PROPOSED RANNEY FALLS GENERATING STATION G3 EXPANSION PROJECT

AQUATIC TECHNICAL SUPPORT DOCUMENT

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EXECUTIVE SUMMARY

Ontario Power Generation Inc. (OPG) is proposing to expand the capacity of its Ranney Falls Generating Station (GS) located on the Trent-Severn Waterway (TSW) in the Municipality of Trent Hills. There are two powerhouses on site. The main powerhouse has the G1 and G2 turbine units, each operating at approximately 5 MW during maximum flows. A secondary powerhouse, referred to as the “Pup”, contains the 0.72 MW G3 unit that ceased operations in June 2014.

Based on a Feasibility Study for the proposed Ranney Falls GS G3 Expansion Project (Ranney Falls G3 Project or Project), it was determined that a new G3 unit of up to 10 MW could be installed at the Ranney Falls GS site. This would increase total station capacity to approximately 20 MW. The “Pup” powerhouse would be decommissioned but the building will be left in place.

The proposed Ranney Falls G3 Project is being undertaken by OPG to improve the efficient use of the available hydroelectric potential at the site, to reduce greenhouse gas emissions and to increase the amount of clean renewable energy from OPG’s Central Operations (COs). The Panel on the Future of the Trent-Severn Waterway (PFTSW, 2008) concluded that the development of renewable energy resources is a sound public policy goal and supported a vigorous effort to pursue green energy generating potential along the TSW. The proposed Project is consistent with the Provincial Policy Statement, which recommends that the use of existing infrastructure and public service facilities should be optimized, whenever feasible, before consideration is given to developing new infrastructure and public service facilities (OMMAH, 2014). OPG will operate the proposed expanded Ranney site within historical water levels (since 1951) and existing water management practices with a flow up to 171 cms at the Ranney site. There will be no increase in water levels operating the proposed site.

Spillway discharge capacity for flood control at Dam 10 (Ranney Falls) is the sole responsibility of the Trent-Severn Waterway (Parks Canada). Installation and operation of a new spillway to be built between the existing and new powerhouse to bypass powerhouse flows in the event of an emergency shutdown of the unit is the responsibility of OPG. The Spillway operation will minimize wave surge and mitigate any rapid increase in water level associated with unplanned station shutdown. The design for the new spillway will be developed during the next stage of development (Interim Licence) whereby General Construction Plans are prepared for the review and approval by the Parks Canada Agency.

This Detailed Environmental Impact Analysis (DIA) Report was prepared to fulfill federal department obligations to the *Canadian Environmental Assessment Act, 2012 CEAA,* section 67. Parks Canada’s legal accountability under CEAA 2012 is to ensure that project activities undertaken on the lands it manages do not result in significant adverse effects (Section 67 CEAA 2012). Parks Canada has jurisdiction over the bed of the canal at Ranney Falls. The DIA Report provides a description of the proposed undertaking, summarizes the overall environmental setting and anticipated environmental effects, recommends appropriate mitigation measures to minimize or obviate these effects, and describes public, agency and Aboriginal consultation. More detailed information on the environmental setting, anticipated environmental effects and recommended mitigation measures is provided in four Technical Support Documents (TSDs) addressing the aquatic environment, terrestrial environment, land use and socio-economic environment, and cultural heritage resources. Two additional TSDs provide a more detailed description of outcomes of public and government agency, as well as First Nation and Métis Nation of Ontario, consultation and engagement.

An Open House was held on the project on June 17, 2015 and over twenty-four individuals attended that meeting. No individuals indicated an opposition to the proposed Project and several people indicated support for it. However, a number of questions were asked about the Project and a few local residents raised questions with respect to traffic, noise and potentially other nuisance effects. Responses were provided to them and OPG takes the position that it is always willing to listen to concerns and issues and address them wherever possible.

Based on assessment of the available baseline information and potential effects, as well as the implementation of the recommended mitigation measures, it is concluded that effects due to construction activities associated with the proposed Project will be minimal, localized and short-term. It is anticipated that substantial economic benefits will be realized by Campbellford and other local communities due to the supply of required goods and services during the construction phase.

Based on assessment of the available baseline information and potential effects, as well as the implementation of the recommended mitigation measures, it is concluded that the operation of the proposed Project will have negligible effects on the environment.

1.0 INTRODUCTION

1.1 SCOPE OF PROJECT

The Ranney Falls Generating Station (GS) site was formerly leased by the Federal Government to the Seymour Power Company. With its purchase of the Seymour Power Company on March 9, 1916, ownership rights to the site were acquired by the Province. Ranney Falls GS G1 and G2 units were commissioned in August 22, 1922 and September 2, 1922, respectively. Unit G3, which started operation in 1926, was acquired by the Hydro-Electric Power Commission of Ontario from the Quinte and Trent Valley Power Company in 1937. Ranney Falls GS was transferred to OPG on April 1, 1999, and is managed by OPG's Central Operations (COs) with remote operation from its North Bay Control Centre and maintained by its Campbellford Service Centre.

OPG is proposing to expand the capacity of its Ranney Falls GS that is located on the Trent-Severn Waterway (TSW) within the community of Campbellford in the Municipality of Trent Hills (Trent Hills), Northumberland County (Figure 1.1). There are two powerhouses on site (Figure 1.2). The main powerhouse has the G1 and G2 turbine units, each operating at approximately 5 MW during maximum flows. A secondary powerhouse, referred to as the "Pup", contains the 0.72 MW G3 unit that ceased operations in June 2014.

Ranney Falls GS was first identified by Ontario Hydro (1992) to be within the scope of the Small Hydroelectric Assessment and Retrofit Program (SHARP) for assessment of its long-term viability as a generating resource. The SHARP was established as a formalized approach to address operational optimization of the 33 existing small and ageing hydroelectric stations within the hydraulic generation system. Based on the criteria for age, capacity and operating condition, the SHARP identified Ranney Falls GS as a potential opportunity for renewal and improvement.

As a result, a Concept Phase Study for the Ranney Falls GS was undertaken by KST Hydroelectric Engineers (KST, 1992) to review all available project options and recommend a preferred alternative, as well as to identify the detailed engineering and environmental studies and their associated costs for the Definition Phase. Due to the cancellation of the SHARP, further work associated with the redevelopment of Ranney Falls GS was terminated.

Figure 1.1 Project Location

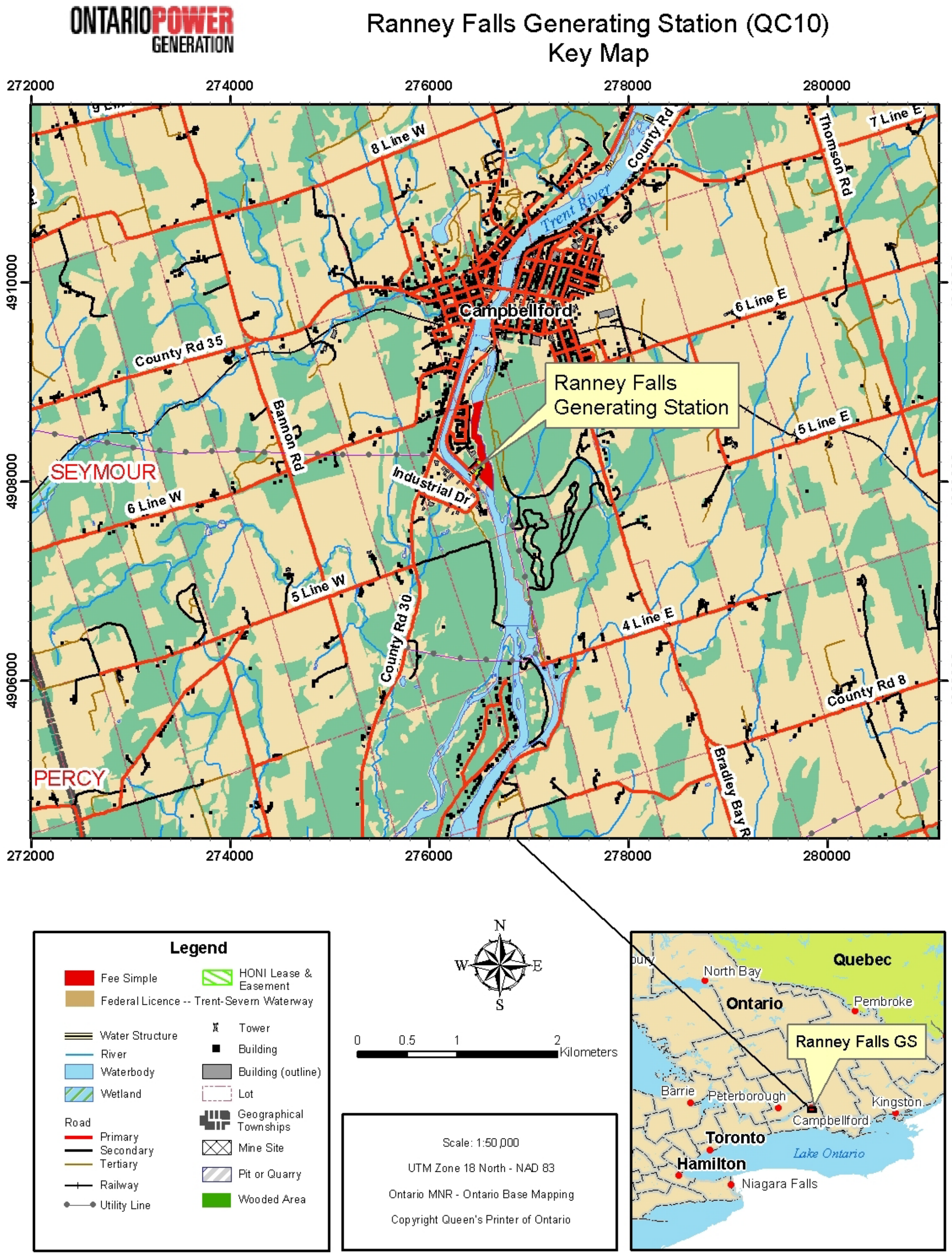


Figure 1.2 Aerial Photo of Ranney Falls GS Setting

In 2005, OPG again initiated a site evaluation and an assessment of concept alternatives for Ranney Falls GS expansion focusing on the redevelopment of the secondary “Pup” powerhouse. A Feasibility Study was completed in 2006, establishing that a new unit of up to 10 MW could be installed at the Ranney Falls GS site (Hatch Acres, 2006). This would increase the total station capacity to approximately 20 MW and result in total average annual generation of 83 GWh (an increase of 30.4 GWh). However, the project was deferred by OPG prior to initiation of the Definition Phase.

Based on the preliminary studies undertaken by KST (1992) and Hatch Acres (2006), OPG has concluded that the existing installed capacity does not make optimal use of the total water available (mean annual flow of approximately 118 m^3/s). As a result, OPG has identified an opportunity to expand its capacity by replacing the secondary “Pup” powerhouse with a new unit having an incremental capacity of up to 10 MW (OPG, 2011a).

Since 2006, the scope of the project including its layouts was further optimized and the proposed Ranney Falls G3 Project includes the following:

- expansion of the existing forebay;
- construction of a new G3 powerhouse with a new intake structure and 10 MW turbine unit adjacent to the existing main powerhouse;
- expansion of the existing tailrace channel;
- construction of a new electrical substation to connect with one of the Hydro One Networks Inc. (Hydro One) local distribution lines on site;
- construction of a new spillway to by-pass station flow to the tailrace channel for emergency situations;
- decommissioning the “Pup” powerhouse;
- rehabilitation of the forebay intake structure and its operating deck (work platform) adjacent to the roadway/TSW bridge;
- relocation of the existing upstream boom; and
- creation of enhanced habitat for Northern Map Turtle and Eastern Snapping Turtle and installation of fencing to prevent turtles accessing the construction area.

1.2 BACKGROUND

1.2.1 Purpose and Justification

The proposed Ranney Falls G3 Project undertaken by OPG is to improve the efficient use of the available hydroelectric potential at the site, to reduce greenhouse gas emissions and to increase the amount of clean renewable energy from OPG’s COs, without any changes to the overall flow within the Trent River or to existing TSW water management. The proposed Project is consistent with the Provincial Policy Statement (PPS), which recommends that the use of existing infrastructure and public service facilities should be optimized, wherever feasible, before consideration is given to developing new infrastructure and public service facilities (OMMAH, 2014).

The Ranney Falls GS is located on OPG land adjacent to Lock #11 and #12 of the TSW, which is designated as a National Historic Site of Canada. Water levels and flows in the Trent River and Trent Canal are managed by Parks Canada – TSW staff to:

- permit safe navigation;
- lessen flooding of agricultural, residential and commercial property;
- provide for recreational activities;
- protect fish and wildlife habitat;
- help maintain water quality; and
- generate green hydroelectric power.

Parks Canada – TSW staff work cooperatively with the MNRF and DFO to protect fish spawning areas and other wildlife habitat, as well as with local Conservation Authorities to reduce flooding. Parks Canada – TSW staff are also in daily contact with OPG, other public utilities and private interests, which operate and maintain generating stations within the TSW drainage basins.

A management plan for the TSW National Historic Site received ministerial approval in 2000 (Parks Canada, 2000). The Panel on the Future of the Trent-Severn Waterway (PFTSW, 2008) was mandated in 2007 to assess and make recommendations to the federal Minister of the Environment concerning the future contributions and management of the TSW. The PFTSW review pre-empted the typical five-year management plan review cycle. The process to develop a new management plan began in late 2011, and was subsequently postponed following a review of the management plan cycle. The next management plan review is scheduled for completion in 2018.

In addition to other considerations, the PFTSW considered “ways in which the Waterway can contribute to economically sustainable communities, including the role of renewable energy.” The PFTSW concluded that the development of renewable energy resources is a sound public policy goal and supported a vigorous effort to pursue the potential for generation of green energy along the TSW. The PFTSW acknowledged that the *Canadian Environmental Assessment Act* (*CEAA*), if applied knowledgeably and rigorously, provides the process and regulatory instrument for proposed hydroelectric projects to ensure the protection of natural and cultural values of the TSW. *CEAA* (S.C. 1992, c. 37) was repealed when the *Canadian Environmental Assessment Act, 2012* (*CEAA 2012*) came into force (see Section 1.0).

Northumberland-Quinte West MPP Rob Milligan held a public meeting on February 18, 2012 in Campbellford to promote new waterpower developments within the provincial riding with 37 potential hydroelectric sites identified that, if developed, could generate 21 MW of electricity, providing power to between 15,000 and 18,000 homes. The sites include old lumber and grist mills, as well as sites along the TSW.

1.2.2 Alternatives and Alternative Means

Alternative 1- Redevelopment

OPG has concluded that the existing installed capacity of Ranney Falls GS does not make optimal use of the total water available at the site. As a result, OPG has identified an opportunity to expand its capacity by replacing the "Pup" with a new unit having an incremental capacity of up to 10 MW (OPG, 2011a).

Alternative 2 – Status quo

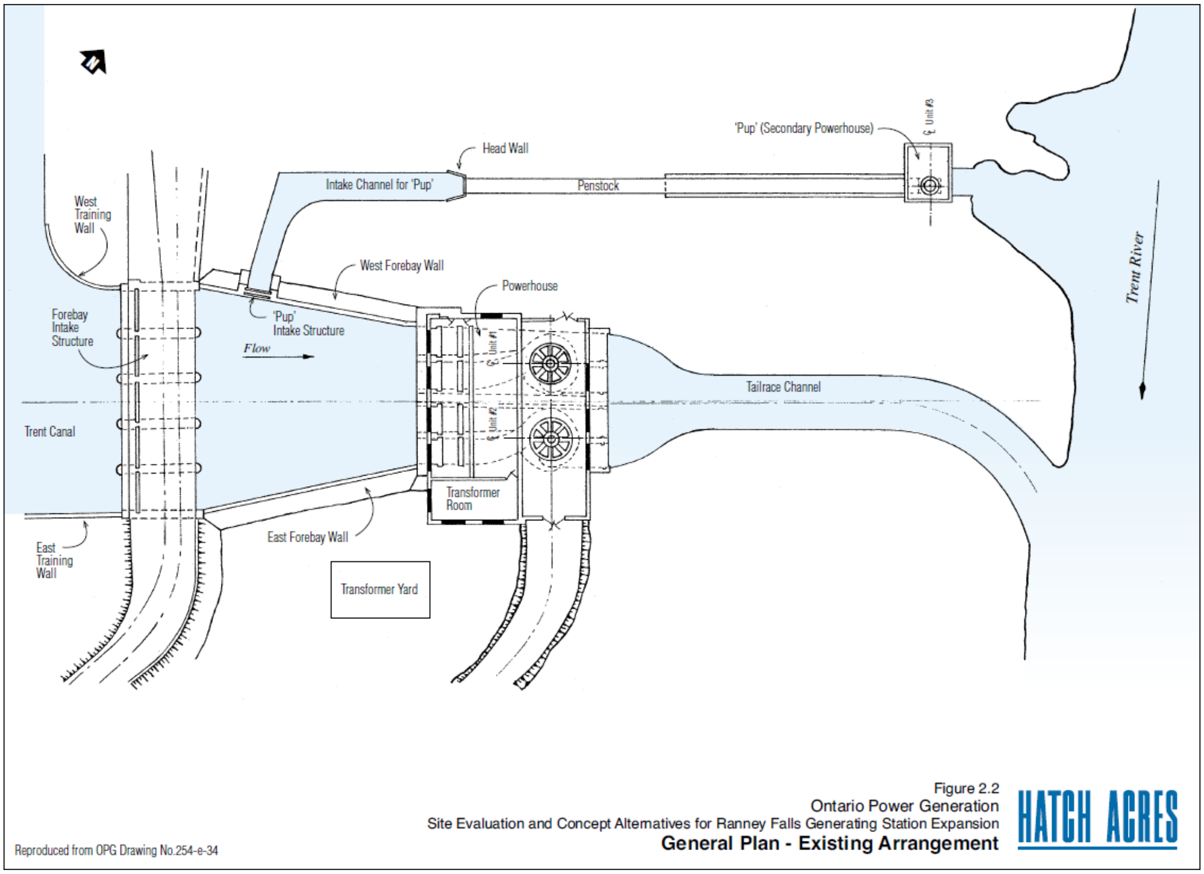
Maintenance of the "status quo" would result in the loss of hydroelectricity production capacity of 0.72 MW due to the decommissioning of the "Pup". It would also preclude the opportunity to expand the capacity of the Ranney Falls GS by replacing the "Pup" with a new unit having an incremental capacity of up to 10 MW.

1.2.3 Existing Conditions

The existing Ranney Falls GS consists of a forebay intake structure, forebay, the main powerhouse and its tailrace, the Pup and its Intake, penstock and tailrace, and storage facilities (see Figures 1.3 and 1.4). A brief description of this existing infrastructure is provided below.

Figure 1.3 Aerial Photo of Existing Ranney Falls GS Infrastructure Layout

Figure 1.4 Schematic of Existing Ranney Falls GS Infrastructure Layout



Forebay Intake Structure

The forebay intake structure, which diverts flow from the Trent Canal to the Ranney Falls GS, consists of five bay sluiceways with a road bridge to the northeast and an operating deck (work platform) for stoplog operation to the southwest. The bridge and the portions of the supporting piers under the bridge are owned and operated by Parks Canada – TSW. Parks Canada – TSW recently rehabilitated the piers with new concrete surfacing.

The operating deck, stoplogs and the portions of the supporting piers under the deck are owned and operated by OPG. The stoplogs are used to dewater the forebay. The stoplog gains and operating deck, and the portions of the supporting piers under the operating deck require repairs.

Safety booms are installed in the Trent Canal and forebay upstream and downstream of the forebay intake structure (see Figures 1.2 and 1.3).

Forebay

The existing forebay is located between the forebay intake and the headworks for the main powerhouse. Concrete gravity retaining walls contain the forebay on the east and west sides. The forebay substrate consists of bedrock. A channel in the west forebay wall supplies water to the “Pup” powerhouse. The east and west retaining walls were resurfaced in 1994 and meet current dam safety requirements.

Main Powerhouse

The main powerhouse accommodates two concrete gravity type intakes, two vertical Kaplan turbine generator units (G1 and G2) and associated electrical and mechanical equipment and systems, auxiliary mechanical and electrical systems, restroom and control room.

The main powerhouse can be accessed by the existing road to the east which was rebuilt in 1992. The road connects to Trent Drive at the bridge spanning Lock #12.

The main powerhouse tailrace channel is a man-made open cut through the layered rock formation to the Trent River.

Main Substation

The main outdoor substation (transformer yard), located to the south of the main powerhouse, accommodates one 44 kV transformer and associated electrical equipment with supporting structures and underground piping (see Figure 1.4). It connects to Hydro One’s 44 kV distribution line (R8S) at the wood pole located at the south of the Trent Drive.

Pup Facilities

The Pup facilities include the entrance gate, approach channel, intake, penstock, and powerhouse and tailrace channel. The entrance gate is located at the west retaining wall and controls the flows to the G3 unit. The approach channel is a concrete-lined open channel extending from the entrance gate to the concrete gravity intake structure at the upstream end of the penstock. The penstock is an exposed steel pipe on supporting concrete saddles which connects to the vertical Kaplan turbine generator (G3) in the “Pup” powerhouse. A short tailrace channel extends from the “Pup” powerhouse to the Trent River.

The “Pup” substation is located to the southeast of the powerhouse, accommodating a 44 kV transformer and associated electrical equipment. It connected to Hydro One’s 44kV distribution line (R9S) at the wood pole located at the south abutment of the Ranney Gorge Suspension Bridge.

The "Pup" powerhouse is accessed from Trent Drive by a road that runs parallel to the penstock to the west of the main powerhouse. A stormwater culvert draining the adjacent property to the west discharges into the penstock trench.

Storage Facility

The storage facility consists of a fenced yard and storage shed to the east of the main powerhouse and public trail to Ranney Gorge Suspension Bridge (see Figure 1.3).

Existing Ranney Falls GS Operation

The current spill discharge for flood control at the site and emergency shutdown and normal outage of the GS is the sole responsibility of Trent-Severn Waterway (TSW). TSW Dam #10 has been operated to discharge the relevant flows.

The main powerhouse has the G1 and G2 units each operating at approximately 5 MW at design flows of 47.5 m^3/s and 45.4 m^3/s, respectively (OPG, 2011a). The "Pup" powerhouse contains the 0.72 MW G3 unit with a design flow of 8 m^3/s. Total design flow is 100.9 m^3/s. The G3 unit has reached its end-of-life and ceased operation in June 2014.

Both powerhouses share a common forebay intake structure, with the G3 unit fed by a penstock from a channel branching off the forebay. The headwater of the Ranney Falls GS is the Trent Canal at the upstream end of Lock #12, with the tailwater merging into the Trent River. The average gross head is approximately 14.27 m. Dam #10 diverts flow down a 1.5 km section of canal to feed the Ranney Falls GS and the operational requirements of Locks #11 and #12. The average available flow is approximately 118 m^3/s. River flow that is in excess to the GS and lockage requirements is spilled through Dam #10 (upstream of the GS) to the original Trent River channel. The Trent River flow merges with flows from the Ranney Falls GS tailrace at 1.1 km downstream of Dam #10.

1.2.4 Federal and Provincial Approvals

Federal Approvals

A number of permits, licences and approvals under federal legislation may be required for the proposed Ranney Falls G3 Project to proceed, including:

- Parks Canada licence to carry out the undertaking under the *Dominion Water Power Act* regulations;
- Parks Canada – TSW Work Permit under the Historic Canals Regulations pursuant to the *Department of Transport Act*;
- *Fisheries Act* authorization from the DFO for harm to fish and fish habitat with conditions for mitigation and compensation; DFO has determined that the proposed Project "will not

likely result in impacts to fish and fish habitat", a formal approval from DFO is not required (C. Strand, DFO, 2012, pers. comm. and follow up DFO Fisheries Protection email dated July 31, 2014);
- *NPA* approval of any substantial interference with navigation, or determination of no interference with navigation, from Transport Canada for any works built or placed in, on, over, under, through or across "scheduled" waters;
- *Species at Risk Act (SARA)* permit for the removal of plant species at risk (SAR), or damage or destruction of SAR habitat on federal lands in Ontario; and
- Explosives Transportation Permit from Natural Resources Canada under the *Explosives Act*.

As indicated in Section 1.0, based on technical information provided by OPG, DFO has determined that the proposed Project "is not likely to result in impacts to fish and fish habitat provided that additional mitigation measures are applied" (see Section 4.1.4). Based on the LOA dated July 17, 2012, a formal approval (authorization) from DFO is not required (C. Strand, DFO, 2012, pers. comm. and follow-up DFO Fisheries Protection email dated July 31, 2014).

Environment Canada, CWS, has approved the "Turtle Nesting Habitat Mitigation Plan" prepared by OPG to create and enhance access and nesting habitat for Northern Map Turtle (*Graptemys geographica*) and Eastern Snapping Turtle (*Chelydra serpentina serpentina*), both designated as Special Concern federally and provincially (K-A. Fagan, Environment Canada, 2012, pers. comm.) (see Section 4.1.3). An In-water and Shoreline Work Permit Application was submitted to Parks Canada – TSW on December 9, 2014 to obtain approval for implementation of the Plan under the Historic Canals Regulations pursuant to the *Department of Transport Act*.

As the Trent River/Canal from Rice Lake to Lake Ontario is included in the *NPA* List of Scheduled Waters, an application (Notice of Works Form) for approval of the proposed Project was submitted by OPG to Transport Canada on December 19, 2014. OPG subsequently received a letter dated December 30, 2014 from Transport Canada indicating that the information provided by OPG was complete for the purpose of commencing agency review.

Provincial Approvals

Based on current information, a number of permits, licences and approvals under provincial legislation may also be required. These approvals and permits may include:

- Permit for SAR plant removal, or disturbance or destruction of SAR habitat from the MNRF under the *Endangered Species Act (ESA)*;
- Permits to Take Water (PTTW) for construction (including use of temporary settling pond) and dewatering if greater than 50,000 L/day from the MOECC (MOE, 2007) under the *Ontario Water Resources Act (OWRA)*;

- Environmental Compliance Approval (MOE, 2011a) for air, noise, waste disposal and/or sewage works and wastewater for spill containment associated with the new facility from the MOECC under the *Environmental Protection Act (EPA)*;
- Waste Manifest from the Ontario Ministry of Transportation (MTC) under the *Dangerous Goods Transportation Act*;
- Letters of Clearance for archaeological resources from the Ontario Ministry of Tourism, Culture and Sport (MTCS) under the *Ontario Heritage Act*; and
- Fish Scientific Collectors Permit for fish removal and relocation from the MNRF under the *Fish and Wildlife Conservation Act*.

A transmission line (115 kV or higher) greater than 2 km long associated with a generation project requires a Section 92 Leave to Construct under the *Ontario Energy Board Act* from the Ontario Energy Board. As the proposed Ranney Falls G3 Project does not involve transmission infrastructure, a section 92 Leave to Construct will not be required.

As indicated in Section 1.0, OPG is exempt from the LTC Permit for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses under Ontario Regulation 163/06 of the *Conservation Authorities Act* (M. Lovejoy, LTC, 2012, pers. comm.).

Under subsection 62.0.1(1) of the *Planning Act*, energy projects that are approved under the *EA Act* are exempt from *Planning Act* requirements. However, as the proposed Ranney Falls G3 Project is not subject to the *EA Act*, OPG will apply for Site Plan approval and a Building Permit from Trent Hills. OPG will also consult with Trent Hills regarding construction planning, schedules, noise regulation (Trent Hills, 2005) and local traffic management. An Access/Use permit for municipal road and heavy load transportation may be required from Trent Hills.

<u>Other Relevant Regulations/Guidelines Not Requiring Permitting</u>

There are a number of federal and provincial regulations/guidelines that need to be considered throughout the regulatory approval process and the subsequent construction phase that do not necessarily require a formal permitting process. These include but are not limited to the following:

<u>Federal</u>

- *Migratory Birds Convention Act (MBCA)* and Migratory Birds Regulations prohibit the taking or killing of migratory birds and their nests and eggs, and the deposit of substances harmful to migratory birds in areas they frequent;
- Migratory birds environmental assessment guideline (Milko, 1998a);
- Ontario In-water Construction Timing Window Guidelines for the Protection of Fish and Fish Habitat (DFO, 2010);

- Canadian Technical Report of Fisheries and Aquatic Sciences 2107 Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters. (Department of Fisheries and Oceans, 1998);
- Policy on Wetland Conservation (Environment Canada, 1991) with the goal of sustaining wetland functions;
- Wetlands environmental assessment guideline (Milko, 1998b);
- A Wildlife Policy for Canada (CWS, 1990; Lynch-Stewart, 2004) with the goal to maintain and restore ecological processes and the diversity of ecosystems, species and genetic variability within species;
- Canadian Biodiversity Strategy (Environment Canada, 1995) based on the Convention on Biological Diversity (UNEP, 1994) with the goal of conserving biological ecosystems, species and genetic variability within species; and
- Practitioner's Guide to the Risk Management Framework for DFO Habitat Management Staff (DFO, 2006).

Provincial

- PPS which provides policy direction on matters of provincial interest related to land use planning and development (OMMAH, 2014);
- *Places to Grow Act* administered by the Ontario Ministry of Infrastructure and the Growth Plan for the Greater Golden Horseshoe (OMPIR, 2006);
- Under the *EPA*, regulations regarding the systematic control of collection, storage, transportation, treatment, recovery and disposal of waste including hazardous waste;
- Water Management Policies and Guidelines (Policy 1 and 2) of the MOECC (MOEE, 1994);
- Ontario Biodiversity Strategy (MNR, 2005; Ontario Biodiversity Council, 2011);
- Standards and Guidelines for Consultant Archaeologists (MTC, 2010); and
- Statements of Environmental Values by the Ontario Ministry of Natural Resources, (now MNRF), Ontario Ministry of the Environment (now MOECC) and Ontario Ministry of Culture (now MTCS) under the *Environmental Bill of Rights*.

In addition, the proposed Ranney Falls G3 Project must conform to Parks Canada policy and directives (see Section 2.2.5).

A final determination of the likely applicable federal and provincial permits and approvals cannot be made until the detailed design phase of the proposed Project is complete.

1.2.5 Conformance with Parks Canada Policy and Directives

As indicated in Section 2.2.1, the management plan for the TSW National Historic Site of Canada received ministerial approval in 2000 (Parks Canada, 2000). The process to develop a new management plan began in late 2011, and was subsequently postponed following a review of the management plan cycle. The next management plan review is scheduled for completion in 2018. The proposed Project must conform to relevant Parks Canada policy and directives. Those policies and directives include:

Parks Canada Guiding Principles and Operational Policies guides stewardship responsibility to ensure that the record of our past, the rich diversity of wild spaces and species, the beauty and grandeur of our lands and seas, and the cultural character of our communities are not inadvertently lost over time. This policy document guides these efforts, designation and management.

National Historic Site Policy objectives are to foster knowledge and appreciation of Canada's past through a program of historical commemoration and to ensure commemorative integrity of national historic sites are maintained by protecting and presenting these sites and their associated resources for future generations.

Cultural Resources Management (CRM) Policy serves as the overall management policy for Parks Canada-administered national historic sites. As *CRM Policy* supports the management of cultural resources, it applies to conserving and preserving the national treasures that are under the stewardship of the Parks Canada Agency.

Historic Canals Policy Regulations outlines respecting the management, maintenance, proper use and protection of the historic canals administered by the Parks Canada Agency.

Historic Canals Policy fosters appreciation, enjoyment and understanding of Canada's historic canals by providing for navigation; by managing cultural and natural resources for purposes of protection and presentation; and by encouraging appropriate uses.

Canal Regulations outlines respecting the use and operations of canals.

OPG respectfully submits that the proposed Ranney Falls G3 Project does conform to the Parks Canada policy and directives presented above. As indicated in Section 3.1.7, the Trent Canal, Trent River, Ferris Provincial Park and Ranney Falls GS are considered to be cultural heritage landscapes (CHLs). As indicated in Section 4.2.5, construction of the proposed Project will not result in displacement of these CHLs. However, there is potential for temporary disruption to public access from the Ranney Falls GS property via the Ranney Gorge Suspension Bridge to Ferris Provincial Park on the opposite side of the Trent River (see Figure 1.3). To minimize and/or manage the potential conflict between public and construction traffic access, an Access Management Plan will be developed in consultation with Ontario Parks and Friends of Ferris Provincial Park. TSW will also be kept informed on the progress of the access management plan.

In addition, there is potential for disruption of local viewsheds from vessels using the section of the Trent Canal adjacent to the proposed Project forebay expansion, as well as for the public accessing the Ranney Gorge Suspension Bridge and Ferris Provincial Park. As partial mitigation, construction will not occur on Sundays and public holidays, likely the time of peak public boating use on the Trent Canal and recreational use of Ferris Provincial Park.

The potential access and visual disruption effects on these CHLs will be temporary, i.e., occurring during the construction phase of the proposed Project, and will be dissipated with the implementation of the Site Rehabilitation Plan.

Furthermore, there will be no displacement of the existing Ranney Falls GS powerhouse buildings. The proposed Ranney Falls G3 Project powerhouse building will adjoin the existing main powerhouse building and have a similar structure and façade, thereby providing overall architectural coherence. The “Pup” powerhouse building and tailrace will be preserved.

The operation of the proposed Ranney Falls GS Project will not affect the status and significance of the Trent Canal, Trent River, Ferris Provincial Park and Ranney Falls GS as CHLs.

As indicated in Section 4.2.4, during proposed Project operation, there will be negligible impacts on vessel utilization of the Trent Canal during the navigation season as a result of slightly higher flow velocities.

As indicated in Section 3.7, the Ranney Falls GS property supports a number of ecological functions and attributes that would potentially qualify portions of the property as Significant Wildlife Habitat. The displacement of turtle nesting habitat and potential snake hibernacula habitat will be offset by existing habitat enhancement on areas of the Ranney Falls GS property unaffected by the proposed Project, as well as on nearby TSW property (see Sections 4.1.2 and 4.1.3). Moreover, habitat on the property will be considerably increased in extent and enhanced after construction. Similarly, the implementation of mitigation measures will ensure that the proposed Project will not have an adverse effect on the proximate Significant Woodlands or their ecological functions (see Section 4.1.2).

As indicated in Section 2.2.1, the PFTSW (2008) was mandated in 2007 to assess and make recommendations to the federal Minister of the Environment concerning the future contributions and management of the TSW. The PFTSW concluded that the development of renewable energy resources is a sound public policy goal and supported a vigorous effort to pursue the potential for generation of green energy along the TSW. The proposed Ranney Falls G3 Project conforms with this policy recommendation.

1.3 PROJECT DESCRIPTION

1.3.1 Project Components

It should be noted that the proposed Project components/structures and activities presented in this section will be refined in this phase, which involves detailed engineering design to be undertaken concurrently with DIA Report preparation.

With the exception of the electrical substation, all of the structures will be located entirely on the west side of the existing main powerhouse.

As indicated in Section 2.1, the stoplog gains and operating deck, and the portions of the supporting piers under the operating deck of the forebay intake structure require rehabilitation, which will be undertaken during construction of the proposed Ranney Falls G3 Project.

The general arrangement of the proposed Project components/structures is presented in Figures 1.5 and 1.6. A brief description of each proposed infrastructure is provided below.

Figure 1.5 Aerial Photo of Existing Ranney Falls GS Showing Proposed Project Infrastructure Layout

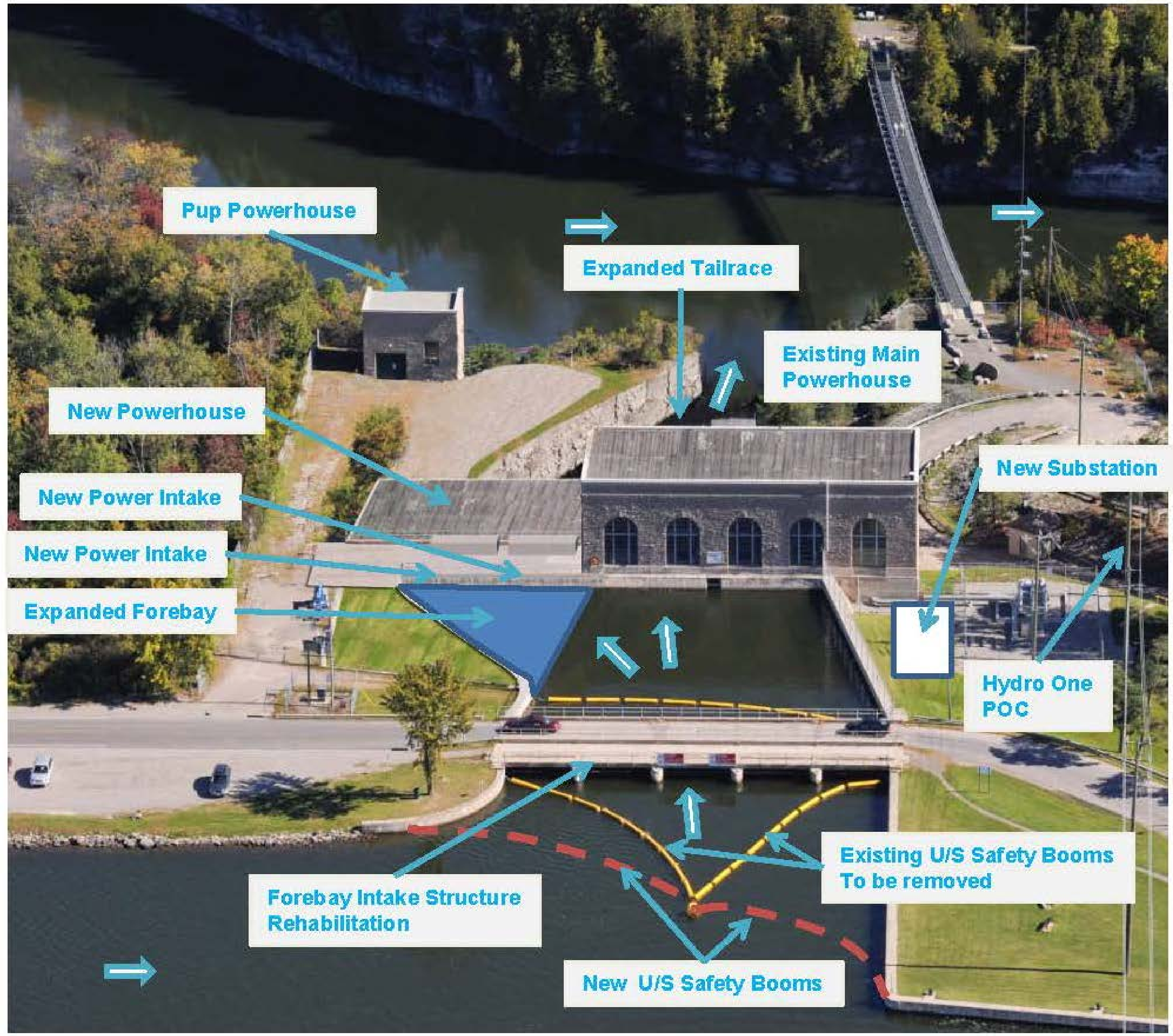
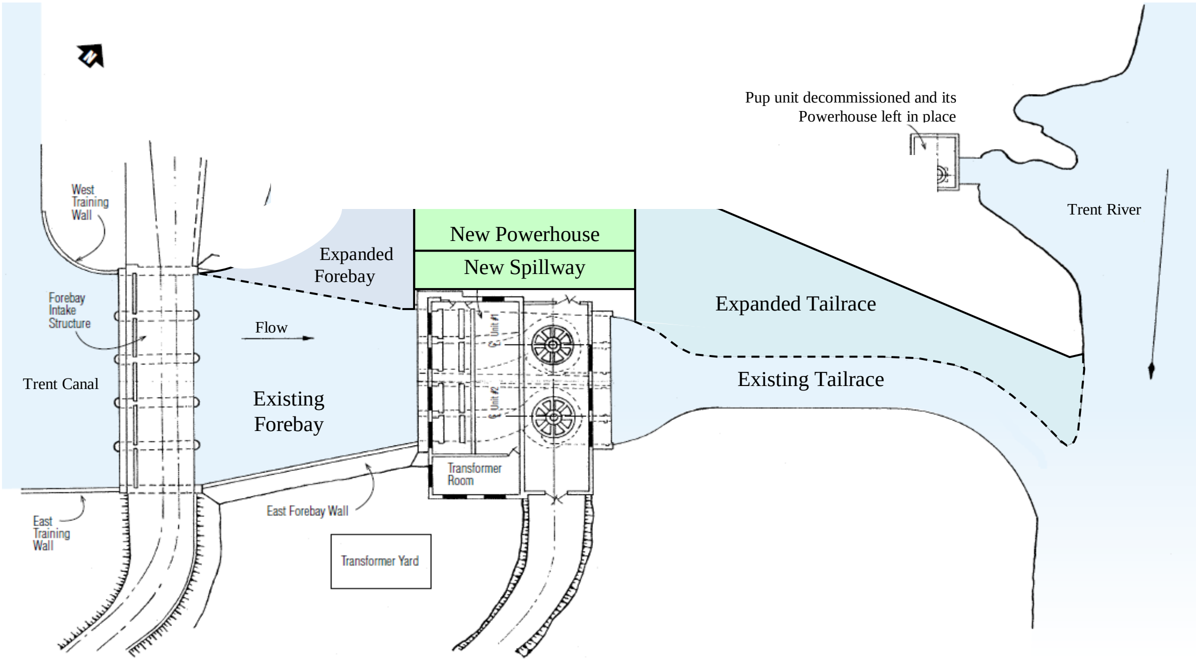


Figure 1.6 Schematic of Proposed Ranney Falls G3 Project Infrastructure Layout



Forebay Intake Rehabilitation

The forebay intake rehabilitation includes repairing the stoplog gains and operating deck, and resurfacing the portions of the supporting piers under the operating deck. The operating deck will be upgraded to accommodate the operational loads incorporate modern railings and safety signage to facilitate pedestrian use. All of the upgrade and repair work will include contemporary concrete and steel materials to renew the structure. The TSW will be provided with engineering drawings and will be consulted with on proposed repairs.

Expanded Forebay

The existing forebay will be extended westward to form a large open channel which will draw water from the Trent Canal through the forebay intake into the intakes of the existing two units (G1 and G2), the new unit (G3) and the new spillway. The new intakes will align with the existing intakes.

The west side wall of the approach channel will be streamlined from the west abutment pier of the forebay intake to the new spillway intake west wall.

The bottom slope of the expanded forebay starting from the forbay intake downstream bottom will smoothly transit downward at an approximately 16% grade. A 2 m wide and 1 m deep rock trap to capture potential debris will be constructed in front of the new powerhouse intake and spillway intake.

The expanded forebay will be designed and verified to satisfy hydraulic requirements under all new operating scenarios. Under normal operational conditions, the expanded forebay will be designed to pass the design flow of 80 m^3/s for the new G3 (a 10-time increase over the existing "Pup" unit), with total station design flow of 171 m^3/s (compared to existing flow of 100m^3/s). The current operating levels in the existing forebay fluctuate from 145.76 m to 146.21 m. The operating levels in the expanded forebay will not change. Under emergency conditions, the expanded forebay will be designed to pass the design flow of 171 m^3/s.

New Powerhouse Intake

The new G3 intake, to be constructed on competent rock foundation, will have one concrete hydraulic passage, approximately 24 m long and 10 m wide, which will initially consist of rectangular sections converging to a circular section of 7.5 m diameter that connects to a Kaplan turbine. The structure will be subject to dam safety requirements.

Trashracks made of steel will be installed in front of the new G3 intake. A 6.5 m high by 7.5 m wide vertical sliding steel gate with a lifting mechanism will be installed to allow for the complete shutdown of the turbine. The gate will be heated for winter operation. Two new sets of stoplogs will be installed upstream and downstream to dewater the water passage for station inspection and maintenance.

New Powerhouse Structures

The new powerhouse footprint will be approximately 10 m by 22 m with sufficient space to satisfy equipment operation and maintenance requirements. The powerhouse will be constructed on competent rock foundation to support the turbine generator, associated equipment and the powerhouse structure. The powerhouse will be above the unit draft tube and the spillway tunnel. The roof will be at elevation 143.0 m to facilitate the mechanical handling for turbine, spillway gate, unit gate and downstream sectional gates. The main floor will be at elevation of 134.0 m to accommodate the electrical and mechanical equipment and associated systems. All floor slabs will be designed and constructed to provide adequate lay-down area and to withstand the heaviest equipment anticipated for loading/unloading of the turbine generator. The west side wall of the powerhouse will be against rock surfaces. The east wall will be against the rock surface of the rock partition between the existing main powerhouse and the new spillway. The north bulkhead wall will face the tailrace. The south side wall will form the power intake downstream wall. All walls will be designed and constructed to be watertight. The walls will be designed to support all loads without dependence on the rock support and the support from second phase concrete. The north bulkhead wall will be designed to withstand the ice load from tailrace freezing.

A single Kaplan turbine (horizontal axis) unit with a nominal capacity of up to 10 MW at design flow of 80 m^3/s will be installed. The design of the draft tube will take into account the turbine hydraulic design requirements which prevent draft tube hydraulic instability.

New Spillway

OPG will operate the proposed expanded Ranney site within historical water levels (since 1951) and existing water management practices with a flow up to 171 cms at the Ranney site. There will be no increase in water levels operating the proposed site.

Spillway discharge capacity for flood control at Dam 10 (Ranney Falls) is the sole responsibility of the Trent-Severn Waterway (Parks Canada). Installation and operation of a new spillway to be built between the existing and new powerhouse to bypass powerhouse flows in the event of an emergency shutdown of the unit is the responsibility of OPG. The Spillway operation will minimize wave surge and mitigate any rapid increase in water level associated with unplanned station shutdown. The design for the new spillway will be developed during the next stage of development (Interim Licence) whereby General Construction Plans are prepared for the review and approval by the Parks Canada Agency.

The spillway consists of intake, tunnel, outlet and stilling basin with an overall foot print of 7 m wide by 37 m long and will be constructed on competent rock foundation. A 5 m high by 5 m wide vertical sliding steel spillway gate with heating system for winter operation will be installed at the downstream to control the flows. Stoplogs will be installed upstream and sectional gates will be installed downstream of the spillway gate to dewater the spillway tunnel.

The spillway intake will be designed to satisfy the hydraulic requirements and the outlet floor will be submerged below the minimum tailrace level to prevent ice formation in the tunnel. The spillway tunnel is 5 m by 5 m tunnel with floor sloping from elevation 13.0 down to elevation 121.44 m. The stilling basin will have energy dissipating concrete blocks to dissipate energy.

The intake and tunnel will be designed as watertight hydraulic structures and to meet dam safety requirements.

Expanded Tailrace Channel

The expanded tailrace channel will be designed with a maximum discharge capacity of 171 m^3/s, either from unit G1, G2 and G3 under normal operation or from spillway during emergency shutdown of the units. The expanded tailrace channel will be located to the east of the “Pup” powerhouse tailrace to accommodate paths for the G3 and stilling basin for the spillway. The tailrace channel will be expanded with the width near the powerhouses from 18 m to 36 m and the width at the outlet from 7 m to 18 m. The channel floor from the new G3 draft tube outlet will have a 5 m horizontal section and then subsequently change from elevation 123.0 m to 126.0 m with a slope 1V:5dvH. The channel floor from the spillway outlet will have a 15 m long stilling basin with energy dissipating blocks and then subsequently change from elevation 120.44 m to 126.0 m with a slope of 1V:2H. The channel floor from the existing G1 & G2 draft tube outlets will not be altered.

Distribution Connection

The new G3 will be connected to the other Hydro One 44 kV distribution line (R8S) that parallels the R9S line east of the existing Ranney Falls GS. The new substation will be built south to the existing substation to accommodate connecting electrical equipment and supporting structures and foundations.

Decommission of the Existing Pup Facilities

The existing Pup facilities will be decommissioned. The entrance gate will be dismantled. The existing approach channel will be incorporated into the expanded forebay. The intake structure and penstock will be removed. The powerhouse building will be preserved in accordance with the environmental assessment commitments. The existing Pup tailrace will be returned back to river bed. The single transformer station will be dismantled and all structures will be removed.

Relocation of the Upstream Safety Boom

The safety boom upstream of the forebay intake will be relocated slightly further upstream to accommodate the new operation. Safety fencing will be installed accordingly.

Creation of Habitat for Northern Map Turtle and Eastern Snapping Turtle

A complimentary habitat for Northern Map Turtle and Eastern Snapping Turtle has been created adjacent to the existing Pup tailrace area (TSW, Environment Canada and Ontario Parks will be consulted with respect to post construction monitoring).

1.3.2 Construction

The Ranney Falls G3 Project will be executed under a design-bid-build approach. During the Definition Phase, a water-to-wire (W2W) contractor will be engaged through a Request-for-Proposal (RFP) to complete the final design and layouts, and then the owner's engineer will complete the detailed design for permanent civil works. A Civil Contractor will be selected through a RFP process. All the temporary works will be the sole responsibility of the selected Civil Contractor and W2W Contractor. The Definition Phase is anticipated to be completed in December 2016.

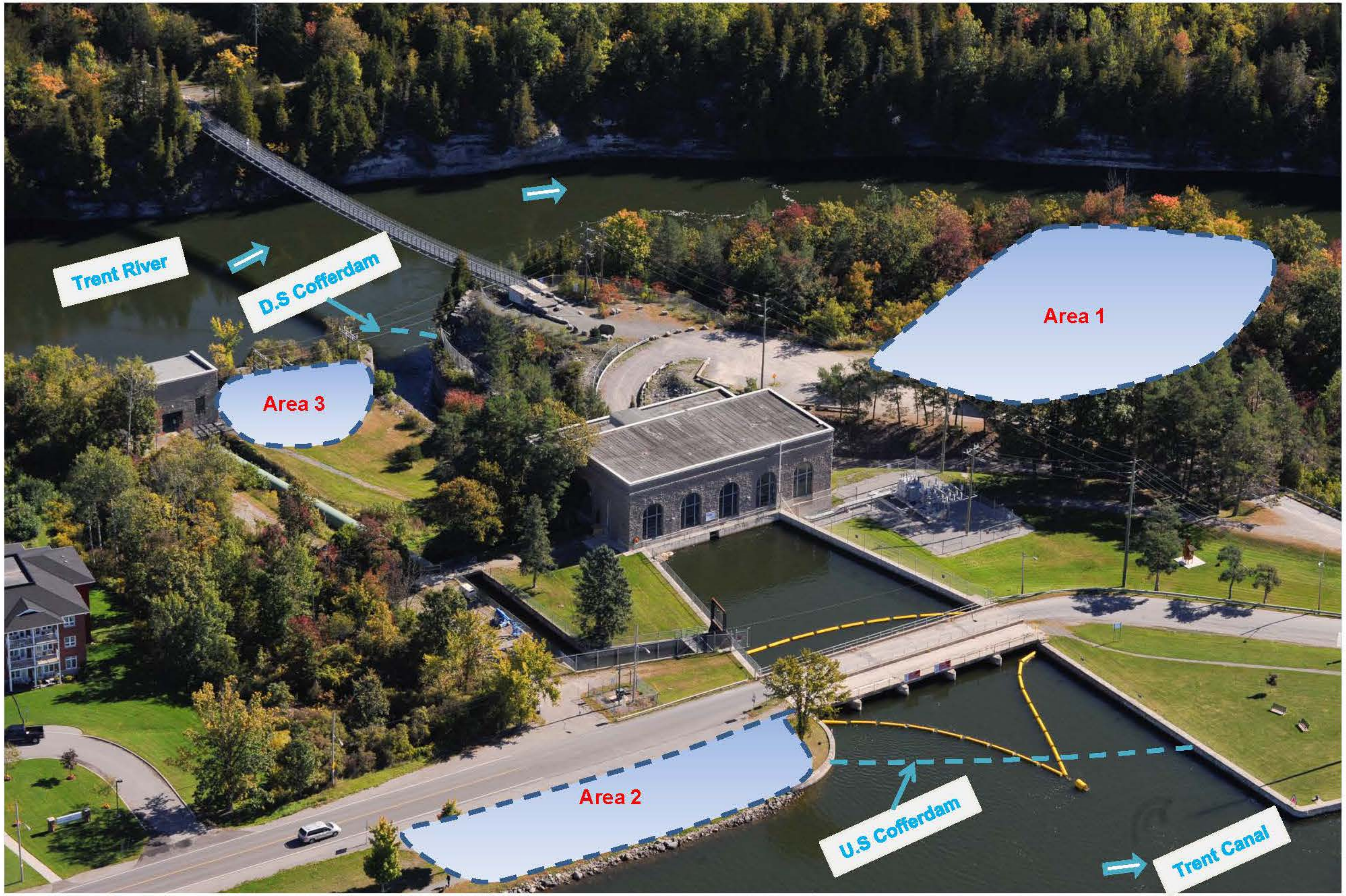
The Execution Phase includes two stages – stage 1 for civil construction and stage 2 for W2W installation. During the stage 1, the existing G1 and G2 will be taken out of service, the Civil Contractor will design, build and remove the upstream and downstream cofferdams, complete the civil construction, including forebay intake rehabilitation, excavation and construction of the expanded forebay, powerhouse intake and powerhouse, spillway, expanded tailrace and new substation foundations, installation of auxiliary electrical and mechanical equipment and systems, trashrack, unit headgate, spillway headgate and stoplogs/section gates, water up the expanded forebay and tailrace, and return the existing G1 and G2 into service. Then the stage 2 starts. The W2W Contractor will install, test and commission the turbine, generator and ancillary electrical and mechanical equipment and systems, and place the new G3 into service. The OPG project team including Owner's engineer will provide oversight during the two stages to ensure quality and schedule. The Execution Phase is anticipated to start in January 2017 and be completed by December 2019.

As the environmental assessment process will be completed during the Definition Phase, the detailed engineering design will be undertaken concurrently with DIA Report preparation. Commitments made in the DIA are being communicated to the design team.

An initial perspective on what might be the construction and installation methods that would be employed by the contractors is presented below. However, it should be noted that the final sequencing, construction and dewatering methods used would be defined by the successful contractors on the basis of environmental requirements and constraints outlined in the OPG procurement process.

Proposed construction laydown areas include OPG's storage yard, the lawn to the south of the main powerhouse and the area between the access road to the "Pup" powerhouse and the proposed expanded tailrace (see Section 4.1.2). OPG is also pursuing approval from Parks Canada – TSW for use of the lawn area south of Trent Drive to the east and west of the existing forebay.

Figure 1.7 Construction Laydown Areas



Fencing will be installed prior to construction initiation to prevent turtle access to current nesting habitat in the construction area.

During stage 1, the Civil Contractor will be the Constructor. An upstream cofferdam will be installed upstream of the forebay intake for repairing the forebay structure and civil construction. The upstream cofferdam may be made of sheet piles or rock fill. The downstream cofferdam will consist of a dam within the existing tailrace channel outlet and rock plug to seal the expanded channel portion. The dam within the existing tailrace may be made of rocks from the excavation and waterproof membrane. A cementitious grout curtain may be installed through the rock plug to stop inflows from the Trent River.

After cofferdams installation, the existing forebay and tailrace channel will be dewatered and any fish present transferred to the Trent Canal and Trent River, respectively, prior to complete dewatering. Cofferdams installation and dewatering will be undertaken outside of the timing restriction for in-water construction to protect the fish spawning and egg incubation period for warmwater and coolwater fish communities (April 1 to June 30).

The upper shale-rich bedrock domain with a thickness in the range of 18 to 23 m will be the main domain encountered during excavation (see Section 3.4). This material will form the walls of all planned excavations, temporary plugs and at least some of the excavation floors, depending on excavation depth. It is expected that the overlying overburden and upper weathered bedrock horizon with a thickness likely varying between 1 and 4 m can be excavated using conventional earthmoving equipment such as excavators and bulldozers, without ripping, or drilling and blasting. Based on the geotechnical findings, the upper shale-rich bedrock domain is considered to be non-rippable and therefore its excavation is expected to require drilling and blasting (Knight Piésold Ltd., 2011a).

The lower shale-poor bedrock domain is likely to be near the base of the excavation and the new powerhouse may be founded on this domain, or near boundaries of the two domains, i.e., upper shale-rich and lower shale-poor. Therefore, significant excavation in the lower shale-poor bedrock domain is not anticipated. If excavation of the lower domain is necessary, it is expected that drilling and blasting will be required due to its greater competency. The current excavation plan indicates that the excavation will be limited to the upper shale-rich bedrock domain (Knight Piésold Ltd., 2011a).

As indicated in Section 3.4, the upper shale-rich bedrock domain consists of inter-bedded shale and limestone with a number of weak clay-like seams believed to be associated with the shale-rich layers. Any seams in the powerhouse foundation area will be excavated if they are within 1.5 m of the excavation base. In the absence of these weak materials in the immediate vicinity of the foundation, the bearing capacity is expected to be within the range of typical values for soft bedrock (Knight Piésold Ltd., 2011a).

It is expected that the material excavated from the upper shale-rich bedrock domain may be suitable for structural fill. It will be important to ensure that the excavated material is well graded and that it contains only a small proportion of thin, flat or elongated particles (which may come from the shale layers) if it is to be used for fill (Knight Piésold Ltd., 2011a).

The shale layers and soil seams encountered in the rock walls may become locally recessed during excavation, resulting in local wall stability issues associated with overhanging limestone beds. Intersecting steeper discontinuities will need to be mapped during excavation and may result in a few wedges that need to be stabilized. Rock mass performance is expected to be reasonable and steep walls should be achievable with careful excavation practices (Knight Piésold Ltd., 2011a).

The groundwater table on the lower level of the Ranney Falls GS property occurs within the upper shale-rich bedrock domain at an approximate depth of 5 to 7 m. Groundwater and precipitation/runoff inflows can be expected due to any excavation within the upper shale-rich bedrock domain. Based on the geotechnical survey findings, inflows are expected to be manageable during excavation with inflow at a rate up to 3 to 5 l/s. Higher than expected inflows may occur if high permeability features are encountered, or if blasting and rock excavation techniques significantly modify the intrinsic hydraulic conductivity of the rock mass (Knight Piésold Ltd., 2011a). To minimize dewatering requirements, a cementitious grouting curtain may be required along the excavation line just before starting the excavation to seal the paths of groundwater inflow. The cementitious grouting will be made of cement, fine sand and water in compliance with industrial practices. Other methods that are generally accepted in the construction industry to reduce or avoid the groundwater inflow may also be employed. All the water from the construction pit will be properly tested and pre-treated if required prior to discharging into Trent River.

The drainage culvert from the adjacent property will be diverted out of the construction pit.

Once the excavation is completed, the Civil Contractor will complete the repair of the forebay structure, decommission of the existing G3 facilities, the construction of the retaining walls, intakes, powerhouse and spillway and installation of the auxiliary electrical and mechanical equipment and systems and gates. Then the Contractor will remove the upstream cofferdam and water up the forebay. The expanded tailrace channel will be watered up, and then the downstream cofferdam including the rock plug and extended riverbed will be removed through in-water excavation, adequate silt curtains will be installed to protect the Trent River water body. After the downstream cofferdam is removed, the existing G1 and G2 units will be returned to service.

During stage 2, the W2W Contractor will be the Constructor. The W2W contractor will install, test, and commission the new G3, including turbine generator, transformer, switchgear, protection and control systems, and also have responsibility for the Hydro One Network connection.

After the Civil and W2W Contractors are retained, they will develop the EMPs that will be provided to the TSW to review. That EMP will be cover a number of details but may not include all the details such as rock plug removal in the EMPs. However, OPG is willing to involve the TSW in a further review of the grouting and removal of the rock plug activities when those work activities are further planned out.

The Execution Phase including civil construction and W2W installation is anticipated to last up to 36 months with the earliest possible in-service date in 2019.

1.3.3 Operation

Operation of the new Ranney Falls complex including the existing G1 and G2, new G3 and new spillway will result in optimal use of the total water available for power generation (mean annual flow of approximately 118 m^3/s), while still complying with the current water level limits.

The new spillway that is to be built in between the existing powerhouse and the new powerhouse will be used solely to control water levels within the Trent Canal which will ensure compliance with the current level limits during an emergency shutdown of the units.

During the navigation season from mid-May to mid-October, generating flows transported through the Trent Canal by TSW are generally up to the current Ranney Falls GS design capacity of 100.9 m^3/s. With the proposed project, the maximum flow transported through the Trent Canal for power generation will be increased from 100 to 120 m^3/s. During the non-navigation season from mid-October to mid-May, the maximum generating flows transported through the Trent Canal will be up to 171 m^3/s.

As illustrated in Figure 1.8 below, Dam #10 currently diverts flow to the 1.5 km section of the Trent Canal to feed the Ranney Falls GS and meet the operational requirements of Locks #11 and #12. River flow that is in excess of the generating station and lockage requirements is spilled through Dam #10 to the original Trent River. The Trent River flow merges with flows from the Ranney Falls GS tailrace approximately 1.1 km downstream of Dam #10. Currently, the 101 m^3/s, passes through the Ranney Falls GS and Locks #11 and #12. With the proposed increased generating capacity, it is planned that a flow of up to 171 cms will be diverted to the Ranney Falls complex and Locks #11 and #12. The hydrological conditions due to dam spillage and leakage are depicted in Photographs 1.1 and 1.2, respectively.

Figure 1.8 Dam #10 & Trent Canal &Trent River

Photograph 1.1 Trent River Hydraulic Regime During Dam #10 Spillage

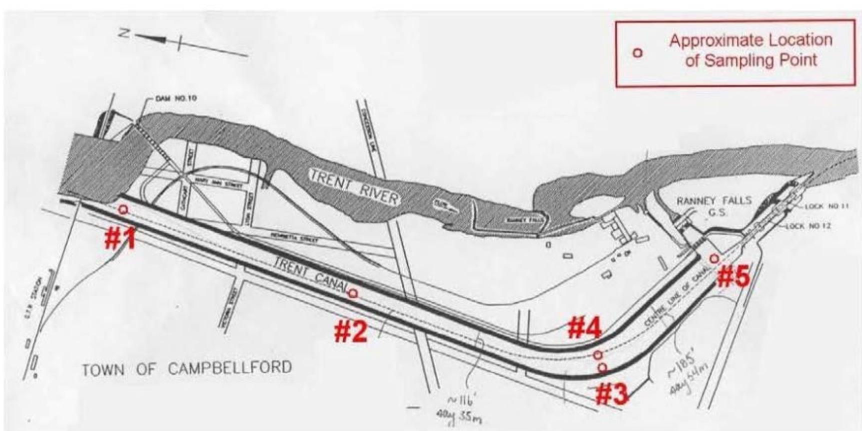
Photograph 1.2 Trent River Hydraulic Regime During Dam #10 Leakage

The new spillway will be used to by-pass station flow to the tailrace channel in emergency shutdown situations to control water levels within the Trent Canal in compliance with the current limits.

A number of studies have been undertaken to verify the hydraulic performance of this 1.5 km section of the Trent Canal under the existing water level limits with the existing and new operation flows, as well as the hydraulic performance of the existing G1 and G2 and proposed G3, and the new spillway. The conclusions have been taken into consideration ensuring the final design in compliance with the existing operation water level limits.

A study of erosion potential of bed substrate in the Trent Canal upstream of Ranney Falls GS (see Figure 1.9) due to increased flows as high as 171 m^3/s was undertaken by Environment Canada (Krishnappan, 2007). The objective of the study was to determine the critical shear stress and erosion rate of the canal's wetted perimeter. It was determined that with an applied shear stress of 8 Pa reflecting an increase in flow velocity from 0.9 m/s at the existing maximum flow of 101 m^3/s to 1.5 m/s at the proposed maximum flow of 171 m^3/s, the canal bottom armour layer remained stable with minor transport of fine material that underlies the armour layer. Moreover, the maximum equivalent canal flow rate of 171 m^3/s could be sustained in the canal without affecting canal dyke stability.

Figure 1.9 Trent Canal Bed Substrate Erosion Potential Study Locations



As part of a numerical hydraulic study, using HEC-RAS software, developed by the Hydrologic Engineering Centre (HEC) of the U.S Army Corps of Engineers (USACE), to investigate water surface profiles and flow velocities in the Trent Canal between Dam #10 and Ranney Falls GS, under the current water level limits, with the existing and future flows. The study concluded that the Trent Canal can transport the maximum power flows up to171 m^3/s, while maintaining the water levels within the current limits and maximum flow velocities within the Trent Canal will increase from 0.9 m/s to 1.5 m/s. Based on the scenarios modeled, the proposed spillway will be able to effectively control water level within the Trent Canal during an emergency shutdown of the units.

A hydraulic study using the Computational Flow Dynamics (CFD) model was undertaken to assess the potential for vortex formation at the forebay under existing and future flow conditions. Simulation of existing flow conditions indicated no major swirling flows in the flow field near the existing intakes, which is consistent with observations at Ranney Falls GS. Simulations of the future flow conditions indicated no significant cross-circulations near the new intakes, suggesting that the potential for vortex formation at the new G3 intake and spillway intake is likely to be negligible.

Figure 1.10 Flow Velocities in the Straight Canal Reach and at the Locks Based on Proposed Flow Increase

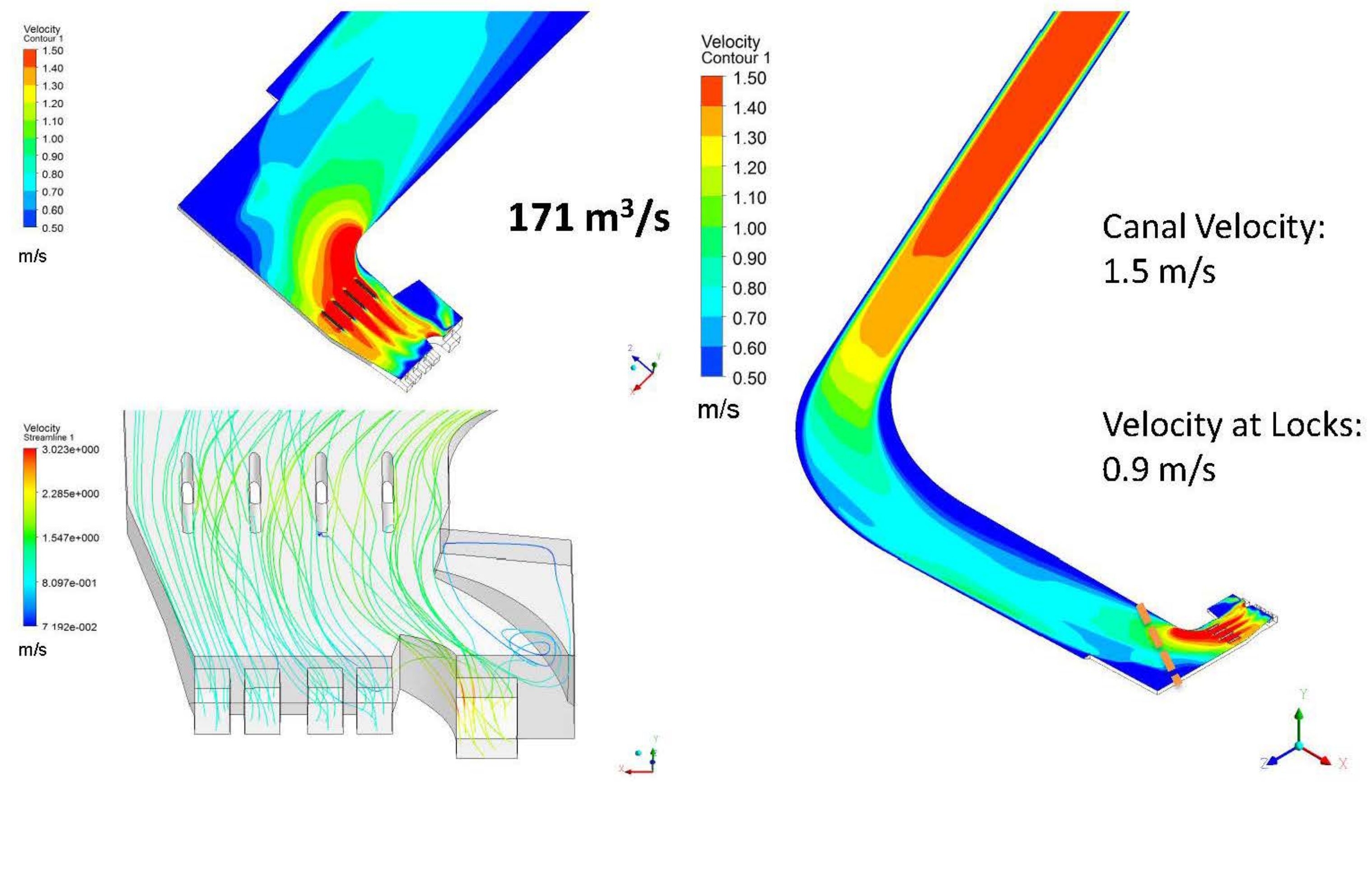
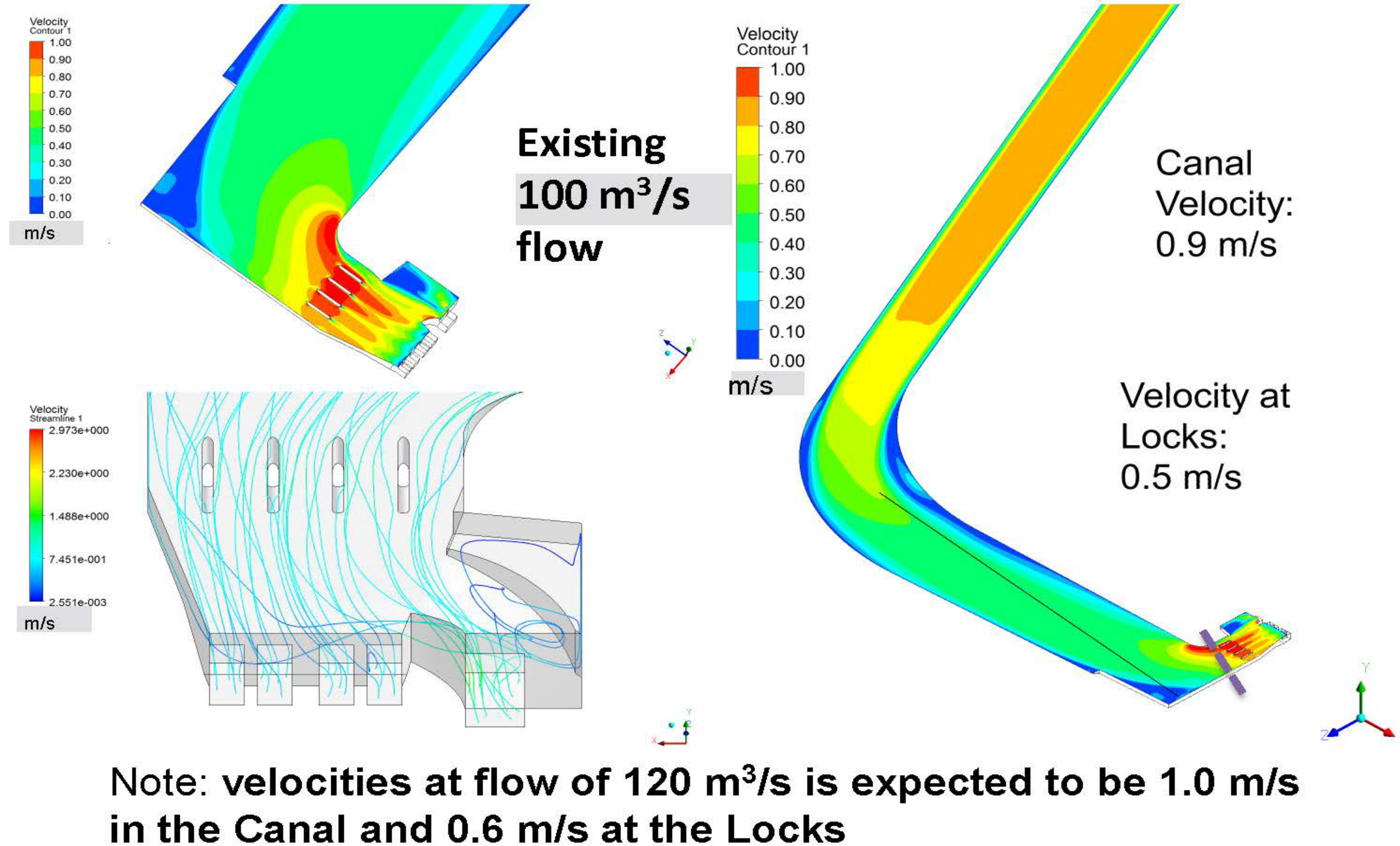


Figure 1.11 Flow Velocities in the Straight Canal Reach and at the Locks Based on Current Navigation Flow



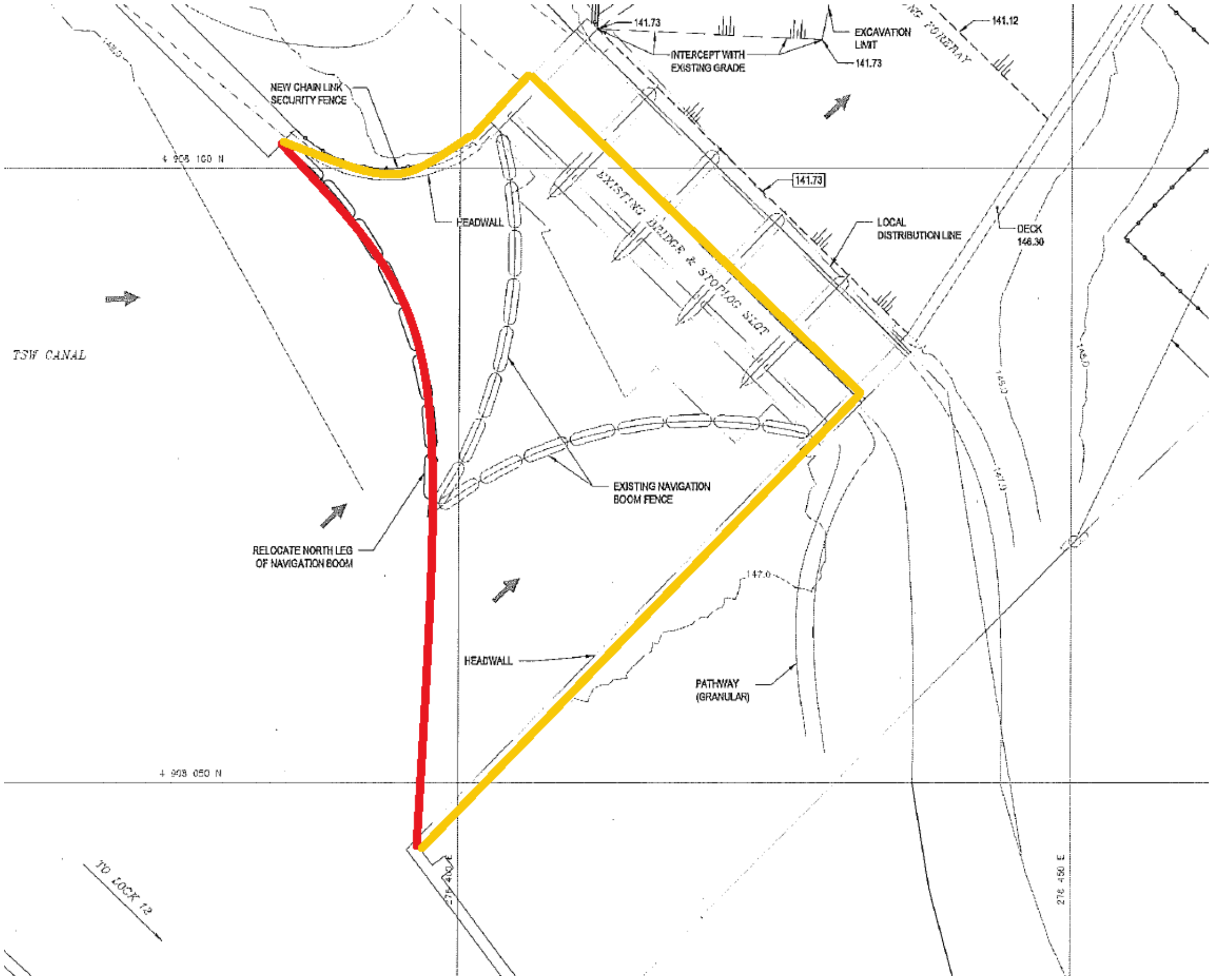
Based on a maximum flow of 171 m^3/s, velocities in the straight section of the canal and near the forebay intake structure were expected to increase from 0.9 to 1.5 m/s and from 0.5 to 0.9 m/s, respectively (see Figure 1.10). However, during the navigation season from mid-May to mid-October with flow limited to 120 m^3/s from the current 100 m^3/s, the maximum flow velocity in the straight section of the canal is expected to increase from 0.9 to 1.0 m/s (see Figure 1.11). In the area near the forebay intake structure, the maximum flow velocity is expected to only increase from 0.5 to 0.6 m/s. It should be noted that flow velocities in the navigable part of the Trent River near the Campbellford main town bridge are higher than those anticipated in the Trent Canal upstream of Locks #11 and #12.

The simulation indicated that the proposed spillway would have sufficient capacity to pass the increased flow up to 171 m^3/s.

As indicated in Section 2.3, a gate with lifting mechanism will provide for complete isolation. The existing stoplog gates in the forebay intake structure will be utilized to dewater the expanded forebay for station inspection and maintenance.

The V-shaped safety booms currently installed in the Trent Canal in front of the Forebay Intake structure will remain in place (see Figure 1.5), but will be reconfigured to prevent vessels from being subjected to the slightly higher traverse velocity. The anchor point at the tip of the north and south leg of the V will be moved outward or upstream along the curved training wall (see Figure 1.12 below).

Figure 1.12 Safety Booms



OPG will operate the proposed expanded Ranney site within historical water levels (since 1951) and existing water management practices with a flow up to 171 cms at the Ranney site. There will be no increase in water levels operating the proposed site.

Spillway discharge capacity for flood control at Dam 10 (Ranney Falls) is the sole responsibility of the Trent-Severn Waterway (Parks Canada). Installation and operation of a new spillway to be built between the existing and new powerhouse to bypass powerhouse flows in the event of an emergency shutdown of the unit is the responsibility of OPG. The Spillway operation will minimize wave surge and mitigate any rapid increase in water level associated with unplanned station shutdown. The design for the new spillway will be developed during the next stage of development (Interim Licence) whereby General Construction Plans are prepared for the review and approval by the Parks Canada Agency.

The technical and environmental aspects associated with the operation of the proposed Ranney Falls G3 Project will be reviewed during this phase, and will be refined and confirmed as the engineering work and DIA proceed.

1.4 PUP FACILITIES DECOMMISSIONING

The Pup facilities ceased operation in June 2014 and will be decommissioned. This will involve incorporation of most of its existing approach channel into the expanded forebay, removal of the intake structure and penstock, removal of single transformer station, and preservation of the powerhouse building and tailrace.

1.5 DESCRIPTION OF THE STUDY AREAS

The proposed Ranney Falls G3 Project is located within the community of Campbellford in the Municipality of Trent Hills (Trent Hills), Northumberland County (Figure 1.1).

In the baseline description of the aquatic environment, reference will be made to regional, local and site-specific study areas. These study areas are defined as follows:

Regional Study Area
The regional setting is generally defined by the lower TSW/Trent River watershed and provides for the baseline description of the watershed and associated general water uses, aquatic macrophytes and fisheries resources.

Local Study Area
The local study area is centred on the proposed Ranney Falls G3 Project location and generally extending up to 10 km in radius. The local setting provides for the environmental baseline description of water quality, benthic macroinvertebrate communities, fisheries resources and aquatic avifauna.

Site-specific Study Area
The site-specific study area includes those sections of the Trent Canal (Dam #10 to Ranney Falls GS and Locks #11 and #12) and the Trent River (Dam #10 to downstream of the Ranney Falls main powerhouse tailrace) and their aquatic components that will be affected by the proposed Project.

1.6 STUDY APPROACH

Since 2006, a number of environmental baseline studies have been undertaken for the previous design concepts for the proposed expansion of the Ranney Falls “Pup” powerhouse, including fisheries resources and fish habitat assessments, and Walleye (*Sander vitreus*) spawning surveys. The site-specific surveys and other desk-top information was used to prepare a draft Project Description (Coker, 2007) and draft Environmental Impact Assessment (Coker *et al.*, 2008) for the previously proposed project. However, the project was deferred by OPG prior to commencement of the formal EA and consultation process. Much of the information collected is still relevant for the current design.

As part of this DIA process, additional field studies have been undertaken including an additional Walleye spawning survey in spring 2008, surface water and groundwater quality monitoring as part of a geotechnical evaluation at the Ranney Falls GS site (Knight Piésold Ltd., 2011b), a bathymetric evaluation and groundwater quality monitoring as part of the Phase II Environmental Site Assessment (SENES, 2012).

1.7 STRUCTURE OF THE REPORT

As the proposed Ranney Falls G3 Project is on a federal waterway and subject to the federal *Dominion Water Power Act* administered by Parks Canada, it is not subject to the Ontario *Environmental Assessment Act* (V. Mitchell, MOE, 2012, pers. comm.). The proposed Project is also exempt from the Lower Trent Conservation (LTC) Permit for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses under Ontario Regulation 163/06 of the *Conservation Authorities Act* (M. Lovejoy, LTC, 2012, pers. comm.).

This report was prepared as a TSD to the DIA Report for the proposed Ranney Falls G3 Project (SENES, 2015) to fulfill federal department obligations to the *CEAA 2012*. As part of the federal government plan for Responsible Resource Development, which seeks to modernize the regulatory system for project reviews, the *CEAA* (S.C. 1992, c. 37) was repealed when the *CEAA 2012* came into force. For projects on federal lands that are not designated projects, *CEAA 2012* requires that before federal authorities make any decision that would allow a project to proceed, they must determine whether a project is likely to cause significant adverse environmental effects (Section 67 CEAA 2012). As *CEAA 2012* does not establish a process for determining whether the undertaking of a non-designated project is likely to cause significant adverse environmental effects, the involved federal departments, e.g., Parks Canada, DFO, Transport Canada, Environment Canada, must establish their own (or conduct joint efforts) for the environmental effects review process. The DIA Report and this Aquatic TSD provide the requisite information to enable the involved federal departments to undertake the environmental effects review process.

The DIA Report provides a description of the proposed undertaking, summarizes the overall environmental setting and anticipated environmental effects, recommends appropriate mitigation measures to minimize or obviate these effects, and describes agency, public and Aboriginal consultation.

This Aquatic TSD is organized into four main chapters:

- Chapter 1.0 **Introduction** – provides a description of the proposed Ranney Falls G3 Project, the study areas and study approach;
- Chapter 2.0 **Baseline Aquatic Environment Conditions** – describes the baseline aquatic environment conditions in the study areas;

- Chapter 3.0 **Effects Assessment and Mitigation Measures** – details the assessment of aquatic environment effects, presents mitigation measures to minimize or obviate these effects and delineates the net effects; and
- Chapter 4.0 **Summary and Conclusions** – summarizes the potential effects and recommended mitigation/remedial measures.

Chapters 5.0, 6.0 and 7.0 provide the References, Acronyms/Abbreviations and Glossary, respectively.

2.0 BASELINE AQUATIC ENVIRONMENT CONDITIONS

2.1 WATER RESOURCES

2.1.1 Site Surface Hydrology

The Ranney Falls GS property is located between the Trent Canal and Trent River. The elevation of water in the Trent Canal near the Ranney Falls GS forebay is approximately 146 m asl (above sea level) while the Trent River near the tailrace is approximately 131 m asl (Knight Piésold Ltd., 2011b). On the property, drainage generally flows from the southwest to the northeast, i.e., towards the Trent River.

A drainage culvert from the adjacent property discharges into the penstock trench under approximately the mid-point of the "Pup" powerhouse penstock.

2.1.2 Groundwater Hydrology and Quality

Four water wells were identified within a 250 m wide radius of the Ranney Falls GS based on the Ontario Ministry of the Environment and Climate Change (MOECC) Water Well Information System. As indicated in Table 2.1, the well depths ranged from 4.6 to 19.8 m, yields ranged from 0.19 to 0.95 L/s and the groundwater was fresh.

Table 2.1 Water Well Information[1]

Well Identification	**4500346**	**4501868**	**4500345**	**4501863**
Construction Date	8/1/1960	8/26/1954	7/30/1960	11/6/1956
Primary Water Use	Domestic	Domestic	Industrial	Industrial
Well Depth (m)	12.2 (40 ft)	4.6 (15 ft)	19.8 (65 ft)	16.2 (53 ft)
Pump Rate (L/s)	0.19 (3 GPM)	0.32 (5 GPM)	0.95 (15 GPM)	0.25 (4 GPM)
Static Water Level (m)	3 (10 ft)	2.1 (7 ft)	9.1 (30 ft)	11.6 (38 ft)
Clear/Cloudy	Clear	Clear	-	Clear
Water Type	Fresh	Fresh	Fresh	Fresh

[1] Source: Ecolog ERIS (2012).

Based on site-specific geotechnical investigations (Knight Piésold Ltd., 2011b), the groundwater table on the lower level of the Ranney Falls GS property is within the lower shale-poor bedrock domain at an approximate depth of 24 m. Water that flows within the unsaturated overburden likely flows down to the water table, although some horizontal flow is expected along the interface between overburden and bedrock, as well as above relatively lower permeability bedding.

The water level readings indicate that groundwater flows from the southwest to the northeast and is directed towards the main powerhouse tailrace channel on the lower section of the property (Knight Piésold Ltd., 2011b). A downward gradient was observed which decreases in magnitude with depth. The response to the Trent Canal and forebay water levels appears to be dampened and delayed in the groundwater system.

Seepage zones were identified in the main tailrace channel faces, within main powerhouse concrete cracks, in the “Pup” tailrace wall, along the “Pup” penstock trench and at the “Pup” intake headwall (Ontario Hydro, 1989; Knight Piésold Ltd., 2011b).

A borehole was drilled through the overburden and bedrock to a depth of 39.9 m on the lower portion of the Ranney Falls GS property in December 2010 and a monitoring well installed at a depth of approximately 36 m. During sampling on December 22, 2010 and June 10, 2011, the groundwater was observed to have an odour and was potentially saturated with dissolved gas as the purged water fizzed and bubbled during sample collection (Knight Piésold Ltd., 2011b).

The chloride (85,000 and 84,000 mg/L) and sodium (29,000 and 25,800 mg/L) concentrations in both samples exceeded their respective MOE (2011a) Ground Water Standards, i.e., 790 mg/L for chloride and 490 mg/L for sodium, possibly reflecting dissolution of marine salt deposits. The selenium (283 µg/L) and silver (2.99 µg/L) concentrations in one of the two samples also exceeded their respective Ground Water Standards, i.e., 10 µg/L for selenium and 1.2 µg/L for silver.

The sulphate and chloride concentrations also exceeded the Canadian Safety Association (CSA) Standards (A23.1-04/A23.2-04 December 2004) for water quality requirements for mixing concrete.

This monitoring well was resampled by SENES on May 9, 2012 to confirm the previous analytical results. The chloride (70,000 mg/L) and sodium (27,000 mg/L) concentrations in the groundwater sample were comparable to the previous two suites of sampling. The metal concentrations did not exceed their respective MOE (2011a) Ground Water Standards.

Slaine and Barker (1990) reported elevated chloride concentrations ranging from 1,000 to 20,000 mg/L and sodium concentrations ranging from 300 to 2,000 mg/L in groundwater sampled from monitoring wells 5 m into Verulam Formation bedrock in the City of Belleville. The bedrock formation in the Campbellford area is the same as in the Belleville area. The elevated concentrations were attributed to reduced permeability and longer residence times for groundwater at these depths.

As indicated above, the groundwater samples at the existing monitoring well were collected at a depth of approximately 36 m, whereas the excavation depth for the new tailrace channel will not exceed 26 m. As a result, three additional boreholes were drilled. BH12-1, located upgradient between the powerhouse and “Pup” intake channel, was drilled to a depth of 20.4 m. BH12-2 and BH12-3, located in the upper and lower portions of the proposed expanded tailrace, were drilled to depths of 26.52 and 15.72 m, respectively. Groundwater levels in the BH12-1, BH12-2 and BH12-3 boreholes were 4.59, 7.02 and 6.27 m, respectively.

Table 2.2 presents the groundwater quality data for the three monitoring wells (SENES, 2012). The concentrations of most parameters analyzed, including chloride and sodium, were below their respective Ground Water Standards and/or Provincial Water Quality Objectives (PWQOs) (MOEE, 1994). The pH of one sample was above the PWQO. Benzene concentrations in all three samples were above the Ground Water Standard, but below the PWQO. Phenolics concentrations in two samples were above the PWQO, but below the Ground Water Standard. The n-hexane concentrations in two samples were above the Ground Water Standard (there is no PWQO for n-hexane).

As a result of the detection of benzene, toluene and xylenes (BTX) in the groundwater samples collected from Verulam Formation bedrock, Slaine and Barker (1990) determined that BTX could be leached from the bituminous layers of shale that were interbedded in the limestone. The rock core testing included gas chromatograph analysis of organic free reagent water used for the leaching tests, flame ionization detection on a solvent used for leaching tests and thermal desorption analysis of the solid rock. It was concluded that hydrocarbons occur naturally within petroliferous or bituminous shale rocks.

COLESTAR (2011) also reported elevated benzene concentrations as high as 45 µg/L in groundwater samples collected from the Verulam Formation bedrock that underlies the Lennox GS property. Based on bulk chemical composition analysis of the bedrock, xylenes and petroleum hydrocarbon fractions 1 and 2 were detected in all five samples analyzed, whereas benzene, toluene and ethylbenzene were detected in three samples. It was concluded that the black shale encountered in the bedrock formation is naturally occurring, bituminous and the likely source of the petroleum hydrocarbon constituents detected in the groundwater samples.

Based on the above study findings, it is concluded that the elevated benzene, phenolics and n-hexane concentrations in groundwater at the proposed Project site are naturally occurring due to their leaching from the bituminous layers of shale that are interbedded in the limestone of the Verulam Formation.

Table 2.2 Groundwater Quality Data[1]

Parameter (mg/L unless otherwise indicated)	**BH12-1**	**BH12-2**	**BH12-3**	**Ground Water Standard[2]**	**PWQO[3]**
Conventional Parameters					
pH (units)	7.97	8.06	**10.4**[4]	-	6.5-8.5
Total Suspended Solids	<10	<10	<10	-	-
Total BOD	16	7	5	-	-
Total Phosphorus	<0.1	<0.1	<0.1	-	30[5]
Total Cyanide	<0.005	<0.005	<0.005	52	5
Chloride	21	97	69	790	-
Sodium	12/13	61/69	36/42	490	-
Metals (µg/L)					
Antimony	(1.3)[6]	(0.89)	(1.2)	6	20
Arsenic	<1.0 (<1.0)	<1.0 (<1.0)	<1.0 (<1.0)	25	5[7]
Barium	(34)	(28)	(35)	1,000	-
Beryllium	(<0.05)	(<0.05)	(<0.05)	4	1,100
Boron	(10)	(130)	(33)	5,000	200[7]

Parameter (mg/L unless otherwise indicated)	BH12-1	BH12-2	BH12-3	Ground Water Standard[2]	PWQO[3]
Cadmium	<0.10 (<0.10)	<0.10 (<0.10)	<0.10 (<0.10)	2.1	0.5[7]
Chromium (Total)	<5.0 (<5.0)	<5.0 (<5.0)	<5.0 (<5.0)	50	100
Chromium (VI)	<5	<5	<5	25	-
Cobalt	(<0.50)	(<0.50)	(<0.50)	38	0.6[7]
Copper	<1.0 (<1.0)	1.0 (<1.0)	3.8 (3.5)	69	5[7]
Lead	<0.50 (<0.50)	<0.50 (<0.50)	<0.50 (<0.50)	10	5[7]
Manganese	<2.0	37	<2.0	-	-
Mercury	<0.1	<0.1	0.16	0.1	0.2[8]
Molybdenum	(0.67)	(6.6)	(6.4)	70	10[7]
Nickel	<1.0 (<1.0)	1.5 (1.3)	7.5 (7.7)	100	25
Selenium	<2.0 (<2.0)	<2.0 (<2.0)	<2.0 (<2.0)	10	100
Silver	<0.10 (0.24)	<0.10 (<0.10)	<0.10 (<0.10)	1.2	0.1
Thallium	(<0.05)	(0.64)	(0.05)	2	0.3[7]
Uranium	(0.43)	(0.61)	(<0.10)	20	5[7]
Vanadium	(0.54)	(<0.50)	(6.2)	6.2	7[7]
Zinc (µg/L)	<5.0 (<5.0)	7.5 (<5.0)	28 (<5.0)	890	20[7]
Petroleum Hydrocarbons (µg/L)					
F1 (C6-C10)	<25	52	35	420	-
F2 (C10-C16)	<100	120	<100	150	-
F3 (C16-C34)	<100	<100	<100	500	-
F4 (C34-C50)	<100	<100	<100	500	-
Volatile Organics (µg/L)					
Acetone	<10	11	16	2,700	-
Benzene	**0.56**	**6.7**	**7.6**	0.5	100[7]
Bromodichloromethane	<0.10	<0.10	<0.10	16	200[7]
Bromoform	<0.20	<0.20	<0.20	5	60[7]
Bromomethane	<0.10	<0.10	<0.10	0.89	0.9[7]
Carbon tetrachloride	<0.10	<0.10	<0.10	0.2	-
Chlorobenzene	<0.10	<0.10	<0.10	30	15
Chlorodibromomethane	<0.20	<0.20	<0.20	25	40[7]
Chloroform	<0.10	<0.10	<0.10	2	-
1,2-Dichlorobenzene	<0.20	<0.20	<0.20	3	2.5
1,3-Dichlorobenzene	<0.20	<0.20	<0.20	59	2.5
1,4-Dichlorobenzene	<0.20	<0.20	<0.20	0.5	4
1,2-Dibromomethane	<0.20	<0.20	<0.20	0.2	-
Dichlorodifluoromethane	<0.50	<0.50	<0.50	590	-
1,1-Dichloroethane	<0.10	<0.10	<0.10	5	200[7]
1,2-Dichloroethane	<0.20	<0.20	<0.20	0.5	100[7]
1,1-Dichloroethylene	<0.10	<0.10	<0.10	0.5	40[7]
cis-1,2-Dichloroethylene	<0.10	<0.10	<0.10	1.6	200[7]
trans-1,2-Dichloroethylene	<0.10	<0.10	<0.10	1.6	200[7]
1,2-Dichloropropane	<0.10	<0.10	<0.10	0.58	0.7[7]
cis-1,3-Dichloropropene	<0.20	<0.20	<0.20	0.5	-
trans-1,3-Dichloropropene	<0.20	<0.20	<0.20	0.5	7[7]
Ethylbenzene	<0.10	1.4	0.95	2.4	8[7]
n-Hexane	2.3	**8.6**	**6**	5	-
Methylene Chloride	<0.50	<0.50	<0.50	26	100[7]
Methyl Ethyl Ketone	<5.0	<5.0	<5.0	1,800	400[7]
Methyl Isobutyl Ketone	<5.0	<5.0	<5.0	640	-
Methyl Tert Butyl Ketone	<0.20	<0.20	<0.20	15	200[7]
Styrene	<0.20	<0.20	<0.20	5.4	4[7]
1,1,1,2-Tetrachoroethane	<0.20	<0.20	<0.20	1.1	20[7]
1,1,2,2-Tetrachloroethane	<0.20	<0.20	<0.20	0.5	70[7]
Tetrachloroethylene	<0.10	<0.10	<0.10	0.5	50[7]
Toluene	0.46	7.1	8.1	22	0.8[7]
1,1,1-Trichloroethane	<0.10	<0.10	<0.10	23	10[7]

Parameter (mg/L unless otherwise indicated)	BH12-1	BH12-2	BH12-3	Ground Water Standard[2]	PWQO[3]
1,1,2-Trichloroethane	<0.20	<0.20	<0.20	0.5	800[7]
Trichlorofluoromethane	<0.20	<0.20	<0.20	150	-
Trichloroethylene	<0.10	<0.10	<0.10	0.5	20[7]
Vinyl Chloride	<0.20	<0.20	<0.20	0.5	400
m+p-Xylene	<0.01	6.0	3.3	-	2[7,9];30[7,10]
o-Xylene	0.13	2.5	2.2	-	40[7]
Xylene (Total)	0..13	8.6	5.5	72	-
Semi-volatile Organics (µg/L)					
Di-N-butyl phthalate	<2	<2	<2	-	-
Bis(2-ethylhexyl)phthalate	<2	<2	<2	-	0.6
3,3'-Dichlorobenzidine	<0.8	<0.8	<0.8	0.5	0.6[7]
Pentachlorophenol	<1	<1	<1	30	0.5
Phenols (µg/L)					
Phenolics	<1	**11**	**45**	890	1
Nonyl phenols	2	20	50	-	0.04[7]
Nonyl phenol ethoxylatesq	<5	<5	5	-	-
Pesticides and Other Organic Compounds (µg/L)					
Aldrin + Dieldrin	<0.005	<0.005	<0.005	0.35[7]	0.001
α-Chlordane	<0.005	<0.005	<0.005	-	-
γ -Chlordane	<0.005	<0.005	<0.005	-	-
Chlordane (Total)	<0.005	<0.005	<0.005	0.04	0.06
o,p-DDT	<0.005	<0.005	<0.005	-	-
p,p-DDT	<0.005	<0.005	<0.005	-	-
o,p-DDT + p,p-DDT	<0.005	<0.005	<0.005	0.00004	0.003[11]
Hexachlorobenzene	<0.005	<0.005	<0.005	0.00004	0.0065
Mirex	<0.005	<0.005	<0.005	0.04	0.001
Total PCBs	<0.05	<0.05	<0.05	0.2	0.001
Total PAHs	<1	3	<1	-	-

1 Source: SENES (2012).
2 Most stringent generic site condition Ground Water Standard for shallow soils (Table 6) and for use within 30 m of a water body (Table 8) in a potable ground water condition (MOE, 2011a).
3 PWQO=Provincial Water Quality Objective (MOEE, 1994).
4 **Bold** value exceeds the MOE (2011a) Ground Water Standard or MOEE (1994) PWQO.
5 Interim PWQG: excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.030 mg/L.
6 Bracketed value based on 0.45 µ filtered sample.
7 Interim PWQO.
8 Based on a filtered water sample.
9 PWQO for m-xylene.
10 PWQO for p-xylene.
11 PWQO for DDT and metabolites, including DDD and DDE.

2.1.3 TSW/Trent River Hydrology

The Trent River and the TSW occur within the Northern Lake Ontario drainage basin in the Great Lakes-St. Lawrence Drainage System (Chapman and Putnam, 1984). The Trent River drainage basin drains more than 12,000 km^2, including several hundred lakes.

The TSW spans two main watersheds: the Trent River watershed drains in a southeasterly direction into Lake Ontario at Trenton, and the Severn River drains in a north-westerly direction to Georgian Bay at Port Severn. At the height of land near Kirkfield, a dug canal joins Balsam Lake to the artificially widened Grass River (known as Mitchell Lake), and thus unites the two watersheds. From Balsam Lake with an elevation of 256.3 m asl, the Trent system flows 260 km to Lake Ontario at 74.4 m asl.

This substantial area results in an average annual flow rate of approximately 150 m^3/s, and a 5-year return peak instantaneous flow of approximately 650 m^3/s, near its mouth. At Ranney Falls GS the average annual flow rate is approximately 118 m^3/s, and the maximum and minimum mean monthly flows are 205 m^3/s (April) and 31.6 m^3/s (August), respectively. Flows in the system are regulated by Parks Canada – TSW, primarily for navigation and maintenance of water levels, with flows in excess of these needs being available for hydroelectric generation.

Table 2.3 presents minimum, maximum, as well as monthly and annual mean discharges for the Trent River at Healey Falls and Glen Ross, upstream and downstream of Ranney Falls GS, respectively, based on Water Survey of Canada historical streamflow data. Flow data are also provided for the Trent Canal at Ranney Falls GS based on summation of flow data for the Trent River at Healey Falls and the Crowe River which is the only source of significant flow to the Trent River upstream of Ranney Falls GS. Greatest flow occurs during the spring freshet in April with the lowest flows occurring during the summer in August.

Table 2.3 Minimum, Maximum, as well as Monthly and Annual Mean Discharges (m^3/s)[1]

Flow	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Trent River at Healey Falls[2]													
Minimum	38.7	31.4	41.4	43.8	18.1	16.4	14.4	15.8	19.4	26.3	28.3	38.4	49.6
Maximum	262	203	293	378	381	160	177	64.8	137	204	242	269	142
Mean	119	109	130	205	128	60.4	38.4	31.6	43.9	64.5	93.0	112	94.5
Trent Canal at Ranney Falls GS[3]													
Minimum	41.6	36.0	46.6	63.9	28.5	18.6	15.7	16.8	19.5	27.2	29.1	40.5	61.8
Maximum	321	251	375	514	478	202	213	81.5	163	260	307	337	176
Mean	143	129	161	281	172	78.6	46.5	35.7	48.8	73.9	112	139	118
Trent River at Glen Ross[4]													
Minimum	73.7	71.9	73.4	77.3	43.1	17.6	16.5	16.3	23.0	27.4	20.8	47.7	67.9
Maximum	441	293	413	505	388	200	259	91.1	171	303	376	350	198
Mean	174	156	208	330	191	88.4	53.7	41.1	58.8	92.1	145	174	142

1 Source: http://www.wsc.ec.gc.ca/hydat/H2O/WEBfmMeanReport_e.cfm
2 Station 02HK002; Latitude: 44º22'14"N, Longitude: 77º46'42"W; Drainage area: 9,090 km^2; Period of record: 1949-2003.
3 Based on summation of flow data for Trent River at Healey Falls and the Crowe River at Marmora (Station 02HK003; Latitude: 44º28'53"N, Longitude: 77º41'5"W; Drainage area: 1,990 km^2; Period of record: 1959-2010).
4 Station 02HK004; Latitude: 44º15'50"N, Longitude: 77º36'10"W; Drainage area: 12,000 km^2; Period of record: 1963-1995.

The Trent River is highly modified and for more than a century has been part of the TSW. Numerous locks and dams punctuate the river, maintaining artificial water levels throughout the river and interconnected lakes for navigation purposes. The only higher gradient sections that provide riffle habitats are outside of the navigation channel, at the base of dams, in spill channels, or in sections of river bypassed by the navigation channel. Habitat in these areas is typically maintained during dry periods by intentional dam spillage to maintain a minimum flow, by leakage through dams and/or groundwater and precipitation event inflows.

During Dam #10 closure, leakage is estimated to be 0.5 m^3/s or less (Coker *et al*., 2012). When the river flow exceeds the capacity of the existing Ranney Falls GS and navigational requirements for Locks #11 and #12, the excess flow is spilled through Dam #10 (see Photograph 1.1). Flow velocity is fast during spillage as there is an approximately 10-m difference in elevation over the 900 m reach between the downstream side of Dam #10 and the brink of Ranney Falls. The excess flow that passes over Ranney Falls creates an area of fast, turbulent flow for a short distance downstream of the falls. The swift flows continue along the east shore of the river and are joined by the flows from the two powerhouse tailraces, creating a visibly turbulent flow across the entire river. The remainder of the reach between Locks #10 and #11 is a 2.75-km long section of deep flatwater habitat.

River freeze-up generally occurs at the end of December, whereas ice break-up usually occurs in mid-March (MNR, 1984). The freeze-up and break-up dates are approximate and will vary according to ambient temperature, channel width and orientation, and water flow.

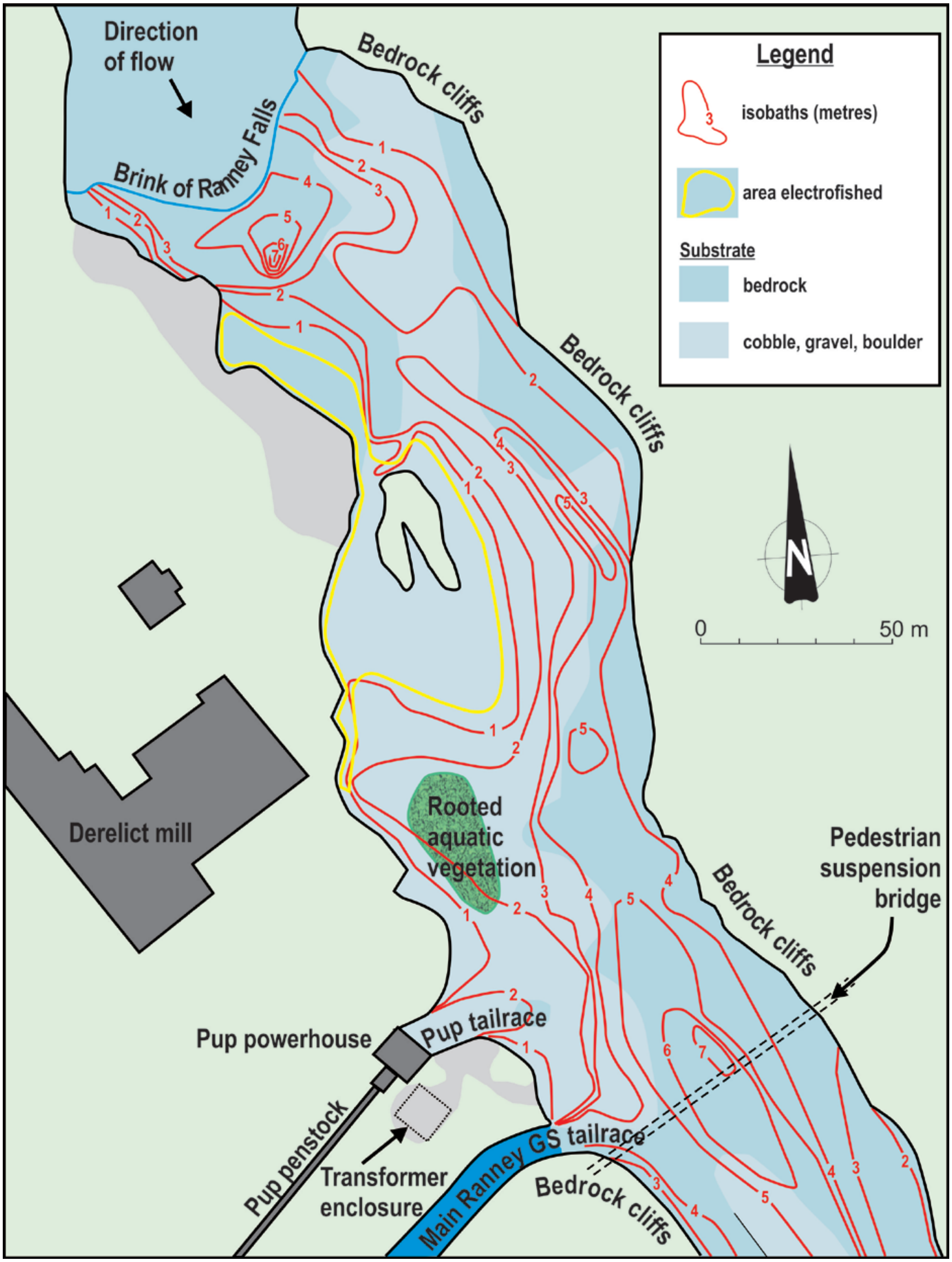
2.1.4 TSW/Trent River Morphology and Bathymetry

The section of the Trent Canal from Dam #10 downstream to Ranney Falls GS and Locks #11 and #12 ranges from 41 to 77 m in width and is approximately 3 m deep throughout, except near the Ranney Falls GS intake where water depth is approximately 5 m (Coker *et al*., 2012).

The section of the Trent River downstream of Dam #10 to Ranney Falls is approximately 900 m long with a maximum depth of 2 to 3 m during dam spillage (Coker *et al*., 2012). As indicated in Section 2.1.3, a small amount of leakage estimated to be 0.5 m^3/s or less occurs when Dam #10 is closed. This flow feeds a series of shallow pools and riffles on the bedrock substrate (see Photograph 1.2).

The section of the Trent River from Ranney Falls to the Ranney Falls GS main powerhouse tailrace is approximately 260 m long and 50 to 80 m wide (Coker *et al*., 2012). During Dam #10 spillage, water depth is generally 2 to 3 m to a maximum of 7 m (see Figure 2.1).

Figure 2.1 Trent River Bathymetry, Substrate and Main Habitat Features



2.2 AQUATIC ENVIRONMENT RESOURCES

2.2.1 Water Quality

Table 2.4 presents water quality data for the Trent River at Healey Falls Dam Bridge and Glen Ross Road upstream and downstream, respectively, of the Ranney Falls GS. In general, the concentrations of the parameters analyzed were below their respective Provincial Water Quality Objectives (PWQOs). Cadmium concentrations in one or more samples and cobalt concentrations in one or two samples collected in all four years exceeded their respective PWQOs. The copper concentration in one sample collected in 2005 was above the PWQO (Table 2.4a). The pH value in one sample taken in 2006 was above the PWQO range of 6.5 to 8.5 to protect aquatic life (Table 2.4b). The total phosphorus concentrations in one sample collected in 2007 and 2008 were above the interim PWQO of 0.030 mg/L for the elimination of excessive plant growth in rivers (Tables 2.4c and 2.4d). The aluminum concentration in one sample collected in 2007 exceeded the PWQO (Table 2.4c); however, it is unlikely that the aluminum analyses were based on clay-free samples as required for comparison with the PWQO.

Table 2.4a 2005 Trent River Water Quality Data[1]

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
	May 16	June 24	July 18	Aug 16	May 16	June 24	July 18	Aug 16	
pH (units)	8.14	8.16	8.41	8.40	8.19	8.27	8.43	8.35	6.5-8.5
Turbidity (NTU)	1.00	1.14	1.27	1.85	0.98	1.31	0.74	2.00	-[3]
Conductivity (µmhos/cm)	264	224	236	247	254	228	233	235	-
Alkalinity (as CaCO^3)	108	85.5	92	95.5	107	89.8	95.8	93.2	-[4]
Hardness (as CaCO^3)	114	92.2	95.0	98.2	113	98.8	98.0	97.4	-
Total Suspended Solids	1.5	1.7	1.6	4.4	1.4	2.3	1.1	3.8	-
Ammonia, Total (as N)	0.031	0.035	0.019	0.002	0.023	0.018	0.018	0.021	-[5]
Nitrite (as N)	0.004	0.002	0.001	0.001	0.004	0.004	0.001	0.002	-
Nitrate (as N)	0.139	0.024	0.005	0.005	0.109	0.039	0.012	0.005	-
Total Kjeldahl Nitrogen	0.40	0.41	0.44	0.48	0.37	0.40	0.41	0.47	-
Total Phosphorus	0.018	0.026	0.026	0.029	0.017	0.018	0.022	0.030	30[6]
Phosphate (as P)	0.0005	0.0102	0.0031	0.0044	0.0007	0.0084	0.0043	0.0045	-
Chloride	14.6	14.4	15.3	15.0	12.7	12.7	13.3	13.9	-
Calcium	37.5	30.1	31.5	32.7	36.8	31.7	32.2	32.2	-
Magnesium	3.48	3.73	3.87	4.02	3.59	3.72	4.02	4.16	-
Potassium	1.15	0.97	1.19	1.12	1.15	0.91	1.05	1.01	-
Sodium	7.84	8.12	8.32	8.18	6.96	7.26	7.44	7.72	-
Aluminum (µg/L)	29.3	15.5	11.6	-	24.0	13.5	10.6	-	75[7]
Barium (µg/L)	30.6	26.7	41.2	-	29.8	29.4	36.4	-	-
Beryllium (µg/L)	0.0079	0.0139	0.0151	-	0.0108	0.0105	0.0146	-	1,100
Cadmium (µg/L)	0.0935	0.0632	**0.469**[8]	-	<0.229	<0.0281	<0.253	-	0.2[9]
Chromium (µg/L)	<0.274	0.352	0.456	-	<0.0551	0.439	<0.291		100
Cobalt (µg/L)	0.509	<0.328	<0.119	-	0.428	0.020	**0.609**	-	0.6[9]
Copper (µg/L)	0.303	0.837	0.919	-	0.578	**5.41**	0.42	-	5
Iron (µg/L)	40.8	38.7	23.2	-	53.3	52.0	25.3	-	300

Parameter (mg/L unless otherwise	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
Lead (µg/L)	<4.50	<0.478	<0.388	-	<2.91	<3.46	<2.05	-	25
Manganese (µg/L)	25.8	24.4	35.0	-	22.9	22.2	20.2	-	-
Molybdenum (µg/L)	1.51	<0.785	1.75	-	0.731	<1.53	<0.41	-	10[9]
Nickel (µg/L)	0.108	0.204	0.611	-	0.435	5.74	0.477	-	25
Strontium (µg/L)	112	103	111	-	119	112	117	-	-
Titanium (µg/L)	<0.436	<0.179	<0.249	-	<0.196	<0.188	<0.332	-	-
Vanadium (µg/L)	0.0039	0.964	0.409	-	0.774	0.137	0.431	-	7[9]
Zinc (µg/L)	0.263	0.0414	0.508	-	0.877	2.18	2.59	-	30

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] PWQO=Provincial Water Quality Objective (MOEE, 1994).
[3] Suspended matter should not be added to surface water in concentrations that would change the natural Secchi disc reading by more than 10%.
[4] Alkalinity should not be decreased by more than 25% of the natural concentration.
[5] Based on pH and temperature, the total ammonia concentration was below the PWQO 0.020 mg/L for un-ionized ammonia.
[6] Interim PWQO: excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.030 mg/L.
[7] Based on total aluminum measured in clay-free samples.
[8] **Underlined Bold** value exceeds the PWQO (MOEE, 1994).
[9] Interim PWQO.

Table 2.4b 2006 Trent River Water Quality Data[1]

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
	June 08	July 10	Aug 01	Dec 06	June 08	July 10	Aug 01	Dec 06	
pH (units)	8.16	8.17	**8.58**[3]	8.18	8.27	8.11	8.46	8.15	6.5-8.5
Turbidity (NTU)	1.15	1.07	4.18	-	0.98	0.89	2.41	-	-[4]
Conductivity (µmhos/cm)	241	244	236	255	239	238	236	250	-
Alkalinity (as $CaCO^3$)	94.0	94.8	94.5	104	95.4	96.2	97.3	105	-[5]
Hardness (as $CaCO^3$)	95.6	95.2	92.0	91.6	97.6	92.0	93.6	107	-
Total Suspended Solids	1.3	2.6	2.9	2.6	1.8	1.2	2.9	3.3	-
Ammonia, Total (as N)	0.065	0.002	0.013	0.016	0.028	0.010	0.015	0.017	-[6]
Nitrite (as N)	0.006	0.003	0.001	0.005	0.006	0.004	0.001	0.005	-
Nitrate (as N)	0.057	0.005	0.005	0.009	0.064	0.038	0.006	0.219	-
Total Kjeldahl Nitrogen	0.49	0.46	0.47	o.45	0.44	0.44	0.47	0.45	-
Total Phosphorus	0.017	0.027	0.025	0.014	0.025	0.026	0.029	0.017	30[7]
Phosphate (as P)	0.0056	0.0014	0.0012	0.0013	0.0031	0.0054	0.0037	0.0005	-
Chloride	15.5	16.2	16.3	14.1	13.7	14.2	14.5	12.3	-
Calcium	33.7	33.4	32.8	37.8	33.8	32.6	32.8	38,0	-
Magnesium	3.66	3.81	3.84	3/67	3.73	3.75	3.93	3.74	-
Potassium	0.84	1.04	1.15	1.17	0.84	0.92	1.07	1.20	-
Sodium	8.30	8.74	8.86	7.80	7.44	7.70	8.22	6.86	-
Aluminum (µg/L)	14.8	4.28	8.11	16.4	14.6	2.39	6.97	19.0	75[8]
Barium (µg/L)	29.7	30.6	33.4	32.9	30.6	32.6	36.2	33.5	-
Beryllium (µg/L)	0.0159	<0.0054	0.0035	0.0216	0.0008	<0.0126	<0.0159	0.0150	1,100
Cadmium (µg/L)	<0.046	**0.319**	<0.181	<0.024	<0.147	<0.210	0.0639	<0.558	0.2[9]
Chromium (µg/L)	<0.138	0.223	0.117	<0.224	<0.494	0.303	0.177	0.274	100
Cobalt (µg/L)	<0.0295	0.154	0.158	0.273	**0.830**	<0.352	0.0031	<0.163	0.6[9]
Copper (µg/L)	0.107	0.636	0.576	<0.024	<0.781	0.662	0.629	0.114	5
Iron (µg/L)	42.3	28.3	31.8	42.5	57.3	38.2	47.6	57.5	300
Lead (µg/L)	0.974	0.0631	<1.90	<2.90	0.305	<2.69	<1.97	<1.28	25

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
Manganese (µg/L)	24.7	22.4	43.2	8.392	21.4	18.0	45.7	10.9	-
Molybdenum (µg/L)	<0.412	<0.0231	0.190	0.2484	<0.412	<0.331	<0.168	<0.127	10[9]
Nickel (µg/L)	<0.390	<0.188	0.411	<0.678	0.301	0.149	0.088	<0.662	25
Strontium (µg/L)	110	111	112	112	117	120	118	120	-
Titanium (µg/L)	<0.394	<0.255	<0.311	0.130	<0.287	<0.281	<0.195	<0.397	-
Vanadium (µg/L)	0.255	<0.239	1.04	<0.398	0.062	1.14	0.847	0.634	7[9]
Zinc (µg/L)	0.80	<0.407	<0.069	3.042	2.29	2.31	0.980	5.25	30

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] PWQO=Provincial Water Quality Objective (MOEE, 1994).
[3] **Underlined Bold** value exceeds the PWQO (MOEE, 1994).
[4] Suspended matter should not be added to surface water in concentrations that would change the natural Secchi disc reading by more than 10%.
[5] Alkalinity should not be decreased by more than 25% of the natural concentration.
[6] Based on pH and temperature, the total ammonia concentration was below the PWQO 0.020 mg/L for un-ionized ammonia.
[7] Interim PWQO: excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.030 mg/L.
[8] Based on total aluminum measured in clay-free samples.
[9] Interim PWQO.

Table 2.4c 2007 Trent River Water Quality Data[1]

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
	May 28	June 20	July 26	Aug 24	May 28	June 20	July 26	Aug 24	
pH (units)	8.39	8.09	8.37	8.33	8.31	8.36	8.34	8.28	6.5-8.5
Turbidity (NTU)	-	-	-	-	-	-	-	-	-[3]
Conductivity (µmhos/cm)	234	230	234	233	242	432	228	219	-
Alkalinity (as $CaCO^3$)	96.2	88.8	90.9	90.2	104	216	89.4	84.3	-[4]
Hardness (as $CaCO^3$)	95.0	92.0	91.6	99.6	100	213	90.6	93.4	-
Total Suspended Solids	2.2	3.0	1.5	2.2	2.2	10.4	2.0	2.0	-
Ammonia, Total (as N)	0.058	0.049	0.026	0.027	0.050	0.049	0.016	0.035	-[5]
Nitrite (as N)	0.009	0.005	0.001	0.001	0.008	0.015	0.001	0.001	-
Nitrate (as N)	0.009	0.012	0.005	0.005	0.014	0.768	0.018	0.005	-
Total Kjeldahl Nitrogen	0.44	0.47	0.46	0.44	0.43	0.57	0.44	0.45	-
Total Phosphorus	0.017	0.020	0.018	0.019	0.018	**0.038**[6]	0.020	0.018	30[7]
Phosphate (as P)	0.0033	0.0048	0.0026	0.0020	0.0026	0.0120	0.0038	0.0042	-
Chloride	13.5	15.0	16.1	16.8	12.0	12.4	14.8	14.9	-
Calcium	32.9	30.7	30.6	31.5	35.0	67.2	29.8	28.9	-
Magnesium	3.55	3.89	3.98	4.19	3.78	12.0	4.21	4.29	-
Potassium	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Aluminum (µg/L)	6.40	9.73	6.32	1.75	13.2	**101**	7.16	7.27	75[8]
Barium (µg/L)	30.2	30.9	34.9	34.8	31.6	87.9	35.8	34.6	-
Beryllium (µg/L)	<0.0382	<0.0297	<0.025	<0.040	<0.020	<0.0241	<0.0296	<0.032	1,100
Cadmium (µg/L)	**0.294**	**1.040**	**0.712**	**1.21**	**0.386**	**0.846**	**0.976**	**1.050**	0.2[9]
Chromium (µg/L)	0.482	0.449	0.204	0.721	1.22	0.788	0.0876	0.105	100
Cobalt (µg/L)	0.537	0.306	0.335	<0.397	**0.624**	0.184	<0.207	<0.161	0.6[9]
Copper (µg/L)	0.204	1.09	0.282	0.127	0.708	1.10	0.282	0.343	5
Iron (µg/L)	37.7	44.4	23.9	23.6	56.3	215	30.1	32.4	300
Lead (µg/L)	<0.668	1.50	<0.542	0.0665	1.45	3.69	3.62	<2.14	25
Manganese (µg/L)	28.8	37.9	29.3	34.7	24.7	30.1	17.7	28.5	-

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
Molybdenum (µg/L)	0.647	0.255	<0.739	1.21	0.537	<0.179	<1.510	0.0903	10[9]
Nickel (µg/L)	0.527	0.127	0.914	1.27	0.294	0.381	0.704	0.388	25
Strontium (µg/L)	99.9	101	122	106	122	196	122	121	-
Titanium (µg/L)	0.148	0.556	0.826	0.227	0.811	4.46	0.45	0.504	-
Vanadium (µg/L)	0.0375	<0.391	0.491	0.605	<0.0515	0.974	1.42	1.55	7[9]
Zinc (µg/L)	1.91	1.75	1.15	1.36	2.10	2.51	1.63	1.24	30

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] PWQO=Provincial Water Quality Objective (MOEE, 1994).
[3] Suspended matter should not be added to surface water in concentrations that would change the natural Secchi disc reading by more than 10%.
[4] Alkalinity should not be decreased by more than 25% of the natural concentration.
[5] Based on pH and temperature, the total ammonia concentration was below the PWQO 0.020 mg/L for un-ionized ammonia.
[6] **Underlined Bold** value exceeds the Provincial Water Quality Guideline (PWQG) for total phosphorus or the PWQO (MOEE, 1994).
[7] Interim PWQO: excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.030 mg/L.
[8] Based on total aluminum measured in clay-free samples.
[9] Interim PWQO.

Table 2.4d 2008 Trent River Water Quality Data[1]

Parameter (mg/L unless otherwise indicated)	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
	May 06	June 17	July 16	Aug 25	May 06	June 17	July 16	Aug 25	
pH (units)	8.22	8.10	8.25	8.29	8.22	8.22	8.45	8.30	6.5-8.5
Turbidity (NTU)	-	-	-	-	-	-	-	-	-[3]
Conductivity (µmhos/cm)	236	242	235	237	232	234	445	246	-
Alkalinity (as CaCO3)	93.5	92.8	99.6	-	99.2	95.1	217	101	-[4]
Hardness (as CaCO3)	99.6	102	107	93.6	97.8	96.8	231	102	-
Total Suspended Solids	1.6	3.7	3.0	2.7	1.1	3.0	10.4	4.2	-
Ammonia, Total (as N)	0.054	0.049	0.062	0.028	0.051	0.045	0.030	0.004	-[5]
Nitrite (as N)	0.003	0.003	0.004	0.007	0.005	0.001	0.013	0.024	-
Nitrate (as N)	0.005	0.003	0.005	0.005	0.048	0.062	0.536	0.005	-
Total Kjeldahl Nitrogen	0.53	0.47	0.52	-	0.49	0.52	0.41	-	-
Total Phosphorus	0.024	0.020	**0.032**[6]	-	0.018	0.027	0.028	-	30[7]
Phosphate (as P)	0.0005	0.0006	0.0080	0.0053	0.0016	0.0054	0.0059	0.0075	-
Chloride	12.9	14.2	12.0	13.0	10.6	12.9	13.8	12.9	-
Calcium	33.3	33.5	36.6	32.7	32.9	32,8	71.1	35.2	-
Magnesium	3.08	3.27	3.77	3.55	3.39	3.26	12.3	3.89	-
Potassium	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Aluminum (µg/L)	4.30	9.59	11.8	4.07	6.82	18.3	66.6	15.4	75[8]
Barium (µg/L)	30.8	30.4	35.2	32.9	32.8	32.7	79.5	35.5	-
Beryllium (µg/L)	<0.0206	<0.0378	<0.029	<0.029	<0.0301	<0.0213	<0.0241	<0.017	1,100
Cadmium (µg/L)	**0.374**	**0.430**	<0.014	**0.393**	**0.873**	**0.821**	**0.316**	**0.705**	0.2[9]
Chromium (µg/L)	<0.766	0.332	<0.001	<0.268	0.246	<0.110	0.378	<0.599	100
Cobalt (µg/L)	0.358	0.328	**0.830**	<0.713	**1.32**	0.122	0.293	<0.402	0.6[9]
Copper (µg/L)	<0.161	0.813	0.633	0.811	0.673	0.611	1.16	0.872	5
Iron (µg/L)	24.5	42.3	53.9	25.6	47.5	60.6	157	52.1	300
Lead (µg/L)	<1.05	<5.40	<1.45	<5.37	<3.53	<0.902	2.38	<0.433	25
Manganese (µg/L)	21.2	28.2	45.1	32.3	29.5	33.8	21.5	-	-
Molybdenum (µg/L)	<0.657	<1.81	1.14	0.312	0.913	<2.03	1.01	0.537	10[9]
Nickel (µg/L)	<0.776	0.733	0.586	0.731	<1.24	0.638	1.42	0.527	25

Parameter (mg/L unless	At Healy Falls Dam Bridge				At Glen Ross Road				PWQO[2]
Strontium (µg/L)	108	113	116	119	113	107	184	114	-
Titanium (µg/L)	0.361	0.361	0.294	0.252	0.502	0.608	2.98	0.783	-
Vanadium (µg/L)	0.882	1.35	1.55	0.332	0.894	<0.512	2.38	0.156	7[9]
Zinc (µg/L)	1.91	4.27	1.45	2.18	2.15	1.89	1.27	0.816	30

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] PWQO=Provincial Water Quality Objective (MOEE, 1994).
[3] Suspended matter should not be added to surface water in concentrations that would change the natural Secchi disc reading by more than 10%.
[4] Alkalinity should not be decreased by more than 25% of the natural concentration.
[5] Based on pH and temperature, the total ammonia concentration was below the PWQO 0.020 mg/L for un-ionized ammonia.
[6] **Underlined Bold** value exceeds the Provincial Water Quality Guideline (PWQG) for total phosphorus or the PWQO (MOEE, 1994).
[7] Interim PWQO: excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.030 mg/L.
[8] Based on total aluminum measured in clay-free samples.
[9] Interim PWQO.

Table 2.5 presents water quality data for samples collected from the Trent River adjacent to Ranney Falls GS property. The concentrations of all parameters were below their respective PWQOs.

Table 2.5 Trent River Water Quality Data, June 10, 2011[1]

Parameter (mg/L unless otherwise indicated)	SW1	SW2	PWQO[2]
Temperature (°C)	23.2	21.9	-[3]
pH (units)	8.13	7.92	6.5-8.5
Conductivity (µS/cm)	266	238	-
Alkalinity (as CaCO[3])	91	87	-[4]
Hardness (as CaCO[3])	338	111	-
Total Dissolved Solids	140	137	-
Ammonia+Ammonium	<0.1	<0.1	-[5]
Nitrite (as N)	<0.06	<0.06	-
Nitrate (as N)	0.05	<0.05	-
Sulphate	5.4	5.4	-
Sulphide	<0.02	<0.02	-
Chloride	11	11	-
Calcium	38.2	37.5	-
Magnesium	4.25	4.32	-
Potassium	1.18	1.20	-
Sodium	8.22	8.53	-
Aluminum (µg/L)	14.2	11.5	75[6]
Antimony (µg/L)	<0.2	<0.2	20[7]
Arsenic (µg/L)	4.8	1.0	100
Barium (µg/L)	31.4	31.4	-
Beryllium (µg/L)	<0.02	<0.02	1,100
Bismuth (µg/L)	0.01	<0.01	-
Boron (µg/L)	36	15	200[7]
Cadmium (µg/L)	0.013	0.006	0.2[7]
Chromium (µg/L)	<0.5	<0.5	100
Cobalt (µg/L)	0.157	0.127	0.6[7]
Copper (µg/L)	0.7	0.6	5
Iron (µg/L)	49	40	300
Lead (µg/L)	0.17	0.14	25
Lithium (µg/L)	8	3	-
Manganese (µg/L)	19.3	18.5	-
Mercury (µg/L)	<0.1	<0.1	0.2
Molybdenum (µg/L)	0.15	0.15	10[7]

Parameter (mg/L unless otherwise indicated)	SW1	SW2	PWQO[2]
Nickel (µg/L)	1.9	1.7	25
Selenium (µg/L)	<1	3	100
Silver (µg/L)	0.01	<0.01	0.1
Strontium (µg/L)	181	175	-
Thallium (µg/L)	<0.2	<0.2	0.3[7]
Tin (µg/L)	1.24	0.48	-
Titanium (µg/L)	0.6	0.5	-
Tungsten (µg/L)	<0.03	<0.03	30[7]
Uranium (µg/L)	0.240	0.239	5[7]
Vanadium (µg/L)	0.36	0.37	7[7]
Yttrium (µg/L)	0.040	0.032	-
Zinc (µg/L)	<2	<2	30

1 Source: Knight Piésold Ltd. (2011b).
2 PWQO=Provincial Water Quality Objective (MOEE, 1994).
3 The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly altered.
4 Alkalinity should not be decreased by more than 25% of the natural concentration.
5 Based on pH and temperature, the total ammonia concentration was below the PWQO 0.020 mg/L for un-ionized ammonia.
6 Based on total aluminum measured in clay-free samples.
7 Interim PWQO.

Overall, the Trent River has relatively good water quality.

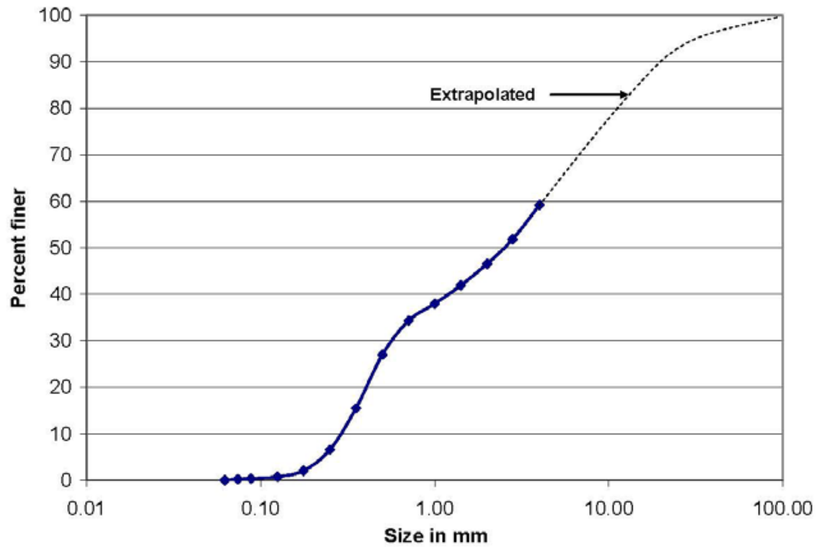
2.2.2 Sediments

In the section of the Trent Canal from Dam #10 downstream to Ranney Falls GS and Locks #11 and #12, the substrate observed from shore was mainly cobble with some boulder and gravel (Coker *et al*., 2012), but is apparently mostly armoured gravel farther from shore (Krishnappan, 2007). Figure 2.2 presents size distribution of bed material in the Trent Canal. Substrate in the Trent River between Dam #10 and Ranney Falls is primarily flat bedrock, which is covered in some areas by a layer of loose rock slabs, or boulder and cobble.

From Ranney Falls downstream to the Ranney Falls GS main powerhouse tailrace, approximately 50% of the substrate is bedrock, with the remainder being a mixture of cobble, gravel and boulder in various proportions (see Figure 2.1). The east shore of this section is mainly bedrock cliff.

Based on the relatively good water quality (see Section 2.2.1) and the predominantly coarse sediment type, the sediments can be expected to have low concentrations of contaminants.

Figure 2.2 Size Distribution of Bed Material Collected at Site #2 in the Trent Canal[1]



[1] Source: Krishnappan (2007); see Figure 1.7 for Site #2 location.

2.2.3 Aquatic Vegetation

Table 2.6 lists the 62 plant taxa (52 species) recorded in the TSW. Of the 52 species that could be ranked, 29 are ranked by the MNRF Natural Heritage Information Centre (NHIC) as S5 (secure – common, widespread and abundant in the Province); one is S5? (secure – with the ? indicating that this rank is uncertain); six are S4 (apparently secure – uncommon but not rare with some cause for long-term concern due to declines or other factors); three are S4? (apparently secure – rank uncertain); five are S4S5 (apparently secure to secure) and two are S1 (critically imperiled – due to extreme rarity, i.e., often five or fewer occurrences, or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation). The remaining six species are designated by the NHIC as SNA (not applicable – a conservation status rank not applicable because the species is not a suitable target for conservation activities).

Table 2.6 Aquatic Macrophyte Species Recorded in the TSW[1]

Scientific *Name*	Common Name	Provincial Status[2]
Acoraceae	**Sweet Flag Family**	
Acorus calamus	Sweetflag	SNA
Alismataceae	**Water Plantain Family**	
Sagittaria spp.	Water Plantain species	-
S. latifolia	Broadleaf Arrowhead	S5
S. rigida	Sessile-fruited Arrowhead	S4?
Apiaceae	**Carrot or Parsley Family**	
Sium suave	Hemlock Water-parsnip	S5
Araceae	**Arum Family**	
Calla palustris	Wild Calla	S5

Scientific *Name*	Common Name	Provincial Status[2]
Asteraceae	**Aster Family**	S5
Megalodonta beckii	Water-marigold	
Cabombaceae	**Water-shield Family**	S5
Brasenia schreberi	Watershield	
Callitrichaceae	**Water Starwort Family**	S5
Callitriche hermaphroditica	Autumnal Water-starwort	
Ceratophyllaceae	**Hornwort Family**	S5
Ceratophyllum demersum	Common Hornwort	
Characeae	**Stonewort or Muskgrass Family**	-
Chara spp.	Stonewort species	
Nitella spp.	Muskgrass species	-
Tolypella inticata	Tassel Stonewort	
Cyperaceae	**Sedge Family**	-
Carex spp.	Sedge species	
Scirpus spp.	Bulrush species	-
Haloragaceae	**Water-milfoil Family**	S4?
Myriophyllum heterophylum	Broadleaf Water-milfoil	
M. sibiricum	Common Water-milfoil	S5
M. spicatum	Eurasian Water-milfoil	SNA
M. vericillatum	Whorled Water-milfoil	S5
Hydrocharitaceae	**Frogbit Family**	S5
Elodea canadensis	Broad Waterweed	
Hydrocharis morsus-ranae	European Frogbit	SNA
Vallesneria americana	Eel-grass	S5
Isoëtaceae	**Quillwort Family**	S5
Isoëtes echinospora	Spiny-spored Quillwort	
I. engelmannii[3]	Engelmann's Quillwort	S1
I. x eatonii	Eaton's Quillwort	S1
Juncaceae	**Rush Family**	-
Juncus spp.	Rush species	
Lemnaceae	**Duckweed Family**	-
Lemna spp.	Duckweed species	
L. trisulca	Star Duckweed	S5
Spirodela polyrrhiza	Common Water-flaxseed	S5
Wolffia spp.	Watermeal species	-
W. columbiana	Columbia Watermeal	S4S5
Lentibulariaceae	**Bladderwort Family**	-
Utricularia spp.	Bladderwort species	
U. intermedia	Flatleaf Bladderwort	S5
U. minor	Lesser Bladderwort	S5
U. vulgaris	Greater Bladderwort	S5
Najadaceae	**Naiad Family**	S5
Najas flexilus	Slender Naiad	
Nymphaeaceae	**Water Lily Family**	S5
Nuphar lutea spp. *variegata*	Yellow Cowlily	
Nymphaea odorata	White water-lily	S5?
Polygonaceae	**Knotweed or Smartweed Family**	-
Polygonum spp.	Smartweed species	
Pontederiaceae	**Pickerelweed Family**	S5
Heteranthera dubia	Grassleaf Mud-plantain	
Pontederia cordata	Pickerel Weed	S5
Potamogetonaceae	**Pondweed Family**	S5
Potamogeton amblifolius	Large-leaf Pondweed	

Scientific *Name*	Common Name	Provincial Status[2]
P. crispus	Curly Pondweed	SNA
P. epihydrus	Ribbon-leaf Pondweed	S4S5
P. foliosus	Leafy Pondweed	S5
P. friesii	Fries' Pondweed	S4
P. gramineus	Grassy Pondweed	S5
P. natans	Floating Pondweed	S5
P. pectinatus	Sago Pondweed	S5
P. perfoliatus	Clasping-leaf Pondweed	S4
P. praelongus	White-stem Pondweed	S4S5
P. pusillus	Slender Pondweed	S4S5
P. richardsonii	Redheadgrass	S5
P. robbinsii	Flatleaf Pondweed	S4S5
P. strictifolius	Straight-leaf Pondweed	S4
P. vaseyi	Vasey's Pondweed	S4
P. zosteriformis	Flatstem Pondweed	S5
Ranunculaceae	**Buttercup or Crowfoot Family**	
Ranunculus aquatilis	White Water Crowfoot	SNA
R. fascicularis	Early Buttercup	S4
Sparganiaceae	**Bur Reed Family**	
Sparganium eurycarpum	Large Bur-reed	S5
S. fluctuans	Floating Bur-reed	S4?
Typhaceae	**Cattail Family**	
Typha angustifolia	Narrow-leaved Cattail	SNA
T. latifolia	Broad-leaf Cattail	S5
Zannichelliaceae	**Horned-pondweed Family**	
Zannichellia palustris	Horned Pondweed	S4

1 Source: Saunders (2006).

2 NHIC: S5 = secure; S5? = secure – rank uncertain; S4 = apparently secure; S4? = apparently secure – rank uncertain; S4S5 = apparently secure to secure; S1 = critically imperiled; SNA = conservation status rank not applicable.

3 Designated as Endangered federally (COSEWIC, 2012) and provincially (MNRF, 2014).

One aquatic macrophyte species present in the TSW and designated as S1 by the NHIC is a species at risk (SAR): Engelmann's Quillwort is designated as Endangered federally (COSEWIC, 2012) and provincially (MNR, 2014). This species is confined to a 4.5 km section of the Severn River in the District Municipality of Muskoka (EQRT, 2007) and a 450 meter section of the Gull River at West Guilford. Its sterile hybrid with Spiny-spored Quillwort (*I. echinospora*), Eaton's Quillwort (*I. x eatonii*) is also ranked as S1 but not designated as a SAR.

A bed of rooted aquatic vegetation consisting primarily of Pondweed (*Potamogeton* spp.) with some Water-milfoil (*Myriophyllum*) is present upstream of the "Pup" powerhouse tailrace (see Figure 2.1). As indicated in Table 2.6, all of the *Potamogeton* species present in the TSW are ranked by the NHIC as S5 (secure), S4 (apparently secure), S4S5 (apparently secure to secure) or SNA (conservation status rank not applicable). Similarly, all of the *Myriophyllum* species are ranked as S5 (secure), S4? (apparently secure – rank uncertain) or SNA (conservation status rank not applicable).

2.2.4 Plankton

There are two algal communities in most lotic (running water) systems: the potamoplankton, or drift plankton, and the periphyton (Aufwuchs), or benthic algae.

Lakes on lotic systems are the major source of potamoplankton, with diatoms almost universally the most important constituents (Williams and Scott, 1962).

However, the periphyton is by far the more important algal community in terms of the ecology and productivity of rivers. This community can be divided into three types (Round, 1973):

1. the epilithic type consisting of benthic algae attached to rocks;
2. the epipelic type attached to larger filamentous algae, bryophytes (mosses) and aquatic macrophytes; and
3. the epipelic type which is a rich algal flora, mainly composed of diatoms, associated with the bed sediments.

Similarly, lakes are the major source of zooplankton with rotifers the dominant taxon in rivers (Williams, 1966).

2.2.5 Benthic Macroinvertebrates

The composition of the benthic macroinvertebrate community has been the most widely used indicator of water quality. This is because the macroinvertebrates form relatively sedentary communities in the sediments, thereby reflecting the character of both the water and sediment. Alteration of benthic community structure is used to assess the trophic or general pollutional status of a waterbody. This assessment is usually based on interpretation of indicator species, changes in the relative numbers of individuals and species, and/or the derivation of a species diversity or community comparison index.

Benthic macroinvertebrate community composition data for the Trent River are available near the OPG Frankfort GS approximately 36 km downstream of the Ranney Falls GS (Table 2.7). Substrate at the sampling location consisted mostly of cobble and gravel, as well as some fractured and broken limestone. Larger cobble and limestone were situated over gravel and coarse sand. This substrate is similar to that in the Trent River proximate to the Ranney Falls GS tailrace (see Figure 2.1). It is therefore likely that the benthic macroinvertebrate community composition at both locations would be similar; however, due to the greater preponderance of bedrock, overall densities can be expected to be lower in the Trent River proximate to the Ranney Falls GS tailrace.

Table 2.7 Benthic Macroinvertebrate Community Composition in the Trent River[1]

	Density[2]					
	June 1996			October 1996		
	Rep 1	Rep 2	Rep3	Rep 1	Rep 2	Rep 3
P. Platyhelminthes						
Cl. Turbellaria		1		1	1	1
P. Annelida						
Cl. Oligochaeta						
F. Tubificidae						
Aulodrilus limnobius					8	
A. pigueti				2	27	1
Limnodrilus hoffmeisteri				1		
Immatures without hair chaetae				18	25	6
Immatures with hair chaetae					3	2
F. Naididae						
Piguetiella michiganensis			1		5	1
Specaria josinae					1	
Stylaria lacustris					1	
P. Arthropoda						
Cl. Malacostraca						
O. Amphipoda						
F. Cragonyctidae						
Crangonyx			1	4	6	
F. Gammaridae						
Gammarus	5		25	15	5	9
G. fasciatus		19				
G. lacustris		1				
F. Talitridae						
Hyalella azteca	15	19	21		6	2
O. Isopoda						
F. Asellidae						
Caecidotea		3	3	1	1	
O. Decapoda						
F. Cambaridae	3	3	7			
Orconectes					2	
Cl. Insecta						
O. Ephemeroptera			3	9	3	11
F. Baetidae	11	9	1			
Acentrella	1					
F. Caenidae						
Brachycercus					1	
Caenis		16	16	129	141	70
F. Ephemerellidae	1					
F. Ephemeridae					2	2
Ephemera						
Hexagenia limbata			3	12	14	15
F. Heptageniidae				32	45	82
Leucrocuta	10	8	15			
Stenacron	41	55	49	17	43	58
Stenonema sp.1	11	25	34	36	27	73
Stenonema sp. 2	2					
F. Leptophlebeidae		1	7			
F. Tricorythidae						
Tricorythodes						

	Density[2]					
	June 1996			October 1996		
	Rep 1	Rep 2	Rep3	Rep 1	Rep 2	Rep 3
O. Odonata						
F. Coenagrionidae						
Argia	3	5				
O. Neuroptera						
F. Sialidae						
Sialis	1	1				
O. Coleoptera						
F. Dytiscidae						
Hydroporus/Hygrotus	1	3	2			
F. Elmidae						
Dubiraphia				2		
F. Psephenidae						
Psephenus	2	3	1	3	3	3
O. Trichoptera						
F. Brachycentridae						
Micrasema	1	2				
F. Glossosomatidae						
Glossosoma		1				
F. Helicopsychidae						
Helicopsyche borealis	1	2				
F. Hydropsychidae						
Cheumatopsyche				5	1	
C. campyla	3		4			
Hydropsyche morose	1					
H. scalaris	1	1				
F. Hydroptilidae						
Hydroptila					1	1
F. Leptoceridae						
Ceraclea				1		
Mystacides					2	
Oecetis		2				
Oecetis sp. 1				2		
Oecetis sp. 2					1	
Oecetis sp. 3					1	
F. Limnephilidae						
Hydatophylax/Pycnopsyche.					1	
F. Polycentropodidae						
Neureclipsis				1		2
Polycentropus.	4	2	7	6	8	13
O. Diptera						
F. Chironomidae		1	1	5	5	1
S.F. Chironominae				3	4	2
Cryptochironomus			2	2	11	2
Cladotanytarsus			5	1	8	2
Demicryptochironomus				1		1
Dicrotendipes		4	2		2	
Micropsectra	1	1	1			
Microtendipes	7	28	42	4	25	18
Paratanytarsus		2	1			
Polypedilum	1					3
Pseudochironomus				3	9	2
Rheotanytarsus	2		1			

	Density[2]					
	June 1996			October 1996		
	Rep 1	Rep 2	Rep3	Rep 1	Rep 2	Rep 3
Stempellinella			4	2	3	3
Tanytarsus			2	2	2	
Tribelos/Endochironomus				1	1	4
S.F. Orthocladiinae				2	2	1
Cricotopus	1	2				
F. Tipulidae						
Antocha			1			
P. Mollusca						
Cl. Bivalvia (Pelecypoda)						
F. Dreissenidae						
Dreissena polymorpha	43	48	42	19	23	38
F. Sphaeriidae		6				
Pisidium					15	10
Sphaerium			1			

[1] Source: Pope (1998).
[2] Number of individuals per air-lift sample (0.25 m^2).

As indicated in Table 2.8, Ephemeroptera (mayfly nymphs) was the dominant major taxon comprising 41% and 63% of the total number of individuals in the spring and fall, respectively, followed by chironomids (midge larvae) and molluscs (snails, clams). Species diversity, based on the Shannon-Weiner diversity index, was similar for the two sampling periods, i.e., 2.7 and 2.6 in the spring and fall, respectively. This index is a measure of the number of species and individuals present at a given location as well as the distribution of those individuals among the various species. Wilhm and Dorris (1969) proposed that benthic macroinvertebrate communities with diversity index values greater than 3 are generally found in unpolluted conditions, whereas communities with values less than 1 are generally found in organically enriched (polluted) conditions.

Table 2.8 Benthic Macroinvertebrate Community Metrics[1]

Metrics	Spring	Fall
Number of Taxa	43	47
Total Abundance	1,027	1,753
Diversity	2.7	2.6
%Oligochaeta	0.8	7.4
%Arthropoda[2]	16.2	3.9
%Ephemeroptera	41.4	63.4
%Trichioptera	3.4	4.0
%Chironomidae	16.8	12.3
%Mollusca	18.3	8.0

[1] Source: Pope (1998).
[2] Includes Amphipoda, Isopoda and Decapoda.

The LTC annually undertakes benthic macroinvertebrate community monitoring of a number of sites within the Trent River watershed which provides an indication of benthic community composition at each site and an understanding of the overall health of the watershed. Table 2.9 presents the major benthic macroinvertebrate taxa and their abundance at three locations: on the Trent River upstream and downstream of Campbellford, and on Trout Creek upstream of its outlet to the Trent River (downstream of Campbellford).

Table 2.9 Major Benthic Macroinvertebrate Taxa[1]

	Number of Organisms								
	TR01[2]			**TR02[3]**		**TC01[4]**			
	2007	2008	2010	2007	2008	2007	2008	2009	2010
Hydra	0	0	0	0	0	0	0	0	0
Platyhelminthes (Flatworms)	0	0	2	0	7	0	0	0	0
Nematoda (Roundworms)	17	0	0	3	0	1	0	0	0
Oligochaeta (Worms)	1	0	149	0	4	7	20	58	254
Hirudinea (Leeches)	1	0	0	0	0	0	0	0	0
Isopoda (Aquatic Sowbugs)	12	9	4	53	1	5	7	85	3
Pelecypoda (Clams)	0	0	0	0	0	0	0	0	0
Amphipoda (Scuds)	273	108	0	139	124	181	106	55	146
Decapoda (Crayfish)	0	1	0	0	0	0	7	0	0
Acarina (Water Mites)	97	81	4	74	43	0	1	3	3
Ephemeroptera (Mayflies)	2	10	0	0	1	254	23	61	62
Anisoptera (Dragonflies)	0	0	0	1	2	0	0	0	0
Zygoptera (Damselflies)	0	2	0	10	40	0	1	0	0
Plecoptera (Stoneflies)	0	1	0	0	0	17	98	0	13
Hemiptera (True Bugs)	0	50	0	0	67	0	0	0	0
Megaloptera (Helgrammites)	0	0	5	0	0	1	0	0	0
Trichoptera (Caddisflies)	0	0	5	10	5	31	1	4	14
Lepidoptera (Aquatic Moths)	0	0	0	0	0	0	0	0	0
Coleoptera (Beetles)	2	0	4	9	3	17	4	8	11
Gastropoda (Snails)	1	1	0	11	0	1	1	0	0
Chironomidae (Midge Flies)	24	5	127	27	19	178	103	48	77
Tabanidae (Horse and Deer Flies)	0	0	2	0	0	3	0	0	1
Culicidae (Mosquitos)	0	23	0	0	0	0	4	0	0
Ceratopogonidae (Biting Midges)	1	31	0	5	26	0	1	0	0
Tipulidae (Craneflies)	0	0	0	0	0	2	0	0	0
Simuliidae (Black Flies)	0	0	0	0	0	6	3	0	0
Other Diptera	2	0	0	1	0	2	0	0	0
Ostracoda (Seed Shrimp)	0	0	0	0	0	0	0	0	0

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] Trent River upstream of Trenton.
[3] Trent River upstream of Campbellford.
[4] Trout Creek upstream of outlet to the Trent River, downstream of Campbellford.

The LTC uses the Hilsenhoff Index and the Simpson Index to assess habitat quality at the monitoring locations. The Hilsenhoff Index was developed to summarize overall pollution tolerance of the benthic macroinvertebrate community and is calculated as the mean tolerance value of all taxa collected at each site (i.e., by multiplying the density of each taxa by its tolerance value, summing the values for all taxa and then dividing by the total density (Hilsenhoff, 1982, 1987). The values range from 0 to 10, increasing with increasing community tolerance to organic pollution, as listed below:

Index Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.0	Very Poor	Severe organic pollution

These categories and associated levels of organic pollution are meant as rough guidelines. Site-specific evaluations concerning the relative degree of organic pollution may not follow these criteria.

The Simpson Index takes into account the number of taxa present and the relative abundance of each taxon and represents the probability that two randomly selected individuals in the habitat will belong to the same taxon (Simpson, 1949). The values range from 0 to 1, with 0 representing infinite diversity and 1 representing no diversity. Therefore, a low Simpson Index value indicates high diversity, whereas a high value indicates low diversity.

Based on the Hilsenhoff Index values, water quality ranges from fairly poor to good at the three monitoring locations, whereas the Simpson Index values indicate generally low biodiversities of the benthic macroinvertebrate communities (Table 2.10).

Table 2.10 Water Quality Indices[1]

	2004	2005	2006	2007	2008	2009	2010
Hilsenhoff Index							
TR01[2]	6.80	6.72	5.42	6.07	6.02	-	7.34
TR02[3]	6.59	6.49	6.42	6.38	5.95	-	-
TC01[4]	5.83	5.85	5.97	4.88	4.90	6.75	6.56
Simpson Index							
TR01	0.17	0.19	0.27	0.45	0.21	-	0.42
TR02	0.18	0.25	0.25	0.24	0.21	-	-
TC01	0.17	0.15	0.21	0.16	0.22	0.19	0.28

[1] Source: E. Bednarczuk, LTC, 2011, pers. comm.
[2] Trent River upstream of Trenton.
[3] Trent River upstream of Campbellford.
[4] Trout Creek upstream of outlet to the Trent River, downstream of Campbellford.

As indicated in Section 2.2.2, nearshore substrate in the Trent Canal proximate to the Ranney Falls GS is mainly cobble with some boulder and gravel, and mostly armoured gravel farther from shore. This substrate would likely support benthic macroinvertebrate communities characterized by low densities and diversities.

2.2.6 Fisheries Resources

A total of 73 fish species have been recorded in the TSW (Table 2.11). Of the 67 native species listed, 43 are ranked by the NHIC as S5 (secure); 17 are S4 (apparently secure); two are S3 (vulnerable – due to a restricted range, relatively few populations, i.e., often 80 or fewer, recent and widespread declines, or other factors making it vulnerable to extirpation); four are S2 (imperiled – because of rarity due to very restricted range, very few populations, i.e., often 20 or fewer, steep declines, or other factors making it very vulnerable to extirpation) and one is S1? (critically imperiled – rank uncertain). Six additional species are designated by the NHIC as SNA (conservation status rank not applicable).

Table 2.11 Fish Species Recorded in the TSW[1]

Common Name	Scientific Name	Provincial Status[2]
Sea Lamprey[3]	*Petromyzon marinus*	SNA
Lake Sturgeon[4]	*Acipenser fulvescens*	S2
Longnose Gar	*Lepisosteus osseus*	S4
American Eel[5]	*Anguilla rostrata*	S1?
Lake Chub	*Couesius plumbeus*	S5
Common Carp[6]	*Cyprinus carpio*	SNA
Brassy Minnow	*Hybognathus hankinsoni*	S5
Eastern Silvery Minnow	*H. regius*	S2
Pearl Dace	*Margariscus margarita*	S5
River Chub	*Nocomis micropogon*	S4
Golden Shiner	*Notemigonus crysoleucas*	S5
Emerald Shiner	*Notropis atherinoides*	S5
Common Shiner	*N. cornutus*	S5
Blackchin Shiner	*N. heterodon*	S4
Blacknose Shiner	*N. heterolepis*	S5
Spottail Shiner	*N. hudsonius*	S5
Mimic Shiner	*N. volucellus*	S5
Northern Redbelly Dace	*Phoxinus eos*	S5
Finescale Dace	*P. neogaeus*	S5
Bluntnose Minnow	*Pimephales notatus*	S5
Fathead Minnow	*P. promelas*	S5
Blacknose Dace	*Rhinichthys atratulus*	S5
Longnose Dace	*R. cataractae*	S5
Creek Chub	*Semotilus atromaculatus*	S5
Fallfish	*S. corporalis*	S4
Quillback	*Carpiodes cyprinus*	S4
Longnose Sucker	*Catostomus catostomus*	S5
White Sucker	*C. commersonii*	S5
Silver Redhorse	*Moxostoma anisurum*	S4
River Redhorse[7]	*M. carinatum*	S2
Shorthead Redhorse	*M. macrolepidotum*	S5
Greater Redhorse	*M. valenciennesi*	S3
Black Bullhead	*Ameiurus melas*	S4
Yellow Bullhead	*A. natalis*	S4

Common Name	Scientific Name	Provincial Status[2]
Brown Bullhead	*A. nebulosus*	S5
Channel Catfish	*Ictalurus punctatus*	S4
Northern Pike	*Esox lucius*	S5
Muskellunge	*E. masquinongy*	S4
Central Mudminnow	*Umbra limi*	S5
Cisco (Lake Herring)	*Coregonus artedi*	S5
Lake Whitefish	*C. clupeaformis*	S5
Rainbow Trout	*Oncorhynchus mykiss*	SNA
Brown Trout	*Salmo trutta*	SNA
Brook Trout	*Salvelinus fontinalis*	S5
Lake Trout	*S. namaycush*	S5
Trout-perch	*Percopsis omiscomaycus*	S5
Burbot	*Lota lota*	S5
Banded Killifish	*Fundulus diaphanus*	S5
Brook Silverside	*Labidesthes sicculus*	S4
Brook Stickleback	*Culaea inconstans*	S5
Mottled Sculpin	*Cottus bairdii*	S5
Slimy Sculpin	*C. cognatus*	S5
White Perch	*Morone americana*	SNA
White Bass	*M. chrysops*	S4
Rock Bass	*Ambloplites rupestris*	S5
Pumpkinseed	*Lepomis gibbosus*	S5
Bluegill	*L. macrochirus*	S5
Longear Sunfish	*L. megalotis*	S3
Smallmouth Bass	*Micropterus dolomieu*	S5
Largemouth Bass	*M. salmoides*	S5
Black Crappie	*Pomoxis nigromaculatus*	S4
Rainbow Darter	*Etheostoma caeruleum*	S4
Iowa Darter[3]	*E. exile*	S5
Fantail Darter	*E. flabellare*	S4
Johnny Darter	*E. nigrum*	S5
Yellow Perch	*Perca flavescens*	S5
Logperch	*Percina caprodes*	S5
Channel Darter[4]	*P. copelandi*	S2
Blackside Darter	*P. maculata*	S4
Sauger	*Sander canadensis*	S4
Walleye	*S. vitreus*	S5
Freshwater Drum	*Aplodinotus grunniens*	S5
Round Goby	*Neogobius melanostomus*	SNA

1. Source: Saunders (2006).
2. NHIC: S5 = secure; S4 = apparently secure; S3 = vulnerable; S2 = imperilled; S1? = critically imperilled, rank uncertain; SNA = conservation status rank not applicable.
3. **Bold** - Reported upstream and downstream (including Percy Reach) of Campbellford (G. Kinsman, Parks Canada - TSW, 2011, pers. comm.; H. Simpson, MNR, 2011, pers. comm.).
4. Designated as Threatened federally by COSEWIC (2012 as listed on Schedule 1 of federal Species at Risk Act (SARA) and provincially by COSSARO (MNRF, 2014).
5. Designated as Special Concern federally and Endangered provincially.
6. **Bold –** Collected and/or observed in the Trent River between Dam #10 and the Ranney Falls GS main powerhouse tailrace (see Tables 2.13 and 2.14).
7. Designated as Special Concern federally and provincially.

Four fish species present in the TSW are SAR: Lake Sturgeon and Channel Darter, designated as Threatened federally (COSEWIC, 2011) and provincially (MNR, 2012); American Eel, designated as Special Concern federally and Endangered provincially; and River Redhorse, designated as Special Concern federally and provincially. Channel Darter and River Redhorse have only been documented downstream of the Ranney Falls GS (Reid, 2005).

The fish communities found within each relatively isolated section of the TSW, i.e., between a set of dams and locks, reflect the habitats available within each section. Centrarchids (sunfishes, Smallmouth Bass and Largemouth Bass) are very common throughout the system due to their preferred habitats found in quiet slow-moving rivers or small lakes with warm water.

Of the 73 species recorded in the TSW, 35 species have been captured upstream and downstream (including Percy Reach) of Campbellford (indicated in bold in Table 2.11). Of these, 24 and seven are designated as S5 (secure) and S4 (apparently secure), respectively, whereas two are SNA (conservation status rank not applicable). The remaining two species are species at risk (SAR). The presence of Lake Sturgeon is based on a 1976 record (NHIC, 2010: Map Square 18TQ70) with no more recent documented occurrences this far upstream (G. Kinsman, TSW-Parks Canada, 2011, pers. comm.). The American Eel was captured upstream of Campbellford based on 2001 or earlier records (H. Simpson, MNR, 2011, pers. comm.) and was not listed in NHIC Map Square 18TQ70.

Fish consumption advice based on a combination of species, fish size and contaminant concentrations has been provided by the MOE for waterbodies throughout Ontario since 1979. Mercury is the major contaminant of fish in inland waters of the Province. A summary of the most recent fish consumption advisories for the Trent River below Percy Reach to Trenton is provided in Table 2.12.

Table 2.12 Summary of Fish Consumption Advisories[1,2]

	Fish Length (cm)											
Fish Species	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**	**40-45**	**45-50**	**50-55**	**55-60**	**60-65**	**65-70**	**70-75**
Common Carp[3]						8[4] (8)[5]	4(4)	4(4)	4(4)	2(0)	2(0)	2(0)
Brown Bullhead[3]		8(8)	8(8)	8(4)								
Northern Pike[6]					8(8)	8(8)	8(4)	8(4)	8(4)	4(0)	4(0)	
Rock Bass[6]	8(8)	8(4)										
Pumkinseed[6]	8(8)											
Smallmouth Bass[3]		8(4)	8(4)	8(4)								
Black Crappie[3]		8(8)	8(8)									
Yellow Perch[6]	8(8)											

1 Source: MOE (2011b).
2 Trent River below Percy Reach to Trenton.
3 Based on mercury, PCBs, mirex/photomirex and pesticides.
4 Number of meals of that size fish that can be consumed each month by the general population.
5 Bracketed number of meals of that size that is advised for consumption by women of child-bearing age and children under 15.
6 Based on mercury.

The maximum recommended number of meals of sport fish per month is eight for the general public (MOE, 2011b). Since young children and developing fetuses are affected by contaminants at lower concentrations than the general population, children under 15 and women of child-bearing age are advised to consume fish only in the eight and four meals per month categories. Top predators, such as Northern Pike, usually have the highest mercury concentrations. Smaller, younger fish and fish that are not top predators, such as Yellow Perch, have lower contaminant concentrations.

Field investigations of fish habitat and fish communities were undertaken in the Trent River upstream and downstream of Ranney Falls in 2006, 2007 and 2008 by C. Portt and Associates staff. The survey was georeferenced (Garmin GPS 12) in conjunction with direct observations and measurement in shallow areas. An electronic hydro-acoustic depth sounder and an underwater video system were used in deeper areas, to map water depths and substrate type within the study area. Granular substrates were classed as boulder (>256 mm), cobble (64-256 mm), gravel (2-64 mm), and sand (0.0625-2 mm) (Wentworth, 1922). Water velocities were estimated visually. Digital photographs were taken at strategic, geo-referenced locations to further characterize habitat. Figure 2.1 depicts the bathymetry, substrate and main habitat features of the Trent River from Ranney Falls to a short distance downstream of the Ranney Falls GS main powerhouse tailrace.

Fish were collected by electrofishing in wadeable areas on June 6 and 7, and August 31, 2006, and on June 4, 2007, using a Smith Root Model 12 backpack electrofisher. The underwater video system also provided for fish observations.

Walleye spawning investigations were undertaken downstream of Ranney Falls on April 13, 2006, April 21, 2007 and April 22, 2008. The timing of the Walleye spawning investigations coincided with observed Walleye spawning at the nearby Crowe River (2006) and in the Trent River at Trenton (2007). At the time of the 2006, 2007 and 2008 field observations, the MNR Peterborough District office confirmed that Walleye were also spawning at TSW Lock #19 in Peterborough. Spawning observations were conducted after nightfall. A powerful spotlight was used to search for Walleye, which were differentiated from other fishes primarily by the light reflected by the *tapetum lucidum* of their eyes, as well as the white tip of the lower caudal lobe of the tail fin.

Electrofishing of approximately 300 m of shoreline of the spillway from Dam #10 downstream to Ranney Falls captured no fish on June 6, 2006 (see Table 2.13), when water was being spilled through Dam #10. However, fish were captured in the spillway when there was only leakage downstream of Dam #10 on August 31, 2006, including 15 Rock Bass, 27 Smallmouth Bass (half of which were young-of-the-year) and one Brown Bullhead, when much of the wetted area throughout the channel for approximately 700 m downstream of Dam #10 was electrofished (1,290 electroseconds). One Rock Bass and 30 Smallmouth Bass were captured on June 4, 2007, again, when the only water passing through Dam #10 was leakage, and with a similar level of electrofishing effort (1,114 electroseconds). The relatively low numbers of fish found in the large area of the spillway indicate that the fish community in this section of river is sparse. This is not surprising, given the poor aquatic habitat with bedrock substrate, shallow water and widely fluctuating flows. It is possible that the fish community in this area may largely be the result of fish washed downstream when spillage occurs at Dam #10 during the high river flows.

Table 2.13 Fish Species Collected Upstream and Downstream of Ranney Falls

Between Dam #10 and Ranney Falls	June 6, 2006	August 31, 2006	June 4, 2007
Rock Bass	0	15	1
Smallmouth Bass	0	27	30
Brown Bullhead	0	1	0
Effort (electroseconds)	388	1,290	1,114
Downstream of Ranney Falls	June 6-7, 2006	August 31, 2006	June 4, 2007
Rock Bass	15	-	1
Smallmouth Bass	13	-	1
Logperch	2	-	0
Pumpkinseed	0	-	1
Effort (electroseconds)	1,507	0	542

Habitat from Ranney Falls to immediately downstream of the main powerhouse tailrace is diverse, with depths up to 7 m, a variety of coarse substrates, rock ledges, areas of quiet water adjacent to faster flowing water, and an area of rooted aquatic plants (see Figure 2.1). The "Pup" tailrace is approximately 2 m deep, with cobble, gravel and boulder substrate.

Shoreline electrofishing downstream of Ranney Falls in 2006 captured 15 Rock Bass, 13 Smallmouth Bass and two Logperch, whereas one each of Rock Bass, Pumpkinseed and Smallmouth Bass were captured in 2007. Although fish were not readily captured by backpack electrofishing in wadeable areas (Table 2.14), dense schools of Pumpkinseed were observed in most areas of deeper water by underwater video, as were individual Smallmouth Bass (Table 2.13). Yellow Perch, Common Carp, Bluegill and White Sucker were each observed only once, either singly or in a small group.

Table 2.14 Fish Species Observed by Underwater Video Downstream of Ranney Falls

	June 7, 2006	**August 31, 2006**
Yellow Perch	✓	-
Smallmouth Bass	✓	-
Common Carp	-	✓
White Sucker	-	✓
Pumpkinseed	✓	✓
Bluegill	✓	-

Although not collected during the 2006 and 2007 surveys, the exotic Round Goby now occurs throughout the Trent River system (Dr. M. Fox, Trent University, 2012, pers. comm.).

It is possible that the section of river between Ranney Falls and Lock #10 contains some Walleye, although, if present, the population in this isolated reach would probably be small. Walleye typically spawn in the spring at water temperatures of 5.6 to 11.1°C over boulder to coarse gravel (Scott and Crossman, 1973), generally in water less than 1.2 m deep (Smith, 1985), and in velocities from 0.3 to 1.0 m/s (McMahon *et al*., 1984; Aadland *et al*., 1991). Spawning grounds are often the rocky areas below impassable falls and dams in rivers, or boulder to coarse gravel shoals of lakes (Scott and Crossman, 1973). An exposed cobble shoal, located a short distance downstream of Ranney Falls, appears to provide a small area of suitable habitat for Walleye spawning. However, no Walleye were observed at this location during night observations in 2006, 2007 and 2008, although water temperatures were appropriate for spawning and Walleye spawning was observed at the same time at other nearby locations within the TSW. It is likely that the small area between Ranney Falls and Hagues Reach is not large enough to sustain many Walleye.

2.2.7 Aquatic Avifauna

Waterfowl in the local study area include Mallard (*Anas platyrhynchos*) and Canada Goose (*Branta canadensis)*. The lands along the Trent River and the TSW encompassing the Ranney Falls GS property are categorized by the Canada Land Inventory (CLI, 1971a) as 60% Class 6 and 40% Class 5 with severe and moderately severe limitations, respectively, to waterfowl production. The Class 6 lands are limited by adverse topography, whereas the Class 5 lands are limited by adverse topography and reduced marsh edge.

Table 2.15 provides a list of bird species recorded in the Ontario Breeding Bird Atlas as breeding or likely breeding within the 10-km by 10-km square gird (18TQ70) encompassing the Ranney Falls GS property (Bird Studies Canada, 2006). Of the 19 species likely or confirmed to be breeding within the grid, 11 are considered by the NHIC to be S5 (secure), six are S4 (apparently secure), one is S3 (vulnerable) and one is SNA (conservation status rank not applicable).

Table 2.15 Breeding Bird Species Recorded within a 10 km by 10 km Square Grid Overlapping the Proposed Ranney Falls G3 Project Area[1]

Common Name	Scientific Name	Breeding Status	Provincial Status[2]
Loons	**Gaviidae**		
Common Loon	*Gavia immer*	Possible	S5
Cormorants	**Phalacrocoracidae**		
Double-crested Cormorant	*Phalacrocorax auritus*	Confirmed	S5
Herons and Bitterns	**Ardeidae**		
American Bittern	*Botaurus lentiginosus*	Possible	S4
Great Blue Heron	*Ardea herodias*	Confirmed	S4
Green Heron	*Butorides virescens*	Confirmed	S4
Swans, Geese and Ducks	**Anatidae**		
Mute Swan	*Cygnus olor*	Probable	SNA
Canada Goose	*Branta canadensis*	Confirmed	S5
Wood Duck	*Aix sponsa*	Confirmed	S5
Blue-winged Teal	*Anas discors*	Probable	S4
Mallard	*A. platyrhynchos*	Confirmed	S5
Common Merganser	*Mergus merganser*	Probable	S5

Common Name	Scientific Name	Breeding Status	Provincial Status[2]
Rails, Gallinules and Coots	**Rallidae**		
Virginia Rail	*Rallus limicola*	Confirmed	S5
Sora	*Porzana carolina*	Probable	S4
Cranes	**Gruidae**		
Sandhill Crane	*Grus canadensis*	Possible	S5
Plovers	**Charadriidae**		
Killdeer	*Charadrius vociferus*	Confirmed	S5
Sandpipers and Phalaropes	**Scolopacidae**		
Spotted Sandpiper	*Actitis macularus*	Confirmed	S5
Wilson's Snipe	*Gallinago delicata*	Confirmed	S5
American Woodcock	*Scolopax minor*	Probable	S4
Gulls and Terns	**Laridae**		
Black Tern[3]	*Chlidonias niger*	Probable	S3

[1] Source: Bird Studies Canada (2006); Cadman *et al*. (2007), based on grid 18TQ70.

[2] NHIC: S5 = secure; S4 = apparently secure; S3 = vulnerable; SNA = conservation status rank not applicable.

[3] Designated as Special Concern provincially (MNRF, 2014) and as Not at Risk federally (COSEWIC, 2012).

A Great Blue Heron was observed on the top of the Ranney Falls GS main powerhouse tailrace wall during the July 6, 2007 breeding bird survey (Coker *et al*., 2008). A pair of nesting Canada Goose was observed near the Trent River shoreline north of the "Pup" powerhouse transformer yard during an April 29, 2012 site visit.

2.2.8 Significant Aquatic Wildlife Species

Federally, SAR are recognized by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2012) and are protected under the *Species at Risk Act* (*SARA*). Provincially these are recognized by the Committee on the Status of Species at Risk in Ontario (COSSARO) under the *Endangered Species Act* (*ESA*), in conjunction with the Species at Risk in Ontario (SARO) List (MNRF, 2014). Species listed as provincially endangered or threatened and their habitat are afforded protection under the *ESA*.

The new *ESA* came into effect on June 30, 2008, providing broader protection of SAR and their habitat and a stronger commitment to recovery and effective enforcement. Once a species is designated to be at risk, it is included on the SARO List. All species that are considered endangered or threatened and their critical habitats are now legally protected under the *ESA*.

As indicated in Section 2.2.3, one aquatic macrophyte species, Engelmann's Quillwort, present in the TSW is ranked as S1 (critically imperiled) by the NHIC and designated as an Endangered species federally (COSEWIC, 2012) and provincially (MNRF, 2014). This species is confined to a 4.5 km section of the Severn River in the District Municipality of Muskoka (EQRT, 2007) and 450 meter section of the Gull River at West Guildford. Its sterile hybrid with Spiny-spored Quillwort, Eaton's Quillwort, is also ranked as S1 (Table 2.6) but not designated as a SAR.

As indicated in Section 2.2.6, four fish species present in the TSW are SAR. A search of the NHIC database indicated that Lake Sturgeon, designated as Threatened federally and provincially, has been recorded in the proposed Ranney Falls G3 Project area (Map Square 18TQ70). The occurrence of Lake Sturgeon is based on a 1976 record with no more recent documented occurrences this far upstream (G. Kinsman, Parks Canada - TSW, 2011, pers. comm.). The American Eel, designated as Special Concern federally and Endangered provincially, was captured upstream of Campbellford based on 2001 or earlier records (H. Simpson, MNR, 2011, pers. comm.) and was not listed in Map Square 18TQ70.

Based on DFO aquatic SAR mapping provided on the Conservation Ontario website (http://www.conservation-ontario.on.ca), Lake Sturgeon is the only fish SAR that is of concern in the area of Ranney Falls GS with the upstream limit of its distribution being Dam #10, Ranney Falls GS and Locks #11 and #12. However, as indicated above, American Eel is known to occur, or to have occurred, upstream of Ranney Falls GS.

Black Tern, designated as Special Concern provincially but Not at Risk federally, has been recorded as probably breeding within Map Square 18TQ70 (see Table 2.15). As a marsh-nesting species, it is likely not present in the proposed Ranney Falls G3 Project study area.

2.2.9 Invasive Species

One aquatic invasive species, Water Soldier was found in the Trent River in 2008 and has since spread. Water soldier is an evergreen perennial a fast-growing aggressive species that can out-compete native plants and decrease plant biodiversity. It can also invade open water converting that habitat into dense vegetation (Trent-Severn Waterway, 2014).

Populations of the invasive within the TSW represent the only known infestation in a public waterway in North America. Currently, MNRF and OFAH are studying the species and have a harvesting and spray program in place. The Water Solider has been was first discovered near Havelock, somewhat north of Ranney Falls.

2.2.10 TSW/Trent River Water Uses

2.2.10.1 General Recreation

The CLI (1971b) categorizes the lands encompassing the Ranney Falls GS property as Class 4 with moderate capability for outdoor recreation providing access to water affording opportunity for angling or viewing of sport fish, shoreland fronting water accommodating yachting and boat tripping, and major, permanent, non-urban, man-made structures of recreational interest, i.e., the TSW.

2.2.10.2 Recreational Boating

The development of the TSW to provide a link between Lake Ontario and Georgian Bay was initially based on the demand for better transportation and access to resources (Parks Canada, 2000, 2011). Completed in 1920, the waterway vision as a commercial transportation route never came to fruition following a shift in mode of transport from steamboat to rail. Subsequently, recreation became an industry of considerable importance to the communities along the waterway due to substantial increase of resorts and cottages. The waterway system is 386 km long and currently encompasses 44 locks including two flight locks, two hydraulic lift locks and one marine railway. The system includes 160 dams and water control structures, 42 bridges, 25 km of concrete wing walls at lock stations and more than 1,700 aids to navigation.

The Federal Government owns and Parks Canada – TSW manages approximately 76,000 ha of lake and river beds that are constituent parts of the waterway (PFTSW, 2008). Approximately 230 wetlands are associated with the waterway, and a diverse assemblage of biota utilizes the principal habitat along the waterway and associated upland areas, including more than 40 SAR. In addition to its ecological importance, the TSW has significant social, economic, cultural and archaeological values.

In 2010, the TSW served more than one million land-based visitors and approximately 130,000 vessels passed through one or more locks (Parks Canada, 2011). The TSW operates from mid-May to mid-October, e.g., in 2011 operation extended from May 20 to October 12. Table 2.16 presents monthly vessel statistics for the locks at Hague's Reach, Ranney Falls and Campbellford between 2004 and 2014. Peak vessel utilization occurs in July and August, with approximately 1,000 vessels passing through the three lock locations annually.

Table 2.16 TSW Monthly Vessel Statistics, 2004-2011[1]

Station	May	June	July	August	September	October	Total
2014							
Ranney Falls	30	150	244	205	80	9	768
2013							
Ranney Falls	34	129	275	263	68	5	774
2012							
Ranney Falls	36	163	469	272	76	5	1021
2011							
Hague's Reach	27	157	367	264	82	16	913
Ranney Falls	23	154	469	263	80	14	1,003
Campbellford	23	143	400	296	101	14	977
2010							
Hague's Reach	43	146	364	313	85	10	961
Ranney Falls	47	139	362	316	85	11	960
Campbellford	50	157	387	356	93	16	1,059
2009							
Hague's Reach	35	155	396	313	98	11	1,008
Ranney Falls	35	148	384	302	91	11	971
Campbellford	37	159	435	350	99	14	1,094
2008							
Hague's Reach	36	143	350	276	103	10	918
Ranney Falls	36	149	353	283	126	9	956
Campbellford	33	154	376	320	120	10	1,013

Station	May	June	July	August	September	October	Total
2007							
Hague's Reach	49	197	482	327	123	4	1,182
Ranney Falls	49	191	479	335	125	4	1,183
Campbellford	48	203	530	442	123	4	1,350
2006							
Hague's Reach	49	208	449	285	108	10	1,109
Ranney Falls	49	200	441	291	112	10	1,103
Campbellford	48	193	463	318	106	10	1,138
2005							
Hague's Reach	52	199	520	397	129	19	1,316
Ranney Falls	50	200	546	409	130	22	1,357
Campbellford	47	200	607	459	136	20	1,469
2004							
Hague's Reach	1	210	468	270	52	8	1,009
Ranney Falls	0	213	478	273	55	8	1,027
Campbellford	4	208	518	293	52	8	1,083

[1] Source: G. Kinsman, Parks Canada - TSW, 2011, pers. comm.

Lock-viewing is also a popular pastime for tourists, with the Locks #11 and #12 near Ranney Falls GS forming one of the two sets of flight locks in the TSW. Flight locks are two conventional locks joined in a sequence or "flight" of locks to overcome great changes in water level.

2.2.10.3 Sportfishing

Recreational fishing is an important facet of the tourist industry and the local economy. Based on the 2000 survey of recreational fishing in Ontario, over 2 million sportfish were caught in the TSW, with the order of predominant catch being sunfishes, Rock Bass, Yellow Perch, Smallmouth Bass, Largemouth Bass and Walleye (MNR, 2003).

Sportfishing is not common in proximity to the Ranney Falls GS.

2.2.10.4 Municipal Water Supply and Wastewater Treatment

The Campbellford Water Treatment Plant, operated by Trent Hills, is a conventional water treatment system which draws all of its raw water supply from the Trent River. A 5,230 m^3 off-site storage reservoir provides for peak hour demands.

The Trent Conservation Coalition Protection Committee (TCCPC) was established as a multi-stakeholder committee selected to represent municipal, economic, general public and First Nation interests across the Source Protection Region, including the Trent River, to develop a Source Protection Plan that establishes policies for preventing, reducing or eliminating threats to drinking water from surface water and groundwater sources. The “Amended Proposed Trent Assessment Report” (TCCPC, 2011) was recently submitted to the MOE for review and consideration.

Trent Hills has a contract with the Ontario Clean Water Agency to operate the Campbellford Wastewater Plant for the management and disposal of solid wastes.

In 2013 Parks Canada – TSW installed a catch basin and storm sewer on lands under its administration adjacent to Trent Drive in order to address seasonal flooding of Parks Canada land and Trent Drive (E. Nowlan, Parks Canada – TSW, 2015, pers. comm.).

2.2.10.5 Other Hydropower Facilities

At the present time, there are 26 hydroelectric generating stations on the TSW generating close to 100 MW collectively. Additional new and expansions of existing stations are being actively considered, including the proposed Ranney Falls G3 Project. As indicated in Section 1.2, the PFTSW (2008) concluded that the development of renewable energy resources is a sound public policy goal and supported a vigorous effort to pursue green energy generating potential along the TSW.

3.0 EFFECTS ASSESSMENT AND MITIGATION MEASURES

The available environmental baseline information and site-specific aquatic vegetation and fisheries survey findings provided the basis for an assessment of potential construction and operational effects on the aquatic environment, e.g., due to cofferdam installation/removal, dewatering, blasting, soil erosion and turbidity generation, etc.

Recommended mitigation measures for the effects on the aquatic environment are based on the OWA (2012) “Best Management Practices Guide for the Mitigation of Impacts of Waterpower Facility Construction”, standard environmental construction guidelines (e.g., Cheminfo, 2005), relevant government guidelines for proposed hydroelectric power plant development (e.g., MOE, 1995; Wright and Hopky, 1998; DFO, 2010), as well as government agency and other organization consultation.

The significance of potential impacts was assessed based on their magnitude, duration and extent after the implementation of recommended mitigation measures.

3.1 SURFACE AND GROUNDWATER HYDROLOGY

As indicated in Section 1.3.1, groundwater inflows due to any excavation can be expected as a result of precipitation/runoff events initially within the upper part of the upper shale-rich bedrock domain. Based on the geotechnical survey findings, inflows are expected to be manageable during excavation with inflow at a rate up to 3.5 L/s. Higher than expected inflows may occur if high permeability features are encountered, or if blasting and rock excavation techniques significantly modify the intrinsic hydraulic conductivity of the rock mass (Knight Piésold Ltd., 2011a). To minimize dewatering requirements, cementitious grouting may be required along the excavation line just before starting the excavation to seal the paths of groundwater inflow. Other methods that are generally accepted in the construction industry to reduce or avoid the groundwater inflow may also be employed.

Careful excavation methods, including controlled drilling and blasting, will need to be implemented especially near the excavation walls to ensure that disturbance to the walls and groundwater inflows are minimized (Knight Piésold Ltd., 2011a). As indicated in Section 1.3.1, OPG also intends to install grouting curtains to minimize groundwater inflow into the excavation pit.

As indicated in Section 4.4.2, benzene, phenolics and n-hexane concentrations in groundwater samples were above their respective Ground Water Standard or PWQO. Based on review of other study findings, it was concluded that these elevated concentrations are naturally occurring due to their leaching from the bituminous layers of shale that are interbedded in the limestone of the Verulam Formation. As the elevated concentrations are not derived from anthropogenic sources, no remediation is recommended. Rather, a monitoring program is recommended to confirm that excess groundwater within the tailrace is suitable for direct discharge to the Trent River and/or Trent Canal based on MOE water management policies (MOEE, 1994). In addition, appropriate health and safety measures for implementation during construction will be developed, as necessary, based on the analytical results.

Approval for groundwater discharge to the Trent River and/or Trent Canal will be obtained from Parks Canada – TSW. A Permit-To-Take-Water will be required from the MOECC for water discharges that are greater than 50,000 L/day.

Drainage ditches are present on the Ranney Falls GS property. These drainage ditches may be affected by sediment loadings due to accelerated soil erosion during construction. Till and gully erosion caused by channelized overland flow can also be a major source of soil erosion. Sheet erosion can be an additional source of sediment.

A site-specific Erosion and Sediment Control Plan will be prepared and implemented during construction (see Terrestrial TSD). With respect to surface drainage, the following guidelines will be applied in the development of the Erosion and Sediment Control Plan:

- diversion of runoff away from exposed areas;
- maintenance of low runoff velocities;
- design of drainage works, such as ditches and outfalls, to handle concentrated runoff;
- diversion of the drainage culvert from the adjacent property out of the construction pit; and
- installation of a silt curtain along the Trent River shoreline prior to removal of the rock plug at the new tailrace channel outlet and the cofferdam at the existing tailrace channel outlet.

The site-specific Erosion and Sediment Control Plan will be part of a broader Environmental Management Plan for the proposed Ranney Falls G3 Project.

The implementation of these standard procedures during construction and rehabilitation will obviate or minimize potential effects on surface hydrology.

Blasting will be required during powerhouse construction and tailrace excavation. Blasting could have a potential effect on groundwater quality and flow in the immediate vicinity of the blasting operations. It has been estimated that peak particle velocities produced from blasting operations in excess of 600 mm/s will cause cracks and discontinuities in sedimentary rock up to a 5-m radial distance from the blast using the sophisticated techniques and control measures employed in modern blasting practice (L. McAnuff, VME/Explotech Associates Ltd., 1991, pers. comm.). It was also indicated that seams may open up between sedimentary strata within the 5 m blast radius. Minimization of the physical effects of blasting will be ensured by following the recommendations of the blasting engineer and the DFO blasting guidelines (Wright and Hopky, 1998).

No effects on groundwater are anticipated as a result of the operation of the proposed Ranney Falls G3 Project; however, all water from excavation pit will be tested and treated if required prior to discharging.

3.2 TSW/Trent River Hydrology

Operation of the proposed Ranney Falls G3 Project will result in optimal use of the total water available (mean annual flow of approximately 118 m^3/s). However, during the navigation season between mid-May and mid-October, flows in the Trent Canal are generally below the current Ranney Falls GS design capacity of 100.9 m^3/s, with mean monthly flows ranging from 35.7 to 78.6 m^3/s between June and October. For the proposed Project, the maximum flow permitted in the Trent Canal during the navigation season will be increased from 100 to 120 m^3/s.

Modifications to the navigation channel are not anticipated, and the only change in habitat due to the proposed Project will be an increase in the range of flows and flow velocities. This will result from the post-construction condition in which the total river flow will be diverted down the navigation channel for a greater proportion of the year, resulting in a flow regime through the channel that will, on average, more closely reflect the annual Trent River hydrograph. This will result, however, in higher flow velocities within the 1.5 km of navigation channel during the wetter seasons. Flow velocity within this channel reach from mid-June to late October, on average, will not change over existing conditions, while flow velocity at other times of the year would be, on average, higher than existing conditions.

As previously indicated, little if any flow currently occurs in the section of the Trent River between Dam #10 to the Ranney Falls GS tailrace from mid-June to late October due to the diversion of water through the Trent Canal. With its proposed increased capacity, all flow will be diverted through the Trent Canal and expanded Ranney Falls GS from the end of the first week of May to the fourth week in March. This means that the proposed Project will result in more water being diverted at Dam #10 into the Trent Canal in November, December, January and February. This will also result in a decrease in the amount of time that water will be intentionally spilled through Dam #10, i.e., April and early May. Leakage of approximately 0.5 m^3/s through the dam will continue during the remaining time period.

The only physical modifications to this section of river will be the new tailrace of the proposed Ranney Falls G3 Project. The proposed tailrace will be large enough to accommodate the increased flow of the new powerhouse, and therefore, the flow velocity exiting the new tailrace will be very similar to the existing main powerhouse tailrace velocity. Provided that the proposed tailrace is constructed so that it has sufficient depth (0.5 m) of substrate with the similar type of substrate present in the existing tailrace, the ecological function provided by the existing tailrace will be replicated, with the area increased. After “Pup” powerhouse decommissioning, flow through its tailrace will cease. There are no critical habitats in the “Pup” tailrace.

As part of a numerical hydraulic study, using HEC-RAS software, developed by the HEC of the USACE, to investigate water surface profiles and flow velocities in the Trent Canal, as well as water level surge due to existing and future hydraulic conditions between Dam #10 and Ranney Falls GS. The study concluded that the Trent Canal can transport the maximum power flows up to 171 m^3/s, while maintaining the water levels within the current limits and maximum flow velocities within the Trent Canal will increase from 0.76 m/s to 1.38 m/s. The total head loss in the canal is sensitive to operating water levels, increasing quickly with decrease of water level. Based on the scenarios modeled, the proposed spillway will be able to effectively control any water level surges during an emergency shutdown of the units.

A hydraulic study using the CFD model was undertaken to assess the potential for vortex formation at the forebay under existing and future flow conditions. Simulation of existing flow conditions indicated no swirling flows in the flow field near the existing intakes, which is consistent with observations at Ranney Falls GS. Similarly, flow fields produced from simulations of the future flow conditions showed no significant cross-circulations near the new intake area, suggesting that the potential for vortex formation at the new G3 intake is likely to be negligible.

The simulation of discharge capacity indicated that the proposed spillway would be sufficient to discharge a flow of 171 m^3/s.

The existing Ranney Falls GS will be shutdown during the Execution Phase. Stage 1, civil construction will be undertaken in the “dry” and will be confined by upstream and downstream cofferdams. It is anticipated that the cofferdams will be in place for 12 to 14 months. During the period when no flow is being diverted through the Ranney Falls GS, flow in the Trent Canal will meet navigational requirements with excess flow spilled through Dam #10.

3.3 TSW/Trent River Morphology and Bathymetry

As indicated in Section 1.3.1, the only physical modifications to the Trent Canal and Trent River will be the expanded forebay and tailrace, respectively.

As indicated in Section 1.3.2, the impact of higher flow velocities on erosion in the Trent Canal was investigated using an *in-situ* flume developed by Environment Canada (Krishnappan, 2007). It was determined that no increase in channel erosion will occur, even though flow velocity is projected to increase from 0.9 m/s at the existing maximum flow of 100 m^3/s to 1.5 m/s at the proposed maximum flow of 171 m^3/s. The canal bottom armour layer remained stable with minor transport of fine material underneath the armour layer. Moreover, the proposed maximum canal flow could be sustained in the canal without affecting canal stability.

No direct modifications to the morphology and bathymetry of the Trent River between Dam #10 and the expanded Ranney Falls GS tailrace are anticipated. The only change to bathymetry will be the amount of time that water will be intentionally spilled through Dam #10, i.e., April and early May. Leakage through the dam will continue during the rest of the year.

3.4 AQUATIC ENVIRONMENT RESOURCES

3.4.1 Water Quality

During the construction period, water quality in the Trent Canal and Trent River may be affected by soil erosion and turbidity generation, in-water construction activities, incidental spills and waste material dispersion.

As indicated in Section 3.1, a site-specific Erosion and Sediment Control Plan will be prepared and implemented during construction. With the implementation of the Erosion and Sediment Control Plan, the potential effects of soil erosion and turbidity generation will be minimized or obviated.

The potential effects of in-water construction activities, such as cofferdam construction on water quality of the Trent Canal and Trent River, will be minimized by using clean rock fill, the placement of rock fill over similar coarse substrate and judicious selection of the discharge location and water pressure during dewatering and as necessary the placement of erosion control structures.

A silt curtain will be installed along the Trent River shoreline prior to removal of the rock plug at the new tailrace channel outlet and the cofferdam at the existing tailrace channel outlet. Specific procedures will be developed for rock and cofferdam removal.

Incidental spills of oil, gas, diesel and other liquids to the environment could occur during construction. In addition, sanitary and other wastes will be generated during construction. Fuelling and lubrication of construction equipment should be carried out in a manner that minimizes the possibility of releases to the environment. Measures for containment and cleanup of contaminant releases will be followed to minimize contamination of the natural environment, followed by approved landfill or other disposal. Interim sanitary waste collection and availability of treatment facilities will be arranged for the duration of the construction period. All construction waste, washwater and wastewater will be disposed of or managed in accordance with regulatory requirements.

OPG acknowledges that re-fuelling 30 meters or more from a watercourse is a good practice and is outlined in the Liquid Fuels Handling Code. However, most of the Ranney site is within a 30 meter radius of either the canal or the River. For mobile re-fuelling, the Liquid Fuels Handling Code allows for a modification to procedure where the mobile re-fueller has an approved procedure to prevent the loss or escape of product from: (a) creating a hazard to public health or safety; (b) contaminating a fresh water source or waterway; (c) interfering with the rights of any person; or (d) entering into a sewer system, underground stream, or drainage system. As OPG will require its constructor to develop an environmental management plan, the constructor will be obligated to provide a procedure that addresses (a) through (d).

The contractor is to also note the MOECC spills response line in their EMP.

A Hazardous Materials Management Plan, Waste Management Plan and a Spills Emergency Preparedness and Response Plan will be developed for the construction phase of the proposed Project as part of the broader Environmental Management Plan. The implementation of these pollution prevention plans will obviate or minimize the environmental effects of accidental releases to the natural environment that have the potential to affect water quality in the Trent Canal and Trent River.

During refurbishment of portions of the supporting piers under the operating deck, there is a potential for accidental loss of cement during surface application. Any dripped cement will be recovered from the forebay bottom for suitable disposal prior to temporary cofferdam removal. All trash and other solid debris will also be collected for appropriate disposal.

Overall, the effects of the construction of the proposed Ranney Falls G3 Project on water quality of the Trent Canal and Trent River are expected to be localized, temporary and negligible.

A Hazardous Materials Management Plan, Waste Management Plan and a Spills Emergency Preparedness and Response Plan will also be developed as part of the broader Environmental Management Plan for the operation of the proposed Project. The implementation of these pollution prevention plans during facility operations will obviate or minimize the environmental effects of accidental releases to the natural environment that have the potential to affect water quality in the Trent Canal and Trent River.

3.4.2 Sediments

A study of erosion potential of bed substrate in the Trent Canal upstream of Ranney Falls GS indicated that the canal bottom armour layer remained stable with minor transport of fine material that underlies the armour layer (Krishnappan, 2007).

As indicated in Section 2.2.2, bottom substrate in the Trent Canal and Trent River in the vicinity of the Ranney Falls GS consists predominantly of coarse material, e.g., sand, gravel, cobble, boulder and/or bedrock. After construction, substrate type and quality will be similar to that currently in place.

No alteration of sediment type or quality is expected during operation of the proposed Ranney Falls G3 Project.

3.4.3 Aquatic Vegetation

As indicated in Section 2.2.3, a bed of rooted aquatic vegetation consisting primarily of Pondweed with some Water-milfoil is present upstream of the “Pup” powerhouse tailrace (see Figure 2.1). These plants will not be affected by construction activities or future operation of the proposed Project.

3.4.4 Plankton

Plankton populations will not be affected by construction or operation of the proposed Project. The loss of any plankton confined in the forebay and main powerhouse tailrace behind the cofferdams due to dewatering will be readily mitigated by ongoing migration from upstream sources.

3.4.5 Benthic Macroinvertebrates

The placement of a cofferdam along the forebay intake entrance and main powerhouse tailrace outlet may have a localized adverse effect on benthic macroinvertebrate communities on the surface and within the substrate. The extent of disruption depends on the type of bottom substrate, the extent of the disturbed area, any resultant turbidity and sedimentation, and the timing of construction. The substrate consists primarily of boulder, cobble, gravel and/or sand over bedrock, or bedrock. Cofferdam placement over this type of substrate will minimize any detrimental effect on the benthic macroinvertebrate communities due to the availability of microhabitat and refugia within the coarse substrate. With the use of the larger-size rockfill, sufficient interstitial spaces will be available for the survival and migration of mobile benthic fauna.

Recovery after cofferdam removal is expected to be rapid. Recovery is defined as the return of aquatic biotypes after disturbance to an abundance and diversity comparable to that in an adjacent undisturbed control area (Rosenberg and Snow, 1977). The principal mechanism of recolonization by invertebrates is drift (Luedtke and Brusven, 1976; Williams and Hynes, 1977), but other mechanisms, such as lateral migration, vertical migration from within the hyporheic zone (i.e., after burial) and larval recruitment from aerial sources are also important (Luedtke and Brusven, 1976; Williams and Hynes, 1977; Griffiths and Walton, 1978; Hirsch *et al*., 1978). The rate of recovery is dependent on ambient environmental conditions, the type of organisms present and the size of the disturbed area. In general, there will be less impact upon benthic macroinvertebrate communities associated with a naturally variable, high energy environment. Benthic organisms that are adapted to high-energy, unstable conditions have life cycles that allow them to better withstand these stresses (Hirsch *et al*., 1978).

Although no specific data are available on negative effects of substrate coverage by rockfill or other material, recovery rates from dredging activities range from six days (McCabe *et al*., 1998), 14 days (Rosenberg and Snow, 1977), three weeks (Diaz, 1994), 38 days (Griffith and Andrews, 1981) and up to one year (Griffiths and Walton, 1978).

Blasting in the dewatered nearshore area of the expanded tailrace will result in localized destruction of the benthic communities. Benthic mortality will be a function of distance from and intensity of the blast (Schwartz, 1961). However, recovery from blasting is expected to be rapid.

Under the operating regime of the proposed Ranney Falls GS expansion, flow velocity will be higher, on average, from about late October to mid-June in the 1.5 km long navigation channel upstream of the Ranney Falls GS and Locks #11 and #12. The maximum average flow velocity under existing conditions is approximately 0.9 m/s, and the maximum average flow velocities due to proposed Ranney Falls GS expansion will be approximately 1.0 m/s during the navigation season and 1.5 m/s during the remainder of the year. These are average values for the entire water column. Changes will be less near the bottom, where local-scale variations in velocities adjacent to the coarse substrate will still occur (Krishnappan, 2007).

Current speed is an important variable in running water, in that it controls the occurrence and abundance of species, and hence the structure of the biotic community (Hynes, 1970). The increased flow velocity through the navigation channel will likely have an effect on the composition of the benthic macroinvertebrate communities. Detrimental effects to benthic macroinvertebrate communities due to current speed are generally caused by sudden and/or extreme changes in flow, such as is caused by severe storms or drought (Hynes, 1970), or by dam operations (Clarke *et al*., 2008). Coarse, stony substrate, such as occurs in the navigation channel, usually has the most diverse macroinvertebrate communities that are also most resilient to sudden changes in flow because the substrate provides a variety of micro-habitats and refugia (Hynes, 1970). Because flow variability will only increase to the extent that the existing hydrograph of Trent River flows will be more closely followed, no negative effect on the benthic macroinvertebrate communities is anticipated.

The section of the Trent River from Dam #10 downstream to Ranney Falls consists of a series of reduced shallow warmwater pools and riffles on the bedrock riverbed for part of the year and a high-velocity river for the remainder of the year. This section does not likely have a very productive benthic macroinvertebrate community. Bedrock is relatively poor invertebrate habitat compared to gravel or cobble (Hynes, 1970), and the summer low flow period and high water temperatures would set the limiting conditions for the benthic macroinvertebrate communities. Therefore, it is anticipated that extending the low flow period in this section of river will not have a significant effect upon the productivity of the benthic macroinvertebrate communities.

The pattern of flow will change immediately downstream of Ranney Falls and in the vicinity of the tailrace due to the proposed Ranney Falls G3 Project. There will be a decrease in the amount of time when water will be intentionally spilled through Dam #10 and over Ranney Falls, and a corresponding increase in flow into this river section via the enlarged Ranney Falls GS tailrace. The backwater effect from the next dam downstream will ensure that no part of this reach will become dry. Although the flow pattern will change somewhat, no changes in overall habitat type or quality will occur, nor will access to particular habitats be restricted. Furthermore, although the composition of the benthic macroinvertebrate community at any given location may change due to a shift in local flow velocity, the overall composition and productivity of the communities throughout this river section will likely not change significantly.

3.4.6 Invasive Species

One aquatic invasive species, Water Soldier was found in the Trent River in 2008 and has since spread. While this aquatic plant has not been identified at Ranney Falls, the TSW and other partners is working to avoid its spread and have issued some Best Management Practices (Trent-Severn Waterway, 2014). It is recommended that OPG operations staff are made aware of what the plant looks like and notify the TSW or MNRF if the plant appears near or at Ranney Falls or other OPG stations along the TSW.

Populations of the invasive within the TSW represent the only known infestation in a public waterway in North America. Currently, MNRF and OFAH are studying the species and have a harvesting and spray program in place. The Water Solider has been was first discovered near Havelock, somewhat north of Ranney Falls.

3.4.7 Fish Populations and Habitat

Cofferdam Installation

After cofferdam installation, the existing forebay and tailrace channel will be dewatered and any fish present collected (i.e., by electrofishing) and transferred to the Trent Canal and Trent River, respectively, prior to complete dewatering. Temporary cofferdam installation could disrupt fish spawning activities and impact on the early life stages of fish, e.g., eggs and fry. Cofferdam installation and dewatering will be undertaken outside of the timing restriction for in-water construction to protect the fish spawning and egg incubation period for warmwater and coolwater fish communities of April 1 to June 30. An impervious geotextile will be placed on the cofferdam face to preclude water ingress. The temporary unavailability of this habitat will have negligible effect on the local fish populations.

Blasting

Blasting of bedrock will be required in the nearshore area of the expanded forebay, powerhouse and spillway, and tailrace. This will be conducted in dry conditions. In-water blasting may be conducted to remove the tailrace cofferdam including the rock plug. Numerous studies have been undertaken to assess fish mortality due to in-water blasting (e.g., Chamberlain, 1976, 1979; Teleki and Chamberlain, 1978). The degree of blasting impact on fish will depend on the type of explosive, type of substrate blasted, blasting technique, fish physiology and timing. Injury to fish from in-water blasting will result from physical abrasion from ejected debris and from pressure changes associated with the blast shock waves.

Common blast-induced injuries to fish include haemorrhage in the coelomic or pericardial cavity and rupture of the swim bladder. Differences in species-specific susceptibility to blast injuries are a function of the fish's shape and swim bladder formation (Teleki and Chamberlain, 1978). Physoclistic (with swim bladder isolated from oesophagus) and laterally compressed fish such as the centrarchids, e.g., Smallmouth Bass, are the most sensitive to pressure changes. Mortality within this group varies with orientation of the laterally-compressed body to the pressure front at the time of a blast. Physostomic (with swim bladder connected to the oesophagus by an open duct, which provides pressure release) fish with fusiform shape, such as the White Sucker, are most resistant to pressure changes.

To obviate injury to fish, blasting will be undertaken in the “dry”, i.e., behind the cofferdam after dewatering and removal of fish. The shockwaves (peak particle velocities) produced from blasting using the sophisticated techniques and control measures employed in modern blasting practice will be attenuated rapidly within the bedrock. With the width of the cofferdam and its sufficient distance from the limit of blasting, no injury to fish from pressure changes associated with the blast shockwaves is expected. Moreover, blasting mats will be used to minimize the occurrence of fly-rock and the rock fragments removed by backhoe.

The DFO has developed a number of guidelines on methods and practices which are intended to prevent or avoid harm to fish and/or fish habitat that could result from the use of explosives (Wright and Hopky, 1998). The use of temporary cofferdams to permit blasting within the dewatered area and adherence to the DFO guidelines and blasting engineer recommendations will avoid the harm to fish and/or fish habitat. Potential effects on fish in the Trent River will be further mitigated by scheduling the blasting during the period of little flow between Dam #10 and the tailrace, i.e., between July and late October, if possible.

As a result, no direct adverse effects on fish or fish habitat are anticipated during construction.

<u>Flows and Flow Velocities</u>

The only physical modifications to this section of river will be the expanded tailrace. The proposed tailrace will be large enough to accommodate the increased flow from the new powerhouse, and therefore, the flow velocity exiting the new tailrace will be very similar to the existing main powerhouse tailrace velocity. Provided that the proposed tailrace is constructed so that it has sufficient depth (0.5 m) of substrate with the similar type of substrate present in the existing tailrace, the ecological function provided by the existing tailrace will be replicated, with aquatic habitat area increased. After “Pup” powerhouse decommissioning, flow through its tailrace will cease. There are no critical habitats in the “Pup” powerhouse tailrace.

There are three areas of aquatic habitat, isolated from each other by barriers to fish migration, potentially affected due to alterations to flow by the operation of the proposed Ranney Falls G3 Project:

1. a 1.5 km section of the Trent Canal navigation channel upstream of the Ranney Falls GS between Dam #10 and Locks #11 and #12;
2. the section of Trent River between Dam #10 and the brink of Ranney Falls; and
3. the section of Trent River downstream of Ranney Falls to the Hague’s Reach GS and Lock #10.

The projected increase in flow velocity from 0.9 m/s at the existing maximum flow of 100 m^3/s to 1.5 m/s at the proposed maximum flow of 171 m^3/s in the Trent Canal will likely affect habitat utilization by fish. For example, given the coarse substrate and depth of the navigation channel, such a change in velocity would be less favourable to centrarchids, but more favourable to catostomids, e.g., White Sucker and redhorse suckers (Aadland *et al*., 1991).

As indicated in Section 3.3, there will be a decrease in the amount of time that water will be intentionally spilled through Dam #10, i.e., April to early May. Leakage through the dam will continue during the remainder of the year. Fish production in the Trent River between Dam #10 and Ranney Falls is currently limited by the low flows during the summer and early fall, the predominantly bedrock substrate and the isolation of the area upstream of Ranney Falls. Leakage through the dam will continue, and decreasing the period of time that additional flow is provided is not expected to have a detrimental effect.

The decrease in the amount of time when water will be intentionally spilled through Dam #10 will result in corresponding decrease in flow over Ranney Falls and into the upstream end of this river section, and a corresponding increase in flow into this river section via the proposed Project expanded tailrace. It is not anticipated that this will have a detrimental effect upon fish production in this section of the Trent River. The depth of water throughout this area is determined by the regulated water level for navigation. The backwater effect from the next dam downstream ensures that no part of this reach becomes dry. There does not appear to be any critical habitats that depend upon a particular combination of flow and substrate type, such as Walleye spawning, between Ranney Falls and the existing Ranney Falls GS tailraces. Certainly there will be some shifts in habitat utilization as fish and invertebrates adjust to the new flow pattern in the area shown in Figure 2.1, but because no critical habitats will be affected, nor will changes in habitat type or quality occur, this is not predicted to result in any changes in fish community or productive capacity.

As indicated Section 3.4.5, the overall composition and productivity of the benthic macroinvertebrate communities within the Trent Canal and Trent River will likely not change significantly as a result of flow modifications. Therefore, a change in food supply for fish is not anticipated.

With the potential increase in flow being diverted through the proposed expanded Ranney Falls GS, there is the potential for increased entrainment and possible injury or mortality of fish. However, fish injury/mortality due to entrainment has not been documented as an issue for hydroelectric stations along the lower TSW. This is likely due to:

- the type of fish community;
- the fragmented condition of the waterway due to the presence of numerous dams; and
- the low-head nature of these stations.

Moreover, the constructed navigation canal upstream of the Ranney Falls GS to Dam #10 has no significant fish spawning areas or other habitats that would attract or support a disproportionate number of fish.

The fish communities found within each relatively isolated section of the TSW, i.e., between a set of dams and locks, reflect the habitats available within each section. Centrarchids (sunfishes, Smallmouth Bass, Largemouth Bass) are very common throughout the system due to their preferred habitats found in quiet slow-moving rivers and small lakes with warm water.

Each reach of the TSW has a dam at the downstream and upstream ends, with mostly deeper flat water between, except for a relatively small section of rapids below the upstream dam that provides spawning habitat for migratory fish such as Walleye, Lake Sturgeon and suckers. For the most part, these mobile fishes remain within their particular reach, as evidenced by spawning observations in which the largest reaches have the largest aggregations of fish within the spawning habitat below the upstream dam. For the larger reaches, young fish that drift downstream from the spawning areas remain in these lentic habitats between the upstream spawning area and the downstream dam. In contrast, the smaller reaches have very few, if any, observable spawning fishes. Therefore, the smaller reaches likely produce fewer young fishes that would tend to drift downstream.

Since most fish species found in the TSW are not compelled to migrate upstream or downstream for some part of their life cycle, there is no mass migration that could result in mortalities below hydroelectric generating stations. While some of their larvae may drift downstream through the generating stations, they are individually very small and unlikely to be harmed by passing through the low-head facilities in the TSW (e.g., Cada, 1990; Dedual, 2007). The exception to this may be the American Eel (see below).

Ranney Falls GS is highly visible to local residents, fishers and visitors due to the adjacent Ferris Provincial Park, the nearby TSW locks and the suspension bridge/walking trail with good views of the existing GS tailrace. Even with extensive observations over decades of operation, there are no reports of dead or damaged fish downstream of the GS. Furthermore, aggregations of piscivorous birds such as seagulls are not attracted to the vicinity of the GS tailrace, suggesting that few fish are injured or killed. During the fisheries field surveys, spawning assessments and field visits undertaken by C. Portt and Associates staff on October 19, 2005, April 13, June 6-7, August 31 and September 8, 2006, April 21 and June 4, 2007, April 22, 2008, April 5, 2010 and April 12, 2011, no injured or dead fish were observed in the Ranney Falls GS tailrace area. Similarly, no injured or dead fish have been observed by OPG CHPG staff based on casual observations over decades of GS operation.

Fish injury and mortality due to entrainment at hydroelectric generating stations generally increases with increased station size, increased intake and turbine passage flow velocity, greater head, turbine design, and the abundance and size of fish susceptible to entrainment.

At Ranney Falls GS, the only aspects that will be changing as a result of the proposed Project that will potentially affect entrainment and associated fish injury and mortality will be the increased seasonal flow velocity upstream of the GS within the navigation canal and forebay, the increased flow volume through the GS, the decreased new powerhouse intake velocity and the design of the new turbine units.

Based on the current maximum flow of 100 m^3/s through the Ranney Falls GS, velocities in the straight navigation canal section and near the forebay intake structure are 0.9 and 0.5 m/s, respectively. This difference of 0.4 m/s is due to the offset location of the Ranney Falls GS relative to the main canal channel. The existing maximum powerhouse intake velocity is approximately 2.1 m/s.

Under the proposed GS expansion, maximum flows through the GS will be increased to 120 m^3/s during the navigation season and 171 m^3/s for the remainder of the year. For the increased flow of 120 m^3/s, velocities will increase from 0.9 to 1.0 m/s in the canal and from 0.5 to 0.6 m/s near the forebay intake structure. For the increased flow of 171 m^3/s, velocities will increase to 1.5 m/s in the canal and 0.9 m/s near the forebay intake structure. However, the maximum design flow velocity at the proposed G3 powerhouse intake will be limited to less than 1.5 m/s.

As mean monthly flows between June and October are less than 100 m^3/s, flow velocities in the straight navigation canal section and near the forebay intake structure will remain unchanged, i.e., less than 0.9 and 0.5 m/s, respectively. This period coincides with fish spawning and egg incubation completion and larvae emergence. As mean flow velocities are not expected to change during this period, the potential for young fish entrainment will remain the same during proposed Ranney Falls G3 Project operation. Furthermore, since the maximum intake velocity of the proposed Ranney Falls G3 Project is less than the intake velocity of the existing GS, it is reasonable to assume that the chances of young fish being entrained into the newer facility will be reduced. Moreover, as indicated above, there are no significant fish spawning areas or other habitats in the constructed navigation canal upstream of the Ranney Falls GS to Dam #10.

It has been predicted that these flow increases may potentially shift the fish community in the navigation canal between Dam #10 and Ranney Falls GS towards one that prefers faster flowing conditions, e.g. from centrarchids to catostomids (suckers). Most adult fish, through rheotaxis, will not allow themselves to be swept downstream due to the increased risk this exposes them to, and will either change location or position in the water column to avoid flow velocity that is too great, or simply swim harder in the short term. Over a relatively short time, species for which the velocity change is too great will move out of the affected area, and will be replaced by species which prefer faster water. If this shift occurs, the fish community will be suited to the new faster-flowing habitat conditions, and will likely not be any more susceptible to being swept downstream than the pre-GS expansion fish community. Again, since the maximum intake velocity of the proposed Ranney Falls G3 Project is less than the intake velocity of the existing GS, it is reasonable to assume that the chances of adult fish being entrained into the newer facility will be reduced. Any fish that are entrained into the newer facility will also have a better chance of survival passing through the new Kaplan turbine (see below).

In the case of turbine design, Kaplan turbines result in less fish injury/mortality than Francis turbines, with average survival rates of 89.85% compared to 76.8%, respectively (JRP, 2009). Differences in survival performance between Kaplan and Francis turbines are likely related to the number of blades. Most conventional Kaplan hydropower turbines have five or six blades attached to a hub, and the blades can be adjusted vertically to optimize unit efficiency through a wide range of water displacement volumes. In contrast, Francis turbines typically have 14 to 18 blades that are fixed in position in a manner that forms a wheel. As a result, there is an increased probability of blade strike and injury to fish with the Francis design. In addition, older design turbines may have gaps between the blades and the turbine hub where fish can get caught, and hence suffer injury/mortality.

Fish survival through hydroelectric turbines is also a function of fish size irrespective of turbine design. Even with Francis turbine designs, fish survival can be high especially if the entrained fish are very small. For example, Dedual (2007) has shown high survival (93.1% after 96 h passage) of Rainbow Trout (*Oncorhynchus mykiss*) with fork lengths of 81 mm or smaller. The author concluded that the Francis turbine at the Hinemaiaia Power Plant which has 15 blades and a head of 22.6 m will provide a safe route for migrating fish less than 80 mm in size. Similarly, Cada (1990) estimated that a 4-cm fish (Walleye fingerling) would have a probability of runner contact of 5% or less. Higher fish mortality and injury is expected for larger-sized fish. For example, Ferguson *et al*. (2008) reported that mean blade-strike mortality was higher for adult Atlantic Salmon (*Salmo salar*) and sea-run Brown Trout (*Salmo trutta*) (25.2-45.3%) than for juveniles (5.3-9.7%).

The vertical Kaplan G1 and G2 turbine units in the main powerhouse are characterized as 5,000 hp, 120 rpm and 3 m in diameter, with14 buckets (spoon-like blades). The design of these older Kaplan units is similar to that of the current Francis turbine described above.

As indicated in Section 1.3, the proposed G3 turbine will be a single Kaplan turbine (CAT S- or SAXO-type) unit with a nominal capacity of up to 10 MW at design flow of 80 m^3/s. Although the turbine characteristics are unknown at this time, it is expected that with the modern design, only six or fewer blades will occur on the unit, thereby improving survival of any entrained fish. As indicated above, survival of any entrained larval and YOY fish through the proposed G3 turbine unit is expected to be very high.

ALDEN (2001) conducted a review of fish survival for the Dunvegan Hydroelectric Project in Alberta and predicted fish survival (S) through axial flow turbines (e.g., Kaplan) as a function of fish length (L), propeller speed (r) and the number of blades (b) using a predictive model developed by Headrick (1998):

$$S = 109.2 – 0.027(L) – 1.038(b) – 0.045(r)$$

The simulations showed that survival rate was negatively correlated with fish length and the number of blades in operation. For example, at a turbine speed of 150 rpm, the estimated survival rate for a 500-mm fish would be 82.7% with six blades and 84.8% with four blades. For a 100-mm fish, the survival rate would be 93.5% with six blades and 95.6% with four blades.

In summary, fish entrainment at the Ranney Falls GS appears to be negligible due to its small size, intake velocity and head, its offset location relative to the main canal channel and the poor fish habitat in this reach of the Trent Canal. Although increased flow will be diverted through the proposed expanded Ranney Falls GS, it is predicted that fish entrainment will remain negligible due to the factors affecting current entrainment potential discussed above, as well as the lower intake velocity at the proposed G3 powerhouse and the use of modern conventional turbine design.

Fish SAR

As indicated in Section 2.2.8, Lake Sturgeon and American Eel are known to occur, or to have occurred upstream of Ranney Falls GS. Based on the habitat requirements of Lake Sturgeon, the habitat conditions at Ranney Falls GS and the proposed minor changes in habitat due to the proposed Ranney Falls G3 Project, potential Lake Sturgeon habitat at the Ranney Falls GS will not be negatively affected by the construction or operation of the proposed Project (Coker *et al*., 2012).

Dams and hydroelectric facilities have a detrimental impact upon American Eel populations. American Eel is adept at passing upstream over barriers as juveniles. Adult eels, which migrate downstream to return to their oceanic spawning grounds, are apparently susceptible to hydroelectric turbine mortality due to their elongated body (COSEWIC, 2006). Although not considered a concern in the vicinity of the Ranney Falls GS according to the Conservation Ontario website (http://www.conservation-ontario.on.ca), American Eel have, in the past, occasionally been reported upstream and downstream of Ranney Falls GS. This species presently occurs in very low numbers in the TSW. Surveys targeting American Eel in the TSW in 2010 and 2011 only found them downstream of Dam #1, although one dead eel was found in the vicinity of Lock #3. More recently, American Eel were captured several times incidentally in the vicinity of Lock #3, approximately 40 km downstream of Ranney Falls GS (S. Reid, MNRF, 2015, pers. comm.).

Due to the very low numbers of American Eel that likely occur at Ranney Falls GS, because of the distance and barriers that occur between Ranney Falls GS and Lake Ontario/Bay of Quinte, as well as their generally low numbers known to be present in their primary habitats of Lake Ontario/Bay of Quinte, negative effects on American Eel populations are likely insignificant at this time (Coker *et al.,* 2012). The potential American Eel issue may need to be reassessed as updated information on their presence within the TSW becomes available.

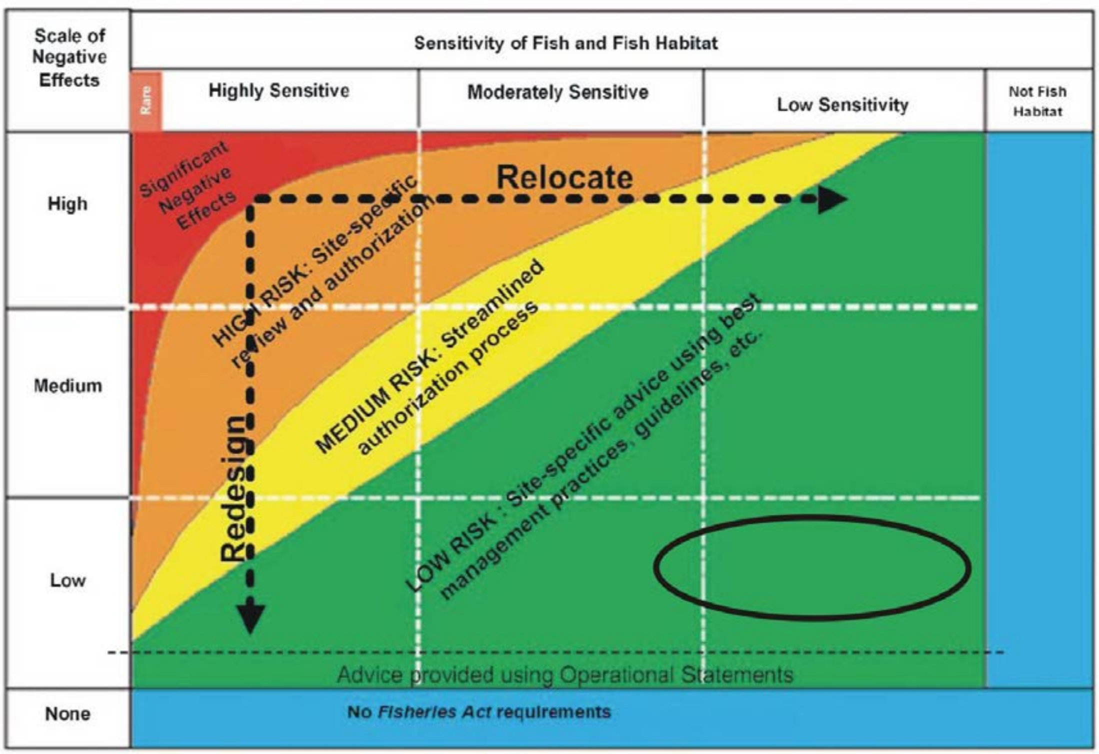
Risk Management Framework Assessment

When these results are considered within the DFO (2006) Risk Management Framework, Coker *et al*. (2012) determined that the proposed Project should be characterized as a “Low Risk” proposal (Figure 3.1). DFO (2006) suggests that an appropriate management option in this case would be to issue a “No HADD Likely as Proposed” letter that would include advice (a list of mitigation measures, applicable guidelines and/or best management practices) that will be part of the basis of the decision.

The key points of the Coker *et al*. (2012) assessment are that:

- A variety of habitats and habitat conditions occur within the study area that are typical of the TSW between Peterborough and Trenton at Lake Ontario. Most of the habitats are deeper with slower flows, since the waterway is operated foremost as a navigation canal. The only higher gradient section providing riffle habitat is the spill channel between Dam #10 and Ranney Falls, which is isolated from the other parts of the study area and in most years receives only dam leakage through the summer and early fall. Centrarchids are very common throughout the study area, as are their preferred habitats.
- The small area of the “Pup” powerhouse tailrace does not serve a critical habitat function and, although it will no longer have flow velocities typical of a tailrace, it will remain as fish habitat.

Figure 3.1 DFO Risk Management Framework[1]



[1] The ellipse designates the risk assessment for the proposed Ranney Falls G3 Project.

- No critical habitat, e.g., Walleye spawning habitat, appears to be present immediately below Ranney Falls, or in the vicinity of the Ranney GS main powerhouse tailrace.
- Following the completion of construction, the total amount of permanent habitat will slightly increase.
- No negative impacts to habitats or productive capacity are anticipated because of the proposed expansion of the Ranney Falls GS, although there will likely be some shifts in fish and benthic macroinvertebrate community composition within part of the study area due to changes in the annual flow regime.
- The expanded Ranney Falls GS will likely increase the potential for entrainment and mortality of fish through the turbines; however, entrainment is not presently thought to be a significant cause of fish mortality, and given the existing fish community and infrastructure of the TSW, it is unlikely to become a significant problem during operation of the proposed Ranney Falls G3 Project.
- When considered within the DFO (2006) Risk Management Framework, the proposed works are characterized as a "Low Risk" proposal.

Provided that the recommended mitigation measures are implemented, Coker *et al*. (2012) concluded that the proposed Ranney Falls G3 Project will not have a negative impact upon the composition or production of the TSW/Trent River fish communities.

Based on the Coker *et al*. (2012) assessment and supplemental information of fish entrainment potential provided by OPG for a meeting with DFO on June 29, 2012, DFO concluded that the proposed Ranney Falls GS expansion will not likely result in impacts to fish and fish habitat provided that the following mitigation measures are implemented (C. Strand, DFO, 2012, pers. comm.):

- "No in-water work should occur from April 1 to June 30 to protect local fish populations during their spawning and nursery periods.

- All materials and equipment used for the purpose of site preparation and project completion should be operated and stored in a manner that prevents any deleterious substance (e.g. petroleum products, silt, etc.) from entering the water.

- Sediment and erosion control measures should be implemented prior to work and maintained during the work phase, to prevent entry of sediment into the water.

- All instream work should be completed in the dry by de-watering the work area and diverting and/or pumping flows around cofferdams placed at the limits of the work area.
    - Fish should be removed from the work area prior to de-watering and released alive immediately downstream.

- Follow DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters*".

OPG was provided a Letter of Advice by the DFO on July 17, 2012, consistent with the above direction.

In addition to the above mitigation measures, DFO recommended that OPG design the new intake structures such that future installation of fish screens is possible. Currently, American Eel numbers are extremely low within the TSW; therefore, no eel mortality has been observed at the Rainey Falls GS. If American Eel populations increase within the TSW, OPG may be asked to provide additional mitigation at the Rainey Falls GS to protect this fish SAR. A properly designed intake structure could reduce potential financial risk in the future.

3.4.8 Aquatic Avifauna

As indicated in Section 2.2.7, the lands along the Trent River and the TSW encompassing the Ranney Falls GS property are categorized by the CLI (1971a) as 60% Class 6 and 40% Class 5 with severe and moderately severe limitations, respectively, to waterfowl production. The Class 6 lands are limited by adverse topography, whereas the Class 5 lands are limited by adverse topography and reduced marsh edge.

The construction disturbance will be sufficiently local that little displacement of aquatic avifauna will occur. Any resident birds can relocate temporarily to avoid human activity associated with construction activities. Most bird species habituate rapidly to noise and vehicular traffic (see Terrestrial TSD).

Noise from blasting could have an initial effect on avian startle flight; however, it is anticipated that over time birds will become habituated to the impulse noise. For instance, during the St. Lawrence River crossing by a natural gas pipeline, blasting had no effect on waterfowl in the area (Silver and Fitchko, 1992). Noise effects due to other construction activities can be acceptably mitigated by conventional construction practices and are predicted to be localized, minor and transient. Additional information on noise effects and mitigation measures is provided in the Terrestrial TSD.

During operation, noise will be generated from the proposed Ranney Falls G3 Project. This steady noise will be similar to that of the existing facility and not elicit an adverse reaction from nearby habituated aquatic avifauna.

3.4.9 Water Uses

During construction and operation of the proposed Ranney Falls G3 Project, there will be negligible impacts on vessel utilization of the Trent Canal during the navigation season.

As indicated in Section 2.3.2, during the navigation season from May to October with flow limited to 120 m^3/s from the current 100 m^3/s, the maximum flow velocity in the canal straight section is expected to increase from 0.9 to 1.0 m/s. As a result, a slight increase in drag velocity can be expected on vessels in the straight section of the canal. In the area near the forebay intake structure, the maximum flow velocity is expected to increase from 0.5 to 0.6 m/s resulting in vessels to be subjected to a slightly higher transverse velocity possibly requiring slight steering counteraction. Flow velocities in the Trent River near the Campbellford main town bridge are higher than those anticipated in the Trent Canal upstream of Locks #11 and #12.

The V-shaped safety booms currently installed in the Trent Canal in front of the forebay intake structure will remain in place (see Figure 1.5), but will be reconfigured to prevent vessels from being subjected to the slightly higher traverse velocity. The anchor point at the tip of the north leg of the V will be moved outward, or upstream along the curved training wall.

Most significantly, as indicated in Section 1.3, the proposed Ranney Falls G3 Project includes a new spillway to by-pass full station flow to the expanded tailrace channel for emergency situations. In the event of an emergency shutdown of the units, the operation of the new spillway will preclude the operation of TSW Dam #10.

4.0 SUMMARY AND CONCLUSIONS

The proposed Ranney Falls G3 Project is being undertaken by OPG to improve the efficient use of the available hydroelectric potential at the site, to reduce greenhouse gas emissions and to increase the amount of clean renewable energy from OPG's CHPG. PFTSW (2008) concluded that the development of renewable energy resources is a sound public policy goal and supported a vigorous effort to pursue green energy generating potential along the TSW. Moreover, the proposed Project is consistent with the PPS, which recommends that the use of existing infrastructure and public service facilities should be optimized, whenever feasible, before consideration is given to developing new infrastructure and public service facilities (OMMAH, 2014). In early 2012, a public meeting was held by Northumberland-Quinte West MPP Rob Milligan to promote new waterpower development within the provincial riding.

During construction of the proposed Ranney Falls G3 Project, potential impacts on the aquatic environment may occur due to cofferdam installation/removal, dewatering, blasting, soil erosion and turbidity generation, and accidental spills. However, based on an assessment of the available baseline information and potential effects, as well as the implementation of the recommended mitigation measures, it is concluded that effects during construction will be minimal, localized and short-term.

During operation of the proposed Ranney Falls G3 Project, potential impacts on the aquatic environment may occur due to accidental spills, flow alteration in the Trent Canal and potential fish impingement and mortality. However, based on assessment of the baseline information and potential effects, as well as the implementation of the recommended mitigation measures, it is concluded that the operation of the proposed Project will have negligible effects on the aquatic environment and water use. DFO has confirmed that the proposed Ranney Falls GS expansion will not likely result in impacts to fish and fish habitat, including American Eel and Lake Sturgeon, provided that the recommended mitigation measures are implemented.

A net benefit of the proposed Project is that in the event of an emergency shutdown of the units, the operation of the new spillway will preclude the operation of TSW Dam #10.

In addition to the noted mitigation measures, DFO recommended that OPG design the new intake structures such that future installation of fish screens is possible. Currently, American Eel numbers are extremely low within the TSW; therefore, no eel mortality has been observed at the Rainey Falls GS. If American Eel populations increase within the TSW, OPG may be asked to provide additional mitigation at the Rainey Falls GS to protect this fish SAR.

Environmental protection during proposed Project construction and operation will be ensured by adherence to the Environmental Management Plan, as well as compliance with regulatory standards and guidelines.

The Environmental Management Plan, with oversight by the Environmental Monitor, will ensure that environmental protection will be achieved by encompassing government agency requirements, OPG policy, proposed Project commitments and recommended mitigation measures to be undertaken. The Environmental Management Plan will include the Erosion and Sediment Control Plan, Spills Emergency Preparedness and Response Plan, Hazardous Materials Management Plan and Waste Management Plan, as well as Site Restoration Plan (see Terrestrial TSD), and Access Management Plan and Traffic Management Plan (see Socio-economics and Land Use TSD).

Table 4.1 summarizes potential construction and operation effects, the recommended mitigation/remedial measures to minimize or obviate these effects and the net residual effects.

Table 4.1 Summary of Potential Effects on the Aquatic Environment and Recommended Mitigation/Remedial Measures

Effect/Activity	Recommended Mitigation/Remedial Measure	Net Residual Effect
Construction		
Noise	• Proper maintenance and operation of equipment, with use of noise baffling, as appropriate.	Negligible effect
Soil erosion	• Adherence to Erosion and Sediment Control Plan.	Negligible effect
Incidental spills of oil, gasoline and other liquids during construction	• Adherence to Spills Emergency Preparedness and Response Plan.	Negligible effect
Hazardous materials/ waste	• Adherence to Hazardous Materials Management Plan and Waste Management Plan. • Waste disposal in accordance with regulatory requirements.	Negligible effect
Blasting	• Adherence to blasting engineer recommendations and DFO guidelines (Wright and Hopky, 1998). • Scheduling blasting during the period of little flow between Dam #10 and the tailrace (mid-June to late October), if possible.	Negligible effect
Excess Groundwater Disposal	• Groundwater discharge to the Trent River and/or Trent Canal based on monitoring program results.	Negligible effect
In-water construction activities	• Use of clean rock fill for cofferdam. • Placement of rock fill over similar coarse substrate. • Judicious selection of discharge location and water pressure during dewatering. • Adherence to in-water construction timing restrictions (April 1 to June 30). • Transfer of fish stranded behind cofferdam prior to dewatering completion.	Negligible effect
Operation		
Noise	• Ambient noise levels to remain unchanged.	Negligible effect
Incidental spills of oil, gasoline and other liquids during operation	• Adherence to Spills Emergency Preparedness and Response Plan.	Negligible effect

Effect/Activity	Recommended Mitigation/Remedial Measure	Net Residual Effect
Increased range of Trent Canal flows and flow velocities	• None: no significant effect on fish and benthic macroinvertebrate communities, and slightly higher traverse velocity may require slight steering counteraction.	Negligible effect
Decreased Dam #10 spillage	• None: no significant effect on fish and benthic macroinvertebrate communities anticipated.	Negligible effect
Cessation of "Pup" powerhouse tailrace flow	• None: no critical habitats in the "Pup" tailrace.	Negligible effect
Expanded tailrace	• Provision of sufficient depth (0.5 m) of similar substrate type will result in replication of ecological function of existing tailrace.	Negligible effect
Fish entrainment and mortality	• None: does not appear to be an issue along the lower TSW (see Section 3.4.6).	Negligible effect

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6.0 ACRONYMS/ABBREVIATIONS

Acronyms

α	Alpha
=	Equal
γ	Gamma
>	Greater than
#	Number
asl	Above sea level
BOD	Biological oxygen demand
c.	Chapter
CAT	Compact Axial Turbine
CEAA	*Canadian Environmental Assessment Act*
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CFD	Computational Fluid Dynamics
CLI	Canada Land Inventory
CHPG	Central Hydro Plant Group
COE	Corps of Engineers
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
CSA	Canadian Standards Association
DDT	Dichlorodiphenyltrichloroethane
DFO	Department of Fisheries and Oceans
DIA	Detailed Environmental Impact Analysis
Ed.	Editor
e.g.	For example (exempli gratia)
EQRT	Engelmann’s Quillwort Recovery Team
ERIS	Environmental Risk Information Services
ESA	*Endangered Species Act*
et al.	And others (et alia)
GPS	Global Positioning System
GS	Generating Station
H	Horizontal
HADD	Habitat alteration, disruption or destruction
HEC	Hydrologic Engineering Centre
Hydro One	Hydro One Networks Inc.
i.e.	That is (id est)
Inc.	Incorporated
KST	KST Hydroelectric Engineers
LTC	Lower Trent Conservation
Ltd.	Limited
MNR	Ontario Ministry of Natural Resources

MNRF	Ontario Ministry of Natural Resources and Forestry
MOE	Ontario Ministry of the Environment
MOECC	Ontario Ministry of the Environment and Climate Change
MOEE	Ontario Ministry of Energy and Environment
MPP	Member of Provincial Parliament
N	North
NHIC	Natural Heritage Information Centre
OMMAH	Ontario Ministry of Municipal Affairs and Housing
OPG	Ontario Power Generation Inc.
OWA	Ontario Waterpower Association
PAHs	Polycyclic aromatic hydrocarbons
Parks Canada – TSW	Parks Canada – Ontario Waterways, Trent-Severn Waterway
PCBs	Polychlorinated biphenyls
pers. comm.	Personal communication
PFTSW	The Panel on the Future of the Trent-Severn Waterway
PPS	Provincial Policy Statement
Project	Ranney Falls Generating Station G3 Expansion Project or Ranney Falls G3 Project
PWQO	Provincial Water Quality Objective
S1?	Critically imperiled – due to extreme rarity (often five or fewer occurrences) or because of some factor(s) such as very steep declines making the species especially vulnerable to extirpation from the Province, with the ? indicating that the rank is uncertain
S1	Critically imperiled – due to extreme rarity (often five or fewer occurrences) or because of some factor(s) such as very steep declines making the species especially vulnerable to extirpation from the Province
S2	Imperiled – due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making the species very vulnerable to extirpation from the Province
S3	Vulnerable – due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making the species vulnerable to extirpation in the Province
S4?	Apparently secure – uncommon but not rare with some cause for long-term concern due to declines or other factors, with the ? indicating that the rank is uncertain
S4	Apparently secure – uncommon but not rare with some cause for long-term concern due to declines or other factors
S4S5	Apparently secure to secure
S5?	Secure – common, widespread and abundant in the Province, with the ? indicating that the rank is uncertain
S5	Secure – common, widespread and abundant in the Province

SAR	Species at risk
SARO List	Species at Risk in Ontario List
S.C.	Statutes of Canada
SENES	SENES Consultants or SENES Consultants Limited
SHARP	Small Hydroelectric Assessment and Retrofit Program
SNA	Not applicable – a conservation status rank not applicable because the species is not a suitable target for conservation activities
TCCSPC	Trent Conservation Coalition Source Protection Committee
3D	Three-dimensional
Trent Hills	Municipality of Trent Hills
TSD	Technical Support Document
TSW	Trent-Severn Waterway
V	Vertical
W	West

Measurement Units

º	degree
‘	minute
“	second
CFU	colony-forming units
°C	degree Celsius
ft	foot
GPM	gallon per minute
GWh	gigawatt-hour
ha	hectare
km	kilometre
km^2	square kilometre
kV	kilovolt
L	litre
L/s	litre per second
µ	micron
m	metre
m^2	square metre
mL	millilitre
mm	millimetre
m/s	metre per second
m^3/s	cubic metre per second
MW	megawatt
Pa	pascal (unit of pressure)
%	percent

7.0 GLOSSARY

Acarina	Water mites.
Algae (Algal)	A group of unrelated simple plant organisms that live in aquatic habitats.
Alkalinity	Measure of a water's capacity to neutralize an acid.
Amphipoda (Amphipods)	Crustaceans of the class Malacostraca commonly known as scuds.
Anisoptera	Dragonflies.
Annelida	A phylum of invertebrates comprising the segmented worms.
Anthropogenic	Human-caused; due to human activities.
Aquatic macrophyte	Rooted, usually vascular, aquatic plants, such as water lily, cattail, coontail, etc.
Arthropoda (Arthropods)	Highly specialized invertebrates including insects.
Avifauna	Birds.
Benthic	Pertaining to the bottom of aquatic habitats and the organisms that inhabit the bottom.
Benthic macroinvertebrates	Larger bottom-dwelling organisms, e.g., snails, clams, worms, insect larvae, crustaceans, etc. living on or within the sediment substrate of waterbodies.
Benthos	Bottom-dwelling organisms.
Bitumen (bitumenous)	Any of various mixtures of hydrocarbons, e.g., as tar or coal, often together with their non-metallic derivatives that occur naturally.
Bryophyte	Moss.
Bulkhead	A steep or vertical wall retaining an embankment, often used to line shorelines and maintain embankment stability and absorb the energy of waves and currents.
Canal	A channel dug or built to carry water.
Capacity	The greatest load which a unit, station or system can supply (usually measured in kilowatts, megawatts, etc.).
Catostomid	Member of the sucker family.
Caudal Lobe	Lower end.

Cavitation	The process of increased water velocities due to channel narrowing resulting in decreased pressure to maintain a constant total energy. If the pressure decreases to the pressure of water as a vapour, bubbles form. As the velocity decreases due to channel expansion, the water pressure increases and the bubbles collapse. The collapse causes shock waves in the water, which move out to the channel walls, causing pitting.
Centrarchid	Member of the sunfish family.
Chironomidae (chironomids)	Midge fly larvae.
Cofferdam	A temporary dam made of concrete, rockfill, sheet-steel piling, timber/timber-crib or other non-erodible material and commonly utilized during construction to exclude water from an area in which work is being executed.
Coleoptera	Beetles.
Conductivity	Numerical expression of a water's ability to conduct an electric current; the conductivity of water is dependent on its ionic concentrations and temperature.
Culicidae	Midge-like flies, including mosquitoes.
Dam	A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir.
Decapoda	Literally "ten-footed" organisms: order of crustaceans within the class Malacostraca including crayfish, crabs, lobsters, prawn and shrimp.
Diatoms	Unicellular algae, usually microscopic, that are characterized by having a cell wall of silica.
Diptera	True flies.
Draft Tube	The flared passage leading vertically from a water turbine to its tailrace.
Endangered	A species facing imminent extirpation (no longer existing in the wild in Canada, but occurring elsewhere) or extinction (no longer exists).
Ephemeroptera	Mayfly nymphs.
Epilithic	Attached to rocks.
Epipelic	Associated with (attached to) bottom sediments of waterbodies.
Epiphytic	Attached to vegetation, e.g., larger filamentous algae, mosses and aquatic macrophytes.
Forebay	The part of a dam's reservoir that is immediately upstream from the powerhouse.

Fusiform	Shaped like a spindle or cigar, tapering at both ends.
Gain	A cut or groove to receive a timber, as a girder or fastener.
Gastropoda (gastropods)	Snails.
Geotechnical	Concerned with the physical properties of soil, rock and groundwater usually in relation to the design, construction and operation of engineered works.
Hardness	Related to a water's capability to produce lather from soap (the harder the water, the more difficult it is to lather soap), principally determined by the sum of calcium and magnesium.
Head	The difference in elevation between the water surface at the intake and tailrace.
Headgate (Headworks)	The gate that controls water flow into a hydroelectric powerhouse.
Headwater	The water that flows into a hydroelectric powerhouse from the section of river or stream with the highest elevation above sea level.
Hemiptera	True bugs.
Hirudinea	Aquatic leeches.
Hydraulic	Of water conveyed through a pipe or channel.
Hydraulic Conductivity	Property of a soil or rock, in the vadose zone or groundwater, that describes the ease with which water can move through pore spaces or fractures.
Intake	A structure which regulates the flow of water into a water-conveying conduit.
Isopoda	Sow bugs.
Lepidoptera	Butterflies and moths.
Limestone	Sedimentary rock composed of carbonate materials, particularly calcium carbonate.
Lock	Structure designed to raise and lower boats vertically through the use of water-filled chambers hydraulically, mechanically, or pneumatically operated.
Lotic	Flowing water, e.g., in streams and rivers.
Megaloptera	Alderflies, dobsonflies and fishflies.

Nematoda (nematodes)	A phylum of pseudocoelomate (lacking a true coelum) invertebrates comprising the roundworms, characterized by a smooth narrow cylindrical unsegmented body tapered at both ends.
Oligochaeta (oligochaetes)	Worms.
Operating Deck	Work platform.
Ostracoda	A class of crustaceans with a body enclosed in a bivalved carapace (dorsal part of the exoskeleton).
Overburden	The soil, rock and other material which lie on top of the underlying mineral or other deposit, e.g., bedrock.
Pelecypoda	Bivalva; clams.
Penstock	A structure associated with a hydroelectric station designed to carry water from the intake to the turbine.
Periphyton	The organisms, collectively, that live attached to rocks, gravel, aquatic vegetation and other substrate.
Petroliferous	Of a rock or geological formation containing or yielding petroleum.
pH	Indicates the balance between the acids and bases in water and is a measure of the hydrogen ion concentration in solution.
Physoclistic	Fish with swim bladder isolated from the oesophagus.
Physostomic	Fish with swim bladder connected to the oesophagus by an open duct, which provides pressure release.
Pier	As part of a hydroelectric station, an abutment extending from the station, either upstream or downstream, and lending foundation support and directionality to water passed through the structure.
Plankton	Minute organisms that drift or float passively with the current of a lake.
Platyhelmenthes	A phylum of acoelomate (without a coelum) invertebrates comprising the flatworms, characterized by a flattened unsegmented body.
Plecoptera	Stonefly nymphs.
Potamoplankton	Drift plankton (associated with flowing water, i.e., streams and rivers.
Powerhouse	A primary part of a hydroelectric facility where the turbines and generators are housed and where power is produced by falling water rotating turbine blades.
Rotifera (rotifers)	Small, usually microscopic, pseudocoelomate (lacking a true coelum) unsegmented animals, with a ciliated region, the corona, at the anterior end, comprising part of the zooplankton community in waterbodies.

Secchi disc	Circular disc used to measure transparency in lakes; the depth at which the pattern on the disc is no longer visible is taken as a measure of the transparency of the water.
Shale	Fine-grained sedimentary rock composed of lithified clay particles.
Simuliidae	Blackflies.
Sluiceway (Sluice)	An open channel designed to divert excess water which could be within the structure of a hydroelectric dam or separate of the main dam (see spillway).
Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Spillway	A passageway, or channel, located near or at the top of a dam through which excess water is released or “spilled” past the dam without going through the turbine(s); as a safety valve for the dam, the spillway must be capable of discharging major floods without damaging the dam while maintaining the reservoir level below some predetermined maximum level.
Stoplog	A gate (sometimes made from squared lumber) which can be placed into an opening to shut off or regulate the flow of water.
Tabanidae	Horse flies.
Tailrace	A channel through which the water flows away from a hydroelectric plant following its discharge from the turbine(s).
Tailwater	The water from a generating station after it has passed through the turbine.
Tapetum lucidum	Light reflecting eye membrane.
Tipulidae	Crane flies.
Total Kjeldahl nitrogen	Measure of both ammonia and organic nitrogen.
Total suspended solids	Measure of particle weight obtained by separating particles from a water sample using a filter.
Trashrack	Bar screen with larger space openings installed to prevent logs, stumps and other large solids from penetrating the intake.
Transformer	A device that changes electric voltage. In Ontario, electricity typically leaves the generator at 20,000 volts or less, is stepped up to 115,000, 230,000 or 500,000 volts to be transmitted long distances and then stepped down to lower voltages to be distributed to customers. Each change in voltage is accomplished with a transformer. Alternatively, the electricity is stepped up directly to the local distribution voltage.

Trichoptera	Caddisfly larvae.
Turbidity	A measure of the suspended particles such as silt, clay, organic matter, plankton and microscopic organisms in water which are usually held in suspension by turbulent flow or Brownian movement.
Turbine	A mechanism in an electrical generation facility which converts the kinetic and potential energy of water (in the case of hydroelectric turbines) into mechanical energy which is then used to drive a generator converting mechanical to electrical energy.
Warmwater fish	Having a water temperature preference of 25°C or higher.
Weir	A dam in the river to stop and raise the water.
Zooplankton	That portion of the plankton consisting of animals, usually minute crustaceans and other small multicellular and single-cell animals.
Zygoptera	Damselflies.