegus* spp.), white spruce (*Picea glauca*) and Norway spruce

(*P. abies*). Figure 2-5 shows the locations of the woodlands and larger hedgerows within and proximate to the 401 Corridor. Most of the woodlands occur within the creek or valley lands. Within Subwatershed 4, the largest forest community, designated as Deciduous Forest 1 (DF1) by Dillon (2000), occurs in the northeast corner of the HHGS property. The remaining woodland areas are smaller in size (less than 1 ha) and are scattered throughout the central and eastern parts of the Subwatershed.

Due to the low percentage of forest cover, the woodlands and hedgerows provide important wildlife habitat. For example, some of the hedgerows link small wooded areas to larger ones, while others link natural terrestrial areas to creeks. As they improve habitat connectivity and decrease forest fragmentation, these features should be preserved within the 401 Corridor, if feasible (Dillon, 2000). However, as indicated by Dillon (2000), the small wooded areas on the SIS site are not categorized as significant areas, based on the Provincial Policy Statement, with the exception of woodland D4 located in the northwestern corner of the HHGS property (Figure 2-5). This woodland is located within the Main Eastern Tributary valleyland also designated as significant and requiring permanent protection (Dillon, 2000).

HHGS Property

The largest forest community (DF1) on the HHGS property was characterized by Dillon (2000) as a mature hardwood forest approximately 1.5 ha in area (see Figure 2-5). The majority of the forest is dry, supporting sugar maple, black walnut, American beech and white ash. There are many mature trees some of which reach 90+ cm diameter at breast height (dbh) and the understorey is dense with overstorey saplings. The ground is somewhat wet along the eastern and southern edges of this forest, supporting many trembling aspen (*Populus tremuloides*), apple (*Malus* spp.), white ash and American (white) elm (*Ulmus americana*). This woodlot was not designated as significant by Dillon (2000).

Figure 2-5: Vegetation Communities on the West Portion of the 401 Corridor Planning Area

As indicated above, woodland D4 in the northeastern corner of the HHGS property (Figure 2-5) was identified by Dillon (2000) "as significant and suitable for the highest degree of protection within the urban setting". Although less than 0.5 ha in size, the woodland is situated within and adjacent to a significant valleyland, which is most likely why it has been designated as a candidate 'significant woodland'(Dillon, 2000).

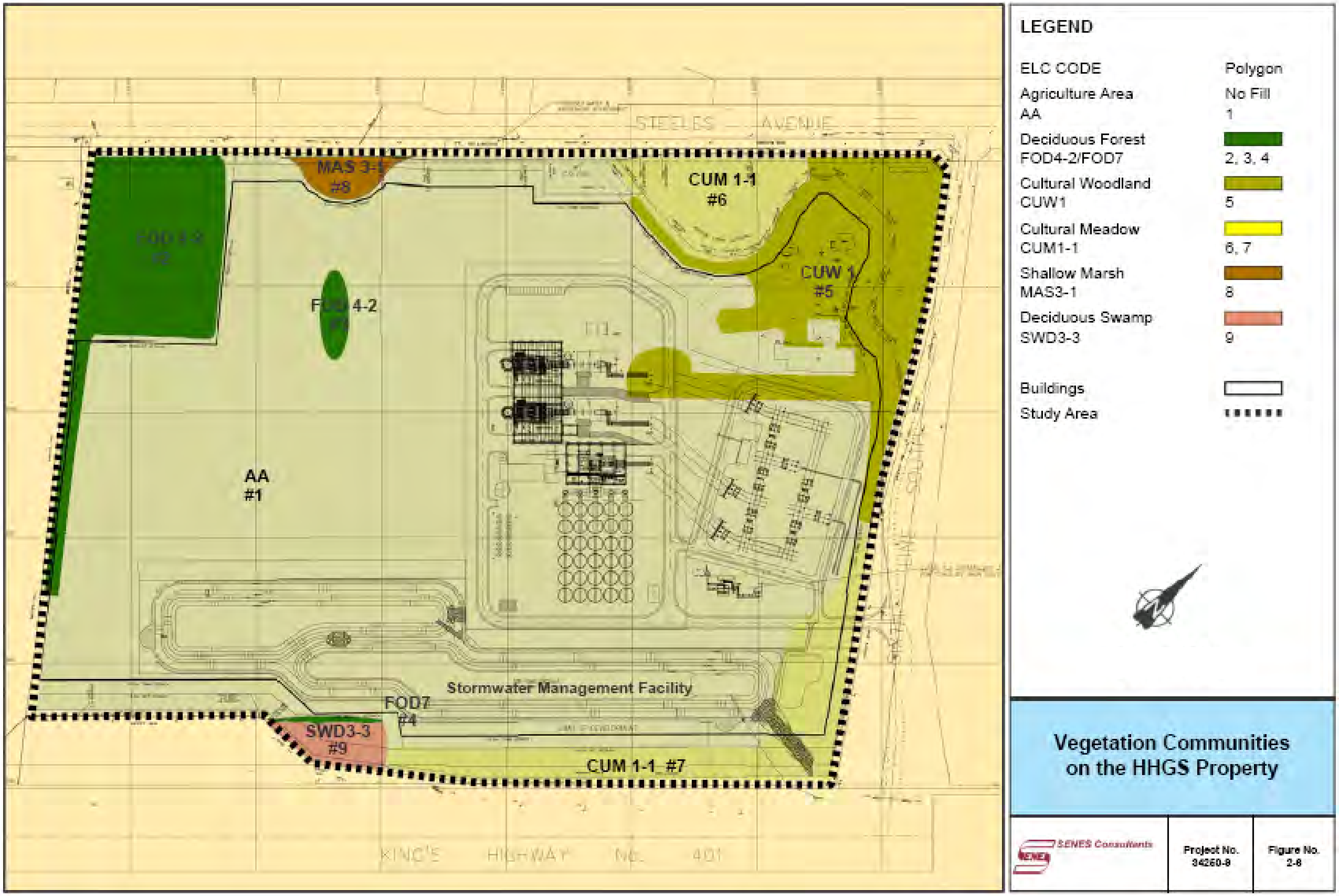
Other vegetation communities identified by Dillon (2000) on the HHGS property are:

- a hedgerow (C1) extension of DF1, with white spruce (*Picea glauca*), bur (mossy-cup) oak, sugar maple, white willow (*Salix alba*) and eastern white cedar;
- another hedgerow (C6) to the east of DF1, consisting of ten mature white spruce and one bur oak;
- a small (0.7 ha) deciduous wet forest (WF2) adjacent to Highway 401 with white elm and silver maple dominant, and some American basswood, willow (*Salix* spp.) and oak (*Quercus* spp.) also present; and
- ornamental plantings around the residential building on the property dominated by conifer trees such as spruce and cedar.

A field survey was undertaken on June 28th 2006 to identify the vegetation communities and inventory the flora on the HHGS property. An additional survey was undertaken on June 11th 2007 to confirm the initial classification of one of the vegetation communities (see Appendix C).

The majority (75%) of the property is an agricultural field (see Figure 2-6). The identification of vegetation communities on the property was based on the Ecological Land Classification (ELC) system to the ecosite level (Lee *et al.*, 1998). Only three natural community types are present: Deciduous Forest, Deciduous Swamp and Shallow Marsh. All are common community types in southern Ontario. Two cultural vegetation communities, which generally owe their origin or continued persistence to human influences (e.g., land clearing for residential use or for agriculture and subsequent abandonment), are also present: Cultural Woodland and Cultural Meadow. The valleyland associated with the Main Eastern Tributary in the northeast corner of the property supports Cultural Woodland and Cultural Meadow communities. The valleyland is approximately 3 m below the upland and terrain is flat.

Brief descriptions of the five vegetation communities present on the HHGS property are provided below.


STEELES AVENUE
MAS 3-1
#8
CUM 1-1
#6
FOD 4-2
CUW 1
#5
AA
#1
Stormwater Management Facility
FOD7
#4
SWD3-3
#9
CUM 1-1 #7
KING'S HIGHWAY No. 401
LEGEND
ELC CODE
Polygon
Agriculture Area
No Fill
AA
1
Deciduous Forest
FOD4-2/FOD7
2, 3, 4
Cultural Woodland
CUW1
5
Cultural Meadow
CUM1-1
6, 7
Shallow Marsh
MAS3-1
8
Deciduous Swamp
SWD3-3
9
Buildings
Study Area
Vegetation Communities
on the HHGS Property
SENES Consultants
Project No.
34260-8
Figure No.
2-8

Deciduous Forest (FOD)

The deciduous forest community type is present at three locations (see Figure 2-6). The largest parcel, classified as a Dry-Fresh White Ash Deciduous Forest (FOD4-2) community, is located on the northwest corner of the property, identified by Dillon (2000) as DF1 and C2 (the southern hedgerow extension of the woodlot). A small fragment of the same forest community type (FOD4-2), identified by Dillon (2000) as C6, is located to the east of the large woodlot. The third parcel, classified as a Fresh to Moist Lowland Deciduous Forest (FOD7) community, is located along the northern edge of a Swamp Maple Mineral Deciduous Swamp (SWD3-3) community, identified by Dillon (2000) as WF2. This woodlot consisting of the two vegetation community types is located along the southern portion of the property.

Within the largest parcel (FOD4-2#2), the dominant tree species are generally white ash and American basswood, with lesser representation by sugar maple, red maple, box elder (Manitoba maple) (*Acer negundo*), and silver maple. The shrub layer is dominated by wild red raspberry (*Rubus idaeus* ssp. *melanolasius*), red-osier dogwood (*Cornus stolonifera*), riverbank grape (*Vitis riparia*) and Virginia creeper (*Parthenocissus quinquefolia*), with Alleghany serviceberry (*Amelanchier laevis*), buckthorn (*Rhamnus cathartica*) and bush-honeysuckle (*Diervilla lonicera*) as sub-dominants. The ground layer is dominated by false Solomon's-seal (*Maianthemum racemosa*), black snake-root (*Sanicula marilandica*), European speedwell (*Veronica beccabunga*) and Virginia strawberry (*Fragaria virginiana*). Additional subdominants in a swale along its southern boundary included sensitive fern (*Onoclea sensibilis*), ostrich fern (*Matteuccia struthiopteris*), sedges (*Carex* spp.) and northern water plantain (*Alisma triviale*). Water depth was approximately 30 cm in the swale at the time of the survey.

The southern hedgerow extension of FOD4-2#2 is comprised of white oak, bur oak, box elder, black walnut, American elm and wild black cherry *(Prunus serotina)*.

It should be noted that there are some discrepancies between the June 28th 2006 field survey findings and those reported by Dillon (2000). Dillon (2000) reported that this woodlot supported many trembling aspen, apple, white ash and white elm, whereas white spruce, bur oak, sugar maple, white willow and eastern white cedar comprised the southern hedgerow extension of this woodlot. Trembling aspen, apple, and white spruce were not encountered during the 2006 field survey.

The small fragment woodlot (FOD4-2#3) is comprised of box elder, red maple, sugar maple, white ash, black walnut and eastern white pine. As indicated above, Dillon (2000) reported that this hedgerow (C6) consisted of ten mature white spruce and one bur oak. The reason for this discrepancy between the June 28th 2006 field survey and the Dillon (2000) findings is unknown.

The Fresh to Moist Lowland Deciduous Forest (FOD7#4) community flanks the northern edge of the woodlot located along the southern boundary of the HHGS property (Figure 2-6). This community is approximately 8 to 10 m in width and is a transitional zone between the upland agricultural fields and the deciduous swamp community that forms the rest of the woodlot. This deciduous forest community is dominated by basswood with box elder, American elm, green ash and bur oak forming associates. It has a well established edge bordering the field and is topographically diverse; likely the result of colonization of fill piles associated with perimeter ditch construction. The understorey and ground flora consist primarily of upland edge species such as wild red raspberry and chokecherry (*Prunus virginiana*). The absence of hybrid maple (*Acer x freemanii*), and other wetland species was a key consideration when establishing the boundary between the two communities.

Deciduous Swamp (SWD)

The Swamp Maple Mineral Deciduous Swamp (SWD3-3#9) community comprises approximately 80% of the woodlot located along the southern boundary of the HHGS property (Figure 2-6). This community is dominated by young to mid-aged hybrid maple (*Acer x freemanii*), with white elm, box elder and green ash being locally abundant. Bur oak and crack willow (*Salix fragilis*) form lesser associates. No standing water was observed on the surface or within pits dug for soil sampling. However, there was evidence in the central and southern portions of the community to suggest that seasonal ponding does occur. Drainage conditions in the woodlot have been substantially altered by the construction of ditches along the perimeter of the site. The perimeter ditches intercept runoff from the broader catchment area and prevent flow into the woodlot. In response to this, it appears that more upland species are being recruited in the ground and understory strata. While this transition may eventually result in the transition of this swamp community to a lowland forest community, current conditions are still reflective of a wetland system (see Appendix C).

Shallow Marsh (MAS)

A small shallow marsh community, classified as Cattail Organic Shallow Marsh (MAS3-1), is located along the northern property boundary east of the deciduous forest community FOD4-2#2 (see Figure 2-6). Narrow-leaved cattail (*Typha angustifolia*) and Canada goldenrod (*Solidago canadensis*) are the dominant species.

Cultural Woodland (CUW)

The Mineral Cultural Woodland (CUW1) community, identified as D4 by Dillon (2000), is located in the northeast corner of the HHGS property and is associated with a residence and other buildings (Figure 2-6). This woodland is comprised of native trees such as white ash, sugar maple, box elder, American basswood and honey locust (*Gleditsia triacanthos*), as well as those of European origin, e.g., Norway spruce, white willow and northern catalpa (*Catalpa speciosa*). The ground cover consists of grass lawn which had not been manicured in recent months.

Cultural Meadow (CUM)

The Dry-Moist Old Field Mineral Cultural Meadow (CUM1-1) community occurs at two locations on the property: along the northern property boundary adjacent and to the west of the cultural woodland community (CUM1-1#6), as well as along the southeastern property boundary and the southern boundary (CUM1-1#7) extending to the deciduous forest/deciduous swamp woodlot (see Figure 2-6). These meadows support sparse trees such as box elder and American basswood and shrubs including Alleghany serviceberry, hawthorn, buckthorn, red-osier dogwood, riverbank grape and Virginia creeper. Both the tree and shrub cover are less than 25%. The predominant ground cover consists of grasses such as meadow timothy (*Phleum pratense*), black bentgrass (*Agrostis gigantea)*, awnless brome (*Bromus inermis* spp. *inermus*) and reed canary grass (*Phalaris arundinacea*), as well as Canada goldenrod, Kansas milkweed (*Asclepias syriaca*) and spotted joe-pye weed (*Eupatorium maculatum* var. *maculatum*). Within the cultural meadow community along the southern boundary, there are ten medium-sized and well-spaced American basswood trees.

A list of the 119 plants identified to species on the HHGS property is presented in Table 2-11. Of these, only 24 species are exotic or 20%, a proportion that is below the general proportion of non-native plants in the province, estimated around 28% (e.g., Kaiser, 1983).

TABLE 2-11
PLANT SPECIES OBSERVED ON THE HHGS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Trees			
Abies balsamea	Balsam fir	S5	2
Acer x *freemanii*	Hybrid maple	S?	9
A. negundo	Box elder (Manitoba maple)	S5	2,3,4,5,6,7,9
A. rubrum	Red maple	S5	2,3,5,6,7
A. saccharinum	Silver maple	S5	2
A. saccharum spp. *saccharum*	Sugar maple	S5	2,3,5
Betula papyrifera	Paper birch	S5	2
Carya ovata	Shagbark hickory	S5	4
Catalpa speciosa	Northern catalpa	SE	5
Fagus grandifolia	American beech	S5	2
Fraxinus americanus	White ash	S5	2,3,5
F. pennsylvanica	Green ash	S5	4,9
Robinia pseudo-acacia	Black locust	SE5	5
Juglans nigra	Black walnut	S4	3,4
Picea abies	Norway spruce	SE	5
Pinus strobus	Eastern white pine	S5	3
Populous deltoides	Eastern cottonwood	S5	4,5

TABLE 2-11 (Cont'd)
PLANT SPECIES OBSERVED ON THE HHGS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Prunus serotina	Wild black cherry	S5	2
P. tremuloides	Trembling aspen	S5	2,4
Quercus alba	White oak	S5	2
Q. macrocarpa	Mossy-cup (Bur) oak	S5	2,4,9
Q. muehlenbergii[LU]	Yellow oak	S4	2
Q. rubra	Northern red oak	S5	2
Salix alba var. *alba*	White willow	SE	2,5
S. fragilis	Crack willow	SE	4
S. lucida[LU]	Shining willow	S5	2
Thuja occidentalis	Eastern white cedar	S5	5
Tilia americana	American basswood	S5	2,3,4,5,6,7,9
Ulmus americana	American (White) elm	S5	2,4,5,6,9
Small Trees, Shrubs and Woody Vines			
Amelanchier laevis[LU]	Alleghany serviceberry	S5	2,3,5,6,7
Cardamine diphylla	Two-leaf toothwort	S5	2
Cornus stolonifera	Red-osier dogwood	S5	2,3,5,6,7,8
Crataegus sp.	Hawthorn	-[4]	6,7
Diervilla lonicera	Bush-honeysuckle	S5	2,3,5,6,7,8
Euonymus obovata	Running strawberry-bush	S5	4
Ilex verticillata	Black holly	S5	2
Parthenocissus quinquefolia	Virginia creeper	S5	2,3,4,5,6,7,8,9
Prunus virginiana	Choke cherry	S5	4
Rhamnus cathartica	Buckthorn	SE	2,3,4,5,6,7,8,9
Rhus typhina	Staghorn sumac	S5	5,6
Ribes americanum	Wild black currant	S5	2,9
Rubus idaeus ssp. *idaeus*	Common red raspberry	SE	4,9
R. idaeus ssp. *melanolasius*	Wild red raspberry	S5	2,3,5,6,7,8
R. pubescens	Catherinettes berry	S5	2,3,5,6,7,8
Salix petiolaris	Meadow willow	S5	2
Solanum dulcamara	Climbing nightshade	SE	9
Syringa vulgaris	Common lilac	SE	5,6,7
Viburnum lantana	Wayfaring-tree	SE	6
Vitis riparia	Riverbank grape	S5	2,3,4,5,6,7,8,9
Graminoids			
Agrostis gigantea	Black bentgrass	SE	2,6,7

TABLE 2-11 (Cont'd)
PLANT SPECIES OBSERVED ON THE HHGS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Bromus inermis spp. *inermis*	Awnless brome	SE	5,6,7
Carex spp.	Sedge species	-[4]	2
C. grayi[LU]	Asa gray sedge	S4	9
C. intumescens	Bladder sedge	S5	9
C. radiata	Stellate sedge	S4	9
C. stipata	Stalk-grain sedge	S5	9
Elymus repens	Creeping wild-rye	SE	2,3,5,6,7,8
Glyceria striata	Fowl manna grass	S4S5	9
Phalaris arundinacea	Reed canary grass	S5	6,7
Poa spp.	Grass species	-[4]	2,3,5,6,7,8
Typha angustifolia	Narrow-leaved cattail	SE	8
Forbs			
Actaea rubra	Red baneberry	S5	2
Agrimonia gryposepala	Tall hairy groovebur	S5	4,9
Alisma triviale	Northern water-plantain	S5	2
Alliaria petiolata	Garlic mustard	SE	4,9
Anaphalis margaritacea[LU]	Pearly everlasting	S5	6,7
Anemone canadensis	Canada anemone	S5	2,5,6
A. quinquefolia	Wood anemone	S5	4
Aralia nudicaulis	Wild sarsaparilla	S5	2
Arctium minus spp. *minus*	Common burdock	SE	4
Arisaema triphyllum	Jack-in-the-pulpit	S5	2,9
Asclepias syriaca	Kansas milkweed	S5	2,3,5,6,7,8
Barbarea vulgaris	Yellow rocket	SE	5,6,7
Chrysanthemum leucanthemum	Oxeye daisy	S5	2,3,5,6,7,8
Circaea alpina	Small enchanter's nightshade	S5	2,3
C. lutetiana	Broadleaf enchanter's nightshade	S5	9
Cirsium muticum	Swamp thistle	S5	6,7
Coptis trifolia	Goldthread	S5	2
Echinocystis lobata	Wild mock-cucumber	S5	4
Epilobium sp.	Willow-herb species	-[4]	9
Epipactis helleborine	Eastern helleborine	SE	2,3,5,6,7,8
Eupatorium maculatum var. *maculatum*	Spotted joe-pye weed	S5	2,3,5,6,7,8
Fragaria virginiana	Virginia strawberry	S5	2,3,5,6,7,8
Geum aleppicum	Yellow avens	S5	4

TABLE 2-11 (Cont'd)
PLANT SPECIES OBSERVED ON THE HHGS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
G. canadense	White avens	S5	2
G. macrophyllum	Large-leaved avens	S5	2
Hesperis matronalis	Dame's rocket	SE	4,9
Impatiens capensis	Spotted jewel-weed	S5	9
Iris versicolor	Blueflag	S5	2
Lactuca sp.	Wild lettuce species	-[4]	6,7
Lotus corniculatus	Birds-foot trefoil	SE	6,7
Maianthemum canadense	Wild-lily-of-the-valley	S5	2
M. racemosum	False Solomon's-seal	S5	2,3,5,6,7,8
M. stellatum	Starflower false Solomon's-seal	S5	4
M. trifolium	Three-leaf Solomon's-seal	S5	2
Oxalis stricta	Upright yellow wood-sorrel	S5	2,3,5,6,7,8
Plantago major	Nipple-seed plantain	S5	2,3,5,6,7,8
Podophyllum peltatum	May apple	S5	4
Polygonatum pubescens	Downy Solomon's seal	S5	2,4
Polygonum persicaria	Lady's thumb	SE	5,6,7
Potentilla palustris[LR]	Marsh cinquefoil	S5	2
Rhus radicans ssp. *negundo*	Poison ivy	S5	4,9
R. radicans ssp. *rydbergii*	Poison ivy	S5	4
Rumex acetosella	Sheep sorrel	S5	2,3,5,6,7,8
R. crispus	Curly dock	SE	5,6,7
Sanicula marilandica	Black snake-root	S5	2
Solidago canadensis	Canada goldenrod	S5	4,6,7
Symphyotrichum. lateriflorum var. *hersuticaule*	Starved aster	S4?	4,9
Taraxacum officinale	Brown-seed dandelion	S5	2,3,4,5,6,7,8
Thalictrum dioicum	Early meadowrue	S5	2,5
Trifolium. pratense	Red clover	S5	2,3,5,6,7,8
T. repens	White clover	S5	2,3,5,6,7,8
Trillium grandilforum	White trillium	S5	4
Urtica dioica	Stinging nettle	S5	6
Verbascum thapsus	Great mullein	SE	3,6,7
Verbena hastata	Blue vervain	S5	9
Veronica beccabunga	European speedwell	SE	2
Vicia cracca	Tufted vetch	SE	2,3,5,6,7,8

TABLE 2-11 (Cont'd)
PLANT SPECIES OBSERVED ON THE HHGS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Viola spp.	Violet species	-[4]	2,3,5
Ferns and Allies			
Equisetum arvense	Field horsetail	S5	2,3
E. pratense[LU]	Meadow horsetail	S5	2,3
E. sylvaticum[LU]	Woodland horsetail	S5	2
Onoclea sensibilis	Sensitive fern	S5	2
Matteuccia struthiopteris	Ostrich fern	S5	2
Mosses			
Dicranum montanum	Lawn moss	S5	2

Notes:
LR Locally rare (Crins *et al.*, 2006).
LU Locally uncommon (Crins *et al.*, 2006).
1 Scientific and common names according to NHIC (2007a).
2 Source: NHIC (2007a); S5 = very common in Ontario and demonstrably secure; S4S5 = common to very common in Ontario; S4 = common in Ontario and apparently secure; S4? = possibly common in Ontario and apparently secure; S2 = very rare in Ontario; SE = exotic, not believed to be a native component of Ontario's flora; S? = status unknown.
3 See Figure 2-6; 2 = FOD4-2#2; 3 = FOD4-2#3; 4 = FOD7#4; 5 = CUW1#5; 6 = CUM1-1#6; 7 = CUM1-1#7; 8 = MAS3-1#8; 9 = SWD3-3#9.
4 Status uncertain as taxonomy only at genus level.

Undisturbed areas of native vegetation have the potential to support plant species which are of concern, i.e., species which are designated with special status under federal and/or provincial legislation. Federally, species at risk are recognized by COSEWIC (2007) and are protected under the *Species At Risk Act*, whereas provincially they are recognized by COSSARO under the Ontario *Endangered Species Act* and the Species at Risk in Ontario List (OMNR, 2006). Species designated as endangered or threatened and their habitat are protected under the *Endangered Species Act*. No protection is currently afforded to provincially designated species of special concern.

No floral species documented on the HHGS property, are designated as species at risk by COSEWIC (2007) or COSSARO (OMNR, 2006).

Of the 92 native species listed in Table 2-11, all but six are ranked by the NHIC (2007a) as S5, i.e., very common in Ontario and demonstrably secure. Fowl manna grass (*Glyceria striata*) is ranked as S4S5, i.e., common to very common. The yellow oak (*Quercus muehlenbergii*), black walnut, Asa gray sedge (*Carex grayi*) and stellate sedge (*C. radiata*) are ranked S4, i.e., common in Ontario and apparently secure. Starved aster (*Symphyotrichum lateriflorum var. hersuticaule*) is ranked S4?, i.e., possibly common in Ontario and apparently secure. Yellow oak and black walnut were present in the deciduous forest communities. The two sedge species and fowl manna grass were present in the deciduous swamp community, whereas starved aster was present in both the deciduous forest and swamp communities forming the woodlot along the southern boundary of the HHGS property.

- Of the plant species listed in Table 2-11, one is locally rare and six are locally uncommon in Halton Region (Crins *et al.*, 2006). All of these species are ranked by the NHIC (2007a) as very common or common in Ontario. The locally rare species marsh cinquefoil (*Potentilla palustris*) is located at 17 0592988E 4823646N and requires replanting.

Giffels Property

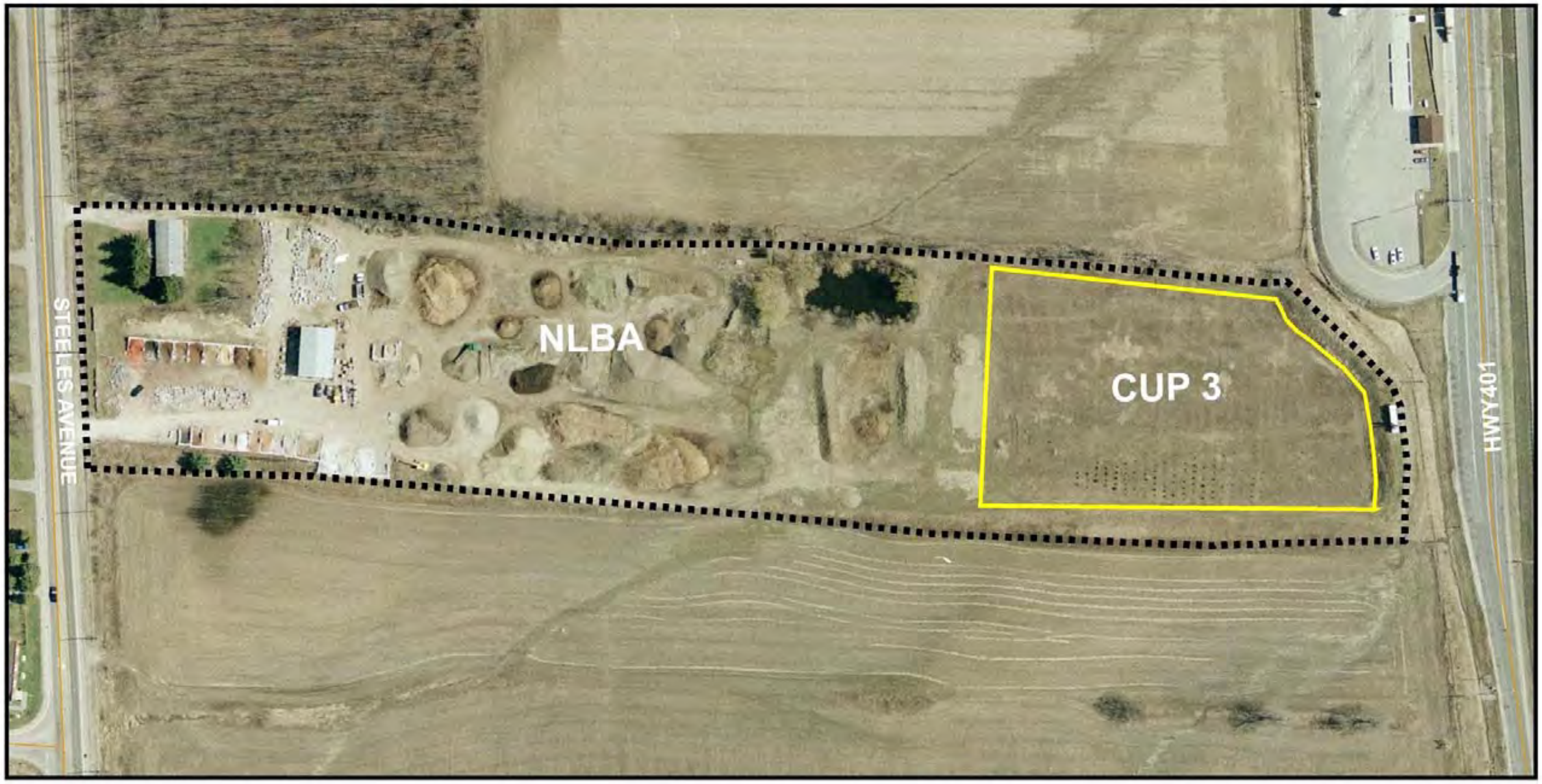
The prior land use on the Giffels property was a plant nursery and landscaping operation. The long rectangular property is approximately 5 ha in size, and includes a residential lot in its northeast corner, a man-made pond in the central portion and a plantation containing small coniferous trees in the southern third portion north of Highway 401 (see Figure 2-7). The rest of the property was utilized as storage areas of various gardening and landscaping materials including mulch, topsoil, gravel and rocks. Earthworks are evident adjacent to the pond and along the southern boundary of the property.

A field survey was undertaken on June 8th 2007 to inventory the flora on the Giffels property. The residence lot contains a few trees, including one black walnut, one silver maple and one northern catalpa, as well as clusters of common lilac (*Syringa vulgaris*). The ground layer is lawn grass.

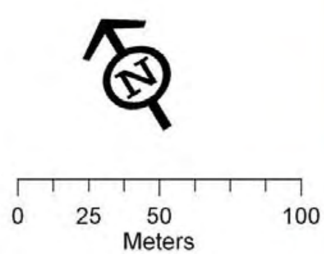
The dug pond, used to supply water to the nursery, is surrounded by a 1 to 2 m border of trees and shrubs. The trees include young to middle-age box elder, white elm and white willow (*Salix alba* var. *alba*). A large specimen of weeping willow (*S. babylonica*) is present on the north side of the pond. The ground layer is unmanicured lawn grass.

The Cultural Coniferous Plantation (CUP3) in the southern one-third of the property contains small (0.5 to 3 m high) Norway spruce (*Picea abies*) and Scotch pine (*Pinus sylvestris*). As the plantation is no longer maintained, the existing unmanicured lawn is high. The ground layer plants include graminoids such as meadow timothy, black bentgrass (*Agrostis gigantea*), awnless brome and reed canary grass, as well as forbs such as Canada goldenrod, Kansas milkweed and spotted joe-pie weed.

A list of the 40 plant species identified on the Giffels property is presented in Table 2-12. Of the 37 plants identified to species and their origin known, 12 are exotic or 32%, slightly above the general proportion of non-native plants in the province, estimated around 28% (Kaiser, 1983).



Legend	Polygon
Nursery & Landscaping Business Area (NLBA)	No Fill
Cultural Coniferous Plantation	CUP 3
Giffels Property	



Vegetation Communities on the Giffels Property

SENES Consultants	Project Number 34250-17	Figure Number 2-7

TABLE 2-12
PLANT SPECIES OBSERVED ON THE GIFFELS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Trees			
Acer negundo	Box elder (Manitoba maple)	S5	NLBA
A. saccharinum	Silver maple	S5	NLBA
Catalpa speciosa	Northern catalpa	SE	NLBA
Fraxinus americanus	White ash	S5	NLBA
Juglans nigra	Black walnut	S4	NLBA
Picea abies	Norway spruce	SE	CUP3
Pinus sylvestris	Scotch pine	SE	CUP3
Populus tremuloides	Trembling aspen	S5	NLBA
Salix alba var. *alba*	White willow	SE	NLBA
S. babylonica	Weeping willow	SE	NLBA
Thuja occidentalis	Eastern white cedar	S5	NLBA
Tilia americana	American basswood	S5	NLBA
Ulmus americana	American (White) elm	S5	NLBA
Small Trees, Shrubs and Woody Vines			
Amelanchier laevis[LU]	Alleghany serviceberry	S5	NLBA
Parthenocissus quinquefolia	Virginia creeper	S5	NLBA
Rubus idaeus ssp. *melanolasius*	Wild red raspberry	S5	NLBA
R. pubescens	Catherines berry	S5	NLBA, CUP3
Salix sp.	Willow species	-[4]	NLBA
S. petiolaris	Meadow willow	S5	NLBA
Syringa vulgaris	Common lilac	SE	NLBA
Graminoids			
Agrostis gigantea	Black bentgrass	SE	NLBA, CUP3
Bromus inermis spp. *inermis*	Awnless brome	SE	NLBA, CUP3
Elymus repens	Creeping wild-rye	SE	NLBA, CUP3
Phalaris arundinacea	Reed canary grass	S5	NLBA, CUP3
Phleum pratense	Meadow timothy	SE	NLBA, CUP3
Poa spp.	Grass species	-[4]	NLBA, CUP3
Typha angustifolia	Narrow-leaved cattail	SE	NLBA
Forbs			
Asclepias syriaca	Kansas milkweed	S5	NLBA, CUP3
Chrysanthemum leucanthemum	Oxeye daisy	S5	NLBA, CUP3
Eupatorium maculatum var. *maculatum*	Spotted joe-pye weed	S5	NLBA, CUP3

TABLE 2-12 (Cont'd)
PLANT SPECIES OBSERVED ON THE GIFFELS PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Fragaria virginiana	Virginia strawberry	S5	NLBA, CUP3
Plantago major	Nipple-seed plantain	S5	NLBA, CUP3
Solidago canadensis	Canada goldenrod	S5	NLBA, CUP3
Taraxacum officinale	Brown-seed dandelion	S5	NLBA, CUP3
Trifolium pratense	Red clover	S5	NLBA, CUP3
T. repens	White clover	S5	NLBA, CUP3
Vicia cracca	Tufted vetch	SE	NLBA, CUP3
Viola spp.	Violet species	-[4]	NLBA, CUP3
Ferns and Allies			
Equisetum arvense	Field horsetail	S5	NLBA, CUP3
E. pratense[LU]	Meadow horsetail	S5	NLBA, CUP3
E. sylvaticum[LU]	Woodland horsetail	S5	NLBA, CUP3

Notes:
LU Locally uncommon (Crins *et al.*, 2006).
1 Scientific and common names according to NHIC (2007a).
2 Source: NHIC (2007a); S5 = very common in Ontario and demonstrably secure; S4 = common in Ontario and apparently secure; SE = exotic, not believed to be a native component of Ontario's flora; SU = status uncertain.
3 See Figure 2-7.
4 Status uncertain as taxonomy only at genus level.

No floral species documented on the Giffels property are designated as species at risk by COSEWIC (2007) or COSSARO (OMNR, 2006).

Of the 25 native species listed in Table 2-12, all but one is ranked by the NHIC (2007a) as S5, i.e., very common in Ontario and demonstrably secure. Black walnut, present in the residence lot, is ranked as S4, i.e., common in Ontario and apparently secure.

Three of the plant species listed in Table 2-12 are considered to be locally uncommon in Halton Region (Crins *et al.*, 2006). These three species are ranked by the NHIC (2007a) as very common in Ontario.

<u>LGI Property</u>

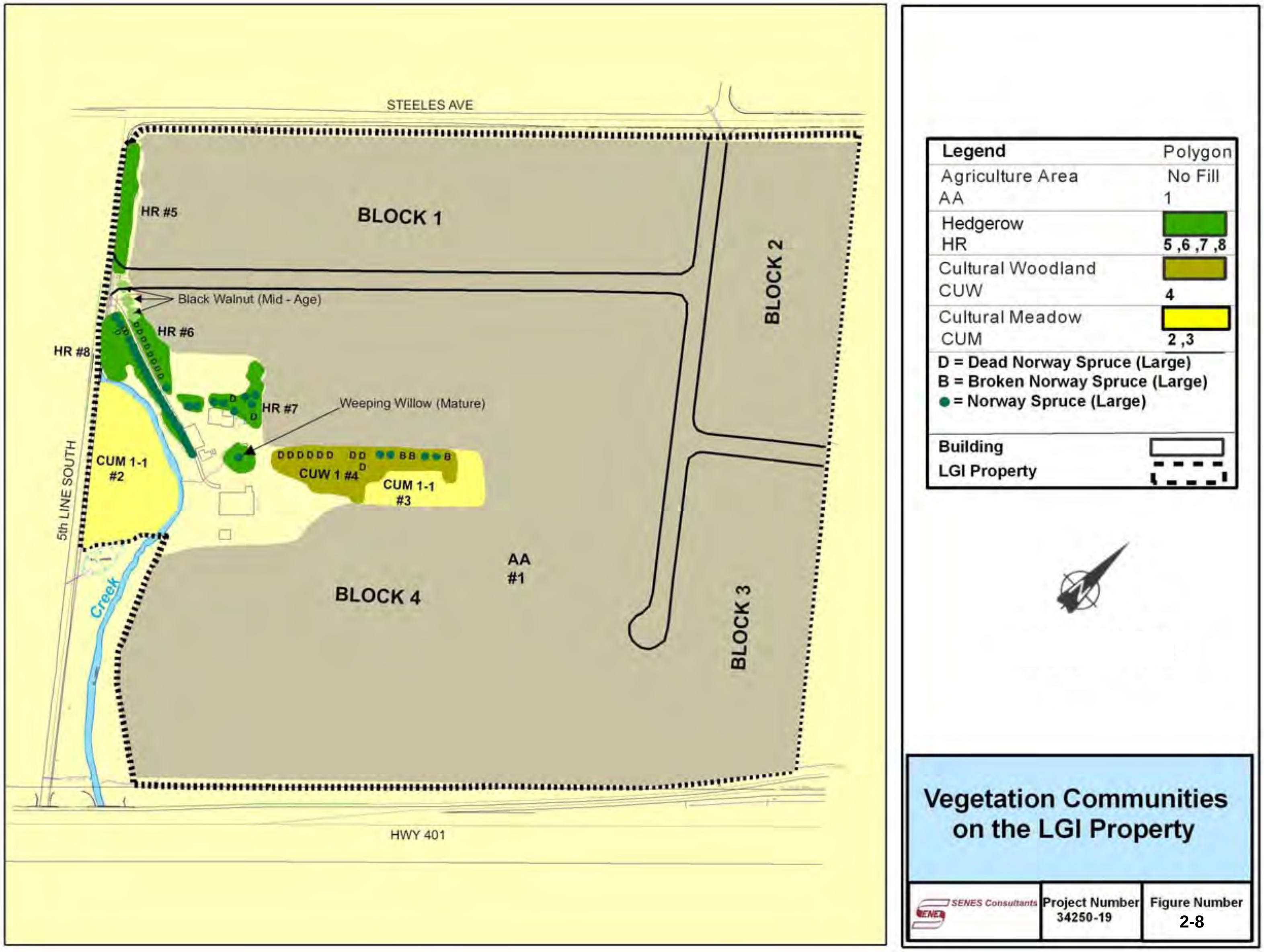
Within the LGI property, the only vegetation community identified by Dillon (2000) was ornamental plantings (D3) dominated by spruce around the residential building (see Figure 2-5). A small riparian wooded area is also shown as present along Middle Branch upstream of the ornamental planting area to 5th Line.

Field surveys were undertaken on March 14th and June 8th 2007 to identify the vegetation communities and inventory the flora on the LGI property. The majority (90%) of the property is in agricultural use (see Figure 2-8).

The remaining area is occupied by two small cultural meadows (CUM1-1#2 and CUM1-1#3), one cultural woodland (CUW1#4) and four hedgerows (HR#5, HR#6, HR#7 and HR#8). Most of the southwest portion of the property adjacent to 5th Line South is part of or adjacent to the Middle Branch valleyland. The valleyland is approximately 3 m below the upland and the terrain is relatively even. Cultural meadow CUM1-1#2 is located between 5th Line South and the watercourse. Cultural meadow CUM1-1#3 is upland and located adjacent to the cultural woodlot CUW1#4. The two cultural meadows contain sparse trees (cover <25%) e.g., small American basswood, and shrubs (cover <25%) including Alleghany serviceberry, hawthorn, buckthorn and wild red raspberry. The ground layer vegetation is dominant in both cultural meadows. On CUM1-1#2, the grasses include meadow timothy, awnless brome, reed canary grass and Canada blue-joint (*Calamagrostis canadensis*) predominate, whereas predominant forbs are Canada goldenrod and Kansas milkweed. On CUM1-1#3, Canada blue-joint is the predominant species.

The cultural woodland (CUW1#4) supports native tree species with black walnut as the dominant species, and white ash, sugar maple and American basswood as sub-dominants. The cultural woodland also includes a former hedgerow on its northwest side. This ancient hedgerow is survived only by few live exotic Norway spruce, with nine dead, three broken and four apparently healthy. The understorey is nearly absent with the ground cover consisting of neglected grass lawn, with two small areas to the north of the hedgerow containing false Solomon’s seal and black snake-root, respectively. Due to the lack of forest layers, this woodland does not provide much habitat function.

Hedgerow (HR#5) is located along the 5th Line South south of Steeles Avenue. It is comprised of various tree species including eastern cottonwood, bur oak, American elm, white ash, black walnut and American basswood. Shrubs include staghorn sumac (*Rhus typhina*) and common lilac. A second hedgerow (HR#6) occurs along the northeastern side of the driveway leading to the old residence and barns. This hedgerow includes three isolated black walnut of intermediate size. In addition, of the nine large Norway spruce that remain standing, only one is alive. Hedgerow (HR#7) is located adjacent to the west of the old residence building. It includes six live and two dead large standing Norway spruce with a few eastern white cedar. Two isolated large Norway spruce and a few eastern white cedar occur together isolated between HR#6 and HR#7. A large specimen of weeping willow occurs at the end of the driveway between the old residence and the main barn. The tree is massive and appears in good health. The fourth hedgerow (HA#8) extends from the 5th Line South along nearly the entire length of the



STEELES AVE
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
HR #5
HR #6
HR #7
HR #8
Black Walnut (Mid - Age)
Weeping Willow (Mature)
CUM 1-1 #2
CUM 1-1 #3
CUW 1 #4
AA #1
5th LINE SOUTH
Creek
HWY 401
Legend
Polygon
Agriculture Area
AA
No Fill
1
Hedgerow
HR
5 ,6 ,7 ,8
Cultural Woodland
CUW
4
Cultural Meadow
CUM
2 ,3
D = Dead Norway Spruce (Large)
B = Broken Norway Spruce (Large)
● = Norway Spruce (Large)
Building
LGI Property
Vegetation Communities on the LGI Property
SENES Consultants
Project Number 34250-19
Figure Number 2-8

southwestern side of the driveway. This hedgerow contains 24 large live and three dead Norway spruce. In all of the hedgerow areas, the understorey is nearly absent or poor. The ground cover is primarily neglected grass lawn. Due to the lack of plant layers, the hedgerow areas do not provide much habitat function.

A list of the 56 plant species identified in the LGI property is presented in Table 2-13. Of the 54 plants identified to species and their origin known, 10 are exotic or 19%, lower than the general proportion of non-native plants in the province, estimated around 28% (Kaiser, 1983).

TABLE 2-13
PLANT SPECIES OBSERVED ON THE LGI PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Trees			
Acer saccharum spp. *saccharum*	Sugar maple	S5	4
Fraximus americanus	White ash	S5	4, 5, 6, 7
Juglans nigra	Black walnut	S4	4, 5, 6, 7
Picea abies	Norway spruce	SE	4, 6, 7, 8
Pinus strobus	Eastern white pine	S5	2
Populus deltoides	Eastern cottonwood	S5	4, 5, 6
Quercus macrocarpa	Bur oak	S5	5
Salix babylonica	Weeping willow	SE	I
Thuja occidentalis	Eastern white cedar	S5	4, 7
Tilia americana	American basswood	S5	2, 3, 4, 5, 6, 7
Ulmus americana	American (White) elm	S5	4, 5, 6, 7
Small Trees, Shrubs and Woody Vines			
Amelanchier laevis	Alleghany serviceberry	S5	3, 4, 5, 6, 7
Crataegus sp.	Hawthorn	S5	2, 3, 4
Parthenocissus quinquefolia	Virginia creeper	S5	3, 4
Rhamnus cathartica	Buckthorn	SE	2, 3
Rhus typhina	Staghorn sumac	S5	5
Ribes glandulosum	Skunk currant	S5	4, 7
Rubus idaeus ssp. *melanolasius*	Wild red raspberry	S5	2, 3, 4, 5, 6, 7
R. pubescens	Catherinettes berry	S5	2, 3, 4, 5, 6, 7
Syringa vulgaris	Common lilac	SE	4, 5
Vitis riparia	Riverbank grape	S5	3, 4, 5, 6, 7
Graminoids			
Agrostis gigantea	Black bentgrass	SE	2, 3, 4, 5, 6, 7
Bromus inermis spp. *inermis*	Awnless brome	SE	2, 3, 4, 5, 6, 7
Calamagrostis canadensis	Canada blue-joint	S5	2, 3, 4, 5, 6, 7
Elymus repens	Creeping wild-rye	S5	2, 3, 4, 5, 6, 7
Phalaris arundinacea	Reed canary grass	S5	2, 3, 4, 5, 6, 7
Phleum pratense	Meadow timothy	SE	2, 3, 4, 5, 6, 7
Typha angustifolia	Narrow-leaved cattail	S5	2
Poa spp.	Grass species	-[4]	2, 3, 4, 5, 6, 7

TABLE 2-13 (Cont'd)
PLANT SPECIES OBSERVED ON THE LGI PROPERTY

Scientific Name[1]	Common Name[1]	Provincial Status[2]	Location[3]
Forbs			
Asclepias syriaca	Kansas milkweed	S5	2, 3, 4, 5, 6, 7
Anemone canadensis	Canada anemone	S4	4
Chrysanthemum leucanthemum	Oxeye daisy	S5	2,3,4,5,6,7
Eupatorium maculatum var. *maculatum*	Spotted joe-pye weed	S5	2
Fragaria virginiana	Virginia strawberry	S5	2,3,4,5,6,7
Geum canadense	White avens	S5	2,3,4,5,6,7
G. macrophyllum	Large-leaved avens	S5	3,4,5,6,7
Maianthemum canadense	Wild-lily-of-the-valley	S5	4
M. racemosum	False Solomon's seal	S5	4
M. trifolium	Three-leaf Solomon's-seal	S5	4
Plantago major	Nipple-seed plantain	S5	2,3,4,5,6,7
Potentilla palustris[LR]	Marsh cinquefoil	S5	2
Sanicula marilandica	Black snake-root	S5	4
Solidago canadensis	Canada goldenrod	S5	2, 3
Taraxacum officinale	Brown-seed dandelion	S5	2,3,4,5,6,7
Trifolium pratense	Red clover	S5	2,3,4,5,6,7
T. repens	White clover	S5	2,3,4,5,6,7
Verbascum thapsus	Great mullein	SE	2,3,4,5,6,7
Vicia cracca	Tufted vetch	SE	2,3,4,5,6,7
Viola sp.	Violet species	-[4]	4
Ferns and Allies			
Equisetum arvense	Field horsetail	S5	2,3,4
E. pratense[LU]	Meadow horsetail	S5	2,3,4
E. sylvaticum[LU]	Woodland horsetail	S5	2
Onoclea sensibilis	Sensitive fern	S5	2,4
Mosses			
Dicranum montanum	Lawn moss	S5	2,4

1 Scientific and common names according to NHIC (2007a).
2 Source: NHIC (2007a); S5 = very common in Ontario and demonstrably secure; S4 = common in Ontario and apparently secure; SU = status uncertain; SE = exotic, not believed to be a native component of Ontario's flora.
3 See Figure 2-8; I = single individual, not part of any vegetation unit.
4 Status uncertain as taxonomy only at genus level.

No floral species documented on the LGI property are designated as species at risk by COSEWIC (2007) or COSSARO (OMNR, 2006).

Of the 44 native species listed in Table 2-13, all but one are ranked by the NHIC (2007a) as S5, i.e., very common in Ontario and demonstrably secure. Black walnut, located in CUW#4, HR#5, HR#6 and HR#7, is ranked as S4, i.e., common in Ontario and apparently secure.

Of the plant species listed in Table 2-11, one is considered to be locally rare and two are locally uncommon in Halton Region (Crins *et al.*, 2006). These three species are ranked by the NHIC (2007a) as very common in Ontario.

2.2.4 Wildlife

The 401 Corridor provides agricultural, woodlot and urban parkland habitat for wildlife. In this area, most wildlife species are fully habituated to human activities and are concentrated in specialized habitats.

Mammals

White-tailed deer (*Odocoileus virginianus*) is the principal large wildlife species in the area. Deer have seasonal ranges as a result of current land use practices. In the spring, summer and early autumn, deer disperse to forest edges around farmlands, woodlots and the fringes of swamps. They are most abundant where there is an optimal mix of sheltering forest and farmland. During the winter, deer congregate in areas of denser cover, especially dense woodlots, swamps and conifer stands. A major restriction to the deer populations in the region is the availability of woodlots and suitable wintering yards.

The Hornby Swamp Complex located about 2 km north of the HHGS property provides a deer wintering area (Ecoplans Ltd., 1995).

Table 2-14 provides a list of mammal species documented or likely present in the Sixteen Mile Creek watershed. Of the 40 native species listed in Table 2-14, 28 species are ranked by the NHIC (2007a) as S5, i.e., very common in Ontario and demonstrably secure; eight are S4, i.e., common in Ontario and apparently secure; and three are S3?, i.e., possibly rare to uncommon in Ontario; and one is S3, i.e., rare to uncommon in Ontario.

TABLE 2-14
MAMMAL SPECIES DOCUMENTED[1] AND LIKELY PRESENT[2] IN THE SIXTEEN MILE CREEK WATERSHED

Common Name[3]	Scientific Name[3]	Status[4]	Field Survey Record[5]	Provincial Status[6]
Virginia opossum	*Didelphis virginiana*	L	R	S4
Masked shrew	*Sorex cinereus*	D		S5
Smoky shrew	*S. fumeus*	D		S5
Water shrew	*S. palustris*	D		S5
Short-tailed shrew	*Blarina brevicauda*	D		S5
Hairy-tailed mole	*Parascalops breweri*	D		S4
Star-nosed mole	*Condylura cristata*	D		S5
Little brown bat	*Myotis lucifugus*	L		S5
Northern long-eared bat	*M. septentrionalis*	L		S3?
Silver-haired bat	*Lasionycteris noctivagans*	L		S4
Big brown bat	*Eptesicus fuscus*	L		S5
Eastern pipistrelle	*Pipistrellus subflavus*	D		S3?
Red bat	*Lasiurus borealis*	L		S4
Hoary bat	*L. cinereus*	L		S4
Eastern cottontail	*Sylvilagus floridanus*	D	O	S5
European hare	*Lepus europaeus*	L		SE
Eastern chipmunk	*Tamias striatus*	D	O	S5
Woodchuck	*Marmota monax*	D	O	S5
Grey squirrel	*Sciurus carolinensis*	D	O	S5
Red squirrel	*Tamiasciurus hudsonicus*	D		S5
Northern flying squirrel	*Glaucomys sabrinus*	D		S5
Southern flying squirrel[7]	*G. volans*	D		S3
Beaver	*Castor Canadensis*	D		S5
White-footed mouse	*Peromyscus leucopus*	D		S5
Deer mouse	*P. maniculatus*	L		S5
Southern bog lemming	*Syneptomys cooperi*	D		S4
Muskrat	*Ondatra zibethicus*	D	O	S5
Meadow vole	*Microtus pennsylvanicus*	D	O	S5
Woodland vole	*M. pinetorum*	D		S3?
Norway rat	*Rattus norvegicus*	L		SE
Meadow jumping mouse	*Zapus hudsonius*	D		S5
Porcupine	*Erethizon dorsatum*	D		S5
Coyote	*Canis latrans*	D	T	S5
Red fox	*Vulpes vulpes*	D	T	S5
Raccoon	*Procyon lotor*	D	T	S5
Ermine	*Mustela erminea*	L		S5
Long-tailed weasel	*M. frenata*	D		S4
Mink	*M. vison*	D		S5
Striped skunk	*Mephitis mephitis*	D	R	S5
River otter	*Lutra canadensis*	L		S5
Bobcat	*Lynx rufus*	D/L		S4
White-tailed deer	*Odocoileus virginianus*	D	T	S5

1 Source: Ecoplans Ltd. (1995).
2 Source: Dobbyn (1994); Dwyer *et al*. (2006).
3 Scientific and common names according to NHIC (2007a).

[4] D = documented; L = likely.
[5] Documented during the 30 June 2006, and 08 June 2007 surveys: R = roadkill; O = observed; T = tracks.
[6] Source: NHIC (2007a): S5 = very common in Ontario, demonstrably secure; S4 = common in Ontario, apparently secure; S3? = possibly rare to uncommon in Ontario; S3 = rare to uncommon in Ontario; SE = exotic, not believed to be a native component of Ontario's fauna.
[7] Designated as a species of special concern provincially by COSSARO (OMNR, 2006).

Of the species listed in Table 2-14, southern flying squirrel is designated as a species of concern provincially by COSSARO (OMNR, 2006). A search of the NHIC (2007a) database indicated that this species has not been recorded on the SIS site. This species is not considered to be at risk federally by COSEWIC (2007).

During the June 28th 2006 survey, all of the mammals listed in Table 2-14, with the exception of muskrat, were recorded on the HHGS property based on direct and indirect observations. Eastern cottontail, grey squirrel, meadow vole, red fox, raccoon and white-tailed deer were recorded on the Giffels and LGI properties during the June 8th 2007 survey, with eastern chipmunk and coyote also recorded on the LGI property. Muskrat was observed at the edge of the pond on the Giffels property during a June 21st 2007 site visit. All but one of the 11 species are ranked S5 by the NHIC (2007), i.e., very common in Ontario and demonstrably secure. The remaining species, Virginia opossum (*Didelphis virginiana*), is ranked S4, i.e., common in Ontario and apparently secure. The only den observed was that of a muskrat at the edge of the pond on the Giffels property.

<u>Avifauna</u>

Habitat in the Sixteen Mile Creek watershed is supportive of a variety of bird species given that watercourse ravines, remnant woodlots, wetlands, thickets and open fields are all represented.

Waterfowl has a limited occurrence in the area, since there are few lakes or expanses of sluggish backwater on the watercourses of the area. Waterfowl in the area include mallard (*Anas platyrhynchos)*, wood duck (*Aix sponsa*) and Canada goose (*Branta canadensis*). All of the 401 Corridor lands are categorized by the CLI (1971) as Class 7 with such severe limitations due to adverse topography that almost no waterfowl are produced. The Main Eastern Tributary south of Highway 401 and the Main Branch further downstream are rated as Class 5 with moderately severe limitations to the production of waterfowl due to adverse topography. A mallard hen and its brood was observed on the Middle Branch during a June 21st 2007 site visit.

Table 2-15 provides a list of bird species documented in the Sixteen Mile Creek watershed, including those likely or confirmed to be breeding within a 10-km by 10-km square grid encompassing the three SIS properties, as well as those observed during the June 28th 2006 vegetation survey of the HHGS property (between 9:00 am and 5:00 pm) and a June 8th 2007 breeding bird survey of all three properties (between 5:00 am and 11:00 am). Of the 150 species listed in Table 2-15, 88 are likely or confirmed breeders based on a 10-km by 10-km square grid encompassing all three properties. Of the 88 likely or confirmed to be breeding within the 10-km x 10-km square grid, 66 are considered by the NHIC (2007) to be S5, i.e., very common in Ontario, demonstrably secure; two are S4S5, i.e., common to very common in Ontario; 15 are S4, i.e., common in Ontario, apparently secure; one species is S3S4, i.e., rare to common in Ontario; and four are SE, i.e., exotic, not believed to be a native component of Ontario's fauna.

TABLE 2-15
BIRD SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Breeding Status in 10-km x 10-km Mercator Grid Square Encompassing the Three Properties[3]	Field Survey Record[4]		Provincial Status[5]
			2006	2007	
Common loon	*Gavia immer*		X	X	S4
Great blue heron	*Ardea herodias*				S5
Green heron[LU]	*Butorides virescens*				S4
Black-crowned night-heron[LU]	*Nycticorax nycticorax*				S3
Mute swan[LU]	*Cygnus olor*				SE
Canada goose	*Branta canadensis*	Confirmed	X	X	S5
Wood duck	*Aix sponsa*	Probable			S5
Northern shoveler	*Anas clypeata*				S4
Green-winged teal	*A. crecca*				S4
Blue-winged teal[LU]	*A. discors*				S5
Mallard	*A. platyrhynchos*	Confirmed		X	S5
American black duck[LU]	*A. rubripes*				S5
Hooded merganser[LU]	*Lophodytes cucullatus*				S5
Turkey vulture	*Cathartes aura*	Probable			S4
Northern harrier[LU]	*Circus cyaneus*	Possible			S4
Cooper's hawk[LU]	*Accipiter cooperii*	Confirmed			S4
Northern goshawk[LU]	*A. gentilis*				S4
Sharp-shinned hawk[LU]	*A. striatus*	Confirmed			S5
Red-shouldered hawk[6,LR]	*Buteo lineatus*				S4
Red-tailed hawk	*B. jamaicensis*	Confirmed	X	X	S5
Broad-winged hawk[LR]	*B. platypterus*				S5
American kestrel	*Falco sparverius*	Confirmed			S5
Ring-necked pheasant[LR]	*Phasianus colchicus*				SE
Ruffed grouse	*Bonasa umbellus*				S5
Virginia rail	*Rallus limicola*				S4
Sora[LU]	*Porzana carolina*	Probable			S4
Common moorhen[LR]	*Gallinula chloropus*				S4

TABLE 2-15 (Cont'd)
BIRD SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Breeding Status in 10-km x 10-km Mercator Grid Square Encompassing the Three Properties[3]	Field Survey Record[4]		Provincial Status[5]
			2006	2007	
Killdeer	*Charadrius vociferus*	Confirmed	X	X	S5
Greater yellowlegs	*Tringa melanoleuca*				S4
Spotted sandpiper	*Actitis macularia*	Confirmed			S5
Upland sandpiper[LR]	*Bartramia longicauda*	Probable			S4
Common snipe[LU]	*Gallinago gallinago*	Possible			S5
American woodcock	*Scolopax minor*	Confirmed			S5
Herring gull	*Larus argentatus*		X	X	S5
Ring-billed gull	*L. delawarensis*		X	X	S5
Black tern[7,LR]	*Chlidonias niger*				S3
Rock dove	*Columba livia*	Probable			SE
Mourning dove	*Zenaida macroura*	Confirmed	X	X	S5
Yellow-billed cuckoo[LR]	*Coccyzus americanus*	Possible			S4
Black-billed cuckoo[LU]	*C. erythropthalmus*	Probable			S4
Eastern screech-owl	*Otus asio*	Probable			S5
Great horned owl	*Bubo virginianus*	Confirmed			S5
Long-eared owl[3,LR]	*Asio otus*	Probable			S4
Common nighthawk[LR]	*Chordeiles minor*	Possible			S4
Whip-poor-will[LR]	*Caprimulgus vociferus*				S4
Chimney swift[LU]	*Chaetura pelagica*	Confirmed			S5
Ruby-throated hummingbird	*Archilochus colubris*	Possible			S5
Belted kingfisher	*Ceryle alcyon*	Confirmed		X	S5
Red-headed woodpecker[6,LR]	*Melanerpes erythrocephalus*				S3
Red-bellied woodpecker[LU]	*M. carolinus*	Possible			S4
Yellow-bellied sapsucker[LU]	*Sphyrapicus varius*				S5
Downy woodpecker	*Picoides pubescens*	Confirmed			S5
Hairy woodpecker	*P. villosus*	Confirmed			S5
Northern flicker	*Colaptes auratus*	Confirmed			S5
Pileated woodpecker[LU]	*Dryocopus pileatus*	Probable			S4S5
Eastern wood-pewee	*Contopus virens*	Confirmed			S5
Alder flycatcher	*Empidonax alnorum*				S5
Least flycatcher[LU]	*E. minimus*	Possible			S5
Willow flycatcher[LU]	*E. traillii*	Probable			S5

TABLE 2-15 (Cont'd)
BIRD SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Breeding Status in 10-km x 10-km Mercator Grid Square Encompassing the Three Properties[3]	Field Survey Record[4]		Provincial Status[5]
			2006	2007	
Eastern phoebe	*Sayornis phoebe*	Confirmed			S5
Great crested flycatcher	*Myiarchus crinitus*	Confirmed			S5
Eastern kingbird	*Tyrannus tyrannus*	Confirmed			S5
Horned lark[LU]	*Eremophila alpestris*	Confirmed			S5
Purple martin[LU]	*Progne subis*				S4
Tree swallow	*Tachycineta bicolor*	Confirmed			S5
Northern rough-winged swallow[LU]	*Stelgidopteryx serripennis*	Confirmed			S5
Bank swallow	*Riparia riparia*			X	S5
Cliff swallow	*Petrochelidon pyrrhonota*	Confirmed			S5
Barn swallow	*Hirundo rustica*	Confirmed		X	S5
Blue jay	*Cyanocitta cristata*	Confirmed	X	X	S5
American crow	*Corvus brachyrhynchos*	Confirmed	X	X	S5
Black-capped chickadee	*Poecile atricapillus*	Confirmed	X	X	S5
Red-breasted nuthatch[LU]	*Sitta canadensis*		X	X	S5
White-breasted nuthatch	*S. carolinensis*	Confirmed			S5
Brown creeper[LU]	*Certhia americana*	Possible		X	S5
Carolina wren[3,LR]	*Thryothorus ludovicianus*	Possible			S3S4
House wren	*Troglodytes aedon*	Confirmed			S5
Winter wren[LU]	*T. troglodytes*				S5
Marsh wren[LU]	*Cistothorus palustris*	Possible			S5
Ruby-crowned kinglet	*Regulus calendula*				S5
Golden-crowned kinglet[LR]	*R. satrapa*				S4
Blue-gray gnatcatcher[LU]	*Polioptila caerulea*	Confirmed			S4
Eastern bluebird[LU]	*Sialia sialis*	Possible			S4S5
Veery	*Catharus fuscescens*	Possible			S5
Hermit thrush	*C. guttatus*				S5
Swainson's thrush	*C. ustulatus*				S5
Wood thrush	*Hylocichla mustelina*	Confirmed			S5
American robin	*Turdus migratorius*	Confirmed	X	X	S5
Gray catbird	*Dumetella carolinensis*	Confirmed		X	S5
Northern mockingbird[LU]	*Mimus polyglottos*	Confirmed			S4
Brown thrasher	*Toxostoma rufum*	Probable			S5
Cedar waxwing	*Bombycilla cedrorum*	Confirmed			S5

TABLE 2-15 (Cont'd)
BIRD SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Breeding Status in 10-km x 10-km Mercator Grid Square Encompassing the Three Properties[3]	Field Survey Record[4]		Provincial Status[5]
			2006	2007	
European starling	*Sturnus vulgaris*	Confirmed			SE
Yellow-throated vireo[LR]	*Vireo flavifrons*				S4
Warbling vireo	*V. gilvus*	Possible			S5
Red-eyed vireo	*V. olivaceus*	Confirmed			S5
Blue-headed vireo[LU]	*V. solitarius*				S5
Golden-winged warbler[LR]	*Vermivora chrysoptera*				S4
Tennessee warbler	*V. peregrina*				S5
Blue-winged warbler[LU]	*V. pinus*				S4
Nashville warbler[LR]	*V. ruficapilla*				S5
Black-throated blue warbler[LR]	*Dendroica caerulescens*				S5
Bay-breasted warbler	*D. castanea*				S4
Yellow-rumped warbler[LR]	*D. coronata*				S5
Blackburnian warbler[LR]	*D. fusca*				S5
Magnolia warbler[LR]	*D. magnolia*				S5
Palm warbler[LU]	*D. palmarum*				S5
Chestnut-sided warbler[LU]	*D. pensylvanica*				S5
Yellow warbler	*D. petechia*	Confirmed			S5
Pine warbler[LU]	*D. pinus*	Possible			S5
Black-throated green warbler[LU]	*D. virens*				S5
Black-and-white warbler[LU]	*Mniotilta varia*	Possible			S5
American redstart	*Setophaga ruticilla*	Possible			S5
Ovenbird	*Seiurus aurocapillus*	Possible			S5
Louisiana waterthrush[6,LR]	*S. motacilla*				S3
Northern waterthrush[LU]	*S. noveboracensis*				S5
Mourning warbler[LU]	*Oporornis philadelphia*	Confirmed			S5
Common yellowthroat	*Geothlypis trichas*	Probable			S5
Canada warbler[LR]	*Wilsonia canadensis*				S5
Wilson's warbler	*W. pusilla*				S5
Scarlet tanager	*Piranga olivacea*	Confirmed			S5
Northern cardinal	*Cardinalis cardinalis*	Confirmed	X	X	S5
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Confirmed			S5
Indigo bunting	*Passerina cyanea*	Probable			S5
Dickcissel	*Spiza americana*				SZN

TABLE 2-15 (Cont'd)
BIRD SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Breeding Status in 10-km x 10-km Mercator Grid Square Encompassing the Three Properties[3]	Field Survey Record[4]		Provincial Status[5]
			2006	2007	
Eastern towhee[LU]	*Pipilo erythrophthalmus*	Confirmed			S4
Clay-coloured sparrow	*Spizella pallida*				S4
Chipping sparrow	*S. passerina*	Confirmed			S5
Field sparrow	*S. pusilla*	Confirmed			S5
Vesper sparrow[LU]	*Pooecetes gramineus*	Probable			S4
Savannah sparrow	*Passerculus sandwichensis*	Confirmed		X	S5
Grasshopper sparrow[LU]	*Ammodramus savannarum*				S4
Swamp sparrow	*Melospiza georgiana*	Possible			S5
Song sparrow	*M. melodia*				S5
White-throated sparrow[LU]	*Zonotrichia albicollis*				S5
Dark-eyed junco	*Junco hyemalis*				S5
Bobolink	*Dolichonyx oryzivorus*	Confirmed			S4
Red-winged blackbird	*Agelaius phoeniceus*	Confirmed	X	X	S5
Eastern meadowlark	*Sturnella magna*	Possible			S5
Western meadowlark	*S. neglecta*				S4
Common grackle	*Quiscalus quiscula*	Confirmed	X	X	S5
Brown-headed cowbird	*Molothrus ater*	Confirmed			S5
Baltimore oriole	*Icterus galbula*	Confirmed	X	X	S5
Orchard oriole[LR]	*I. spurius*				SZN
House finch	*Carpodacus mexicanus*	Probable	X	X	SE
Purple finch[LU]	*C. purpureus*				S5
Red crossbill	*Loxia curvirostra*				S5
Pine siskin	*Carduelis pinus*				S5
American goldfinch	*C. tristis*	Confirmed	X	X	S5
House sparrow	*Passer domesticus*	Confirmed	X	X	SE
Total Confirmed	54				
Total Probable	15				
Total Possible	19				
Total Breeding Species	88				
Total Species at Risk	4				
Breeding Species at Risk	0				

LR Locally rare (McIlveen, 2006).
LU Locally uncommon (McIlveen, 2006).
1 Source: Ecoplans (1995).

2 Scientific and common names according to NHIC (2007a).
3 Source: Bird Studies Canada (2006): likely and confirmed breeding birds only.
4 Documented during the June 28th 2006 (9.00 am – 4.30 pm) and June 8th 2007 (5.00 am – 11.00 am) surveys.
5 Source: NHIC (2007a); S5 = very common in Ontario, demonstrably secure; S4S5 = common to very common in Ontario; S4 = common in Ontario, apparently secure; S3S4 = rare to common in Ontario; S3 = rare to uncommon in Ontario; SE = exotic; SZN = not of practical conservation concern as there are no clearly definable occurrences.
6 Designated as a species of special concern federally by COSEWIC (2007), as well as provincially by COSSARO (OMNR, 2006).
7 Designated as a species of special concern provincially by COSSARO (OMNR, 2006).

Of the 150 species listed in Table 2-15, 23 and 43 are locally rare and locally uncommon in Halton Region, respectively. Of the 23 locally rare species, five species are likely breeding in the 10-km by 10-km grid encompassing the HHGS. Four of these species are ranked by NHIC (2007a) as common in Ontario. The Carolina wren is ranked S3S4, i.e., rare to common in Ontario. Of the 43 locally uncommon species, 23 are likely or confirmed to be breeders in the grid. All of these species are very common or common in Ontario.

During the June 8th 2007 breeding bird survey, 26 species were recorded on the SIS site of which 21 species are confirmed or identified as likely to be breeding in the 10-km by 10-km grid. Of these 21 species, 19 are very common in Ontario, whereas two are non-native or exotic.

During the June 28th 2006 vegetation survey, 19 bird species were recorded on the HHGS property of which 15 species are confirmed or identified as likely to be breeding in the 10-km by 10-km grid. Of these 15 species, 13 are very common in Ontario, whereas two are non-native or exotic.

Of the species listed in Table 2-15, red-shouldered hawk, red-headed woodpecker and Louisiana waterthrush are designated as species of special concern federally by COSEWIC (2007), as well as provincially by COSSARO (OMNR, 2006). Black tern is designated as a species of concern by COSSARO (OMNR, 2006). Black tern is not considered to be at risk by COSEWIC (2007). None of these species at risk have been documented as confirmed or likely to be breeding in the 10-km by 10-km square grid encompassing the HHGS, Giffels and LGI properties and were not recorded during the June 28th 2006 vegetation survey of the HHGS property or the June 8th breeding bird survey of the three properties.

The locally uncommon red-breasted nuthatch was observed during both surveys, whereas the locally uncommon brown creeper was observed during the June 8th 2007 survey. Both species are ranked by the NHIC (2007a) as very common in Ontario. No locally rare species were observed.

Herpetofauna

Grouped together, amphibians and reptiles are called herpetofauna. They are generally dependent on wetland habitats associated with mature forests.

Table 2-16 provides a list of amphibian and reptile species documented in the Sixteen Mile Creek watershed. Jefferson salamander is designated as a threatened species federally by COSEWIC (2007), as well as provincially by COSSARO (OMNR, 2007). Northern map turtle, eastern ribbonsnake and milksnake are designated as species of special concern federally by COSEWIC (2007), as well as provincially by COSSARO (OMNR, 2006).

TABLE 2-16
AMPHIBIAN AND REPTILE SPECIES DOCUMENTED IN THE SIXTEEN MILE CREEK WATERSHED[1]

Common Name[2]	Scientific Name[2]	Presence in 10-km x 10-km Mercator Grid Square Encompassing the HHGS/LGI Properties[3]	Field Survey Record[4]	Provincial Status[5]
AMPHIBIANS				
Red-spotted newt	*Notophthalmus viridescens viridescens*			S5
Jefferson salamander complex[6,LU]	*Ambystoma jeffersonianum x laterale*	X		S2
Blue-spotted salamander[LR]	*A. laterale*			S4
Spotted salamander[LU]	*A. maculatum*			S4
Red-backed salamander	*Plethodon cinereus*	X		S5
American toad	*Bufo americanus*	X	X	S5
Gray treefrog	*Hyla versicolor*	X		S5
Spring peeper	*Pseudacris crucifer*	X		S5
Western chorus frog	*P. triseriata*	X		S4
American bullfrog[LU]	*Rana catesbeiana*		X	S4
Green frog	*R. clamitans*	X	X	S5
Pickerel frog[LU]	*R. palustris*			S4
Northern leopard frog	*R. pipiens*	X		S5
Wood frog	*R. sylvatica*			S5
REPTILES				
Snapping turtle	*Chelydra serpentina*	X		S5
Midland painted turtle	*Chrysemys picta marginata*	X		S5
Pond slider	*Trachemys scripta*			SE
Northern map turtle[7, LR]	*Graptemys geographica*			S3
Dekay's brownsnake	*Storeria dekayi*	X		SU
Northern red-bellied snake	*S. occipitomaculata occipitomaculata*			S5
Northern watersnake[LU]	*Nerodia sipedon sipedon*			S5
Eastern ribbonsnake[7, LR]	*Thamnophis sauritus*			S3
Eastern gartersnake	*T. sirtalis sirtalis*	X	X	S5
Smooth greensnake[LR]	*Opheodrys vernalis*	X		S4
Ring-necked snake[LR]	*Diadophis punctatus*			S4
Milksnake[7]	*Lampropeltis triangulum*	X		S3

[LR] Locally rare (Curry, 2006).
[LU] Locally uncommon (Curry, 2006).

1 Source: Ecoplans Ltd. (1995).
2 Scientific and common names after NHIC (2007a).
3 Grid square 17NU92 (Ecoplans Ltd., 1995).
4 Documented during the June 28th 2006 survey of the HHGS property and a June 21st 2007 site visit of the Giffels property.
5 Source: NHIC (2007a); S5 = very common in Ontario, demonstrably secure; S4 = common in Ontario, apparently secure, usually more than 100 occurrences; S3 = rare to uncommon in Ontario; S2 = very rare in Ontario; SE = exotic; SU = status uncertain.
6 Designated as a threatened species federally by COSEWIC (2007), as well as provincially by COSSARO (OMNR, 2006).
7 Designated as a species of special concern federally by COSEWIC (2007) as well as provincially by COSSARO (OMNR, 2006).

One amphibian and four reptile species are considered to be locally rare in Halton Region, whereas four amphibian and one reptile species are locally uncommon (see Table 2-16).

The absence of extensive wetland habitat on the SIS site precludes the presence of most herpetofauna. As indicated in Table 2-16, eastern garter snake and American toad were recorded on the HHGS property during the June 28th 2006 survey. Both species are ranked by the NHIC (2007a) as S5, i.e., very common in Ontario. American bullfrog and green frog, designated as common and very common, respectively, in Ontario, were observed at the edge of the pond on the Giffels property during a site visit on June 21st 2007.

Insects

A search of the NHIC (2007) database indicated that Halloween pennant (*Celithemis eponina*), a dragonfly considered to be a significant species by the OMNR, was documented at the southern limit of the local study area in 1974. This species is not designated to be at risk by COSEWIC (2007) or COSSARO (OMNR, 2006).

Moreover, the monarch butterfly (*Danaus plexippus*), considered to be a species of special concern by COSEWIC (2007) and COSSARO (OMNR, 2006), likely migrates throughout southern Ontario, including the local study area during the summer.

2.2.5 Environmentally Significant Areas

Wetlands and other environmentally significant areas provide important habitat for a variety of wildlife and plant species. Further, wetlands provide water storage and control functions which reduce erosion and flooding, and improve water quality. Wetlands also increasingly provide areas for a range of recreational pursuits, including nature appreciation.

The Ontario Government (1992) issued a Wetlands Policy Statement intended to ensure that there will be no net loss of wetland functions of Provincially Significant Wetlands (PSWs). Recently, the Wetlands Policy Statement was incorporated into the Provincial Policy Statement (OMMAH, 2005). A PSW is either a Class 1, 2 or 3 wetland situated south and east of the Canadian Shield, or a wetland in another area of the province that the OMNR has classified as Provincially Significant through an evaluation of biological, social, hydrological and special features of the area. Development and site alteration are not permitted in PSWs in Ecoregions 5E, 6E and 7E in Southern Ontario (OMMAH, 2005). North of Ecoregions 5E, 6E and 7E, development and site alteration are not permitted unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

Areas of Natural and Scientific Interest (ANSIs) and Environmentally Sensitive Areas (ESAs) have been identified by the OMNR and conservation authorities and/or municipalities, respectively, where it has been determined that the natural landscape and/or its features are in need of protection for heritage appreciation, scientific study or conservation education purposes. Life Science ANSIs are natural areas selected to protect outstanding landscapes, environments and biotic communities. Earth Science ANSIs are geological sites selected to protect outstanding examples of rock types, fossil localities, landform associations and areas containing significant groundwater resources. ESAs are land and water areas with natural features or ecological functions of such significance as to require their protection or preservation. Other natural areas of local and possibly regional significance have also been identified.

There are no PSWs, ANSIs or ESAs in the 401 Corridor or in the vicinity to the north or south (Halton Region, 1978; Hanna, 1984; Geomatics, 1991, 1993; Halton Region and NSEI, 2005; NHIC, 2007b). None of the remnant forested areas in the 401 Corridor were included in Halton Natural Areas Inventory project (Dwyer, 2006). The Class 7 Hornby Swamp Complex, about 18 ha in size, is located approximately 2 km north of the SIS site.

2.2.6 Land Use

As indicated in Section 2.2.3, agriculture is the predominant land use in the 401 Corridor. However, some commercial development has occurred within this area.

2.3 HABITAT/ECOLOGICAL FUNCTION ENHANCEMENT

2.3.1 Terrestrial Environment

As indicated by Dillon (2000), higher proportions of wooded and riparian land uses correlate positively with the quality of fish species found in associated watercourses. For example, Subwatershed 3 has a total of 35% wooded riparian land use, indicating a relatively high degree of riparian cover resulting in highest quality of fish species (coldwater). Subwatershed 4 which has a total of 15% wooded riparian land use and a moderate degree of riparian cover, has a mixed quality of species in its two main tributaries. Subwatershed 5, with only 8% wooded riparian land use, has the lowest quality of fish species (warmwater).

The identification of opportunities for the rehabilitation, restoration and improvement of environmental features should be an integral part of the planning process for individual SIS sites (Dillon, 2000). The objective of these measures is to increase the size, extent and quality of the core valleylands and stream corridors, natural corridors and woodlands, thereby improving the ecosystem diversity, ecological functions and the resiliency of the Subwatersheds.

For example, reforestation to create new woodland areas and/or to expand existing areas responds to the long-term objective to increase the percentage of total forest cover within the Subwatersheds, thereby contributing to the creation/maintenance of a healthy ecosystem. The Restoration and Preservation Strategy for Terrestrial Resources for the 401 Corridor Planning Area is shown on Drawing No. 3 of the Dillon (2000) report. Generic recommendations for the Main Eastern Tributary are to plant native species along wood edges to stabilize edges and enlarge the area, and to enhance hedgerows with plantings of native species. More specific recommendations presented in the Dillon (2000) report are listed below:

- plantings in corridors should be pursued to extend the linkages connecting woodlands and vegetation remnants, thereby reducing the effects of forest fragmentation, as well as creating new habitat and terrestrial resource areas;
- bur oak, hawthorn and sugar maple should be planted in the hedgerows with low tree densities to improve connectivity of the wooded areas;
- the existing forests in the 401 Corridor should be maintained and would benefit from restoration to improve forest composition and structure;
- the larger forest area WF1 and the cluster of WF3-F1-WF4-F2 (see Figure 2-5) warrant protection and enhancement to improve forest composition and structure, with reforestation between WF1 and G2 increasing the size of WF1 and plantings between WF3, F1, WF4 and F2 creating a continuous larger forest complex; and
- some of the smaller forests could also be protected and enhanced to improve the overall environmental character of the Planning Area.

As indicated in Section 2.2.3, the majority of the HHGS (75%) and LGI (90%) properties were in agricultural use (see Figures 2-6 and 2-8). Prior land use on the Giffels property was a plant nursery and landscaping operation (Figure 2-7). No significant or unusual areas of native vegetation were identified that would preclude or be affected by developments in the SIS site. The significant woodland D4 designated by Dillon (2000) in the northeastern corner of the HHGS property will be protected by its conferment to the municipality. In addition, no floral species documented on the three properties are designated to be at risk by COSEWIC (2007) or COSSARO (OMNR, 2006).

In the case of the HHGS property, the three natural (deciduous forest, deciduous swamp and shallow marsh) and two cultural (woodland and meadow) community types are generally located at the corners and along the edge of the property, or associated with the Sixteen Mile Creek tributary valleylands (see Figure 2-6). Much of the cultural woodland (CUW#5) including all of the significant woodland D4 (Dillon, 2000), and all of the cultural meadow (CUM#6) associated with the Main Eastern Tributary valleylands in the northeast corner of the HHGS property will be conferred to the municipality (see Section 2.4). Similarly, vegetation communities FOD#4, MAS#8 and SWD#9 will not be affected by the HHGS. Vegetation community FOD#3 will be removed to allow for the creation of a parking area. The southern hedgerow extension of FOD#2 will also be removed to provide room for topsoil storage. Moreover, a portion of CUM#7 will be directly affected by the installation of the stormwater management facility (see Figure 2-6).

In addition, a portion of the cultural meadow (CUM#7) in the southeastern corner of the property will be affected by horizontal directional drilling (HDD) activities to facilitate transmission line routing under Highway 401 (see Figure 2-6).

Prior land use on the Giffels property was a plant nursery and landscaping operation. As indicated in Figure 2-7, the only vegetation community present on the property is a Cultural Coniferous Plantation. It is assumed that this plantation will be eliminated by future development.

In the case of the LGI development, the valleylands of the Middle Branch on the property including all of the cultural meadow (CUM#2) between the watercourse and 5th Line South will be conferred to the municipality (see Section 2.4.1). Although a detailed site plan for the LGI development is not currently available (see Figure 1-2), it is assumed that most if not all of the cultural woodland (CUW#4), cultural meadow (CUM#3) and hedgerows (HR#6 and HR#7) will be eliminated, whereas all of hedgerow (HR#5) and most if not all of HR#8 will be preserved (see Figure 2-8). As indicated in Section 2.2.3, a number of trees in the hedgerows are dead or damaged. Moreover, as the understorey consists primarily of neglected grass lawn, the cultural woodland and hedgerows do not provide much habitat function. Where possible, specimen trees, e.g., black walnut in CUW#4 and HR#6 and the weeping willow west of CUW#4 (see Figure 2-8) will be preserved as part of the Tree Survey and Preservation Plan to be prepared for site plan approval.

During construction on the properties, topsoil will be stripped accurately to ensure no mixing with subsoil and stockpiled separately for re-use. Topsoil stripping, stockpiling and re-use will be carried out when the soil is relatively dry to minimize compaction and destruction of soil structure.

As required by the Halton Region Tree By-Law No. 121-05, the developers will apply for a permit for tree removal prior to construction. As stipulated in the draft new Official Plan (Halton Hills, 2006), a Tree Survey and Preservation Plan must be prepared, together with a proposed planting program (Landscape Plan), to compensate for the potential loss of trees. Tree Survey and

Preservation Plans and Landscape Plans for each of the three properties will be prepared for site plan approval.

After construction, the HHGS property will be landscaped according to the Landscape Plan, taking into consideration the Conservation Halton (2005a) planting and tree preservation guidelines. The Landscape Plan will include native vegetation species including trees and shrubs to soften the building edges, and provide visual enhancement of the property from Steeles Avenue and 6th Line. Aside from the parking area, roadway and gravel areas (e.g., the gas metering area), the land area around the HHGS will be grassed, where not planted with trees and shrubs. Although the Landscape Plan will involve as many native plants as possible, non-native plants may be necessary for screening purposes in the short term as certain non-native species grow faster, thereby providing screening sooner and allowing native plantings to establish.

To compensate for the loss of FOD#3, the southern hedgerow extension of FOD#2, and portions of CUW#5 and CUM#7, as well as to provide for habitat and ecological function enhancement within the HHGS property and Subwatershed 4, three restoration/improvement measures are proposed.

First, visual screenings of the property will involve hedgerow plantings of native (e.g., bur oak, hawthorn, sugar maple) and faster-growing cultivar (non-native) tree species around the perimeter of the property providing connectivity from FOD#2 to CUW#5, encompassing FOD#4/SWD#9 and the unaffected portion of CUM#7 (see Figure 2-6). Hedgerow plantings will also be undertaken along the north property boundary along Steeles Avenue from CUM#6 to MAS#8 and from MAS#8 to FOD#2 to provide connectivity between CUM#6 and FOD#2.

Secondly, HHGS will be improving forest composition and structure of CUM#6 and CUW#5 on lands to be conferred to the municipality based on the Landscape Plan involving native plant species developed for these lands for site plan approval.

Finally, based on the Dougan (2007) recommendation, removal of the ditch along the northern and eastern border of the woodlot (FOD#4/ SWD#9) will focus surface flow to the deciduous swamp community via the Highway 401 ditch (see Appendix C).

The plantings associated with the SWM facility will assist in controlling erosion and sediment inputs, as well as controlling water temperature. The selection of appropriate species planting will ensure the long-term survivability and function of the SWM facility. Criteria for plantings associated with the SWM facility will include shading of southern exposures to reduce thermal warming, as well as the inclusion of submergent, floating-leaved and emergent aquatic plant species. Plant material will be selected from non-invasive, regionally native species.

An overall ground cover on sloped and upland areas adjacent to the SWM facility will be comprised of no-maintenance, non-invasive seed mix comprising predominantly native flower and grass species.

The woodlot (FOD#2) in the northwestern corner of the HHGS property was not designated by Dillon (2000) as a "significant woodland". As indicated above, its southern extension (hedgerow) will be removed to provide for topsoil storage. Moreover, due to available property space constraints, the construction access road will be aligned adjacent to this woodlot. It is likely that this woodlot will be removed in the future to permit development of the western portion of the HHGS property.

A compensation strategy has been developed for further enhancement of the forest composition and structure within the SIS site lands conferred to the municipality. If appropriate opportunities do not exist within the SIS site lands for compensation plantings as determined by Conservation Halton and the municipality, alternative locations within existing natural features outside, but in close proximity to, the SIS site would be considered. If Conservation Halton cannot locate a suitable area for compensation, the responsibility to find a location still lies with the landowner at the time.

The proposed compensation strategy identifies an approach to the inventory, assessment, evaluation and quantification of existing individual trees identified for loss and subsequently determining a formula for replacement trees as part of an overall compensation strategy, as follows:

- all trees, inclusive of native and non native species, will be part of the inventory and compensation strategy. A specific compensation plan, including inventory and assessment of those portions of the woodlot affected or impacted by proposed development will be provided at the time of the respective site plan applications which pose an impact to the woodlot either in whole or in part;
- compensation plantings will be comprised of native plant species in accordance with Conservation Halton's landscape guidelines;
- Conservation Halton's proposal to utilize Conservation Halton's landscape guidelines can be used as an alternative to conducting a detailed woodlot inventory. This option would be exercised by the respective development proponent at the time a site specific development application was filed;
- locations for compensation plantings, as deemed appropriate by Conservation Halton and Town of Halton Hills, will be determined through the site plan approval process of each development application, at which time the impact of development on the woodlot would be most accurately assessed; and,

- the site plan approval process will involve consultation with and conditions of approval from both Conservation Halton and the Town of Halton Hills relating to woodlot compensation matters.

This compensation strategy will be applicable to all development properties within the SIS site, including the woodlot in the northwestern corner of the HHGS property. Planting proposed as part of the Compensation Plan shall be comprised of a variety of native, non-invasive species specific to areas they are presently found, and that are appropriate for the site conditions.

As indicated above, the only vegetation on the Giffels property is a Cultural Coniferous Plantation consisting of exotic (non-native) Norway spruce and Scotch pine. As part of property development, visual screenings will be provided along the perimeter to provide connectivity with the HHGS and LGI properties. A Tree Survey and Preservation Plan and Landscape Plan for the Giffels property will be prepared for site plan approval.

As part of the LGI development, visual screenings will also be provided along the perimeter of the property again including as many native plants as possible but also faster growing non-native species. These plantings will compensate for lost trees in the cultural woodland and some of the hedgerows. These plantings will provide habitat connectivity around the property with hedgerows HR#5 and HR#8. Moreover, LGI will be improving forest composition and structure of CUM#2 and HR#8 to enhance habitat/ecological functions of the valleyland and buffer zone associated with the Middle Branch on the property (see Figure 2-8). A Tree Survey and Preservation Plan and Landscape Plan involving native plant species for the LGI property will be prepared for site plan approval.

All plantings adjacent to or within natural areas will be random to mimic, to the extent possible, a natural landscape element.

An edge management plan will be developed and implemented at the site plan approval stage for each development application specific to lands adjacent to natural features identified for retention. The plan shall address the protection, enhancement and rehabilitation of areas of the site, adjacent to natural features disturbed by grading or other impacts resulting from development activities on the site. The edge management plan will incorporate a variety of regionally native plant species which enhance and reinforce the natural boundary of the features they border.

2.3.2 Aquatic Environment

As indicated by Dillon (2000), the focus of stream and aquatic habitat restoration in the 401 Corridor is to improve the overall physical structure of the stream channels and bordering shorelines while restoring the natural morphological characteristics of the watercourse. Appropriate stream rehabilitation measures should be implemented to restore and enhance aquatic habitats that have been degraded. Physical improvements to aquatic habitat enhance stream stability (from the effects of erosion) and its ecological function. For example, initiatives such as the planting of riparian vegetation and removal of in-stream barriers and anthropogenic debris would serve to further enhance existing fish habitat (as indicated by the direct correlation between riparian vegetation coverage and fish species quality), extend the range of fish movement and help improve downstream water quality. The Restoration and Preservation Strategy for Aquatic Resources for the 401 Corridor Planning Area is shown on Drawing No. 3 of the Dillon (2000) report.

Generic recommendations for the Main Eastern Tributary are to implement natural channel design techniques in certain areas to reinstate pool-riffle complexes and restore stream bed structure to create conditions suitable for brook trout; to cease mowing to the water's edge in Hornby Park; and to plant with native riparian plant species in the park. More specific recommendations presented in the Dillon (2000) report are listed below:

- restoration and enhancement of stream bed structure in certain areas through selective placement of gravel, boulders, deflector logs and lunker structures;
- replanting of vegetative buffer zones, particularly through Hornby Park, using native woody plant species to provide shade and increase vegetative diversity, with the subsequent temperature moderation possibly resulting in conditions suitable for brook trout year round;
- rechannelization, where appropriate, using natural channel design techniques and bioengineering materials (coconut fibre fabric, live willow stakes) and reinstating a regular riffle-pool complex, thereby providing habitat quality which will support a permanent brook trout population; and
- consideration of opportunities to integrate/create/enhance fish habitat as part of new development, e.g., naturalized outlet channels from stormwater management facilities and temperature-mitigating outlet design features (bottom draw).

As indicated above, some of the generic and specific recommendations are directed towards the Main Eastern Tributary reach in Hornby Park.

As indicated in Section 2.3.1, measures have been developed for the HHGS property for enhancing the CUM#6 and CUW#5 lands to be conferred to the municipality to improve forest composition and structure. These measures will include plantings along the riparian zone using native woody plant species to stabilize streambanks, provide shade and increase vegetation diversity along the stream edge. Specifically, the riparian plantings will be implemented to mitigate areas identified in the Slope Stability Report (see Supporting Document 2) as subject to short- and long-term erosion.

Plantings will include non-invasive, regionally native trees, shrubs (including live stakes), graminoids and wildflowers in suitable applications. Bioengineering measures will be implemented, where appropriate. The riparian plantings will be developed as part of the Landscape Plan to be completed at the site plan application stage.

The Main Eastern Tributary channel between Steeles Avenue and 6th Line is approximately 50 m in length. The predominant geofluvial concern is the pervasive erosion occurring along the entire extent of the southern bank (S. Kostyniuk, Parish Geomorphic Ltd., 2007, pers. comm.). Banks in this area are approximately 2 m in height and consist of a mixture of clay and silt. Excessive toe erosion is causing bank angles to become overly steep resulting in substantial risk of failure. As a remedial measure, stone or wood structures could be placed along the toe of the bank to deflect flow away from the bank towards the centre of the channel. These structures would also result in enhanced aquatic habitat. More detailed information on potential restoration/enhancement measures will be included in a report providing an evaluation of watercourse ecosystem components based on OSAP (see Section 2.6.4).

Generic recommendations for the Middle Branch are to implement natural channel design techniques throughout the reach to reinstate pool-riffle complexes and restore streambed structure to provide suitable conditions for year-round rainbow trout populations; and to replant the vegetation buffer zone to stabilize banks and provide temperature moderation. More specific recommendations presented in the Dillon (2000) report are listed below:

- replanting of vegetative buffer zones using native woody plant species to stabilize streambanks, provide shade and increase vegetative diversity along the stream edge, with the temperature moderation resulting from this measure possibly resulting in conditions suitable for rainbow trout year round;
- restoration and enhancement of streambed structure, through selective placement of gravel, boulders, deflector logs and lunker structures to reinstate regular pool-riffle complexes and improve habitat quality for the resident rainbow trout population; and
- consideration of opportunities to integrate/create/enhance fish habitat as part of new development, e.g., naturalized outlet channels from stormwater management facilities and temperature-mitigating outlet design features (bottom draw).

Measures have been developed for the LGI poperty for enhancing forest composition and structure of CUM#2 and HR#8 to enhance habitat/ecological functions of the Middle Branch valleyland. These measures will include native plantings along the riparian zone to stabilize streambanks, provide shade and increase vegetation diversity along the stream edge. Particular emphasis will be placed on areas of active erosion, with the implementation of bioengineering measures, where appropriate. The riparian planting strategy will be developed as part of the Landscape Plan for the LGI property to be completed at the site plan application stage.

The Main Branch reach downstream of 5th Line has well-defined riffle-pool sequences and well-vegetated banks. Based on preliminary investigation, vegetative restoration, concrete apron removal, bank regrading and/or toe protection along three segments of the reach would stabilize the valley slope and stream banks, minimize sediment loadings and enhance aquatic habitat (S. Kostyniuk, Parish Geomorphic Ltd., 2007, pers. comm.). More detailed information on potential restoration/enhancement measures will be included in a report providing an evaluation of watercourse ecosystem components based on OSAP (see Section 2.6.4).

For these restoration/enhancement measures to be meaningful, Conservation Halton and the municipality should develop a mitigation strategy for decreasing the high peak flows in the two watercourses during spring freshet and major rainfall events resulting in severe bank degradation, as well as for lessening sediment loadings from upstream agricultural activities (see Section 2.1).

Since discharge water from the SWM facility will be drawn from the bottom of the pond, water temperature will be lower thus minimizing potential thermal effects on the Main Eastern Tributary (see Section 3.7.7).

As indicated in Section 2.1.8, the drainage ditches on the SIS site provide no fish habitat, but do provide a surface water conveyance function. This surface drainage system will be converted to an underground piped or open channel stormwater system.

The Highway 401 drain is intermittent with only pools observed in the reach downstream of the 6th Line bridge during a June 21st 2007 site visit (see Appendix B). These pools were remnants of groundwater discharge earlier in the week from the construction of the Halton Region Lift Station on the southside of Steeles Avenue via the most easterly agricultural drain (#1 on Figure 2-4). On June 21st 2007, this discharge had been diverted to the Main Eastern Tributary via a pipeline along Steeles Avenue by Halton Region. The reach downstream of the 6th Line bridge was subsequently dry on June 28th 2007 (see Appendix B).

Based on the existing ditch channel configuration downstream of 6th Line, it is apparent that this reach is subjected to very high peak flows for short periods of time due to stormwater runoff from the SIS site and Highway 401. Currently, the narrow, steep-sided channel and the high, dense riparian vegetation (primarily grasses and forbs) afford considerable shading.

Once the SIS site is fully developed, runoff from the site will be managed with the operation of the SWM facility resulting in decreased peak flows and a more regular base flow. As a result, this reach will likely convert from indirect fish habitat to fish habitat. Naturalization of this outlet channel will be undertaken possibly including channel reconstruction to provide a wider shallower channel profile. The detailed design will be provided with the permit application to Conservation Halton for 6th Line culvert replacement.

Table 2-17 summarizes the proposed restoration/enhancement measures for the Main Eastern Tributary and Middle Branch on the SIS site relative to the Dillon (2000) rehabilitation recommendations.

TABLE 2-17
SUMMARY OF RESTORATION/ENHANCEMENT MEASURES[1]

Watercourse	Dillon (2000) Recommendations	SIS Proposed Measures
Main Eastern Tributary (HHGS property)	Stream bed structure restoration/enhancement	Bank toe reinforcement
	Vegetative buffer zone replanting	Yes
	Rechannelization where appropriate	Not applicable
	SWM facility outlet channel naturalization	Yes
	SWM facility temperature-mitigating outlet design	Yes
Middle Branch (LGI property)	Vegetative buffer zone replanting	Yes
	Streambed structure restoration/enhancement	Concrete apron removal, bank regrading and toe protection
	SWM facility restoration/enhancement opportunities	Not applicable

[1] Additional rehabilitation measures will be determined at the site plan/detailed design stage and the measures listed in the table above are considered conceptual only

2.4 PRELIMINARY ENVIRONMENTAL PROTECTION PLANS

An integral component of a SIS for the 401 Corridor Planning Area is the development of environmental protection plans demonstrating how high constraint terrestrial features (including heritage trees), valleylands and fish habitat will be protected and enhanced using buffers and other measures.

2.4.1 Terrestrial Environment

Only one woodland on the SIS site has been designated by Dillon (2000) as being significant and suitable for the highest degree of protection, i.e., woodland D4 in the northeastern corner of the

HHGS property (see Figure 2-5). This woodland associated with the Main Eastern Tributary valleylands is part of a cultural woodland (CUW#5) (see Figure 2-6). There are no native heritage trees on the properties.

As indicated in Section 2.2.3, the majority (75%) of the HHGS property is an agricultural field (see Figure 2-6). Of the natural and cultural vegetation community types present on the property, vegetation community FOD#3 will be removed to allow for the creation of a parking area, whereas the southern hedgerow extension of FOD#2 will be removed to provide for topsoil storage. In addition, a portion of CUM#7 will be directly affected by the installation of the SWM facility (see Figure 2-6). Only a small portion of CUW#5 will be directly affected by construction of the HHGS. The significant woodland D4 (Dillon, 2000) included as part of CUW#5 will not be affected by construction activities. Section 2.3.1 provides a discussion of the restoration/improvement measures that will be undertaken to compensate for the loss of FOD#3, the southern hedgerow extension of FOD#2, and portions of CUW#5 and CUM#7, as well as to enhance habitat and ecological function within Subwatershed 4.

As indicated in Section 2.2.3, all but seven plant species on the HHGS property are designated by the NHIC (2006) as S5, i.e., very common in Ontario and demonstrably secure, and therefore, their removal will have negligible effect on their overall populations in Ontario. Only two of the seven species will be affected by construction. The removal of black walnut (FOD#2 and FOD#3), designated by the NHIC (2007a) as S4, i.e., common in Ontario and apparently secure, will have negligible effect on its population in Ontario. The honey locust, designated by the NHIC (2007a) as S2, i.e., very rare in Ontario, is present in the cultural woodland community (CUW#5), likely the result of plantings several years ago. The hedgerow along 6th Line consists of 80 specimens with dbh of 10 cm or greater. Thirteen specimens also occur at four other locations within CUW #5. About half of the specimens occur on lands to be conferred to the municipality. A comprehensive Tree Preservation Plan for the remaining specimens will be provided for site plan approval.

The locally rare marsh cinquefoil, and the locally uncommon shining willow, Alleghany serviceberry, pearly everlasting, meadow horsetail and woodland horsetail were recorded in one or all four of the communities, i.e., FOD#2 (southern extension only), FOD#3, CUW#5 and CUM#7, to be affected by construction activities (see Table 2-11). As requested by Conservation Halton, mitigation measures, e.g., transplantation, for the locally rare marsh cinquefoil will be provided, if required. The exact location of this plant species will be provided to Conservation Halton at the site plan application stage.

A portion of the cultural meadow in the southeastern corner of the property will be affected by HDD activities to facilitate transmission line routing under Highway 401. All of the plant species in this area are designated by the NHIC (2007a) as very common (S5) in Ontario, and therefore, their removal will have negligible effect on their overall populations in Ontario.

The only vegetation community present on the Giffels property is a cultural coniferous plantation which does not warrant protection.

As indicated in Section 2.3, where possible, specimen trees on the LGI property will be preserved as part of the Tree Survey and Tree Preservation Plan to be prepared for site plan approval when necessary. The locally rare plant species, marsh cinquefoil, identified in CUM#2 will not be affected by construction activities.

Woodland and meadow communities that will not be affected by construction activities, i.e., portions of FOD#2, CUW#5 and CUM#7 on the HHGS property (Figure 2-6) and HR#5 and HR#8 on the LGI property (Figure 2-8), will be protected with silt fencing. For woodlands, silt fencing will be installed at the exterior tree dripline. Conservation Halton will undertake dripline limit staking. The cultural meadows on the HHGS (CUM#6) and LGI (CUM#2) properties will be protected by their locations relative to the watercourses, i.e., the lands containing those cultural meadows will be conferred to the municipality.

Conservation Halton, as have all Conservation Authorities in Ontario, has recently updated its O. Reg. 150/90 "Fill, Construction and Alteration to Watercourses" (Conservation Halton, 1999) under the *Conservation Authorities Act*, which controlled placing of fill, grading and construction of buildings and structures, in a flood vulnerable area, as well as alteration of watercourses. This updated regulation O. Reg. 160/06 (Conservation Halton, 2006) was in response to the Generic Regulation (O. Reg. 97/04), commonly referred to as the "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses". The Generic Regulation established the content that a regulation made by a Conservation Authority under Section 28(1) of the *Conservation Authorities Act* must meet. The key change is that all areas subject to the regulation are now based on the "Natural Hazards". Natural Hazards are areas that are subject to flooding, erosion, or unstable soils or bedrock, as defined by the Provincial Policy Statement (OMMAH, 2005). Under Reg. 162/06, Conservation Halton (2006) now regulates a broader scope of natural features and activities, including development within regulated areas and any interferences or alterations to watercourses, wetlands and shorelands.

In the case of wetlands, Conservation Halton (2006) regulates all wetlands greater than 0.5 ha in size. The two wetlands, i.e., MAS#8 and SWD#9, identified on the HHGS property are less than 0.5 ha in size and therefore setbacks required by Conservation Halton (2006) for larger wetlands do not apply. MAS#8 will be protected by silt fencing. SWD#9 will be protected by the deciduous forest along its northern border and by silt fencing installed at the exterior tree dripline along its eastern limit. Conservation Halton will undertake dripline limit staking.

For those vegetation communities affected by construction on the HHGS and LGI properties, vegetation clearing will adhere to standard construction practices as listed below:

- vegetation clearing should be restricted to the minimum necessary for construction activities;
- brush and trees should be felled into the area to be cleared to prevent damage to adjacent vegetation;
- branches overhanging the cleared area should be cut (pruned) cleanly and stubs should not be dressed;
- merchantable timber should be cut and neatly stacked for predetermined use;
- specimen trees marginal to the cleared area should be identified prior to construction, flagged and protected from damage, where possible; and
- all slash, brush, roots and stumps should be raked into piles for appropriate disposal.

As indicated in Section 2.2.4, a number of terrestrial bird species are likely locally resident and may nest on the SIS site. Most of these species are protected under the *Migratory Birds Convention Act*. Recently, the Canadian Wildlife Service has stipulated that vegetation clearing should not be undertaken during the breeding season of migratory birds in order to avoid the destruction of any bird nests. Specifically, clearing should not take place between 01 May and 31 July in southern Ontario (R. Dobos, Environment Canada, 2006, pers. comm.). Otherwise, a breeding bird survey must be conducted by a qualified avian biologist and any nests found must not be disturbed by the clearing activity until the young have fledged. A buffer zone with a 50 m allowance restricting active construction activities is usually applied around a nest. To preclude the potential institution of a buffer zone that may affect construction activities, it is recommended that vegetation be removed prior to nesting season initiation, i.e., May 1st, or after nesting season completion, i.e., July 31st.

The construction disturbance will be sufficiently local that little displacement of wildlife will occur. Any resident animals can relocate temporarily to avoid noise and disturbance associated with construction activities. In the construction area, resident animals have adapted to noise and disturbance resulting from traffic along Steeles Avenue, 5th Line, 6th Line and Highway 401, as well as nearby agricultural activities.

Once construction of the HHGS, Giffels and LGI developments is completed, any displaced animals could reoccupy the habitat created on the landscaped areas of the properties and the habitat associated with the natural and cultural vegetation communities not directly affected by construction activities, e.g., the northeastern corner of the HHGS property and the valleylands on the LGI property, respectively, to be conferred to the municipality (see below). Conservation

Halton and/or the municipality may consider opportunities for enhancing wildlife (e.g., bat) habitat on the conferred lands.

2.4.2 Aquatic Environment

The Middle Branch and its Main Eastern Tributary have been designated as significant valleylands requiring permanent protection (Dillon, 2000). These lands have been identified as a "natural corridor" in the Sixteen Mile Creek Watershed Plan (Gore & Storrie/Ecoplans Ltd., 1996). Natural corridors are defined as linear natural features, such as streams, floodplains, steep slopes, valleys, contiguous narrow woodlands and wetlands that connect two or more natural core areas.

The valleylands of the Middle Branch and Main Eastern Tributary had also been identified as "Hazard Lands" in Schedule 4 of Halton Hills (1994) Official Plan. Hazard Lands were defined as all lands with such inherent physical hazards as flood susceptibility, steep slope, erosion susceptibility, wet organic soils, or other physical limitations to development. For watercourses, the precise delineation of the limits of Hazard Lands was based on staking of the valley "physical" top-of-bank by Conservation Halton.

The new Official Plan (Halton Hills, 2006b) does not permit new development or site alteration below the "stable" top-of-bank of a valley/watercourse. A geotechnical study is required to confirm that the "physical" top-of-bank represents the stable top-of-bank. Furthermore, all new lots must be located a minimum of 7.5 m and 15 m from the stable top-of-bank of a minor and major valley/watercourse, respectively.

Conservation Halton (2006) has identified Sixteen Mile Creek as a "major valley system". For this major valley system, including all of the associated tributaries, Conservation Halton utilizes a 15 m allowance adjacent to the stable top-of-bank, consisting of a 7.5 m lot line setback from the greater of the physical or stable top-of-bank and then a further 7.5 m internal development setback.

The physical top-of-bank for the Main Eastern Tributary had been staked in the field in 2002 by Conservation Halton staff and the limits were subsequently surveyed. A geotechnical survey had been undertaken by TCE to confirm that the physical top-of-bank is coincident with the stable top-of-bank (See Supporting Document 2). The 7.5 and 15m lot line and internal development setbacks are shown on Figure 2-9.

As indicated in Section 2.1.7, the Main Eastern Tributary on the HHGS property has been classified as redside dace survival habitat resulting in the institution of a 30 m meander belt setback from the edge of the channel (see Figure 2-9). The meander belt width is a tool for

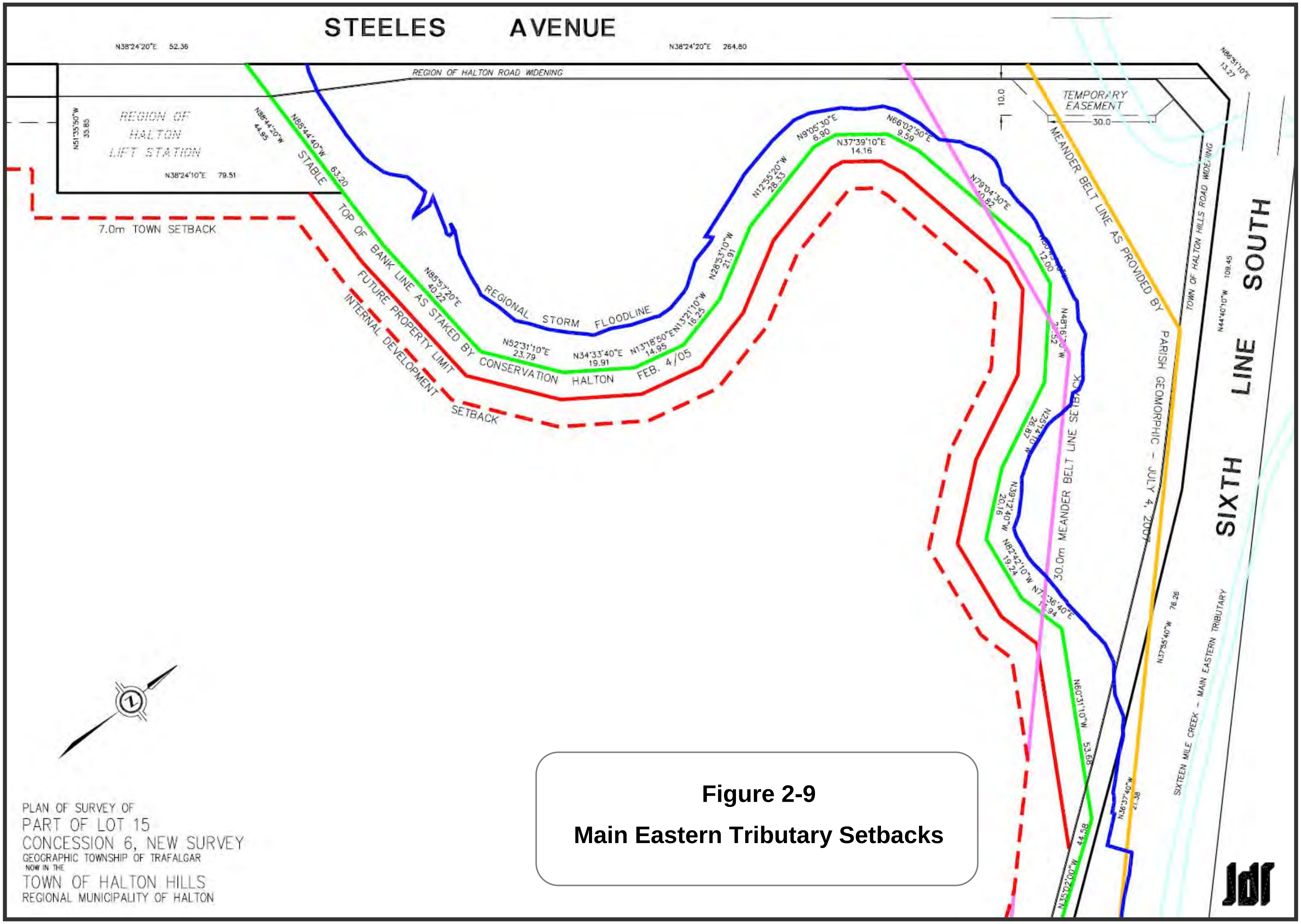


Figure 2-9

Main Eastern Tributary Setbacks

managing risk to property and infrastructure from erosion, as well maintaining the integrity of the watercourse. Since a watercourse is expected to move across its floodplain, any feature positioned within the active corridor has the potential of being altered through channel erosion. Thus, the meander belt width is a valid approach for defining the area in which river processes occur and will likely occur in the future; thereby limiting the cost for mitigative measures. The limits of the meander belt are defined by parallel lines drawn tangential to the outside meanders of a planform for the study reach. The 30m redside dace setback was taken from the meander belt width line. An offset of 30 m was drawn from each side of the belt width corridor.

In addition to the 30 m meander belt setback, additional mitigative/remedial measures to protect this endangered species and its habitat include thermal mitigation (see Section 3.7.7), and implementation of restoration/enhancement measures (see Section 2.3.2). LGI has also determined the limits of the stable and physical tops-of-bank for the Middle Branch on their property (see Supporting Document 4). Figure 2-10 shows the 7.5 and 15 m lot line and internal development setbacks.

Stewardship of watercourses is part of the Conservation Halton (2005b) Strategic Conservation Plan. As a contribution to this mandate, LGI and TCE will confer the Middle Branch and Main Eastern Tributary valleylands, respectively, on their properties, including the 7.5 m buffers from the stable top-of-bank and, in the case of the Main Eastern Tributary, encompassing a 30 m meander belt setback, to the municipality. These conferments include the lands to the west to 5th Line on the LGI property and the lands to the north and east to Steeles Avenue and 6th Line, respectively, on the HHGS property.

Finally, the presence of brook trout and rainbow trout in the Main Eastern Tributary and rainbow trout in the Middle Branch results in their classification as coldwater Type 1 habitat. A 30 m setback is recommended for each side of a Type 1 watercourse. The HHGS and LGI developments will be located more than 30 m from the Main Eastern Tributary and the Middle Branch, respectively (see Figures 2-9 and 2-10).

2.5 NATURAL HERITAGE SYSTEM CONCEPTUAL PLAN

Natural heritage systems are made up of core conservation lands and waters linked by natural corridors and restored connections, and are identified as landscape networks for the conservation of biological diversity, natural processes and viable populations of indigenous species and ecosystems.

The Natural Heritage System (NHS) for the 401 Corridor Planning Area consists of natural core areas (Ecoplans Ltd., 1995). Natural core areas include ESAs, PSWs, critical habitat of species

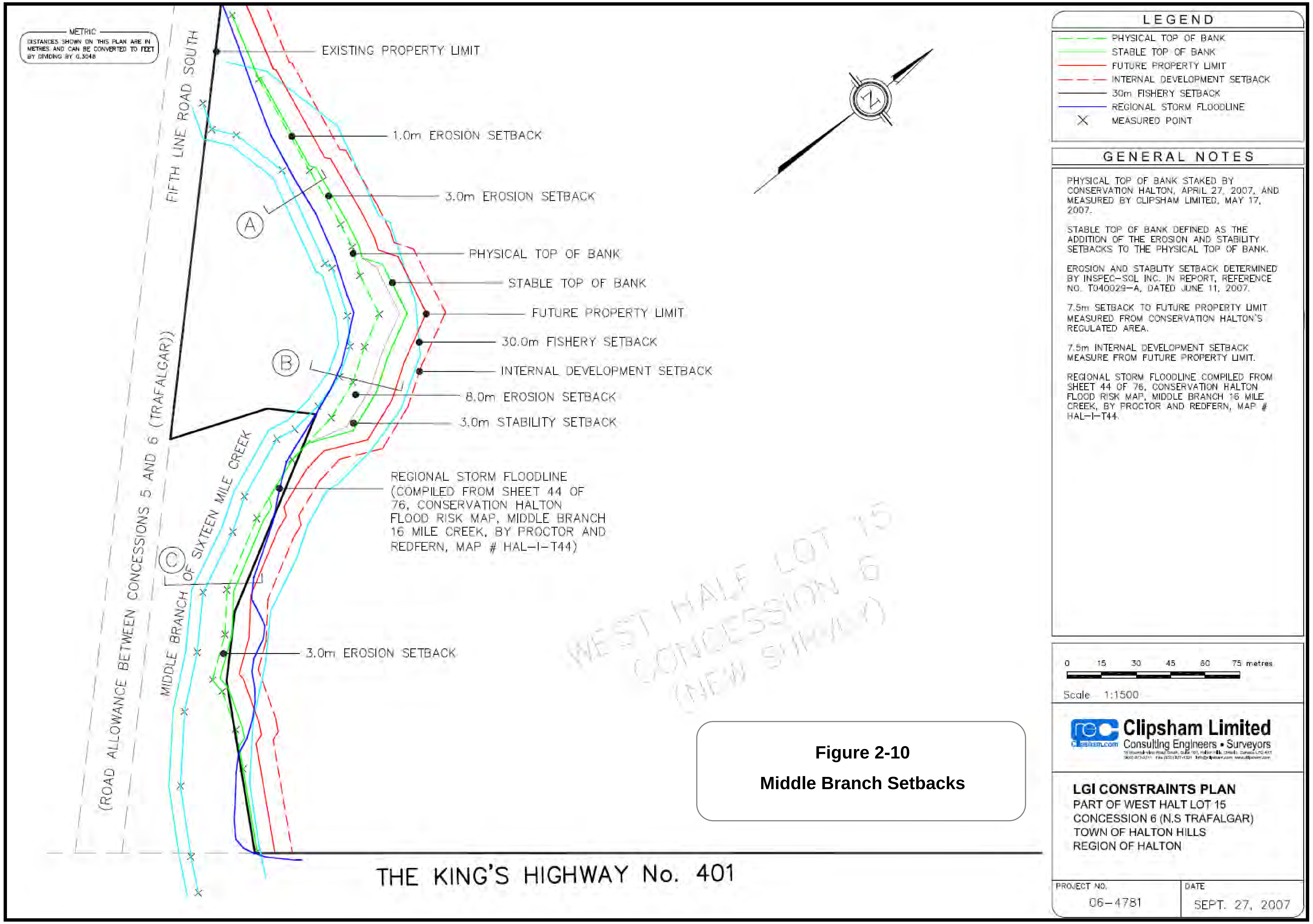


Figure 2-10
Middle Branch Setbacks

at risk, old growth woodlands (i.e., greater than 100 years) and large natural woodlands (i.e., equal to or greater than 30 ha in size).

As indicated in Figure 2-11, “there are no natural core areas on the SIS site”. The nearest natural core area is located north of Steeles Avenue and mostly west of 6th Line approximately 200 m northwest of the northwest corner of the HHGS property and 160 m north of the LGI property (see Figure 2-11). This natural core area is also illustrated in Figure 2-5. The Main Eastern Tributary traverses this natural core area, whereas the Middle Branch flows through its westernmost edges. Being upstream, this natural core area will not be affected by developments on the SIS site.

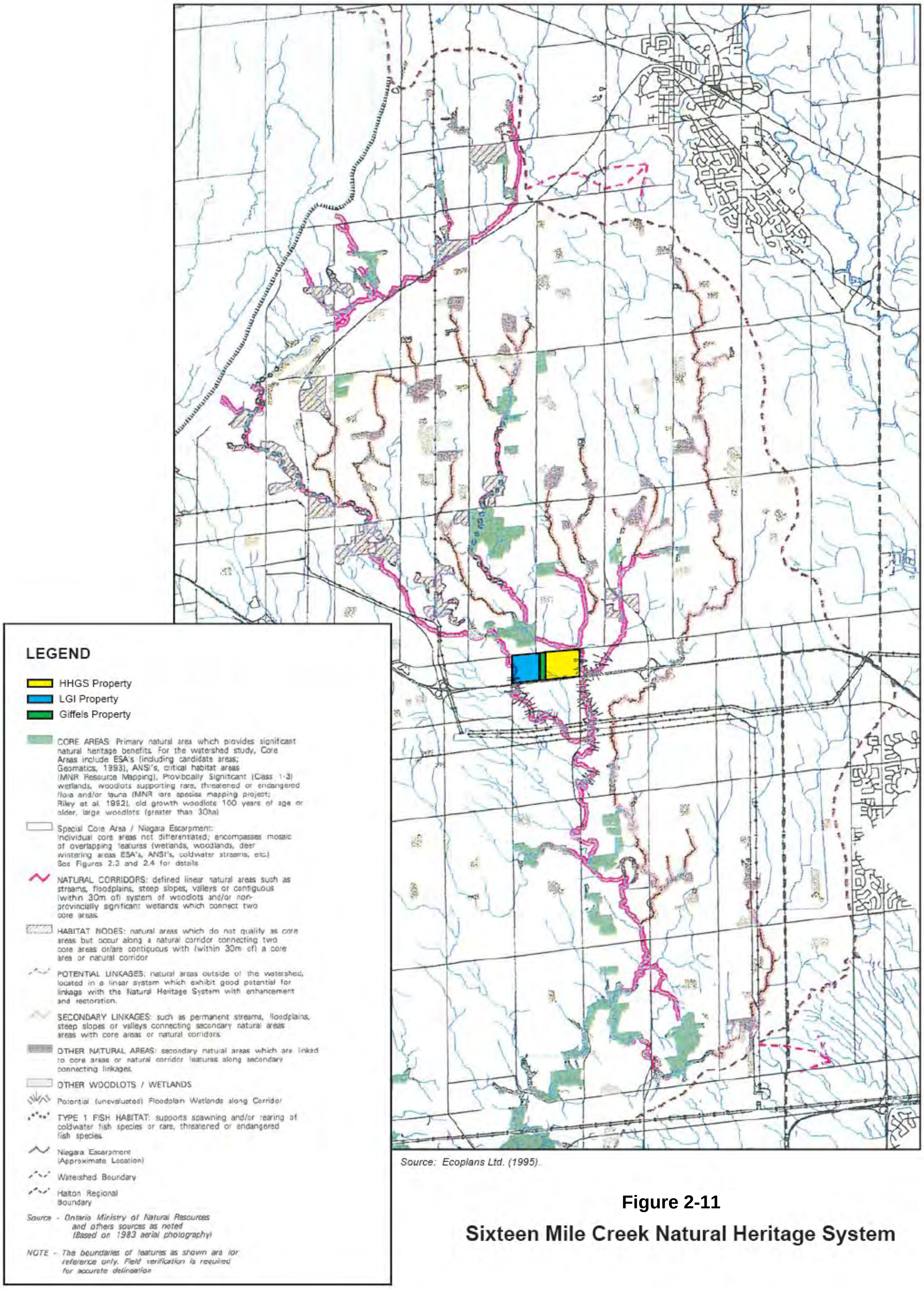
In addition to natural core areas, the NHS includes an array of natural corridors, secondary and potential linkages, and other natural areas (habitat nodes, secondary natural areas) that together form a landscape network of interconnected natural areas and features.

As indicated in Section 2.4.2, the Middle Branch and its Main Eastern Tributary on the LGI and HHGS properties, respectively, have been designated as significant valleylands requiring permanent protection (Dillon, 2000). They are also natural corridors extending from the natural core area upstream of the SIS site and continuing downstream beyond their confluence. Linkages and nodes occur upstream of the natural core area upstream of the LGI and HHGS properties and on the Hornby Tributary (Figure 2-11). As natural corridors, the Middle Branch and its Main Eastern Tributary connect the core area upstream to one approximately 1.5 km downstream of their confluence.

The proposed plantings, as outlined in the Landscape Plan, in the Middle Branch and Main Eastern Tributary valleylands will enhance wildlife movement potential through the SIS site.

To ensure permanent preservation of these natural corridors in the SIS site, the watercourse valleylands, including a 7.5 m buffer from the “stable” top-of-bank and, in the case of the Main Eastern Tributary, a 30 m meander belt setback, will be conferred to the municipality (see Figures 2-9 and 2-10 and descriptions in Section 2.4). These conferments include the lands to the west to 5th Line on the LGI property and the lands to the north and east to Steeles Avenue and 6th Line, respectively, on the HHGS property. Forest composition and structure will be improved by native tree plantings, as outlined in the Landscape Plan, on these lands (currently cultural woodland and/or cultural meadow). Native woody species will also be planted along the riparian zone to stabilize streambanks, provide shade and increase vegetation diversity along the stream edge.

As indicated in Section 2.3.1, visual screenings of the three properties will involve hedgerow plantings of native (e.g., bur oak, hawthorn, sugar maple) and faster growing cultivar tree species



Source: Ecoplans Ltd. (1995).

Figure 2-11

Sixteen Mile Creek Natural Heritage System

around the property perimeters. For the HHGS property, this hedgerow will provide connectivity between the natural corridor lands and the unaffected natural community types, including the woodlot at the southern edge of the property, and shallow marsh on the northern edge of the property (see Figure 2-6).

As indicated in Section 2.3, riparian zone plantings are planned for fish habitat restoration/enhancement for the watercourse reaches on the HHGS and LGI properties. Additional restoration measures have been recommended for the two reaches, including stone or wood structure installation along the bank toe of the Main Eastern Tributary, as well as concrete apron removal, bank regrading and toe protection for the Middle Branch.

Finally, the establishment of a more regular base flow in the ditch downstream of 6th Line due to SWM facility operation will likely convert this reach from indirect fish habitat to fish habitat. As indicated in Section 2.3.2, this habitat will be enhanced by channel naturalization.

2.6 NATURAL ENVIRONMENT MONITORING PLANS TERMS OF REFERENCE

A number of pre- and post-development surveys will be undertaken to confirm that construction activities and the developments have no negative effects on the valued terrestrial and aquatic resources on the three properties.

2.6.1 Terrestrial Monitoring

Terrestrial resources monitoring will include edge monitoring of the woodlots during construction to confirm no encroachment on the protective silt fencing. Additional monitoring will be undertaken after construction and silt fence removal.

The Tree Survey and Preservation Plan and Landscape Plan to be submitted for site plan approval will include a long-term maintenance plan. This monitoring plan will address those trees preserved on the properties as well as planted vegetation. As a minimum, monitoring by the Certified Arborist will be undertaken every two years. The extent and duration of the monitoring will be determined by the Certified Arborist responsible for the implementation of the two plans.

In addition, any general changes to the woodland areas and natural corridors will be assessed every five years using aerial photography.

2.6.2 Fisheries Monitoring

As indicated in Section 2.1.7, a fisheries survey of the Main Eastern Tributary was undertaken on June 26th 2006 to document the fish communities and habitat upstream and downstream of the HHGS property. This fisheries survey will be repeated at the same time a year after HHGS commencement to confirm that HHGS construction activities, including stormwater management facility operation, have had no negative effect on the fisheries resources of the watercourse.

Similarly, as indicated in Section 2.1.6, a pre-development fisheries survey has been undertaken on Middle Branch upstream and downstream of the LGI development (Dillon, 2000). A post-development survey will be undertaken to confirm that LGI development construction activities have had no negative effects on the fisheries resources of the watercourse.

With the implementation of riparian plantings and other restoration measures (see Section 2.3.2) improved fisheries resources can be anticipated for both watercourses. The fisheries surveys will adhere to the standard operating procedures for conducting semi-quantitative fish collection outlined in Section 2.1.7. TCE and LGI will undertake post-construction fisheries monitoring for years 1, 3 and 5. The fisheries monitoring data reporting, along with the electronic form of the data will be provided to Conservation Halton.

2.6.3 Benthic Monitoring

To further confirm the anticipated negligible effects of construction activities on the watercourses, pre-construction baseline surveys of the benthic macroinvertebrate communities were conducted in June 2007 at two stations upstream and downstream of both the HHGS and LGI properties, i.e., upstream of Steeles Avenue and downstream of Highway 401, respectively, on both watercourses. The survey findings will provide a baseline for comparison with those based on post-operational surveys at the same locations and time of year. TCE and LGI will undertake post-construction benthic monitoring for years 1, 3 and 5. OBBN data reporting, along with the electronic form of the data will be provided to Conservation Halton.

At each of the two sampling locations on each watercourse, three transects were sampled as per the Ontario Benthos Biomonitoring Network (OBBN) Protocol (Jones *et al.*, 2005): two riffle transects and one pool transect. The qualifications of the individual who collected the samples are provided in Appendix D. At each transect, three grab samples were collected and composited for taxonomic analysis for a total of six composite samples and two composited samples (i.e., three upstream and three downstream samples) on each watercourse. Each composite sample was screened through a 500 µ sieve and preserved in 10% formalin. The sediment samples were characterized according to texture, odour and presence of petroleum materials. Water quality at each location was assessed by on-site measurements of water temperature, conductivity and dissolved oxygen. Observations were also made on water clarity and colour, as well as the presence of any surface film, aquatic macrophytes and attached filamentous algae.

To ensure co-occurrence of site sampling locations during the subsequent post-construction survey(s), a photograph of each sampling location was taken and the distance offshore and upstream or downstream of a permanent shoreline feature measured.

The organisms are currently being identified by a qualified taxonomist (see Appendix D) to the lowest practical level, which in most cases is genus or species.

The benthic invertebrate community data assessment will entail the following:

- abundance (number/m^2);
- number of taxa;
- % of major groups;
- Shannon-Wiener diversity index, including equitability and richness values;
- Hilsenhoff Biotic Index (Hilsenhoff, 1982, 1987);
- EPT (Ephemeroptera, Plecoptera and Trichoptera) Index; and
- Water Quality Index (Griffiths, 1993, 1996, 1998; MOEE, 1993).

A report will be prepared as part of the benthic invertebrate community assessment for submission to Conservation Halton late summer 2007. At that time, the benthic data will be entered in the OBBN database and provided electronically to Conservation Halton.

The benthic data for each watercourse will be analyzed according to a before-after-control-impact (BACI) analysis. The BACI test is incorporated into the *Phase*Site* interaction effect of the ANOVA. The *Phase* term refers to the different time periods of the sampling, with pre- and post-construction phases investigated. If there is no statistically significant difference in pre- and post- construction monitoring results based on the one-year after construction survey, the need for further sampling will be discussed with Conservation Halton.

2.6.4 Fluvial Geomorphology Monitoring

In addition to the fisheries and benthic surveys, an evaluation of the ecosystem components of both watercourse reaches was undertaken in June 2007 utilizing OSAP. The qualifications of the individuals undertaking this evaluation is provided in Appendix D. The evaluation involved the completion of the following OSAP modules:

S1.M1 – Defining Site Boundaries and Key Identifiers
S1.M2 – Screening Level Site Documentation

S.M3 – Assessment Procedures for Site Feature Documentation
S4 – Assessing Physical Processes and Channel Structure

All original field data and data sheets will be provided with the monitoring report to Conservation Halton and the OMNR Habprogs database.

The OSAP evaluation of the two watercourse reaches will be repeated one-year after construction. The need for any subsequent OSAP surveys will be determined in consultation with Conservation Halton. TCE and LGI will undertake post-construction sampling for years 1, 3 and 5. An electronic form of the data will be provided to Conservation Halton.

2.6.5 Temperature Monitoring

Finally, four continuous temperature monitoring loggers (Onset StowAway TidbiTs) were installed in June 2007 in the vicinity of the proposed SWM facility outfall location. Temperature monitoring adheres to OSAP module S6.M2 Characterizing Stream Temperature Variability using Digital Records (Stanfield, 2007). The installation locations were photographed and demarcated appropriately to facilitate logger retrieval. The loggers will be relocated, downloaded and reset on a monthly basis, with final removal at the end of September/early October.

TCE will undertake post-construction temperature monitoring for years 1, 3 and 5. In addition, the Ontario Ministry of the Environment will require temperature monitoring between April 1st and October 1st in the Main Eastern Tributary during the first and second year of the SWM facility operation as a condition of the Certificate-of-Approval. An electronic form of the data will be provided to Conservation Halton.

3.0 STORMWATER MANAGEMENT FACILITY

3.1 EXISTING CONDITIONS

3.1.1 Drainage Patterns

Dillon (2000) estimated a drainage area of 65.9 ha for the SIS site. However, the effective drainage area is 64.45 ha, as estimated by Philips Engineering, where the drainage area south of the proposed SWM facility was excluded since it cannot be drained by gravity to the facility. The conceptual design of the SWM facility is based on a drainage area of 65 ha (Figure 3-1) and is guided by the approved SSP (Dillon, 2000) together with the Town of Halton Hills Stormwater Management Policy (Halton Hills, 2002), and the Stormwater Management Planning and Design (SWMPD) Manual (MOE, 2003). It should be noted that the area north of Steeles is included in the SIS drainage boundary only for its drainage contribution, however it is not included in the SIS site since it is not part of the developed area.

3.1.2 Topography

In general, the site drains from west to east towards the Middle Branch of Sixteen Mile Creek at a point just north of Highway 401 and west of 6th Line South. Surface flow is conveyed through low points or "draws" in the land; there are no defined watercourses on the tableland portion of the site. The average slopes within the SIS site are approximately 1% and the surficial soils consist of Chinguacousy clay loam and Oneida silt loam (hydrologic soil group "C").

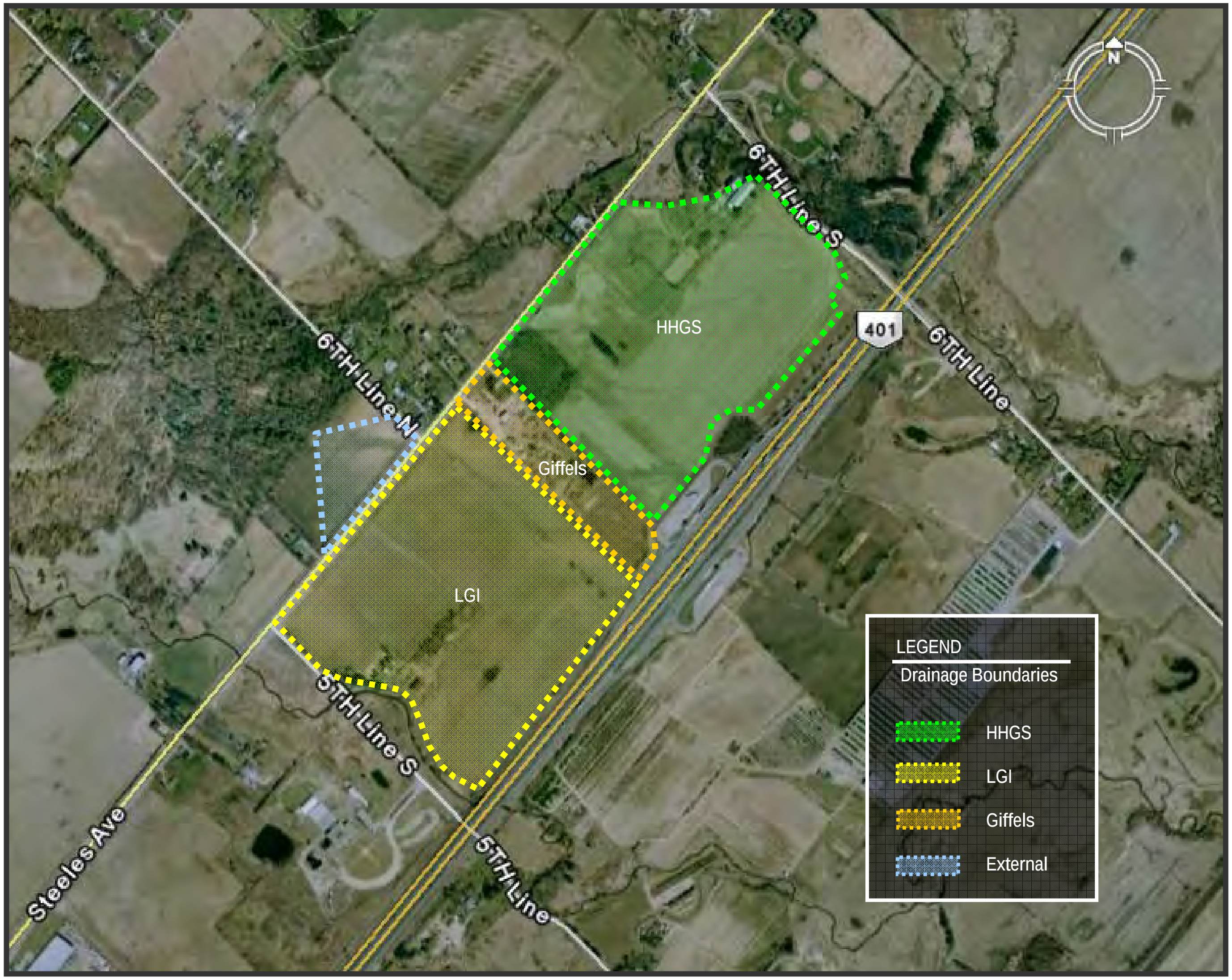
3.1.3 Groundwater Conditions

3.1.3.1 HHGS Property

A geotechnical investigation was conducted on the HHGS property (see Supporting Document 1). The purpose of the investigation was to determine subsurface soil and groundwater conditions in order to develop recommendations to guide the design and construction of the proposed generating station from a geotechnical perspective.

The field work for the geotechnical investigation involved the drilling of 20 boreholes, to depths ranging from 15.26 to 33.81 m below grade. Sampling in the overburden was carried out at approximately 0.76 m depth intervals from surface to 4.27 m, and at approximately 3 m intervals from 6.1 m depth, using a split-spoon sampler in conjunction with the Standard Penetration Test. Bedrock was cored using wire line techniques in HQ (96 mm diameter) size.

FIGURE 3-1
DRAINAGE BOUNDARIES



Six of the boreholes were drilled as groundwater monitoring wells to determine groundwater depth and flow direction and to allow samples of the groundwater to be collected for assessment. Copies of the borehole logs and a map of borehole locations completed during the geotechnical investigation at the HHGS property are provided in Appendices of Supporting Document 1.

Groundwater monitoring wells were installed in boreholes BH1, BH3, BH6, BH10, BH17 and BH20. The water levels in the monitoring wells were measured on June 12th 2006 and August 10th 2006 and are shown on the individual borehole logs and summarized in Table 3-1.

TABLE 3-1
GROUNDWATER LEVEL OBSERVATIONS AT THE HHGS PROPERTY[1]

BOREHOLE Nº.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Surface Elevation (m)
BH1	196.50	0.66	195.84
BH3	194.55	0.23	194.32
BH6	195.73	0.96	194.77
BH10 (at the proposed location of the SWM Facility)	194.92	0.68	194.24
BH17 (at the proposed location of the SWM Facility)	195.20	0.93	194.27
BH20	196.21	0.50	195.71

Note: [1] Observed elevations recorded in August 2006 were the same as elevations recorded in June 2006.

The measured water levels were all within one meter of the ground surface. However, it is anticipated that over the summer, the groundwater surface will drop to greater depths. In general, groundwater is expected to flow in a southerly direction, toward Lake Ontario, as shown by the observed water levels.

In accordance with (*O. Reg. 903)*, a well tag (A043835) was attached to the monitoring well installed in BH1 and a well record filed with the Ontario Ministry of the Environment (MOE). All of the wells were left in place to allow for future groundwater measurements. When the six monitoring wells are decommissioned, it will be done in accordance with *(O.Reg. 903)* and a record of the decommissioning will be filed with the MOE.

3.1.3.2 LGI Property

In addition, groundwater observations were made at boreholes drilled at the LGI property. Borehole locations details are shown in the Subsurface Investigation and Slope Stability Analysis report completed for the LGI property (see Supporting Document 4). A summary of the water levels in the five open borings upon completion of drilling is summarized in Table 3-2.

TABLE 3-2
GROUNDWATER LEVEL OBSERVATIONS AT THE LGI PROPERTY

BOREHOLE Nº.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Surface Elevation (m)
BH1	197.50	3.10	194.40
BH2	197.50	3.30	194.30
BH3	197.50	1.00	196.50
BH6	199.00	1.75	197.25
BH8	197.90	1.85	196.05

3.1.3.3 Giffels Property

Based on data from the HHGS and LGI properties, it is anticipated that groundwater conditions in the Giffels property will be similar to its surrounding sites and no further investigations are required at this time.

3.1.4 Hydrology

In order to determine the existing peak flow and the impacts of proposed developments on the SIS site with respect to peak flow, a hydrology model was completed using SWMHYMO for the SIS site. The hydrology model was set up to reflect the existing catchment discretization provided in Figure 3-1. Available soils, land use and topographic information were used to calculate a number of SWMHYMO parameter values including curve number (CN), total imperviousness (TIMP), directly connected imperviousness (XIMP), and average catchment slope for all catchments. Catchments with a TIMP less than 20% were coded using the Nash's unit hydrograph (NashHYD), whereas catchments with a TIMP greater than or equal to 20% were coded using the Standard unit hydrograph (StandHYD). Using the proposed site plan, values for TIMP and XIMP were calculated. Time-to-peak calculations were completed using the Airport Method. Additional details and calculations associated with the model parameter development are provided in Appendix E.

The Chicago 24-hr design storm distribution and return period depths were used as per the Town of Halton Hills IDF and Rainfall Distribution Std. No. 108. The CN values for return period events (i.e., 2-yr through 100-yr design storms) were set to Antecedent Moisture Condition II (AMC II). The CN values for the Regional Storm (Hurricane Hazel) were set to AMC III conditions as per standard procedure. No areal reduction for rainfall events was required for the

SIS site given the small drainage area. Based on the SWMHYMO model, the peak flows for existing conditions at the SIS site were between 1.85 m^3/s and 6.69 m^3/s for the 2-yr and 100-yr design storms, respectively (see Appendix E). Additional peak flow data for existing conditions are provided in Table 3-5.

3.1.5 Floodlines

As per discussions with Conservation Halton, the 100-yr and Regional (i.e., Hurricane Hazel) water surface elevations along the Sixteen Mile Creek near Highway 401 and 6th Line South are 191.30 m and 193.50 m, respectively. These elevations are based on the most recent hydraulic model (HEC-RAS) available for the Sixteen Mile Creek and are reflective of existing conditions. In addition, the proposed SWM facility will match or exceed the required level of quality/erosion and quantity control as per the recommendations in the SSP (Dillon, 2000). Therefore, it is not anticipated that the controlled runoff from the SIS site will result in any increase in flooding within the Sixteen Mile Creek.

In order to determine the location of the existing Regional floodline on the SIS site, the approved HEC-RAS model has been extended, with additional sections placed on the Main Eastern Triburay of Sixteen Mile Creek, immediately north of Highway 401 (HEC-RAS modelling details are provided in Appendix G). The Main Eastern Tributary currently flows through a 900 mm diameter corrugated steel pipe (CSP) culvert, under the 6th Line embankment north of the Highway 401 overpass. The Main Eastern Tributary continues westerly along Highway 401, however, there is a small watercourse that branches into the southeast corner of the SIS site, approximately 30 m west of the culvert (see Regional floodline map in Appendix G).

Given that drainage area to this point is approximately 65 ha, the existing peak flow would have entered the Sixteen Mile Creek well in advance of the peak flow on the main creek. The Regional floodlines on the SIS site, therefore, would be at the highest when they are at the maximum levels in the Sixteen Mile Creek. The floodwaters would back up through the existing culvert under 6th Line thus, given the existing conditions, there is currently a potential for a spill onto and across the Highway 401. The new design for the culvert will minimize/eliminate this potential impact. The construction of a new culvert will require a Permit from Conservation Halton pursuant to *O.Reg. 162/06*.

The existing Regional floodline has been delineated on the Conservation Authority mapping Sheet No. 50 for illustrative purposes (see Appendix G). The Regional floodline has been mapped on the proposed future land use conditions in Section 3.6.6.

3.1.6 Slope Stability

3.1.6.1 HHGS Property

A slope stability analysis (see Supporting Document 2 and accompanying letter report) was conducted, according to MNR (1997) guidelines, to address concerns regarding the long-term stability of the Main Eastern Tributary slopes on the HHGS property leading down to the floodplain in the northeast corner of the SIS site. The purpose of this analysis was aimed at determining subsurface soil and groundwater conditions along the length of the slope to permit slope stability analyses to be completed.

The embankment along the Main Eastern Tributary at the HHGS property was found to be stable, and from a geotechnical perspective, should not be affected by the proposed development of the property. Conservative soil parameters and groundwater conditions were used in the analyses. Factors of safety in excess of 1.5 were computed for the most critical slopes within the HHGS property under static loading conditions. Applying seismic loading effects yielded factors of safety greater than unity for the slopes. Based on the results of the field work and computer aided stability analyses, it is concluded that the slopes of the Main Eastern Tributary, where it crosses the northeast corner of the SIS site, possess an adequate factor of safety against instability. It is recommended that the present vegetation cover on the slopes be maintained to guard against shallow translational instabilities.

3.1.6.2 LGI Property

A slope stability analysis for the LGI property was also conducted (see Supporting Document 4) to address the long-term stability of the valley slope for the Middle Branch of Sixteen Mile Creek which is located along the west limit of the SIS site adjacent to 5th Line.

Based on survey data, review of topographical information and SLOPE/W software analysis, it was concluded that the existing valley slope is stable (with a factor of safety exceeding 1.5), with the exception of the area immediately north of Borehole 7, where the slope inclination is steeper than 2:1. This steepened area is approximately 45 long and an additional stability setback component of 3 m is recommended. The remaining slope areas along the Middle Branch in the LGI property are considered stable and no additional stability setbacks are deemed necessary.

3.1.6.3 Giffels property

A slope stability analysis for the Giffels property is not applicable as there is no watercourse on the property.

3.2 STORMWATER MANAGEMENT CRITERIA

The following stormwater management criteria have been identified for the SIS site, based on the recommendations from the SSP (Dillon, 2000), the Town of Halton Hills Stormwater Management Policy (April 2002) and the SWMPD Manual (MOE, 2003).

- Level 1 water quality control shall be provided, as per the SWMPD Manual (MOE, 2003).
- Erosion control shall be provided consisting of 52 mm per impervious hectare - 48 hour extended detention control. The effectiveness of the prescribed level of erosion control will need to be assessed, in terms of the mitigation of impacts on the downstream receiving watercourse, in accordance with the Town's Terms of Reference for Subwatershed Impact Studies (see Section 3.6.7).
- Water quantity control shall be provided to control the 2-yr through 100-yr design storm flows to pre-development magnitudes. The 100-yr storm flow quantity control volume shall be 87 mm per impervious hectare.

3.3 REVIEW AND SELECTION OF PREFERRED SWM ALTERNATIVE

Stormwater management practices are specific measures to manage the quality and quantity of urban runoff to mitigate drainage impacts. Stormwater management options can be divided into three groups as follows:

- Source controls such as roof leaders discharging to grass or soakaway pits;
- Conveyance controls such as grassed swales or vegetative filter strips; and
- End-of-pipe controls such as extended detention ponds.

Each option was evaluated on the basis of its capabilities, limitations, physical constraints associated with implementation, and its effectiveness in achieving the stormwater management objectives. The preferred option should ideally accomplish the following goals:

- Emulate as closely as possible the hydrological conditions of the SIS site in its existing condition;
- Reduce nutrient and pollutant loadings in untreated urban runoff;
- Minimize temperature increases in treated runoff;
- Integrate with the planned urban form and municipal service requirements; and
- Be reasonably cost effective in comparison to other options and have acceptable future maintenance requirements for the local municipality.

3.3.1 Evaluation Criteria

The first step in the selection process is to review SWMPs on the basis of the following screening factors:

- Suitability of study area soils and groundwater elevations (where known);
- Existing hydrogeological relationship of site drainage to adjacent tributaries;
- Size of contributing drainage areas;
- Compatibility with urban form;
- Municipal servicing requirements; and
- Water quality control effectiveness.

3.3.2 SIS Site Infiltration Potential

The surficial soils throughout the SIS site consist of Chinguacousy clay loam and Oneida silt loam. These soils are classified as a hydrologic soil group "C" (HSG C) which is characterized by moderate to high runoff potential and below average infiltration after presaturation. Based on initial available soils information, the SIS site has limited potential for infiltration facilities due to low to borderline estimated percolation rates associated with soils in the area. Based on the literature, the percolation rate for clay loam is typically ≤ 15 mm/hr. However, it is important to promote infiltration where soils are suitable in order to help offset the reduction in infiltration due to increased impervious area from proposed development. Therefore, infiltration practices should be reviewed at the detail design stage to determine viable lot level and conveyance controls such as the following:

- reduced lot grading to promote ponding and infiltration;
- roof leaders directed to rear lot ponding areas, soakaway pits, cisterns, rain barrels, etc.;
- infiltration trenches;
- grassed swales;
- pervious pipe systems;
- vegetated filter strips; and
- stream and valley corridor buffer strips.

Initial infiltration estimates indicate that end-of-pipe infiltration basins are likely not an option. It should be noted that the proposed SWM facility is sized to provide adequate storage and flow attenuation assuming that there will be no enhanced infiltration of impervious runoff.

If soakaway pits and/or infiltration trenches are considered at the detailed design stage, it must be shown, that the soil percolation rate is ≥ 15 mm/hr, through additional soils testing. In addition, soakaway pits and infiltration trenches must be set back a minimum of 4 m from any building foundation. It should also be confirmed at the detailed design stage for the SWM facility that groundwater mounding will not be an issue where slope stability and/or a high water table is encountered. It is understood that site servicing and building envelopes will be designed to minimize/prevent any potential impact on groundwater.

Only roof runoff will be directed to any/all proposed enhanced infiltration facilities. Runoff from other impervious areas such as parking lots that have the potential to be contaminated with pollutants will not be encouraged to infiltrate into the ground in order to avoid potential groundwater contamination.

Given that only roof runoff will be directed to soakaway pits and infiltration trenches, it is anticipated that future maintenance will not be onerous. Roof runoff is very low in suspended solids and, therefore, the potential for clogging and subsequent maintenance is minimal.

3.3.3 Selection of Stormwater Management Option

Based on the evaluation of management options, an “end-of-pipe” wet extended detention pond is the most feasible stormwater management option for the SIS site because:

- Direct infiltration facilities are not ideally suited given the soil properties of the SIS site;
- Large scale use of grassed swales and vegetative filter strips is not feasible due to the large area of the SIS site (65ha);
- Wet ponds are acceptable for outlets to coldwater receiving watercourses; and

Further, because large scale infiltration may not be feasible, measures such as discharging rooftops to pervious areas should be implemented wherever possible.

3.4 SITE WATER BALANCE

A water balance was completed for the SIS site for both existing and proposed conditions.

3.4.1 Methodology

The existing and proposed SIS site water balances were estimated using the methodology outlined in SWMPD Manual (MOE, 2003) using soils and land use information to calculate weighted evapotranspiration values. Weighted water surplus quantities were calculated as per the MOE methodology (2003); a weighted infiltration factor was calculated and surplus quantities were then split into runoff and infiltration components for existing and proposed conditions.

3.4.2 Pre-Development Water Balance Quantities

The results of the annual water balance analysis for existing conditions including pervious and impervious areas for the SIS site are presented in Table 3-3. Based on a total average annual precipitation of 940 mm, approximately 129,025 m^3 of water infiltrates the ground under existing conditions.

3.4.3 Post-Development Water Balance Quantities

Two scenarios were modelled for the post-development condition, including "No Infiltration Enhancements" and "With Infiltration Enhancements". The results of the water balance analysis for proposed conditions are presented in Table 3-3. Under proposed conditions without implementing any infiltration enhancements, approximately 35,525 m^3 of water will infiltrate the ground. This represents 27.5% of the existing infiltration quantity. Under proposed conditions with the implementation of infiltration enhancements, approximately 58,566 m^3 of water will infiltrate the ground or approximately 45.4% of the existing infiltration quantity.

3.5 SITE INFILTRATION CONSIDERATIONS

In order to minimize the impact of development on the future water balance for the SIS site, enhanced infiltration measures are recommended for all proposed developments within the SIS site drainage areas wherever possible. The suitability of implementing infiltration measures must be verified at the detailed design stage and will require more detailed soil information including soil percolation tests. If the soil is suitable for the implementation of infiltration measures, the following best management practices are proposed for the SIS site:

- Roof drains will be directed to pervious lawn areas and/or soakaway pits where applicable, to promote infiltration;
- Infiltrate runoff from roads, parking areas and other impervious commercial/industrial areas will not be directed to pervious areas or pits due to the small potential for groundwater contamination; and where applicable, grassed swales will be constructed along rear lot lines;

TABLE 3-3
ANNUAL SITE WATER BALANCE CALCULATIONS

Condition	Site Area (ha)	Water Balance Components	Pervious Area (ha)	Impervious Area Without Infiltration BMP's (ha)	Impervious Area With Infiltration BMP's (ha)	TOTAL SITE VOLUMES					Percent of Existing Infiltration (%)
						Precipitation (m^3)	*Evapo-transpiration (m^3)*	*Surplus (m^3)*	*Runoff (m^3)*	*Infiltration (m^3)*	
		Area (ha)	65.00	0.0000	0.0000						
		Infiltration Factor	0.50	0.00	0.50						
		Precipitation (mm)	940.00	940.00	940.00						
Existing	65.0	Evapotranspiration (mm)	543.00	0.00	543.00	611,000	352,950	258,050	129,025	129,025	100.0
		Surplus (mm)	397.00	940.00	397.00						
		Infiltration (mm)	198.50	0.00	198.50						
		Runoff (mm)	198.50	940.00	198.50						
		Area (ha)	17.50	47.5	0.0000						
		Infiltration Factor	0.50	0.00	0.50						
		Precipitation (mm)	940.00	940.00	940.00						
Proposed (No Infiltration BMP's)	65.0	Evapotranspiration (mm)	534.00	0.00	534.00	611,000	93,450	517,550	482,025	35,525	27.5
		Surplus (mm)	406.00	940.00	406.00						
		Infiltration (mm)	203.00	0.00	203.00						
		Runoff (mm)	203.00	940.00	203.00						
		Area (ha)	17.50	36.15	11.35						
		Infiltration Factor	0.50	0.00	0.50						
		Precipitation (mm)	940.00	940.00	940.00						
Proposed (With Roof Infiltration BMP's)	65.0	Evapotranspiration (mm)	534.00	0.00	534.00	611,000	154,059	456,941	398,376	58,566	45.4
		Surplus (mm)	406.00	940.00	406.00						
		Infiltration (mm)	203.00	0.00	203.00						
		Runoff (mm)	203.00	940.00	203.00						

Notes:

1. Site water balance calculations based on the methodology outlined in SWMPD Manual (MOE, 2003).
2. Proposed (with roof infiltration BMP's) assumes 30% of the LGI property and 5% of the HHGS property is roof area that could be infiltrated to the ground.
3. BMP is best management practice.

3.6 CONCEPTUAL STORMWATER MANAGEMENT PLAN

3.6.1 General Description and Location

The proposed conceptual stormwater management plan has been designed to provide the required level of water quality and quantity protection as identified in the SSP (Dillon, 2000), the Town of Halton Hills Stormwater Management Policy (2002) and the SWMPD Manual (MOE, 2003).

The conceptual SWM facility consists of a forebay, a main treatment/flood storage pond, a multi-stage outlet structure and an emergency spillway. A decanting area (15 m x 250 m) for drying the excavated material during construction and maintenance is shown in Figure 3-3. The proposed depth of the pond up from the permanent pool surface water elevation (i.e., 191.8 m) to the bottom is 1.8 m in the forbay, while the depth in the main facility is 1 m. The permanent pool depth in the cooling trench is indeed deeper at 1.8 m. Figure 3-4 shows the deeper cooling trench in the sectional view A-A. Table 3-7 also summarizes the pool depths.

The total permanent pool surface area is approximately 1.5 ha and the total pond block is approximately 4.5 ha. The conceptual grading plan confirms that the 4.5 ha pond block is sufficient to provide the required storage volumes while meeting the design guidelines. Flows from a 100-yr storm enter the pond block at the northwest end and flow through a sewer and/or channel through the outlet at the east end of the pond block. Outflows from the pond will be safely conveyed to a newly constructed culvert located at 6th Line South via an engineered channel and subsequently to the Sixteen Mile Creek to the east of 6th Line South and to the north of Highway 401. The SWM facility has been designed so that it will not be impacted by the 100-yr or Regional floodline of the Sixteen Mile Creek and there is no impact on existing floodplain storage.

3.6.2 Volume Requirements

The permanent pool requirements for the SWM facility were determined based on the SWMPD Manual (MOE, 2003). The active storage volume, both extended detention and quantity control, was determined through hydrologic modelling using SWMHYMO and established design criteria (MOE, 2003; Dillon, 2000). The pre-development model set the “targets” for the SWM facility and the post-development model calculated the required storage volumes for the 2-yr through 100-yr design storm flow. Details of the SWMHYMO hydrologic modelling are presented in Appendix F. Table 3-4 summarizes the required storage volumes for each component of the SWM facility.

TABLE 3-4
SWM FACILITY VOLUME REQUIREMENTS AND PROVIDED DESIGN[1]

Drainage Area (ha)	Land Imperviousness (%)	Permanent Pool Volume (m^3)	Extended Detention/ Erosion Control Volume (m^3)	Total Active Volume (m^3)
65	71	12,155	23,920	
Provided Design		21,398	29,595	56,121

Notes: [1] Based on wet pond designation in Table 3.2 of SWMPD Manual (MOE, 2003). See Appendix E for calculations.

3.6.3 Design Rating Curve

Table 3-5 summarizes the storage-discharge requirements for the facility. This curve represents the target release rates and active storage volumes necessary to meet the extended detention and post-to-pre control design requirements. Using the hydrologic model with reservoir routing and hydraulic calculations assuming a broadcrested weir, it was confirmed that the facility is capable of passing the Regional storm flow without the risk of overtopping.

TABLE 3-5
POND RATING CURVE

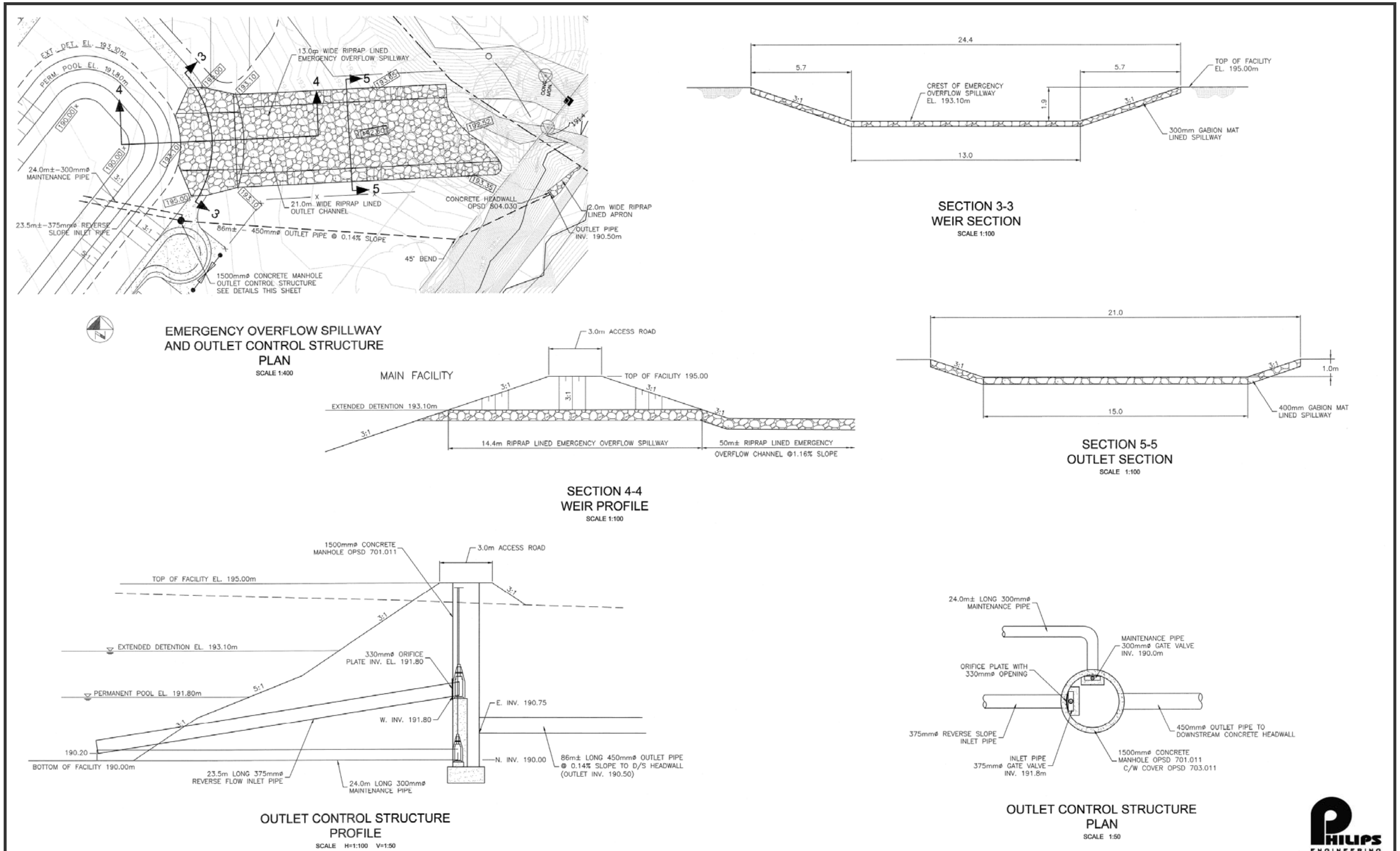
Design Storm Flow Event	Release Rate (m^3/s)	Storage (m^3)
52 mm	0.10	11,860
2-yr	0.19	22,560
5-yr	0.25	29,370
10-yr	0.53	34,100
25-yr	1.62	36,080
50-yr	2.94	37,690
100-yr	4.50	39,280

3.6.4 Conceptual Design of Outlet Structures

Extended Detention Outlet Structure and Maintenance Pipe

The extended detention outlet structure (see Figure 3-2) consists of a 375 mm diameter reverse slope pipe connected to a 1500 mm diameter concrete manhole with a 330 mm diameter orifice set to an invert elevation of 191.80 m (i.e., normal water level). The reverse slope pipe helps to minimize thermal loading to the Sixteen Mile Creek by drawing water from the bottom of the pond. A 300 mm maintenance pipe is also connected to the manhole to partially drain the pond by gravity during pond maintenance activities. Flow from the concrete manhole is conveyed via a 450 mm outlet pipe to the outlet near the ditch along Highway 401.

FIGURE 3-2
QUANTITY WEIR/EMERGENCY OVERFLOW SPILLWAY AND OUTFLOW CONTROL



Quantity Control Outlet Structure and Emergency Spillway

The quantity control outlet structure (see Figure 3-2) consists of a trapezoidal concrete weir 13 m long, 0.5 m deep, with side slopes of 3:1, set to an invert elevation of 193.1 m and is designed to safely convey up to the uncontrolled Regional storm flow (i.e., outlet structures are assumed to be blocked). Flow from the quantity control structure is conveyed to the culvert under 6th Line South via a 10:1 sloped, 22 m wide, 0.1 m deep riprap lined outlet channel and a portion of the ditch along Highway 401.

3.6.5 SWM Facility Operational Characteristics

The effectiveness of the conceptual SWM facility at attenuating peak flows and providing the required amount of storage was evaluated using the hydrologic model SWMHYMO. Simulations were performed for the post-development condition with the proposed SWM facility in place for the 2-yr through 100-yr design storm flow and Regional storm (i.e., Hurricane Hazel). A comparison of pre-development and post-development stormwater flows and proposed facility operational characteristics is provided in Table 3-6. Based on the results, the post to pre-flow control targets are maintained and/or exceeded. The 100-yr post-development peak stormwater flow is controlled to 4.5 m^3/s which is less than the pre-development peak stormwater flow (6.69 m^3/s).

The calculated drawdown time based on the proposed orifice size (330 mm) and the conceptual pond design is 56 hours (see Appendix E). This is consistent with the minimum required drawdown time of 48 hours as per the SSP (Dillon, 2000). The SWM facility has been designed to safely convey the Regional storm without overtopping either the spillway or the pond perimeter.

TABLE 3-6
COMPARISON OF PRE-DEVELOPMENT AND POST-DEVELOPMENT FLOWS

Return Period	Post Development Uncontrolled Peak Inflow (m^3/s)	Storage Used (m^3)	WSEL (m)	Pre-Development Peak Flow (m^3/s)	Post-Development Controlled Peak Flow (m^3/s)
2-yr	8.15	22,560	192.43	1.85	0.19
5-yr	12.41	29,370	192.87	3.04	0.25
10-yr	14.95	34,100	192.14	3.92	0.53
25-yr	18.25	36,080	193.28	5.02	1.62
50-yr	21.48	37,690	193.35	5.88	2.94
100-yr	24.08	39,280	193.45	6.69	4.50
Regional	9.45	43,210	193.62	7.57	9.15

The major features of the conceptual SWM facility design are provided in Table 3-7:

TABLE 3-7
CONCEPTUAL SWM FACILITY FEATURES

Area	*Drainage Area to Pond [ha]*	65	
	Required Pond Block [ha]	4.5	
Pond Storage Provided		***Storage Volume [m^3]***	***Depth [m]***
	Permanent Pool[1]	21,398	1.0 to 1.8[1]
	Extended Detention (Water Quality and Erosion)	56,121	1.3
	100-yr stormwater event (incl ext. det.)	39,280	1.65 (above perm pond)
	Total Pond (to top of berm)[2]	108,469	4.2 to 5.0
Outlet Configuration		***Orifice*[3]**	***Quantity Weir/ Emergency Spillway*[4]**
	Invert [m]	191.8	193.1
	Dimension [m]	0.33	13 (L), 3:1 (SS)
Pond Shape Characteristics[5]	*Slope*	3:1 / Variable	
	Length to Width Ratio at Permanent Pool Elevation	13:1	

Notes:
[1] Permanent pool water surface elevation is at 191.8 m. Depth of permanent pool is larger near the outlet.
[2] Top of berm is at 195 m.
[3] Dimension value for orifice is its diameter.
[4] Trapezoidal weir dimensions are in length (L) and side slopes (SS).
[5] Forebay area is approximately 1/3 of the permanent pool area.

The design of the SWM facility is shown in Figures 3-3 and 3-4.

FIGURE 3-3
SWM FACILITY: PLAN VIEW

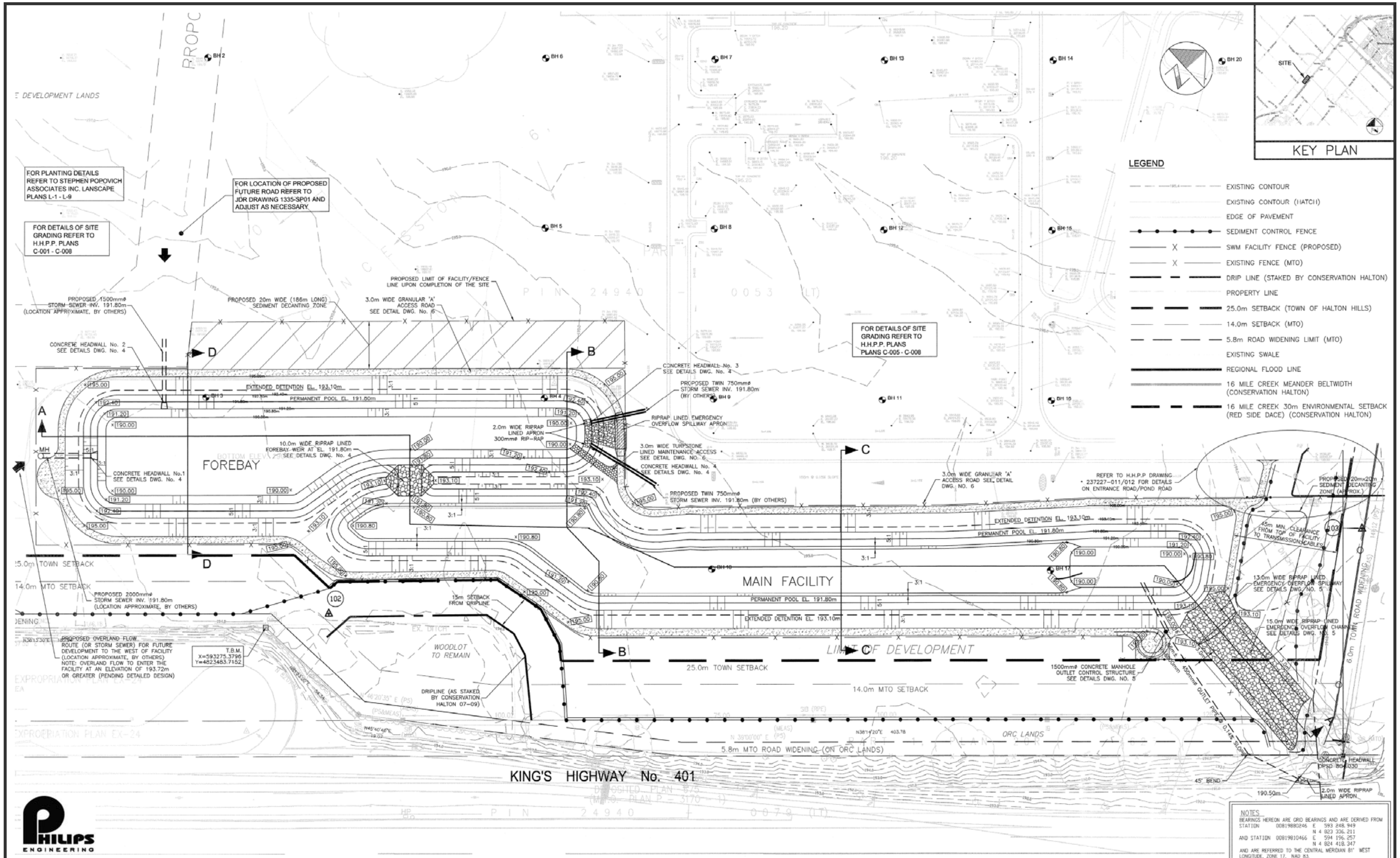
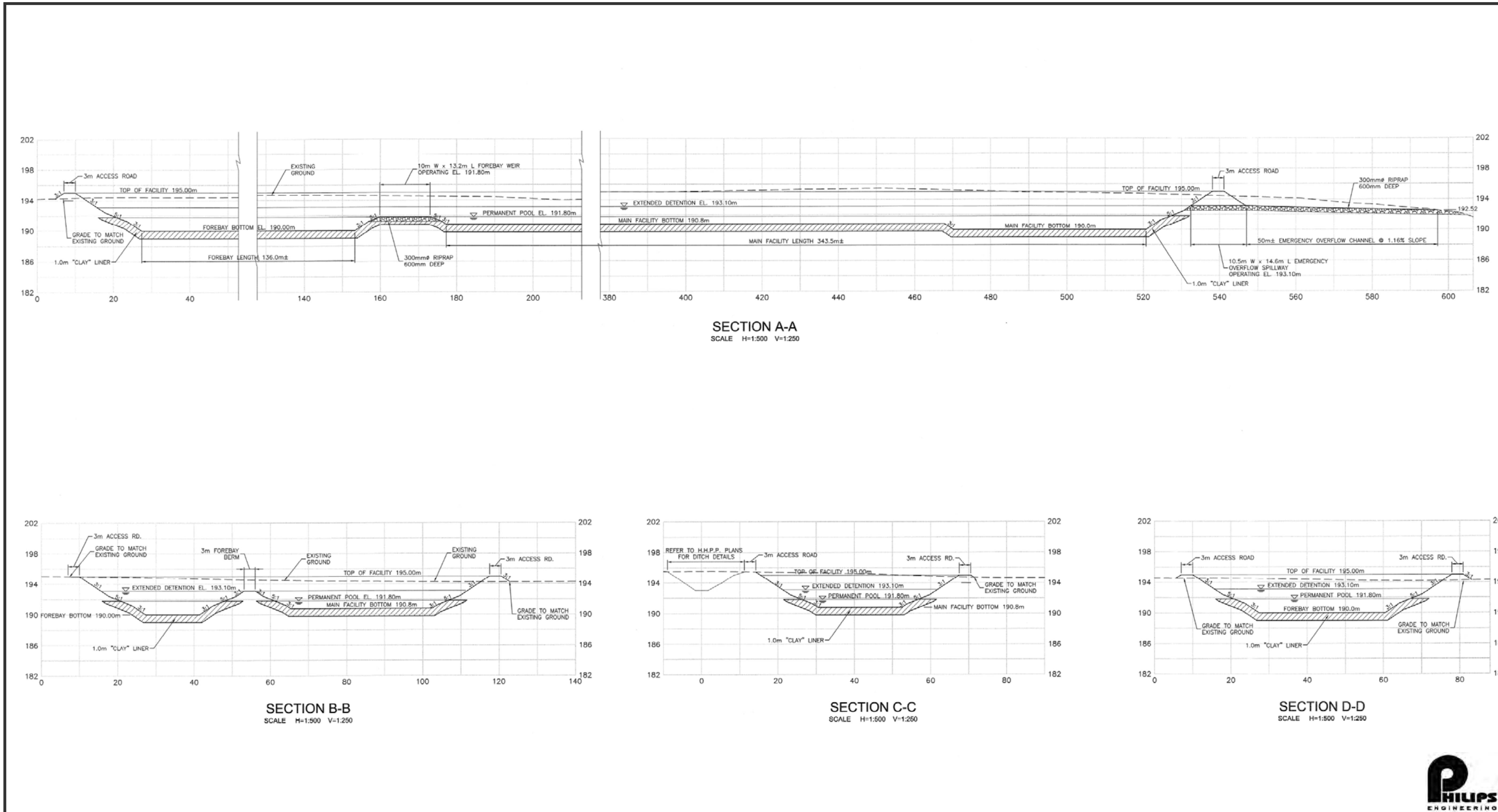


FIGURE 3-4
SWM FACILITY: SECTION VIEWS



3.6.6 Water Surface Elevations of Sixteen Mile Creek

The Regional water surface elevation at the Sixteen Mile Creek in the vicinity of the proposed outlet north of Highway 401 and immediately west of 6^{th} Line South is 193.50 m based on available floodline mapping and discussions with Conservation Halton. The invert of the quantity control weir/emergency spillway is 193.10 m. Figure 3-5 shows the existing and proposed Regional floodlines along with the quantity control weir/emergency spillway invert.

3.6.7 Effectiveness of Erosion Control

In order to demonstrate conformance with the SSP (Dillon, 2000), the future development scenario with the recommended SWM facility in place was modelled using the Town's approved QUALHYMO model (see Appendix H).

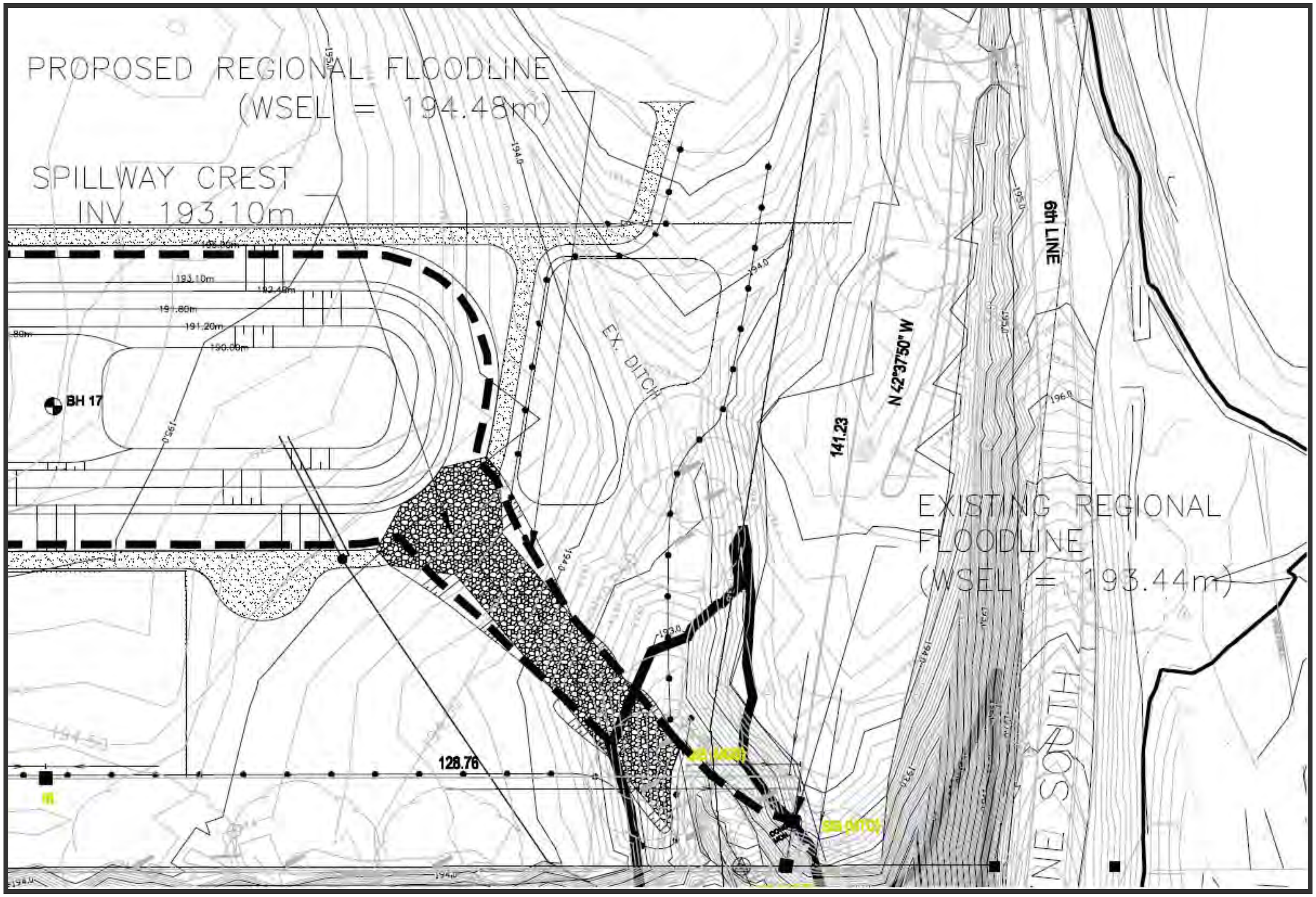
The proposed facility for the SIS site has been designed in conformance with the SSP criteria, including 52 mm per impervious hectare of development for erosion control. The facility effectively reduces the runoff peak to a point below the erosive threshold in the receiving creek (see Figures in Appendix H).

The duration analysis has been completed for two points of comparison: at the outlet of Subwatershed 4 (see Figure 2-1), and downstream of the existing culvert located just east of 6^{th} Line South and south of Highway 401. In both cases, the model of the proposed SWM facility indicates that the facility performance meets or exceeds the conceptual SSP facility design requirements (Dillion, 2000) at roughly 100 L/s (for the comparison at the outlet of subwatershed) and 30 L/s (for the comparison downstream). Both flows are below the erosive threshold of 420 and 2080 L/s, respectively, and hence the facility as designed effectively mitigates the potential increase in erosion caused by development.

3.6.8 SWM Facility Inlets

Based on the proposed development plans for the SIS site, it is anticipated that there will be two inlets to the pond located within the forebay. The proposed invert for the inlets is 191.80 m. This will ensure that the inlet capacity is not affected by ice blockage during winter conditions. Should it be determined that the inverts need to be lowered, then consideration of potential ice blockage and impacts on conveyance capacity must be addressed.

FIGURE 3-5
EXISTING AND PROPOSED REGIONAL FLOODLINE



3.6.9 SWM Facility Outlet

The proposed outlet for the SWM facility will be at the low point of the SIS site located immediately north of Highway 401 and west of 6th Line South. Flow from the pond outlet structure will be conveyed via an engineered channel to the low point. It is proposed that the flow from the low point be conveyed via an existing culvert under 6th Line South to Sixteen Mile Creek. However, based on preliminary calculations, the capacity of the existing culvert is not sufficient to convey the 100-yr flow without significant backwater effects under existing conditions.

Backwater Sensitivity Analysis

The performance of the outlet structure has been analyzed under various scenarios using the HEC-RAS model (see Appendix F). Various flood events have been routed through the proposed drainage system from the SWM facility to the Sixteen Mile Creek under various flood conditions in Sixteen Mile Creek and it has been concluded that there will be no backwater effects up to a 100-yr and, furthermore, there will be no adverse effects on the weir.

Spill Flows to Highway 401

The existing 6th Line culvert is an 900 mm corrugated steel pipe (CSP) and is proposed to be replaced with a 2.4 m by 1.2 m box culvert. This would reduce the spill conditions under the 100-yr and Regional storms. The spill volumes onto the Highway 401 right-of-way are estimated using MTO Monographs (see Appendix F and Table 3-8), assuming any flow above the capacity of culvert would spill onto Highway 401, both under exiting and proposed conditions. It is evident that under the proposed 6th Line culvert condition, the Regional spill onto Highway 401 would be substantially reduced, while the 100 year spill would be eliminated.

TABLE 3-8
COMPARISON OF SPILL VOLUMES (m^3)

Event	Existing Culvert	Proposed Culvert
100 Year	21,213	0
Regional	104,681	900

Given the setback of the SWM facility from the road, it is not anticipated that the proposed widening of 6th Line South will have any significant impact on the proposed SWM facility design. TCE will be replacing the existing culvert during the construction of the HHGS.

To facilitate water temperature control, a reverse slope bottom draw outlet pipe is proposed. The permanent pool area in the vicinity of the outlet pipe is designed to provide a greater depth for water cooling. The permanent pool bottom in the outlet area of is dropped to an elevation of 190.00 m for an area of approximately 28 m x 22 m, thereby increasing the permanent pool depth to 1.8 m. By drawing cooler water from the deeper part within the pond, thermal impacts to the Sixteen Mile Creek should be minimized. A detailed discussion on thermal impact mitigation can be found in Section 3.7.7.

In addition, opportunities to integrate, create or enhance fish habitat as part of the new development would include a naturalized outlet channel from the SWM facility. The proposed outlet location should minimize any disturbance to Sixteen Mile Creek.

3.7 GENERAL DESIGN REQUIREMENTS

Sections 3.7.1 through 3.7.8 provide general design requirements for the SWM facility in order to ensure that the stormwater management objectives will be met. The requirements are based primarily on the SSP (Dillon, 2000), the SWMPD Manual (MOE, 2003) and the Stormwater Management Policy (Halton Hills, 2002).

3.7.1 General

The SWM facility will be located outside of the 100-yr and Regional floodplain limits. Quantity control structures will incorporate a bottom-draw outlet or cooling conduit to reduce thermal impacts to the receiving watercourse.

3.7.2 Storage Depth

The permanent pool will be designed with a mean depth of water between 1.0 m and 2.0 m above the lowest point of the SWM facility. The maximum fluctuation for the active volume (i.e., extended detention plus quantity control) will not exceed 2.0 m. An additional 0.3 m freeboard is required above the maximum extended storage level.

3.7.3 Pond Slope

The pond will have a maximum side slope of 3:1 from between the pond bottom and 1.0 m below the normal operating water level. Side slopes within 3 m of the permanent pool elevation (either side) shall not be steeper than 5:1.

3.7.4 Access Road

The maintenance access road around the SWM facility will have a minimum width of 3.0 m. Further, a minimum 10 m turning radius and a flat 10 m loading area are required. The access road will be constructed of 300 mm of 50 mm diameter crusher run limestone, 100 mm of topsoil and seeded. The access road will not exceed a slope of 8:1.

3.7.5 Planting

The planting guidelines provided in the Stormwater Management Policy (Halton Hills, 2002) and Guidelines for Stormwater Management Pond and Creek Realignment Planting Plans (Conservation Halton, 2005) will be followed. The minimum setback for planting from the maintenance access road, engineering structures and rear lot lines is 1 to 3 m.

3.7.6 Erosion Control

Erosion control and energy dissipation solutions will be provided around the inlets and outlets. An erosion resistant emergency spillway should be provided to ensure that any overtopping flows are safely discharged from the facility. A freeboard of 0.3 m should be allowed in the design of the emergency spillway. A decanting area (15 m x 20 m) for drying the excavated material will be provided as shown in Figure 3-3.

3.7.7 Thermal Impact Considerations

In order to mitigate thermal impacts of the discharge on Sixteen Mile Creek, the length-to-width ratio is maximized (13:1) to prevent the occurrence of large open areas that cannot be shaded by riparian vegetation. It is also noted the outflow from the pond is conveyed through a subsurface cooling trench filled with small stones to enable heat transfer, thus extracting heat from the water and cooling the pond outflow to the receiving waters. In addition, the following Best Management Practices (BMPs) (MOE, 2003) will be used to mitigate thermal loading to receiving waters:

- *Bottom draw outlet:* By drawing cooler water from deeper in the pond, thermal loading can be reduced;
- *Riparian planting strategy:* Planting in the shoreline fringe and flood fringe zones will help to maintain cooler pond temperatures;
- *Night time release:* Releasing water from the pond early in the morning when the water is coolest can reduce the thermal loading to the receiving waters. This would also apply to the draining of the pond for maintenance;

3.7.8 SWM Facility Liner

The proposed SWM facility will require excavation to an elevation of approximately 190.0 m to 190.8 m. Groundwater elevations in the vicinity of the SWM facility are reported to be approximately 194.2 m. As such, a clay liner is proposed for the forebay and permanent pond to ensure the protection of groundwater quality and local groundwater levels based on the hydrogeological investigations (see Supporting Document 3) at the proposed SWM facility location. A short summary of the hydrogeological investigation is given below:

Field Testing

Six test pits were excavated on March 5th 2007 to a depth of 3.66 m (see Appendices of Supporting Document 1). The test pit locations were selected to provide general coverage of the proposed SWM facility location, taking into consideration the locations of boreholes and monitoring wells completed previously.

The test pits indicated that topsoil in the area of the SWM facility ranged in thickness from 0.30 to 0.46 m, and was underlain by sandy silt to silty clay soils. In two test pits, TP2 and TP4, located near the southwestern part of the SWM facility, a layer of sand was encountered at a depth of 3.35 m (groundwater infiltration was slight or nonexistent except in TP 2 and TP 4 where heavy groundwater inflow was encountered within the sand layer). This shallow sand layer was also observed in BH10 drilled in 2006, but was not observed in any other boreholes drilled in the general area of the SWM facility. Thus, it is inferred that the sand layer observed in TP2, TP4 and BH10 is a lens, and does not represent a continuous layer. Groundwater levels measured in the wells were approximately 1 m below the existing ground surface.

Rising head permeability tests were completed in the monitoring wells installed in 2006 boreholes BH1, BH3, BH10, BH17 and BH20. Coefficients of hydraulic conductivity were estimated using a module in the MODFLOW computer program and were found to range between 5 x 10^{-5} cm/s and 5 x 10^{-6} cm/sec.

Laboratory Testing

Soil samples recovered from the test pits were tested to determine a wide range of geotechnical and hydrogeological parameters, including natural moisture content, grain size distribution, Atterberg limits and Standard Proctor Maximum Dry Density (SPMDD)/optimum moisture content relationships. As well, two bulk samples of the silty till soils were compacted to approximately 98% of the maximum SPMDD and subjected to a laboratory permeability test in an attempt to determine the hydraulic properties of material that could serve as the compacted clay liner in the SWM facility.

The natural moisture content of the silty sand to clayey silt soils was found to range between 9.4 and 26.3 %. The maximum SPMDD for the silty soils was determined to be between 1.8 and 2.0 t/m^3, with optimum moisture contents between 12 and 16%. When these materials were compacted to 98 % of the SPMDD and subjected to a laboratory permeability test, no water was observed to exit from the permeameter after 48 hours, indicative of soils of low permeability. Based on the gradation curves, the coefficient of hydraulic conductivity was estimated to range between 10^{-3} and 10^{-7} cm/sec, with the highest values estimated in the sand lens and the lowest values estimated in the clayey silt soils.

Based on the hydrogeological results of the test pit investigation program, *in situ* permeability testing, laboratory testing and hydrogeologic modelling the proposed location of the SWM facility was concluded to be suitable. Most of the area of the SWM facility is underlain by silty and clayey soils that will retard exfiltration of pond water into the natural environment. The southwest corner of the SWM facility will likely intersect a sand lens, but the application of a 1 m thick compacted clay liner over the bottom of the pond will greatly reduce the flow of pond water into the lens. Further, it is not believed that the sand lens is connected hydraulically to Sixteen Mile Creek. It is likely that, post construction there will not be groundwater discharge from the SWM facility towards Sixteen Mile Creek. Thus, potentially warm water impounded in the pond is not expected to affect the cold water fish habitat of the creek through a groundwater pathway.

The laboratory testing on bulk samples of the near surface silty till soils indicate that it is suitable for use as a compacted liner material. In order to construct the SWM facility, substantial quantities of the near surface clayey silt soils will be excavated and can be stockpiled for later re-use as the pond liner. When choosing stockpiled soils for the pond liner, soils that are slightly wetter (within 2%) than the optimum moisture content will yield a lower permeability material when compacted than soils compacted when dry.

In the southwest corner of the SWM facility, a sand lens is present that is expected to generate large groundwater flows when intersected during pond excavation activities. It is recommended that consideration be given to installing measures in this area to dewater the sand lens prior to construction, so as to permit dry working condition. Dewatering of the sand lens will require a Permit To Take Water from the MOE. One of the wells already drilled on-site in the vicinity of the proposed SWM facility during the geotechnical investigations (see Supporting Document 1) will be monitored to determine any dewatering effects on fluctuating groundwater levels.

3.8 OPERATION, MAINTENANCE AND MONITORING CONSIDERATIONS

It is recommended that a SWM facility operation and maintenance report be prepared along with the Detail Design Stormwater Management Plan, in accordance with the Terms of Reference (Halton Hills, 2006) and the Stormwater Management Policy (Halton Hills, 2002). This report should outline in detail the operation, maintenance and monitoring requirements for the SWM facility. The following is an overview of general requirements that should be considered.

The SWM facility should be inspected periodically to determine the frequency of maintenance activities. As such, maintenance activities will be performed on an as-required basis. During the first two years of operation, it is recommended that the SWM facility be inspected following significant storm events to determine if and when maintenance activities are required. Subsequently, inspections should be carried out twice per year. The following items should be considered when inspecting the pond:

- Sediment accumulation;
- Erosion of side slopes and outfall channel;
- Safety hazards;
- Hydraulic operation of the pond and trash accumulation near hydraulic structures;
- Drawdown time following a rainfall event (extended drawdown time significantly greater than 48 hours may indicate a blocked orifice or intake);
- Condition of terrestrial and aquatic vegetation;
- Surface sheen indicating possible oil contamination; and
- Structural integrity (e.g. visual cracks) of inlet and outlet structures.

3.8.1 Sediment Removal

Sediment accumulation reduces the effective storage volume and the long-term SWM facility removal efficiency of total suspended solids (TSS). Theoretical estimates of sediment accumulation and removal will be calculated in the Detailed Design Stormwater Plan. Current provincial guidelines provide storage volume and removal frequency for maintenance relationship curves. The need or sediment removal is based on how long it takes for sediment accumulation to cause the total suspended solid removal efficiency to be reduced by 5%. For 70% impervious catchments containing 250 m^3/ha storage volumes, sediment removal is needed after roughly 32 years for the SWM facility.

It may be necessary to remove sediment accumulated in the pond following the construction period and prior to the operation of the SWM facility.

The forebay of the permanent facility will act as a temporary pond until the permanent SWM facility has been completed. The amount of sediment build-up in the forebay during construction will depend to a large extent on the effectiveness of the erosion and sediment control measures implemented and how well they are maintained. Once construction is completed within the SWM facility drainage basin, the amount of sediment accumulation within the facility will be reduced. The SWM facility operation and maintenance report will provide details regarding sediment removal and disposal consistent with the current provincial guidelines.

3.8.2 Erosion and Sediment Control during Construction

3.8.2.1 General

Erosion and sediment control should be implemented for all construction activities within the SIS site, including topsoil stripping, parking lot construction, foundation excavation and stockpiling of materials. The basic principles considered to minimize erosion and sedimentation include:

- Minimize local disturbance activities (e.g., grading);
- Expose the smallest possible land area to erosion for the shortest possible time;
- Implement erosion and sediment control measures before the outset of construction activities; and
- Carry out regular inspections and reporting of erosion and sediment control measures and repair or maintain as necessary.

Preventing erosion must be a priority and is a superior approach to controlling sedimentation caused by the exposed soils. The proposed grading, servicing and building construction should be carried out in such a manner that a minimum amount of erosion occurs and such that sedimentation facilities control any erosion that does occur. Erosion and sediment control measures should include, but are not be limited to, the following:

- Construction of temporary siltation control ponds:
  - The Greater Golden Horseshoe Area (GGHA) Conservation Authorities (2006) require siltation/erosion control of 250 m^3/ha of dry runoff storage. The forebay which will act as a temporay pond satisfies this requirement. This level of erosion control was deemed acceptable since the runoff is discharged to road ditches that do not support fish habitat.
  - It is proposed that the forbay of the permanent pond will act as a temporary sediment control pond.
  - The forebay banks will be stabilized with topsoil/vegetation treatment will be carried out to ensure that coldwater fisheries are protected from sediment discharge.

- Erection of silt fences around all construction sites:
  - Silt fencing should be used for siltation control as well as for access control. A standard silt fence should be installed along the majority of the SIS site perimeter to prevent loss of sediment from the site. As a minimum requirement, silt fencing should be erected adjacent to waterways located on the SIS site. Silt fences should also be installed in the vicinity of any temporary topsoil or earth stockpiles to minimize sediment transport from these areas off-site.
- Providing sediment traps (e.g., berms, geotextile stone barriers in swales):
  - As the construction of roads and storm sewers is completed at the SIS site, sediment traps should be installed in the catchbasins until such a time as the majority of construction activities have been completed and the area has been stabilized with topsoil and sod.
- Providing construction access:
  - In order to reduce the amount of mud tracked off site by construction vehicles, a 10 m x 60 m mud mat consisting of 300 mm deep, 50 mm crusher-run limestone should be installed near the access points.
- Cutting off swales, in conjunction with silt fence, adjacent to valley and stream corridors;
- Inlet controls at catchbasins;
- Implementing a street sweeping and cleaning program if required; and
- The location and types of all erosion and sediment control measures should be illustrated on the final design drawings. Removal of the erosion and sediment controls should be done once construction is completed and sediment runoff from the construction activities has stabilized.
- The erosion and sediment control measures implemented must be monitored on a regular basis and will likely require periodic cleaning (e.g., removal of accumulated silt), maintenance and/or reconstruction. In addition, all controls should be inspected following heavy rainfall and repairs completed as required.

3.8.2.2 Construction Grading and Sediment Control

The first development on the SIS site is the construction of the HHGS. It also should be noted that the SWM facility will be located in the southeast corner of the SIS site on property to be conveyed from TCE to the Town of Halton Hills. A silt fence will be installed around the entire perimeter of the HHGS property prior to any construction being initiated. The initial phase of construction grading includes clearing and grubbing of the HHGS property followed by stripping of the topsoil. The topsoil can be stripped and stored in the temporary topsoil stockpile area. The amount of topsoil to be stripped from the HHGS property is approximately 64,000 m^3. The topsoil stockpile will be graded to a maximum 3:1 side slope, be hydro-seeded, and encircled with a silt fence. Following the topsoil stripping, the construction of the temporary stormwater retention area can begin along with the grading of the HHGS property to subgrade.

The forebay of the permanent SWM facility will act as a temporary pond. The forebay is designed to store a runoff volume up to a maximum of 46,608 m^3, which is up to the top of the berm. This storage volume well exceeds the minimum volume requirement of 16,250 m^3 (250 m^3/ha (GGHA, 2006) multiplied by the entire area of the SIS site). Therefore, the forebay area has more than sufficient storage volume to meet all requirements. The amount of sediment build-up in the forebay during construction will depend to a large extent on the effectiveness of the erosion and sediment control measures implemented and how well they are maintained.

The temporary pond will operate in batch mode, where water will be pumped to the existing ditch located on the south of the HHGS property line immediately north of Highway 401 following the minimum retention time of 24 hours. The water will be pumped using a floating head suction to minimize sediment to the ditch. Water will be discharged through a series of sediment check dams to assure sediment is controlled before it reaches the ditch. Energy dissipation measures (e.g. riprap) will be installed at the outlet of the temporary pond to minimize/eliminate potential eorion.

There is a large ditch that runs around the perimeter of the location of the Power Block (See "Construction Grading Plan and Erosion/Sedimentation" drawings in Appendix I). This ditch will be built during the construction phase to provide for construction drainage from the Power Block area and some of the temporary parking area located to the north. This ditch is also required for final grading, so it will remain in place once construction is completed. A swale that flows from the northwest corner to the southeast corner of the temporary parking area provides for the remainder of the drainage. Culverts and catch basins will be required on the large ditch draining the Power Block. During the construction phase, only the culverts will be installed, and the catch basins will be installed during the final grading phase. The culverts will be installed at this point because the road that runs around the perimeter of the Power Block will also be constructed at this time and the culverts need to be placed under the road to be able to drain the stormwater runoff from the interior of the Power Block.

In addition to the permanent culverts required for final grading, two temporary culverts are required for construction only. They will allow stormwater to flow under the construction haul road and under the required temporary access driveways (See "Construction Grading Plan and Erosion/Sedimentation" drawings in Appendix I).

To adequately drain the temporary stockpile area and the construction laydown area, a series of temporary swales are required. There are two swales: one to the south and one to the north of the laydown area that will provide for adequate drainage from this portion of the HHGS property.

The construction laydown area will be covered with 600mm of granular material (approximately 600 mm thickness) on filter fabric reinforcement.
There is a swale that flows from the north of the SIS site from Steeles Avenue towards the temporary stormwater retention area/forebay that drains the east side of the temporary topsoil area, as well as the western portion of the construction laydown area and the construction haul road. This swale will be required for final grading to direct stormwater from the western portion of the HHGS property towards the permanent SWM facility. The temporary topsoil area has a second temporary swale located on its west side that flows towards the southern edge of the HHGS property.

Once the main cell of the permanent SWM facility is constructed, all of the ditches previously going to the forebay during construction will be redirected to the main cell temporarily while the forebay is re-graded and completed. Once the forebay is completed, all the swales and ditches within the HHGS property will then be re-directed permanently such that the stormwater from the Power Block will drain into the forebay, so that the SWM facility can function as designed. (See “Final Grading Plan” drawings in Appendix I).

Similar measures will be taken for the development activities on the LGI and Giffels properties to assure appropriate stormwater management and sediment control is in place during construction on the properties.

3.8.3 Spill Prevention and Contingency Plan

In general, any industrial development should prepare a Spill Prevention and Contingency Planning and Reporting (SPCR) plan. The primary purpose of the SPCR document is to provide owners and operators of any industrial development on the SIS site with guidance in the development of a site specific Emergency Response Plan to allow for the timely and effective response to industrial emergencies involving the release of hazardous chemicals or dangerous goods to the environment.

The owner/operator of an industrial facility on the SIS site will outline a process of responding to an emergency which involves situational assessment, defining and prioritizing critical issues, emergency action planning and effective activation of resources. The situational assessment will consider, but not be limited to:

- Determining specific nature of the emergency;
- Identifying conditions related to location, time, weather;
- Determining potential threats to life, property and the environment;
- Determining the appropriate protective and corrective strategies;
- Assessing the effectiveness of the response.

In general, spill prevention practices and systems applicable to developments on the SIS site are summarized below:

Construction and Pre-operation Period

Specific physical spill prevention measures include:

- On site location of spill kits, and containment facilities for oils, fuels and hazardous materials;
- Installation of booms in the temporary pond in the event that unavoidable spills reach the pond;
- Provision for fire protection and isolation of fire hazards that could result in the release of noxious gaseous and liquid hazards; and
- Disposal of solid wastes, if any, according to laws and practices of Ontario.

Start-up Commissioning, and Normal Operating Period

Oil/grit separators will be incorporated at locations where potential spills may occur during the routine operations of the final developed areas in the SIS site.

3.8.4 Monitoring Program

A monitoring program is required to confirm that the fully constructed pond is performing as designed and to ensure that there will be no adverse impacts further downstream. It is recommended that key locations in the vicinity of the pond be monitored for water quality, quantity and temperature.

Construction Phase Monitoring

The pond construction will occur immediately upon mobilization of the SIS site in parallel with grubbing and grading to act as a temporary sedimentation basin during the construction of the HHGS. During this period, the pond will not function as designed because inflows and pollutant loadings will not correspond to those expected over the longer term. The sediment load is likely to be higher than after the stabilization of the developed areas. Visual monitoring and inspections for sediment accumulation and pond storage capacity should be completed on a weekly basis and following significant runoff events during construction. It should be noted that on-site sediment control measures as outlined in sections 3.8.1 and 3.8.2, will help minimize pond maintenance requirements. In addition, the site plan will include a requirement for weekly monitoring of the sediment and erosion control measures, including the temporary pond.

Additionally, sediment and erosion control will be monitored during and after major storm events. This monitoring program will continue for the duration of the construction activities.

Compliance Monitoring

It is recommended that regular inspection, monitoring, and performance assessment of the SWM facility be carried out for a period of two years following the completion of the construction of the SWM facility according to the requirements outlined in Table 3-9 to ensure that the SWM facility performance is according to the design objectives. Monitoring will also be repeated at years 4, 6 and 10.

In accordance with the Ontario Water Resources Act (as amended 2007), as administered by the MOE, the approval process for the SWM facility results in a Certificate of Approval being granted to the owner/operator. The Certificate of Approval requires provisions pertaining to proper operation, maintenance and performance monitoring that are the responsibility of the owner/operator. Monitoring locations should be established at both the inlet and outlet of the SWM facility. This will allow determination of the pollutant contribution from the development area draining to the SWM facility and determine the pollutant removal efficiency of the facility.

The water quality monitoring can be completed by means of either grab samples or continuous sampling procedures, and must be completed during wet weather conditions to establish the change in pollutant concentrations. Continuous flow measurements will be necessary at the time of water quality sample collection. The following is a monitoring program guide:

1. Finalize the monitoring objectives;
2. Select monitoring parameters: Parameter selection must reflect the desired water enhancement purpose. Selection of the monitoring parameters must reflect seasonal relevance and applicability;
3. Finalize sampling times and frequencies: Sampling should be undertaken between March-April and November in order to coincide with the critical periods of spring melt and wet weather flow. Measurements during these periods will give an indication of the critical water quality conditions in the serviced drainage area;
4. Develop and implement an operating plan and procedures: Sample collection procedures and schedule will be defined for co-ordination with laboratory and other field operations (e.g., flow monitoring, data retrieval, etc.); and
5. Recommend a reporting format: Data should be summarized and presented in a clear and concise manner to facilitate performance assessment.

A detailed water quality monitoring program such as that presented in Table 3-9 will be initiated to ensure that the TSS being discharged from the facility to the Sixteen Mile Creek meet the design removal criterion of 80%. The pond inlet and outlet will be monitored year round, mainly during spring, summer and fall for the following parameters at the specified frequency.

TABLE 3-9
EXAMPLE OF DETAILED MONITORING PROGRAM

Parameter	Frequency
Flow	Continuously
Temperature	Continuously
Total Suspended Solids	Daily during each discharge event
Oil and Grease	Daily during each discharge event
Total Phosphorus	Periodically with a minimum of one sample per each season
Ammonia	
Total Kjeldahl Nitrogen	
Nitrate plus nitrite	
CBOD5	
Scan for heavy metals	
E.coli.	

It is anticipated that as monitoring programs mature, the monitoring and maintenance programs may require refinements. Any changes would be dictated by the observations noted during regular monitoring. Table 3-10 outlines the minimum frequency of various maintenance activities (Halton Hills, 2002) that will be required to ensure the proper operation, longevity and aesthetic functioning of the SWM facility.

TABLE 3-10
MAINTENANCE FREQUENCY

Activity	Maintenance Interval (years)
Litter Removal	½
Weed Control	1
Landscape Restoration *(Aquatic Vegetation)*	10
Landscape Restoration *(Terrestrial Vegetation)*	10
Sediment Removal and Disposal	10
Pumping Storm Flows around Pond	10
Soil Sampling and Testing	10
Inspection of Inlet/Outlet	1
Pervious Pipe Cleanout	10

3.8.5 Site Restoration and Landscaping

A Site Restoration and Landscape Plan must be completed for the site approval. The SWM facility Landscape Plans must be consistent with the SWM facility planting guidelines as per the Stormwater Management Policy (Halton Hills, 2002) and Guidelines for Stormwater Management Pond and Creek Realignment Planting Plans (Conservation Halton, 2005).

3.9 LAND OWNERSHIP AND COST SHARING CONSIDERATIONS

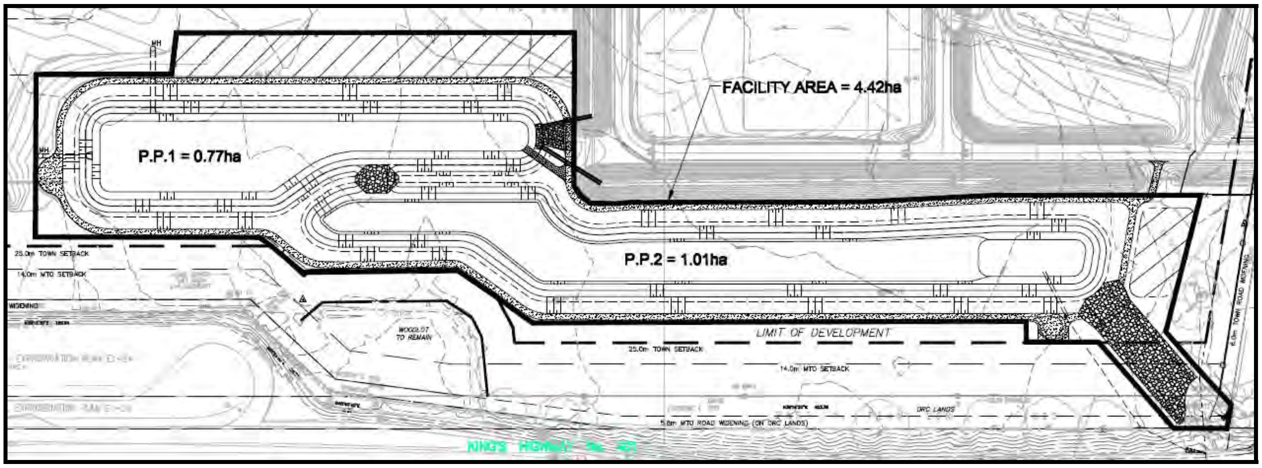
The cost of the SWM facility and related infrastructure is proposed to be shared by the three parcels of land which will contribute stormwater runoff from their developed sites, namely TCE, LGI and Giffels (see Figure 1-2). A cost sharing agreement will be formulated between the parties prior to construction and will be made available upon its completion.

The limits of the SWM facility are roughly set at the perimeter of the facility, also approximated by the proposed fence (see Figure 3-6). For the purpose of the costing exercise, it has been assumed that this is the land which will ultimately be transferred to the Town of Halton Hills. The current estimate, based on the current working drawings, is 4.42 ha or 10.92 acres. The balance of the internal site grading, stormsewers, and major overland flow routing are all assumed to be part of the individual parcels. All of the contributing land owners have agreed to the overall grading concept presented in the SIS, and acknowledge that minor changes will likely be made to the minor and major stormwater conveyance systems.

Figure 3-6 indicates the permanent pool areas for the forebay and main cell of the stormwater management facility, totalling 1.78 ha. These areas will not be included in the maintenance calculations for litter and weed control, and landscape rehabilitation. This area would therefore be (4.42 ha - 1.78 ha =) 2.64 ha. The landscaping plans depict the limits of the aquatic fringe plantings and the upland plantings.

The 6th Line culvert crossing upgrade, and watercourse improvements have necessarily been included in the total cost, as these are fundamental improvements to the existing system that are required as part of the stormwater management plan. Land costs for the crossing is not included, as the crossing is currently in public ownership.

FIGURE 3-6
SWM FACILITY AREAS



3.9.1 Cost Estimate

The cost of the new facility has been broken down in Table 3-11, and includes the background study and detailed design, capital cost of construction, operations and maintenance costs (covering a 50 year maintenance period and converted to present value), land, landscaping and contingency. As an integral part of the proposed SWM facility, the proposed improvements to the culvert crossing at 6th Line, and downstream watercourse improvements from 6'th Line to the Main Eastern Tributary are proposed to be cost shared as well. The proposed total cost of the facility is $9,646,101.26. The final cost to be shared will be determined after the pond construction has been completed and the total costs have been reconciled.

TABLE 3-11
TOTAL COST

Description	Cost
Study and Design - SIS and Engineering	$450,000.00
Construction (ref. Table 3-12)	$3,150,000.00
Landscaping (ref. Table 3-13)	$550,000.00
Land (10.92 Acres @ $406,000/Acre)	$4,433,520.00
Long-term Monitoring	$50,000.00
6th Line Culvert Replacement Costs (see Table 3-15)	$250,000.00
Town of Halton Hills Public Service Administration Fee	$190,805.38
Facility Operation and Maintenance (see Table 3-14)	$271,775.88
Contingency	$300,000.00
Total Facility Cost	***$9,646,101.26***

Tables 3-12 to 3-15 provide details of the estimated quantities involved in the construction of the stormwater management facility, landscaping, operation and maintenance for the required 50 year period, and the 6th Line culvert crossing.

TABLE 3-12
DETAILED CONSTRUCTION QUANTITY ESTIMATE

Item No.	Description	Unit	Est. Qty.
1	Clearing and Grubbing	L.S.	1
2	Dewatering	L.S.	1
3	Stripping and Stockpile of Topsoil (to 450mm)	m^3	17,820
4	Earth Excavation	m^3	130,380
5	Placement of Stormwater Management Facility Liner	m^3	21,550
6	Sediment Control Fence	m	875
7	Riprap		
7.1	Forebay Weir (Class 1 nominal 300 mm)	m^3	144
7.2	Emergency Outlet Weir & Channel	m^3	525
7.3	Outlet Pipe Apron	m^3	5
7.4	Inlets #3 #4 Pipe Apron and spillway	m^3	40
8	Concrete Headwalls		
8.1	Concrete Headwall (OPSD 804.030) single	ea	1
8.2	Concrete Headwall (OPSD 804.030) twinned	ea	2
8.3	Concrete Headwall (OPSD 804.040)	ea	2
9	SWM Facility Outlet Control Structure (Complete)	L.S.	1
10	Concrete Storm Sewers		
10.1	2100 mm dia. Inlet #1 Pipe (incl. Excavation, bedding, restoration, and end cap)	m	25
10.2	1500 mm dia. Inlet #2 Pipe (incl. Excavation, bedding, restoration, and end cap)	m	25
10.3	450mm dia. Outlet Pipe (incl. Excavation, bedding, restoration)	m	85
11	3.0m wide Turfstone Maintenance Access Ramp	m^2	90
12	3.0m wide Granular 'A' Access Road	m^2	2,700

The landscaping costs (see Table 3-13) are based on landscaping in accordance with the Town of Halton Hills and Conservation Halton guidelines.

TABLE 3-13
LANDSCAPING QUANTITY ESTIMATE

Item No.	Description	Unit	Est. Qty.
1	Deciduous Trees Plantings – 45mm Cal.	ea	200
2	Deciduous Trees Plantings – 40m Cal.	ea	150
3	Deciduous Trees Plantings – 30cm Height	ea	150
4	Coniferous Trees Plantings – 150cm Height	ea	100
5	Coniferous Trees Plantings – 1.2m Height	ea	200
6	Coniferous Shrub Plantings – 30cm Height	ea	300
7	Deciduous Shrub Plantings – 30cm Height	ea	3,000
8	Aquatics Plantings – 1 gallon	ea	3,800
9	Topsoil, Fine Grading and Seeding (Natural Mix)	m^2	24,000

The operation and maintenance cost estimate (see Table 3-14) is based on the Town of Halton Hills guidelines, and current unit rates. The estimate has been reviewed by the Town.

TABLE 3-14
OPERATION AND MAINTENANCE COST ESTIMATE

Item No.	Frequency *Period (x per yr)*	Description	Qty	Unit	Cost/Unit	Annual Cost	Present Value Cost by Frequency Group [5%/50 yr]
1	6 mths (2)	Litter Removal	2.64	ha	$1,000	$5,280	$97,581.48
2	1 yr (1)	Weed Control	2.64	ha	$1,000	$2,640	
3	1 yr (1)	Inspection of Inlet/Outlet Structures	6	L.S.	$150	$900	$64,625.98
4	10 yrs (0.1)	Landscape Restoration (Aquatic)[1]	0.52	ha	$1,500	$77	
5	10 yrs (0.1)	Landscape Restoration (Terrestrial)	2.12	ha	$1,000	$212	
6	10 yrs (0.1)	Sediment Removal and Disposal[2]	1,950	m^3	$35	$6,825	
7	10 yrs (0.1)	Dewatering of Forebay/Pump Bypass	1	L.S.	$3,000	$300	
8	10 yrs (0.1)	Soil sampling and testing	1	L.S.	$1,000	$100	
9	10 yrs (0.1)	Riser/Pipe cleanout	1	L.S.	$150	$15	$109,568.42
						Total O&M Cost	***$252,402.80***

[1] Aquatic landscaping coverage is based on a 4 m planted band around the forebay and main pool shorelines.
[2] Sediment loading has been estimated with MOE (2003) Table 6.3: 71% impervious - 3.0 m^3/ha/yr = 1950 m^3 every 10 years

TABLE 3-15
6TH LINE CROSSING DETAILED CONSTRUCTION QUANTITY ESTIMATE

Item No.	Description	Unit	Est. Qty.
1	Clearing and Grubbing	L.S.	1
2	Dewatering	L.S.	1
3	Sediment Control Fence	m	80
4	Regrading ditch at transitions	m^3	200
5	*Stone and Pools*		
5.1	Armour stone headwalls	m^3	100
5.2	Cobble/boulder clusters	m^3	6
5.3	Riffle Construction	ea	1
5.4	Pool construction	ea	4
5.5	Rip-rap apron	m^3	2
6	2400 mm dia. Concrete jacking pipe (CSA A257.2 Class 100 D pipe, voids grouted)	m	48
7	Restoration of work areas and access routes	m^2	700
8	Hydroseeding	m^2	700

3.9.2 Cost Sharing

The three contributing parcels of land occupy approximately 32.4 ha (TCE), 28.3 ha (LGI) and 5.2 ha (Giffels) in area. For the purpose of this study, it has been assumed that all three parcels will develop to the allowable 71% imperviousness, and hence the cost is proposed to be shared on an areal basis (i.e., neglecting each site's final impervious coverage, which may vary by a few percent, provided the total imperviousness of the total contributing drainage area to the facility does not exceed 71%).

The cost-sharing has therefore been proposed to be split as follows: TCE 49.2%, LGI 42.9%, and Giffels 7.9%. The component shares for the SWM facility would therefore be $4,745,881.82, $4,138,177.44, and $762,042.00 respectively for TCE, LGI and Giffels.

The costs provided for the Subwatershed Impact Study are estimated final costs for the SIS development, facility design, construction, monitoring and maintenance costs. The final costs will be based on actual costs which will be reconciled once installation activities are complete.

4.0 PROPOSED STORM DRAINAGE

4.1 GENERAL

A functional grading plan has been prepared for the SIS site demonstrating the conveyance of surface water runoff to the proposed Stormwater Management (SWM) facility. The proposed grading plan reflects both the general trend of the existing topography, the proposed boundaries set out in the SSP, and a proposed internal road configuration developed by the proponent and the other majority landowners.

The drainage is proposed to be conveyed in a standard urban major/minor system, with the major system on the roads and the minor system in a storm drainage system. The grading stage for the storm drainage consists of two parts, final grading and installation of the culverts and drainage ditches. All temporary construction areas (temporary construction laydown area, temporary heavy equipment area, temporary parking) that consist of gravel will be removed and replaced with topsoil at the completion of construction. Also, all swales and drains in these areas will remain in place but the stone cover may be removed and the area will be graded to the proposed final elevations with topsoil. Appropriate erosion control measures will be applied.

Minor and major flows from the external area north of Steeles Avenue and west of 6th Line North will be collected by a storm sewer located on the LGI property.

The proposed SWM facility in the southeast corner of the SIS site has been established relative to the outlet constraints, and the balance of the grading plan has been set from the SWM facility extended detention elevation of 191.8 m and the surface drainage inverts at the inlet to the SWM facility are set at 193.72m. The maximum proposed perimeter elevation of 195.0 m. The overland grades have been set at between 0.3% and 1.0%. The maximum elevation proposed for the SIS site matches the existing elevation of 200.0 m in the northwest limit.

4.2 MINOR AND MAJOR SYSTEMS DESIGN

4.2.1 HHGS Property

Minor system storm drainage at the HHGS property will consist of roadside swales, culverts and ditches which is designed to capture runoff from "minor" storm events (i.e., 5-yr return period or less). All swales will collect stormwater and direct it to catch basins which are connected to culverts that then drain to large ditches flowing through two twin inlets located at the eastern end of the forebay of the permanent SWM facility (see Figure 3-3). Future runoff from the westerly portion of the HHGS property will be conveyed through an inlet located at the north-westerly end of the forebay of the SWM facility (see Figure 3-3).

For the swale and storm sewer sizing, the HHGS property was divided into 37 catchment areas (See "Stormwater Catchment Areas" figure in Appendix I). The minor system refers to the storm sewer system on the SIS site. A 5-yr storm was utilized to size all culverts and ditches, using the rational method for open channel flow to develop the storm flows as per the Stormwater Management Policy (Halton Hills, 2002). The design sheet for the final sizing of the ditches and culverts can be found in Appendix I.

As described above, the minor system (ditches and swales) are designed to convey the 5-yr design storm, the remaining storms (10, 25, 50 and 100-yr) combine to form the major system flow. Therefore, once the culverts are full during a low frequency event, they will surcharge and the roadside ditches will fill and become conveyance channels. The graded roads and ditch system will thereby convey the excess flow to the storm water retention pond.

To verify that the culvert and ditch design is sufficient, as well as to ensure the depth of major flow in the ditches during a 100-yr storm does not exceed the basement floor elevations that have been proposed for the HHGS property, stormwater and open channel modeling was undertaken.

Visual OTTHYMO v2.0 was used to model the sub-catchments draining to the ditches for a 100-yr storm flow. The flows from the OTTHYMO model were then utilized in a HEC-RAS model of the ditch and culvert system to determine the areas of surcharging and the water levels in the ditches during this storm. OTTHYMO results can be found in Appendix J.

It was determined that the total 100-yr storm flow for the HHGS property is 10.52 m^3/s. According to the HEC-RAS modeling, the ditches as designed have ample capacity to handle the 100-yr storm, but some of the culverts do not, and surcharge; however, overtopping of the road does not occur.

The basement floor elevations for the buildings on the HHGS property are set at elevation 196.2 m, the highest water level that occurs in the culvert and ditch system during the 100-yr storm is 195.58 m. Therefore, the ditch and culverts are designed adequately to support the flows on-site and the site grading is sufficient to prevent basement flooding for the buildings. HEC-RAS modeling output can be found in Appendix J. The "Final Grading Plan" drawings for the HHGS property are provided in Appendix I.

4.2.2 LGI Property

Since a small portion located in the southwest of the LGI property (approximately 6.7ha) drains to the Middle Branch of the Sixteen Mile Creek, fill will be placed in this portion to ensure that minor/major storm water flows are routed to the SWM facility.

Appendix K contains the schematic of the drainage plan for the LGI property showing major and minor system flows.

The minor system refers to the storm sewer system on the SIS site and this system will be designed to accommodate the 5-yr storm flows. The system will be located on the proposed roads and will connect the LGI property, across the Giffels and HHGS properties, to the SWM facility. The combined 5-yr storm flow from the LGI and Giffels properties is 7.2 m^3/s.

The major system refers to the surface storm system of ditches and swales. This system will be designed to accommodate the remaining (10, 25, 50 and 100-yr) storm flows. The system will be located on the streets and blocks of development lands and will connect the LGI property, across the Giffels and HHGS properties, to the SWM facility. The combined 100-yr storm flow from LGI and Giffels properties is 12.5 m^3/s.

4.2.3 Giffels Property

It is anticipated that the major flow from the Giffels property will be conveyed southward to meet the storm sewer coming from the LGI property and will eventually be directed to the SWM facility through the inlet located at the western end of the forebay (see Figure 3-3).

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APPENDIX A

FISHERIES SURVEY INFORMATION

Photo 1: Upstream view to the west of Middle Sixteen Mile Creek Tributary at Station 1. At this location, above 6th Line, canopy cover is dense as the watercourse flows within a forested area.

Photo 2: Upstream view to the west of Middle Sixteen Mile Creek Tributary at Station 1. The substrate is primarily gravel and sand and the stream banks show evidence of frequent high flows.

Photo 3: Downstream view to the south of Middle Sixteen Mile Creek Tributary at Station 2. At this location, adjacent to 6th line, the canopy is party open.

Photo 4: View of Middle Sixteen Mile Creek Tributary at Station 2. The adjacent landuse is parkland and this rock weir is man-made.

Photo 5: Downstream view to the south of Middle Sixteen Mile Creek Tributary at Station 3. At this location, upstream of the Highway 401 crossing, the canopy is party open.

Photo 6: View of Middle Sixteen Mile Creek Tributary at Station 3. The substrate is primarily cobble with heavy algal growth and moderate sediment overlying.

Photo 7: Upstream view to the north of Middle Sixteen Mile Creek Tributary at Station 4. At this location, upstream of the Canadian Pacific Railway crossing, canopy cover is mainly open and instream submergent aquatic macrophytes are abundant.

Photo 8: Downstream view to the south of Middle Sixteen Mile Creek Tributary at Station 4. The confluence with Middle Sixteen Mile Creek occurs almost immediately downstream of the railway crossing.

EcoMetrix Incorporated
Stream Habitat Assessment Form

Client: HHEC
Project No.: 06-1329
Investigators: R. Eakins & B. Lebeau

Date: June 26, 2006
Time: 11:30 am

LOCATION DATA

Watercourse: Middle 16 Mile Creek Tributary	Station Number: #1
Local Name:	Location: US 6TH LINE
Township: Halton Hills	Coordinates: 43° 33.442' N 79° 51.398 W
Topographic Map Name/Number: 30M 12 Brampton	Stream Order: 3

STATION DATA

Flow Vel. (m/s): 0.20	Length (m): 55 m	Mean Width (m): 3	Mean Depth (m): 0.2

HABITAT CHARACTERISTICS

Bank Stability (%)

Highly Unstable:	Moderately Unstable: 50%	Stable: 50%

Stream Morphology (% Total Surface Area)

Pool: 45%	Riffle: 20%	Run: 5%	Flat: 30%

Stream Gradient (% Reach)

High:	Moderate: 100%	Low:

Stream Channel Type (% Reach)

Straight:	Meandering: 100%	Braided:	Ponded:

Stream Canopy (% Stream Shaded)

Dense: 100%	Partly Open:	Open:

Instream Cover (% Total Surface Area)

Undercut Banks: 5%	Boulder:	Logs & Trees: 10%	Log Jams: 10%	Deep Pool: 25%	Aquatic Macrophyte: <0%

Substrate Types (%)

Bedrock: —	Boulder: —	Cobble: 15	Gravel: 30	Sand: 30
Silt: 10	Clay: 15	Marl:	Muck:	Detritus:

Terrain Characteristics (%)

Cultivated:	Meadow:	Lawn:	Forested Upland: 100%	Forested Lowland:
Marsh:	Beaver Pond:	Bog:	Swamp:	

Dominant Terrestrial Vegetation: White ash, Manitoba Maple, White elm, Am. Willow, basswood
Dominant Aquatic Vegetation: Arrowhead
Adjacent Land Use: Forested – Across street is rural residential

Sediment Overlaying Substrate: None ( ) Slight (X) to Moderate (X) Heavy ( )
Algae Overlaying Substrate: None (X) Slight ( ) Moderate ( ) Heavy ( )
Barriers Observed: None (X) Natural ( ) Artificial ( ) Type:______

WEATHER

Cloud Cover (%): Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )
Air Temperature (°C): 24°C Recent Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )

CHEMICAL PARAMETERS

Water Temperature (°C): 18.9°C	Dissolved Oxygen (mg/L): 7.00 mg/L (76.4%)
Conductivity (umhos/cm): 599 µS/cm	pH: 7.89

Water Colour: Colourless ( ) Yellow/Brown ( ) Blue/Green (X)
Water Clarity: Clear (X) Stained ( ) Turbid ( )

BIOLOGICAL CHARACTERISTICS

Benthic Community
Not Assessed (X) Ekman ( ) Surber ( ) Ponar ( ) Visual ( ) Collection ( )

Substrate Sampled: none Number of Replicates: na

Benthic Community Notes: na / crawfish

Fish Community
Not Assessed ( ) Electrofisher (X) 718 sec Seine ( ) Dipnet ( ) Angling ( )
Minnow Trap ( ) Visual ( ) Collection ( )

Sampling Methods: Qualitative (X) Quantitative ( ) I.B.I. ( ) Other ( )

Fish Community Notes: White sucker, creek chub, common shiner, bluntnose minnow, rainbow darter, Johnny darter, rock bass, blacknose dace, brook stickelback

EcoMetrix Incorporated
Stream Habitat Assessment Form

Client: HHEC
Project No.: 06-1329
Investigators: R. Eakins & B. Lebeau
Date: June 26, 2006
Time: 10:00 AM

LOCATION DATA

Watercourse: Middle 16 Mile Creek Tributary	Station Number: #2
Local Name:	Location: D/S Steeles Avenue
Township: Halton Hills	Coordinates: 43° 33.871 N 079° 50.646 W
Topographic Map Name/Number: 30M 12 Brampton	Stream Order: 3

STATION DATA

Flow Vel. (m/s): 0.15	Length (m): 80m	Mean Width (m): 2.5	Mean Depth (m): 0.3

HABITAT CHARACTERISTICS

Bank Stability (%)

Highly Unstable:	Moderately Unstable:	Stable: limestone reinforced

Stream Morphology (% Total Surface Area)

Pool: 45%	Riffle: 5%	Run: 30%	Flat: 20%

Stream Gradient (% Reach)

High:	Moderate: 100%	Low:

Stream Channel Type (% Reach)

Straight:	Meandering: 100%	Braided:	Ponded:

Stream Canopy (% Stream Shaded)

Dense:	Partly Open: 50%	Open: 50%

Instream Cover (% Total Surface Area)

Undercut Banks: –	Boulder: 5%	Logs & Trees: –	Log Jams: –	Deep Pool: 10%	Aquatic Macrophyte: 25%

Substrate Types (%)

Bedrock: —	Boulder: 10%	Cobble: 5%	Gravel: 10%	Sand: 40%
Silt: 35%	Clay:	Marl:	Muck:	Detritus:

Terrain Characteristics (%)

Cultivated:	Meadow:	Lawn: 100%	Forested Upland:	Forested Lowland:
Marsh:	Beaver Pond:	Bog:	Swamp:	

Dominant Terrestrial Vegetation: Manitoba Maple, Am. Willow, Silver Maple, White Elm
Dominant Aquatic Vegetation: Arrowhead, Watercrest, grasses, calamagrostis can., solidago, Asclepiad
Adjacent Land Use: Rec. Park, lawn area, picnic areas.

Sediment Overlaying Substrate: None ( ) Slight ( ) Moderate (X) Heavy ( )
Algae Overlaying Substrate: None ( ) Slight ( ) Moderate ( ) Heavy (X)
Barriers Observed: None ( ) Natural ( ) Artificial (X) Type: simple stone barrier

WEATHER

Cloud Cover (%): 100% Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )
Air Temperature (°C): 24 Recent Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )

CHEMICAL PARAMETERS

Water Temperature (°C): 18,1	Dissolved Oxygen (mg/L): 7.69
Conductivity (umhos/cm): 661 µS/cm	pH: 8.15

Water Colour: Colourless ( ) Yellow/Brown ( ) Blue/Green (X) clay colour
Water Clarity: Clear ( ) Stained ( ) Turbid (X)

BIOLOGICAL CHARACTERISTICS

Benthic Community
Not Assessed (X) Ekman ( ) Surber ( ) Ponar ( ) Visual ( ) Collection ( )

Substrate Sampled: none Number of Replicates: none

Benthic Community Notes: crayfish

Fish Community
Not Assessed ( ) Electrofisher (X) 1042 sec. Seine ( ) Dipnet ( ) Angling ( )
Minnow Trap ( ) Visual ( ) Collection ( )

Sampling Methods: Qualitative (X) Quantitative ( ) I.B.I. ( ) Other ( )

Fish Community Notes: White sucker, creek chub rainbow trout, bluntnose minnow, rainbow darter, Johnny darter, rock bass, stonecat, blacknose dace

EcoMetrix Incorporated
Stream Habitat Assessment Form

Client: HHtC
Project No.: 06-1329
Investigators: R. Eakins & B. Lebeau

Date: June 26, 2006
Time: 3:00 pm

LOCATION DATA

Watercourse: Middle 16 Mile Creek Tributary	Station Number: #3
Local Name:	Location: U/S HWY 401
Township: Halton Hills	Coordinates: 43 °33 .258' N 79 °50 .426' W
Topographic Map Name/Number: 30M 12 Brampton	Stream Order: 3

STATION DATA

Flow Vel. (m/s): 0.2	Length (m): 90m	Mean Width (m): 2.5	Mean Depth (m): 0.2

HABITAT CHARACTERISTICS

Bank Stability (%)

Highly Unstable:	Moderately Unstable: 20%	Stable: 80%

Stream Morphology (% Total Surface Area)

Pool: 15	Riffle: 15	Run: 45	Flat: 25

Stream Gradient (% Reach)

High:	Moderate: 100%	Low:

Stream Channel Type (% Reach)

Straight:	Meandering: 95%	Braided: 5%	Ponded:

Stream Canopy (% Stream Shaded)

Dense:	Partly Open: 100%	Open:

Instream Cover (% Total Surface Area)

Undercut Banks: 5	Boulder: 5	Logs & Trees: 10	Log Jams: —	Deep Pool: 10	Aquatic Macrophyte: 5

Substrate Types (%)

Bedrock:	Boulder: 5	Cobble: 60	Gravel: 10	Sand: 5
Silt: 10	Clay: 10	Marl:	Muck:	Detritus:

Terrain Characteristics (%)

Cultivated:	east side Meadow: 50%	Lawn:	westside Forested Upland: 50%	Forested Lowland:
Marsh:	Beaver Pond:	Bog:	Swamp:	

Dominant Terrestrial Vegetation: White ash, Manitoba maple, green alder, White elm
Dominant Aquatic Vegetation: Watercress, arrowhead, potamogeton sp.
Adjacent Land Use: One side: forested; Otherside: meadow

Sediment Overlaying Substrate: None ( ) Slight ( ) Moderate (X) Heavy ( )
Algae Overlaying Substrate: None ( ) Slight ( ) Moderate ( ) Heavy (X)
Barriers Observed: None (X) Natural ( ) Artificial ( ) Type:______

WEATHER

Cloud Cover (%): 100% Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )
Air Temperature (°C): 24 Recent Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )

CHEMICAL PARAMETERS

Water Temperature (°C): 20.3 °C	Dissolved Oxygen (mg/L): 10.34 mg/L (110% sat)
Conductivity (umhos/cm): 640 µS/cm	pH: 8.54

Water Colour: Colourless ( ) Yellow/Brown ( ) Blue/Green (X)
Water Clarity: Clear (X) Stained ( ) Turbid ( )

BIOLOGICAL CHARACTERISTICS

Benthic Community
Not Assessed (X) Ekman ( ) Surber ( ) Ponar ( ) Visual ( ) Collection ( )

Substrate Sampled: none Number of Replicates: na

Benthic Community Notes: na

Fish Community
Not Assessed ( ) Electrofisher (X) 718s. Seine ( ) Dipnet ( ) Angling ( )
Minnow Trap ( ) Visual ( ) Collection ( )

Sampling Methods: Qualitative (X) Quantitative ( ) I.B.I. ( ) Other ( )

Fish Community Notes: White sucker, creek chub, blacknose minnow, rainbow darter, Johnny darter, rock bass, blacknose dace, fantail darter, stonecat, pumpkinseed

EcoMetrix Incorporated
Stream Habitat Assessment Form

Client: HHEC
Project No.: 06-1329
Investigators: R. Eakins & B. Lebleu
Date: June 26, 2006
Time: 2:00 pm

LOCATION DATA

Watercourse: Middle 16 Mile Creek Tributary	Station Number: #5
Local Name:	Location: U/S CPR LINE
Township: Milton	Coordinates: 43 °33.286' N 79 °49.702' W
Topographic Map Name/Number: 30 M 12 Brampton	Stream Order: 4

STATION DATA

Flow Vel. (m/s): 0.15	Length (m): 60	Mean Width (m): 3.5	Mean Depth (m): 0.35

HABITAT CHARACTERISTICS

Bank Stability (%)

Highly Unstable:	Moderately Unstable: 50%	Stable: 50%

Stream Morphology (% Total Surface Area)

Pool: 25%	Riffle: 20%	Run: 20%	Flat: 35%

Stream Gradient (% Reach)

High:	Moderate: 100%	Low:

Stream Channel Type (% Reach)

Straight:	Meandering: 100%	Braided:	Ponded:

Stream Canopy (% Stream Shaded)

Dense:	Partly Open: 20%	Open: 80%

Instream Cover (% Total Surface Area)

Undercut Banks:	Boulder: 5	Logs & Trees: 5	Log Jams:	Deep Pool: 20	Aquatic Macrophyte: 20

Substrate Types (%)

Bedrock:	Boulder: 10%	Cobble: 20%	Gravel: 20%	Sand: 35%
Silt: 15%	Clay:	Marl:	Muck:	Detritus:

Terrain Characteristics (%)

Cultivated:	Meadow: 100%	Lawn:	Forested Upland:	Forested Lowland:
Marsh:	Beaver Pond:	Bog:	Swamp:	

Dominant Terrestrial Vegetation: Manitoba Maple, Am. Willow, ~~green~~ alder
Dominant Aquatic Vegetation: Arrowhead, watercrest, potamogeton sp., chara, spike rush, juncus sp.
Adjacent Land Use: Open lands, cattle field

Sediment Overlaying Substrate: None ( ) Slight ( ) Moderate (X) Heavy ( )
Algae Overlaying Substrate: None ( ) Slight ( ) Moderate ( ) Heavy (X)
Barriers Observed: None (X) Natural ( ) Artificial ( ) Type: ______

WEATHER

Cloud Cover (%): 100% Precipitation: None (X) Light ( ) Moderate ( ) Heavy ( )
Air Temperature (°C): 24° Recent Precipitation: None ( ) Light ( ) Moderate ( ) Heavy ( )

CHEMICAL PARAMETERS

Water Temperature (°C): 21.0 °C	Dissolved Oxygen (mg/L): 11.12 (126%)
Conductivity (umhos/cm): 668 µS/cm	pH: 8.49

Water Colour: Colourless ( ) Yellow/Brown ( ) Blue/Green (X)
Water Clarity: Clear (X) Stained ( ) Turbid ( )

BIOLOGICAL CHARACTERISTICS

Benthic Community
Not Assessed (X) Ekman ( ) Surber ( ) Ponar ( ) Visual ( ) Collection ( )

Substrate Sampled: none Number of Replicates: na

Benthic Community Notes: na / crawfish

Fish Community
Not Assessed ( ) Electrofisher (X) 1004 sec. Seine ( ) Dipnet ( ) Angling ( )
Minnow Trap ( ) Visual ( ) Collection ( )

Sampling Methods: Qualitative (X) Quantitative ( ) I.B.I. ( ) Other ( )

Fish Community Notes: White sucker, creek chub, common shiner, bluntnose minnow, rainbow darter, Johnny darter, rock bass, smallmouth bass, pumpkinseed.

Ontario

[redacted]

Licence to Collect Fish for Scientific Purposes
Field Collection Record

Licence No: 1032583	Licencee Name: ROBERT EAKINS
Business Name: ECOMETRIX INCORPORATED	Telephone: 794-2325 / Fax: 794-2338
Mailing Address: 14 ABACUS ROAD	Town/City: BRAMPTON / Postal Code: L6T 5B7
Waterbody Name: MIDDLE SIXTEEN MILE CREEK TRIB	Township/Municipality: HALTON HILLS

General Description of Sampling Site Location/Access: U/S 6TH LINE

Collection Site No. 1 of 4	Site UTM Coordinates: 592442 E 4823719 N		
Collection Date: 26/06/06	Start Time: 11:00	End Time: 12:30	Duration (hrs) 1.5
Electrofisher Seconds: 718	Length of Station (m) 55	Water Temp. (C) 18.9	Air Temp. (C) 24

Stream Type: [ ] Intermittent [x] Permanent — Watercress Present: [ ] Yes [x] No

Waterbody Type: [ ] Spring [ ] Canal [x] Stream/River [ ] River/Lake Junction [ ] Flooded Area [ ] Pool [ ] Pond [ ] Lake [ ] Reservoir [ ] Muskeg/Bog [ ] Other *(Describe)*

Bottom Type by Percent: *(Total = 100%)*					
	Rock	Boulder	Rubble 15	Gravel 30	Sand 30
	Silt 10	Clay 15	Muck	Marl	Detritus
	Other *(Description)*				

Current: [ ] Still [ ] Slow [x] Medium [ ] Fast [ ] Quantitative (m/s) ______

Water Colour/Clarity: [ ] Colourless [ ] Yellow/Brown [x] Blue/Green [ ] Turbid [ ] Other ______ Secchi Depth: (m) ______

Aquatic Vegetation: [ ] Submergent [ ] Floating [ ] Emergent [x] None

Cover (Shore): [ ] None [ ] Sparse [ ] Moderate [x] Dense [ ] Other ______

Cover (In Water): [ ] None [ ] Sparse [x] Moderate [ ] Dense [ ] Other ______

Gear: [ ] Seine [ ] Gill Net [ ] Dip Net [ ] Angled [ ] Trawl [ ] Minnow Trap [ ] Piscicide [ ] Trap Net [x] Electrofisher [ ] Surber [ ] Other ______

Size of Net (Gill or Seine Net) Length (m):	Size of Net or Mouth (Trap, Hoop or Trawl) (m):	Mesh Size (cm) Smallest:	Largest:

Selectivity of Sample: [ ] All Kept [x] None Kept* [ ] Some Kept* [ ] No Catch

* *Record released fish on back.*

Date: Day 26 Month 06 Year 2006

Collectors: R. EAKINS, B. LEBEAU

Additional Data: *(Pollution, Condition of Fish, Habitat Conditions)*

STREAM BANKS SHOW EVIDENCE OF FREQUENT HIGH FLOWS (SCOURING)

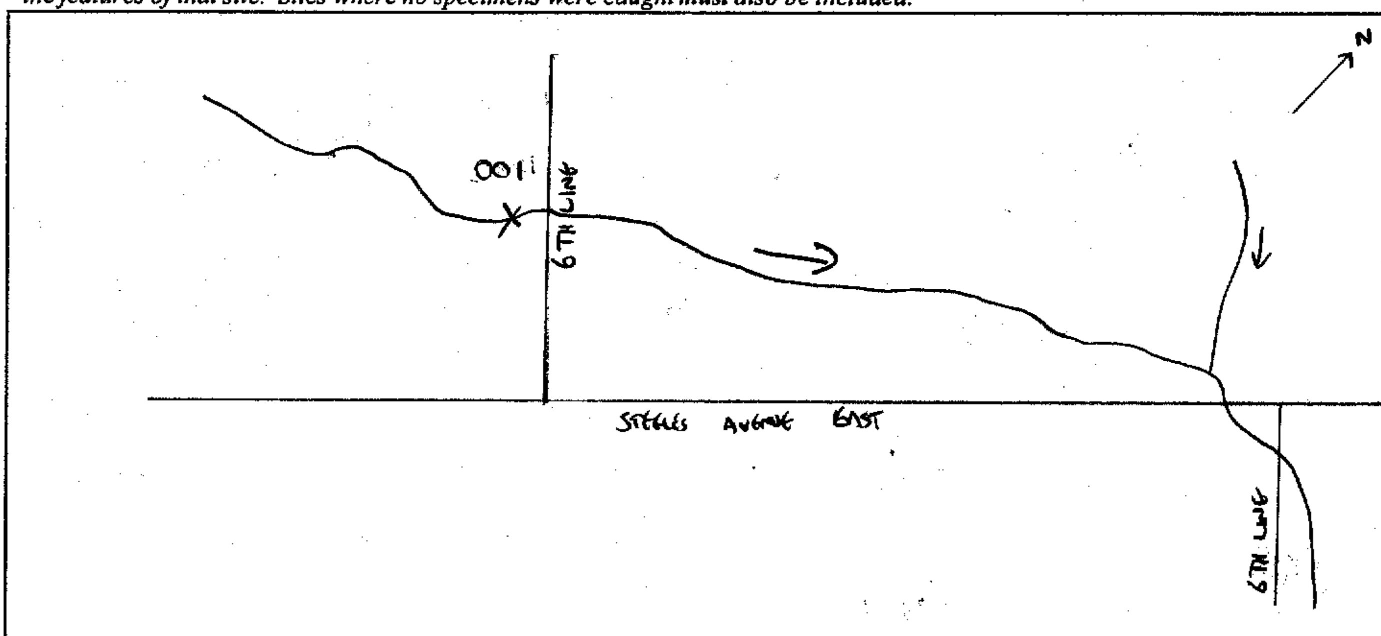
Continued on Reverse

Species Captured

Species	Code	No. Caught	No. Kept	Size Range (T.L. in mm)
WHITE SUCKER	163	22	—	Y J A
CREEK CHUB	212	17	—	J A
COMMON SHINER	198	5	—	J A
BLUNTNOSE MINNOW	208	3	—	J A
RAINBOW DARTER	337	33	—	J A
JOHNNY DARTER	341	30	—	Y J A
ROCK BASS	311	1	—	J
BLACKNOSE DACE	210	36	—	J A
BROOK STICKLEBACK	281	1	—	A
				Y = YOUNG OF THE YEAR
				J = JUVENILE
				A = ADULT
Identified By: R. EAKINS				Date: 26/06/06

Station Diagram

(Include a map that illustrates clearly, at an appropriate scale, the location of each collection site and a diagram that illustrates the features of that site. Sites where no specimens were caught must also be included.



Ontario

[redacted]

Licence to Collect Fish for Scientific Purposes
Field Collection Record

Licence No: 1032583 | Licencee Name: ROBERT EAKINS

Business Name: ECOMETRIX INCORPORATED | Telephone: 794-2325 | Fax: 794-2338

Mailing Address: 14 ABACUS ROAD | Town/City BRAMPTON | Postal Code: L6T 5B7

Waterbody Name: MIDDLE SIXTEEN MILE CREEK TRIBUTARY | Township/Municipality: HALTON HILLS

General Description of Sampling Site Location/Access:

Collection Site No. 2 of 4 | Site UTM Coordinates: 593349 E 4824156 N

Collection Date: 26/06/06 | Start Time: 9:15 | End Time: 10:45 | Duration (hrs) 1.5

Electrofisher Seconds: 1042 | Length of Station (m) 80 | Water Temp. (C) 18.1 | Air Temp. (C) 24

Stream Type: ☐ Intermittent ☒ Permanent | Watercress Present: ☒ Yes ☐ No

Waterbody Type: ☐ Spring ☐ Canal ☒ Stream/River ☐ River/Lake Junction ☐ Flooded Area ☐ Pool ☐ Pond ☐ Lake ☐ Reservoir ☐ Muskeg/Bog ☐ Other *(Describe)*

Bottom Type by Percent: *(Total = 100%)*					
	Rock	Boulder 10	Rubble 5	Gravel 10	Sand 40
	Silt 35	Clay	Muck	Marl	Detritus
	Other *(Description)*				

Current: ☐ Still ☐ Slow ☒ Medium ☐ Fast ☐ Quantitative (m/s) ________

Water Colour/Clarity: ☐ Colourless ☐ Yellow/Brown ☒ Blue/Green ☒ Turbid ☐ Other ________ Secchi Depth: (m) ________

Aquatic Vegetation: ☐ Submergent ☐ Floating ☒ Emergent ☐ None

Cover (Shore): ☐ None ☒ Sparse ☐ Moderate ☐ Dense ☐ Other ________

Cover (In Water): ☐ None ☐ Sparse ☒ Moderate ☐ Dense ☐ Other ________

Gear: ☐ Seine ☐ Gill Net ☐ Dip Net ☐ Angled ☐ Trawl ☐ Minnow Trap ☐ Piscicide ☐ Trap Net ☒ Electrofisher ☐ Surber ☐ Other ________

Size of Net (Gill or Seine Net) Length (m):	Size of Net or Mouth (Trap, Hoop or Trawl) (m):	Mesh Size (cm) Smallest:	Largest:

Selectivity of Sample: ☐ All Kept ☒ None Kept* ☐ Some Kept* ☐ No Catch

** Record released fish on back.*

Date: Day 26 Month 06 Year 2006

Collectors: R. EAKINS, B. LEBEAU

Additional Data: *(Pollution, Condition of Fish, Habitat Conditions)*

ADJACENT PARKLAND

Continued on Reverse

Species Captured

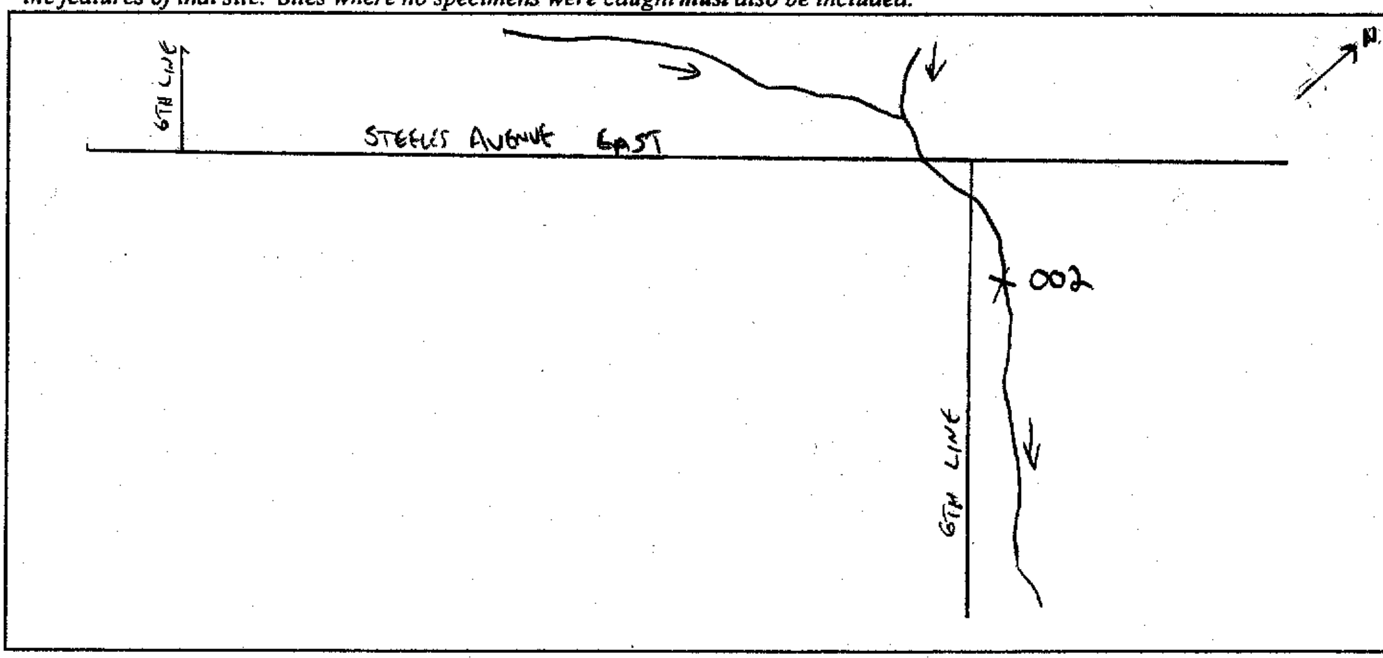
Species	Code	No. Caught	No. Kept	Size Range (T.L. in mm)
WHITE SUCKER	163	30	—	Y J A
CREEK CHUB	212	5	—	Y J A
RAINBOW TROUT	076	2	—	Y
BLUNTNOSE MINNOW	208	13	—	Y J A
RAINBOW DARTER	337	14	—	J A
JOHNNY DARTER	341	35	—	J A
ROCK BASS	311	5	—	J A
STONECAT	235	1	—	J
BLACKNOSE DACE	210	6	—	Y J A
				Y = YOUNG OF THE YEAR
				J = JUVENILE
				A = ADULT

Identified By: R. EAKINS

Date: 26/06/06

Station Diagram

*(Include a map that illustrates clearly, at an appropriate scale, the location of each collection site and a diagram that illustrates the features of that site. Sites where no specimens were caught **must** also be included.*



Ontario

[redacted]

Licence to Collect Fish for Scientific Purposes
Field Collection Record

Licence No: 1032583 | Licencee Name: ROBERT EAKINS

Business Name: ECOMETRIX INCORPORATED | Telephone: 794-2325 | Fax: 794-2338

Mailing Address: 14 ABACUS ROAD | Town/City: BRAMPTON | Postal Code: L6T 5B7

Waterbody Name: MIDDLE SIXTEEN MILE CREEK TRIBUTARY | Township/Municipality: HALTON HILLS

General Description of Sampling Site Location/Access: U/S HWY 401

Collection Site No. 3 of 4 | Site UTM Coordinates: 593648 E 4823950 N

Collection Date: 26/06/06 | Start Time: 14:30 | End Time: 16:00 | Duration (hrs) 1.5

Electrofisher Seconds: 718 | Length of Station (m) 90 | Water Temp. (C) 20.3 | Air Temp. (C) 24

Stream Type: ☐ Intermittent ☒ Permanent | Watercress Present: ☒ Yes ☐ No

Waterbody Type: ☐ Spring ☐ Canal ☒ Stream/River ☐ River/Lake Junction ☐ Flooded Area ☐ Pool ☐ Pond ☐ Lake ☐ Reservoir ☐ Muskeg/Bog ☐ Other *(Describe)*

Bottom Type by Percent: *(Total = 100%)*					
	Rock	Boulder 5	Rubble 60	Gravel 10	Sand 5
	Silt 10	Clay 10	Muck	Marl	Detritus
	Other *(Description)*				

Current: ☐ Still ☐ Slow ☒ Medium ☐ Fast ☐ Quantitative (m/s) ________

Water Colour/Clarity: ☐ Colourless ☐ Yellow/Brown ☒ Blue/Green ☐ Turbid ☐ Other ________ Secchi Depth: (m) ________

Aquatic Vegetation: ☒ Submergent ☐ Floating ☒ Emergent ☐ None

Cover (Shore): ☐ None ☐ Sparse ☒ Moderate ☐ Dense ☐ Other ________

Cover (In Water): ☐ None ☐ Sparse ☒ Moderate ☐ Dense ☐ Other ________

Gear: ☐ Seine ☐ Gill Net ☐ Dip Net ☐ Angled ☐ Trawl ☐ Minnow Trap ☐ Piscicide ☐ Trap Net ☒ Electrofisher ☐ Surber ☐ Other ________

Size of Net (Gill or Seine Net) Length (m):	Size of Net or Mouth (Trap, Hoop or Trawl) (m):	Mesh Size (cm)	
		Smallest:	Largest:

Selectivity of Sample: ☐ All Kept ☒ None Kept* ☐ Some Kept* ☐ No Catch

** Record released fish on back.*

Date: Day 26 Month 06 Year 2006

Collectors: R. EAKINS, B. LEBEAU

Additional Data: *(Pollution, Condition of Fish, Habitat Conditions)*

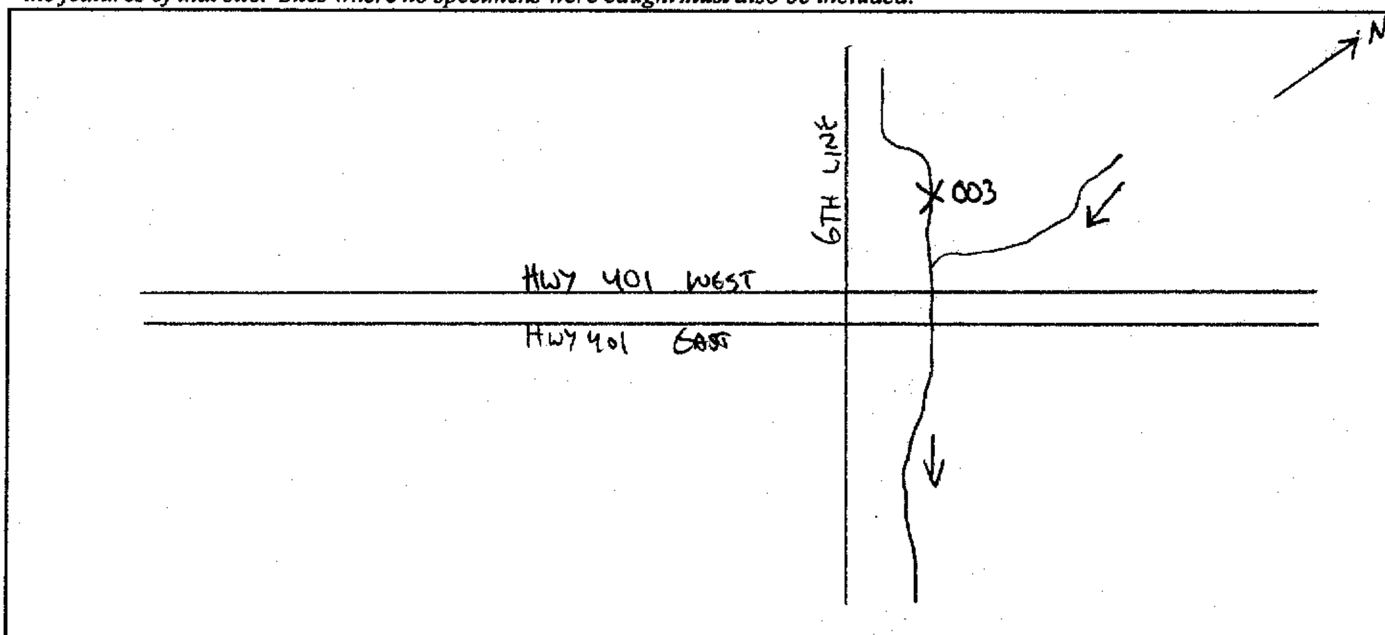
Continued on Reverse

Species Captured

Species	Code	No. Caught	No. Kept	Size Range (T.L. in mm)
WHITE SUCKER	163	26	–	Y J
CREEK CHUB	212	3	–	J
STONECAT	235	1	–	J
BLUNTNOSE MINNOW	208	36	–	Y J A
RAINBOW DARTER	337	48	–	Y J A
JOHNNY DARTER	341	29	–	Y J A
ROCK BASS	311	3	–	J A
BLACKNOSE DACE	210	24	–	J A
PUMPKINSEED	313	2	–	J
FANTAIL DARTER	339	1	–	A
				Y = YOUNG OF THE YEAR
				J = JUVENILE
				A = ADULT
Identified By: R. EAKINS				Date: 26/06/06

Station Diagram

(Include a map that illustrates clearly, at an appropriate scale, the location of each collection site and a diagram that illustrates the features of that site. Sites where no specimens were caught must also be included.



Ontario

[redacted]

Licence to Collect Fish for Scientific Purposes
Field Collection Record

Licence No: 1032583	Licencee Name: ROBERT EAKINS
Business Name: ECOMETRIX INCORPORATED	Telephone: 794-2325 / Fax: 794-2338
Mailing Address: 14 ABAKUS ROAD	Town/City: BRAMPTON / Postal Code: L6T 5B7
Waterbody Name: MIDDLE SIXTEEN MILE CREEK TRIBUTARY	Township/Municipality: MILTON

General Description of Sampling Site Location/Access: U/S CANADIAN PACIFIC RAILWAY LINE, ABOVE CONFLUENCE WITH MIDDLE SIXTEEN MILE CREEK

Collection Site No. 4 of 4	Site UTM Coordinates: 594635 E 4823090 N		
Collection Date: 26/06/06	Start Time: 13:00	End Time: 14:00	Duration (hrs) 1.0
Electrofisher Seconds: 1004	Length of Station (m) 60	Water Temp. (C) 21.0	Air Temp. (C) 24

Stream Type: ☐ Intermittent ☒ Permanent — Watercress Present: ☒ Yes ☐ No

Waterbody Type: ☐ Spring ☐ Canal ☒ Stream/River ☐ River/Lake Junction ☐ Flooded Area ☐ Pool ☐ Pond ☐ Lake ☐ Reservoir ☐ Muskeg/Bog ☐ Other *(Describe)*

Bottom Type by Percent: *(Total = 100%)*					
	Rock	Boulder 10	Rubble 20	Gravel 20	Sand 35
	Silt 15	Clay	Muck	Marl	Detritus
	Other *(Description)*				

Current: ☐ Still ☐ Slow ☒ Medium ☐ Fast ☐ Quantitative (m/s) ______

Water Colour/Clarity: ☐ Colourless ☐ Yellow/Brown ☒ Blue/Green ☐ Turbid ☐ Other ______ Secchi Depth: (m) ______

Aquatic Vegetation: ☒ Submergent ☐ Floating ☒ Emergent ☐ None

Cover (Shore): ☐ None ☐ Sparse ☒ Moderate ☐ Dense ☐ Other ______

Cover (In Water): ☐ None ☐ Sparse ☒ Moderate ☐ Dense ☐ Other ______

Gear: ☐ Seine ☐ Gill Net ☐ Dip Net ☐ Angled ☐ Trawl ☐ Minnow Trap ☐ Piscicide ☐ Trap Net ☒ Electrofisher ☐ Surber ☐ Other ______

Size of Net (Gill or Seine Net) Length (m):	Size of Net or Mouth (Trap, Hoop or Trawl) (m):	Mesh Size (cm) Smallest:	Largest:

Selectivity of Sample: ☐ All Kept ☒ None Kept* ☐ Some Kept* ☐ No Catch

** Record released fish on back.*

Date: Day 26 Month 06 Year 2006

Collectors: R. EAKINS, B. LEBEAU

Additional Data: *(Pollution, Condition of Fish, Habitat Conditions)*

Continued on Reverse

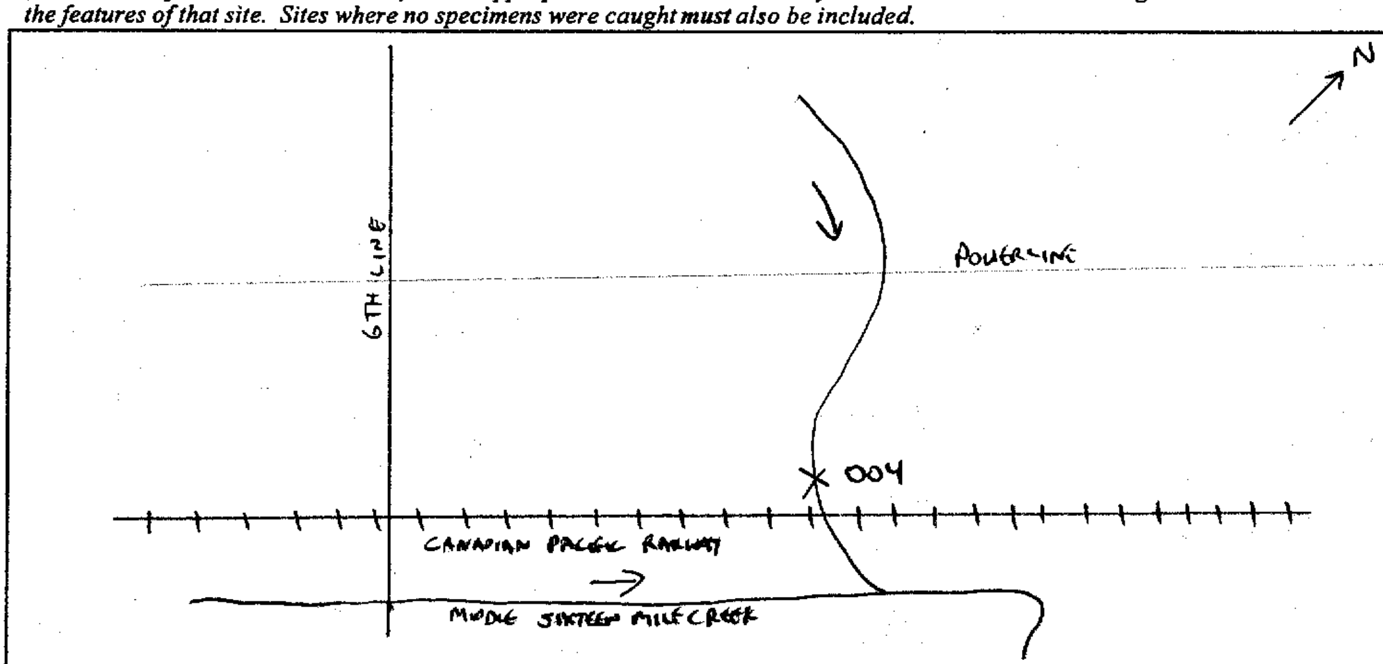
Species Captured

Species	Code	No. Caught	No. Kept	Size Range (T.L. in mm)
WHITE SUCKER	163	13	—	Y, J A
CREEK CHUB	212	6	—	JA
COMMON SHINER	198	1	—	A
BLUNTNOSE MINNOW	208	68	—	JA
RAINBOW DARTER	337	20	—	JA
JOHNNY DARTER	341	23	—	J A
ROCK BASS	311	16	—	J A
SMALLMOUTH BASS	316	2	—	J
PUMPKINSEED	313	1	—	A
				Y - YOUNG OF THE YEAR
				J - JUVENILE
				A - ADULT

Identified By: R. EAKINS   Date: 26/06/2006

Station Diagram

(Include a map that illustrates clearly, at an appropriate scale, the location of each collection site and a diagram that illustrates the features of that site. Sites where no specimens were caught must also be included.



Client: HHEC
Project No. 06-1329
Investigators: R. Eakins & B. Lebeau

ECOMETRIX INCORPORATED
FISH COLLECTION FORM 2

Waterbody: Middle 16 Mile Creek Trib. Station No.: #1 Location: U/S 6TH LINE
Coordinates: 43° 33.642 N 79° 51.348 W Datum: WGS 84
Date: June 26, 2006 Time: 11:30 am Water Temperature: 18.9 (°C)
Electrofishing Effort: 718 (seconds) Length of Stream Sampled: 55 (m) Mean Width: 3 (m)

Species	YOY	Juvenile	Adult
White sucker	////	///////////	/////////
Creek chub		//////////	/////////
Common shiner		///	//
Bluntnose minnow		//	/
Rainbow darter	/	//////////////////////	/////////////////
Johnny darter	/	///////////////	/////////////////
Rock bass		/	
Blacknose dace		/////////////////////////	//////////////////
Brook stickleback			/
TOTALS			

Comments:

Client: AHEC
Project No. 06-1379
Investigators: R. Eakins & B. Labeau

ECOMETRIX INCORPORATED
FISH COLLECTION FORM 2

Waterbody: Middle 16 Mile Creek Station No.: #2 Location: D/S STEELES AVENUE
Coordinates: 43° 33' 871 N 079° 50' 646 W Datum: WGS 84
Date: June 26, 2006 Time: 10:00 am Water Temperature: 18.1 (°C)
Electrofishing Effort: 1042 (seconds) Length of Stream Sampled: 80 (m) Mean Width: 2.5 (m)

Species	YOY	Juvenile	Adult
White sucker	/////////	/////////////////	[illegible]/////
Creek chub	/	/	///
Rainbow trout	//		
Bluntnose minnow	/	/	///////////
Rainbow darter		///////	///////
Johnny darter		////////////	//////////////////////////////
Rock bass		///	//
Stonecat		/	
Blacknose Dace	/	/	////
Note: photographs taken			
TOTALS			

Comments:

Client: HHEC
Project No. 06-1329
Investigators: R. Eakins & B. Lebeau

ECOMETRIX INCORPORATED
FISH COLLECTION FORM 2

Waterbody: Middle 16 Mile Creek Trib. Station No.: #3 Location: U/S HWY 401
Coordinates: 43° 33.758 N 79° 50.426 W Datum: WGS 84
Date: June 26, 2006 Time: 3:00 pm Water Temperature: 20.3 (°C)
Electrofishing Effort: 718 (seconds) Length of Stream Sampled: 90 (m) Mean Width: 2.5 (m)

Species	YOY	Juvenile	Adult
White sucker	||||||||	||||||||||||||||||||	
Creek chub		|||	
Stonecat		|	
Bluntnose minnow	||	||||||| |||||||	|||||||||||||||||||||||||||||| |||||||
Rainbow darter	|	|||||||||||||||||||||||||	|||||||||||||||||||||||||
Johnny darter	||	||||||	||||||||||||||||||||||
Rock bass		||	|
Blacknose dace		|||||	||||||||||||||||
Pumpkinseed		||	
Fantail darter			|
TOTALS			

Comments:

Client: HHEC
Project No. 06-1329
Investigators: R. Eakins & B. Lebeau

ECOMETRIX INCORPORATED
FISH COLLECTION FORM 2

Waterbody: Middle 16 Mile Creek Trib. Station No.: #4 Location: U/S CPR LINE
Coordinates: 43° 33.286 N 79° 49.702 W Datum: WGS 84
Date: June 26, 2006 Time: 1:00 pm Water Temperature: 21°C (°C)
Electrofishing Effort: 1004 (seconds) Length of Stream Sampled: 60 (m) Mean Width: 3.5 (m)

Species	YOY	Juvenile	Adult
White sucker	|	|||||||||	||||
Creek chub		|	||||
Common shiner			|
Bluntnose minnow		|||||||||||||||||||||| |||||||||||||||||||||||||||||||||||	|||||||||||||||||||||||||
Rainbow darter		|||||||||	||||||||||
Johnny darter		||||||||||	|||||||||||
Rock bass		||||||||||||||	|||
Smallmouth bass		||	
Pumpkinseed			|
TOTALS			

Comments:

APPENDIX B

PHOTOGRAPHS OF WATERCOURSES AND DRAINAGE FEATURES

Swale 1 on 21 June 2007 (looking upstream); water in the channel due to groundwater discharge from Steeles Avenue construction activities.

Swale 1 on 28 June 2007 (looking upstream).


Swale 2 (looking upstream).


Swale 3 (looking downstream).


Swale 4 (looking downstream).


Swale 5 (looking south).

Highway drain 6 (looking downstream).


Highway drain 7 (looking upstream).

Highway drain 8 on 21 June 2007 (looking upstream); water in the channel due to groundwater discharge from Steeles Avenue construction activities.

Highway drain 8 on 28 June 2007 (looking downstream).

Groundwater discharge area 9.

Groundwater seepage 9.


Cattail wetland 10 (looking east).


Off-line pond 11 (looking southeast).

Highway drain 12 (looking downstream).

Main Eastern Tributary 13 (looking upstream); note turbidity.


Middle Branch 14 (looking downstream).

APPENDIX C

WOODLOT ASSESSMENTS (DOUGAN & ASSOCIATES)

July 4th, 2007

Jerry Fitchko
Environment & Energy Limited
38 Meadowcrest Road
Toronto, ON M8Z 2Y7
905 817-2084

RE: WOODLOT ASSESSMENT OF HALTON HILLS GENERATING STATION SITE

Dear Mr. Fitchko

As per your request, we have completed an ecological assessment of a 0.39 ha woodlot situated on the site of the proposed Halton Hills Generating Station (see Figure 1). The purpose of the assessment was to determine an appropriate classification of the woodlot based on the Ecological Land Classification System for Southern Ontario (ELC).

Figure 1 - Site Location - Milton, Ontario.

The assessment was performed on June 11th, 2007 using standard ELC protocols. The vegetation assessment included recording species composition and abundance for each forest strata. Specimens of taxa that were difficult to field identify were collected for verification. Two prism sweeps were performed to estimate stand composition and basal area. Soil texture and moisture regime was determined from two auger samples. Soil and prism sweep sampling points were placed in locations to capture the predominant condition. Representative photographs of vegetation and soil conditions were also taken. Copies of the ELC data cards have been included in Appendix 1. A checklist of all vascular plant species observed and their significance status is provided in Appendix 2. Representative photographs of the site are included in Appendix 3.

Based on the vegetation and soils data collected, it is our opinion that 80% of the site (0.31 ha) should be classified as a Swamp Maple Mineral Deciduous Swamp (SWD3-3), while the remaining 20% (0.07 ha) corresponding with the northern edge should be categorized as a Fresh to Moist Lowland Deciduous Forest ecosite (FOD7) (see Figure 2). A complete set of ELC data cards have been completed for the primary vegetation unit (SWD3-3); the secondary unit has been treated as an inclusion due to its relatively small size.

Figure 2 - Vegetation Map

<u>Swamp Maple Mineral Deciduous Swamp Vegetation Type (SWD3-3)</u>

This community is dominated by young to mid-aged swamp maple with white elm, Manitoba maple and green ash being locally abundant. Bur oak and willow form lesser associates. Soil conditions are relatively homogenous throughout the site consisting of clay loams with a moisture regime value of 6 or very moist and poorly drained. This is consistent with the Halton County Soil Survey Map which identifies the entire site as clay loams belong to the Chingacousy soil series. Prominent mottles were observed at depths of 20 and 30 cm respectively in both soil samples extending to 100 cm indicating that most of the soil profile is saturated for at least part of the year. No standing water was observed on the surface or within the pits at the time of sampling; however there was evidence in the central and southern potions of the community to suggest that seasonal ponding does occur. Drainage conditions in the woodlot have been substantially altered by the construction of ditches along the perimeter of the site. The perimeter ditches intercept runoff from the broader catchment area and prevent flow into the woodlot. In response to this, it appears that more upland species are being recruited in the ground and understory strata. While this transition may eventually result in the transition of this swamp community to a lowland forest community, current conditions still are still reflective of a wetland system.

Fresh to Moist Lowland Deciduous Forest Ecosite (FOD7)

This community flanks the northern edge of the woodlot and is approximately 8-10 m in width. It is a transitional zone between the upland fields and swamp community. The community is dominated by basswood with Manitoba maple, white elm, green ash and bur oak forming associates. It has a well established edge bordering the field and is topographically diverse; likely the result of colonization of fill piles associated with perimeter ditch construction. The understorey and ground flora consist primarily of upland edge species such as raspberry and chokecherry. The absence of swamp maple and other wetland species was a key consideration when establishing the boundary between the two communities. Soil sample #2 was taken in close proximity to this community suggesting that soil conditions would be somewhat similar with a probable moisture regime value of 5 and imperfect drainage.

Species

A total of 42 vascular plants were observed from the site, suggesting that the site has a relatively low level of diversity. Of these 34 species are considered native to Ontario, while and 8 considered are introduced, including highly invasive species such as garlic mustard and dame's rocket. One species, Gray's Sedge (*Carex grayi*) is ranked as regionally significant in Halton; two other species Shagbark Hickory (*Carya ovata*) and Eastern Cottonwood (*Populus deltoides*) are considered regionally uncommon in Halton. The population of *C. grayi* is confined to swamp community SWD3-3. Shagbark Hickory occurs in unit FOD7 and Eastern Cottonwood occurs in community SWD3-3

Recommendations

1. Preserve the wetland - it supports a population of a regionally significant plant species.
2. Restore natural overland flows to the wetland by plugging the ditches and creating swales to redirect flow into the wetland. Ensure the quality of any water contributions are maintained or improved. If this is to be done artificially through SWM, then the design should emulate the natural hydroregime of the wetland. Maintain unit FOD7 as a buffer to the wetland. It has a natural well-developed edge.

Should you have any further questions, please do not hesitate to contact me.

Sincerely,

Ken Ursic

Ken Ursic, M.Sc.
Senior Ecologist & Manager

APPENDIX 1 – ELC DATA CARDS

ELC COMMUNITY DESCRIPTION & CLASSIFICATION	SITE: HHGS		POLYGON: 1
	SURVEYOR(S): KU / HP	DATE: June 11/07	TIME: start / finish
	UTMZ:	UTMZ:	UTMN:

POLYGON DESCRIPTION

SYSTEM	SUBSTRATE	TOPOGRAPHIC FEATURE	HISTORY	PLANT FORM	COMMUNITY
☐ TERRESTRIAL ☒ WETLAND ☐ AQUATIC	☐ ORGANIC ☒ MINERAL SOIL ☐ PARENT MIN. ☐ ACIDIC BEDRK. ☐ BASIC BEDRK. ☐ CARB. BEDRK.	☐ LACUSTRINE ☐ RIVERINE ☐ BOTTOMLAND ☐ TERRACE ☐ VALLEY SLOPE ☒ TABLELAND ☐ ROLL. UPLAND ☐ CLIFF ☐ TALUS ☐ CREVICE / CAVE ☐ ALVAR ☐ ROCKLAND ☐ BEACH / BAR ☐ SAND DUNE ☐ BLUFF	☒ NATURAL ☐ CULTURAL	☐ PLANKTON ☐ SUBMERGED ☐ FLOATING-LVD. ☐ GRAMINOID ☐ FORB ☐ LICHEN ☐ BRYOPHYTE ☒ DECIDUOUS ☐ CONIFEROUS ☐ MIXED	☐ LAKE ☐ POND ☐ RIVER ☐ STREAM ☐ MARSH ☒ SWAMP ☐ FEN ☐ BOG ☐ BARREN ☐ MEADOW ☐ PRAIRIE ☐ THICKET ☐ SAVANNAH ☐ WOODLAND ☐ FOREST ☐ PLANTATION
SITE			**COVER**		
☐ OPEN WATER ☐ SHALLOW WATER ☒ SURFICIAL DEP. ☐ BEDROCK			☐ OPEN ☐ SHRUB ☒ TREED		

STAND DESCRIPTION:

	LAYER	HT	CVR	SPECIES IN ORDER OF DECREASING DOMINANCE (up to 4 sp) (>> MUCH GREATER THAN; > GREATER THAN; = ABOUT EQUAL TO)
1	CANOPY	3		ACE FREE > ULM AMER > ACE NIGR = TILI AMER
2	SUB-CANOPY	4		ULM AMER > ACE FREE = TIL AMER = ACE NIGR
3	UNDERSTOREY	5		PAR INSE > RHA CATH > RUB IDAE > PRU VIRG
4	GRD. LAYER	6	4	ALLI PETI > MAI STEL > GLY STRI = CAR GRAY

HT CODES: 1 = >25 m 2 = 10<HT≤25 m 3 = 2<HT≤10 m 4 = 1<HT≤2 m 5 = 0.5<HT≤1 m 6 = 0.2<HT≤0.5 m 7 = HT<0.2 m

CVR CODES 0= NONE 1= 0% < CVR ≤ 10% 2= 10 < CVR ≤ 25% 3= 25 < CVR ≤ 60% 4= CVR > 60%

STAND COMPOSITION: ACEFREE 42 TILAMER 25 ULMAMER 8 QUEMACR 8	BA: 24

SIZE CLASS ANALYSIS:	A	< 10	A	10 - 24	O	25 - 50	N	> 50
STANDING SNAGS:	O	< 10	O	10 - 24	O	25 - 50	N	> 50
DEADFALL / LOGS:	A	< 10	A	10 - 24	O	25 - 50	N	> 50

ABUNDANCE CODES: N = NONE R = RARE O = OCCASIONAL A = ABUNDANT

COMM. AGE:		PIONEER		YOUNG	X	MID-AGE		MATURE		OLD GROWTH

SOIL ANALYSIS:

TEXTURE: CL	DEPTH TO MOTTLES / GLEY	g = 20	G= 50
MOISTURE: 6	DEPTH OF ORGANICS: Ø		(cm)
HOMOGENEOUS / VARIABLE	DEPTH TO BEDROCK: >120		(cm)

COMMUNITY CLASSIFICATION:

COMMUNITY CLASS:	Swamp	CODE: SW
COMMUNITY SERIES:	Deciduous Swamp	CODE: SWD
ECOSITE:	Maple Mineral Deciduous Swamp	CODE: SWD3
VEGETATION TYPE:	Swamp maple mineral Deciduous Swamp	CODE: SWD3-3
INCLUSION		CODE:
COMPLEX		CODE:

Notes:

ELC PLANT SPECIES LIST	
	SITE: HH6S
	POLYGON: 1
	DATE: June 11/07
	SURVEYOR(S): KU / HP

LAYERS: 1 = CANOPY 2 = SUB-CANOPY 3 = UNDERSTOREY 4 = GROUND (GRD.) LAYER
ABUNDANCE CODES: R = RARE O = OCCASIONAL A = ABUNDANT D = DOMINANT

SPECIES CODE	LAYER 1	2	3	4	COLL.
ACE FREE	D	O			
ULM AMER	A	A			
TIL AMER	O	O			
QUE MACR	R	O			
POP DELT	R				
SAL AMY?	R				1
ACE NEGU	O	O	O		
FRA PENN	R	O	O		
TOX RADI			O		
RUBIDAE			A		
VIT RIPA			R		
CAR OVA			R		
RHA CATH			A		
PAR INSE			A		
SOL DULC			O		
PRU VIRG			O		
JUG NIGR			R		
POP TREM		R			
RIBE SP				O	2
CAR GRAY				A	
ALLI PETI				D	
IMP CAPE				A	
GLY STRI				A	
EUON OBOV				O	
ARI TRIP				O	
MAI STEL				A	
TRI GRAN				R	
PODO PELT				O	
AGR GRYP				O	
CIR LUTE				O	
TAR OFFI				O	

SPECIES CODE	LAYER 1	2	3	4	COLL.
AST LATE				O	
HESP MAT				R	
MATT STRU				R	
ARC MINU				R	
CAR				R	3
GEUM ALE				O	
SOL CANA				O	
ECHI LOBA				R	
CAR				R	4
ANE QUIN				R	
TOX RYBD				R	
CAR					5
CAR INTU				R	
EPIL SP.				R	
VERB HAST				R	

ELC

STAND & SOIL CHARACTERISTICS

SITE: HHGS

POLYGON: 1

DATE: June 11/07

SURVEYOR(S): KU / HP

TREE TALLY BY SPECIES:

PRISM FACTOR: 2

SPECIES	TALLY 1	TALLY 2	TALLY 3	TALLY 4	TALLY 5	TALLY 6	TALLY 7	TALLY 8	TOTAL	REL. AVG
ACE FREE	𝍸 IIII	I							10	42
TIL AMER	I	𝍸							6	25
POP DELT	I								1	4
SAL AMY	I								1	4
ULM AMER	II								2	8
FRA PENN		II							2	8
QUE MACR		II							2	8
TOTAL	14	10							24	100
BASAL AREA (BA)	28	20							48	24
DEAD	1	1								

STAND COMPOSITION: ACEFREE$_{42}$ TILAMER$_{25}$ ULMAMER$_{8}$ QUEMACR$_{8}$ FRA PENN$_{8}$

SOIL ASSESSMENT:	1	2	3	4	5	6	7	8
EFFECTIVE TEXTURE								
DEPTH TO: MOTTLES (g)	g=	g=	g=	g=	g=	g=	g=	g=
GLEY (G)	G=	G=	G=	G=	G=	G=	G=	G=
DEPTH OF ORGANICS								
DEPTH TO BEDROCK								
MOISTURE REGIME								

COMMUNITY PROFILE DIAGRAM

Notes:

ELC

MANAGEMENT / DISTURBANCE

SITE: HH6S

POLYGON: 1

DATE: June 11/07

SURVEYOR(S): KU / HP

DISTURBANCE / EXTENT	0	1	2	3	SCORE †
TIME SINCE LOGGING	> 30 YRS	15 - 30 YRS	5 - 15 YRS	0 - 5 YEARS	1
INTENSITY OF LOGGING	NONE	FUEL WOOD	SELECTIVE	DIAMETER LIMIT	0
EXTENT OF LOGGING	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
SUGAR BUSH OPERATIONS	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF OPERATIONS	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
GAPS IN FOREST CANOPY	NONE	SMALL	INTERMEDIATE	LARGE	2
EXTENT OF GAPS	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
LIVESTOCK (GRAZING)	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF LIVESTOCK	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
ALIEN SPECIES	NONE	OCCASIONAL	ABUNDANT	DOMINANT	4
EXTENT OF ALIEN SPECIES	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
PLANTING (PLANTATION)	NONE	OCCASIONAL	ABUNDANT	DOMINANT	0
EXTENT OF PLANTING	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
TRACKS AND TRAILS	NONE	FAINT TRAILS	WELL MARKED	TRACKS OR	0
EXTENT OF TRACKS/TRAILS	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
DUMPING (RUBBISH)	NONE	LIGHT	MODERATE	HEAVY	1
EXTENT OF DUMPING	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
EARTH DISPLACEMENT	NONE	LIGHT	MODERATE	HEAVY	3
EXTENT OF DISPLACEMENT	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
RECREATIONAL USE	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF RECR. USE	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
NOISE	NONE	SLIGHT	MODERATE	INTENSE	9
EXTENT OF NOISE	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
DISEASE/DEATH OF TREES	NONE	LIGHT	MODERATE	HEAVY	9
EXTENT OF DISEASE /	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
WIND THROW (BLOW DOWN)	NONE	LIGHT	MODERATE	HEAVY	9
EXTENT OF WIND THROW	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
BROWSE (e.g. DEER)	NONE	LIGHT	MODERATE	HEAVY	6
EXTENT OF BROWSE	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
BEAVER ACTIVITY	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF BEAVER	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
FLOODING (pools & puddling)	NONE	LIGHT	MODERATE	HEAVY	6
EXTENT OF FLOODING	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
FIRE	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF FIRE	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
ICE DAMAGE	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT OF ICE DAMAGE	NONE	LOCAL	WIDESPREAD	EXTENSIVE	
OTHER	NONE	LIGHT	MODERATE	HEAVY	0
EXTENT	NONE	LOCAL	WIDESPREAD	EXTENSIVE	

† INTENSITY x EXTENT = SCORE

ELC WILDLIFE	
	SITE: HHGS
	POLYGON: 1
	DATE: June 11/07
	SURVEYOR(S): KU / HP
	START TIME: / END TIME:

TEMP (°C): 22	CLOUD (10th): 1	WIND: 0	PRECIPITATION: NONE
CONDITIONS: SUNNY			

POTENTIAL WILDLIFE HABITAT:

	VERNAL POOLS	✓	SNAGS
	HIBERNACULA	✓	FALLEN LOGS

SPECIES LIST:

TY	SP. CODE	EV	NOTES	#	TY	SP. CODE	EV	NOTES	#
H	AMTD	OB		1					

FAUNAL TYPE CODES (TY):
B = BIRD M = MAMMAL H = HERPETOFAUNA L = LEPIDOPTERA F = FISH O = OTHER

EVIDENCE CODES (EV):

BREEDING BIRD - POSSIBLE:
SH = SUITABLE HABITAT SM = SINGING MALE

BREEDING BIRD - PROBABLE:
T = TERRITORY D = DISPLAY P = PAIR
A = ANXIETY BEHAVIOUR N = NEST BUILDING V = VISITING NEST

BREEDING BIRD - CONFIRMED:
DD = DISTRACTION NU = USED NEST FY = FLEDGED YOUNG
NE = EGGS NY = YOUNG FS = FOOD/FAECAL SACK
AE = NEST ENTRY

OTHER WILDLIFE EVIDENCE:
OB = OBSERVED VO = VOCALIZATION CA = CARCASS
DP = DISTINCTIVE PARTS HO = HOUSE/DEN FY = EGGS OR YOUNG
TK = TRACKS FE = FEEDING EVIDENCE SC = SCAT
SI = OTHER SIGNS (specify)

ELC SOILS ONTARIO	SITE: HHGS
	POLYGON: 1
	DATE: June .11 /07
	SURVEYOR(S): KU / HP

	P/A	P	Dr	Slope Type	Class	%	N pos	Nlength	E pos	Elength	UTM Z	EAST	NORTH
Asp. 218° 1	A	4	5	C	3	3							
30° 2	A	4	5	C	4								
3													
4													
5													
6													
7													
8													

SOIL ASSESSMENT:	1	2	3	4	5	6	7	8
TEXTURE x HORIZON								
0 – 20 cm	A / B	A / B	17cm					
A TEXTURE	L	L						
COURSE FRAGMENTS	–	–						
B TEXTURE	CL	CL						
COURSE FRAGMENTS	–	–						
C TEXTURE								
COURSE FRAGMENTS								
EFFECTIVE TEXTURE	CL	CL						
SURFACE STONINESS	∅	∅						
SURFACE ROCKINESS	∅	∅						
DEPTH TO / OF								
DISTINCT MOTTLES	20	25						
PROMINENT MOTTLES								
MOTTLES + GLEY	50	50						
GLEY								
BEDROCK	N/A	N/A						
CARBONATES	N/A	N/A						
DEPTH OF ORGANICS								
PORE SIZE DISC #1	20							
PORE SIZE DISC #2								
MOISTURE REGIME	6	6						

	1	2	3	4	5	6	7	8
SOIL SURVEY MAP UNIT(S)	Halton County, Ontario, Soil Survey Report #43, 1:63,360							
LEGEND CLASS	Ch	Ch						
TEXTURE	CL	CL						

Appendix 2: Checklist of Vascular Plants observed - May 11th, 2007.

SCIENTIFIC NAME	COMMON NAME	Unit FOD7	Unit SWD3-3	Halton Status (based on Varga et al. Jan 2005)	NATIVE
Acer x freemanii	Freeman's Maple		X		N
Acer negundo	Manitoba Maple	X	X		N
Agrimonia gryposepala	Tall Hairy Agrimony	X	X		N
Alliaria petiolata	Garlic Mustard	X	X		I
Anemone quinquefolia var quinquefolia	Wood Anemone	X			N
Arctium minus ssp. minus	Lesser Burdock	X			I
Arisaema triphyllum ssp. triphyllum	Jack-in-the-pulpit		X		N
Aster lateriflorus	Hairy Calico Aster	X	X		N
Carex grayi	Asa Gray Sedge		X	R4	N
Carex intumescens	Bladder Sedge		X		N
Carex radiata	Stellate Sedge		X		N
Carex stipata	Stalk-grain Sedge		X		
Carya ovata var ovata	Shagbark Hickory	X		U	N
Circaea lutetiana ssp. canadensis	Enchanter's Nightshade		X		N
Echinocystis lobata	Wild Mock-cucumber	X			N
Epilobium sp	Willow-herb Species		X		
Euonymus obovata	Running Strawberry-bush	X			N
Fraxinus pennsylvanica	Green Ash	X	X		N
Geum aleppicum	Yellow Avens	X			N
Glyceria striata	Fowl Manna Grass		X		N
Hesperis matronalis	Dame's Rocket	X	X		I
Impatiens capensis	Spotted Jewel-weed		X		N
Juglans nigra	Black Walnut	X			N
Maianthemum stellatum	Starflower False Solomon's Seal	X			N

SCIENTIFIC NAME	COMMON NAME	Unit FOD7	Unit SWD3-3	Halton Status (based on Varga et al. Jan 2005)	NATIVE
Matteuccia struthiopteris var pensylvanica	Ostrich Fern		X		N
Parthenocissus inserta	Thicket Creeper	X	X		N
Podophyllum peltatum	May Apple	X			N
Populus deltoides ssp. deltoides	Eastern Cottonwood	X		U	N
Populus tremuloides	Quaking Aspen	X			N
Prunus virginiana ssp. virginiana	Choke Cherry	X			N
Quercus macrocarpa	Bur Oak	X	X		N
Rhamnus cathartica	Buckthorn	X	X		I
Rhus radicans ssp. negundo	Poison Ivy	X	X		N
Rhus radicans ssp. rydbergii	Western Poison Ivy	X			N
Ribes americanum	Wild Black Currant		X		N
Rubus idaeus ssp. idaeus	Red Raspberry	X	X		I
Salix fragilis	Crack Willow	X			I
Solanum dulcamara	Climbing Nightshade		X		I
Solidago canadensis	Canada Goldenrod	X			N
Taraxacum officinale	Common Dandelion	X			I
Tilia americana	American Basswood	X	X		N
Trillium grandiflorum	White Trillium	X			N
Ulmus americana	American Elm	X	X		N
Verbena hastata	Blue Vervain		X		N
Vitis riparia	Riverbank Grape	X	X		N

APPENDIX 3 – SELECT PHOTOGRAPHS

Photo 1- Soil Sample # 1

Photo 2 - Soil Sample # 2


Photo 3 - Central Portion of Unit SWD3-3

Photo 4 - Looking into Unit FOD7 from SWD3-3.

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN
77 Wyndham Street South • Guelph ON N1E 5R3 • T 519.822.1609 • F 519.822.5389 • www.dougan.ca

November 1st, 2007

Jerry Fitchko
Environment & Energy Limited
38 Meadowcrest Road
Toronto, ON M8Z 2Y7
905 817-2084

RE: WOODLOT ASSESSMENT OF HALTON HILLS GENERATING STATION SITE

Dear Mr. Fitchko

As per your request, we have completed a further analysis of the Halton Hills Generating Station site to evaluate the best approach for ensuring the recommendations made in our original assessment of the woodlot are implemented appropriately. You will recall that the recommendations outlined in our letter report dated June 12th, 2007 were as follows:

1. Preserve the wetland- it supports a population of a regionally significant plant species.
2. Restore natural overland flows to the wetland by plugging the ditches and creating swales to redirect flow into the wetland. Ensure the quality of any water contributions are maintained or improved. If this is to be done artificially through SWM, then the design should emulate the natural hydroregime of the wetland. Maintain unit FOD7 as a buffer to the wetland. It has a natural well-developed edge. (Ref. Figure 1)

Figure 1 – Vegetation Communities and drainage map.

A site inspection on October 17th, 2007 confirmed that the woodlot/wetland has been preserved as per our recommendation #1. A 15m setback has been established between the wetland and the stormwater management facility currently being constructed to the north. Sediment and erosion control measures are in place and perimeter fencing is intact. We believe that this setback should be sufficient to protect the key ecological features and functions of the wetland. We also believe that these features and functions of the wetland can be enhanced through naturalization of the setback zone through planting of native trees and shrubs. The most efficient approach to naturalizing the setback would be to include this work as part of the landscaping contract works for the SWM facility. We can assist by preparing planting plans for the area.

Recommendation #2 relates to site drainage. It was made in response to observations that runoff contributions to the wetland from the site are currently being intercepted by a series of ditches at the perimeter of the wetland. These ditches prevent runoff from entering the wetland and divert flows to the Highway 401 ditch. It is suspected that this drainage diversion has contributed to a transition in wetland plant species composition. Plugging the ditches and creating a series of new inlets to the wetland would improve positive drainage to the wetland and help restore the natural wetland hydro-regime. A sketch outlining the proposed modifications to achieve the recommendation is presented in Figure 2. Key steps and conditions to be implemented are as follows:

1. All works to be conducted under the direct field supervision of a qualified ecologist/landscape architect.
2. Areas to be modified should be marked in the field by a qualified ecologist/landscape architect prior to any earth works.
3. Impacts to trees should be avoided. Any trees to be removed must be confirmed with the ecologist/landscape architect.
4. Earth works within the setback should be completed to achieve positive drainage to the wetland as per sketch (Figure 2).
5. A series (5-6) of inlet swales should be constructed at the low point located at northeast corner of the wetland.
6. Ditches at the northwest and southeast corners of the wetland should be plugged with clean impermeable fill to an elevation necessary to ensure positive drainage to the wetland inlet swales.
7. Excess brush and foreign debris to be removed from the edge of wetland.
8. Swales, ditch plugs and setback zone to be re-vegetated and naturalized.

We trust that the implementation of the proposed modifications outlined in this report will satisfy any outstanding conditions identified by Conservation Halton with respect to the woodlot feature on the HHGS site.

Should you have any further questions, please do not hesitate to contact me.

Sincerely,

Ken Ursic, M.Sc.
Senior Ecologist & Manager

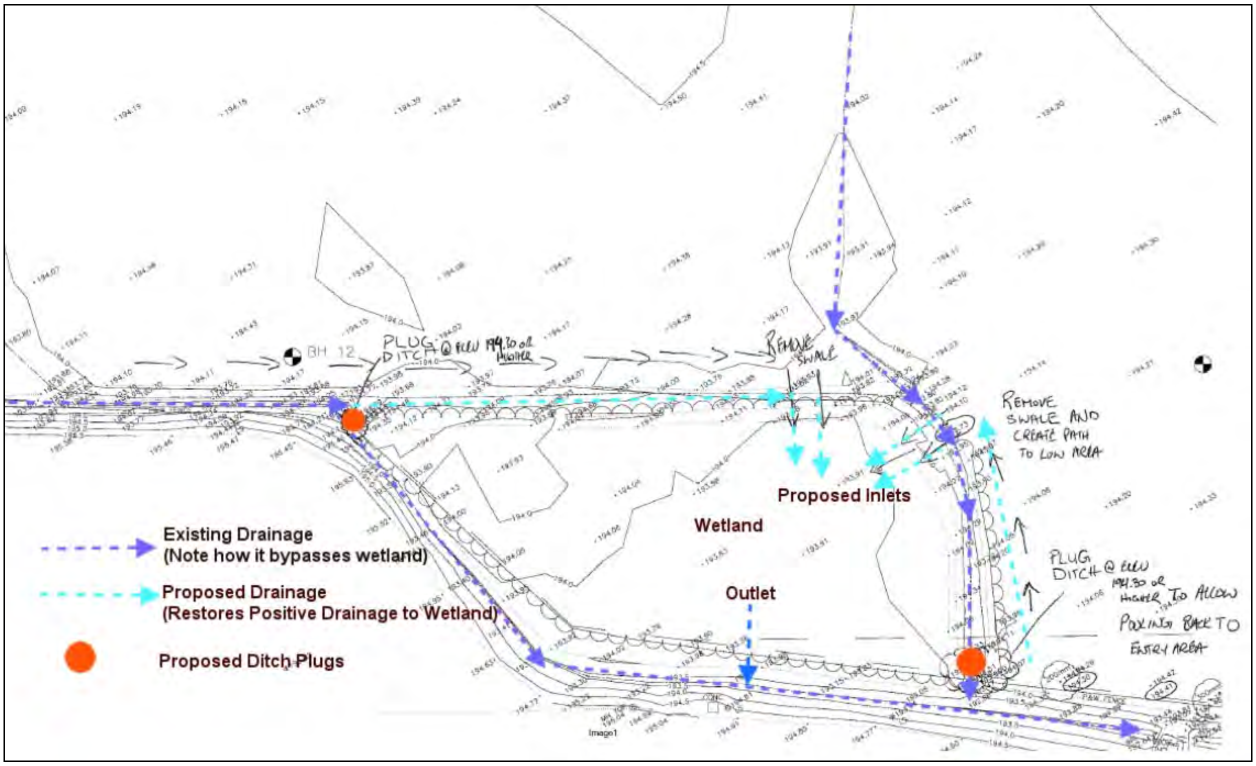


Figure 2. Sketch of proposed drainage modifications to restore wetland hydrology.

APPENDIX D

QUALIFICATIONS

ROBERT J. EAKINS, TECH. DIPL. F&W

ASSOCIATE, SENIOR FISHERIES BIOLOGIST

Rob joined Beak International in 1988, and worked for BEAK until its acquisition by Stantec Consulting in 2002. He left Stantec in 2004 to form EcoMetrix Incorporated. Rob is an Associate of the company and has over 18 years experience as a fisheries biologist. His responsibilities include project management, data collection and analysis, and report preparation. He has successfully completed a large number of aquatic monitoring studies in both marine and freshwater ecosystems across North America and Internationally. He has extensive experience in the assessment of critical fish habitats and recognizes the specific habitat requirements of various life-stages of most Canadian freshwater fish species. In addition, Rob is proficient at fish taxonomy and assigning age classes and is skilled in the use of a variety of fish collection techniques including electrofishing, seining, gillnetting and trap netting. Rob is also experienced with various fish tagging and monitoring methodologies including floy tags, radio tags and pit tags. He has experienced using fish habitat evaluation protocols including the OMNR Manual of Instructions for Aquatic Inventory Surveys, Ontario Stream Assessment Protocol, Ontario Benthos Biomonitoring Network Protocol and the Habitat Classification System developed by the U.S. Fish and Wildlife Service.

Mr. Eakins played an important role in the development of our Standard Operating Procedures (SOPs) for conducting environmental monitoring programs and has trained staff to ensure that SOPs for field sampling are consistently applied. As a senior biologist, Mr. Eakins routinely supervises several technical staff, coordinates field logistics and oversees the field component of many studies. He has extensive experience using and developing Indices of Biotic Integrity (IBI) for fish, benthic macroinvertebrate community sampling and data evaluation, and habitat assessment. Rob is also the author of the Ontario Freshwater Fishes Life History Database published on the World Wide Web (http://www.fishdb.ca) and is currently seeking a publisher for his handbook of Ontario Freshwater Fishes. During his career, Rob has participated in a broad range of projects all across Canada, the United States and Internationally, for both the private and public sector.

EDUCATION

- Technical Diploma, Fish & Wildlife, Sir Sandford Fleming College

PROFESSIONAL AFFILIATIONS

- American Fisheries Society (Ontario Chapter and Canadian Aquatic Resources Section)

SELECTED PROJECT EXPERIENCE

MUNICIPALITIES

Fisheries resources assessment of the Upper Credit River subwatershed involving the collection and analysis of fish community data, IBI calculation, habitat assessment and comparison to historical studies.

Brook trout fry surveys on the Upper Credit River.

Comprehensive fisheries resources and habitat surveys of Peninsula Harbour and tributaries as part of contaminated sediment removal and waterfront development feasibility studies in Marathon, Ontario.

Fisheries inventory, benthic macroinvertebrate collection, and aquatic habitat evaluation at more than 100 riverine sites in southwestern Ontario as part of the London Subwatershed Study - Vision '96. Used the data collected to develop an IBI model for use in southwestern Ontario.

Fisheries inventory, aquatic habitat evaluation and application of the IBI to Harmony and Farewell Creeks as part of the Subwatershed Management Plan.

Historical fish community and habitat data collection and analysis, for Duffins Creek watershed study.

GOVERNMENT

Aquatic environment baseline studies including characterization of fish communities and habitats of lake and stream environments related to the Port Hope Area Initiative. Study included the collection and analysis of radionuclide levels in fish tissues.

Winterkill investigation for the Trent-Severn Waterway involving including radio tag implantation in walleye and largemouth bass, and under-ice radio-tracking on Chemong Lake, Ontario.

In-situ contaminant bioaccumulation study at the Toronto Main Water Pollution Control Plant (WPCP) facility and receiving environment (Ashbridges Bay, Lake Ontario).

Experimental work to evaluate the bioaccumulation potential of triallate in rainbow trout.

Radionuclide survey of Lake Ontario involving the collection and preparation of water, sediment, fish tissues and fish bones.

Sediment collection for bioassessment and sampling of live benthic macroinvertebrates for contaminant analysis in Hamilton Harbor.

OIL AND GAS

Fisheries resource assessments of hundreds of watercourses traversed by proposed natural gas pipelines throughout Saskatchewan, Manitoba, Ontario, Quebec and Nova Scotia, including comprehensive assessments of large rivers and lakes.

Evaluation of the potential effects on coldwater streams in southern Ontario due to water taking and pipe de-watering for hydrostatic test purposes.

Development of stream relocation and habitat restoration/enhancement plans required as a result of pipeline construction in northern and southern Ontario.

Snorkeling surveys of aquatic habitat enhancement in the St. Lawrence River and assessment of suitability for smallmouth bass spawning.

POWER GENERATION

Temperature logger installation, data retrieval and analysis of thermal effects on coldwater habitats related to discharge from a cogeneration facility in northern Ontario. Analysis incorporated other thermal influences such as, groundwater, air temperature, etc.

Live collection, transfer and release of all fish from natural and man-made environments, necessitated by future and concurrent dewatering activities.

Fish habitat assessment, thermal plume monitoring and evaluation of the nearshore fish and benthic communities in the Detroit River, adjacent to a cogeneration facility cooling water discharge.

Multiple fisheries community assessments including larval tows, to determine seasonal utilization of habitats adjacent to a proposed cogeneration facility on Toronto Portlands. Baseline study included continuous monitoring of water temperature between April and October.

Seasonal fish community assessment, habitat evaluation and determination of habitat utilization by spring and fall spawning species in the Ogoki River downstream of the Waboose Dam. Study included the collection of blackfin cisco a species designated as Threatened by COSEWIC.

Fisheries resources survey including habitat assessment and fish community sampling of the nearshore St. Lawrence River and drainage channels tributary to the river, near Trois Rivieres, Quebec.

Walleye spawning study involving observations of spawning fish below hydroelectric generation stations and assessment of habitat parameters within the Trent River.

Evaluation of the thermal effects on lake whitefish spawning in the Abitibi River caused by cogeneration facility cooling water discharge.

Walleye population analysis related to habitat enhancement and flow regulation in Six Mile Lake.

PULP AND PAPER

Cycles 1, 2, 3 and 4 Environmental Effects Monitoring (EEM) programs in marine and freshwater environments in British Columbia, Nova Scotia, New Brunswick and Ontario.

Anadromous smelt (Eulachon) spawning run assessment, as well as, preference/avoidance and tainting response evaluation to pulp and paper effluent in British Columbia.

Baseline survey of water, sediment and biological quality in the Saskatchewan River including sample collection and preparation for chemical analysis.

Dioxin and Furan surveys involving the collection and sample preparation of Dungeness crabs from the Kitimat Arm, British Columbia.

TRANSPORATION

Assessment of impacts on aquatic habitats associated with train derailment spills including fisheries resources surveys.

Monitoring the fish utilization of newly created wetland habitat near Parry Sound, Ontario. Creation of the wetland was necessitated as a result of train derailment clean-up activites.

MINING

Biomonitoring studies of the Panther Creek watershed related to cleanup efforts at a closed mine site in Idaho. Studies incorporated the ecological assessment approach to determine aquatic life use support (ALUS) developed by the Idaho Department of Environmental Quality (IDEQ). Data was collected following Beneficial Use Reconnaissance Program (BURP) protocols and used to calculate the various multimetric indicies. Stream Habitat Index (SHI), Stream Macroinvertebrate Index (SMI) and Stream Fish Index (SFI) were used.

Fish, water and sediment collection for radionuclide analysis at a mine exploration facility in northern Labrador.

Environmental Effects Monitoring involving the collection of sediments, water, benthos and fish tissues, as well as, fish and benthic community analysis, at base metal mine and concentrate handling port facilities in Peru.

Fish removal project involving the collection, measurement, pit-tagging and transfer to a previously fishless lake, necessitated by lake de-watering associated with mining activities in Labrador.

Aquatic Effects of Mining (AQUAMIN) Studies in New Brunswick and Ontario to evaluate EEM criteria for the mining industry.

Environmental baseline studies for proposed mining facilities in northern Ontario, Labrador and New Brunswick.

Atlantic salmon population studies to evaluate the effects of base metal mining activities on the Northwest Miramichi River and Little River, New Brunswick.

Mine closure plan studies and environmental monitoring at sites in northern Ontario, Labrador and New Brunswick.

Receiving water and aquatic habitat assessment in the North Porcupine River and tributaries, Timmins, Ontario.

ZEAS INCORPORATED

COMPANY PROFILE

ZEAS, established in 1988, specializes in benthic ecology and fisheries. The assessment of biological communities, coupled with the physical/chemical analysis of water and sediments, provides researchers with a better understanding and evaluation of environmental conditions.

Benthic macroinvertebrate and fish community assessments constitute the core of regulatory programs such as the Environmental Effects Monitoring (EEM) for the mining and pulp and paper industry, Subwatershed Planning and the Biological Monitoring and Assessment Program (BioMAP) currently run by MOE Southwestern Ontario

We have been intensively involved in benthic invertebrate projects providing taxonomic services to environmental companies such as Beak International Inc. (Ecometrix), Ecological Services for Planning Ltd. (Stantec), EVS Environment Consultants (Golder), and Conestoga-Rovers and Associates, as well as government agencies such as the Ontario Ministry of the Environment, the Ontario Ministry of Natural Resources, Essex Region Conservation Authority, Maitland Valley Conservation Authority and Environment Canada.

ZEAS' extensive expertise and contacts in benthic ecology and fisheries makes us an attractive subconsultant in this field. We recognize the need for larger firms and government agencies to have expertise in the field of biological sciences when submitting proposals on interdisciplinary studies such as subwatershed planning, landfill site selection and environmental effects monitoring programs.

Over the last ten years, ZEAS has been involved in a number of diverse projects ranging from Remedial Action Plans (RAPs), environmental impact and baseline assessments, biological monitoring and environmental quality assessments to ecological research and modeling. Our technical expertise lies in study designs, quantitative and qualitative sampling of aquatic environments, taxonomic identification and enumeration of benthic macroinvertebrates and fish, and theoretical and empirical modeling of aquatic ecosystems.

ZEAS incorporates QA/QC programs in all of our studies, which guarantees our clients that our services meet or exceed the Quality Assurance/Quality Control guidelines established by agencies such as Environment Canada, the U.S. EPA and U.S. Geological Survey. The company prides itself in its ability to provide a high quality product on schedule and within specified budgets. Confidentiality is a high priority with ZEAS since our success depends on subcontracts from often competing firms, industry and government regulatory agencies.

<u>WORK EXPERIENCE</u>

ENVIRONMENTAL POLICY

i) The Use of Biocides to Control Aquatic Invasive Species: An overview of Policy, Regulation and Future Plans, 2002.

ZEAS was contracted by The Department of Fisheries and Oceans to review current legislation, policy and protocols relating to the use of biocides as a control or eradication measure in the event of an Aquatic Nuisance Species (ANS) invasion. Particular emphasis was paid to ANS control procedures in Australia, the United States and Canada. Federal, provincial and state legislation, responsibilities and procedures were examined.

ENVIRONMENTAL QUALITY/IMPACT ASSESSMENTS:

i) Environmental Assessment of Detroit River Sediments and Benthic Macroinvertebrate Communities.
- subconsultant to Beak Consultants Ltd. (Ecometrix Ltd.)
The environmental quality of the Detroit River has been seriously impaired as a result of heavy industrialization. The Ministry of Environment (MOE) instigated an environmental assessment of the river which involved collecting and analyzing benthic macroinvertebrate, water and sediment samples. Environmental quality zones were mapped within the river, delineating various degrees of impacted communities. The condition of the river was evaluated and compared to the previous assessment conducted by the MOEE.

ii) Effect of Zebra Mussels on the benthic communities of Lake Ontario.
A study assessing the effects of zebra mussels on biological communities of the Great Lakes.

iii) Analysis of benthic macroinvertebrate communities to assess the impact of a mine tailings spill on fisheries habitat.
- subconsultant to ESG International (Stantec).
Stream macroinvertebrates were analyzed to determine the degree of impact on fish and benthic macroinvertebrate populations following a spill of mine tailings in the Porcupine River.

iv) Wheatley Harbour Remedial Action Plan (RAP).
Wheatley Harbour was identified as an "Area of Concern" by the Water Quality Board of the IJC because of dissolved oxygen depletion, elevated bacterial

levels, nutrient enrichment and PCB contamination of sediments. ZEAS was contracted to:

- review all background information on Wheatley Harbour;
- obtain public input by determining local water use goals and beneficial uses for Wheatley Harbour through distributed questionnaires, newsletters and meetings with local officials, residents, and stakeholders;
- select a set of remedial measures that would restore the impaired beneficial uses in Wheatley Harbour and thus allow the harbour to be delisted as an Area of Concern;
- synthesizing all data and information into a consolidated Stage 1/Stage 2 RAP Report for submission to the International Joint Commission, and;
- Collect additional data and review AOC status for 2003.

v) Thermal Profile and Potential Impacts of thermal discharges from Wastewater Treatment facilities on Aquatic Environments, 2002 and 2003.
-subconsultant to Pollutech Enviroquatics Ltd.
ZEAS was contracted by Pollutech to assess the potential impacts of increased temperature on benthic and fish communities in a small drainage ditch and the St. Clair River.

BASELINE ASSESSMENTS:

i) Identification of macroinvertebrates for the Aquatic Habitat Inventory Program, Ministry of Natural Resources, Fisheries Branch, Toronto.
- subconsultant to Aquatic Ecostudies Ltd.
Benthic macroinvertebrates were collected from various streams and lakes in northern Ontario to document the aquatic resources of the area.

ii) Baseline assessment for placement of gas pipelines across the St. Lawrence River.
- subconsultant to Beak Consultants Ltd (Ecometrix).
Analysis of benthic communities prior to the installation of gas pipelines to transport natural gas to the United States.

iii) Effect of agricultural land use on benthic macroinvertebrate community structure in Southwestern, Ontario.
- subconsultant to MOE and the Essex Conservation Authority.
The study involved establishing baseline macroinvertebrate communities to monitor the effects of land use changes on ecosystem health and to establish monitoring programs for subwatershed studies.

iv) Aquatic biology component of the City of London subwatershed studies.
- subconsultant to Beak Consultants Ltd. (Ecometrix).
Senior taxonomist for the Aquatic Biology Component of the City of London Subwatershed Studies. Benthic macroinvertebrate data were used to assess water quality in the subwatershed studies using the BioMAP Protocol outlined by the Ministry of Environment and Energy.

v) Biological Monitoring in the Scugog River.
- subconsultant to ESG International (Stantec).
Benthic macroinvertebrate data were used to assess water quality in the Scugog River using the BioMAP Protocol outlined by the Ministry of Environment and Energy.

vi) Baseline assessments of aquatic communities prior to rural development in the Innisfil Creek area.

ACIDIFICATION

i) The Effect of Reduced Acidification and Fish Predation on the Benthic Macroinvertebrate Community Structure of Whitepine Lake, Sudbury, Ontario.
- subconsultant to Beak Consultants Ltd. (Ecometrix).
In the early 1980s, Whitepine Lake supported an impoverished indigenous lake trout community. The stocking of hatchery-reared lake trout and a noted improvement in lake water quality prompted an environmental impact assessment in 1988. The study involved the collection and analysis of water, sediment, benthic macroinvertebrates, zooplankton and the gut contents of lake trout.

ii) Effect of reduced acidification on zooplankton and benthic macroinvertebrate communities in Swan Lake.
- subconsultant to MOE.
The study involved the identification, size class and biomass determination of *Chaoborus* species and benthic macroinvertebrates from acid-stressed lakes in northern Ontario.

iii) Assessment of acid-mine wastewater on benthic macroinvertebrate community structure.

ENVIRONMENTAL MONITORING

i) Detection of PCBs in Pottersburg Creek, London, Ontario using biota as environmental monitors.
In the early 1980s, PCBs were discovered in fish and sediments collected from Pottersburg Creek. Abatement measures included the removal of sediments from the most contaminated areas of the creek, however, subsequent monitoring of the remediated areas revealed the presence of PCBs in sediments. ZEAS was contracted by the Ministry of Environment and Energy to determine the extent of recontamination in the creek. The study involved the collection and deployment of several species of biota (used here as bio-monitors of environmental contamination), collection of water and sediment samples, and interpretation and modeling of the data.

ii) Monitoring PCBs in a wetland, Guelph, Ontario.

- subconsultant to Conestoga-Rovers and Associates.
This study addressed the impact of PCBs on wetland and riverine communities. PCB concentrations in water, sediments, and biota were quantified to determine the extent of contamination in the ecosystem as well as to determine the bioavailability of PCBs to aquatic organisms.

iii) Monitoring the effects of sewage treatment discharges and the ability of wetlands to absorb nutrient loads.
- subconsultant to Beak Consultants Ltd. (Ecometrix).
Our component of the study involved the analysis of benthic macroinvertebrate samples to determine long-term temporal and spatial effects.

iv) Effect of pulp and paper mill effluent on benthic community structures.
- subconsultant to Aquatic Ecostudies and Beak Consultants Ltd. (Ecometrix).
Investigation of the effects of secondary treatment on the environmental quality of the aquatic ecosystem. Also routine biological monitoring to assess the effects of pulp and paper wastes on biological communities of the Spanish River.

v) Effect of landfill leachate on downstream benthic macroinvertebrates.
- subconsultant to Conestoga Rovers & Associates.
Our component of the study involved the sampling and analysis of benthic macroinvertebrate communities influenced by leachate discharge from an existing landfill site. Benthic data was used to assess water quality upstream and downstream of the landfill using the BioMAP Protocol outlined by the Ministry of Environment and Energy.

vi) Environmental Effects Monitoring Program (EEM) for Pulp and Paper Mills in Canada.
- subconsultant to Acres International Ltd., Beak Consultants Ltd. (Ecometrix), and ESG International (Stantec).
Monitoring requirements for the first cycle of EEM include a benthic macroinvertebrate survey. Benthic macroinvertebrate community assessments are, in turn, used to infer effects on fish habitat. ZEAS has provided taxonomic services to several major environmental consulting firms and has collectively processed more benthic samples for EEMs than any other firm in Canada.

vii) Effect of open water disposal of mine tailings on fisheries habitat and benthic macroinvertebrates in a small lake in Labrador.
- subconsultant to Beak Consultants Ltd. (Ecometrix).
The project involved the evaluation of fisheries habitat, fish communities and benthic macroinvertebrate communities to assess the feasibility of relocating open water disposal lots.

viii) 1995 Field Evaluation of Aquatic Effects Monitoring Methods.
- subconsultant to Beak International Inc. (Ecometrix).

ZEAS was responsible for all the detailed taxonomy of the first Aquatic Effects Technology Evaluation pilot study conducted in 1995. Benthic samples were processed through three sieve sizes, (i.e., 1 mm, 500 μm, and 250 μm) and benthic macroinvertebrates were identified to species. The effect of sieve size and level of taxonomy were investigated to determine if these variables influenced the ability to detect area differences.

ix) 1996 Field Evaluation of Aquatic Effects Technology Evaluation Program.
- subconsultant to ESG International (Stantec), EVS Environment Consultants (Golder), and Jacques Whitford Environment Ltd.
ZEAS was responsible for all the detailed taxonomy of the second Aquatic Effects Technology Evaluation Program conducted in 1996. Samples were processed through a 500 μm and 250 μm sieve and all benthic macroinvertebrates were identified to the lowest practical level, usually genus.

x) 1997 Field Evaluation of Aquatic Effects Technology Evaluation Program.
- subconsultant to Beak International Inc. (Ecometrix).
ZEAS was responsible for all the detailed taxonomy of the final Aquatic Effects Technology Evaluation Program conducted in 1997. Benthic macroinvertebrates were identified to the lowest practical level, usually genus from both the 500 μm and 250 μm fractions. An additional component to this study was the examination of chironomids for abnormalities in the head capsule.

xi) Clam Biomonitoring Study, 1996.
- subconsultant to Conestoga-Rovers and Associates.
A mussel biomonitoring study was conducted in the spring of 1996 by Zaranko Environmental Assessment Services (ZEAS) in co-operation with Conestoga-Rovers and Associates. The primary objective of the study was to determine the extent of PCB bioavailability to aquatic organisms at the former GE Power Transformer Plant and in the Speed River, Guelph, Ontario.

xii) Biological Monitoring Program - Kempenfelt Bay, 1998.
- subconsultant to Conestoga-Rovers and Associates.
A biological monitoring program was carried out in the vicinity of a former coal/oil gasification plant located on the shore of Kempenfelt Bay, Barrie Ontario. The purpose was to determine if the known presence of PAHs and various other hydrocarbon compounds in sediments were bioavailable and/or having an impact on the aquatic life in the area. The biological monitoring program consisted of a benthic macroinvertebrate survey and a mussel biomonitoring study.

xiii) Benthic Assessment Study of Selected Tributaries of the St. Clair River, Detroit River and Wheatley Harbour, 1998.
ZEAS was contracted by the Friends of the St. Clair River to collect and process 42 benthic samples from three Areas of Concern around the Great Lakes. Benthic macroinvertebrate data were evaluated and used to assess water quality

in the three areas using the BioMAP Protocol outlined by the Ministry of the Environment.

xiv) Environmental Assessment of Levi and Mullet Creek, Mississauga.
- subconsultant to Greenland International Consulting Ltd.
ZEAS was responsible for the benthic invertebrate component of this study which involved using the BioMAP protocol.

xv) Dingman Creek/Thames River Water Quality Monitoring Program 2006.
ZEAS was hired by the City of London to undertake an extensive biological monitoring program which involved the collection and processing of approximately 100 benthic invertebrate samples from 29 stations. Water samples were collected quarterly from 10 stations. The final report summarized the biological data and presented an overview of the health of the watershed.

DANUTA T. ZARANKO, M.Sc
Aquatic Ecologist
(Revised September 2006)

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EDUCATION:

1988 ¨ B.Sc. (Honours Biology), Aquatic Sciences, University of Guelph.
1994 ¨ M.Sc., Environmental Biology, University of Guelph.

TAXONOMIC EXPERIENCE

¨ 19 years as an Aquatic Invertebrate Taxonomist.
- (#) = number of samples processed.
- 622 projects/18,998 samples

PUBLICATIONS

¨ Zaranko, D.T., Farara, D.G. and F.G. Thompson. 1997. Another exotic mollusc in the Laurentian Great Lakes: the New Zealand native *Potamopyrgus antipodarum* (Gray 1843) (Gastropoda, Hydrobiidae). Can. J. Fish. Aquat. Sci. 54(4): 809-814.
¨ McCaffery, W.P. 2000. A hierarchical classification of the Timpanoginae (Ephemeroptera: Ephemerellidae) and description of a new species from Quebec. Annls Limnol. 36(3): 157-161. (description of *Dentatella danutae*).
¨ Randolph, R.P., McCaffery, W.P., Zaranko, D., Jacobus, L.M. and J.M. Webb. 2002. New Canadian records of Baetidae (Ephemeroptera) and adjustments to North American *Cloeon*. Entomological News 113(5): 306-309.

Acres International Ltd.
1995 · (86) Northern Quebec. (38) Southern Ontario.

Alliance Environent, Quebec
2002 · (40) Harricana River.
2003 · (40) R. des Outaouais.

Amec, B.C.
2004 · (15) Stouts Gulch/Lowhee Creek.

Aquafor Beech Ltd.
2003 · (5) Mullet Creek, Levi Creek.
2006 · (15) Niagara Region, (19) Highland Creek.

Aquatic Ecostudies Ltd.

1988 · (150) Moosonee (Kesagami River, Kattawagami River, Harricanaw River, Tweed, (Moira River, Black River, Jordan River, Clare River) Terrace Bay (Steel River, McKellar Creek, Mink Creek, Dead Horse Creek), Hearst (Jackfish River), (27) Pottersburg Creek, Ontario.

1989 · (67) Spanish River. (178) Aurora Lakes. (139) Whitepine Lake. (24) Detroit River. (24) Saugeen River, Rocky Saugeen. (105) Swan Lake. (67) Teeswater Creek, Mill Creek, Willow Creek. (32) Massey Creek, Porcupine River.

Aquatic Sciences Inc. (ASI Group)

1990 · (97) Zebra Mussel Monitoring Program.
1991 · (638) Zebra Mussel Monitoring Program.
1992 · (354) Zebra Mussel Monitoring Program.
1993 · (36) Zebra Mussel Monitoring Program.
2005 · (4) Timmins, verifications.
2006 · (6) Cream Hill, Lockerly, Strathcona.

Ausable Bayfield Conservation Authority

1998 · (7) Zurich Creek.

Beak International Inc. (Stantec Consulting Ltd.)

1987 · (15) Orangeville Marsh.
1988 · (42) Whitepine Lake.
1989 · (12) St. Lawrence River.
1990 · (24) Lake Ontario.
1991 · (24) Lake Ontario. (12) Innisfil Creek, Ontario. (43) Jackfish Bay.
1992 · (231) Detroit River. (10) Wabush Lake, Labrador. (28) Lake Ontario.
1993 · (46) St. Lawrence River. (12) Nipisiquit River, New Brunswick. (23) Lake Ontario. (1) York River, Quebec. (501) Swan Lake. (90) North Bay. (16) New Brunswick.

1994 · (324) Southwestern Ontario (Stanton Drain, Kettle Creek, Thames River, Sharon Creek, Dodd's Creek, Medway River, Pottersburg Creek, Crumlin Drain, Mud Creek, and Stoney Creek). (13) Credit River. (11) Humber River. (57) Sudbury, Ontario. (81) Aurora Lakes. (150) Yamaska River, Quebec. (96) Keating Channel.

1995 · (26) Coon Creek, Clifford. (15) Rouge River. (24) Rainy River. (24) Winnepeg River. (12) Kitimat River, British Columbia. (30) Lake Erie. (12) Half-Mile Lake, New Brunswick. (12) Mission River, Kam River, Thunder Bay. (117) St. Clair River**.** (13) Lake Matano, Mahalona Lake, Larong River, Pungkeru River, Sulewasi Indonesia. (6) Salo Lematang River, Sumatra Indonesia**.** (12) Rudsdale Creek, Tay River, Ottawa. (6) Wabigoon River. (7) Susport River. (28) Ottawa River, Gatineau, Quebec. (21) Mulatto Bayou/Whites Bayou, Mississippi. (12) New Brunswick. (12) Crooked Creek, northern Ontario. (21) Rogers Creek, Terra Cotta. (4) Bousquet River, Quebec. (82) River Noire, Quebec. (24) St. Maurice River, Quebec. (22) New Brunswick, **marine** samples. (32) Whitepine Lake. (21) Blackbird Creek, northern Ontario. (24) Napanee River. (24) St. Mary's River. (22) Crabtree, northern Quebec. (9) Kirkland Lake. (24) Roanoke River, Welch Creek, Conaby Creek, North Carolina.

1996 · (35) Lake Huron**.** (9) Lake Matano, Mahalona Lake, Larong River, Pungkeru River, Lake Towuti, Sulewasi Indonesia**.** (24) Lake Ontario. (12) Montreal Harbour. (9) Beaver Creek, Ohio. (15) Lightning River, Ontario. (54) McCabe Lake, Sherrif Creek, Canyon Creek, May Lake, Pecors Lake, Serpent River, Dunlop Lake. (26) Tomogonops River, Miramichi River, Mosquito Brook, New Brunswick. (63) Belledune Harbour/Baie des Chaleurs, New Brunswick, **marine** samples.(15) Orangeville. (18) Bell Creek, Timmins. (4) Cataraqui Bay, Kingston. (18) Hawkes Bay, Newfoundland, **marine**. (56) Garson Lake, Joe Lake, Lisa Creek, Post/Whistle Creek, Rapid River, Thin Lake. (42) Alice Lake, Blue Lake, Gatchell Pit. (23) Port of Montreal.

1997 · (15) Eagle River, Wawa. (11) Atan River, Kelinjau River, Luun Besar River, Menyuk River,Lunuk River, Luun Bening River, Tinggu River, Sulewasi, Indonesia. (39) Lake Erie, (35) Etobicoke Creek, (9) Kam River/Thunder Bay, (21) New Brunswick, (5) Wye River, (6) Myra Creek, B.C., (22) Red Lake, Ont., (3) Penelope Lake, (17) Nama Creek, Lake Stag, Garnet Lake, (30) Welland Canal, (21) Brewster/Buttle Lake, B.C., (20) Myra Creek, B.C., (8) Pampa Moruna River System, Peru, (16) Ayash River System, Peru.

1998 · (23) Nairn/Bear Creek, (21) South Porcupine River, (6) Lac Nere/Poleon, Quebec, (21) Tomogonops River, Miramichi River, New Brunswick, (18) Nelson Creek, Fraser River Trib., B.C., (23) Ambrose Lake, Cleaver Lake, Lyne Lake, Hornblende Lake, Longcane Lake, Lake Superior Area, (12) Bay of Fundy, **marine,** (15) Orangeville marsh, (32)Cayuga Inlet, New York, (9) Huntsville, (12) Salve Creek/Nickle Creek, Matheson, Ont., (4) Gazelle/Point Lake, N.W.T., (6) Elliot Lake, (27) Cataraqui Bay, (21) Sturgeon Lake, Bell Creek, Ignace, Ont., (57) Belledune Harbour/Baie des Chaleurs, New Brunswick, **marine** samples.

1999 · (12) St. Louis River, Quebec, (40) Jack Creek, Peachland Creek, Greta Creek, Trepanier Creek, MacDonald Creek, British Columbia, (15) New Lake, Peterson Lake, Kerr Lake, Giroux Lake, Peterson Creek, Crosswise Creek, Farr Creek, Sutton Creek - Cobalt, Ont., (29) Bathurst N.B., Chaleur Bay, **marine** and freshwater samples, (14) Mirimichi/Tomogonops River, N.B., (22) Wabigoon River, (15) Carol Lake, Labrador, (66) Pampa Moruna River System, Ayash River System, Peru, (71) Pictou Road North Humberland Strait, N.S., **marine**, (22) Liverpool Harbour N.S. **marine**, (26) Mactaquac Lake-St. Anne, (40) Bathurst, N.B., **marine,** (21) Kitimat River, B.C., (45) Topley, B.C. (Bulkley River, Findlay Creek), (20) Thunder Bay, (3) Argentina, (15) Marathon, (54) Jumbo Lake, (16) Ottawa River, Gatineaux, (25) Terrace Bay.

2000 · (20) Sixteen Mile Creek, (25) Terrace Bay, (23) Strait of Canso, Port Hawksebury, N.S., **marine**, (18) Bowater, N.B., **marine,** (20) Trent River, (15) Blackbird Creek, (31) Cornerbrook, Newfoundland, **marine,** (70) Jack Creek, Peachland Creek, Greta Creek, Trepanier Creek, MacDonald Creek, British Columbia, (63) Morehead Creek, Bootjack Creek, Hazeltine Creek, Edney Creek, Jacobie Creek, Bootjack Lake, Polley Lake, Jacobie Lake, Likely, B.C., (81) Serpent River, (12) Antamina, Peru, (6) Kingston Harbour, (18) Hornet Lake, Rabbit Creek, Temagami; (10) Lima, Peru **marine**; (50) Serpent River; (47) Peru; (3) Peninsula Harbour; (15) Detroit River; (3) Argentina; (5) Port of Montreal; (18) Orangeville Marsh; (11) Bathurst, N.B.; (6) Chile; (68) Northern Ontario.

2001 · (30) Jack Creek, Peachland Creek, Greta Creek, Trepanier Creek, MacDonald Creek, British Columbia; (14) Heathe Steel, New Brunswick; (51) BMS New Brunswick, **marine**; (58) Alumbrera mine Argentina, South America; (60) Carp River Watershed; (15) London Ontario; **(15**) Peru**, marine;** (17) Inmet; (9) Keemle Lake, Nipigon; (33) Detour Lake; (14) IOCC; (22) Lake Erie; (15) Orangeville;

2002 · (40) Brenda Mines, British Columbia; (30) Peru **marine**; (8) Gananoque, (12) Kitimat River, B.C., (66) Orangeville Marsh, (46) Peru, (5) Toronto Harbour, (14) GranIsle, (6) Samotosa.

2003 · (14) Orangeville, (29) Port Hope, (45) Brenda Mines, British Columbia; (12) Detroit River, (15) Peru **marine**; (27) Cataraqui Bay, (19) Absecon Creek, Atlantic City, New Jersey, (56) St. Clair River, (27**) marine** Pictou, N.S., (20) Jackfish Bay, (11) Rainy Lake, (45) St. Lawrence River, (46) Peru, (15) **marine** Peru, (51) **marine** Pictou, N.S., (12) ATCO, (20) Falconbridge Raglan, (21) Panther Creek, Salmon River Idaho, U.S., (23) Lake Superior, (37) Inmet.

2004 · (35) **marine** Corner Brook, Nfld., (25 **marine** St. John River, N.B., (23) **marine** Strait of Canso, Port Hawksbury, N.S., (21) **marine** Bathurst N.B., (13) **marine** Bay of Fundy, (12) Orangeville Marsh, (26) Mirimichi/Tomogonops River, NB.

BZ Environmental Ltd.

2005 · (18) Northern Ontario.

2006 · (9) Redstone River, (12) Night Hawk Lake.

Chris Wren and Associates.

2004 · (36) Detour Lake, (6) Comfort Prop. /Byers Prop.

2005 · (2) Southern Ontario.

City of London

2006 · (87) Digman/Thames River Watershed.

Conestoga-Rovers & Associates Limited

1989 · (27) Thames River tributary, Ingersol, Ontario.

1994 · (5) Marden complex wetlands, Guelph.

1995 · (12) Thames River tributary, Ingersol, Ontario.

1996 · (12) Thames River tributary, Ingersol, Ontario.

1997 · (12) Thames River tributary, Ingersol, Ontario.

1998 · (12) Thames River tributary, Ingersol, Ontario, (10) Kempenfelt Bay, Barrie.
1999 · (23) Kempenfelt Bay, Barrie, (12) Thames River tributary.
2000 · (15) Thames River tributary, Ingersol, Ontario.
2001 · (15) Thames River tributary, Ingersol, Ontario.
2002 · (15) Thames River tributary, Ingersol, Ontario.
2003 · (18) Thames River tributary, Ingersol, Ontario.
2004 · (15) Thames River tributary, Ingersol, Ontario.
2005 · (15) Thames River tributary, Ingersol, Ontario.

Credit Valley Conservation Authority
2001 · (8) Silver Creek; (30) Fletcher's Creek, Glen Williams Trib., Mill Creek, Lower Monora Creek, Credit River, Shaws Creek, Silver Creek, Carolyn Creek, Levi Creek, Mullet Creek, West Credit River, Huttonville Creek, Clack Creek, Caledon Creek.

Dames & Moore Canada
1994 · (12) Saugueen River, Ontario.

Dillon Consulting Ltd.
2004 · (30) Belle River, (8) Puce River, (8) Norman Drain/Ninteen Mile Creek, (2) Black Creek.
2005 · (9) Beaver Pond.

DST Consulting Engineers Inc., Sudbury, Thunder Bay
2000 · (15) MacIntyre River, Thunder Bay; (11) Northern Ontario; (20) Lost River, Redrock.

D.W. Draper & Associates Ltd.
2001 · (19) Gibson Lake

Ecological Services Group International (Stantec Consulting Ltd.)
1991 · (21) Porcupine River.
1994 · (96) Trent River, (53) Lake Superior.
1995 · (85) Lake Ontario, Great Lakes Embayments and Harbours Investigation Program. (33) West Morgan Lake, Sudbury. (54) Porcupine River. (51) Ledum Lake, East Lake, Good Friday Lake, Sunday Lake, Ghost Lake. (24) Scugog River. (5) Bilberry Creek, Orleans, Ont.
1996 · (66) Porcupine River, Night Hawk Lake, Three Nations Lake. (12) Onaping River. (12) Porcupine river. (5) Nyth River.
1997 · (6) Nemo Creek, (30) Credit River, (5) Torrance Creek, (13) Linden Creek, Little Hopper Lake, (21) Sudbury, Ont., (10) Mad/Pine River, Barrie, Ont., (10) Talfourd Creek, Sarnia.
1998 · (8) Hughy property, southern Ont., (36) Canagagiguae Creek, Elmira, (12) Torrance Creek, (14) Huttonville, Springbrook Creek, (45) St. Lawrence River, (27) Abitibi River, (3) Foley Creek, (40) Kapuskasing River, (44) Ledum Lake, East Lake, Good Friday Lake, Sunday Lake, Ghost Lake, Sunday Creek, East Lake Creek, East Creek, Detour River, Sunday Creek.
1999 · (9) Wilmot Creek, (8) Ground Hog River, Moose River Basin, (24) Lake Superior, (24) Thunder Bay Harbour, (36) Mattagami River, (49) Canagagiguae Creek, Elmira, (4) Forwell Creek, (18) Balmer Lake, (9) Formosa Creek, (18) Garrett Creek, (24) Lake Gibson, (28) Ottawa River, (12) Maitland, (9) Nine Mile River, (18) Medway Creek, (33) Porcupine River/Kidd Creek.
2000 · (15) Pine River, (42) Canagagiguae Creek, Elmira, (3) Springville Creek; (21) **marine** Hawkes Bay, Nfld; (15) Balmer Lake; (13) **marine/est**. Rio Higuamo, Dominican Republic.
2001 · (27) Long Sault; (8) Trent River; (33) Shekak/Nagagami River (8) Ottawa; (24) Beaver Dams Drains; (9) Oxbow Tributary; (54) Canagagigue Creek; (9) Credit River Tributary; (36) Kidd/Jocko Creek; (30) Spruce Falls, Kapuskasing River; (16) Trent River; (4) Lake Erie; (18) Balmer Lake; (10) Medway Creek; (12) Maitland River.
2002 · (5) Port Stanley, (48) Canagagigue Creek, (16) 4 Mile Creek, (6) Nanquan River, (3) McIntyre Rapids, (8) Sawmill Creek, (39) Still/Magnetawan River, (24) Otonabee River, (30) Mattagami River, (12) Maitland River.
2003 · (27) Abitibi River, (16) Trent River, (8) Lilabelle Creek, (15) Balmer Creek, (53) Grand River, (95) Lake Erie, (36) Gibson Lake, (36) Detour Lake, (6) Dominican Republic **marine,** (25) Bronte Creek, (48) Canagagigue Creek, (8) Norman Creek, (3) Trois Riviere, Q.B., (12) Dedrick Creek,

(7) Oakville Creek, (2) Brookhill Creek, (20) Trent River, (12) Shekak River, (30) Redrock, (28) 14 Mile Creek, (21) 12 Mile Creek.

2004 · (42) Canagagigue Creek, (36) Mountsberg/Flamborough Creeks, (27) Oakville Creek, (24) Wawagosic River, QB., (9) Nipigon, (5) Redhill Creek, (56) Flin Flon Manitoba, (10) Ruttan, (10) Giroux Lake/Sass Lake, (12) Maitland River, (15) 14 Mile Creek, (12) Brighton Beach Power.

2005 · (15) Georgian Bay, (13) Wells Creek, (12) Spencer Creek, (56) St. Clair River, (12) Detroit River, (42) Lake Gibson, (24) 14 Mile Creek, (12) Maitland River, (9) Baden Creek, (15) Medway Creek.

2006 · (5) Ching Landfill, (16) Humber River, (38) Canagagigue River, (3 Mattagami River, (1) Montreal River, (21) Orangeville Marsh, (2) Welland Canal, (3) Black Creek, (5) Wolfe Island, (15) Mountsberg Creek.

Ecometrix Inc.

2004 · (15) Peru, **marine,** (52) Peru, (23) Panther Creek, Salmon River Idaho, U.S., (5) Bouchette Pond, Gages Creek/Port Granby Creek.

2005 · (35) Peru, **marine**. (26) Salaverry Peru **marine**, (50) Antamina Peru, (10) Ground Hog River, N.B., (22) Idaho, (220) Wabush, Nfld., (2) Tuktoyaktuk Arctic, (4) Van Wagner's Pond.

2006 · (9) Salaverry Peru **marine**, (30) Bayovar, Peru **marine**, (32) Antamina Peru, (17) Southern Peru **marine**, (15) Antamina Peru **marine,**

Environment Canada

2001 · (30) Welland Canal.

2006 · (6) Georgian Bay.

Essex Region Conservation Authority

1992 · (120) Southwestern Ontario: Thames River, Dodd Creek, Kettle Creek, Catfish Creek, Big Otter Creek, Sauble River, Rocky Saugeen River, Saugeen River, Bayfield River, Ausable River, Boyne River, Spey River, Pretty River, Beaver River, Bighead River, Hamilton Creek, Walters Creek, Maxwell Creek, Pottawatomi River, Sauble River, Sydenham River.

EVS Environment Consultants (Golder), British Columbia.

1996 · (12) Contwoyto Lake/Echo Bay, North West Territories. (29) British Columbia.

1997 · (35) Ledum/Ketchum Creek, North Central B.C.

1998 · (40) Ledum/Ketchum Creek, North Central B.C.

1999 · (62) Ledum/Ketchum Creek, North Central B.C.

2000 · (58) North Central B.C.

2001 · (58) North Central B.C.; (13) Pinchi Lake; (13) Elk Valley.

2002 · (47) North Central B.C.

2003 · (40) North Central B.C.

2004 · (45) North Central B.C., (25) North Central B.C.

2005 · (20) Northern B.C.

2006 · (120) Wabamun Lake, Alberta, (19) Herman, (15) Brule, (20) Wolverine, (15) Nemi.

Friends of the St. Clair River

1998 · (27) St. Clair River Trib. {Talfourd Creek, Baby Creek, Bowens Creek, Clay Creek, Grape Run}, (6) Detroit River Trib.{Turkey Creek}, (9) Wheatley Harbour Area {Muddy Creek, Two Creeks}.

G3 Consulting Ltd, B.C.

2003 · (25) voucher verifications, B.C.

2005 · (9) British Columbia, (30) British Columbia, (6) British Columbia.

2006 · (27) British Columbia.

Gamsby and Mannerow (Owen Sound)

1996 · (15) Saugeen River, Durham, Ont.

1999 · (15) Saugeen River, Durham, Ont.

2004 · (15) Saugeen, Durham, Ont.

Gartner Lee Ltd.
2006 · (49) Guelph wetland.

Georgian Bay Association
2002 · (20) Honey Harbour, 12 Mile Bay.
2003 · (39) Honey Harbour, 12 Mile Bay.
2005 · (31) Georgina Bay.
2006 · (15) Georgina Bay.

Goldcorp Inc.
2004 · (15) Balmer Lake.

Golder Associates Ltd.
2002 · (15) Port Hope.
2003 · (20) Darkie Creek, (21) Scugog River.
2004 · (8) Stitsville Quarry, (27) Swicks Island, Belleville, (10) Thunder Creek, (20) Three Nations Creek.
2005 · (24) Sudbury, (12) Hay Creek, (18) Moose Creek.
2006 · (9) Hunter Lake, (15) Sutherland Creek.

Grand River Conservation Authority
1996 · (55) Eramosa River.

Greenland International Consulting Ltd.
2004 · (6) Levi/Mullet Creek.
2005 · (6) Levi/Mullet Creek.

Groupe-conseil Génivar Inc., Quebec
1999 · (20) Saint François, Massawipi River Lennoxville, Quebec, (39) Rivière Saint-Francois, (20) Rivière Portneuf, (20) Ouareau River.
2000 · (41) New Richmond**, marine,** (25) Rivière des Outaouais.
2001 · (25) Sept Isles, Quebec**, marine**.
2002 · (12) St. Lawrence River, Quebec City.
2003 · (10) St. Lawrence River, Monteal..

GWS Ecological & Forestry Services
2000 · (12) Penetangore River.
2001 · (12) Penetangore River.
2002 · (12) Penetangore River.

Jacques Whitford Environment Limited, New Brunswick
1999 · (65) Mirimichi Estuary, N.B **marine**.
2001 · (41) Sydney Tar Ponds, N.S **marine**.
2003 · (80) Mirimichi Estuary, N.B **marine,** (60) Restigouche Estuary, **marine,** (43) Petitcodiac River, N.B.

Jacques Whitford Environment Limited, Newfoundland
2001 · (23) Exploits River, Botwood Harbour, Nfld **marine**.

Jacques Whitford Environment Limited, Nova Scotia
1999 · (49) **marine**, Sable Island, (45) Restigouche Estuary.
2000 · (106) **marine**, Sable Island.

Knight & Piesold, North Bay
1998 · (17) English River, Kenora.
1999 · (24) Northern Ontario.
2000 · (61) Cargill Lake, Lost Lake, Lost River.

Knight & Piesold, British Columbia

2005 · (10) Baffin Island.

Maitland Valley Conservation Authority

1994 · (40) Maitland River and tributaries.
1995 · (39) Maitland River and tributaries.
1996 · (41) Maitland River and tributaries
1997 · (22) Maitland River and tributaries.
1998 · (20) North Maitland River, Boyle Drain, South Maitland River, McCall Drain, Little Maitland River, Middle Maitland River, Eighteen Mile River, Vandiepenbeek Drain, Ackert Drain, Dickies Creek, Kinloss Creek.
1999 · (34) Maitland River, Dillon Drainage Works, Murray-Lamb Drain, Blyth Brook, Kelly Drain, Verburg Drain, Redgrave Creek, Naftel's Creek, Nine Mile River, Boyd Creek.
2000 · (9) Maitland River, Listowel.
2004 · (6) Southwestern Ontario.

Michalski Nielson Associates Ltd.

2004 · (16) 4 Mile Creek.

Minnow Environmental

2001 · (18) Northern Ontario; (10) Northern Ontario; (9) Flack, Semiwite, Summers Lake; (27) Lost/Cargill Lake; (12) Williams; (12) Pearl Lake; (44) Dona Lake.
2002 · (21) Northwestern Ontario, (18) Lynn River, Burge, Eldon and Cockeram Lakes Manitoba, (20) Lost Lake, (10) Southeastern B.C., (15) Ottawa River Gatineau, (10) Mistassini River Quebec.
2003 · (10) Barrigar Lake, Northern Ontario, (35) Spanish/Mississagi River, (10) Napanee River, (6) Porcupine River, (8) Elliot Lake, (24) Agrium, (15) St. Lawrence, Quebec, (20) **marine** Mahone, Chester N.S., (15) Bathurst N.B., (30) **marine** Liverpool, N.S., (20) Kaministiquia River, (2) Timmins.
2004 · (13) Big Meadow Brook, Georges Lake, Pug Lake, East Tusket River System, N.S., (15) Wabush, Labrador, (45) Porcupine River, (134) Serpent River Watershed, (25) Belledune Harbour, N.B.
2005 · (105) Serpent River watershed, (20) Bathurst, N.B., (12) Cobalt Ont., (10) Raglan, Quebec, (10) Strathcona, (30) Golden Giant, (42) Williams mine, (25)Cedar Creek, (20) Conchenour, (16) Red Lake, (28) Musselwhite, (

Morton, Bill

2002 · (194) Wabush Lake; (88) Bay of Quinte;

N.A.R. Environmental Consultants Inc.

2000 · (60) Tetapoga River, Link Lake, Johnny Creek, Lake Temagami.
2003 · (9) Mount Forest, (15) Watford.
2004 · (12) Agnew Lake.
2005 · (3) Gertrude West, (18) Agnew Lake, (15) Patricia mine.

National Oceanic and Atmospheric Administration (NOAA), Seattle, Washington

2000 · (100) Oregon, U.S (Kloutchie Creek, Bergsvik Creek, Buster Creek, N.F. Rock Creek, Farmer Creek, Bear Creek, S.F. Little Nestucca River, Lobster Creek).

Nottawasaga Conservation Authority

1996 · (9) Boyne River**.**
1999 · (5) Nottawasaga tributary.
2004 · (9) Angus Sewage Lagoon.

Ontario Ministry of Environment

1996 · (105) Albermarle Creek, Rocky Saugueen River, Sucker Creek, Beaver River, Big Otter Creek, Belgrave Creek, Washington Creek, South Thames River, Sydenham River, Ontario.
1997 · (120) Avon River, Boyne River, Dingman Creek, Dutton Creek, Kettle Creek, Lucknow River, Middle Maitland River, Pottawatomi River, Silver Creek, South Saugeen River, Spey River, Thames

River, Tricks Creek, Waubuno River, Little River, Maxwell Creek, Pottersburg Creek, Black River. (99) Lake Huron and Georgian Bay.

1998 · (89) Lake Ontario -{Cobourg Harbour, Prince Edward Point, Collins Bay, Trenton, Belleville, Hamilton Harbour, Windemere Basin, Keating Channel, Toronto Harbour, Humber River, Port Dalhousie}, (96) Southern Ontario - {Albermarle Creek, Beaver River, Belgrave Creek, Big Otter Creek, Rocky Saugeen River, Ruscom River, Sucker Creek, South Thames River, Sydenham River, Washington Creek, Avon River, Boyne River, Kettle Creek, Silver Creek, Spey River, Pottawatomi River, Dutton Creek, Dingman Creek, Lucknow River, Tricks Creek, South Saugeen, Waubuno River}, (24) Camp Creek, Sydenham River, Styx River, Meux River, Beaver River, Saugeen River, Coon Creek, Cedar Brook, Beatty Saugeen, Maple Creek, (9) Saugeen River, Walkerton, (15) Thames River, Ingersoll/Woodstock.

1999 · (150) Porcupine River, (33) Wheatley Harbour, (50) Lake Erie [Port Stanley, Western Basin, Peacock Point, Grand River, Fort Erie, Leamington], (19) Maitland Valley Conservation Authority - Maitland River and Tributaries, (36) Nottawasaga Valley Conservation Authority - Nottawasaga River and Tributaries, (34) Central Lake Ontario Conservation Authority, (8) Credit Valley Conservation Authority.

2000 · (93) Junction Creek, (65) Lake Superior; (13) Lake St. John; (11) Lake Couchiching.

2001 · (147) Madawaska Mine: Bentley Lake, Siddon Lake, Bow Lake, Bentley Creek, Crowe River, Dyno Mine: Farrel Lake, Farrel Creek, Brough Lake, Eels Lake, Bicroft Mine: Centre Lake, Deer Creek, Paudash Lake, Kindom Mine: Mississippi River; (199) Lake Ontario: Lake St. Francis, Humber Bay, Toronto Harbour, Oakville Harbour, Hamilton Harbour, Port Dalhousie, 6 Mile Creek, Stoney Creek, Prince Edward Point, North Channel, Newcastle, Presqu'ile, Trenton, Prescott, Pickering; Lake Erie: Thames River, Port Stanley, Kettle Creek, Big Otter Creek, Port Bruce, Catfish Creek, Leamington Harbour, Wheatley Harbour, Lynne River, Nanticoke Creek, Grand River; Lake Superiour:Kam River, Mission River, Nippigon Bay, Moberly Bay, Blackbird Creek, Jellicoe Cove, Spanish River, Lake Ontario: Whitby Harbour, Centre Island, Parrots Bay, Kingston Harbour; (8) Wheatley Harbour.

2002 · (14) Wheatley Harbour.

2003 · (20) Wheatley Harbour.

2004 · (158) Lake Ontario.

<u>Phoenix mg</u>

2000 · (15) Lost River/Cargill Lake, (5) Hollinger Golf Course, (13) Lac Des Iles Mine, Thunder Bay; (10) Sherriff Creek.

<u>Pine River Cheese & Butter Co-operative</u>

1998 · (12) South Pine River.
1999 · (09) South Pine River.
2000 · (06) South Pine River.
2001 · (09) South Pine River.
2003 · (06) South Pine River.

<u>Placer Dome, Campbell Mine</u>

2003 · (21) Balmer Lake.

<u>Pollutech Enviroquatics Limited</u>

1995 · (24) Southern Ontario.
1996 · (39) St. Clair River.
2000 · (30) St. Lawrence River, Cornwall; (36) St. Clair River, Baby Creek.
2001 · (39) Baby Creek; (72) St. Clair River.
2002 · (48) St. Clair River.
2003 · (51) St. Clair River.

<u>P. Riebel & Associates Environmental Services, Quebec</u>

1999 · (42) Rivière du Loup, Quebec.
2000 · (24) Napanee River, Ontario.

SENES Consultants Ltd.

2004 · (40) Pickering Wetland.
2005 · (30) Long Lac, (14) Manitoulin.

South Nation River Conservation Authority

1996 · (3) Shields Creek.
1997 · (18) Leitrim/Winchester, Ontario.
1999 · (12) Ottawa River.

Tarandus

2001 · (20) Buchans, Newfoundland.
2002 · (32) Buchans, Newfoundland.
2003 · (6) Indian Brook, Blue Mtn.
2004 · (25) Holland River, (6) Lamont Creek, (21) Kempenfelt Bay, (6) Henderson Pond.
2005 · (9) Lamont Creek., (45) Frederick House Lake.

Toronto Region Conservation Authority

2002 · (70) Toronto River Mouths, (152) Don River, Humber River, Rouge River, Etobicoke Creek, Mimico Creek, Highland Creek, Petticoat Creek, Duffins Creek, Carruthers Creek..

Trent University

2003 · (8) Milton, Ont.
2004 · (6) Milton, Ont.
2005 · (6) Milton, Ont
2006 · (29) Milton, Ont

True North Explorations, Guelph.

2004 · (18) Boyne River, (12) South Saugeen, (106) Whitefish stomachs Lake Ontario.
2005 · (10) Kirkland Lake.

Water Systems Analysts, Guelph.

1999 · (45) **marine,** Newfoundland.

Westwood, John, London

2003 · (18) Little Sauble River.
2004 · (18) Little Sauble River.
2005 · (18) Little Sauble River.

XCG Consultants Ltd.

2006 · (8) Nonquan River

ZEAS

1995 · (6) Caves Branch River, Sibun River, Mahogany Creek Belize.
1996 · (4) Sigatoka River Viti Levu Fiji, (4) Vanua Levu Fiji.
1999 · (8) Samara, Costa Rica.

John D. Parish, M.A., P.Geo.

Director and Senior Fluvial Geomorphologist

Curriculum Vitae

Mr. Parish has applied fluvial geomorphology in numerous and diverse projects and studies throughout Ontario and the North-Eastern United States. Recently completed, as well as ongoing projects have included the application of fluvial geomorphology to subwatershed planning studies, channel rehabilitation work, erosion assessments, aquatic habitat enhancement, monitoring, method and policy development and natural channel designs. John's experience and expertise has been drawn upon regularly for presentation, training and expert witness purposes.

EDUCATION

Mr. Parish received his M.A. in 1990 from Wilfred Laurier University. He received his B.E.S. from the University of Waterloo in 1985, with a major in Physical Geography and a minor in Earth Sciences.

PROFESSIONAL BACKGROUND

1997 to Present: PARISH Geomorphic Ltd.
Director
Senior Fluvial Geomorphologist
1999 to Present: Reach Training Inc.
Director
1991 to 1997: ORTECH Corporation
Fluvial Geomorphologist
GIS Specialist
1986 to 1988: St. Clair Region Conservation Auth.
Conservation Services Technician
1985 to 1986: Kent-Elgin Natural Area Survey
Geomorphologist

QUALIFICATIONS OF EXPERTISE

- Ontario Municipal Board – Oak Ridges Moraine – Expert Witness
- Provincial Offences Court – Tree By-Law Hearing – Expert Witness regarding Landform and Processes
- Ontario Municipal Board – Morningside Heights – Expert Witness

PUBLISHED PAPERS AND REPORTS

- P. V. Villard and J. D. Parish 2003 A Geomorphic-based protocol for assessing stream sensitivity and erosion thresholds: A tool for stormwater management. *16th Hydrotechnical Conference of the Canadian Society for Civil Engineers*, 21-23 October 2003, Burlington

- Parish J.D., Kilgour, B., Muriel, A., Nelson, M., Staton, M. 2002. *Journal of Environmental Monitoring and Assessment.* Status and Trends of Ontario's Sydenham River Ecosystem in Relation to Aquatic Species at Risk.

- Parish, John D. 2001. Chapter 2. The Formation of Streams and Their Valleys. *Natural Channel Systems Interactive CD. Adaptive Management of Stream Corridors in Ontario; Natural Hazards Technical Guide*. Watershed Science Centre, Trent University. Peterborough.

- Parish, John D. 2001. Chapter 3. Impacts of Past and Present Landuse Practices. *Natural Channel Systems Interactive CD. Adaptive Management of Stream Corridors in Ontario; Natural Hazards Technical Guide*. Watershed Science Centre, Trent University. Peterborough.

- Parish, John D. 2001. Chapter 4. Stream Corridors: Form, Function and Process. *Natural Channel Systems Interactive CD. Adaptive Management of Stream Corridors in Ontario; Natural Hazards Technical Guide*. Watershed Science Centre, Trent University. Peterborough.

- Parish, J.D. 1999. Natural Channel Initiatives Training; Geomorphology - General. *Proceedings of the Second International Conference of Natural Channel Systems.* Niagara Falls, Canada.

- Parish, J.D. and Kostaschuk, R. 1999. Natural Channel Initiatives Training; Geomorphology-Technical. *Proceedings of the Second International Conference of Natural Channel Systems.* Niagara Falls, Canada.

- Snodgrass, W.J., Mack - Mumford, D., Trushinski, B., Arishenkoffi, L., MacRae, C., Patterson, T., D'Andrea, M., Maunder, D., Farrell, L., Parish, J., and Ali, M. 1999. Cost Estimation of Stream Restoration Projects and Engineered/Natural Channel Systems in Ontario. *Proceedings of the Second International Conference of Natural Channel Systems.* Niagara Falls, Canada.

- Tinkler, K.J. And Parish, J.D. 1998. Recent Adjustments to the Long Profile of Cooksville Creek, and Urbanized Bedrock Channel in Mississauga, Ontario. In K.J. Tinkler and E.E. Wohl (ed) *Rivers over Rock: Fluvial Processes in Bedrock Channels.* Geophysical monograph series; 107.

- Snodgrass, W.J., Kilgour, B.W., Leon, L., Eyles, N., Parish, J.D. And Barton, D.R. 1997. Applying Ecological Criteria for Stream Biota and an Impact Flow Model for Evaluating Sustainable Urban Water Resources in Southern, Ontario. *Proceedings from the Engineering Foundation Conference*. Malmo, Sweden, Sept. 1997.

- Snodgrass, W.J., Kilgour, B.W., Jones, M., Parish, J.D., and Reid, K. 1997. Can Environmental Impacts of Watershed Development be measured? In L.A. Roesner (ed) Effects of watershed development and management on aquatic ecosystems. *Proceedings of an Engineering Foundation Conference.*

- Parish, J.D. And Stanfield, L. 1996. Evaluation of Morphological and Physical habitat Management Techniques for Watershed Analysis. Proceedings of the Watershed Management Symposium. Canadian Water Resources Association. Pp. 268-270.

- Bellamy, K.L. Parish, J.D., Saunderson, H.C., and Beebe, J.T. 1992. Watershed Management and the Health of Fish Habitats: a perspective from fluvial geomorphology. *Ontario Ministry of Natural Resources.*

- Bellamy, K.L. And Parish, J.D. 1992. Agricultural utilization of paper sludges in the Niagara Area, Ontario: hydrogeological aspects. *National Groundwater Association, Book 13 - Eastern Regional Groundwater Issues.* Pp. 675-688.

CONFERENCE ABSTRACTS AND PRESENTATIONS

- Villard, P .V., Parish, J. D., Snodgrass, W., (submitted) Identifying Systematic Channel Adjustment and Active Processes in Urban Channels: The First Step to Selecting Site-appropriate In-stream Structures, *5th International Symposium on ECOHYDRAULICS*, Madrid (Spain), 12-17 September 2004.

- Parish, J. D., Villard, P. V., Boyd, D., and Imhof, J., (submitted) Fluvial Geomorphological Perspectives in the Determination of Instream Flow Requirement for the Maintenance of Aquatic Habitat, *5th International Symposium on ECOHYDRAULICS*, Madrid (Spain), 12-17 September 2004.

- Villard, P.V., Parish, J., Wright, J. and Dudley. R. 2003. Regional curves for Maine's coastal streams: Developing tools to guide Atlantic salmon habitat restoration, *American Fisheries Society 133rd Annual Meeting,* August 2003, Quebec City, Quebec.

- Parish, J., Forder, D., and Dextrase, A. 2003. Determination of physical habitat preferences of the Redside Dace (Clinostomus elongates);

a component of a regional recovery strategy, *American Fisheries Society 133rd Annual Meeting*, August 2003, Quebec City, Quebec.

TRAINING AND SHORT COURSES

- *Fluvial Geomorphology and Bedrock Channels in Northern Ontario* – Department of Fisheries and Oceans. Haliburton Forest Conference Centre. April 16, 2003.
- *Natural Channels Presentation* – Maitland Valley Conservation Authority, April 3, 2003.
- Reach Training Inc. – *Fluvial Geomorphology Training.* Series of training courses for Government and Municipal groups from 1999 to 2002.
- *Fluvial Geomorphology Training* – Augusta, Maine. June 10-11, 2002.
- *Building a Restoration Toolbox - River Restoration* – Harvard Design School. Cambridge, Mass. Nov 8, 2001.
- *Stream Restoration* – Biologists Training Center. Shepherdstown, West Virginia. Oct 17, 2001.
- *Natural Channel Design: An International Prospective*. Fairlee, Vermont. May 23-24, 2000.
- *Fluvial Geomorphology Training – Technical Session.* Natural Channels Conference, Niagara Falls, Ontario. March, 1999.
- Numerous presentations to various agencies and groups (DFO; MNR)
- Regular guest lectures at various Universities (University of Toronto; Trent University; University of Guelph; Brock University)

REPRESENTATIVE PROJECT EXPERIENCE

Basin Scale Planning and Inventory

- US Fish and Wildlife – Maine Regional Curve Study
- Kingston Subwatershed Inventory and Assessment – Kingston
- Errol Creek Assessment - Errol
- Waterloo Channel Inventory - Waterloo
- Dick's Creek – St. Catherines
- Morningside Creek Subwatershed Study
- Credit River Tributary – Alton/Cheltenham
- Fourteen Mile Creek – Palermo
- Sixteen Mile Creek Subwatersheds 2 & 5
- Shirley's Brook and Watt's Creek Subwatershed Study – Ottawa
- Huttonville Creek / Credit Valley Secondary Plan - Brampton
- Credit Valley Subwatershed 16 & 18 Study
- Credit River Subwatershed 8B – Brampton
- Carruther's Creek – Ajax
- Seaton Lands – Durham Region
- Cooksville Creek – Mississauga

Channel Design & Restoration

- Owasco Inlet – Auburn, New York
- South Branch, Sandy River – Phillips, Maine
- Carruther's Creek – Ajax
- Tributary of Columbia Lake – Waterloo
- Gilbert Creek – Paris GCC
- Miller Creek – Ajax
- Grand River Wetland Restoration – Paris
- Lynde Creek Channel Design
- Tributary of Etobicoke Creek – Tomken Road
- Sawmill Creek – Mississauga
- Colonial Creek – Waterloo
- Cooksville Creek – Meadows Blvd.
- Little Etobicoke Creek – Mississauga
- Sixteen Mile Creek Tributary – Milton
- Mary Fix Creek – North of Dundas St.
- Loyalist Creek, Phase III – Mississauga

Erosion and Channel Assessments

- Sunday River Assessment - Maine
- Penjajowoc Creek – Bangor, Maine
- Credit River Sanitary Sewer Review - Brampton / Mississauga
- Upper Monora – Orangeville
- Big East River – Huntsville
- Grindstone Creek – Burlington
- Etobicoke Creek & Spring Creek – Lester B. Pearson International Airport, Toronto

- Credit River – Mississauga
- Maitland River – Goderich
- Highway 410 Extension - Snelgrove
- Little Creek and Hepburn Creek – Port Stanley
- Channel Erosion Inventory – Oakville
- Block 12 – Richmond Hill
- Pringle Creek – Whitby
- Tributary of Silver Creek – Glen Williams
- Rouge River Tributary – Richmond Hill
- Credit River Electric Fish Barrier – Caledon
- Credit River - Inglewood
- Black Creek Tributary – Georgetown
- Newpost Creek Diversion Study – Cochrane

Monitoring Projects

- Morningside Tributary - Scarborough
- Rockbed Monitoring Study
- Grand River, Mohawk St. Landfill Erosion Monitoring – Brantford
- Credit Valley Conservation Monitoring Project
- Carroll Creek Channel and Groundwater Assessment – Elora
- Fletchers Creek Monitoring – Brampton

Methods and Policy Development

- Geomorphological Protocols for Subwatershed Studies – Regional Municipality of Ottawa Carleton
- Habitat Assessment Protocol – Site to Reach Analysis
- Natural Channel Systems, Geomorphology Design Component
- Methods for Determining Meander Beltwidths – Toronto and Region Conservation Authority
- Stream Assessment Protocol – Ministry of Natural Resources

Project Management

- Grand River Pedestrian Bridge Study Kitchener
- Stoney Creek Design – Stoney Creek
- 'The Coves' Sediment Accumulation Study London
- Waterdown Gardens Monitoring Study Waterdown
- Redside Dace Recovery Strategy Project
- Toronto and Region Conservation Authority Toronto Monitoring Study – 2002
- DOW Property Channel Rehabilitation Milton
- Shields Creek Subwatershed Study - Ottawa
- Toronto and Region Conservation Authority Toronto Monitoring Study – 2001
- Welland River Study - Welland
- Forwell Creek Rehabilitation – Waterloo
- Black Creek, Lambton Golf Course Restoration – Toronto
- Springville Channels Assessment - Springville

PROFESSIONAL AFFILIATIONS

- Ontario Association of Geoscientists
- Canadian Geomorphological Research Group
- Canadian Hydrographic Association
- Canadian Water Resources Association
- Soil and Water Conservation Society
    - Ontario Chapter President 1998-2000
- Watershed Report Card
    - Secretary Treasurer 1995-1999

PARISH geomorphic

Susi Kostyniuk, B.Sc (Hons)

Stream Process Specialist
Curriculum Vitae

Since joining the company, Ms. Kostyniuk has been responsible for leading and coordinating field investigations on hundreds of watercourses throughout Ontario and the Northeastern United States. Her responsibilities have included interacting with clients, managing field personals, and report writing. She has applied her knowledge of fluvial systems to numerous projects including subwatershed and monitoring studies, erosion threshold assessments, stream restoration and hazard assessments. Other responsibilities with the company include review and analysis of historical information (including air photography and topographical mapping), detailed and rapid channel assessments, surveying, data analysis and extensive spatial analysis support including GIS and CAD applications.

EDUCATION

Ms. Kostyniuk received her Honours Degree in Biology and Environmental Science from the University of Toronto. During recent years, she has upgraded her skills and received training in GIS ArcView and AutoCAD.

PROFESSIONAL BACKGROUND

1998 to Present: PARISH Geomorphic Ltd.
Stream Process Specialist

REPRESENTATIVE PROJECT EXPERIENCE

The following are a sub sample of representative projects that Ms. Kostyniuk has participated in or lead during her employment with PARISH Geomorphic Limited.

Basin Scale Planning and Inventory

- Kingston Subwatershed Inventory and Assessment – Kingston
- Errol Creek Assessment - Errol
- Waterloo Channel Inventory - Waterloo
- Dick's Creek – St. Catherines
- Morningside Creek Subwatershed Study
- Credit River Tributary – Alton/Cheltenham
- Fourteen Mile Creek – Palermo
- Sixteen Mile Creek Subwatersheds 2 & 5
- Huttonville Creek / Credit Valley Secondary Plan - Brampton
- Credit Valley Subwatershed 16 & 18 Study
- Credit River Subwatershed 8B – Brampton
- Carruther's Creek – Ajax
- Gilbert Creek Natural Channel Construction – Paris

Monitoring Projects

- Morningside Tributary - Scarborough
- Rockbed Monitoring Study
- Grand River, Mohawk St. Landfill Erosion Monitoring – Brantford
- Credit Valley Conservation Monitoring Project
- Fletchers Creek Monitoring – Brampton
- Toronto and Region Conservation Authority – Toronto Monitoring Study – 2001
- Toronto and Region Conservation Authority – Toronto Monitoring Study – 2002
- Toronto and Region Conservation Authority – Toronto Monitoring Study – 2003
- Waterdown Gardens Monitoring Study – Waterdown
- Rouge River Tributaries - Toronto
- Montgomery Creek Post Construction Monitoring - Hamilton
- Etobicoke Creek Tributary Post Construction Monitoring – Brampton
- Dicks Creek – Stoney Creek

Project Management

- Waterdown Gardens Monitoring Study - Waterdown
- Toronto and Region Conservation Authority – Toronto Monitoring Study – 2002
- Toronto and Region Conservation Authority – Toronto Monitoring Study – 2003
- Shields Creek Subwatershed Study - Ottawa
- Waterloo Channel Inventory – Waterloo
- Northwest Brampton - Brampton

APPENDIX E

SWMHYMO MODELLING AND STORAGE CALCULATIONS

Hydrologic Modeling Calculations
(Input into SWMHYMO)

Existing Conditions

Existing land use : Agricultural (corn and soybeans)
Existing soils : Chinguacousy clay loam and Oneida silt loam (HSG C)
Existing CN* value : 90 (for all properties)

Using the Airport Method for:

HHGS Property Catchment

$Tc = [3.26(1.1-0.35)800^{0.5}]/[1.1\%)^{0.33}] = 67$ mins
$Tp = 0.67*Tc = 45$ mins $= 0.75$ hrs

LGI + Giffels + External Property Catchments

$Tc = [3.26(1.1-0.35)700^{0.5}]/[1.0\%)^{0.33}] = 65$ mins
$Tp = 0.67*Tc = 43$ mins $= 0.72$ hrs

Future Conditions

HHGS Property Catchment

Future land use : Industrial
Total area : 28.5 ha
Total agricultural area : 8.5 ha
Total impervious area : 20.0 ha (12 ha gravel parking + 8 ha pavement)
Total imperviousness : 70%

LGI + Giffels + External Property Catchments

Future land use : Industrial
Total area : 32.5 ha
Total agricultural area : 6.5 ha
Total impervious area : 26.0 ha (pavement)
Total imperviousness : 80%

Pond

Future land use : SWM pond
Total area : 4.0 ha
CN* : 95
Tc : 10 mins
Tp (0.67*Tc [min]) : 0.11 hrs

```
==============================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 =========
                                                      9   9  9   9 # 3569108
      StormWater Management HYdrologic Model           999    999  =========

 ****************************************************************************
 *************************** SWMHYMO-99 Ver/4.02 ****************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                 OTTHYMO-83 and OTTHYMO-89.                  *******
 ****************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                 Ottawa,  Ontario: (613) 727-5199            *******
 *******                 Gatineau, Quebec: (819) 243-6858            *******
 *******                 E-Mail: swmhymo@jfsa.Com                    *******
 ****************************************************************************

 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Philips Engineering Ltd                      +++++++
 +++++++                Burlington            SERIAL#:3569108        +++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ****************************************************************************
 *******           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *******
 *******           Maximum value for ID numbers  :     10            *******
 *******           Max. number of rainfall points:  15000            *******
 *******           Max. number of flow points    :  15000            *******
 ****************************************************************************


 ********************   D E T A I L E D   O U T P U T   ********************
 ****************************************************************************
 *       DATE: 2007-07-31     TIME: 16:26:05     RUN COUNTER: 001588       *
 ****************************************************************************
 * Input   filename: G:\WORK\107012\WATER\SWMHYMO\FUT100.dat               *
 * Output  filename: G:\WORK\107012\WATER\SWMHYMO\FUT100.out               *
 * Summary filename: G:\WORK\107012\WATER\SWMHYMO\FUT100.sum               *
 * User comments:                                                          *
 * 1:_______________________________________________________________________*
 * 2:_______________________________________________________________________*
 * 3:_______________________________________________________________________*
 ****************************************************************************

-------------------------------------------------------------------------------
001:0001-----------------------------------------------------------------------
*** Halton Hilla Power Generating Station
*** Source : Sernes SIS Study, April 2007
***Sixteen Mile Creek
*** FUTURE CONDITIONS - STORAGE INCLUDED
*** Rationg Curve -ED at 193.3 m
--------------------
| START            |  Project  dir.: G:\WORK\107012\WATER\SWMHYMO\
--------------------  Rainfall dir.: G:\WORK\107012\WATER\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   1
           #  1=HOUR 100 YEAR STORM
-------------------------------------------------------------------------------
```

```
001:0002---------------------------------------------------------------------
--------------------
| CHICAGO STORM    |     IDF curve parameters: A=1777.200
| Ptotal=112.99 mm |                           B=   9.000
--------------------                           C=    .795
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 12.00 hrs
                         Storm time step    = 10.00 min
                         Time to peak ratio =   .33

              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.107 |   3.17   8.170 |   6.17   6.156 |   9.17   2.906
               .33   2.187 |   3.33  10.161 |   6.33   5.765 |   9.33   2.830
               .50   2.274 |   3.50  13.618 |   6.50   5.425 |   9.50   2.757
               .67   2.370 |   3.67  21.150 |   6.67   5.126 |   9.67   2.689
               .83   2.475 |   3.83  50.352 |   6.83   4.862 |   9.83   2.625
              1.00   2.591 |   4.00 171.052 |   7.00   4.626 |  10.00   2.563
              1.17   2.720 |   4.17  65.474 |   7.17   4.414 |  10.17   2.505
              1.33   2.864 |   4.33  35.296 |   7.33   4.223 |  10.33   2.450
              1.50   3.027 |   4.50  24.060 |   7.50   4.049 |  10.50   2.398
              1.67   3.213 |   4.67  18.291 |   7.67   3.890 |  10.67   2.348
              1.83   3.426 |   4.83  14.801 |   7.83   3.745 |  10.83   2.300
              2.00   3.673 |   5.00  12.469 |   8.00   3.611 |  11.00   2.254
              2.17   3.964 |   5.17  10.800 |   8.17   3.487 |  11.17   2.210
              2.33   4.313 |   5.33   9.547 |   8.33   3.373 |  11.33   2.169
              2.50   4.738 |   5.50   8.571 |   8.50   3.266 |  11.50   2.129
              2.67   5.269 |   5.67   7.789 |   8.67   3.167 |  11.67   2.090
              2.83   5.953 |   5.83   7.147 |   8.83   3.075 |  11.83   2.053
              3.00   6.870 |   6.00   6.611 |   9.00   2.988 |  12.00   2.018

-----------------------------------------------------------------------------
001:0003---------------------------------------------------------------------
***
----------------------
| CALIB NASHYD       |   Area    (ha)=    4.00   Curve Number   (CN)=95.00
| 01:102    DT= 5.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .110

     Unit Hyd Qpeak  (cms)=    1.389

     PEAK FLOW       (cms)=    1.402 (i)
     TIME TO PEAK    (hrs)=    4.000
     RUNOFF VOLUME    (mm)=   96.093
     TOTAL RAINFALL   (mm)=  112.989
     RUNOFF COEFFICIENT   =     .850

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

      *** WARNING: Time step is too large for value of TP.
                   R.V. may be ok.  Peak flow could be off.
-----------------------------------------------------------------------------
001:0004---------------------------------------------------------------------
***
----------------------
| CALIB STANDHYD     |   Area    (ha)=   28.50
| 02:100    DT= 5.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      19.95         8.55
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     435.90        40.00
```

```
     Mannings n            =        .013         .250

     Max.eff.Inten.(mm/hr)=     171.05       137.60
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.99 (ii)   11.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .10
                                                                *TOTALS*
     PEAK FLOW       (cms)=       8.55         2.05          10.310 (iii)
     TIME TO PEAK    (hrs)=       4.00         4.08           4.000
     RUNOFF VOLUME    (mm)=     111.99        85.61         104.076
     TOTAL RAINFALL   (mm)=     112.99       112.99         112.989
     RUNOFF COEFFICIENT   =        .99          .76            .921
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  90.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0005------------------------------------------------------------------------
----------------------
| CALIB STANDHYD     |   Area    (ha)=   32.50
| 03:101    DT= 5.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      26.00         6.50
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     465.50        40.00
     Mannings n            =        .013         .250

     Max.eff.Inten.(mm/hr)=     171.05       137.60
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       5.19 (ii)   11.40 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .21          .10
                                                                *TOTALS*
     PEAK FLOW       (cms)=      11.04         1.55          12.366 (iii)
     TIME TO PEAK    (hrs)=       4.00         4.08           4.000
     RUNOFF VOLUME    (mm)=     111.99        85.61         106.714
     TOTAL RAINFALL   (mm)=     112.99       112.99         112.989
     RUNOFF COEFFICIENT   =        .99          .76            .944

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  90.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0006------------------------------------------------------------------------
--------------------
| ADD HYD (001000) | ID: NHYD     AREA     QPEAK   TPEAK  R.V.     DWF
--------------------              (ha)     (cms)   (hrs)  (mm)   (cms)
                 ID1 02:100       28.50   10.310    4.00 104.08    .000
                +ID2 03:101       32.50   12.366    4.00 106.71    .000
                 =======================================================
                 SUM 04:001000    61.00   22.676    4.00 105.48    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
-------------------------------------------------------------------------------
001:0007-----------------------------------------------------------------------
--------------------
| ADD HYD (001000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:102        4.00     1.402    4.00  96.09    .000
                +ID2 04:001000    61.00    22.676    4.00 105.48    .000
                 ====================================================
                 SUM 06:001000    65.00    24.079    4.00 104.90    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0008-----------------------------------------------------------------------
*** Spillway at ED 193.1 m, 13 m long
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  2.0 min.
|  IN>06:(001000)   |
| OUT<07:(001111)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.054  .3533E+01
                            .174  .2071E+01   |    2.460  .3718E+01
                            .220  .2517E+01   |    4.276  .3909E+01
                            .234  .2675E+01   |    8.861  .4303E+01
                            .270  .3176E+01   |   63.631  .7592E+01
                            .281  .3352E+01   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >06: (001000)      65.00    24.079     4.000    104.904
     OUTFLOW<07: (001111)      65.00     4.496     4.556    104.900
    OVERFLOW<05: (      )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   18.670
                   TIME SHIFT OF PEAK FLOW         (min)=    33.33
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3928E+01

-------------------------------------------------------------------------------
001:0009-----------------------------------------------------------------------
      FINISH
----------------------------------------------------------------------------
```

```
=============================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 =========
                                                      9   9  9   9 # 3569108
      StormWater Management HYdrologic Model           999    999  =========

 ***************************************************************************
 *************************** SWMHYMO-99 Ver/4.02 ***************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                OTTHYMO-83 and OTTHYMO-89.                   *******
 ***************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
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 *******                 Gatineau, Quebec: (819) 243-6858            *******
 *******                 E-Mail: swmhymo@jfsa.Com                    *******
 ***************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Philips Engineering Ltd                      +++++++
 +++++++               Burlington            SERIAL#:3569108         +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************
 *******          ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *******
 *******          Maximum value for ID numbers  :     10             *******
 *******          Max. number of rainfall points:  15000             *******
 *******          Max. number of flow points    :  15000             *******
 ***************************************************************************


 ********************   D E T A I L E D   O U T P U T   ********************
 ***************************************************************************
 *       DATE: 2007-07-31     TIME: 16:30:30     RUN COUNTER: 001594       *
 ***************************************************************************
 * Input   filename: G:\WORK\107012\WATER\SWMHYMO\FUT-Regb.dat             *
 * Output  filename: G:\WORK\107012\WATER\SWMHYMO\FUT-Regb.out             *
 * Summary filename: G:\WORK\107012\WATER\SWMHYMO\FUT-Regb.sum             *
 * User comments:                                                          *
 * 1:______________________________________________________________________*
 * 2:______________________________________________________________________*
 * 3:______________________________________________________________________*
 ***************************************************************************

-------------------------------------------------------------------------------
001:0001-----------------------------------------------------------------------
*** Halton Hilla Power Generating Station
*** Source : Sernes SIS Study, April 2007
***Sixteen Mile Creek
*** FUTURE CONDITIONS - STORAGE INCLUDED
*** REGIONAL FLOWS
--------------------
| START            |  Project  dir.: G:\WORK\107012\WATER\SWMHYMO\
--------------------  Rainfall dir.: G:\WORK\107012\WATER\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   1
           #  1=HAZEL.STM
-------------------------------------------------------------------------------
```

```
001:0002------------------------------------------------------------------------------
--------------------
| READ STORM        |    Filename: G:\WORK\107012\WATER\SWMHYMO\HAZEL.STM
| Ptotal= 212.34 mm|    Comments: Hurricane Hazel Regional Design Storm
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	6.350	3.08	12.700	6.08	23.110	9.08	52.830
.17	6.350	3.17	12.700	6.17	23.110	9.17	52.830
.25	6.350	3.25	12.700	6.25	23.110	9.25	52.830
.33	6.350	3.33	12.700	6.33	23.110	9.33	52.830
.42	6.350	3.42	12.700	6.42	23.110	9.42	52.830
.50	6.350	3.50	12.700	6.50	23.110	9.50	52.830
.58	6.350	3.58	12.700	6.58	23.110	9.58	52.830
.67	6.350	3.67	12.700	6.67	23.110	9.67	52.830
.75	6.350	3.75	12.700	6.75	23.110	9.75	52.830
.83	6.350	3.83	12.700	6.83	23.110	9.83	52.830
.92	6.350	3.92	12.700	6.92	23.110	9.92	52.830
1.00	6.350	4.00	12.700	7.00	23.110	10.00	52.830
1.08	4.320	4.08	16.760	7.08	12.700	10.08	37.850
1.17	4.320	4.17	16.760	7.17	12.700	10.17	37.850
1.25	4.320	4.25	16.760	7.25	12.700	10.25	37.850
1.33	4.320	4.33	16.760	7.33	12.700	10.33	37.850
1.42	4.320	4.42	16.760	7.42	12.700	10.42	37.850
1.50	4.320	4.50	16.760	7.50	12.700	10.50	37.850
1.58	4.320	4.58	16.760	7.58	12.700	10.58	37.850
1.67	4.320	4.67	16.760	7.67	12.700	10.67	37.850
1.75	4.320	4.75	16.760	7.75	12.700	10.75	37.850
1.83	4.320	4.83	16.760	7.83	12.700	10.83	37.850
1.92	4.320	4.92	16.760	7.92	12.700	10.92	37.850
2.00	4.320	5.00	16.760	8.00	12.700	11.00	37.850
2.08	6.350	5.08	13.970	8.08	12.700	11.08	12.700
2.17	6.350	5.17	13.970	8.17	12.700	11.17	12.700
2.25	6.350	5.25	13.970	8.25	12.700	11.25	12.700
2.33	6.350	5.33	13.970	8.33	12.700	11.33	12.700
2.42	6.350	5.42	13.970	8.42	12.700	11.42	12.700
2.50	6.350	5.50	13.970	8.50	12.700	11.50	12.700
2.58	6.350	5.58	13.970	8.58	12.700	11.58	12.700
2.67	6.350	5.67	13.970	8.67	12.700	11.67	12.700
2.75	6.350	5.75	13.970	8.75	12.700	11.75	12.700
2.83	6.350	5.83	13.970	8.83	12.700	11.83	12.700
2.92	6.350	5.92	13.970	8.92	12.700	11.92	12.700
3.00	6.350	6.00	13.970	9.00	12.700	12.00	12.700

```
------------------------------------------------------------------------------
001:0003------------------------------------------------------------------------------
***
----------------------
| CALIB NASHYD        |   Area    (ha)=    4.00   Curve Number   (CN)=98.00
| 01:102    DT= 5.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .110

     Unit Hyd Qpeak  (cms)=    1.389

     PEAK FLOW       (cms)=     .586 (i)
     TIME TO PEAK    (hrs)=   10.000
     RUNOFF VOLUME    (mm)=  202.283
     TOTAL RAINFALL   (mm)=  212.340
     RUNOFF COEFFICIENT   =     .953

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

      *** WARNING: Time step is too large for value of TP.
                   R.V. may be ok.  Peak flow could be off.
```

```
-------------------------------------------------------------------------------
001:0004-----------------------------------------------------------------------
***
----------------------
| CALIB STANDHYD     |   Area    (ha)=   28.50
| 02:100    DT= 5.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      19.95         8.55
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     435.90        40.00
     Mannings n          =        .013         .250

     Max.eff.Inten.(mm/hr)=      52.83        52.60
                over (min)       10.00        15.00
     Storage Coeff.  (min)=       7.98 (ii)   17.10 (ii)
     Unit Hyd. Tpeak (min)=      10.00        15.00
     Unit Hyd. peak  (cms)=        .13          .07
                                                               *TOTALS*
     PEAK FLOW       (cms)=       2.93         1.21              4.133 (iii)
     TIME TO PEAK    (hrs)=      10.00        10.00             10.000
     RUNOFF VOLUME    (mm)=     211.34       197.27            207.119
     TOTAL RAINFALL   (mm)=     212.34       212.34            212.340
     RUNOFF COEFFICIENT   =       1.00          .93               .975

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  96.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0005-----------------------------------------------------------------------
----------------------
| CALIB STANDHYD     |   Area    (ha)=   32.50
| 03:101    DT= 5.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      26.00         6.50
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     465.50        40.00
     Mannings n          =        .013         .250

     Max.eff.Inten.(mm/hr)=      52.83        52.60
                over (min)       10.00        15.00
     Storage Coeff.  (min)=       8.30 (ii)   17.42 (ii)
     Unit Hyd. Tpeak (min)=      10.00        15.00
     Unit Hyd. peak  (cms)=        .13          .07
                                                               *TOTALS*
     PEAK FLOW       (cms)=       3.81          .92              4.729 (iii)
     TIME TO PEAK    (hrs)=      10.00        10.00             10.000
     RUNOFF VOLUME    (mm)=     211.34       197.27            208.526
     TOTAL RAINFALL   (mm)=     212.34       212.34            212.340
     RUNOFF COEFFICIENT   =       1.00          .93               .982

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  96.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
```

```
001:0006---------------------------------------------------------------------------------
--------------------
| ADD HYD (001000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 02:100       28.50    4.133   10.00 207.12    .000
                +ID2 03:101       32.50    4.729   10.00 208.53    .000
                 =======================================================
                 SUM 04:001000    61.00    8.862   10.00 207.87    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0007---------------------------------------------------------------------------------
--------------------
| ADD HYD (001000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:102        4.00     .586   10.00 202.28    .000
                +ID2 04:001000    61.00    8.862   10.00 207.87    .000
                 =======================================================
                 SUM 06:001000    65.00    9.448   10.00 207.53    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0008---------------------------------------------------------------------------------
**** Weir at 193.1 m, L=13 m Trapezoidal
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  2.0 min.
|  IN>06:(001000)   |
| OUT<07:(001111)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.054  .3533E+01
                            .174  .2071E+01   |    2.460  .3718E+01
                            .220  .2517E+01   |    5.312  .4005E+01
                            .234  .2675E+01   |    8.861  .4303E+01
                            .270  .3176E+01   |   49.251  .6809E+01
                            .281  .3352E+01   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >06: (001000)      65.00     9.448    10.000    207.525
     OUTFLOW<07: (001111)      65.00     9.150    10.056    207.518
    OVERFLOW<05: (      )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   96.846
                   TIME SHIFT OF PEAK FLOW         (min)=     3.33
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4321E+01
```

Required Permanent Pool Volume Calculations
Halton Hills Power Station SWM Pond – Enhanced Wet Pond

Assumptions:

1. The total drainage area tributary to the SWMP was calculated to be 65.0 ha with an area-weighted TIMP of 71%.
2. The SWMP is a wet pond facility with an Enhanced level of protection for receiving waters.

Calculations:

- Using Table 3.2 from the SWM Planning & Design Manual (MOE, March 2003), the pro-rated volume requirement for the permanent pool and extended detention = [(71 - 70)/15] x (25) + 225 = 227 m^3/ha total storage.
- Per MOE guidelines, 40 m^3/ha of the total volume is for extended detention which leaves 227 – 40 = 187 m^3/ha required for the permanent pool.
- The min. required permanent pool volume, therefore, is 65.0 ha x 187 m^3/ha = 12,155 m^3.

Conclusion:

Based on the conceptual pond design, the permanent pool volume provided is 21,398 m^3, therefore, the SWM pond design meets the min. MOE requirements.

Required Extended Detention Volume Calculations
Halton Hills SWM Pond – Enhanced Wet Pond

Assumptions:

1. The total drainage area tributary to the SWMP was calculated to be 65.0 ha with an area-weighted TIMP of 71%.
2. The SWMP is a wet pond facility with an Enhanced level of protection for receiving waters.
3. Per the Dillon report, the erosion storage requirement is 52 mm per impervious ha with a release over 48 hrs.

Calculations:

- Using Table 3.2 from the SWM Planning & Design Manual (MOE, March 2003), the volume requirement for extended detention = 40 m^3/ha.
- The min. required extended detention volume, therefore, is 65.0 ha x 40 m^3/ha = 2,600 m^3.
- The required erosion control volume is 0.052 m x 46 ha x 10,000 m^2/ha = 23,920 m^3
- The average calculated drawdown time is 23,920/(48x3600) = 0.138 m^3/s

Conclusion:

Based on the conceptual design, the extended detention volume provided for both water quality and erosion control is 36,960 m^3 with a drawdown time of approximately 50 hours. Therefore, the SWM pond design meets the min. MOE requirements and other requirements per the Dillon report for extended detention.

CALCULATE STORMWATER MANAGEMENT FACILTY DRAWDOWN TIME

Equation 4.11 MOE SWMP Manual

$$t = [0.66C_2h^{1.5} + 2C_3h^{0.5}]/2.75A_o$$

t = drawdown time (sec)

C_2 = slope coeff. From the area-depth linear regression

C_3 = intercept from the area-depth linear regression

A_o= orifice area (m^2)

h = max head (m)

C_2 = 3312.7

C_3 = 21398

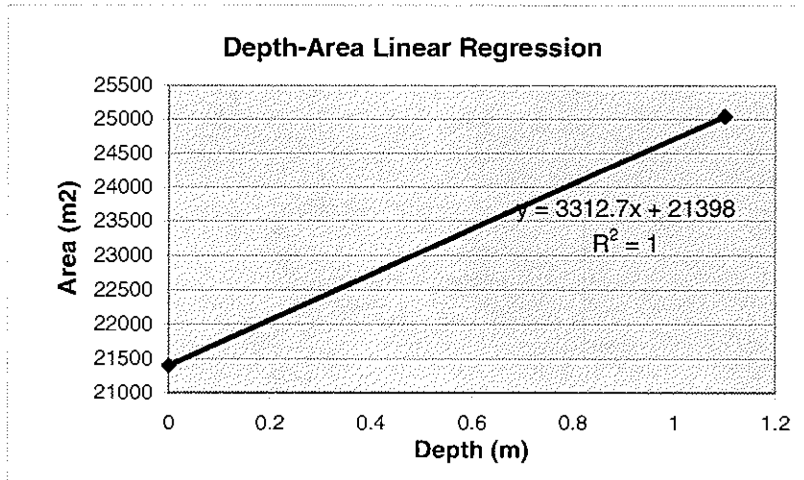
A_o= 0.0855 m^2 d = 330 mm

h = 1.1 m

t = 201555 seconds

t = 55.99 hours

	Facility Depth (m)	Surface Area (m^2)
Orifice (P.P.)	0	21398
E.D.	1.1	25042



APPENDIX F

CULVERT DESIGN

HEC-RAS Plan: 22m-2.4 x1.2 River: 1 Reach: 1

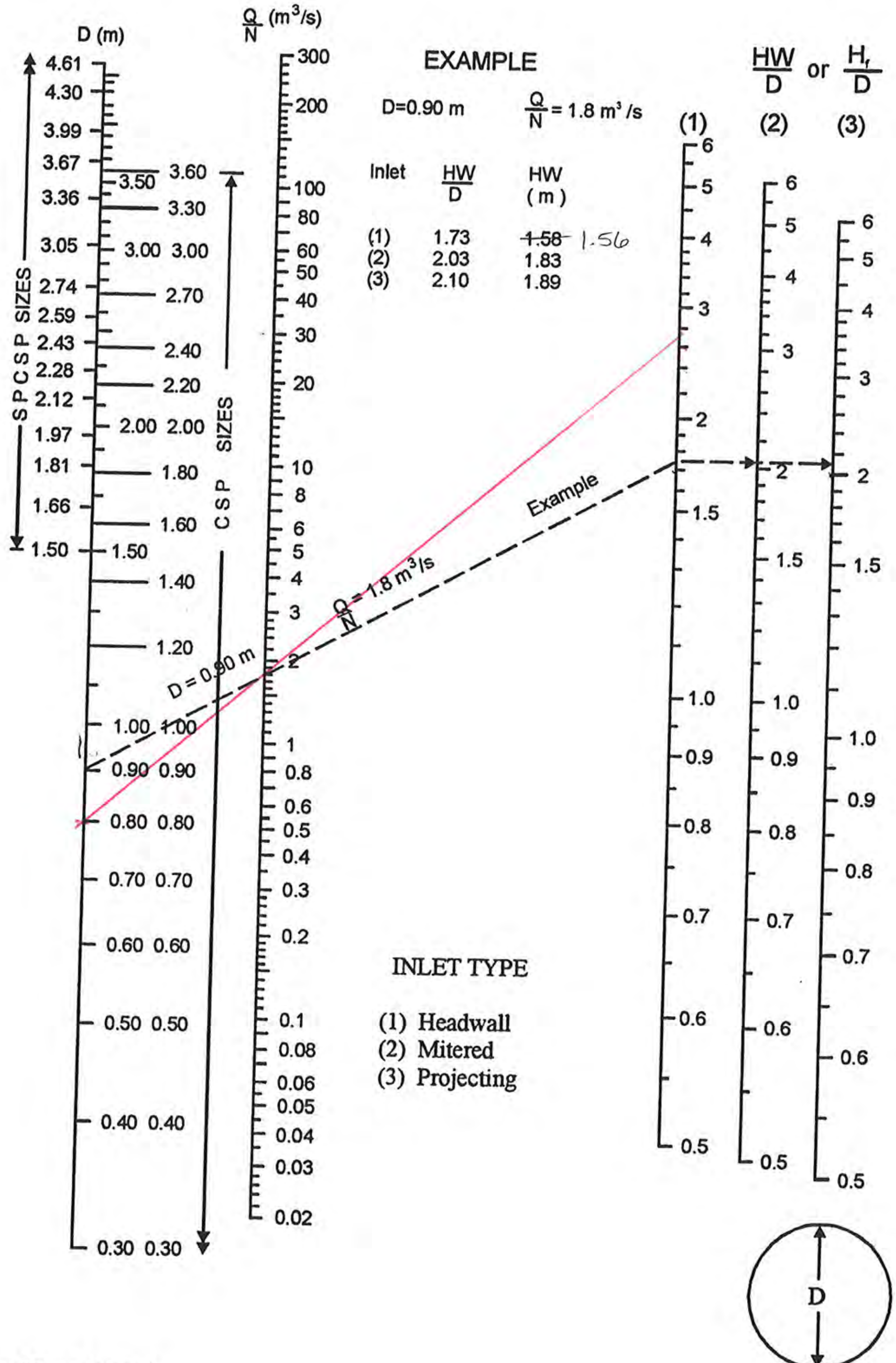
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	Regional	9.13	192.60	194.48		194.48	0.000026	0.24	45.22	75.64	0.06
1	10	100 Yr	5.59	192.60	193.05		193.08	0.001799	0.78	7.14	17.20	0.39
1	10	50 Yr	3.85	192.60	192.97		192.99	0.001636	0.66	5.81	16.73	0.36
1	10	25 Yr	2.24	192.60	192.88		192.90	0.001423	0.52	4.32	16.19	0.32
1	10	10 Yr	0.81	192.60	192.77		192.77	0.001109	0.33	2.48	15.49	0.26
1	10	5 Yr	0.40	192.60	192.71	192.64	192.72	0.000942	0.24	1.69	15.18	0.23
1	10	2 Yr	0.19	192.60	192.68		192.68	0.000798	0.17	1.13	14.96	0.20
1	9	Regional	9.13	192.52	194.48		194.48	0.000018	0.21	64.35	91.98	0.05
1	9	100 Yr	5.59	192.52	192.76	192.76	192.88	0.014680	1.51	3.71	16.21	1.01
1	9	50 Yr	3.85	192.52	192.71	192.71	192.80	0.015720	1.34	2.88	15.84	1.00
1	9	25 Yr	2.24	192.52	192.65	192.65	192.72	0.017470	1.12	1.99	15.44	1.00
1	9	10 Yr	0.81	192.52	192.59	192.59	192.62	0.021838	0.81	1.00	14.98	1.00
1	9	5 Yr	0.40	192.52	192.56	192.56	192.58	0.025213	0.64	0.62	14.80	1.00
1	9	2 Yr	0.19	192.52	192.55	192.55	192.56	0.032710	0.52	0.37	14.68	1.04
1	8	Regional	9.13	190.85	194.48		194.48	0.000002	0.09	134.22	160.36	0.02
1	8	100 Yr	5.59	190.85	191.59		191.64	0.003720	1.03	5.45	15.09	0.55
1	8	50 Yr	3.85	190.85	191.39	191.37	191.49	0.012213	1.42	2.71	11.26	0.92
1	8	25 Yr	2.24	190.85	191.28	191.28	191.37	0.016088	1.38	1.62	8.64	1.02
1	8	10 Yr	0.81	190.85	191.15	191.15	191.21	0.017907	1.13	0.72	5.59	1.01
1	8	5 Yr	0.40	190.85	191.08	191.08	191.13	0.019954	1.01	0.40	3.98	1.02
1	8	2 Yr	0.19	190.85	191.03	191.03	191.07	0.021090	0.90	0.21	2.64	1.01
1	7	Regional	9.13	190.40	194.48		194.48	0.000003	0.13	98.72	80.47	0.02
1	7	100 Yr	5.59	190.40	191.57		191.61	0.002202	0.89	6.30	14.44	0.43
1	7	50 Yr	3.85	190.40	191.29	191.22	191.38	0.007947	1.33	2.89	9.41	0.77
1	7	25 Yr	2.24	190.40	191.14	191.08	191.23	0.009143	1.30	1.73	6.45	0.80
1	7	10 Yr	0.81	190.40	190.92	190.85	190.98	0.007562	1.09	0.75	3.07	0.70
1	7	5 Yr	0.40	190.40	190.82	190.75	190.85	0.006495	0.86	0.46	2.42	0.63
1	7	2 Yr	0.19	190.40	190.73	190.67	190.75	0.005704	0.68	0.28	1.86	0.56
1	6	Regional	9.13	190.33	194.48		194.48	0.000003	0.12	111.13	82.83	0.02
1	6	100 Yr	5.59	190.33	191.56		191.59	0.001456	0.77	7.30	15.30	0.35
1	6	50 Yr	3.85	190.33	191.11	191.11	191.27	0.014016	1.76	2.19	7.15	1.01
1	6	25 Yr	2.24	190.33	190.96	190.96	191.11	0.014866	1.70	1.31	4.65	1.02
1	6	10 Yr	0.81	190.33	190.77	190.77	190.87	0.016691	1.39	0.58	3.05	1.01
1	6	5 Yr	0.40	190.33	190.67	190.67	190.75	0.018639	1.22	0.33	2.24	1.02
1	6	2 Yr	0.19	190.33	190.59	190.59	190.65	0.020612	1.07	0.18	1.58	1.02
1	5.7	Regional	9.13	190.04	194.44	191.18	194.48	0.000097	0.87	10.55	80.10	0.13
1	5.7	100 Yr	5.59	190.04	191.42	190.87	191.57	0.001756	1.70	3.29	13.12	0.46
1	5.7	50 Yr	3.85	190.04	191.00	190.68	191.14	0.002797	1.68	2.29	5.01	0.55
1	5.7	25 Yr	2.24	190.04	190.70	190.49	190.81	0.003280	1.42	1.58	4.10	0.56
1	5.7	10 Yr	0.81	190.04	190.41	190.27	190.46	0.002992	0.92	0.88	3.23	0.48
1	5.7	5 Yr	0.40	190.04	190.30	190.19	190.32	0.002538	0.66	0.61	2.88	0.42
1	5.7	2 Yr	0.19	190.04	190.29	190.13	190.30	0.000628	0.32	0.59	2.86	0.21
1	5.5		Culvert									
1	5	Regional	9.13	189.75	193.44	190.97	193.44	0.000003	0.10	142.62	75.40	0.02
1	5	100 Yr	5.59	189.75	191.18	190.65	191.33	0.003452	1.73	3.23	26.47	0.48
1	5	50 Yr	3.85	189.75	190.95	190.44	191.05	0.003054	1.44	2.68	14.96	0.43
1	5	25 Yr	2.24	189.75	190.61	190.23	190.68	0.003444	1.20	1.87	5.24	0.43
1	5	10 Yr	0.81	189.75	190.40	189.99	190.41	0.001024	0.58	1.39	2.15	0.23
1	5	5 Yr	0.40	189.75	190.30	189.90	190.30	0.000406	0.34	1.17	2.15	0.15
1	5	2 Yr	0.19	189.75	190.29	189.84	190.29	0.000094	0.16	1.16	2.15	0.07
1	4	Regional	9.13	189.55	193.44		193.44	0.000004	0.14	104.74	62.28	0.03
1	4	100 Yr	5.59	189.55	191.27		191.28	0.000349	0.50	11.40	17.49	0.19
1	4	50 Yr	3.85	189.55	191.00		191.01	0.000728	0.54	7.09	14.57	0.25
1	4	25 Yr	2.24	189.55	190.61		190.65	0.002192	0.79	2.85	7.51	0.41
1	4	10 Yr	0.81	189.55	190.39		190.40	0.001130	0.52	1.56	4.57	0.28
1	4	5 Yr	0.40	189.55	190.29		190.30	0.000613	0.35	1.15	3.81	0.20
1	4	2 Yr	0.19	189.55	190.29		190.29	0.000139	0.17	1.14	3.81	0.10
1	3	Regional	9.13	189.50	193.44		193.44	0.000003	0.12	127.56	70.22	0.02
1	3	100 Yr	5.59	189.50	191.27		191.28	0.000089	0.33	19.58	24.20	0.10
1	3	50 Yr	3.85	189.50	191.00		191.01	0.000115	0.31	13.53	20.93	0.11
1	3	25 Yr	2.24	189.50	190.62		190.63	0.000304	0.34	6.60	15.72	0.16
1	3	10 Yr	0.81	189.50	190.39		190.39	0.000275	0.24	3.37	11.49	0.14
1	3	5 Yr	0.40	189.50	190.29		190.29	0.000171	0.17	2.33	9.14	0.11
1	3	2 Yr	0.19	189.50	190.29		190.29	0.000039	0.08	2.32	9.13	0.05

HEC-RAS Plan: 22m-2.4 x1.2 River: 1 Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	2	Regional	9.13	189.17	193.44		193.44	0.000002	0.10	163.54	75.22	0.02
1	2	100 Yr	5.59	189.17	191.27		191.27	0.000047	0.26	33.06	47.64	0.07
1	2	50 Yr	3.85	189.17	191.00		191.01	0.000068	0.27	20.56	45.22	0.09
1	2	25 Yr	2.24	189.17	190.62		190.63	0.000146	0.29	8.13	20.09	0.12
1	2	10 Yr	0.81	189.17	190.39		190.39	0.000071	0.16	4.94	10.60	0.08
1	2	5 Yr	0.40	189.17	190.29		190.29	0.000031	0.10	3.94	9.31	0.05
1	2	2 Yr	0.19	189.17	190.29		190.29	0.000007	0.05	3.94	9.31	0.02
1	1	Regional	9.13	188.84	193.44	190.15	193.44	0.000001	0.07	216.59	93.59	0.01
1	1	100 Yr	5.59	188.84	191.27	190.00	191.27	0.000051	0.26	35.30	72.11	0.07
1	1	50 Yr	3.85	188.84	191.00	189.89	191.00	0.000075	0.28	16.20	24.50	0.09
1	1	25 Yr	2.24	188.84	190.62	189.75	190.62	0.000090	0.25	8.96	13.64	0.09
1	1	10 Yr	0.81	188.84	190.39	189.39	190.39	0.000029	0.13	6.43	9.74	0.05
1	1	5 Yr	0.40	188.84	190.29	189.23	190.29	0.000011	0.07	5.48	9.32	0.03
1	1	2 Yr	0.19	188.84	190.29	189.12	190.29	0.000003	0.03	5.48	9.32	0.01

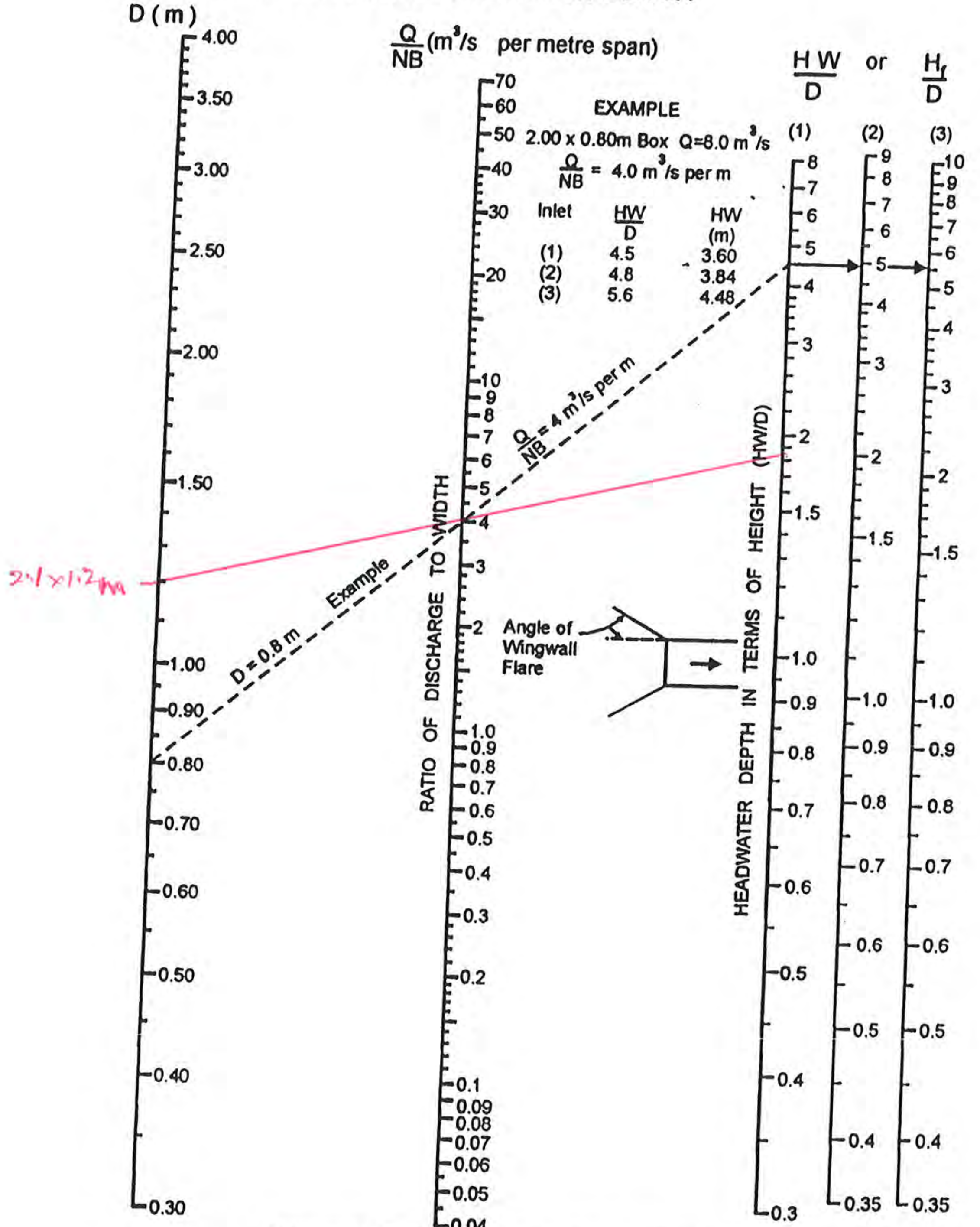
Existing 800mm CSP.
Flow Capacity

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



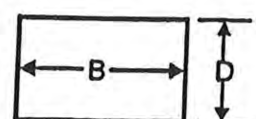
Source: Herr (1977)

Design Chart 5.39: Inlet Control: Box Culvert



Wingwall Flare	Bevels	HW/D Scale
30° - 75°	None	1
30° - 75°	Top Bevel	1*
90° (headwall)	None	2
90° (headwall)	Top & sides	Use chart 5.40
0° (parallel)	Top Bevel	2
0° (parallel)	None	3

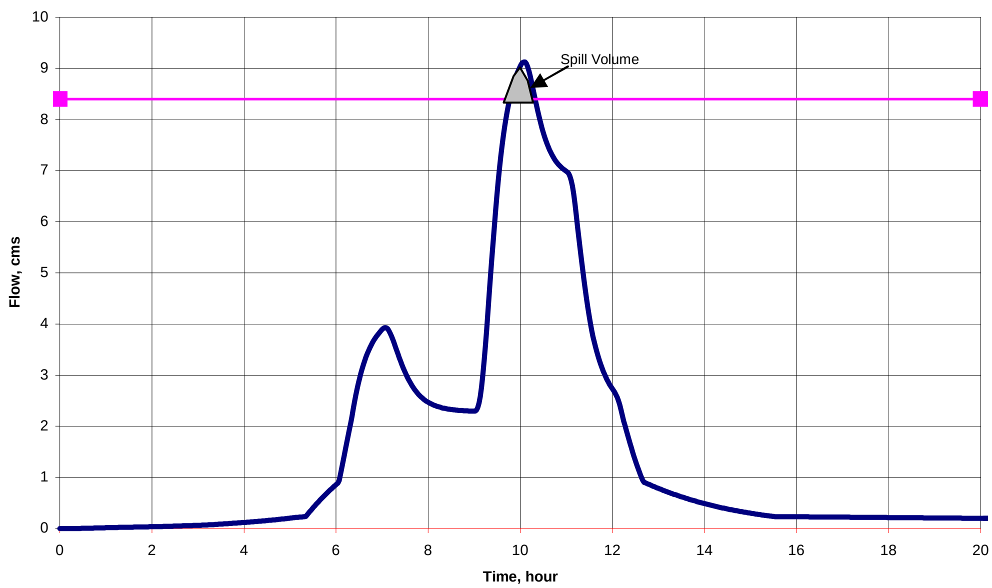
See Design Chart 5.42 also for flares 18° - 45°



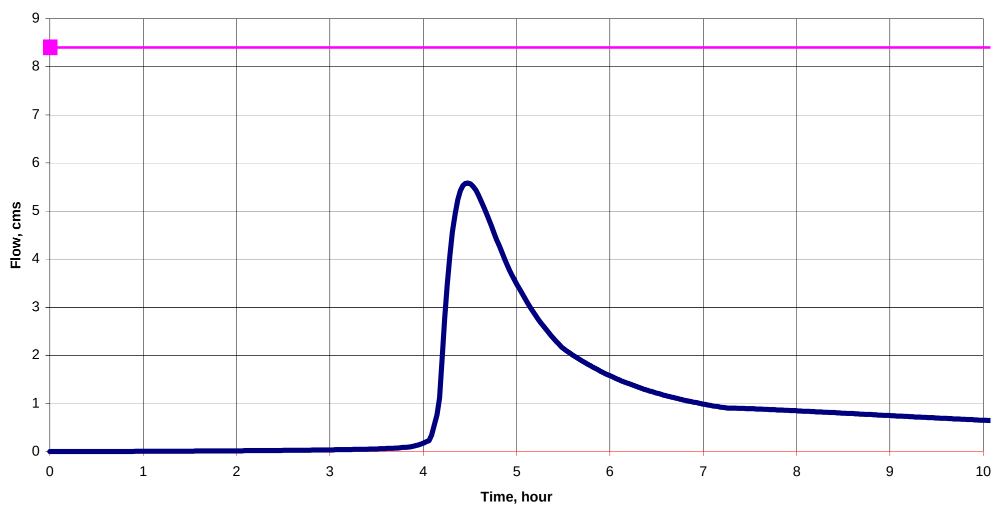
Inlet Control
Box Culvert

Source: Herr (1977)

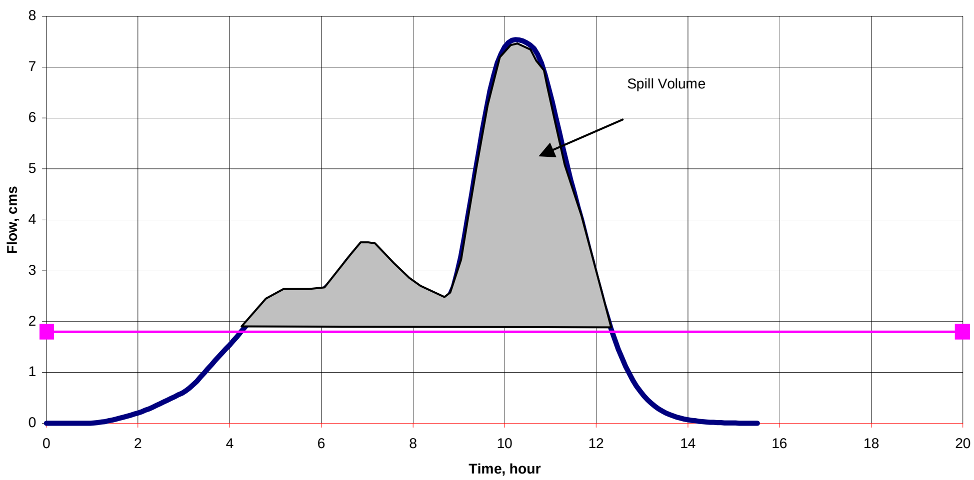
Halton Hill Power Generation
Regional Hydrograph at 6th Line
Future Conidtions



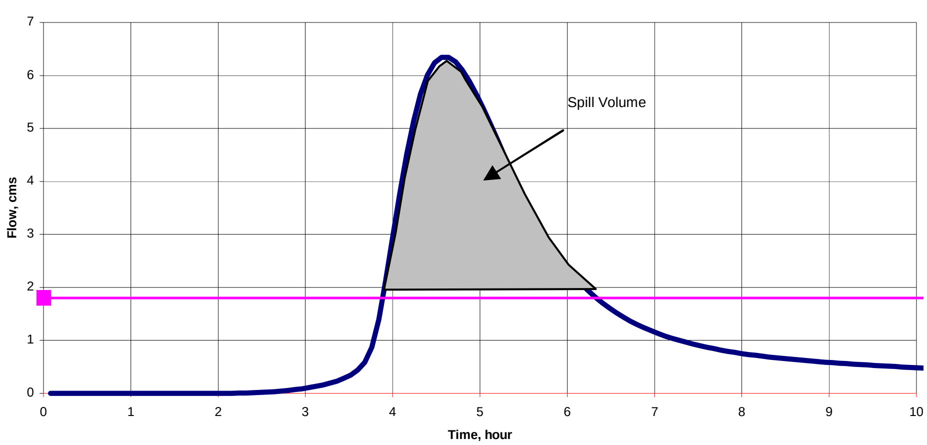
Halton Hill Power Generation
100 Year Hydrograph at 6th Line



Halton Hill Power Generation
Regional Hydrograph at 6th Line
Existing Conditions



Halton Hill Power Generation
100 Year Hydrograph at 6th Line
Existing Conditions

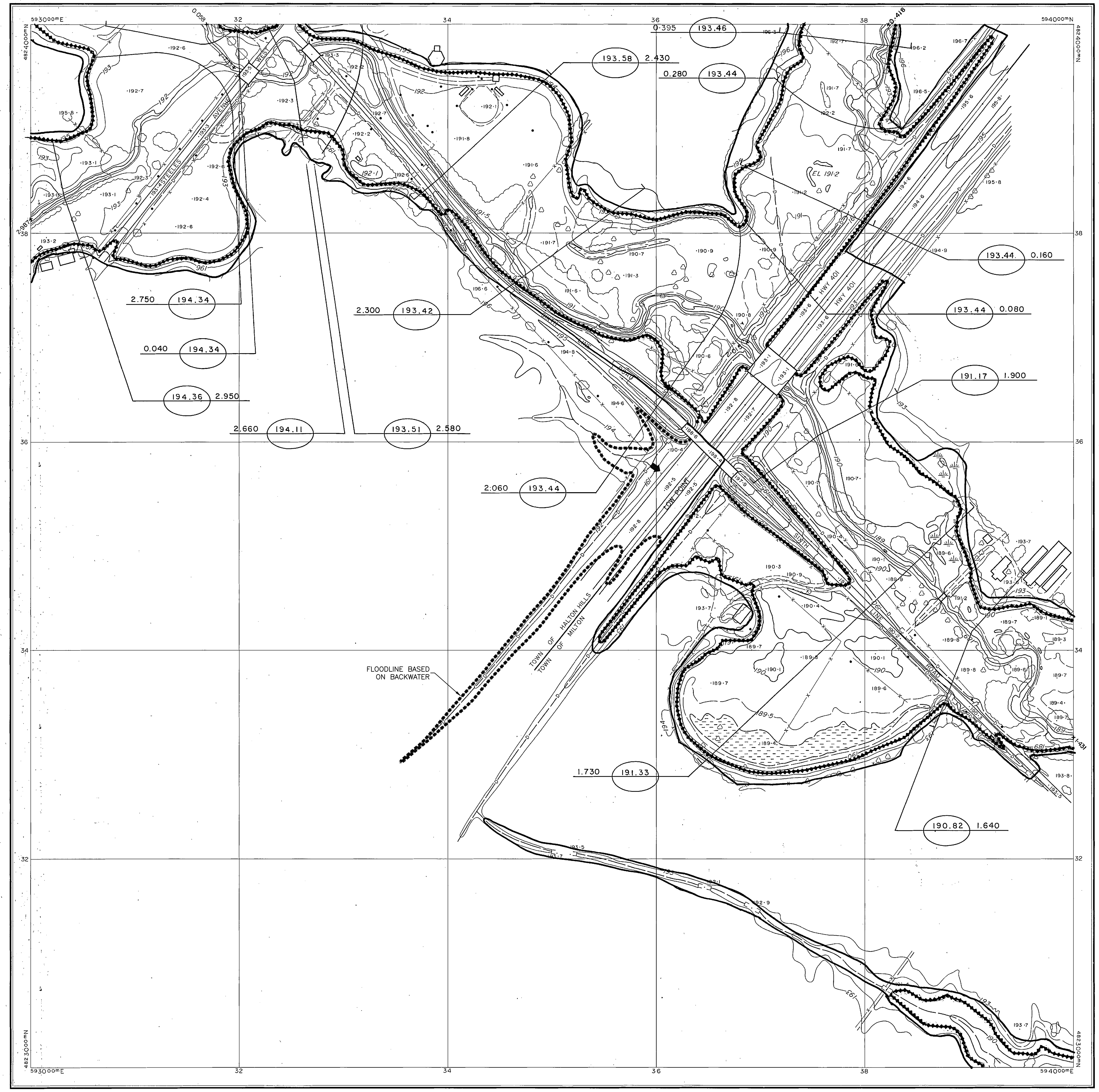


APPENDIX G

FLOODLINE MAPPING & HEC-RAS MODELLING

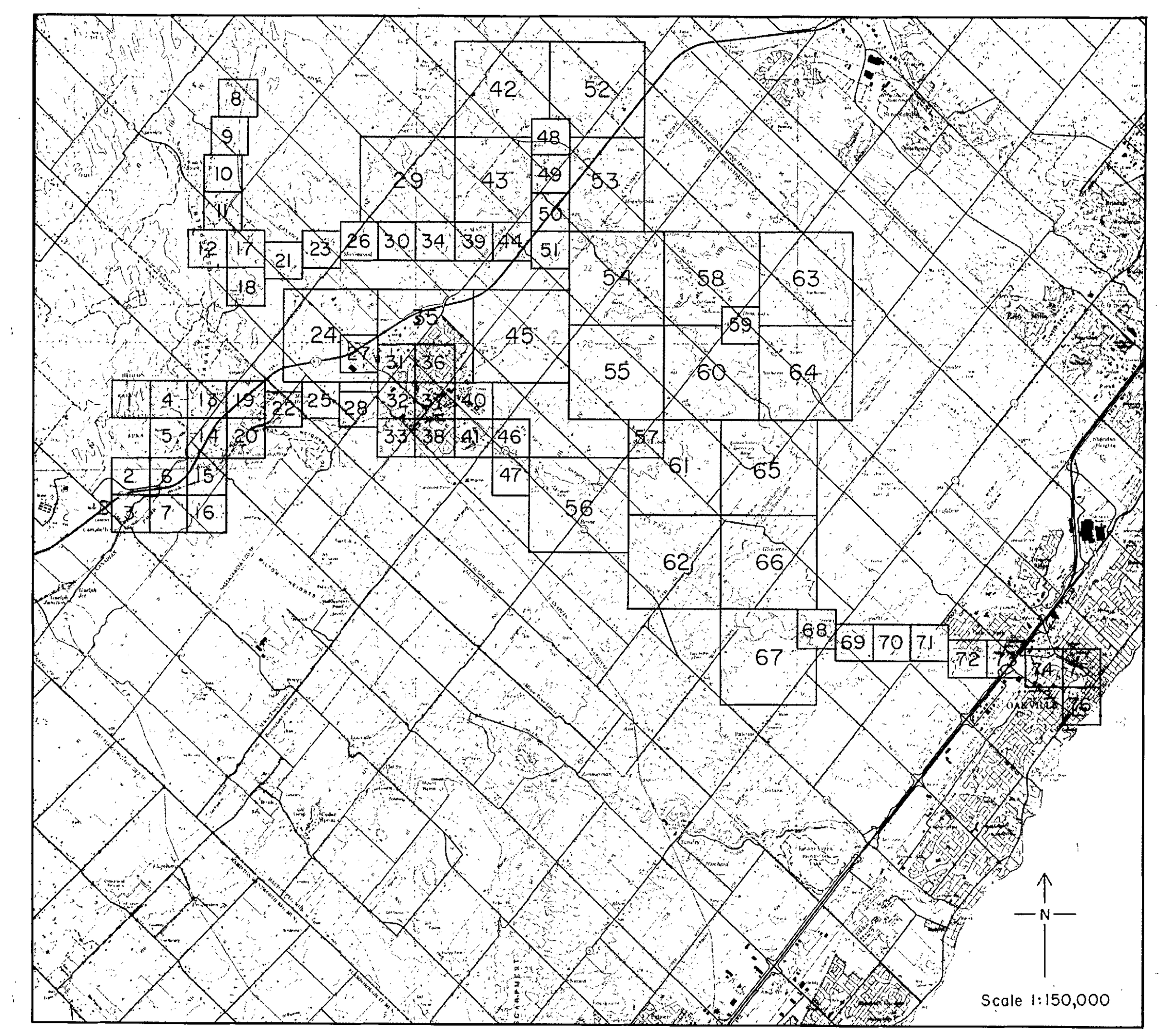
THE HALTON REGION CONSERVATION AUTHORITY

FLOOD RISK MAP
SIXTEEN MILE CREEK
CARTE DU RISQUE D'INONDATION
SIXTEEN MILE CREEK



LEGEND		LÉGENDE
Regional storm floodline		Tempête et crue des eaux régionale
Regional flood elevation	255.51	Niveau régional des crues
Fill line		Limite de remplissage
Cross-section number	1.060	Numéro de coupe transversale

SHEET INDEX — TABLEAU D'ASSEMBLAGE



No.	REVISIONS Amendment/Revision REVISIONS

GENERAL INFORMATION		RENSEIGNEMENTS GENERAUX	
Vertical datum	mean sea level	Niveau de référence vertical:	niveau moyen de la mer
Horizontal datum	North American 1927	Niveau de référence horizontal	Nord-americain 1927
Map projection	Transverse Mercator	Projection cartographique	Transverse de Mercator
Central Meridian	81°	Méridien central	81°
Grid Spacing	200 metres	Espacement—du quadrillage	200 mètres
Aerial Photography:	April 1983	Photographies aériennes prises le	Avril 1983

COMPILATION NOTE

Production techniques used in the preparation of this map are designed for Class "A" standards.

This map was prepared under the auspices of the Canada-Ontario Flood Damage Reduction Agreement signed MARCH 31, 1978.

PHOTOGRAMMETRIE

Les normes de production de cette carte se conforment aux standards de premiere classe.

Cette carte a ete preparee dans le cadre de l'accord Canada-Ontario de la reduction des dommages dus inondations conclu le 31 MARS, 1978

Environment Canada — Inland Waters Directorate
Environnement Canada — Direction Générales des Eaux Intérieures

Ministry of Natural Resources
Ministère des richesses naturelles
Ontario

SCALE 1:2000 ECHELLE

METRES 40 0 100 200 METRES
FEET 100 0 100 200 300 400 500 600 700 800 PIEDS

CONTOUR INTERVAL 1.0 METRE — EQUIDISTANCE DES COURBES DE NIVEAU 1.0 METRE
NORTH AMERICAN DATUM 1927 — SYSTEME DE REFERENCE GEODESIQUE NORD-AMERICAIN 1927

Proctor & Redfern Limited
Consulting Engineers and Planners
Toronto

REGISTERED PROFESSIONAL ENGINEER A. R. PERKS PROVINCE OF ONTARIO

Kenting Earth Sciences Limited
TORONTO

REGISTERED PROFESSIONAL ENGINEER R. W. STEMP PROVINCE OF ONTARIO

REGULATION No ______ N° DU RÉGLEMENT
SCHEDULE No 1 CÉDULE No
MAP No HAL-I-T50 CARTE No

SHEET No. 50 of 76

Geometric File:
Halton Hill Power Generation
Project No. 107012
Philips Engineering Ltd
April 5, 2007
****
Geom Title=Large 3 m x 2.4 m box culvert
Program Version=3.12
Viewing Rectangle=-0.0642 , 0.9612 , 0.7417 , 0.4918
River Reach=1 ,1
Reach XY= 2
-.0528571 .66 .9485714 .6342857
Rch Text X Y=0.1975,0.6535714
Reverse River Text= 0
Type RM Length L Ch R = 1 ,9 ,22,28,25
Node Last Edited Time=Mar/29/2007 11:48:41
#Sta/Elev= 4
0 192.5 2 192 15 192 17 192.5
#Mann= 3 , 0 , 0
0 .07 0 0 .05 0 17 .07 0
Bank Sta=0,17
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,8 ,17,11,8
Node Last Edited Time=Mar/29/2007 13:38:07
#Sta/Elev= 12
-22 194 -10 193.5 -3 192.5 0 192 3.2 191.5
11 191 12 190.85 13 191 17.2 191.5 20 192
26 193 30 193.5
#Mann= 3 , 0 , 0
-22 .07 0 3.2 .05 0 17.2 .07 0
Bank Sta=3.2,17.2
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,7 ,10,10,10
Node Last Edited Time=Mar/29/2007 13:39:47
#Sta/Elev= 13
-3 192.5 0 192 3.5 191.5 11 191 12.6 190.5
12.8 190.33 13 190.5 14.6 191 17.2 191.5 19.2 192
24 193 27.5 193.5 35.5 194
#Mann= 3 , 0 , 0
-3 .07 0 11 .05 0 14.6 .07 0
Bank Sta=11,14.6
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,6 ,6,6,6
Node Last Edited Time=Mar/29/2007 13:41:06
#Sta/Elev= 13
-3 192.5 0 192 3.8 191.5 12 191 14 190.5
14.6 190.33 14.8 190.5 17 191 20 192 22 192.5
26 193 31 193.5 38 194
#Mann= 3 , 0 , 0
-3 .07 0 12 .05 0 17 .07 0
Bank Sta=12,17
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,5.7 ,49,49,49
Node Last Edited Time=Mar/29/2007 14:13:37

```
#Sta/Elev= 12
-3 192.5 0 192 3.8 191.5 13.4 190.04 14.5 190.04
15.55 190.04 17 191 20 192 22 192.5 26 193
31 193.5 38 194
#Mann= 3 , 0 , 0
-3 .07 0 13.4 .05 0 17 .07 0
#XS Ineff= 2 , 0
0 13 197 16 0 197
Permanent Ineff=
F F
Bank Sta=13.4,17
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 2 ,5.5 ,,,
BEGIN DESCRIPTION:
3 m x 2.4 m box
END DESCRIPTION:
Node Last Edited Time=Mar/29/2007 14:34:26
Bridge Culvert--1,0,-1,-1, 0
Deck Dist Width WeirC Skew NumUp NumDn MinLoCord MaxHiCord MaxSubmerge Is_Ogee
1,47,1.44,0, 2, 2, , , 0.95, 0, 0,0,,
-10 50
197.5 197.5
-10 50
197.5 197.5
BR Coef=-1 , 0 , 0 ,, 0 ,,,0.8,0,,0,
WSPro=,,,, 1 ,,,, 0 ,,,, 0 ,,,,-1 ,-1 ,-1 , 0 , 0 , 0 , 0 , 0
Culvert=2,2.4,3,47,0.03,0.5,1,10,1,190.04,14.5,189.75,13,Culvert #1 , 0 ,1
Culvert Bottom n=0.03
BC Design=,, 0 ,, 0 ,,,,,,
Type RM Length L Ch R = 1 ,5 ,8,8,8
Node Last Edited Time=Mar/29/2007 14:14:10
#Sta/Elev= 11
-2 192.66 0 192.5 2 192 4.2 191.5 6.6 191
11.9 189.75 14.5 189.75 18.2 191 23 192 25 192.5
29 194
#Mann= 3 , 0 , 0
-2 .07 0 11.9 .05 0 14.5 .07 0
#XS Ineff= 2 , 0
0 11.5 192.3 14.5 0 192.3
Permanent Ineff=
F F
Bank Sta=11.9,14.5
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,4 ,12,12,11
Node Last Edited Time=Mar/29/2007 13:48:27
#Sta/Elev= 16
0 192.5 2 192 4.2 191.5 6.4 191 11.6 190.5
12.2 190 13 189.55 13.8 190 17 190.5 21 191
24.2 191.5 39 192 50 192.5 57 193 63 193.5
70 194
#Mann= 3 , 0 , 0
0 .07 0 11.6 .05 0 17 .07 0
Bank Sta=11.6,17
Exp/Cntr=0.3,0.1
```

Type RM Length L Ch R = 1 ,3 ,21,21,21
Node Last Edited Time=Mar/29/2007 13:50:14
#Sta/Elev= 14
-2 192.9 0 192.5 4 191.5 8 190.5 11.2 190
12.6 189.5 12.8 189.5 13.6 190 22 190.5 26.9 191
31 191.5 45 192 56 192.5 69 193.5
#Mann= 3 , 0 , 0
-2 .07 0 11.2 .05 0 13.6 .07 0
Bank Sta=11.2,13.6
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,2 ,21,21,21
Node Last Edited Time=Mar/29/2007 13:51:09
#Sta/Elev= 15
-2 192.9 0 192.5 1.8 192 5.8 191 7.6 190.5
11.6 190 12.8 189.5 13.2 189.17 13.7 189.5 17.2 190
19.6 190.5 51 191 56 192 61 192.5 74 193.5
#Mann= 3 , 0 , 0
-2 .07 0 11.6 .05 0 17.2 .07 0
Bank Sta=11.6,17.2
Exp/Cntr=0.3,0.1
Type RM Length L Ch R = 1 ,1 ,,,
Node Last Edited Time=Mar/29/2007 13:51:40
#Sta/Elev= 14
-2 192.9 0 192.5 3.9 191.5 5.7 191 9.5 190
16 189.5 16.5 189 16.85 188.84 17.2 189 18 191
20.6 190.5 30.2 191 75 191 92 193.5
#Mann= 3 , 0 , 0
-2 .07 0 16 .05 0 18 .07 0
Bank Sta=16,18
Exp/Cntr=0.3,0.1
Chan Stop Cuts=-1
Use User Specified Reach Order=0
User Specified Reach Order=1 ,1

Flow Data File:
****

ROJECT DATA
Project Title: Halton Hill Power Generation
Project File : HHPower.prj
Run Date and Time: 3/29/2007 2:27:39 PM

Project in SI units

FLOW DATA

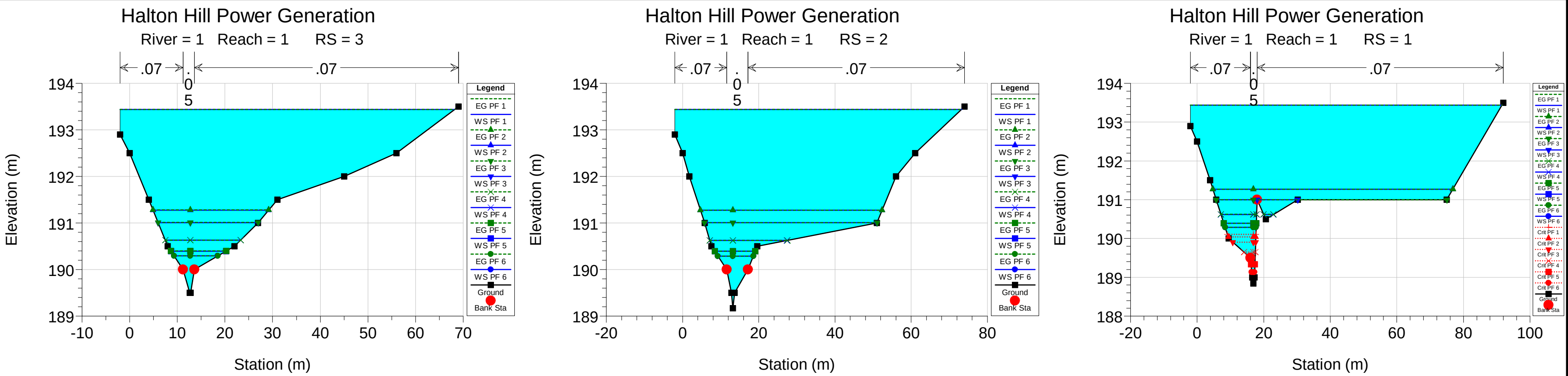
Flow Title: Flow 01
Flow File : g:\Work\107012\WATER\HEC-RAS\HHPower.f01

Flow Data (m3/s)

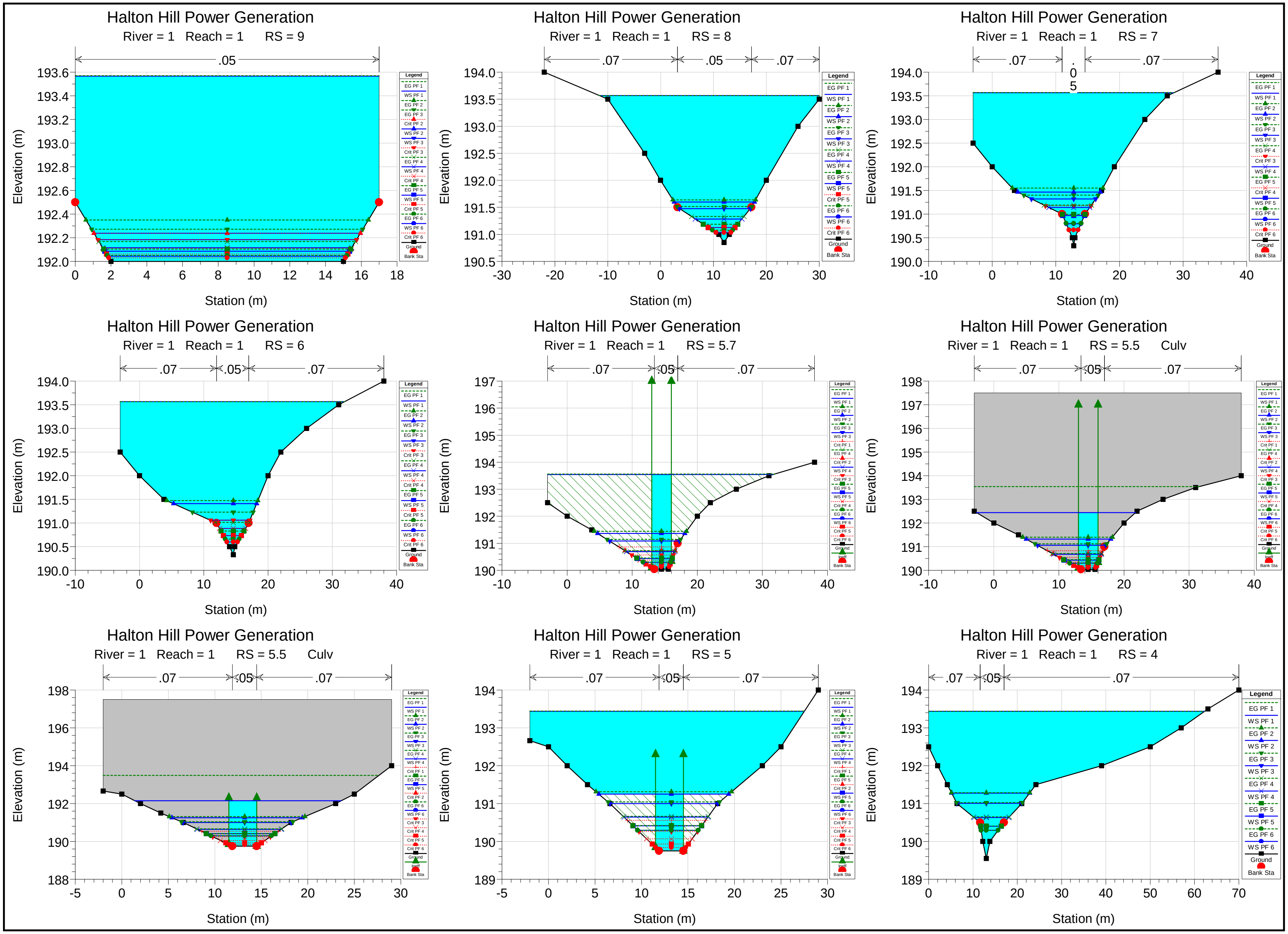
River	Reach	RS	PF 1	PF 2	PF 3	PF 4	PF 5	PF 6
1	1	9	6.6	4.93	3.33	1.59	.66	.21

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
1	1	PF 1		Known WS = 193.44
1	1	PF 2		Known WS = 191.27
1	1	PF 3		Known WS = 191
1	1	PF 4		Known WS = 190.62
1	1	PF 5		Known WS = 190.39
1	1	PF 6		Known WS = 190.29



Halton Hill Power Generation
River = 1 Reach = 1 RS = 3
.07
.07
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
EG PF 2
WS PF 2
EG PF 3
WS PF 3
EG PF 4
WS PF 4
EG PF 5
WS PF 5
EG PF 6
WS PF 6
Ground
Bank Sta
Halton Hill Power Generation
River = 1 Reach = 1 RS = 2
.07
.07
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
EG PF 2
WS PF 2
EG PF 3
WS PF 3
EG PF 4
WS PF 4
EG PF 5
WS PF 5
EG PF 6
WS PF 6
Ground
Bank Sta
Halton Hill Power Generation
River = 1 Reach = 1 RS = 1
.07
.07
Elevation (m)
Station (m)


Halton Hill Power Generation
River = 1 Reach = 1 RS = 9
.05
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 8
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 7
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 6
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 5.7
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 5.5 Culv
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 5.5 Culv
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 5
.07 .05 .07
Elevation (m)
Station (m)
Halton Hill Power Generation
River = 1 Reach = 1 RS = 4
.07 .05 .07
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
EG PF 2
WS PF 2
EG PF 3
WS PF 3
EG PF 4
WS PF 4
EG PF 5
WS PF 5
EG PF 6
WS PF 6
Ground
Bank Sta

APPENDIX H

OFF-SITE EROSION ASSESSMENT (QUALHYMO)

```
1234567890 *./-
21
START                 1 37
STORE                 2  4
GENERATE              3 74
PRINT SPAN            4 10
PLOT SPAN             5 10
ADD SERIES            6  4
POND                  7310
REACH                 8310
CALIBRATE             9310
POLLUTANT SERIES     10  9
SPLIT SERIES         11310
DUMP PRINT           12  1
EXCEEDANCE CURVES    13310
DUMP PLOT            14  9
SHEAR1               15310
MAXFLW               16  8
SERIES STATS         17  7
PRINT FLOWS          18  8
ROUTE RESERVOIR      19 64
SCAN SERIES          20 16
FINISH               21  0
*
*  *****************    Q  U  A  L  H  Y  M  O    *********************
*                            VERSION 2.1
*
*          ====       HALTON HILLS 401 CORRIDOR      ====
*          ====       INTEGRATED PLANNING STUDY      ====
*          ====                                      ====
*          ====       EXISTING CONDITIONS MODEL      ====
*          ====       SUBWATERSHEDS 4, 5, 6 & 7      ====
*          ====     6 YEAR SIMULATION - DT=15min     ====
*
*******    UPDATED - APRIL 20, 2007, Philips Engineering Ltd
**** REVISED RATING CURVE FOR ‘HALTON HILL POND - AREA D’
***  BASED ON SERNES POND DESIGN
*******
*
START               START DATE OF SIMULATION         69 11 01
                    END DATE OF SIMULATION           75 10 31
                    RAINFALL WILL BE READ ON DEVICE IRAIN   9
                    PRECIP IS IN AES HOURLY FORMAT  IPFORM  1
                    FLOW FILE WILL BE READ ON DEVICE       99
                    TEMPERATURE DATA IN AES FORM     ITFORM 1
                    EVAPORATION FLAG ON              ICASE  1
                    EVAPORATION PAN CORRECTION COEF  CPAN 1.0
                        POTENTIAL EVAPOTRANSPIRATION (MM)
                        JAN  6.26  FEB  12.6  MAR  20.7
                        APR  41.4  MAY 169.0  JUN 174.6
                        JUL 204.6  AUG 184.1  SEP 121.5
                        OCT  72.5  NOV  31.5  DEC  15.5
                    SET POLLUTANT FLAG ON            IFDECA=0
                    SET SEDIMENTATION FLAG ON        IFSEDT=0
**************************************************************
*    Subwatershed 6                                          *
**************************************************************
*        hydrograph for area 303A - u/s of future development area
*
GENERATE            ID=1 ISER=661 DT=0.25  DA=22.91  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=0.37
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.56 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
```

```
                        CET=1.0
                ===== REDUCED HEAT BUDGET SNOWMELT ANALYSIS =====
                ISNOW=2      BASET=1.5   SNOFAC=1.0    PACDEP=0.0
                ALPHAA=2.5   XKL=15      BCOEF=1.05    XNCOEF=150
                KFLAG=0      PSTATE=1.0  COEFD=0.012   COEFE=1.2
                CFACTR=1.0   CFACTS=1.7  IZFLAG=3
*
*         Development area  I
*
GENERATE        ID=2 ISER=850 DT=0.25  DA=22.33  AB=0 FRIMP=0.67
                IMPERVIOUS AREA AA=1    N=4    TP=0.25
                                IA=2.5  RC=0.90  CETIMP = 1.0
                PERVIOUS AREA   AA=1 N=2 TP=0.25  Smin=28.3 So=389.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                ===== REDUCED HEAT BUDGET SNOWMELT ANALYSIS =====
                ISNOW=2      BASET=1.5   SNOFAC=1.0    PACDEP=0.0
                ALPHAA=2.5   XKL=15      BCOEF=1.05    XNCOEF=150
                KFLAG=0      PSTATE=1.0  COEFD=0.012   COEFE=1.2
                CFACTR=1.0   CFACTS=1.7  IZFLAG=3
*
ADD SERIES      IDOUT=3  ISER=851  IDI=1  IDII=2
*
ROUTE RESERVOIR IDIN=3  IDOUT=1  ISER=851  OUTFLAG=0 NINTER=4
                SSTOR=0.0  NPAIRS=12
                STORAGE (CU.M.) OUTFLOW (CMS)
                   0.0          0.0
                  1460.        0.027
                  2970.        0.039
                  4540.        0.047
                  6170.        0.055
                  7850.        0.061  Quality Level
                  7860.        0.062  Weir Crest
                  8850.        0.487
                  9860.        1.263
                 10890.        2.266
                 11940.        3.454
                 13000.        4.800  Max. Weir Depth
*
*     407 interchange (303C)
*
GENERATE        ID=2 ISER=860  DT=0.25  DA=9.99  AB=0 FRIMP=0.37
                IMPERVIOUS AREA AA=1    N=4    TP=0.25
                                IA=2.5  RC=0.90  CETIMP = 1.0
                PERVIOUS AREA   AA=1 N=2 TP=0.25  Smin=28.3 So=389.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                ===== REDUCED HEAT BUDGET SNOWMELT ANALYSIS =====
                ISNOW=2      BASET=1.5   SNOFAC=1.0    PACDEP=0.0
                ALPHAA=2.5   XKL=15      BCOEF=1.05    XNCOEF=150
                KFLAG=0      PSTATE=1.0  COEFD=0.012   COEFE=1.2
                CFACTR=1.0   CFACTS=1.7  IZFLAG=3
*
ADD SERIES      IDOUT=4   ISER=861   IDI=1  IDII=2
*
ROUTE RESERVOIR IDIN=4  IDOUT=3  ISER=865  OUTFLAG=0 NINTER=4
                SSTOR=0.0  NPAIRS=12
```

```
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      770.        0.022
                     1530.        0.031
                     2300.        0.038
                     3070.        0.044
                     3830.        0.049
                     4600.        0.053
                     5900.        0.059
                     7830.        1.170
                    10330.        3.000
                    12830.        5.100
                    15310.        8.670
*
*/////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => I
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.001  0.002  0.003  0.005  0.010
                    EXES=  0.05   0.15   0.50   1.00   2.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=3
                    START=  69 11 02
                    FINISH= 75 10 30
*
*     d/s of development area  303C
*
GENERATE            ID=1 ISER=303 DT=0.25  DA=579.83  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=1.93
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=2.88 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5   SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15      BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0  COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7  IZFLAG=3
*
*        route through 303 and add 303 laterally
*
REACH               IDOUT=4  ISER=304  NIDH=1 IDH=3  NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=1 XLEN=6500 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
******************************************************
*  Development areas J, K, L, M and 407 Interchange  *
******************************************************
*      u/s of development area  J
*
GENERATE            ID=1 ISER=870  DT=0.25  DA=47.88 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=0.55 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.84 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
```

```
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*         - development area  J
*
GENERATE            ID=2  ISER=871 DT=0.25  DA=13.00 AB=0 FRIMP=0.67
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=872   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=873  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      830.        0.016
                     1700.        0.022
                     2620.        0.027
                     3580.        0.032
                     4590.        0.035  Quality Level
                     4600.        0.036  Weir Crest
                     5150.        0.480
                     5720.        1.290
                     6300.        2.339
                     6900.        3.581
                     7500.        4.990  Max. Weir Depth
*
*         - Hwy 407 interchange  304C
*
GENERATE            ID=2 ISER=874  DT=0.25  DA=12.72 AB=0 FRIMP=0.253
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=875   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=2  ISER=876  OUTFLAG=0 NINTER=4
```

```
                    SSTOR=0.0  NPAIRS=9
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     1125.        0.037
                     2275.        0.053
                     3450.        0.065
                     4630.        0.075
                     5800.        0.083
                     7700.        1.900
                    11000.        6.400
                    12500.        9.200
*
*         - u/s of development area  K
*
GENERATE            ID=1 ISER=880 DT=0.25  DA=52.69 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=0.87 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=1.32 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*         - development area  K
*
GENERATE            ID=2  ISER=881 DT=0.25  DA=14.71 AB=0 FRIMP=0.65
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=882   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=883  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      930.        0.018
                     1900.        0.025
                     2920.        0.031
                     3980.        0.035
                     5100.        0.039
                     5110.        0.040
                     5740.        0.573
                     6380.        1.547
                     7040.        2.807
                     7710.        4.298
                     8400.        5.990
```

```
*
*         - Hwy 407 interchange  304C
*
GENERATE            ID=2 ISER=884  DT=0.25  DA=15.41 AB=0 FRIMP=0.442
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=885   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=886  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      750.        0.045
                     1620.        0.063
                     2460.        0.089
                     3930.        0.100
                     5600.        0.118
                     7200.        0.133
                     8830.        1.680
                    10800.        3.871
                    12000.        7.383
                    13600.        9.610
                    18800.       14.250
*
ADD SERIES          IDOUT=5   ISER=890   IDI=2  IDII=1
*
*         - u/s of development area  L
*
GENERATE            ID=1 ISER=900  DT=0.25  DA=32.76 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=0.67 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.94 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*         - development area  L
*
GENERATE            ID=2  ISER=901 DT=0.25  DA=18.11 AB=0 FRIMP=0.67
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
```

```
                            APIK=0.90 0.80 0.40 0.40
                            APIK=0.50 0.50 0.95 0.99
                            APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                            SVOL=15.0 SWILT=0.001 SFIELD=2.0
                            SLOSKA=0.000001  SLOSKB=0.25
                            CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=902   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=903  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     1180.        0.022
                     2400.        0.031
                     3680.        0.038
                     5010.        0.044
                     6400.        0.050  Quality Level
                     6410.        0.051  Weir Crest
                     7190.        0.411
                     8000.        1.069
                     8820.        1.920
                     9650.        2.928
                    10500.        4.070  Max. Weir Depth
*
*         - Hwy 407 interchange  304C
*
GENERATE            ID=2 ISER=904  DT=0.25  DA=5.88 AB=0 FRIMP=0.461
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                            RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                            SK=0.089
                            APIK=0.99 0.99 0.99 0.99
                            APIK=0.90 0.80 0.40 0.40
                            APIK=0.50 0.50 0.95 0.99
                            APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                            SVOL=15.0 SWILT=0.001 SFIELD=2.0
                            SLOSKA=0.000001  SLOSKB=0.25
                            CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=905   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=906  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=13
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      400.        0.020
                     1540.        0.035
                     2340.        0.045
                     3160.        0.054
                     4000.        0.061
                     5000.        0.068
                     5700.        0.450
                     5750.        0.930
                     6500.        1.500
                     7300.        2.600
                    10200.        5.200
                    12000.        7.700
*
```

```
ADD SERIES          IDOUT=6   ISER=908   IDI=5  IDII=1
*
*   Ddevelopment area  M
*
GENERATE            ID=1  ISER=910 DT=0.25  DA=45.47 AB=0 FRIMP=0.67
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=1  IDOUT=2  ISER=911  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     3010.        0.055
                     6110.        0.078
                     9280.        0.096
                    12540.        0.111
                    15880.        0.124  Quality Level
                    15890.        0.125  Weir Crest
                    17920.        0.342
                    19980.        0.733
                    22060.        1.238
                    24170.        1.835
                    26300.        2.510  Max. Weir Depth
*
*         - Hwy 407 interchange  304C
*
GENERATE            ID=1 ISER=912  DT=0.25  DA=9.99 AB=0 FRIMP=0.212
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.25 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=913   IDI=2  IDII=1
*
ROUTE RESERVOIR     IDIN=3  IDOUT=1  ISER=914  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=13
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      500.        0.023
                      610.        0.033
                      870.        0.040
                     1240.        0.046
                     3400.        0.051
```

```
                     4000.        1.100
                     4300.        1.980
                     4400.        2.310
                     4600.        2.920
                     4700.        3.200
                     4900.        3.770
                     5940.        7.200
*
*     Total development area 304B + Hwy 4073 + area 304A
*
ADD SERIES          IDOUT=2   ISER=675   IDI=6  IDII=1
*
*//////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => J + K + L + M + 407 interchange
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.005  0.015  0.03  0.05  0.15
                    EXES=  0.5    1.0    2.00  4.00  8.50
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=2
                    START=  69 11 02
                    FINISH= 75 10 30
*
*    d/s of development area  304D
*
GENERATE            ID=1 ISER=304 DT=0.25  DA=825.41 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.06 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.07 Smin=28.3 So=389.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3   ISER=305   IDI=1  IDII=2
*
*       route 304 through Lisgar detention pond
*
POND                IDOUT=1 ISER=602 IDIN=3 TDET=0 NELS=5 RTINC=0.125
                    BFLOW=0.025 CPAN=1.0 IFQBY=1 NPTQQ=0 NPTSQI=0
                    ====OPERATED OUTFLOW CURVE DATA=======
                    ISIG=1 NPTSQII=9
                    STAGE OUTFLOW DATA
                    0.00        0.00
                    0.75        0.85
                    1.75        2.7
                    2.00        3.1
                    3.00        5.2
                    3.50        12.8
                    4.00        39.3
                    4.25        56
                    4.50        85
                    ====OVERFLOW OUTFLOW CURVE=====
                    ISIG=2 STHD=4.50 BHE=4.75 XLENG=5.0
                    ====POND DATA=====
                    ISIG=1 NPTSV=9
                    STAGE VOLUME DATA
                    0.00        0.00
```

```
                    0.75        1200
                    1.75        28000
                    2.00        40400
                    3.00        76400
                    3.50        107700
                    4.00        197600
                    4.25        256400
                    4.50        357400
                    NPTSA=0
                    ====STARTING LEVEL=====
                    SBEGIN=0.0 FEMULT=1 SEMULT=1 SPILL=4.50
*
*        add 304 to 303
*
ADD SERIES          IDOUT=2 ISER=603 IDI=1 IDII=4
*
*
*        hydrograph for area 305
*
GENERATE            ID=1 ISER=306 DT=0.25  DA=906.56  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=3.79 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=5.66 Smin=30.0 So=406.5
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5   SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15      BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0  COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7  IZFLAG=3
*
*        route 303+304 through 305 and add 305 laterally
*
REACH               IDOUT=3 ISER=307 NIDH=1 IDH=2 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=1 XLEN=9700 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*
*/////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => Lisgar Confluence (SW 6 excluding 302)
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.01  0.05  0.15 0.26  0.50
                    EXES=  1.0  2.0  4.00  15.0  25.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=3
                    START=  69 11 02
                    FINISH= 75 10 30
*
*     hydrograph for area 302
*
GENERATE            ID=2 ISER=302 DT=0.25  DA=713.5  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.33 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.48 Smin=39.3 So=500.4
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
```

```
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*     Subwatershed # 6 total flow:
*         - add 302 and 305
*
ADD SERIES          IDOUT=6  ISER 666  IDI=3  IDII=2
*
*////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVES => SUBWATERSHED #6
*   (302, 303, 304 & 305)
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.01  0.07  0.11  0.22  0.33
                    EXES=  4.0  8.0  14.80 19.90  31.80
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=6
                    START=  69 11 02
                    FINISH= 75 10 30
********************************************************
*    Subwatershed  5                                   *
********************************************************
*     hydrograph for area 300 - u/s of development area
*
GENERATE            ID=1 ISER=300 DT=0.25  DA=1902.3  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=2.12
                                IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.17 Smin=33.4 So=440.6
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 300
*         - u/s of development area
*
REACH               IDOUT=2 ISER=551  NIDH=0 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=1 XLEN=15000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*****************************************************
*    Development areas G + H                        *
*****************************************************
*      development area G
*
GENERATE            ID=1 ISER=825 DT=0.25  DA=22.93  AB=0 FRIMP=0.68
                    IMPERVIOUS AREA AA=1    N=4    TP=0.25
                                IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.27 Smin=42 So=533
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
```

```
                         APIi=40 IA=10.0 CETPER=1.0
                BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET = 1.0
                =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=1  IDOUT=5  ISER=825  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     1510.        0.028
                     3090.        0.040
                     4720.        0.049
                     6410.        0.057
                     8160.        0.063  Quality Level
                     8170.        0.064  Weir Crest
                     9200.        0.379
                    10250.        0.953
                    11320.        1.696
                    12400.        2.574
                    13500.        3.570  Max. Weir Depth
*
*     Development area  H
*
GENERATE            ID=1 ISER=830 DT=0.25  DA=61.89  AB=0 FRIMP=0.66
                    IMPERVIOUS AREA AA=1    N=4    TP=0.35
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.47 Smin=42 So=533
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=1  IDOUT=4  ISER=813  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     4110.        0.075
                     8310.        0.106
                    12610.        0.130
                    17000.        0.150
                    21490.        0.168  Quality Level
                    21520.        0.169  Weir Crest
                    24290.        0.678
                    27100.        1.601
                    29930.        2.793
                    32800.        4.203
                    35700.        5.800  Max. Weir Depth
*
ADD SERIES          IDOUT=3 ISER=553 IDI=5 IDII=4
*
*//////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => G + H
*
EXCEEDANCE CURVES   IFLAG=1
```

```
                    NINQ=10   LFIM=12
                    EXES=  0.001  0.005  0.009  0.02  0.05
                    EXES=  0.15  0.5  1.50  4.00  10.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=3
                    START=  69 11 02
                    FINISH= 75 10 30
*
*         - d/s of development area - 301B
*
GENERATE            ID=1 ISER=301 DT=0.25  DA=882.43  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=1.29
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=1.92 Smin=42 So=533
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*      Subwatershed # 5 total flow:
*
REACH               IDOUT=4 ISER=555  NIDH=1 IDH=3 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=1 XLEN=12000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*//////////////////////////////////////////////////////////////////////
*
*   EXCEEDANCE CURVES => SUBWATERSHED #5
*   (300 & 301)
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.005  0.01  0.06  0.10   0.19
                    EXES=  0.29   1.0   2.2   9.0  18.80
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=4
                    START=  69 11 02
                    FINISH= 75 10 30
*
*   SW #5 + SW #6
*
ADD SERIES          IDOUT=5  ISER=670  IDI=4  IDII=6
*
**********************************************************
*    Subwatershed 4                                      *
**********************************************************
*      hydrograph for area 203
*
GENERATE            ID=1 ISER=203 DT=0.25  DA=2136.7 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=2.99
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=4.66 Smin=29.7 So=402.7
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
```

```
                                CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*          hydrograph for area 204A  - u/s of development area
*
GENERATE            ID=2 ISER=204  DT=0.25  DA=896.78 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.11 IA=2.5
                                RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.07 Smin=35.6 So=462.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=3 ISER=204 IDI=1 IDII=2
*
*          u/s of development area
*
GENERATE            ID=1 ISER=810 DT=0.25  DA=4.28 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=0.57  IA=2.5
                                RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.8 Smin=35.6 So=462.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
************************************************
*   development Areas D, E, F                  *
************************************************
*     Development Area D
*
GENERATE            ID=2 ISER=811  DT=0.25  DA=65.90 AB=0 FRIMP=0.66
                    IMPERVIOUS AREA AA=1 N=4 TP=0.35 IA=2.5
                                RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.47 Smin=35.6 So=462.9
                                SK=0.089
                                APIK=0.99 0.99 0.99 0.99
                                APIK=0.90 0.80 0.40 0.40
                                APIK=0.50 0.50 0.95 0.99
                                APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                SLOSKA=0.000001  SLOSKB=0.25
                                CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
```

```
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=4 ISER=812 IDI=1 IDII=2
*
*********************************************************************************
*FLOW before Pond
*
*********************************************************************************
MAXFLW               ID=4   IOPT=1
                     START DATE = 69 11 02
                     END DATE   = 75 10 30
*
* Rating culve revised based on desing Halton Hill Power Generation Pond
*
ROUTE RESERVOIR     IDIN=4  IDOUT=2  ISER=813  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                    29166.        0.078
                    35220.        0.174
                    40221.        0.220
                    47267.        0.270  Quality Level
                    49068.        0.281  Weir Crest
                    49974.        0.486
                    50885.        0.858
                    52730.        1.903
                    56510.        4.851
                    58423.        6.661  Max. Weir Depth
*
*
MAXFLW               ID=2   IOPT=1
                     START DATE = 69 11 02
                     END DATE   = 75 10 30
*
*     Development Area E
*
GENERATE            ID=1 ISER=815  DT=0.25  DA=15.16 AB=0 FRIMP=0.56
                    IMPERVIOUS AREA AA=1 N=4 TP=0.25 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.27 Smin=35.6 So=462.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=1  IDOUT=4  ISER=816  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                      810.        0.016
                     1670.        0.022
                     2560.        0.027
                     3510.        0.031
                     4490.        0.035  Quality Level
                     4500.        0.036  Weir Crest
                     5050.        0.241
                     5620.        0.617
                     6200.        1.103
                     6800.        1.678
```

```
                     7400.        2.330  Max. Weir Depth
*
ADD SERIES           IDOUT=1 ISER=817 IDI=4 IDII=2
*
*/////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => D + E
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.001  0.01  0.03  0.05  0.15
                    EXES=  1.00  2.08  4.00 10.00  20.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=1
                    START=  69 11 02
                    FINISH= 75 10 30
*
*     hydrograph for area 205A  - u/s of development area
*
GENERATE            ID=2 ISER=205 DT=0.25  DA=934.08 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=1.95 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=2.91 Smin=29.1 So=396.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*      development area - F
*
GENERATE            ID=4 ISER=818 DT=0.25  DA=36.51 AB=0 FRIMP=0.72
                    IMPERVIOUS AREA AA=1 N=4 TP=0.26 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.37 Smin=29.1 So=396.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=4  IDOUT=3  ISER=819  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     2610.        0.048
                     5300.        0.068
                     8060.        0.084
                    10910.        0.096
                    13820.        0.108  Quality Level
                    13840.        0.109  Weir Crest
                    15600.        0.530
```

```
                    17390.        1.297
                    19200.        2.289
                    21040.        3.461
                    22900.        4.790  Max. Weir Depth
*
ADD SERIES          IDOUT=4 ISER=442 IDI=3 IDII=2
*
*/////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => F
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.001  0.006  0.01  0.041  0.11
                    EXES=  0.50  1.00   2.00   4.00   15.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=4
                    START=  69 11 02
                    FINISH= 75 10 30
*
ADD SERIES          IDOUT=2 ISER=443 IDI=4 IDII=1
*
*/////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => D + E + F
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.001  0.007  0.02  0.05  0.25
                    EXES=  0.41  1.00  4.00  10.0   30.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=2
                    START=  69 11 02
                    FINISH= 75 10 30
*
*      d/s of development area -  205C
*
GENERATE            ID=1 ISER=245 DT=0.25  DA=109.25 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=0.45 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.67 Smin=29.1 So=396.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*    Total Subwatershed 4
*
*        route 203 and 204 through 205 and add 205 laterally
*
REACH               IDOUT=4 ISER=444  NIDH=1 IDH=2  NIDL=1 IDL=1
                    IFOARM=2 NELS=10 SMAX=1 XLEN=3000 RTINC=0.125
                    RN=0.05 SF=0.0015 SS=0.4 B=4.3
*
*
*/////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => SUBWATERSHED #4
*   (203, 204 & 205)
```

```
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.002  0.005  0.01  0.05  0.14
                    EXES=  0.28  0.42  6.1  14.50  35.60
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=4
                    START=  69 11 02
                    FINISH= 75 10 30
*
********************************************************
*   Subwatershed 3                                     *
********************************************************
*        hydrograph for area 200
*
GENERATE            ID=1 ISER=200 DT=0.25  DA=1327 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=2.44
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2  TP=3.64 Smin=44.7 So=550.9
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=60 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=.0001 SFIELD=5.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=0.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.5   IZFLAG=3
*
*        hydrograph for area 201
*
GENERATE            ID=2 ISER=201 DT=0.25  DA=2000 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=3.86 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2  TP=5.76 min=63.3 So=766.7
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=60 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=.0001 SFIELD=5.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=0.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.5   IZFLAG=3
*
*        route 201 through reservoir to simulate swamp storage
*
ROUTE RESERVOIR     IDIN=2 IDOUT=3 ISER=800  OUTFLAG=0 NINTER=2
                    SSTORAGE=200000 NPAIRS=6
                         8000      0.02
                       200000      0.1
                      1000000      0.5
                      5000000      1.2
                     10000000      2.0
                    100000000      6.0
*
*        add 200 + 201
*
ADD SERIES          IDOUT=2 ISER=501 IDI=1 IDII=3
*
```

```
*        hydrograph for area 201-B
*
GENERATE            ID=1 ISER=202 DT=0.25  DA=566 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.44 IA=1.0
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2  TP=3.64 Smin=63.3 So=766.7
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=60 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.20 BFACR=5.0
                                    SVOL=15.0 SWILT=.0001 SFIELD=5.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=0.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.5   IZFLAG=3
*
*        add 201-B
*
ADD SERIES          IDOUT=3 ISER=502 IDI=1 IDII=2
*
*        route through Scotch Block reservoir
*
POND                IDOUT=2 ISER=503 IDIN=3 TDET=0 NELS=5 RTINC=0.125
                    BFLOW=0.0 CPAN=1.0 IFQBY=0 NPTQQ=0 NPTSQI=0
                    ====OPERATED OUTFLOW CURVE DATA=======
                    ISIG=1 NPTSQII=6
                    STAGE     OUTFLOW DATA
                    0.0           0.000
                    9.14          0.020
                    9.75          0.05
                    10.36         0.125
                    10.67         0.142
                    10.97         0.170
                    ====OVERFLOW OUTFLOW CURVE=====
                    ISIG=1 NPTSQV=5
                    STAGE     OUTFLOW
                    10.97         0.000
                    11.28        25.357
                    11.58        46.610
                    11.89        72.646
                    12.19       102.955
                    ====POND DATA=====
                    ISIG=1 NPTSV=13
                    STAGE VOLUME DATA
                    0.0         0
                    0.31        1233.5
                    0.61        3700.5
                    2.08        30837.5
                    9.14        703095
                    9.75        838780
                    10.36       999135
                    10.67       1085480
                    10.97       1171825
                    11.28       1270505
                    11.58       1369185
                    11.89       1467865
                    12.19       1578880
                    NPTSA=0
                    ====STARTING LEVEL=====
                    SBEGIN=9.75   FEMULT=1 SEMULT=1 SPILL=12.19
*
*        hydrograph for area 202A  - u/s of development area
*
GENERATE            ID=1 ISER=210 DT=0.25  DA=1195.1 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=2.37
                                    IA=2.5  RC=0.90  CETIMP = 1.0
```

```
                    PERVIOUS AREA   AA=1 N=2 TP=3.54 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 202A and add 202A laterally
*
REACH               IDOUT=3 ISER=331  NIDH=1 IDH=2 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=3 XLEN=12000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*******************************************************
*   Development Areas 202B, A, B, C                   *
*******************************************************
*     Development area 202B
*
GENERATE            ID=1 ISER=100 DT=0.25  DA=62.27 AB=0 FRIMP=0.87
                    IMPERVIOUS AREA AA=1    N=4    TP=0.25
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.31 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=1  IDOUT=2  ISER=800  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=7
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     6150.        0.146
                    14730.        0.179
                    24140.        0.206
                    33770.        0.790
                    38680.        1.601
                    41140.        2.152
*
GENERATE            ID=1 ISER=101 DT=0.25  DA=1.91 AB=0 FRIMP=0.87
                    IMPERVIOUS AREA AA=1    N=4    TP=0.11
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.15 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
```

```
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=6 ISER=801 IDI=1 IDII=2
*
*    development area C
*
GENERATE            ID=1 ISER=102 DT=0.25  DA=66.89 AB=0 FRIMP=0.67
                    IMPERVIOUS AREA AA=1    N=4    TP=0.28
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.39 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=2 ISER=802 IDI=1 IDII=6
*
*     development area B
*
GENERATE            ID=1 ISER=103 DT=0.25  DA=60.02 AB=0 FRIMP=0.67
                    IMPERVIOUS AREA AA=1    N=4    TP=0.35
                                   IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.47 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ADD SERIES          IDOUT=6 ISER=803 IDI=1 IDII=2
*
ROUTE RESERVOIR     IDIN=6  IDOUT=2  ISER=804  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     8450.        0.156
                    17150.        0.221
                    26100.        0.270
                    35300.        0.312
                    44760.        0.349  Quality Level
                    44790.        0.350  Weir Crest
                    50500.        1.694
                    56280.        4.135
                    62140.        7.289
                    68080.       11.021
                    74100.       15.250  Max. Weir Depth
*
*     development area A
*
```

```
GENERATE            ID=1 ISER=104  DT=0.25  DA=18.39  AB=0 FRIMP=0.7
                    IMPERVIOUS AREA AA=1    N=4    TP=0.25
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=0.31  Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
ROUTE RESERVOIR     IDIN=2  IDOUT=6  ISER=805  OUTFLAG=0 NINTER=4
                    SSTOR=0.0  NPAIRS=12
                    STORAGE (CU.M.) OUTFLOW (CMS)
                       0.0          0.0
                     1240.        0.023
                     2540.        0.033
                     3890.        0.041
                     5300.        0.047
                     6760.        0.052  Quality Level
                     6761.        0.053  Weir Crest
                     7600.        0.162
                     8450.        0.360
                     9320.        0.616
                    10200.        0.918
                    11100.        1.260  Max. Weir Depth
*
ADD SERIES          IDOUT=1 ISER=806 IDI=2 IDII=6
ADD SERIES          IDOUT=2 ISER=332 IDI=1 IDII=3
*
*
*/////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => A + B + C
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.25  0.36  0.45   0.55   0.75
                    EXES=  1.10  2.56  5.00   15.5   23.9
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=2
                    START=  69 11 02
                    FINISH= 75 10 30
*
*     d/s of development area - 202C
*
GENERATE            ID=1 ISER=220 DT=0.25  DA=238.45 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=1.27
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=1.90 Smin=38.5 So=492.8
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
```

```
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 202C and add 202C laterally
*
REACH               IDOUT=3 ISER=333  NIDH=1 IDH=2 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=3 XLEN=3000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*/////////////////////////////////////////////////////////////////
*
*   EXCEEDANCE CURVE => SUBWATERSHED #3
*   (200, 201 & 202)
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.25  0.36  0.45  0.55  0.75
                    EXES=  1.10  3.10  5.00 15.50 23.90
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=3
                    START=  69 11 02
                    FINISH= 75 10 30
*
*        add midoak
*
ADD SERIES          IDOUT=1 ISER=110 IDI=3 IDII=4
*
*/////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVES => E2
*   (SW 3 + SW 4)
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.1  0.3  0.45  0.65  0.96
                    EXES=  3.10  5.0 15.0   23.90  45.0
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=1
                    START=  69 11 02
                    FINISH= 75 10 30
************************************************************
*   Subwatershed 7                                         *
************************************************************
*        hydrograph for area 206
*
GENERATE            ID=2 ISER=375 DT=0.25  DA=710 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.24 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.34 Smin=32.8 So=434.2
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 206 and add 206 laterally
*
REACH               IDOUT=3 ISER=376 NIDH=1 IDH=1 NIDL=1 IDL=2 IFOARM=2
                    NELS=10 SMAX=3 XLEN=4000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
```

```
*   Aera 207 A
*
GENERATE            ID=1 ISER=380 DT=0.25  DA=781 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.13 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.19 Smin=37.1 So=477.7
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        hydrograph for area 207 B
*
GENERATE            ID=4 ISER=385 DT=0.25  DA=442 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=1.90 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=2.85 Smin=37.1 So=477.7
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 207 B and add 207 B laterally
*
REACH               IDOUT=2 ISER=386 NIDH=2 IDH=3 IDH=1 NIDL=1 IDL=4
                    IFOARM=2 NELS=10 SMAX=3 XLEN=3140 RTINC=0.125 RN=0.05
                    SF=0.0019 SS=0.4 B=4.3
*
*        add eastoak + SW # 6
*
ADD SERIES          IDOUT=3 ISER=387 IDI=2 IDII=5
*
*        hydrograph for area 306
*
GENERATE            ID=2 ISER=390 DT=0.25  DA=643 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.62 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.90 Smin=32.1 So=427.4
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
```

```
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 306 and add 306 laterally
*
REACH               IDOUT=4 ISER=388 NIDH=1 IDH=3  NIDL=1 IDL=2
                    IFOARM=2 NELS=10 SMAX=3 XLEN=5000 RTINC=0.125 RN=0.05
                    SF=0.0015  SS=0.4 B=4.3
*
*/////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVES => E5
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.1  0.3  0.54  0.75  1.10
                    EXES=  1.84  5.00  15.0  50.0  100.
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=4
                    START=  69 11 02
                    FINISH= 75 10 30
*
*        hydrograph for area 307
*
GENERATE            ID=1 ISER=395 DT=0.25  DA=508  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=2.44
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.64 Smin=31.9 So=425.0
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        hydrograph for area 308
*
GENERATE            ID=2 ISER=400 DT=0.25  DA=594 AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1 N=4 TP=2.34 IA=2.5
                                    RC=0.90 CETIMP=1.0
                    PERVIOUS AREA   AA=1 N=2 TP=3.49 Smin=31.9 So=425.0
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET=1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 308 and add 308 laterally
*
REACH               IDOUT=3 ISER=401 NIDH=1 IDH=1 NIDL=1 IDL=2 IFOARM=2
                    NELS=10 SMAX=2 XLEN=5000 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*        total hydrograph at WSC Gauge 2hb004
```

```
*
ADD SERIES          IDOUT=5 ISER=402 IDI=4 IDII=3
*
*        hydrograph for area 309
*
GENERATE            ID=1 ISER=405 DT=0.25  DA=525  AB=0 FRIMP=0.03
                    IMPERVIOUS AREA AA=1    N=4    TP=1.73
                                    IA=2.5  RC=0.90  CETIMP = 1.0
                    PERVIOUS AREA   AA=1 N=2 TP=2.58 Smin=28.3 So=389.2
                                    SK=0.089
                                    APIK=0.99 0.99 0.99 0.99
                                    APIK=0.90 0.80 0.40 0.40
                                    APIK=0.50 0.50 0.95 0.99
                                    APIi=40 IA=10.0 CETPER=1.0
                    BASE FLOW       NSVOL=0.0 BASmin=0.00 BFACR=5.0
                                    SVOL=15.0 SWILT=0.001 SFIELD=2.0
                                    SLOSKA=0.000001  SLOSKB=0.25
                                    CET = 1.0
                    =====  REDUCED HEAT BUDGET SNOWMELT ANALYSIS  =====
                    ISNOW=2      BASET=1.5    SNOFAC=1.0    PACDEP=0.0
                    ALPHAA=2.5   XKL=15       BCOEF=1.05    XNCOEF=150
                    KFLAG=0      PSTATE=1.0   COEFD=0.012   COEFE=1.2
                    CFACTR=1.0   CFACTS=1.7   IZFLAG=3
*
*        route through 309 and pick up East branch (id=5)
*
REACH               IDOUT=2 ISER=777  NIDH=1 IDH=5 NIDL=1 IDL=1 IFOARM=2
                    NELS=10 SMAX=3 XLEN=6500 RTINC=0.125 RN=0.05 SF=0.0015
                    SS=0.4 B=4.3
*
*
*////////////////////////////////////////////////////////////////////
*
*XX   EXCEEDANCE CURVE => SUBWATERSHED #7
*   (206, 207, 306, 307, 308 & 309)
*
EXCEEDANCE CURVES   IFLAG=1
                    NINQ=10   LFIM=12
                    EXES=  0.10  0.40  0.67   1.33   2.00
                    EXES= 15.6  39.7  72.70  98.00  162.20
                    NIND=0
                    NINS=0
                    NUMINT=1  ID=2
                    START=  69 11 02
                    FINISH= 75 10 30
*
FINISH_
```

Halton Hills - 401 Corridor Integrated Planning Project
Qualhymo Model Exceedance Curves
6 Year Simulation - Hornby Data

No. hrs of simulation from 69/11/1 to 75/10/31 = 52584 hrs

Input Files :
fut6yr.inp - July 1, 1999
ex6yr.inp - July 1, 1999
fut6yrR.inp - April 23, 2007

2080 41.1

D + E

2080 0

Flow (m3/s)	(L/s)	Existing DILLON Exceed (hrs)	(%)	Future DILLON Exceed (hrs)	(%)	Future PHILIPS Exceed (hrs)	(%)
0.001	1	23095	43.9	21619	41.1	44160	84.0
0.01	10	20662	39.3	11241	21.4	19175	36.5
0.03	30	16951	32.2	6442	12.3	6235	11.9
0.05	50	14155	26.9	4462	8.5	2701	5.1
0.15	150	6677	12.7	630	1.2	221	0.4
1	1000	2161	4.1	16	0.0	8	0.0
2.08	2080	1366	2.6	1	0.0	0	0.0
4	4000	775	1.5	0.5	0.0	0	0.0
10	10000	230	0.4	0.1	0.0	0	0.0
20	20000	78	0.1	0.05	0.0	0	0.0

420 59.3

SW # 4

420 0

Flow (m3/s)	(L/s)	Existing DILLON Exceed (hrs)	(%)	Future DILLON Exceed (hrs)	(%)	Future PHILIPS Exceed (hrs)	(%)
0.002	2	30252	57.5	31166	59.3	42151	80.2
0.005	5	27199	51.7	27092	51.5	34911	66.4
0.01	10	24470	46.5	22890	43.5	27927	53.1
0.05	50	16697	31.8	10142	19.3	11334	21.6
0.14	140	9386	17.8	4950	9.4	4670	8.9
0.28	280	5246	10.0	2979	5.7	2714	5.2
0.42	420	4077	7.8	2186	4.2	2048	3.9
6.1	6100	686	1.3	126	0.2	125	0.2
14.5	14500	207	0.4	8	0.0	5	0.0
35.6	35600	30	0.1	1	0.0	0	0.0

4/23/2007 13:17

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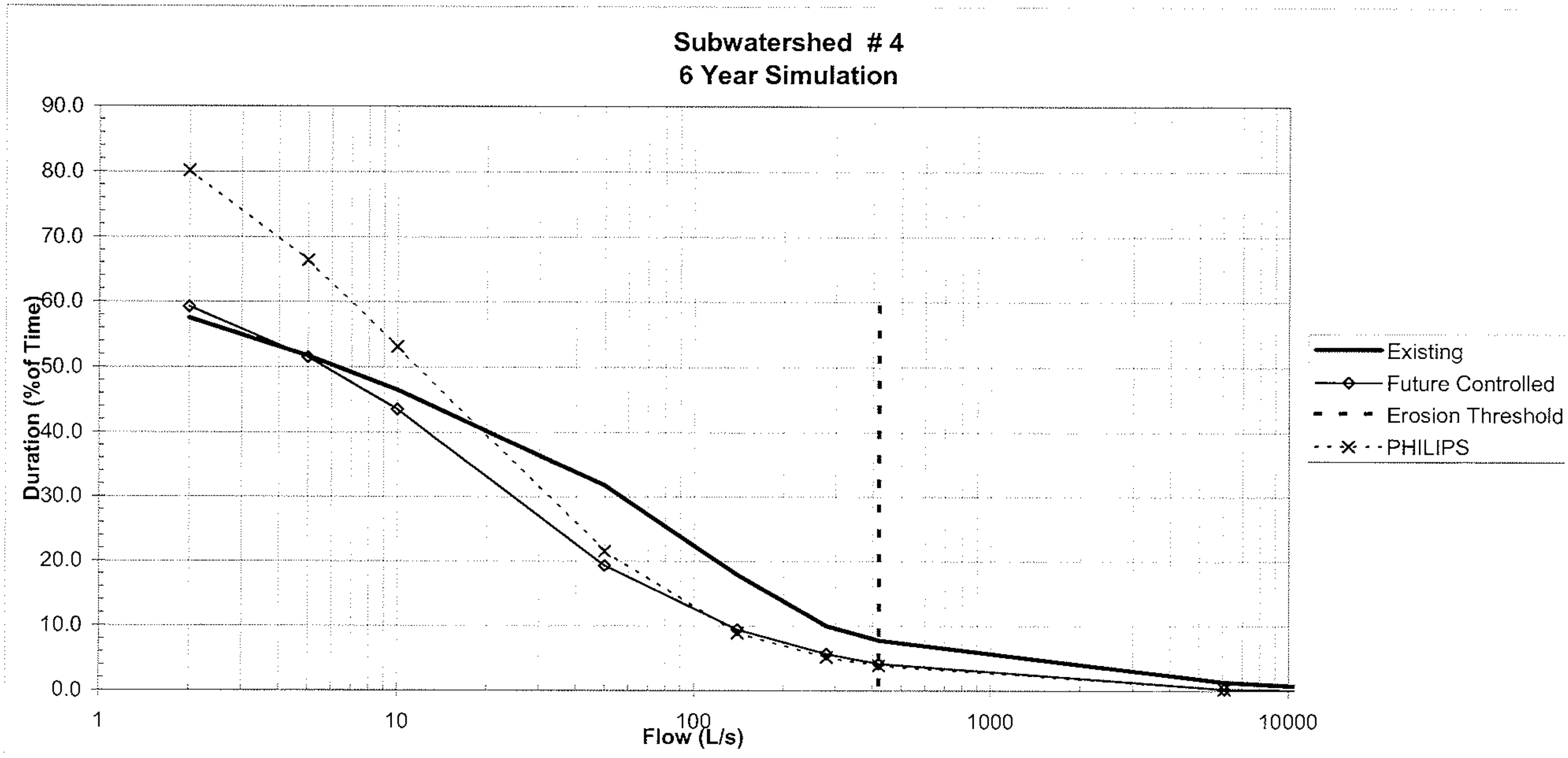
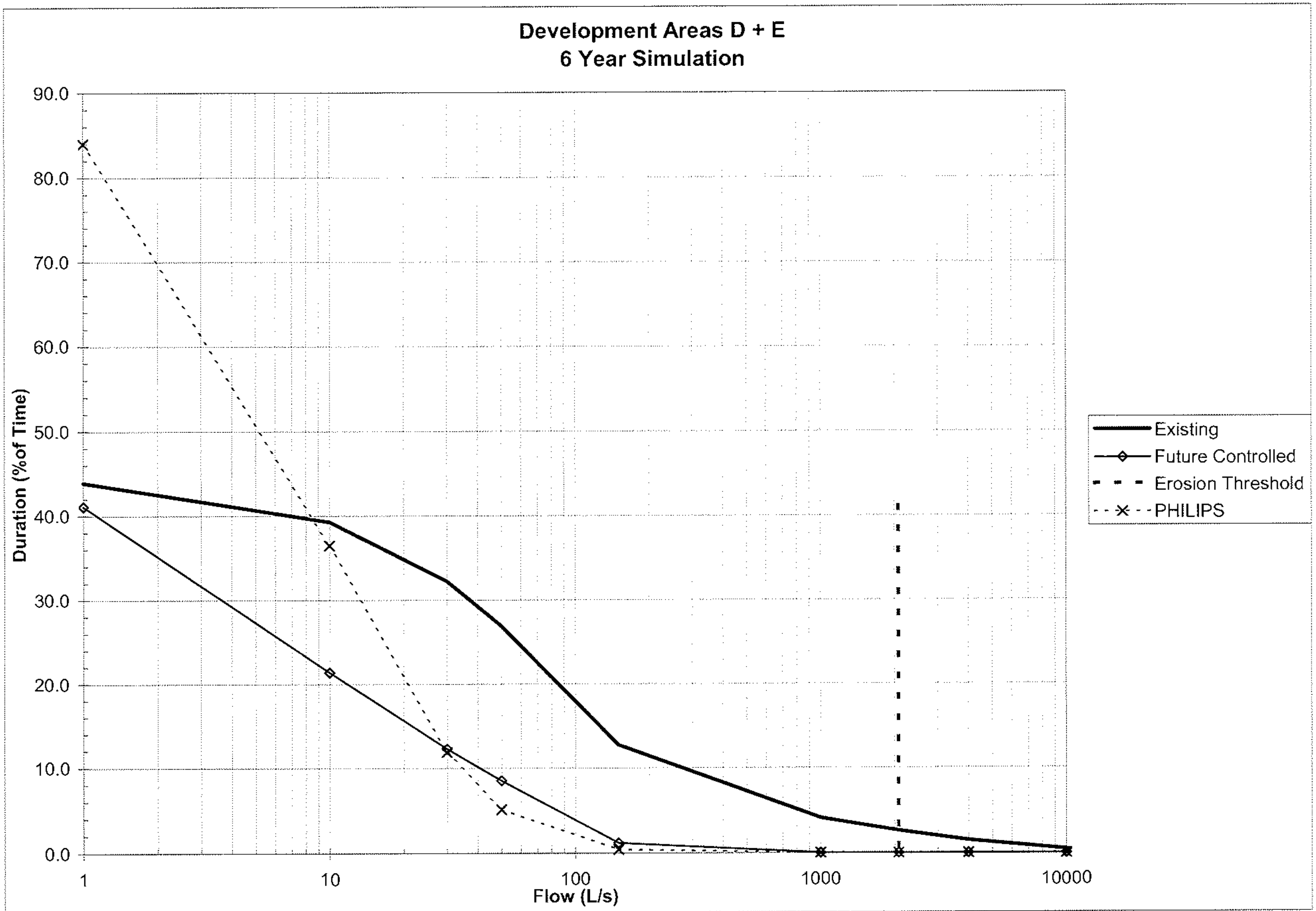


Subwatershed # 4
6 Year Simulation
Duration (%of Time)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1
10
100
1000
10000
Flow (L/s)
Existing
Future Controlled
Erosion Threshold
PHILIPS

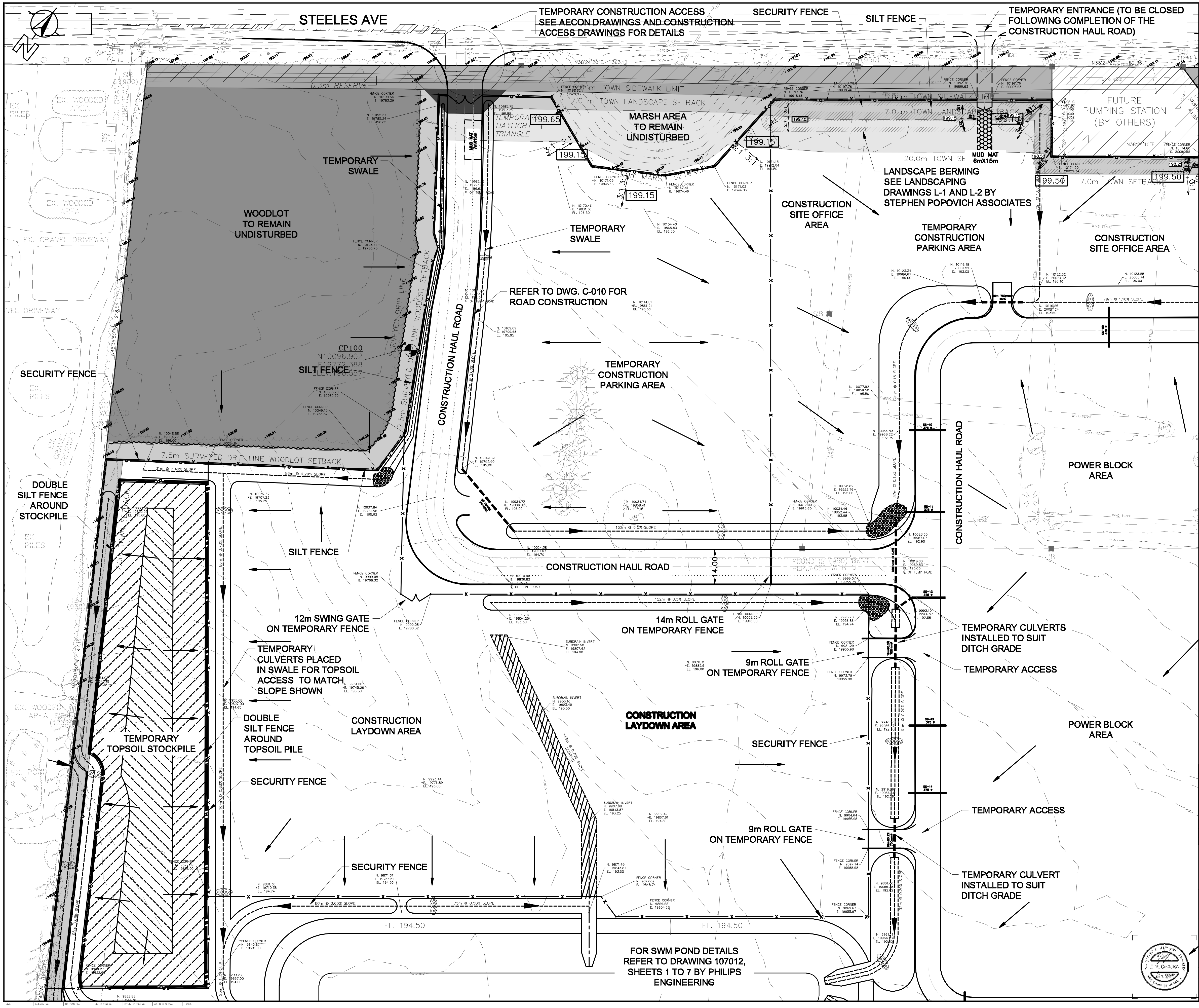


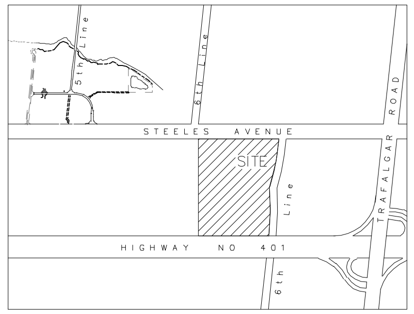
Development Areas D + E
6 Year Simulation
Duration (%of Time)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1
10
100
1000
10000
Flow (L/s)
Existing
Future Controlled
Erosion Threshold
PHILIPS

D+E Chart 1

APPENDIX I

HHGS CONSTRUCTION AND FINAL GRADING PLANS





Key Plan N.T.S.

SEDIMENTATION AND EROSION CONTROL

1. INSTALL ROCK CHECK DAMS IN DITCHES AS PER OPSD 219.211.
2. INSTALL TEMPORARY SILT FENCE, AS PER OPSD 219.110 ,AROUND PERIMETER OF SITE, APPROX. 1m INSIDE SITE FENCING, AS SHOWN, OR AS DIRECTED BY THE ENGINEER.
3. INSTALL TEMPORARY SILT FENCE AROUND TOPSOIL/SOIL STOCKPILE AREA AS SHOWN.
4. REFER TO DWG. C-009 FOR EROSION CONTROL DETAILS.
5. PLAN (CONSTRUCTION) NORTH SHOWN ON DRAWINGS IS ROTATED 52°7'2" COUNTER CLOCKWISE FROM TRUE NORTH.
6. TOPSOIL SHALL BE STRIPPED TO INERT SOIL LAYER.
7. TOPSOIL WILL BE STOCKPILED ON SITE (LOCATION INDICATED ON DRAWING C-001).
8. REFER TO DRAWING C-009 FOR IINVERTS OF CULVERT AND CATCHBASIN LEADS.
9. DURING CONSTRUCTION OF CONSTRUCTION ACCESS ROADS, INSTALL ALL CATCHBASIN LEADS, BUT NOT THE CATCHBASINS.
10. AREAS TO REMAIN DISTURBED >30 DAYS REQUIRE VEGETATIVE GROUND COVER.

LEGEND

- SILTATION CONTROL FENCE
- TEMPORARY SECURITY FENCE
- ROCK CHECK DAM
- CENTERLINE OF DITCH
- EDGE OF TEMPORARY ROAD
- PROPERTY LINE
- TEMPORARY CULVERT
- PERMANENT CULVERT
- SUBDRAIN STRUCTURE UNDER CONSTRUCTION LAYDOWN AREA
- DIRECTION OF OVERLAND FLOW

CONSTRAINT SETBACKS

- ROAD WIDENING TO BE DEDICATED TO THE TOWN
- ROAD WIDENING TO BE DEDICATED TO THE REGION
- ROAD WIDENING TO BE DEDICATED TO THE MTO
- LAND TO BE DEDICATED TO TOWN FOR GREENBELT CONSERVATION
- LANDS SUBJECT TO 14.0m MTO SETBACK – LANDSCAPING & GRADING ONLY
- LANDS SUBJECT TO 7.5m CH SETBACK – LANDSCAPING ONLY
- LANDS SUBJECT TO WOODLOT – TO REMAIN UNTOUCHED BY TCE
- LANDS SUBJECT TO 7.0m TOWN SETBACK – LANDSCAPING & GRADING ONLY
- LANDS SUBJECT TO TOWN SETBACK – PAVING, LNADSCAPING & GRADING ONLY

CONSTRUCTION GRADING

1. SUBGRADE ELEVATIONS OF POWER BLOCK AND TRANSFORMER AREAS TO BE ACCORDING TO FINAL GRADING ELEVATIONS (SEE PLANS C-004 TO C-008) LESS THE THICKNESS OF COVER MATERIAL AS DIRECTED BY THE ENGINEER.
2. ELEVATIONS OF SWALE AND DITCH INVERTS ARE SHOWN AS 150mm BELOW FINAL DITCH GRADE TO ALLOW FOR EROSION PROTECTION MATERIAL AS DIRECTED BT THE ENGINEER.

0 10 20 30 40 50

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01/09/08	6	ADDITIONAL NOTES	E.C.		
12/13/07	5	BERMS & SIDEWALK SETBACK ADDED, DOUGAN REPORT	E.C.		
11/19/07	4	CB LEADS REVISED, AND GRADES ADJUSTED	E.C.		
10/25/07	3	CONSTRUCTION ACCESS & SWITCHYARD GRADING REVISED	E.C.		
10/10/07	2	ACCESS RD. MOVE TO 7.5m O/S FROM WOODLOT	E.C.		
09/26/07	1	REVISED PER SITE ALTERATION COMMENTS	E.C.		
07/25/07	0	ISSUED FOR CONSTRUCTION	E.C.		
06/18/07	A	ISSUED FOR TENDER	E.C.		

Halton Hills Power Partners, LLP

Burns & McDonnell · AKER KVÆRNER · Hatch Mott MacDonald

HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

CONSTRUCTION GRADING PLAN AND EROSION/SEDIMENTATION

SHEET 1 OF 4

Hatch Acres

DESIGN — PREPARED: C.T. — CHECKED: E.C.

DRAWING — PREPARED: A.L. — CHECKED: C.T.

PROJECT DISCIPLINE LEAD: E.C.

PROJECT ENGINEER: E.C.

PROJECT MANAGER: E.C.

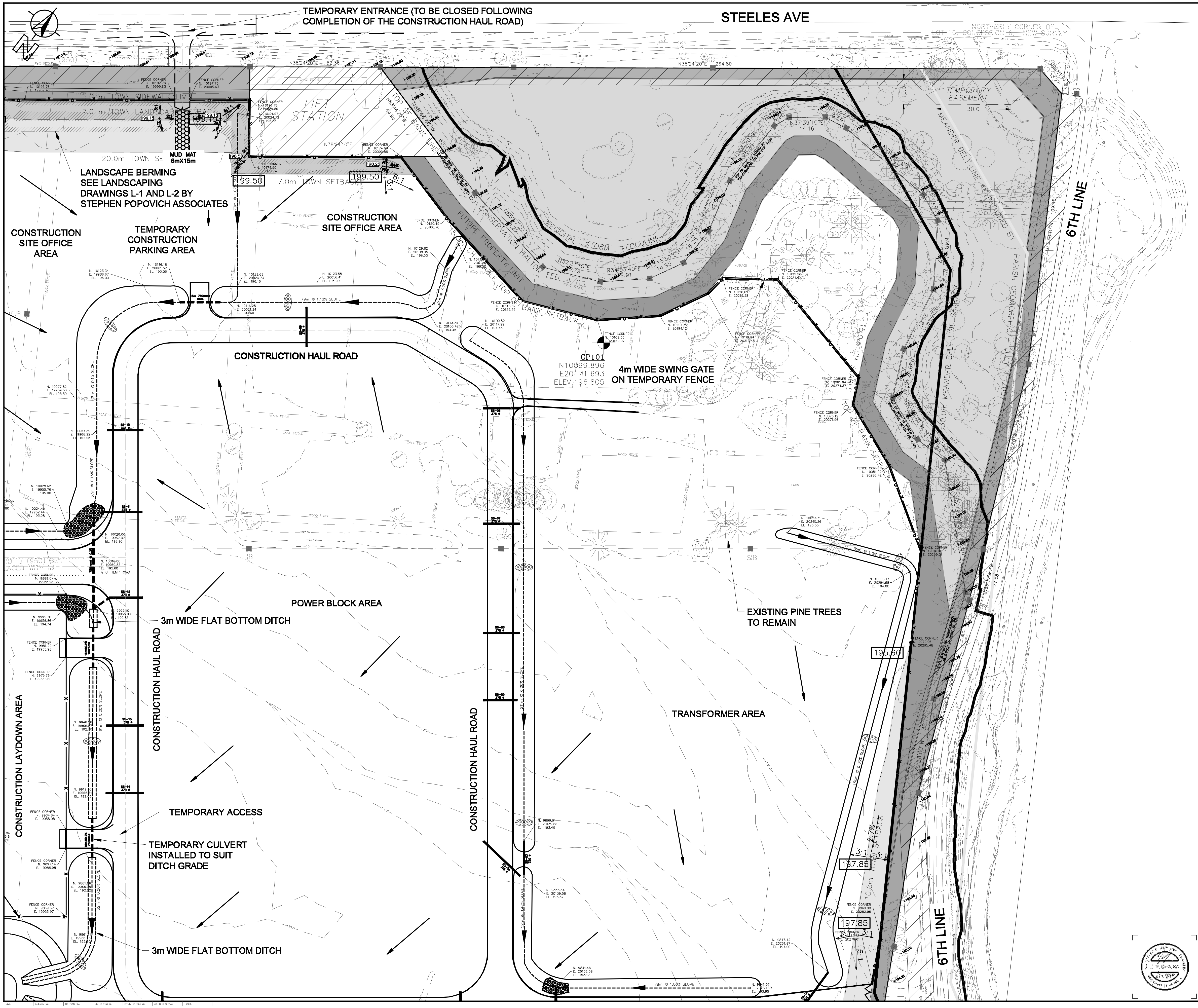
SCALE: 1:500

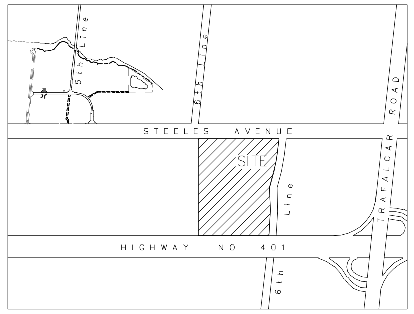
HATCH ENERGY PROJECT: 234438

DRAWING NO.: 234438-C-001

REVISION: 6

DRAWING No. 234438-C-001 6





Key Plan N.T.S.

SEDIMENTATION AND EROSION CONTROL

1. INSTALL ROCK CHECK DAMS IN DITCHES AS PER OPSD 219.211.
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9. DURING CONSTRUCTION OF CONSTRUCTION ACCESS ROADS, INSTALL ALL CATCHBASIN LEADS, BUT NOT THE CATCHBASINS.
10. AREAS TO REMAIN DISTURBED >30 DAYS REQUIRE VEGETATIVE GROUND COVER.

LEGEND

- SILTATION CONTROL FENCE
- TEMPORARY SECURITY FENCE
- ROCK CHECK DAM
- CENTERLINE OF DITCH
- EDGE OF TEMPORARY ROAD
- PROPERTY LINE
- TEMPORARY CULVERT
- PERMANENT CULVERT
- SUBDRAIN STRUCTURE UNDER CONSTRUCTION LAYDOWN AREA
- DIRECTION OF OVERLAND FLOW

CONSTRAINT SETBACKS

- ROAD WIDENING TO BE DEDICATED TO THE TOWN
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0 10 20 30 40 50

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Halton Hills
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HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

CONSTRUCTION GRADING PLAN AND EROSION/SEDIMENTATION

SHEET 2 OF 4

Hatch Acres

DESIGN PREPARED C.T. CHECKED E.C.

DRAWING PREPARED A.L. CHECKED C.T.

PROJECT DISCIPLINE LEAD E.C.

PROJECT ENGINEER E.C.

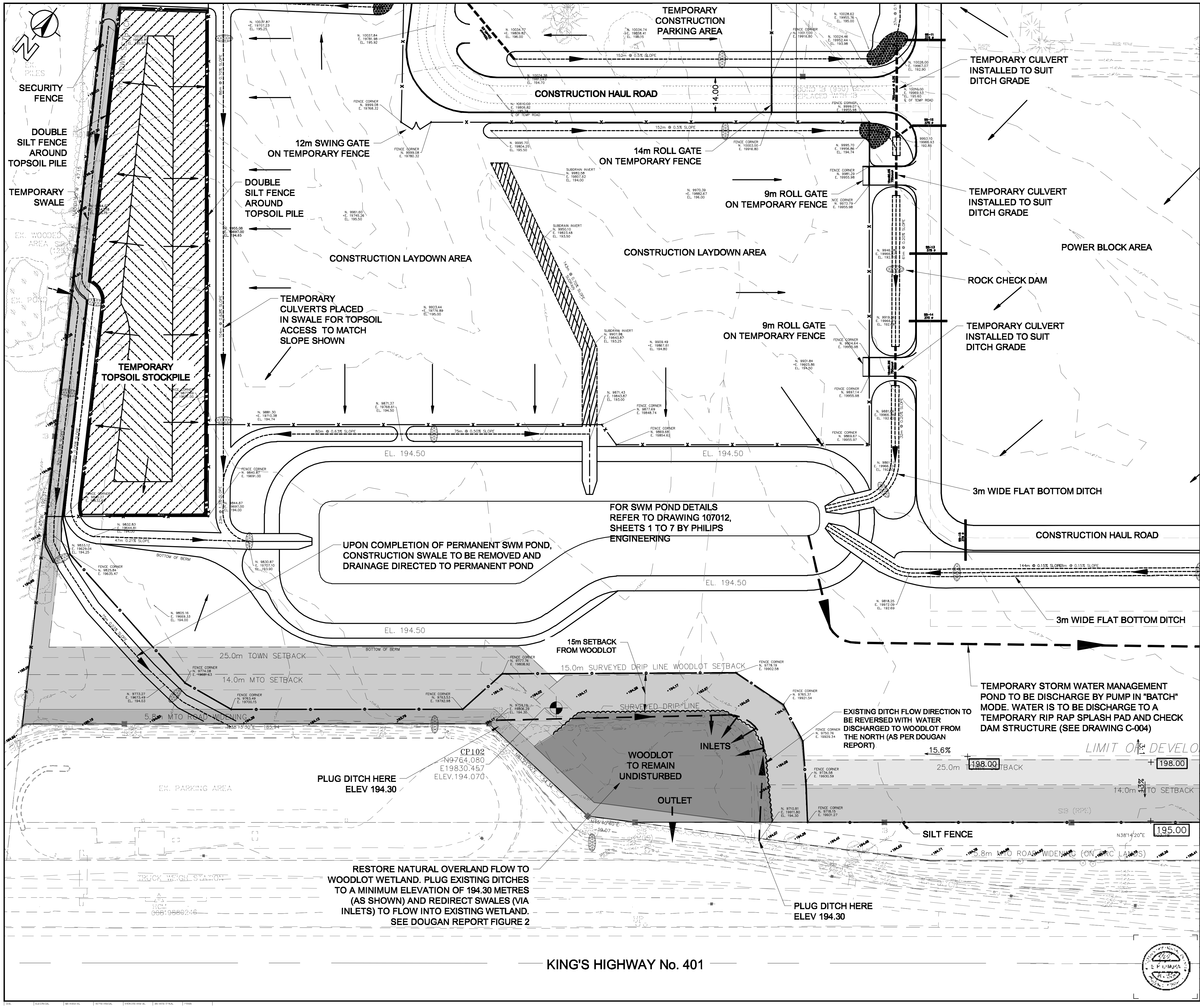
PROJECT MANAGER E.C.

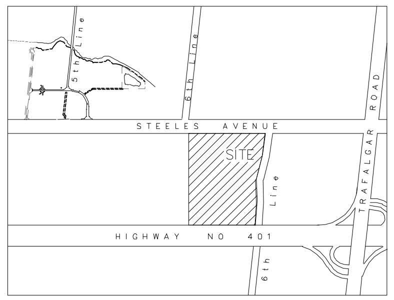
SCALE 1:1000

HATCH ENERGY PROJECT 234438

DRAWING NO. 234438-C-002

REVISION 6





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- TEMPORARY SECURITY FENCE
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10/10/07	2	ACCESS RD. MOVE TO 7.5m O/S FROM WOODLOT	E.C.		
09/26/07	1	REVISED PER SITE ALTERATION COMMENTS	E.C.		
07/25/07	0	ISSUED FOR CONSTRUCTION	E.C.		
06/18/07	A	ISSUED FOR TENDER	E.C.		

Halton Hills
Power Partners, LLP

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

Hatch Acres

DESIGN PREPARED C.T
CHECKED E.C.
DRAWING PREPARED A.L.
CHECKED C.T.
PROJECT DISCIPLINE LEAD E.C.
PROJECT ENGINEER E.C.
PROJECT MANAGER E.C.

CONSTRUCTION GRADING PLAN AND EROSION/SEDIMENTATION

SHEET 3 OF 4

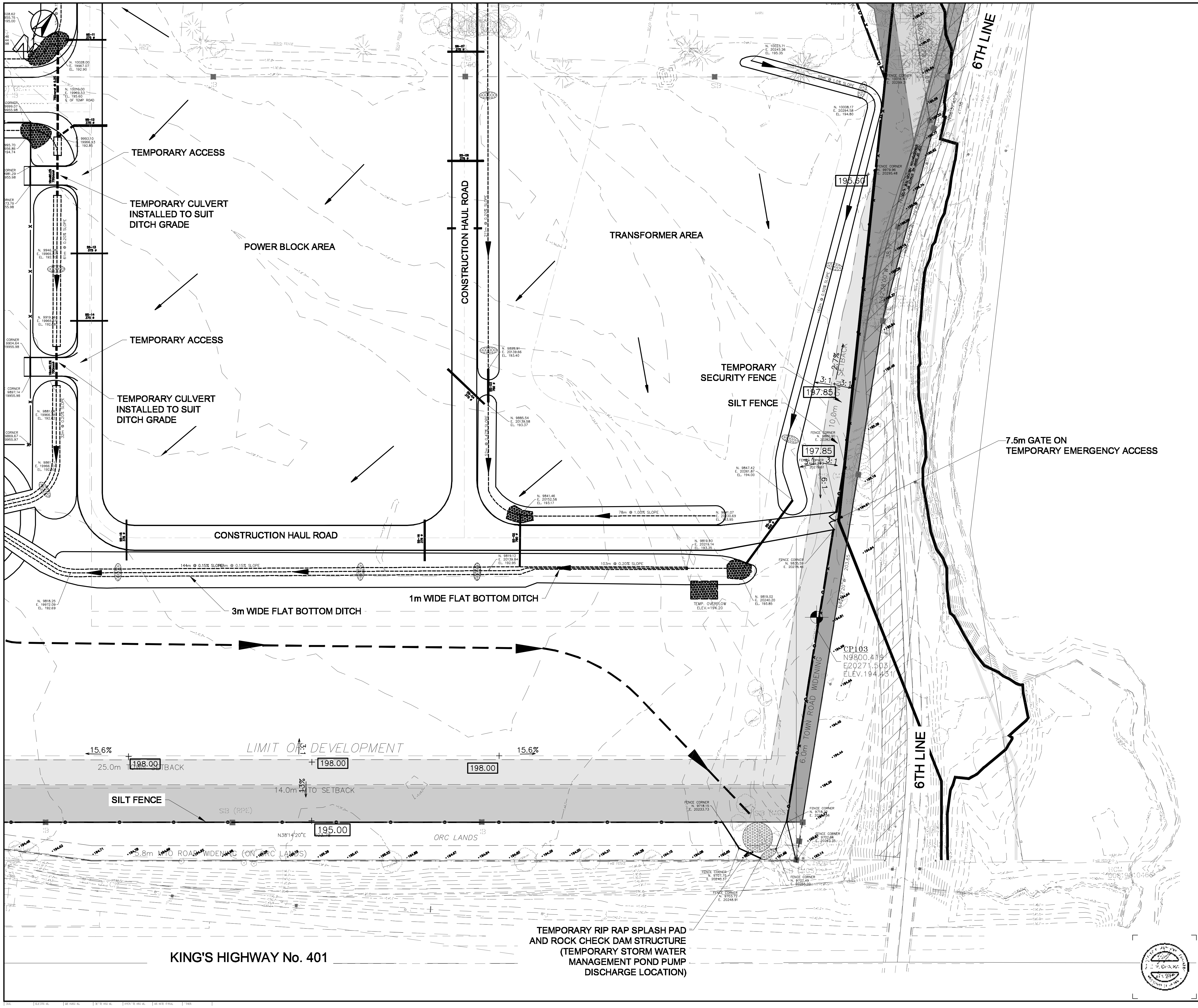
SCALE 1:500

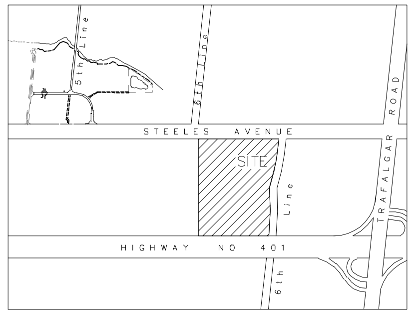
HATCH ENERGY PROJECT 234438

DRAWING NO. 234438-C-003

REVISION 6

DRAWING No. 234438-C-003





Key Plan N.T.S.

SEDIMENTATION AND EROSION CONTROL

1. INSTALL ROCK CHECK DAMS IN DITCHES AS PER OPSD 219.211.
2. INSTALL TEMPORARY SILT FENCE, AS PER OPSD 219.110 ,AROUND PERIMETER OF SITE, APPROX. 1m INSIDE SITE FENCING, AS SHOWN, OR AS DIRECTED BY THE ENGINEER.
3. INSTALL TEMPORARY SILT FENCE AROUND TOPSOIL/SOIL STOCKPILE AREA AS SHOWN.
4. REFER TO DWG. C–009 FOR EROSION CONTROL DETAILS.
5. PLAN (CONSTRUCTION) NORTH SHOWN ON DRAWINGS IS ROTATED 52°7'2" COUNTER CLOCKWISE FROM TRUE NORTH.
6. TOPSOIL SHALL BE STRIPPED TO INERT SOIL LAYER.
7. TOPSOIL WILL BE STOCKPILED ON SITE (LOCATION INDICATED ON DRAWING C–001).
8. REFER TO DRAWING C–009 FOR IINVERTS OF CULVERT AND CATCHBASIN LEADS.
9. DURING CONSTRUCTION OF CONSTRUCTION ACCESS ROADS, INSTALL ALL CATCHBASIN LEADS, BUT NOT THE CATCHBASINS.
10. AREAS TO REMAIN DISTURBED >30 DAYS REQUIRE VEGETATIVE GROUND COVER.

LEGEND

- SILTATION CONTROL FENCE
- TEMPORARY SECURITY FENCE
- ROCK CHECK DAM
- CENTERLINE OF DITCH
- EDGE OF TEMPORARY ROAD
- PROPERTY LINE
- TEMPORARY CULVERT
- PERMANENT CULVERT
- SUBDRAIN STRUCTURE UNDER CONSTRUCTION LAYDOWN AREA
- DIRECTION OF OVERLAND FLOW

CONSTRAINT SETBACKS

- ROAD WIDENING TO BE DEDICATED TO THE TOWN
- ROAD WIDENING TO BE DEDICATED TO THE REGION
- ROAD WIDENING TO BE DEDICATED TO THE MTO
- LAND TO BE DEDICATED TO TOWN FOR GREENBELT CONSERVATION
- LANDS SUBJECT TO 14.0m MTO SETBACK – LANDSCAPING & GRADING ONLY
- LANDS SUBJECT TO 7.5m CH SETBACK – LANDSCAPING ONLY
- LANDS SUBJECT TO WOODLOT – TO REMAIN UNTOUCHED BY TCE
- LANDS SUBJECT TO 7.0m TOWN SETBACK – LANDSCAPING & GRADING ONLY
- LANDS SUBJECT TO TOWN SETBACK – PAVING, LNADSCAPING & GRADING ONLY

CONSTRUCTION GRADING

1. SUBGRADE ELEVATIONS OF POWER BLOCK AND TRANSFORMER AREAS TO BE ACCORDING TO FINAL GRADING ELEVATIONS (SEE PLANS C–004 TO C–008) LESS THE THICKNESS OF COVER MATERIAL AS DIRECTED BY THE ENGINEER.
2. ELEVATIONS OF SWALE AND DITCH INVERTS ARE SHOWN AS 150mm BELOW FINAL DITCH GRADE TO ALLOW FOR EROSION PROTECTION MATERIAL AS DIRECTED BT THE ENGINEER.

0 10 20 30 40 50

DATE	NO.	ISSUE / REVISION	CH.	APP.	APP.
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HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

CONSTRUCTION GRADING PLAN AND EROSION/SEDIMENTATION

SHEET 4 OF 4

Hatch Acres

DESIGN: PREPARED C.T.; CHECKED E.C.

DRAWING: PREPARED A.L.; CHECKED C.T

PROJECT DISCIPLINE LEAD: E.C.

PROJECT ENGINEER: E.C.

PROJECT MANAGER: E.C.

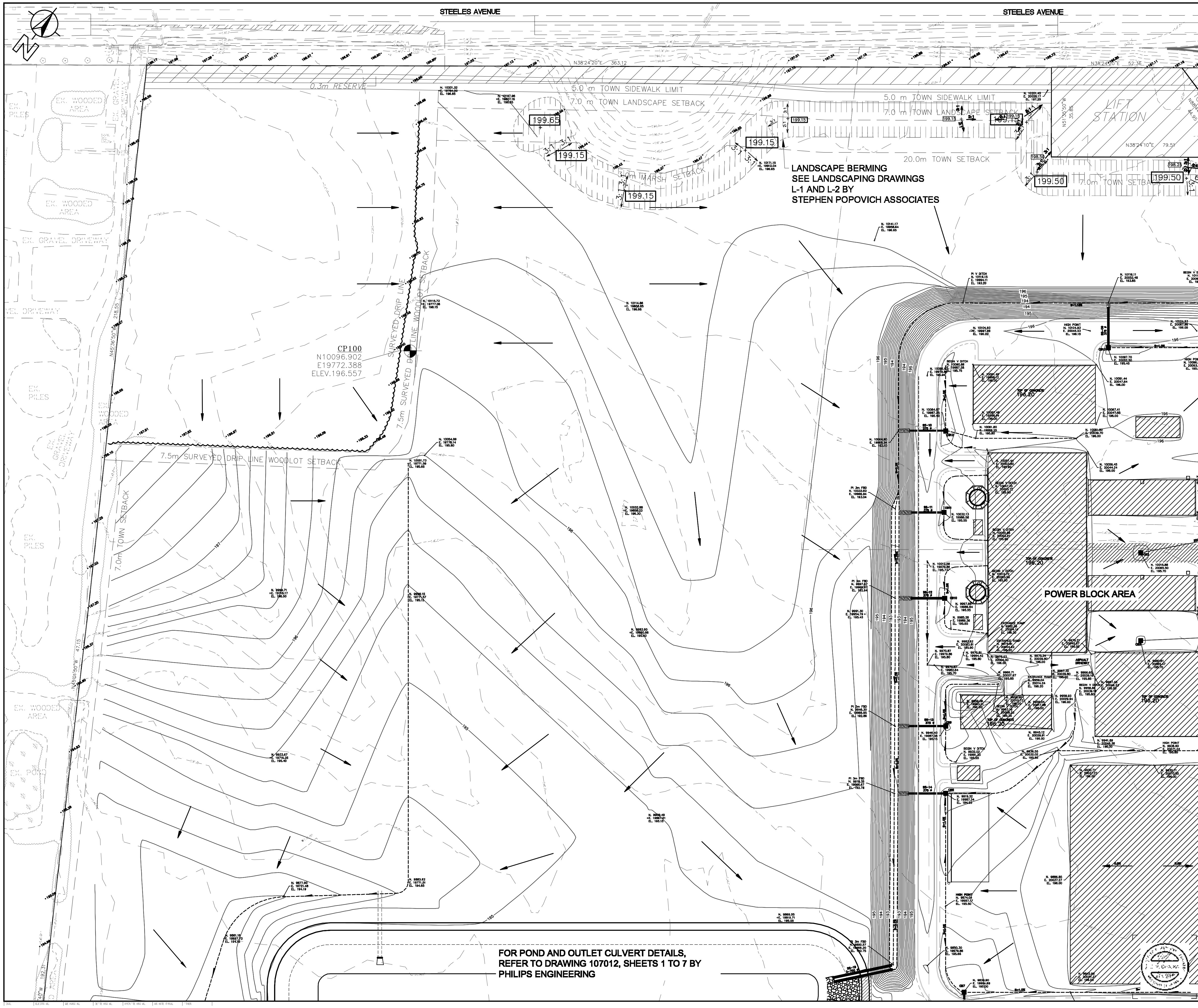
SCALE: 1:500

HATCH ENERGY PROJECT: 234438

DRAWING NO.: 234438–C–004

REVISION: 6

DRAWING No. 234438–C–004 6



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Power Partners, LLP

Burns & McDonnell | AKER KVÆRNER | Hatch Mott MacDonald

HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

Hatch Acres

DESIGN PREPARED C.T.
CHECKED E.C.

DRAWING PREPARED A.L.
CHECKED C.T.

PROJECT DISCIPLINE LEAD E.C.

PROJECT ENGINEER E.C.

PROJECT MANAGER E.C.

FINAL GRADING PLAN

SHEET 1 OF 4

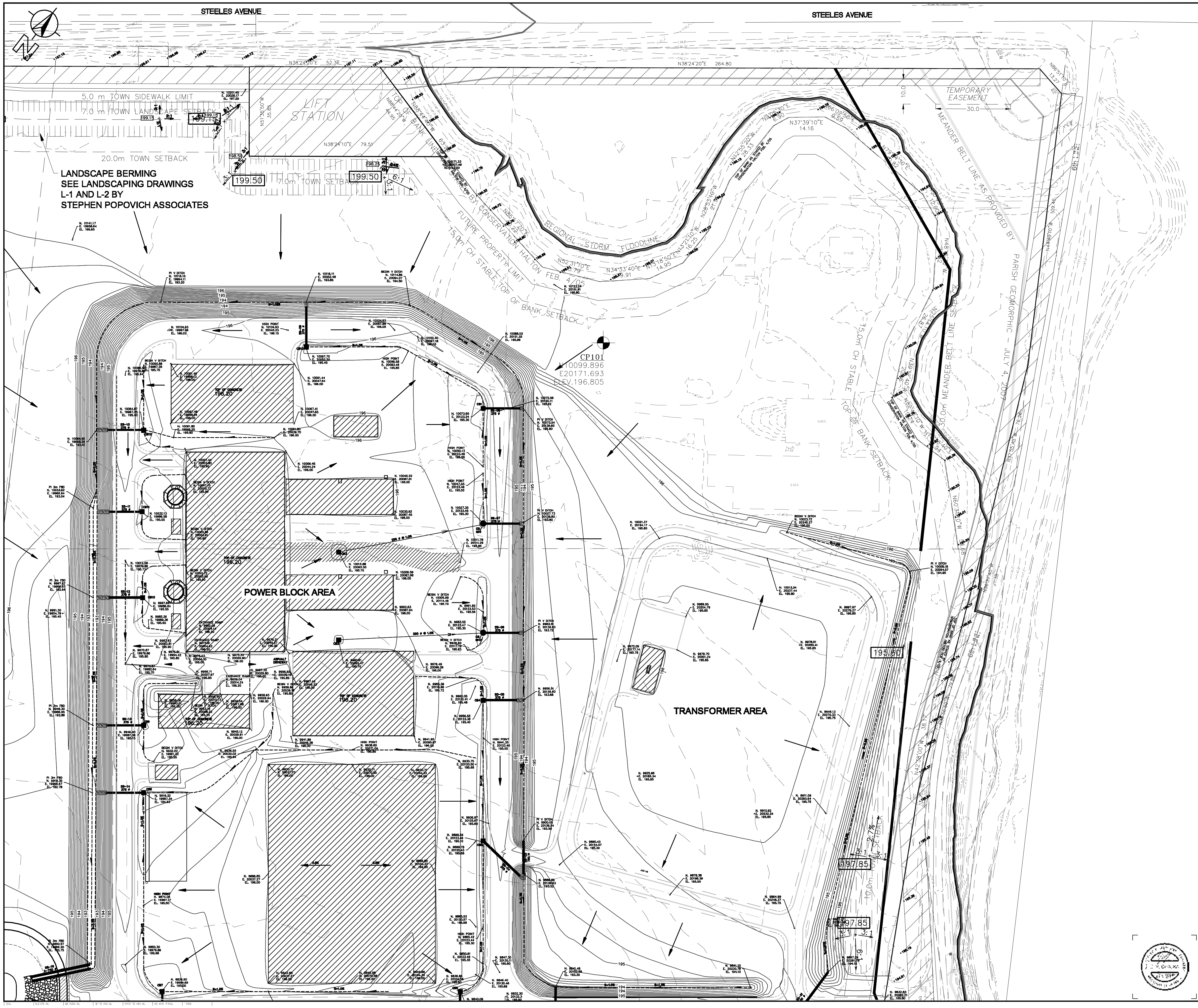
SCALE 1:500

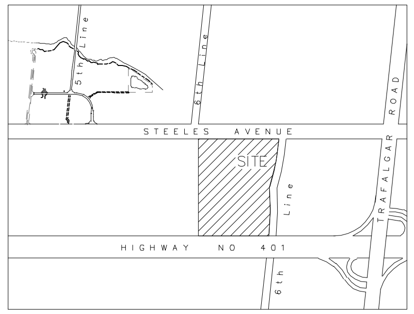
HATCH ENERGY PROJECT 234438

DRAWING NO. 234438-C-005

REVISION 6

DRAWING No. 234438-C-005





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Halton Hills
Power Partners, LLP

Burns & McDonnell — AKER KVÆRNER — Hatch Mott MacDonald

HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

Hatch Acres

DESIGN PREPARED C.T.
CHECKED E.C.

DRAWING PREPARED A.L.
CHECKED C.T.

PROJECT DISCIPLINE LEAD E.C.

PROJECT ENGINEER E.C.

PROJECT MANAGER E.C.

FINAL GRADING PLAN

SHEET 2 OF 4

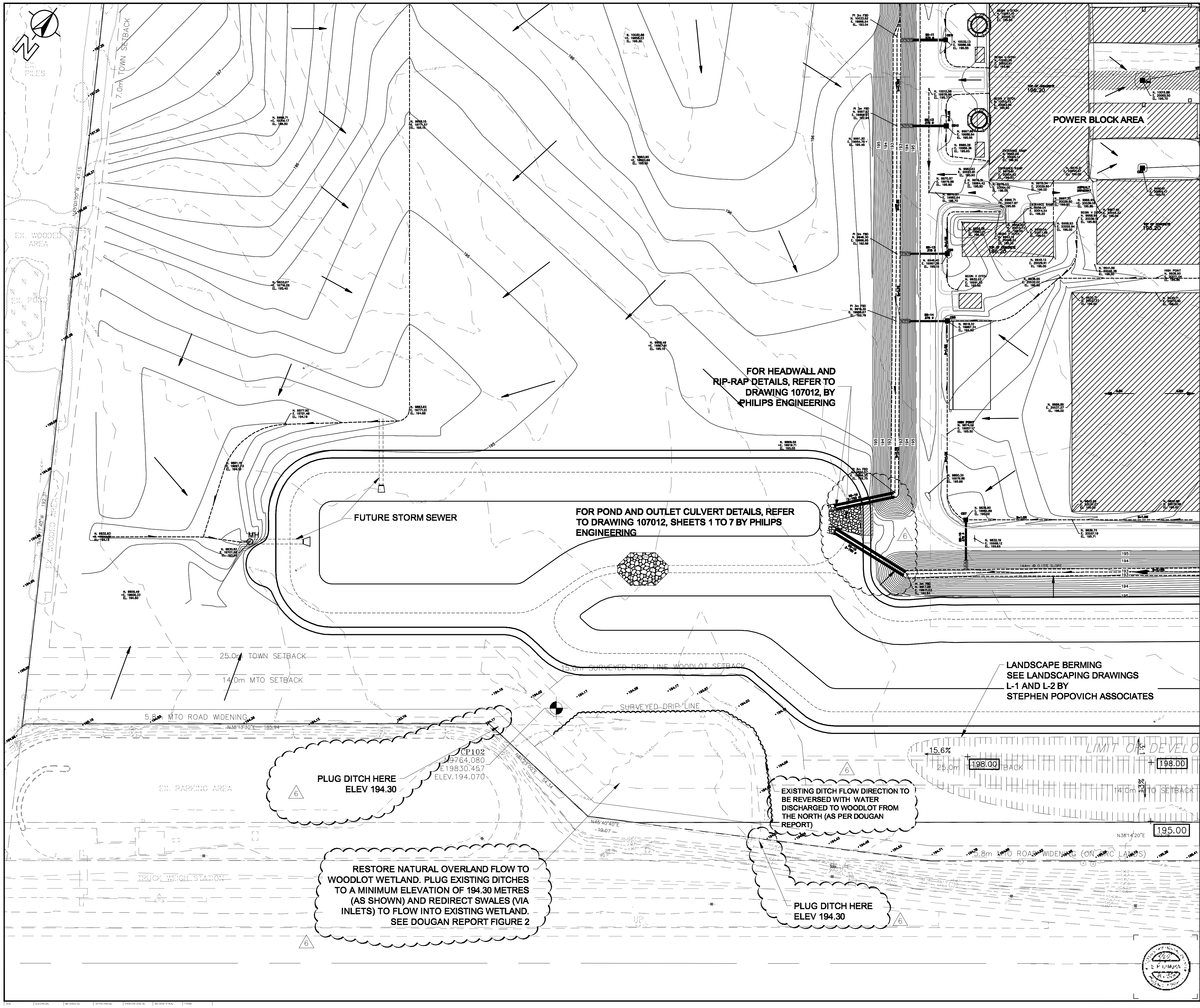
SCALE 1:500

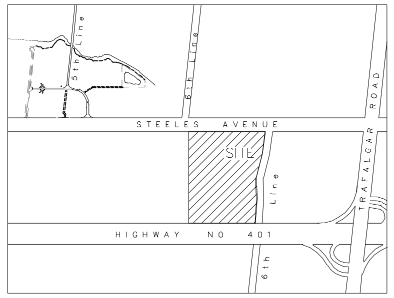
HATCH ENERGY PROJECT 234438

DRAWING NO. 234438-C-006

REVISION 6

DRAWING No. 234438-C-006 6





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HATCH energy

Trans Canada Energy Inc.

HALTON HILLS GENERATING STATION

Hatch Acres

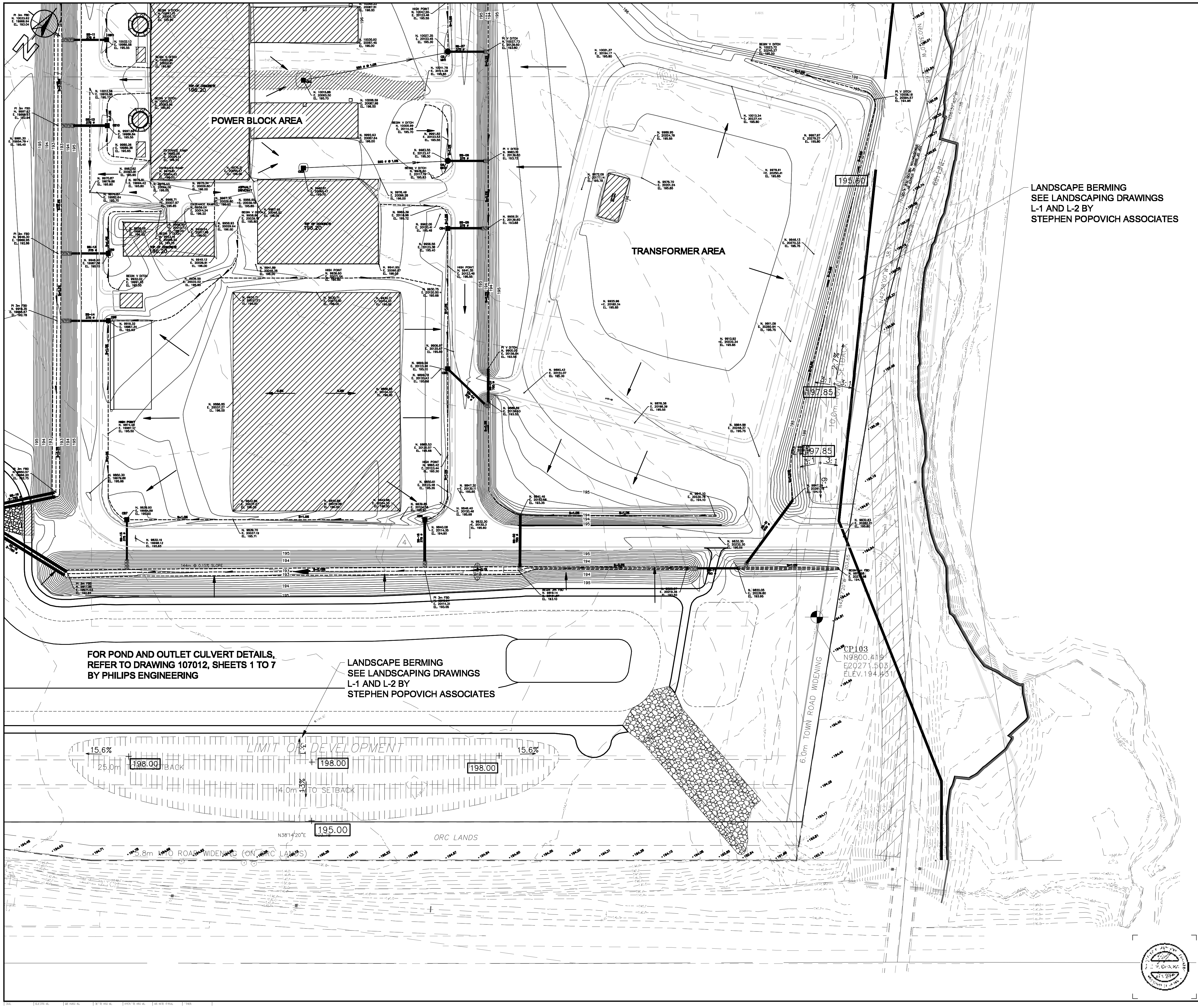
DESIGN: PREPARED C.T., CHECKED E.C.
DRAWING: PREPARED A.L., CHECKED C.T.
PROJECT DISCIPLINE LEAD: E.C.
PROJECT ENGINEER: E.C.
PROJECT MANAGER: E.C.

FINAL GRADING PLAN

SHEET 3 OF 4

SCALE: 1:500
HATCH ENERGY PROJECT: 234438
DRAWING NO.: 234438-C-007
REVISION: 6

DRAWING No. 234438-C-007



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PROJECT ENGINEER E.C.

PROJECT MANAGER E.C.

FINAL GRADING PLAN

SHEET 4 OF 4

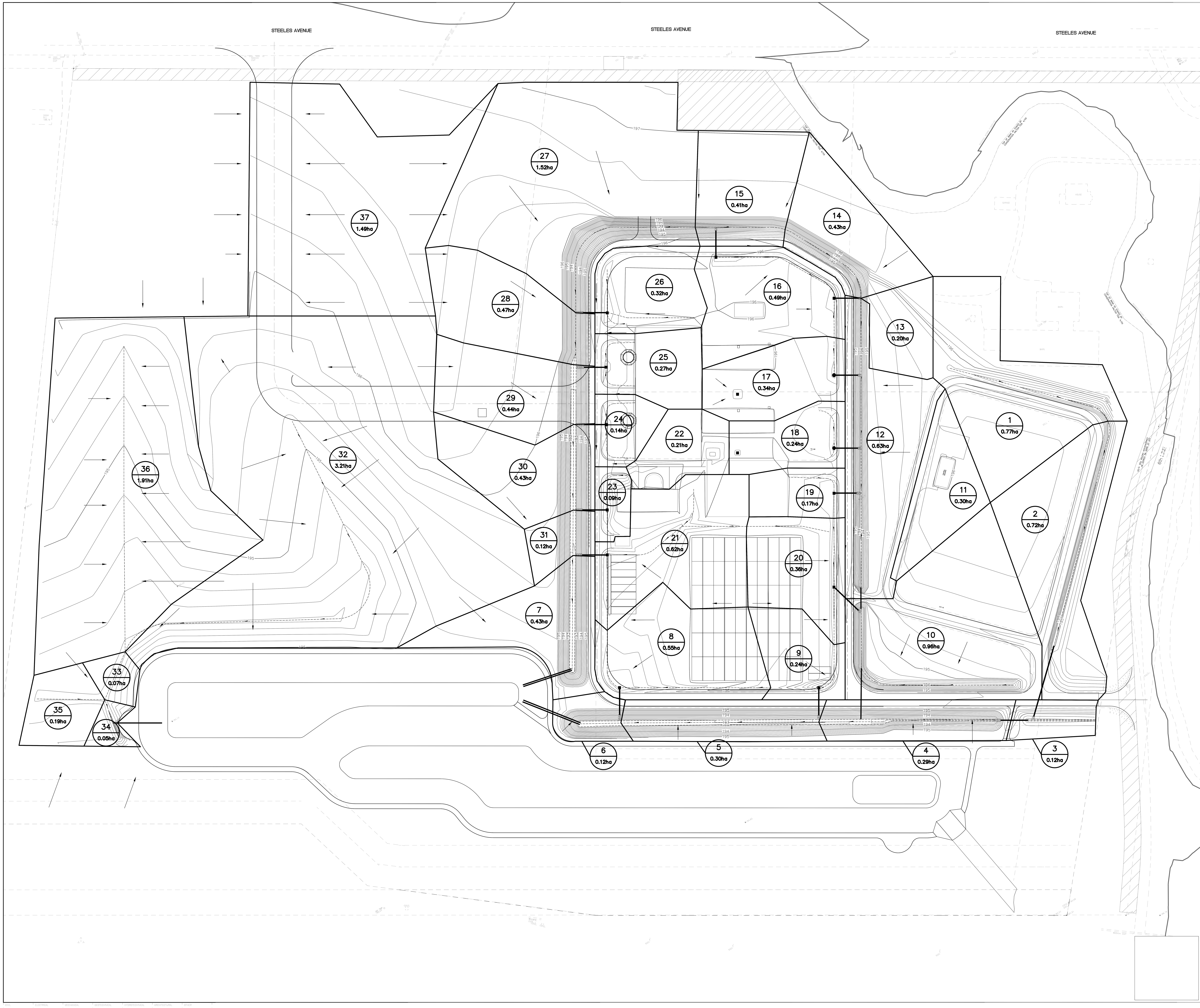
SCALE 1:500

HATCH ENERGY PROJECT 234438

DRAWING NO. 234438-C-008

REVISION 6

DRAWING No. 234438-C-008



Key Plan N.T.S.

NOT FOR CONSTRUCTION

DATE	NO.	ISSUE / REVISION	CH.	APP.	APP.
06/18/07	A	ISSUED FOR TENDER	E.C.		

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PROJECT ENGINEER E.C.

PROJECT MANAGER E.C.

FINAL GRADING PLAN
STORM WATER CATCHMENT AREAS
FIGURE 3.0

SCALE 1:1000

HATCH ENERGY PROJECT 234438

DRAWING NO. FIGURE 3.0

REVISION A

DRAWING No. FIGURE 3.0 A

OPEN DRAINAGE CHANNEL DESIGN SHEET

TOWN OF HALTON HILLS

2.00	0.238
1.50	0.270
3.00	0.195
4.00	0.166

5 YEAR Storm Return Period - Alternate Outlet Channel

RUNOFF COEFFICIENT ` C '

MIXED INDUSTRIAL - OPEN SPACE - OPEN DITCH / PARKING	0.75

CULVERT DESIGN

CITY OF HALTON HILLS

5 YEAR Storm Return Period

RUNOFF COEFFICIENT ` C '

MIXED INDUSTRIAL - OPEN SPACE - OPEN DITCH / F	0.75

AREA								RAINFALL INTENSITY				OPEN CHANNEL DESIGN											CULVERT DESIGN				
AREA NO.	Open Channel Location	AREA ha.	RUNF. COEFF C	AxC	TOTAL SECTION AxC	TOTAL SEWER AxC	TOTAL 2.78 AxC	TIME ENTRY min SECT.	ACCUM.	INTEN. "i" mm/hr	Q l/s	WIDTH m	Peak Water Depth In Swale	SLOPE %	n	VEL. m/s.	CAP. l/s	LEN. m.	TIME OF FLOW min.	Qxn/s^.5			DIA mm	n	SLOPE %	VEL m/s	CAP l/s
	1	0.77	0.75	0.58	0.58	0.58	1.605		10.00	101.5	163	0.00	0.240	1.00	0.025	0.94	162	110	1.95	41							
	2	0.72	0.75	0.54	0.54	1.12	3.107	1.95	11.95	93.2	289	0.00	0.403	0.20	0.025	0.59	289	155	4.35	162							
	SS-01	**1.49**				1.12	3.107	4.35	16.30	79.2	246												600	0.012	0.20	1.05	297
	3	0.12	0.75	0.09	0.09	0.09	0.250	0.00	0.00	204.3	51	0.00	0.210	0.20	0.025	0.38	51	155	6.72	29							
	SS-17	**1.61**				0.09	0.250	0.00	0.00	204.3	297												750	0.012	0.20	1.22	539
	14	0.43	0.75	0.32	0.32	0.32	0.897		10.00	101.5	91	0.00	0.193	1.00	0.025	0.81	91	45	0.92	23							
	13	0.20	0.75	0.15	0.15	1.10	3.044	1.09	11.09	96.6	294	3.00	0.169	0.20	0.025	0.50	294	140	4.71	164							
	16	0.49	0.75	0.37	0.37	0.37	1.022	0.92	10.00	101.5	104	0.00	0.202	1.00	0.025	0.84	103	55	1.09	26							
	SS-08 (AREA 16)	**0.49**				0.37	1.022	1.09	11.09	96.6	99												375	0.012	0.50	1.22	134
	17	0.34	0.75	0.26	0.26	0.26	0.709		10.00	101.5	72	0.00	0.176	1.00	0.025	0.76	71	55	1.20	18							
	SS-07 (AREA 17)	**0.34**				0.26	0.709	0.00	10.00	101.5	171												375	0.012	1.00	1.72	190
	12	0.63	0.75	0.47	0.47	1.57	4.358		10.00	101.5	442	3.00	0.213	0.20	0.025	0.57	439	105	3.09	247							
	11	0.30	0.75	0.23	0.23	0.23	0.626	3.09	13.09	89.0	56	3.00	0.063	0.20	0.025	0.27	55	105	6.45	31							
	18	0.24	0.75	0.18	0.18	0.18	0.500	0.00	10.00	101.5	51	3.00	0.060	0.20	0.025	0.26	50	105	6.65	28							
	SS-06 (AREA 18)	**0.24**				0.18	0.500	6.65	16.65	78.3	39												375	0.012	0.50	1.22	134
	19	0.17	0.75	0.13	0.13	0.31	0.855	0.00	16.65	78.3	67	3.00	0.071	0.20	0.025	0.29	67	105	5.98	37							
	SS-05 (AREA 19)	**0.41**				0.31	0.855	5.98	22.63	65.5	56												375	0.012	0.50	1.22	134
	SS-03 (AREAS 14,16,13,17,18, 19,12,11)	**2.80**				2.10	5.838	17.91	17.91	75.1	439												750	0.012	0.20	1.22	539
	20	0.36	0.75	0.27	0.27	0.27	0.751	0.00	10.00	101.5	76	3.00	0.076	0.20	0.025	0.31	75	105	5.73	43							
	SS-04 (AREA 20)	**0.36**				0.27	0.751	0.00	10.00	101.5	76												375	0.012	0.50	1.22	134
	10	0.96	0.75	0.72	0.72	0.72	2.002	0.00	10.00	101.5	203	0.00	0.261	1.00	0.025	0.99	203	90	1.51	51							
	SS-02 (SS-03+SS-04+AREA 10)	**4.12**				3.09	8.590	0.00	37.91	47.2	406												750	0.012	0.20	1.22	539
	9	0.24	0.75	0.18	0.18	0.18	0.500	0.00	10.00	101.5	51	0.00	0.155	1.00	0.025	0.70	51	90	2.14	13							
	SS-16	**0.24**				0.18	0.500	0.00	10.00	101.5	51												375	0.012	0.50	1.22	134
	4	0.29	0.75	0.22	0.22	1.34	3.711	0.00	10.00	101.5	377	1.00	0.313	0.20	0.025	0.62	376	115	3.09	211							
	5	0.30	0.75	0.23	0.23	0.23	0.626	3.09	13.09	89.0	56	0.00	0.160	1.00	0.025	0.72	55	90	2.09	14							
	6	0.12	0.75	0.09	0.09	0.09	0.250	2.09	15.19	82.3	21	0.00	0.110	1.00	0.025	0.56	20	90	2.69	5							
	SS-18 INTO POND	**5.07**				3.80	10.571	2.69	17.87	75.2	795												1050	0.012	..25	######	#VALUE!
																						2 x	750	0.012	0.25	1.36	603
																											1,206
	15	0.41	0.75	0.31	0.31	0.31	0.855		10.00	101.5	87	0.00	0.183	1.18	0.025	0.85	86	110	2.15	20							
	16	0.49	0.75	0.37	0.37	0.37	1.022	0.00	10.00	101.5	104	0.00	0.202	1.00	0.025	0.84	103	55	1.09	26							
	SS-09 (AREA 16)	**0.49**				0.37	1.022	1.09	13.25	88.5	90												375	0.012	0.50	1.22	134
	27	1.52	0.75	1.14	1.14	1.45	4.024	2.15	12.15	92.4	372	1.00	0.311	0.20	0.025	0.62	371	100	2.70	208							
	26	0.32	0.75	0.24	0.24	0.61	1.689	1.09	10.00	101.5	171	1.00	0.210	0.20	0.025	0.50	171	100	3.34	96							
	SS-10 (AREA 26)	**0.32**				0.24	0.667	3.34	13.34	88.1	59												375	0.012	0.50	1.22	134
	28	0.47	0.75	0.35	0.35	0.35	0.980	2.70	10.00	101.5	99	1.00	0.158	0.20	0.025	0.43	99	100	3.91	56							
	25	0.27	0.75	0.20	0.20	0.20	0.563	0.00	10.00	101.5	57	1.00	0.117	0.20	0.025	0.36	57	100	4.61	32							
	SS-11 (AREA 25)	**0.27**				0.20	0.563	4.61	14.61	84.0	47												375	0.012	0.50	1.22	134
	29	0.44	0.75	0.33	0.33	0.33	0.917	3.91	10.00	101.5	93	1.00	0.152	0.20	0.025	0.42	92	100	3.99	52							
	24	0.14	0.75	0.11	0.11	0.11	0.292	0.00	10.00	101.5	30	1.00	0.081	0.20	0.025	0.29	30	100	5.67	17							
	SS-12 (AREA 24)	**0.14**				0.11	0.292	5.67	15.67	80.9	24												375	0.012	0.50	1.22	134
	30	0.43	0.75	0.32	0.32	0.32	0.897	3.99	10.00	101.5	91	1.00	0.150	0.20	0.025	0.41	90	100	4.02	51							
	22	0.21	0.75	0.16	0.16	0.16	0.438	5.67	10.00	101.5	44	1.00	0.101	0.20	0.025	0.33	44	100	5.01	25							
	23	0.09	0.75	0.07	0.07	0.07	0.188	0.00	10.00	101.5	19	1.00	0.063	0.20	0.025	0.25	19	100	6.56	11							
	SS-13 (AREA 22 , 23)	**0.30**				0.23	0.626	6.56	16.56	78.5	49												375	0.012	0.50	1.22	134
	31	0.12	0.75	0.09	0.09	0.09	0.250	0.00	10.00	101.5	25	1.00	0.074	0.20	0.025	0.28	25	100	5.97	14							
	21	0.62	0.75	0.47	0.47	0.47	1.293	5.01	10.00	101.5	131	1.00	0.183	0.20	0.025	0.46	131	100	3.60	73							
	SS-14 (AREA 21)	**0.62**				0.47	1.293	3.60	13.60	87.2	113												375	0.012	0.50	1.22	134
	7	0.43	0.75	0.32	0.32	0.32	0.897	0.00	10.00	101.5	91	1.00	0.150	0.20	0.025	0.41	90	100	4.02	51							
	SS-19 INTO POND	**5.04**				3.78	10.508	4.02	14.02	85.9	902												1050	0.012	0.15	1.32	1,146
																						2 x	750	0.012	0.15	1.06	467
																											934

APPENDIX J

DRAINAGE MODELLING: OTTHYMO AND HEC-RAS OUTPUTS

```
=============================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Hatch Mott MacDonald E&P
        OOO     T      T    H   H    Y    M   M   OOO                 VO2-0079
```



```
                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
  Output  filename: m:\234438 HHGS\100 yearmoedlling\Scenario2.out
  Summary filename: m:\234438 HHGS\100 yearmoedlling\Scenario2.sum


DATE: 6/20/2007                            TIME: 4:14:54 PM

USER:



COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1777.200
| Ptotal= 88.44 mm |                          B=   9.000
--------------------                          C=    .795
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    5.95 |  1.17   50.35 |  2.17   14.80 |  3.17    7.15
                  .33    6.87 |  1.33  171.05 |  2.33   12.47 |  3.33    6.61
                  .50    8.17 |  1.50   65.47 |  2.50   10.80 |  3.50    6.16
                  .67   10.16 |  1.67   35.30 |  2.67    9.55 |  3.67    5.77
                  .83   13.62 |  1.83   24.06 |  2.83    8.57 |  3.83    5.43
                 1.00   21.15 |  2.00   18.29 |  3.00    7.79 |  4.00    5.13


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0005) |   Area    (ha)=   2.33
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.75          .58
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     124.60        40.00
     Mannings n           =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    5.95 | 1.083   50.35 | 2.083   14.80 |  3.08    7.15
                 .167    5.95 | 1.167   50.35 | 2.167   14.80 |  3.17    7.15
                 .250    6.87 | 1.250  171.05 | 2.250   12.47 |  3.25    6.61
                 .333    6.87 | 1.333  171.05 | 2.333   12.47 |  3.33    6.61
                 .417    8.17 | 1.417   65.47 | 2.417   10.80 |  3.42    6.16
                 .500    8.17 | 1.500   65.47 | 2.500   10.80 |  3.50    6.16
                 .583   10.16 | 1.583   35.30 | 2.583    9.55 |  3.58    5.77
                 .667   10.16 | 1.667   35.30 | 2.667    9.55 |  3.67    5.77
                 .750   13.62 | 1.750   24.06 | 2.750    8.57 |  3.75    5.43
                 .833   13.62 | 1.833   24.06 | 2.833    8.57 |  3.83    5.43
```

```
                 .917   21.15 | 1.917   18.29 | 2.917    7.79 |  3.92    5.13
                1.000   21.15 | 2.000   18.29 | 3.000    7.79 |  4.00    5.13

     Max.Eff.Inten.(mm/hr)=     171.05       148.55
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.98 (ii)    9.00 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .75          .15           .883 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42           1.33
     RUNOFF VOLUME    (mm)=      87.44        42.87          76.30
     TOTAL RAINFALL   (mm)=      88.44        88.44          88.44
     RUNOFF COEFFICIENT   =        .99          .48            .86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=   .00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0004) |   Area    (ha)=   3.63
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.72          .91
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     155.60        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     171.05       148.55
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.98 (ii)    9.00 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.17          .24          1.376 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42           1.33
     RUNOFF VOLUME    (mm)=      87.44        42.87          76.30
     TOTAL RAINFALL   (mm)=      88.44        88.44          88.44
     RUNOFF COEFFICIENT   =        .99          .48            .86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=   .00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0005):     2.33    .883     1.33    76.30
        + ID2= 2 (0004):     3.63   1.376     1.33    76.30
          ==================================================
          ID = 3 (0003):     5.96   2.260     1.33    76.30

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

 FINISH
============================================================================================================
```

```
================================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I       SS  U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Hatch Mott MacDonald E&P
        OOO     T      T    H   H    Y    M   M   OOO                 VO2-0079
```



```
                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
  Output  filename: m:\234438 HHGS\100 yearmoedlling\Scenario2.out
  Summary filename: m:\234438 HHGS\100 yearmoedlling\Scenario2.sum


DATE: 6/20/2007                           TIME: 4:14:54 PM

USER:



COMMENTS: ____________________________________________________________


----------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1777.200
| Ptotal= 88.44 mm |                          B=   9.000
--------------------                          C=    .795
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    5.95 |  1.17   50.35 |  2.17   14.80 |  3.17    7.15
                  .33    6.87 |  1.33  171.05 |  2.33   12.47 |  3.33    6.61
                  .50    8.17 |  1.50   65.47 |  2.50   10.80 |  3.50    6.16
                  .67   10.16 |  1.67   35.30 |  2.67    9.55 |  3.67    5.77
                  .83   13.62 |  1.83   24.06 |  2.83    8.57 |  3.83    5.43
                 1.00   21.15 |  2.00   18.29 |  3.00    7.79 |  4.00    5.13


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0005) |   Area    (ha)=   2.33
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.75          .58
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     124.60        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    5.95 | 1.083   50.35 | 2.083   14.80 |  3.08    7.15
                 .167    5.95 | 1.167   50.35 | 2.167   14.80 |  3.17    7.15
                 .250    6.87 | 1.250  171.05 | 2.250   12.47 |  3.25    6.61
                 .333    6.87 | 1.333  171.05 | 2.333   12.47 |  3.33    6.61
                 .417    8.17 | 1.417   65.47 | 2.417   10.80 |  3.42    6.16
                 .500    8.17 | 1.500   65.47 | 2.500   10.80 |  3.50    6.16
                 .583   10.16 | 1.583   35.30 | 2.583    9.55 |  3.58    5.77
                 .667   10.16 | 1.667   35.30 | 2.667    9.55 |  3.67    5.77
                 .750   13.62 | 1.750   24.06 | 2.750    8.57 |  3.75    5.43
                 .833   13.62 | 1.833   24.06 | 2.833    8.57 |  3.83    5.43
```

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                .917   21.15 | 1.917   18.29 | 2.917    7.79 |  3.92    5.13
               1.000   21.15 | 2.000   18.29 | 3.000    7.79 |  4.00    5.13

     Max.Eff.Inten.(mm/hr)=     171.05       148.55
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.98 (ii)    9.00 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .75          .15           .883 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42           1.33
     RUNOFF VOLUME    (mm)=      87.44        42.87          76.30
     TOTAL RAINFALL   (mm)=      88.44        88.44          88.44
     RUNOFF COEFFICIENT   =        .99          .48            .86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=   .00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD  (0004) |   Area    (ha)=   3.63
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.72          .91
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     155.60        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     171.05       148.55
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.98 (ii)    9.00 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       1.17          .24          1.376 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42           1.33
     RUNOFF VOLUME    (mm)=      87.44        42.87          76.30
     TOTAL RAINFALL   (mm)=      88.44        88.44          88.44
     RUNOFF COEFFICIENT   =        .99          .48            .86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=   .00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

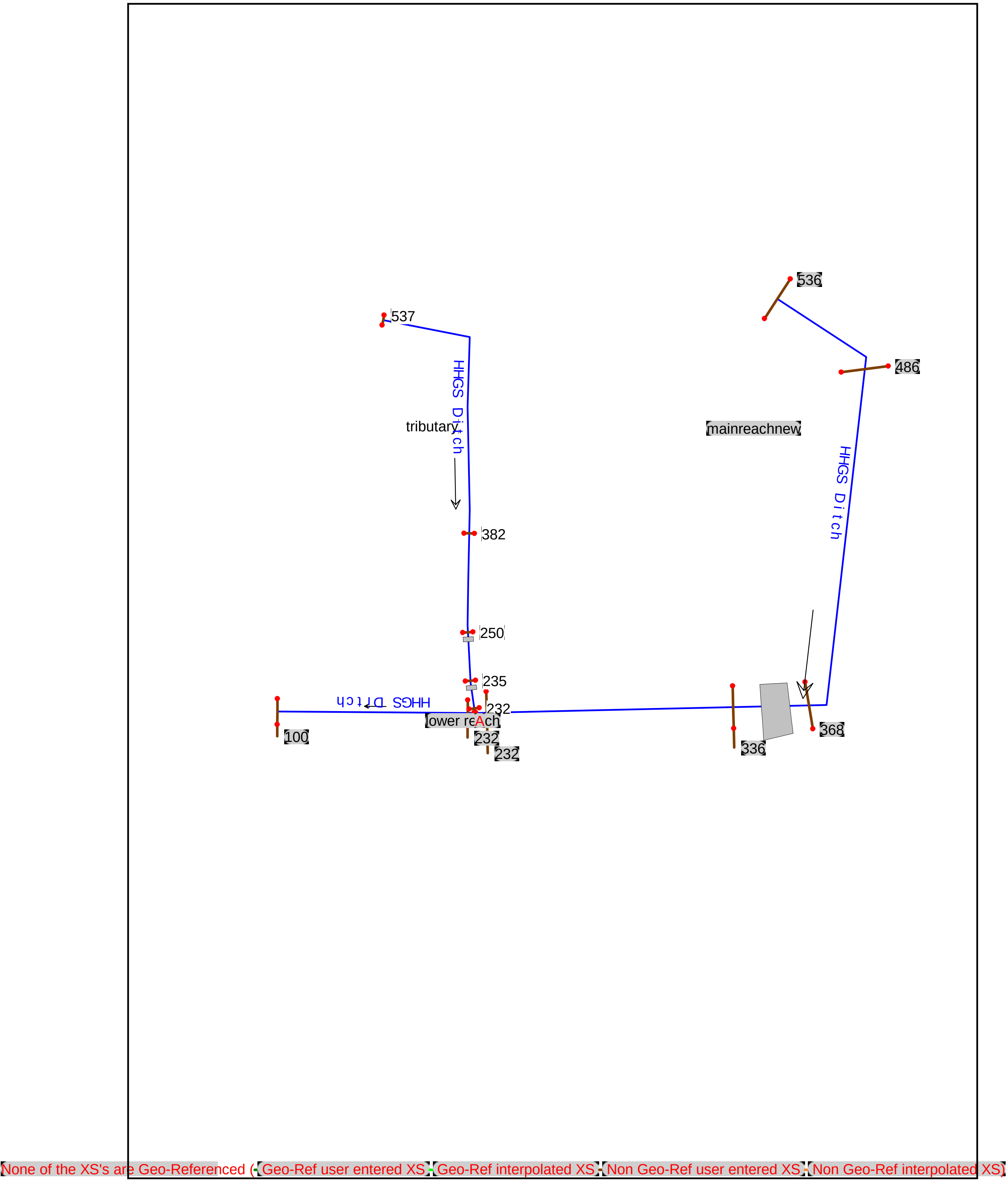
-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0005):     2.33    .883     1.33    76.30
        + ID2= 2 (0004):     3.63   1.376     1.33    76.30
          ==============================================
          ID = 3 (0003):     5.96   2.260     1.33    76.30

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

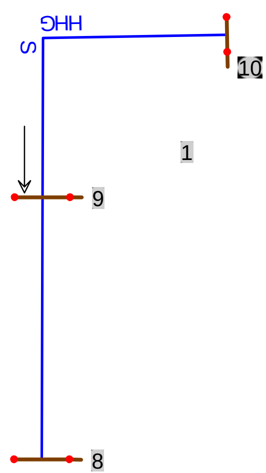
-------------------------------------------------------------------------------

 FINISH
===========================================================================================================
```


537
HHGS Ditch
tributary
382
250
235
232
lower reAch
232
232
100
HHGS Ditch
536
486
mainreachnew
HHGS Ditch
336
368
None of the XS's are Geo-Referenced (Geo-Ref user entered XS Geo-Ref interpolated XS Non Geo-Ref user entered XS Non Geo-Ref interpolated XS)

HEC-RAS Plan: Plan 01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
tributary	537	PF 1	0.25	194.50	195.15		195.15	0.000055	0.14	1.79	5.50	0.08
tributary	382	PF 1	1.09	193.72	195.14		195.14	0.000040	0.19	5.65	7.99	0.07
tributary	250	PF 1	1.09	193.35	195.13	193.87	195.13	0.000016	0.14	7.78	8.72	0.05
tributary	240		Culvert									
tributary	235	PF 1	1.09	193.30	194.64	193.82	194.64	0.000069	0.24	4.49	6.70	0.09
tributary	233		Culvert									
tributary	232	PF 1	1.87	193.30	193.94	193.94	194.11	0.010178	1.80	1.04	3.22	1.01
mainreachnew	536	PF 1	0.13	195.50	195.58	195.58	195.60	0.018202	0.62	0.20	5.22	1.00
mainreachnew	486	PF 1	0.13	194.95	195.54		195.54	0.000003	0.03	4.14	13.97	0.02
mainreachnew	368	PF 1	0.53	194.60	195.54	194.84	195.54	0.000009	0.07	7.40	15.71	0.03
mainreachnew	352		Culvert									
mainreachnew	336	PF 1	0.69	194.55	194.70	194.70	194.77	0.012544	1.11	0.62	5.02	1.01
mainreachnew	232	PF 1	0.69	193.30	193.83		193.83	0.000143	0.24	2.83	7.68	0.13
lower reach	232	PF 1	2.56	193.30	193.75		193.82	0.003796	1.15	2.24	6.96	0.64
lower reach	100	PF 1	3.02	192.84	193.58	193.24	193.61	0.000859	0.73	4.12	8.14	0.33



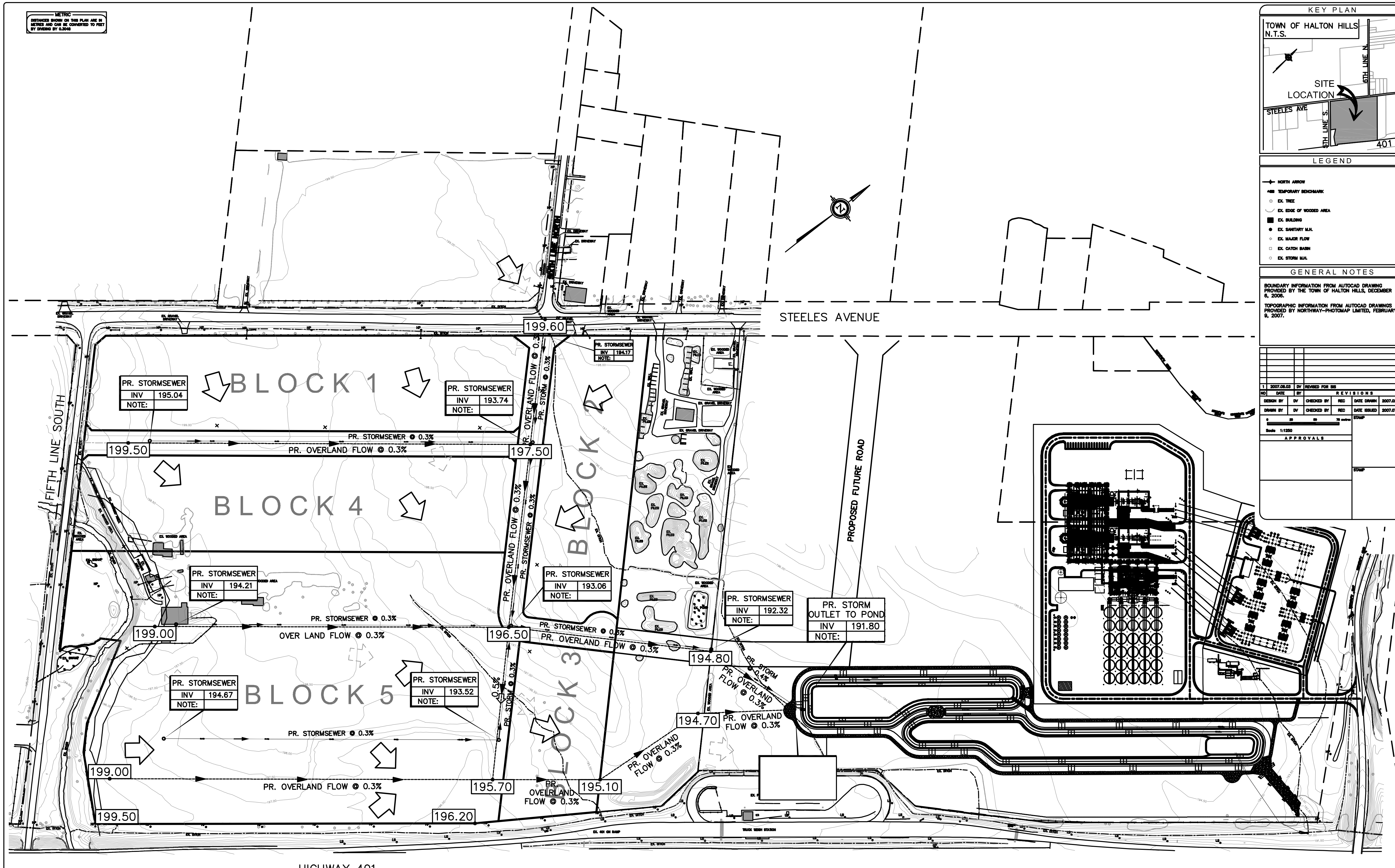
None of the XS's are Geo-Referenced (Geo-Ref user entered XS Geo-Ref interpolated XS Non Geo-Ref user entered XS Non Geo-Ref interpolated XS)

HEC-RAS Plan: Plan 01 River: HHGS Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	PF 1	0.22	193.85	194.11	194.11	194.18	0.013449	1.15	0.19	1.47	1.01
1	9	PF 1	1.38	192.94	193.61		193.62	0.000273	0.39	3.49	7.38	0.18
1	8	PF 1	2.26	192.75	193.58	193.09	193.59	0.000338	0.49	4.57	8.01	0.21

APPENDIX K

LGI DRAINAGE PLAN



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Consulting Engineers • Surveyors

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LGI DRAINAGE PLAN
SUBWATERSHED IMPACT STUDY
PART OF WEST HALF LOT 15
CONCESSION 6 (N.S TRAFALGAR)
TOWN OF HALTON HILLS
REGIONAL MUNICIPALITY OF HALTON

MUNICIPAL DRAWING No.	REGIONAL DRAWING No.
PROJECT No. 06-4761	DRAWING No. 1